UDP

Complete Course on Computer Networks - Part I

Ravindrababu RAVULA • Lesson 13 • Feb 1, 2021

Computer Networks

Supernetting OR Aggregation

In subnetting, a single network is divided into multiple smaller subnetworks.

In Supernetting/Aggregation, multiple networks are combined into a bigger network termed as a Super network or Supernet.

Rules for Aggregation :

1.All the Networks should be contiguous.

2.The block size of every networks should be equal and must be in form of 2^n.

3.First Network id should be exactly divisible by whole size of supernet.

Points to be checked before aggregation :

1.All the Networks should be contiguous.

2.The block size of every networks should be equal and must be in form of 2^n.

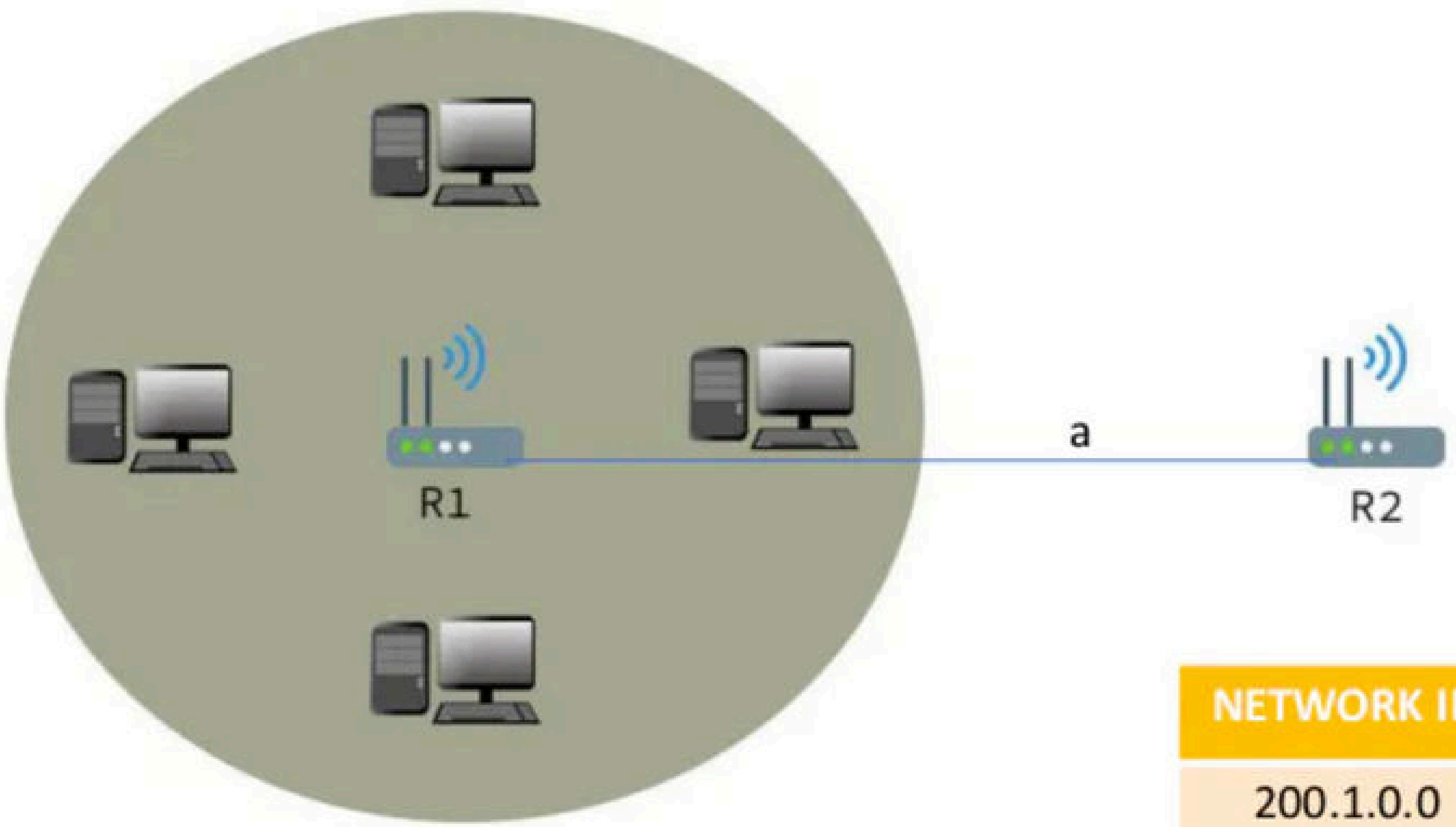
3.First Network id should be exactly divisible by whole size of supernet.

Example:

200.1.0.0 / 24
200.1.1.0 / 24
200.1.2.0 / 24
200.1.3.0 / 24

Total size of the supernet = $4 \times 2^8 = 2^{10}$
Diving the First Network id with 2^{10}
Has 0 in last 10 bits. Therefore Divisible.

All are satisfied, hence we can move forward with aggregation.



Instead of having 4 entries
We want just one entry in R2
having a single supernet id

ROUTING TABLE AT R2

NETWORK ID	SUBNET MASK	INTERFACE
200.1.0.0	255.255.255.0	a
200.1.1.0	255.255.255.0	a
200.1.2.0	255.255.255.0	a
200.1.3.0	255.255.255.0	a

Finding the Supernet mask:

It is 32 bit number

In Supernetting, the Number of 1’s represent the Fixed part
And Number of 0’s represent the Variable part

Fixed	Variable
200.1.000000	00.00000000
200.1.000000	01.00000000
200.1.000000	10.00000000
200.1.000000	11.00000000

Replacing the fixed part with 1’s and variable with 0’s
We get the supernet mask,

255.255.252.0

Finding the Supernet mask:

It is 32 bit number

In Supernetting, the Number of 1's represent the Fixed part
And Number of 0's represent the Variable part

200.1.00000000.00000000
200.1.00000001.00000000
200.1.00000010.00000000
200.1.00000011.00000000

Fixed Variable

Replacing the fixed part with 1's and variable with 0's
We get the supernet mask,

255.255.252.0

SHORTCUT TO FIND THE SUPERNET ID AND SUPERNET MASK

If the network id's follow the Rules then,
The first IP address is always the Supernet id.

Add the network size of all the networks given
The total denotes the host if part of the subnet mask .
From the example:
Network size of all = $2^8 + 2^8 + 2^8 + 2^8 = 2^{10}$
Therefore the subnet mask contains 10 bits in host id part.
And the network id part will contain 22 bits.

That is what is the subnet mask

20.10.100.0
20.10.100.1
⋮
20.10.100.63

→ Supernet? → yes

sup id → IP addr

N/w id

(i) conti
(ii) size - 2^n
(iii) 20.10.100.0 → $2^6 = 64$

20.10.100.00$\boxed{000000}$ → rem

NM =

HID   Host ⇒ 2^{6}

⇒ HID = 6

NID = 32 - 6 = 26

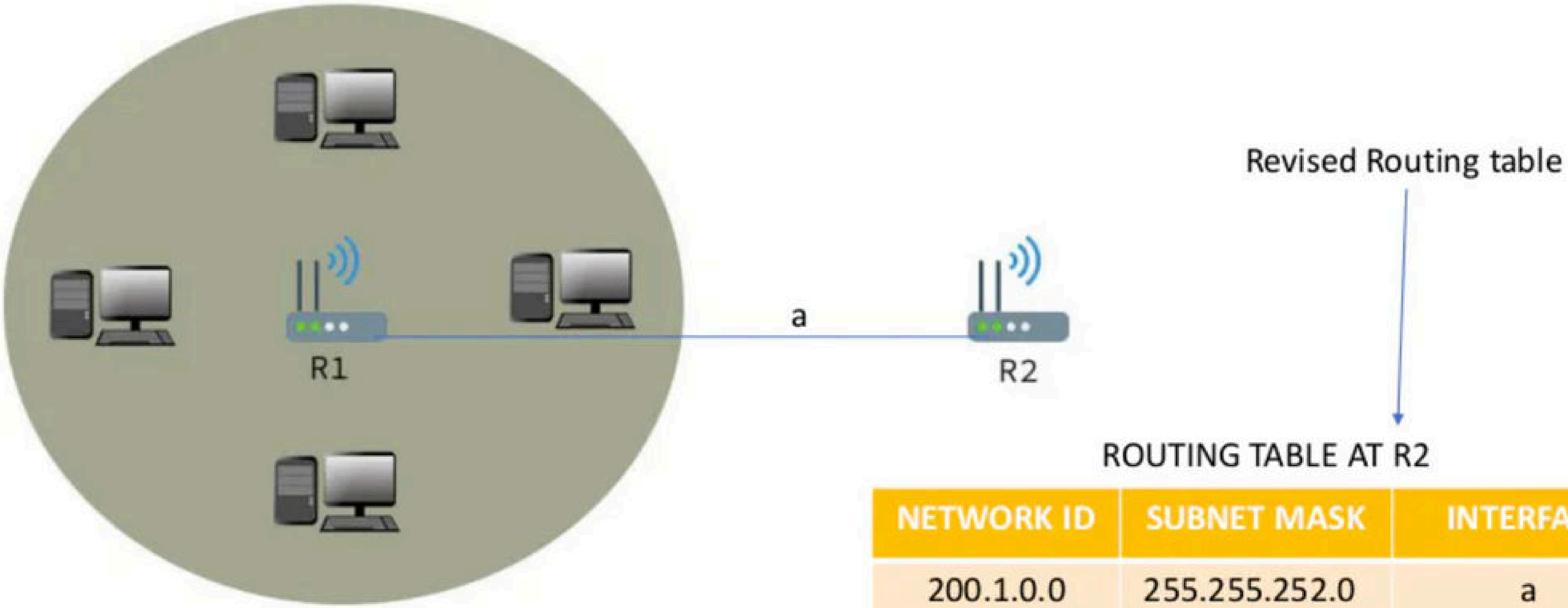
20.10.100.0/26

200.10.20.0
200.10.20.1
⋮
200.10.20.32

→ sup id block

(i) con ✓
(ii) $2^0 = 1$
(iii) 2^n

33 ⇒ × 2^k



ROUTING TABLE AT R2

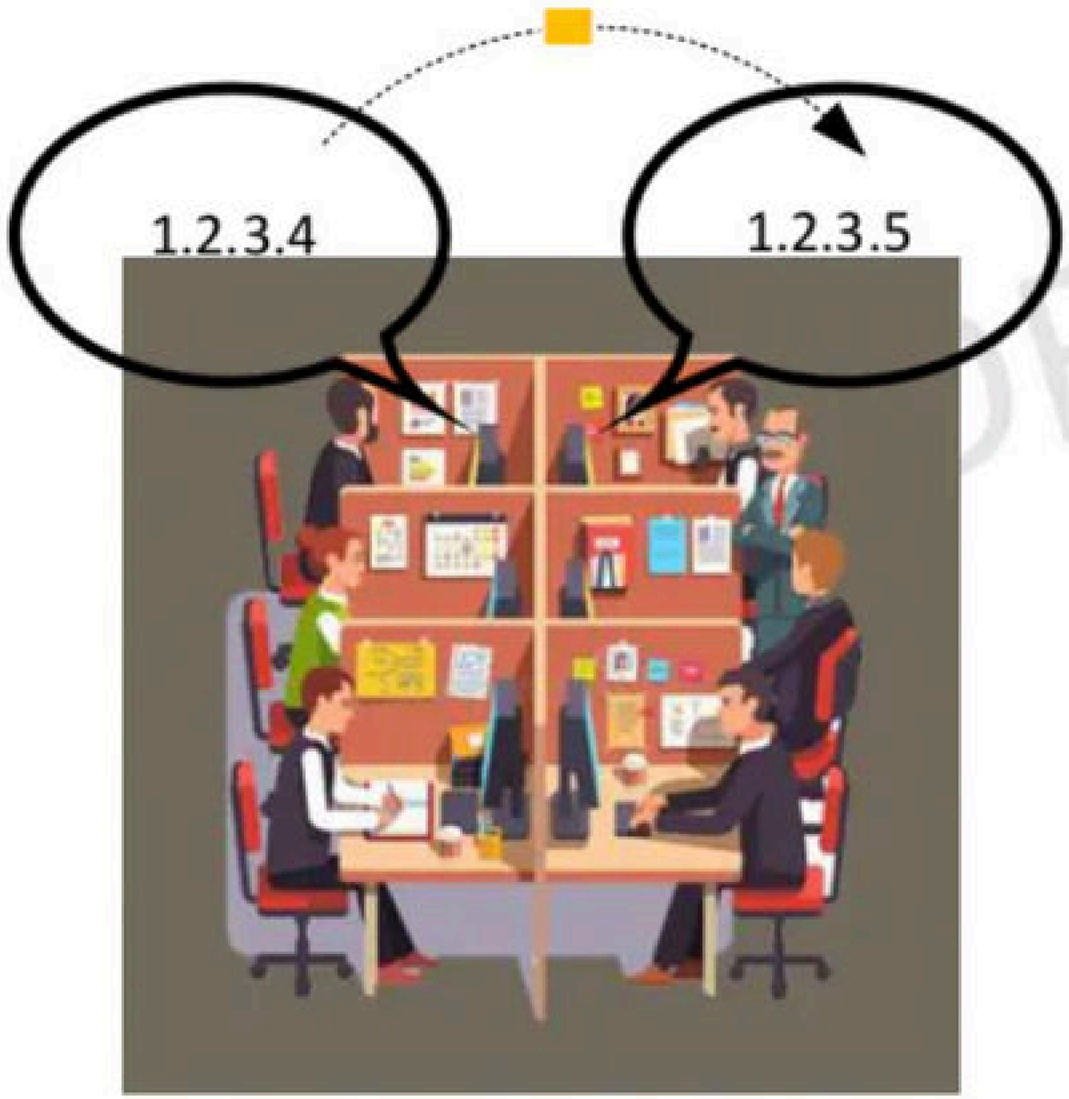
NETWORK ID	SUBNET MASK	INTERFACE
200.1.0.0	255.255.252.0	a

Note : In case of R1, we need all the 4 entries

Computer Networks

Private IP addresses

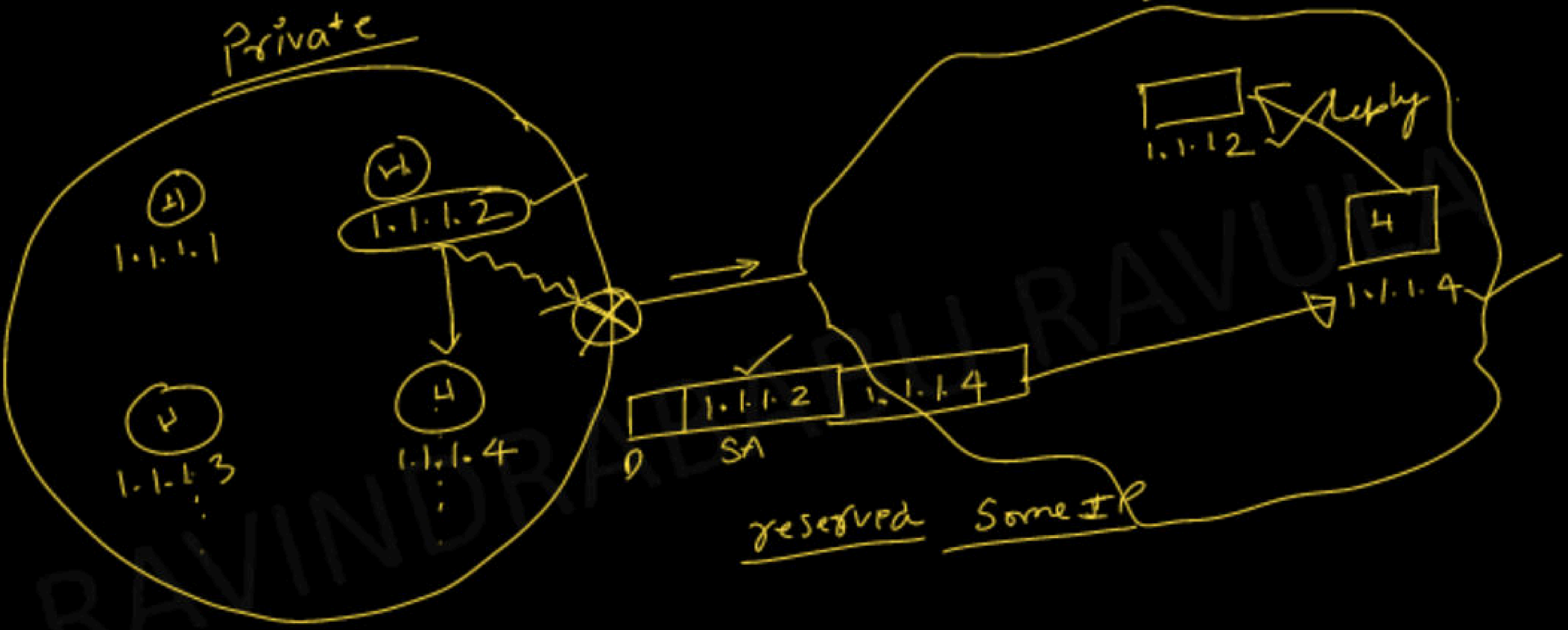
Imagine there is a software company, in which there are 6 PCs and the company has 2 criteria:
1.)No internet access / No communication with the outside world
2.)All the employees can communicate between each other



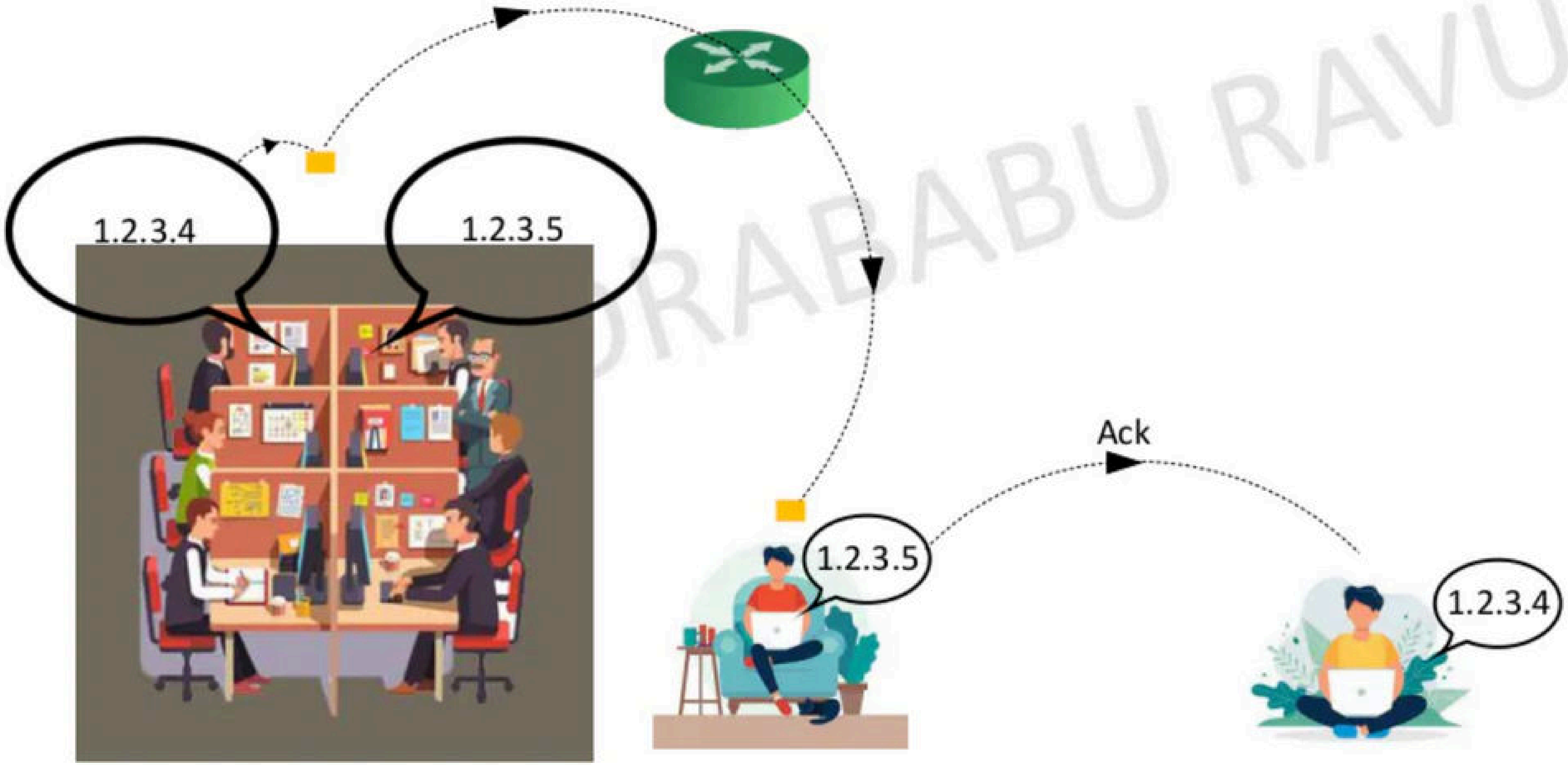
For this you can set a TCP/IP network and
Assign any IP address to the hosts

This allocation remains safe only till the packet is sent within the network

Private & NAT


Private
1.1.1.1
1.1.1.2
1.1.1.3
1.1.1.4
Internet
1.1.1.2
Reply
4
1.1.1.4
1.1.1.2
1.1.1.4
D
SA
reserved
Some IP

Suppose internet was accessed and the packet sent from 1.2.3.4 To 1.2.3.5 escaped onto the internet



IANA has come to a solution to the problem and introduced **Private IP address**

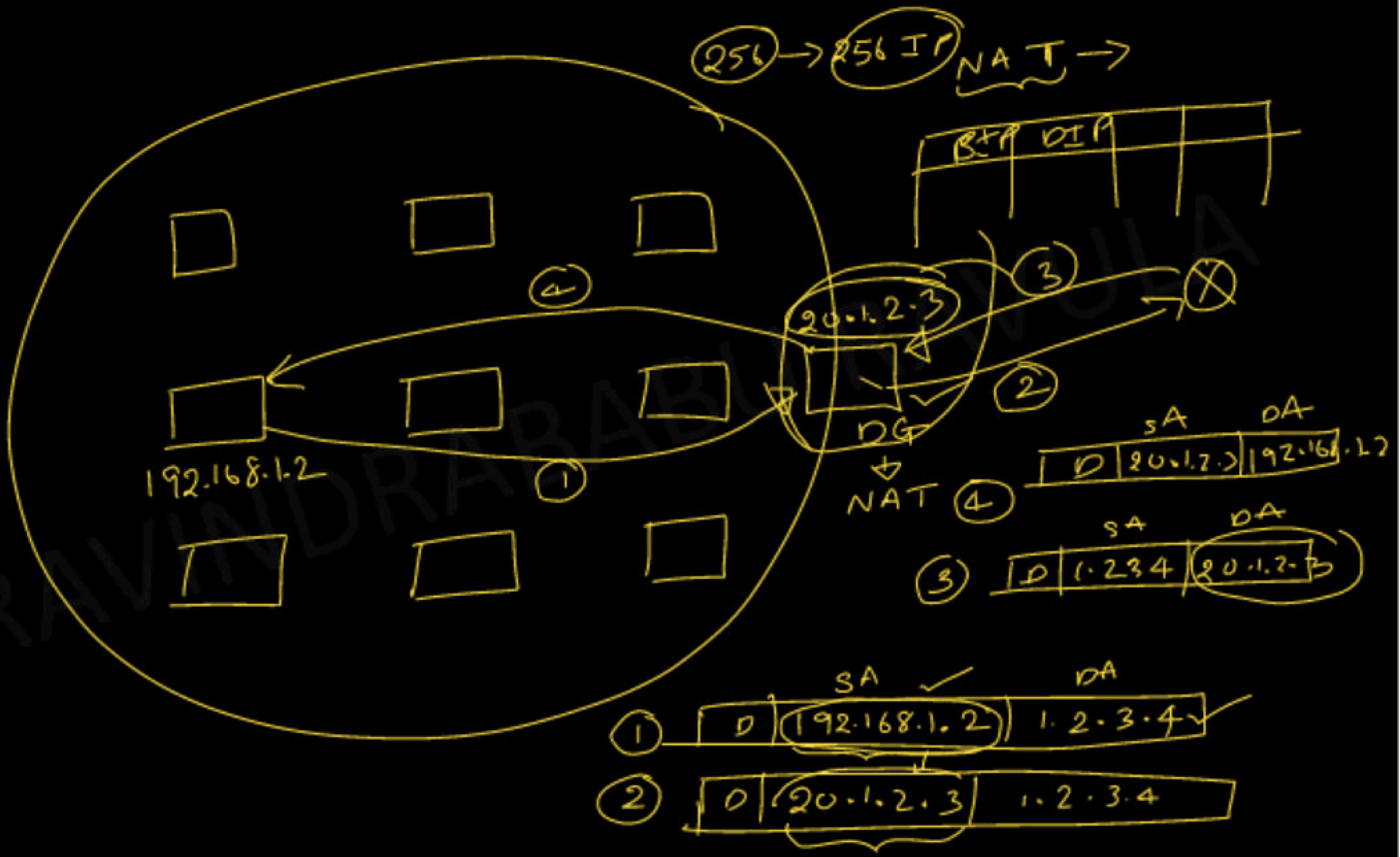
So if one wishes to use Ips only within the Private Network, Private IPs should be assigned and not the Public IPs

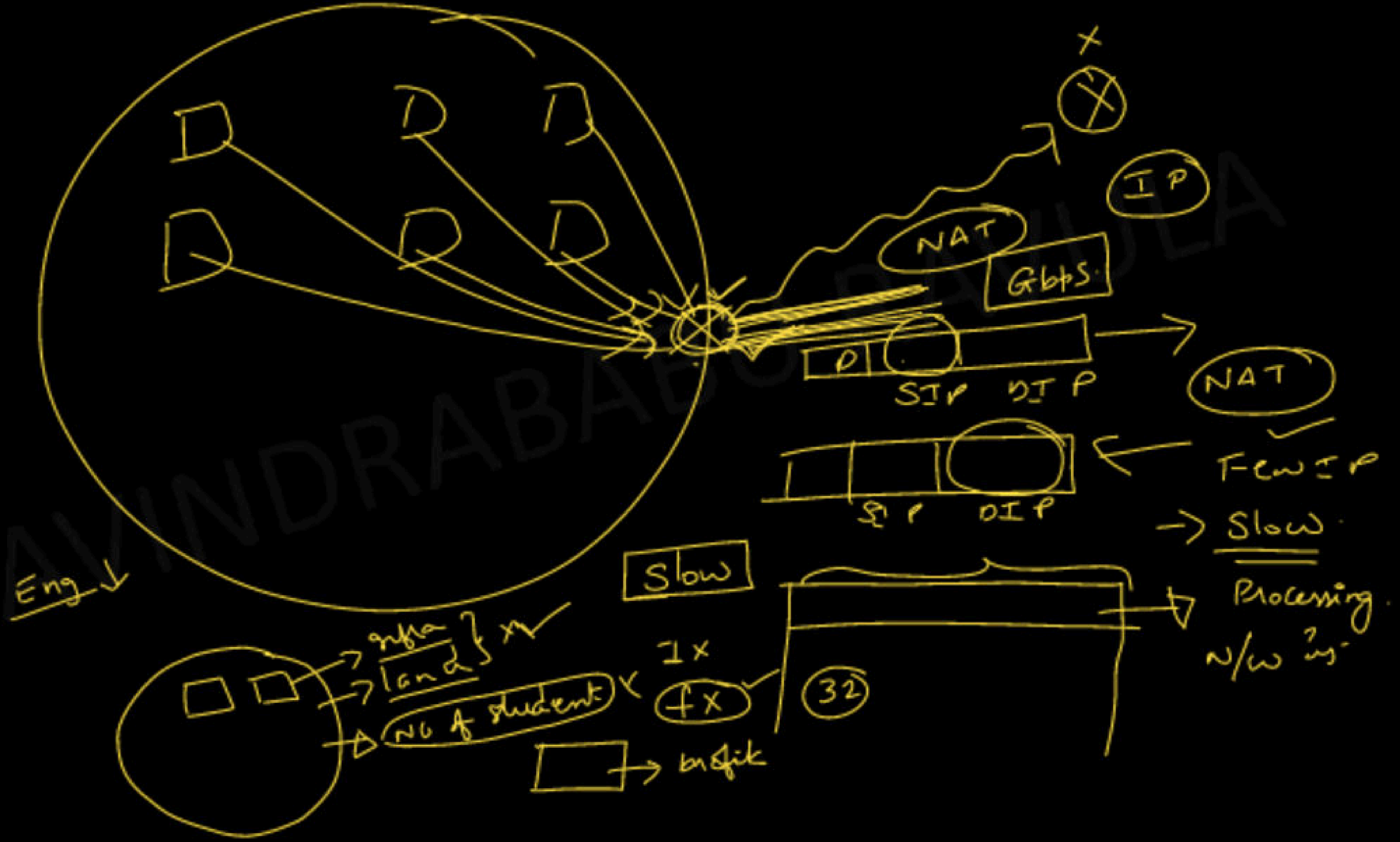
PRIVATE IP RANGE

- 10.0.0.0 to 10.255.255.255 → 1 CA → 2^{24} → 16m
- 172.16.0.0 to 172.31.255.255 → 16 CB → 16×2^{16} → 2^{20} ⇒ 1m
- 192.168.0.0 to 192.168.255.255 → 256 CC → $2^8 \times 2^8$ → 2^{16} ⇒ 64K

10.1.2.3 | 172.16.1.2 | 192.168.1.2

So, due to this what happens is even if the packet goes outside the private network the router discards it because It was send from a Private IP.


256 → 256 IP
NAT →
BIP
DIP
20.1.2.3
DG
NAT
192.168.1.2
SA
DA
① D 192.168.1.2 1.2.3.4
② D 20.1.2.3 1.2.3.4
③ D 1.234 20.1.2.3
④ D 20.1.2.3 192.168.1.2
RAVINDRABABU RAVULA



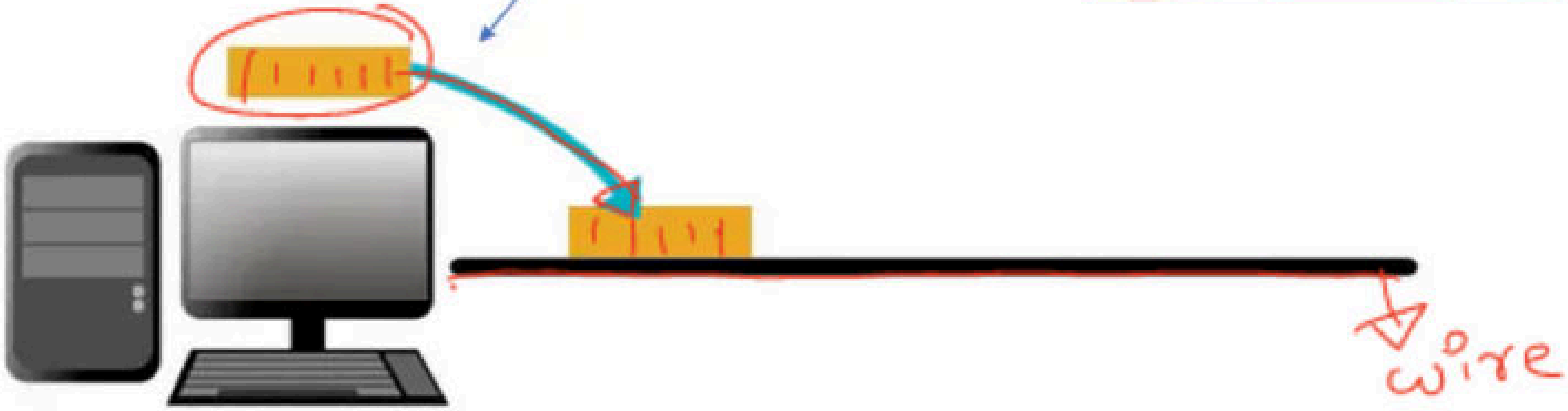
IP
NAT
Gbps.
SIP
DIP
NAT
Few IP
Slow.
Processing.
N/W is
Slow
Eng
infra
land
No of student
1x
fx
32
traffic

Computer Networks

Flow

Delays in Computer Networks

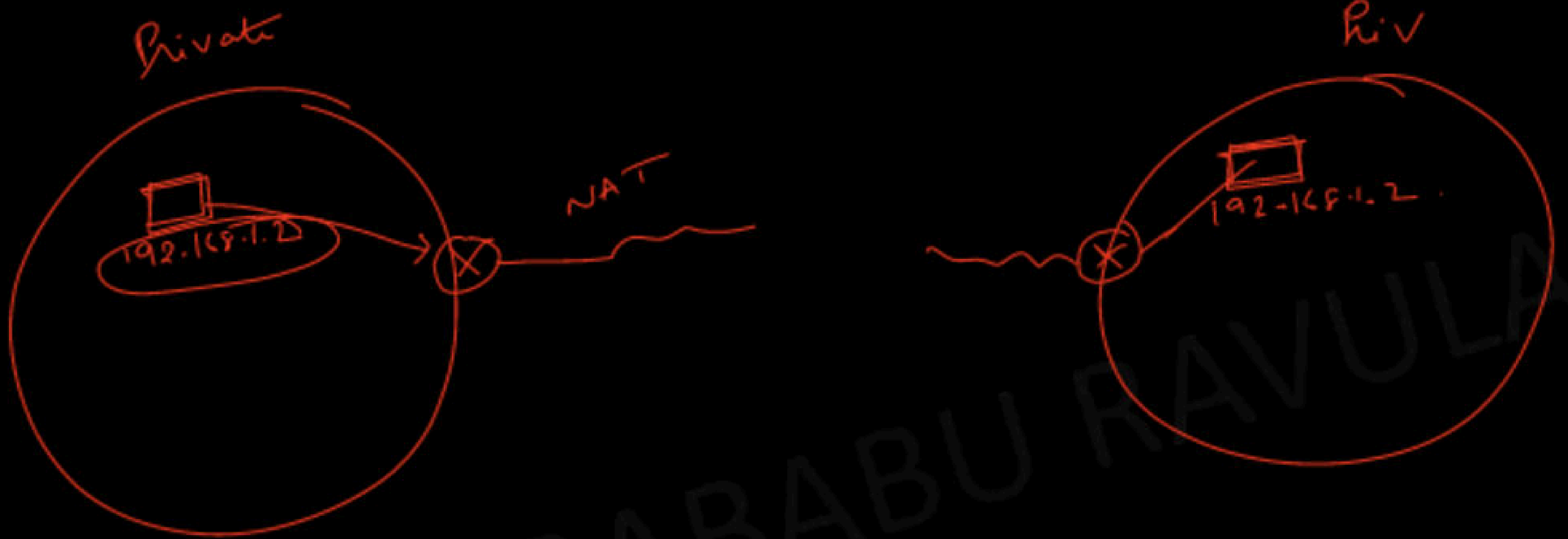
TRANSMISSION DELAY (Tt)



Informal definition:

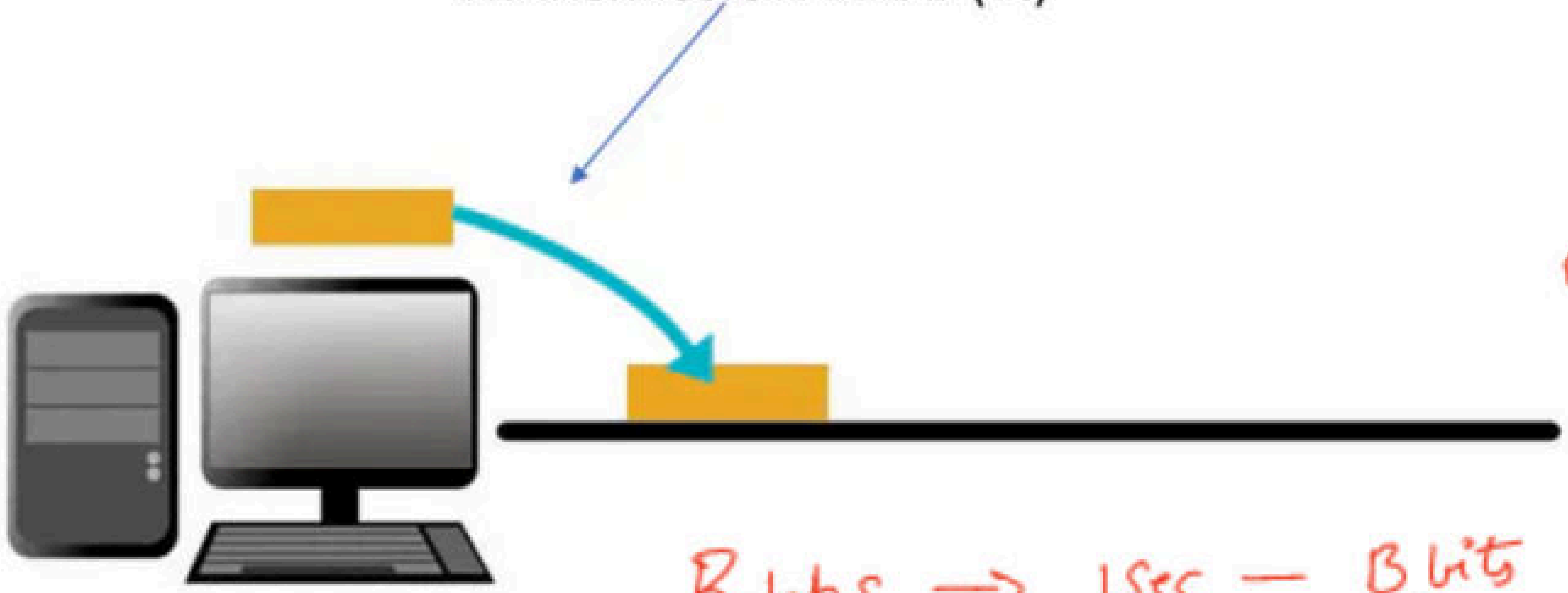
The time taken by the host to put the data packet into the transmission link is called Transmission Delay

transfer



Private
NAT
192.168.1.2
Priv
192.168.1.2

TRANSMISSION DELAY (Tt)



1bps $\Rightarrow$

1 Sec $\rightarrow$ 1 bit on link.

Packet = 10 bits — ?

BW = 1bps

If Bandwidth is 1 bps
And data to be sent is 10 bits
The Tt would be 10 sec

B bps $\rightarrow$ 1 Sec — B bits

$\Rightarrow$ 1 bit — $\frac{1}{B}$ sec

L bits $\rightarrow$?

$\boxed{\frac{L}{B} \text{ Sec}}$

So, in general we can say that,

$$Tt = \frac{\text{Length of data (bits)}}{\text{Bandwidth(bps)}} = \frac{L}{B} \text{ sec}$$

$$T_t = \frac{L}{B} \text{ sec}$$

$$\frac{b}{b/s} = \text{sec}$$

$$\frac{B}{B/s} \Rightarrow \text{sec}$$

Consider these 2 examples

Example 1 : If L = 1000 bits and BW = 1 Kbps
Then

$$Tt = \frac{L}{B} = \frac{1000}{1000} = 1 \text{ sec}$$

Example 2 : If L = 1 KB and BW = 1 Kbps
b
Then

$$Tt = \frac{L}{B} = \frac{1024}{1000} = 1.024 \text{ sec}$$

BW → speed → 10

1Kbps

Data → bits

$$T_t = \frac{1000}{1000} = 1\text{sec.}$$

K → 1000
m → 10^6
G → 10^9

K → 1024
m → 1024 × 1024
G → 1024 × 1024 × 1024

Ankit → 13th

$$T_t = \frac{L}{B} = \frac{1024}{1000} = 1.024 \text{ sec.}$$

5 hour

8th

6pm-9pm
→ Alg
→ OS
→ TOC
→ CN

7am-8am
→ CN class
8am-9am
→ OS class

Consider these 2 examples

Example 1 : If L = 1000 bits and BW = 1 Kbps
Then

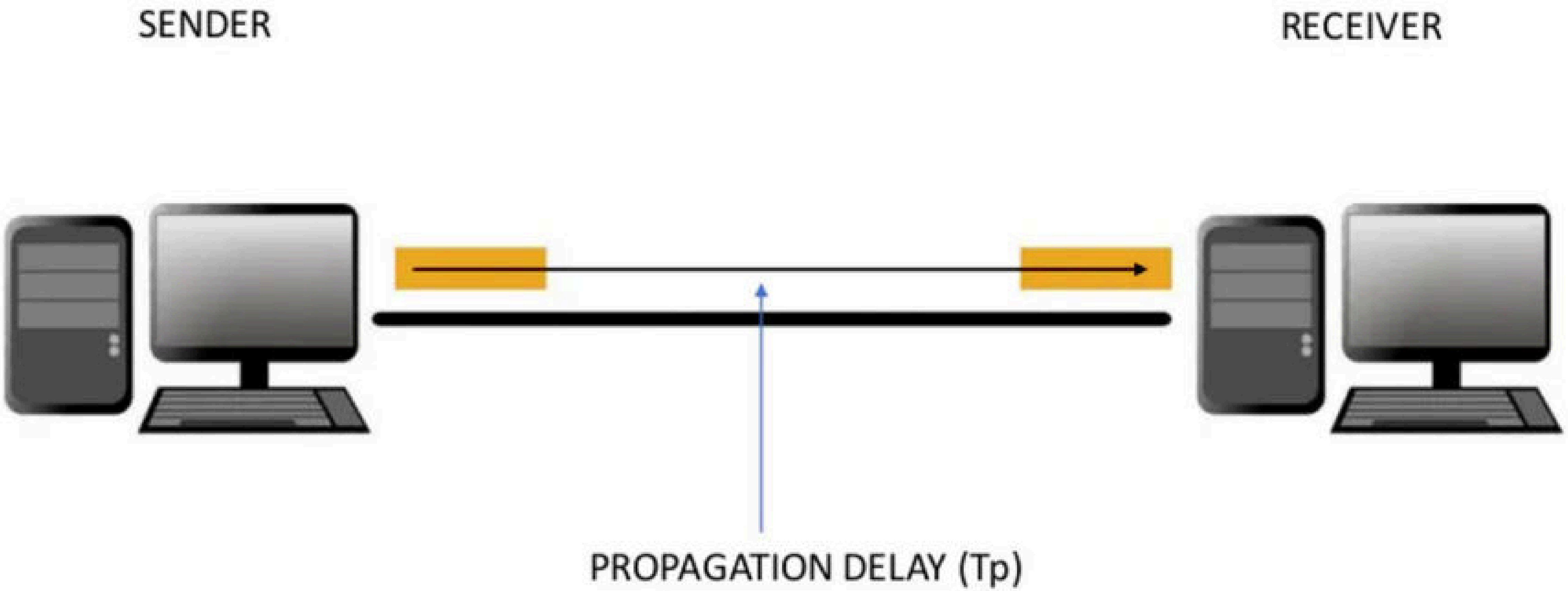
$$Tt = \frac{L}{B} = \frac{1000}{1000} = 1 \text{ sec}$$

Example 2 : If L = 1 KB and BW = 1 Kbps
Then

$$Tt = \frac{L}{B} = \frac{1024}{1000} = 1.024 \text{ sec}$$

REMEMBER

Whenever data has **K**, K= 1024	Whenever Bandwidth has **K**, K= 1000 = 10^3
Whenever data has **M**, M=1024 X 1024	Whenever Bandwidth has **M**, M= 10^6
Whenever data has **G**, G=1024 X 1024 X 1024	Whenever Bandwidth has **G**, G= 10^9



Time taken for one bit to travel from sender to receiver end of the link is called as propagation delay.

$$Tp = \frac{\text{distance of the link (d)}}{\text{Velocity(v)}} \text{ seconds}$$

Generally the link nowadays is optical fibre and
We know that the speed at which the light travels
is 3 X 10^8 m/s.

In optical fibre the light travels with 70% of the original speed of light(3 X 10^8 m/s)
=>v = 0.7 X 3 X 10^8 m/s = 2.1 X 10^8 m/s

Generally the velocity will be given in the question but, in questions where velocity is not given, we need to take it as 2.1 X 10^8 m/s

Example: d = 2.1 km and v = 2.1×10^8 m/s

$$T_p = \frac{\text{distance of the link (d)}}{\text{Velocity(v)}}$$

$$T_p = \frac{2.1}{2.1 \times 10^8}$$

$$= \frac{2.1 \times 1000}{2.1 \times 10^8}$$

$$T_p = 10^{-5} \text{ sec}$$

Converting 10^{-5} sec to µsec

We know that µ is 10^{-6}

Step 1 :Divide and multiply by 10^{-6}

$$10^{-5} \times \frac{10^{-6}}{10^{-6}}$$

Step 2 :Combine

$$10^{-5} \times \frac{10^{-6}}{10^{-6}} = 1 \times 10^{-6}$$

= 1 µsec

Time taken by the processor to process the data packet is called as **processing delay**

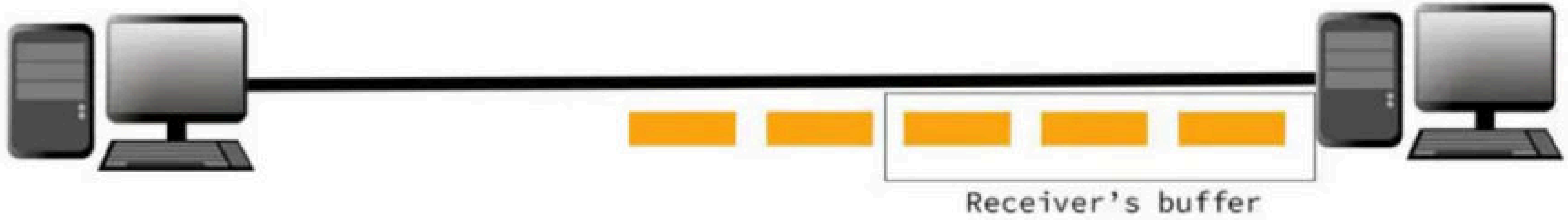
Time spent by the data packet waiting in the queue before it is taken for execution is called as **queuing delay**.

NOTE :THESE TWO DELAYS DEPEND UPON THE TYPE OF PROCESSOR USED AND CANNOT BE EVALUATED AND THEREFORE ARE CONSIDERED AS ZERO IN ALMOST ALL NUMERICALS

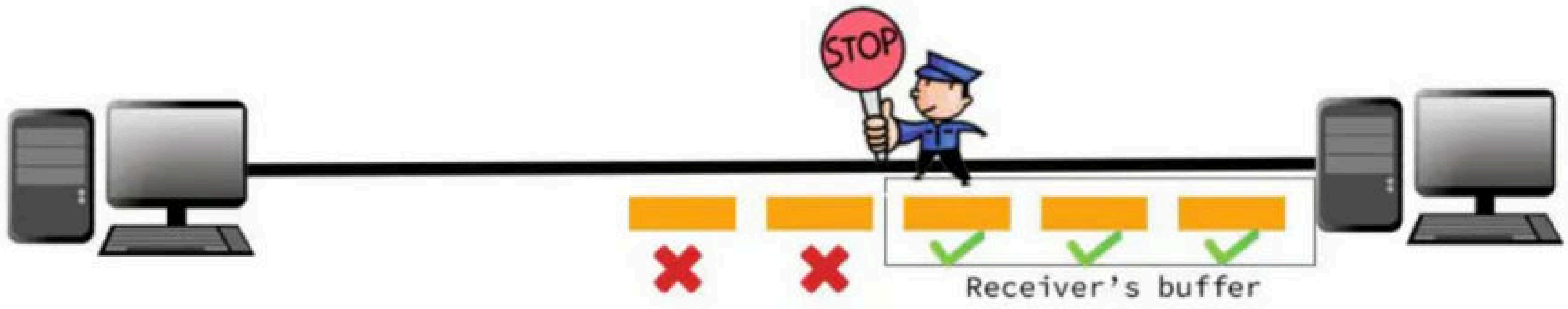
Computer Networks

Flow Control Methods- Stop and Wait

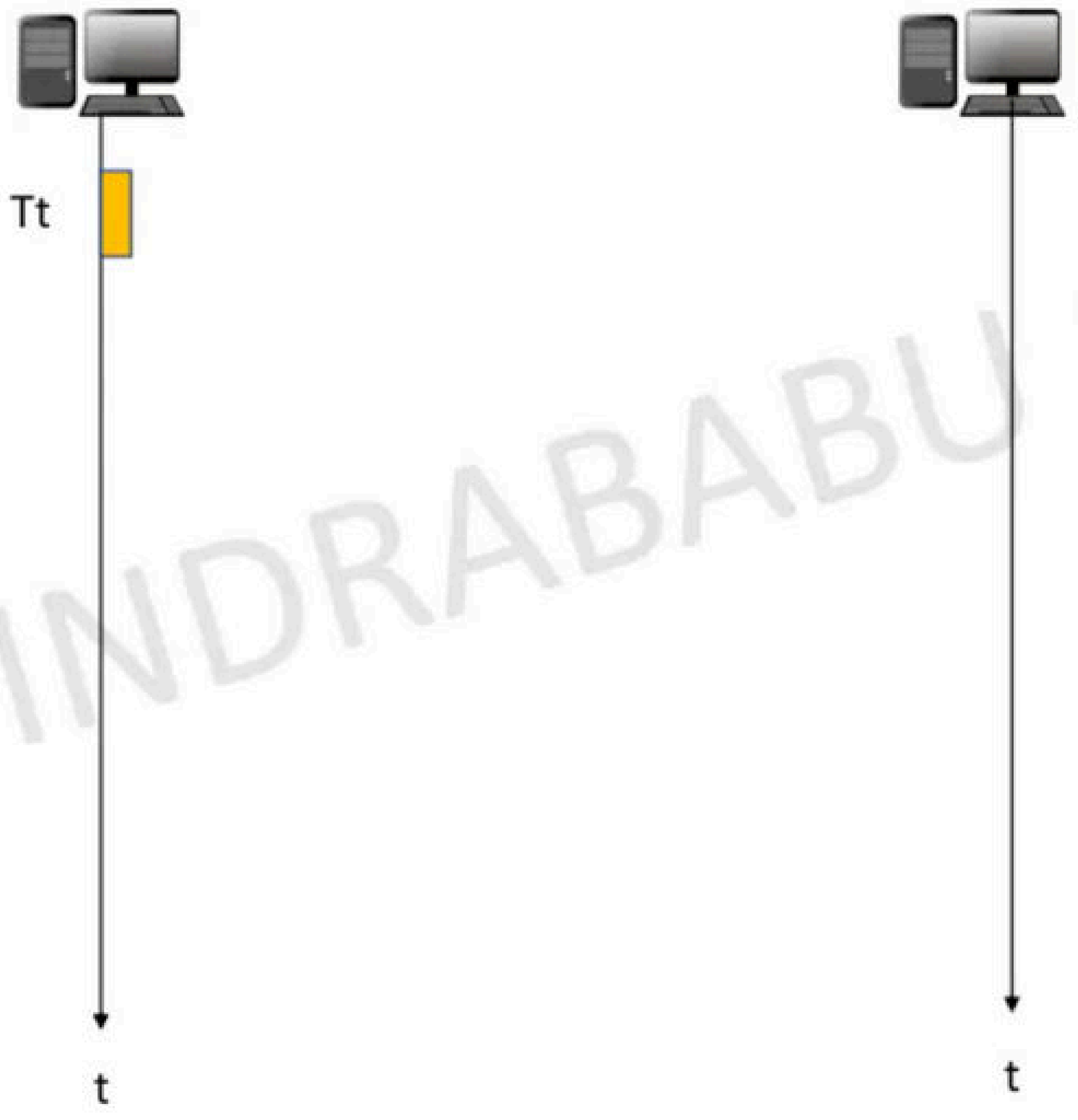
WHY FLOW CONTROL IS REQUIRED?



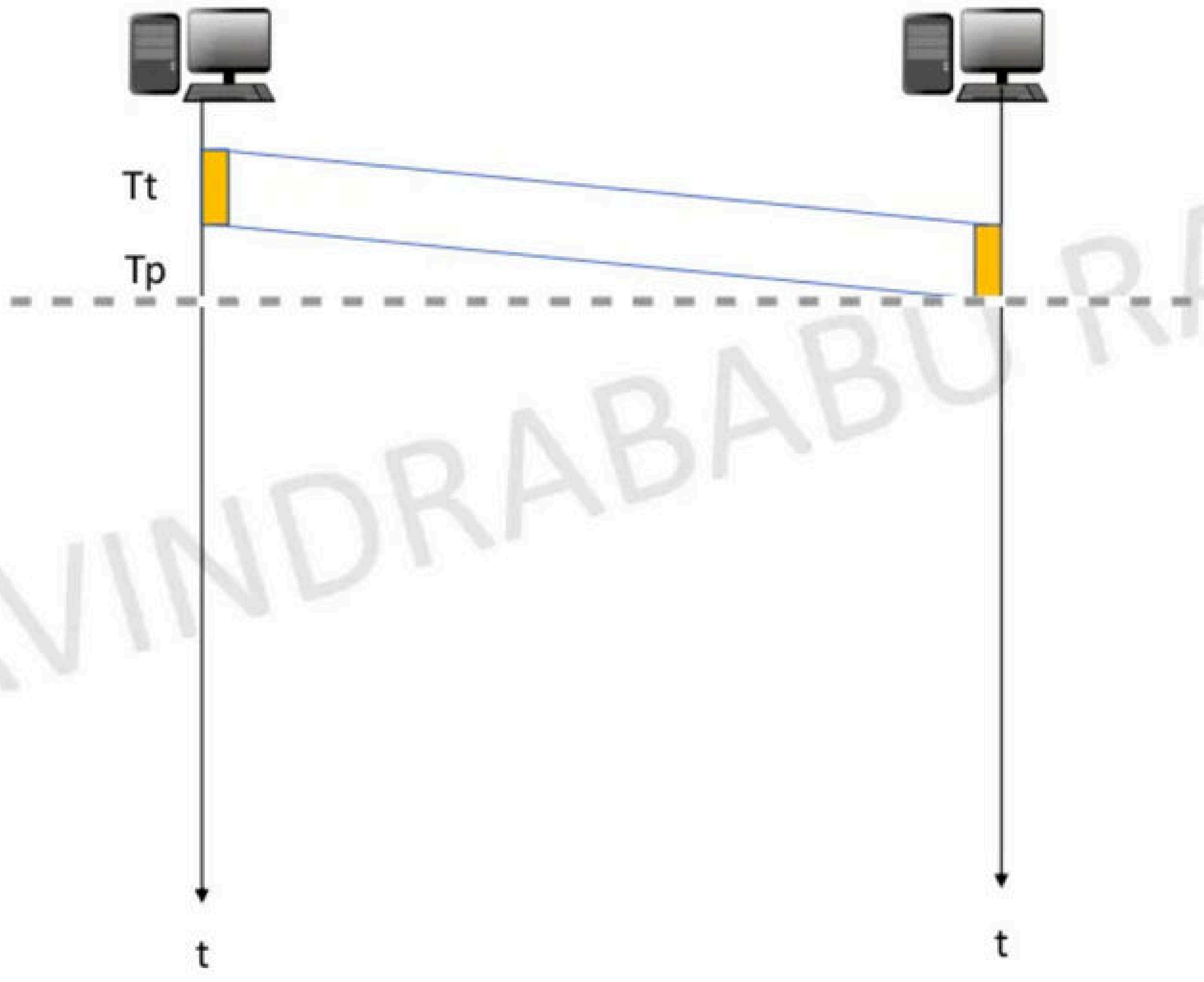
WHY FLOW CONTROL IS REQUIRED?



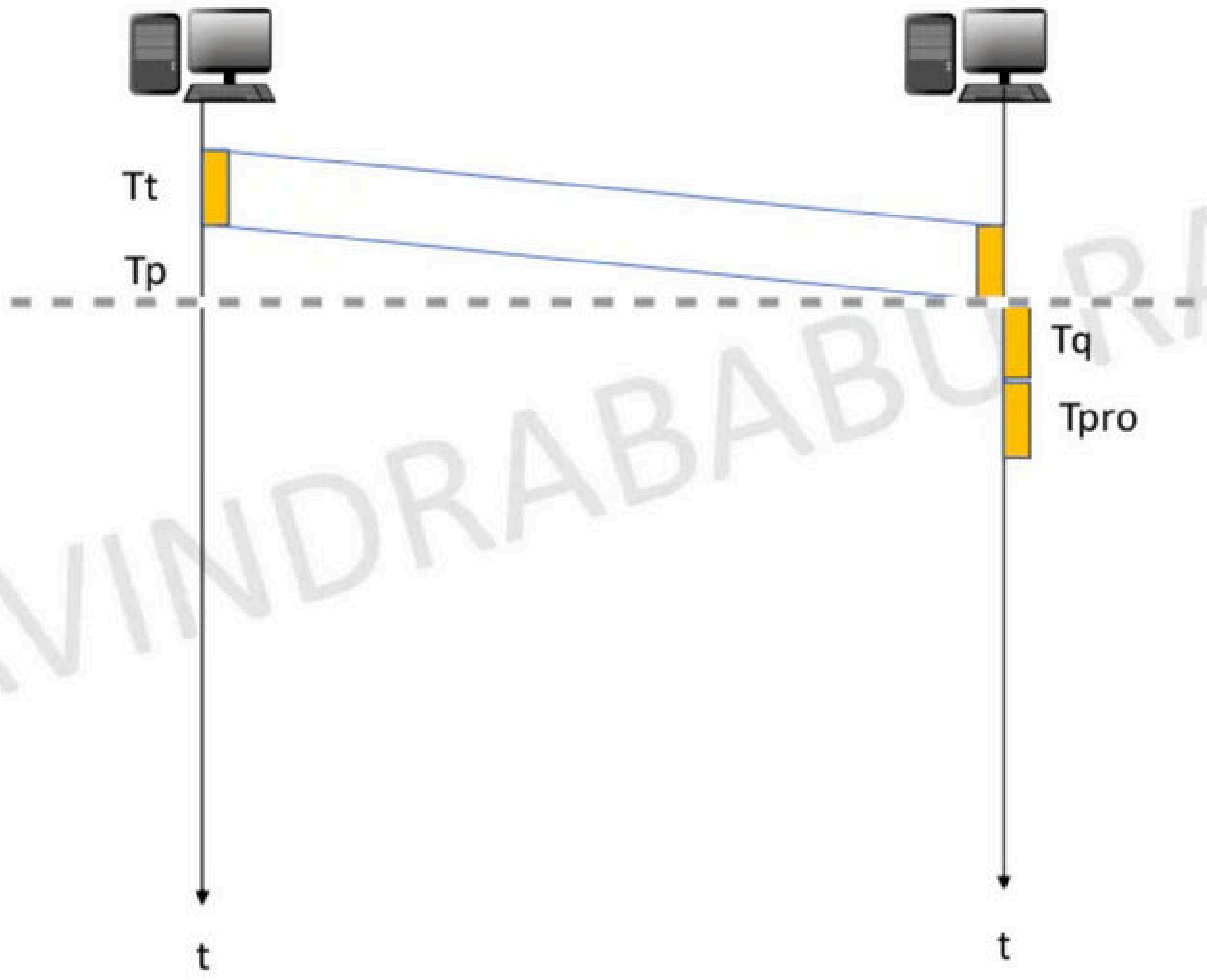
Buffer size of receiver was 3, so other 2 packets got discarded
Therefore, The sender must send the packets in the rate at which the receiver can receive it.
Here is where **Flow control** comes in picture.



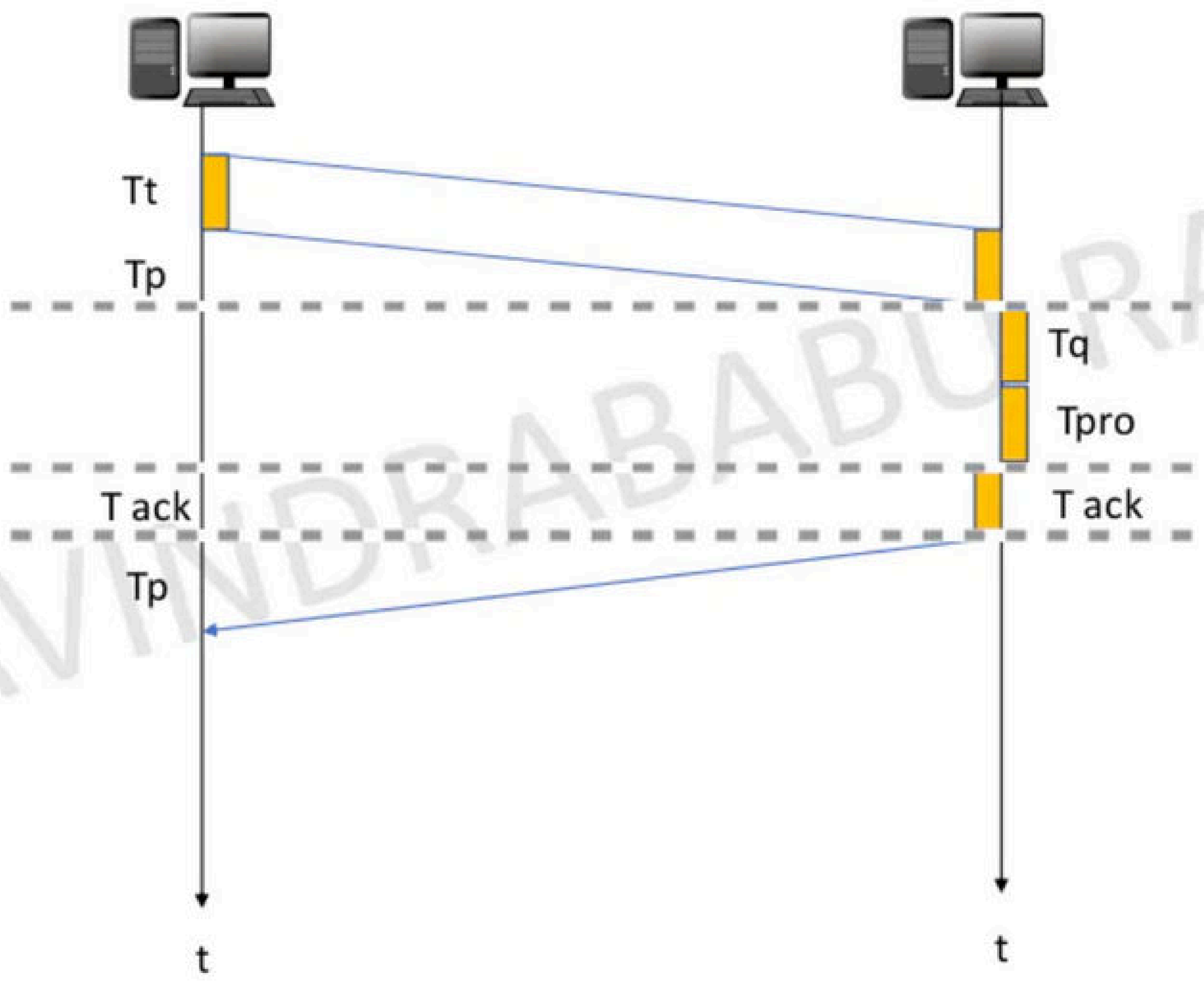
Tt
t
t

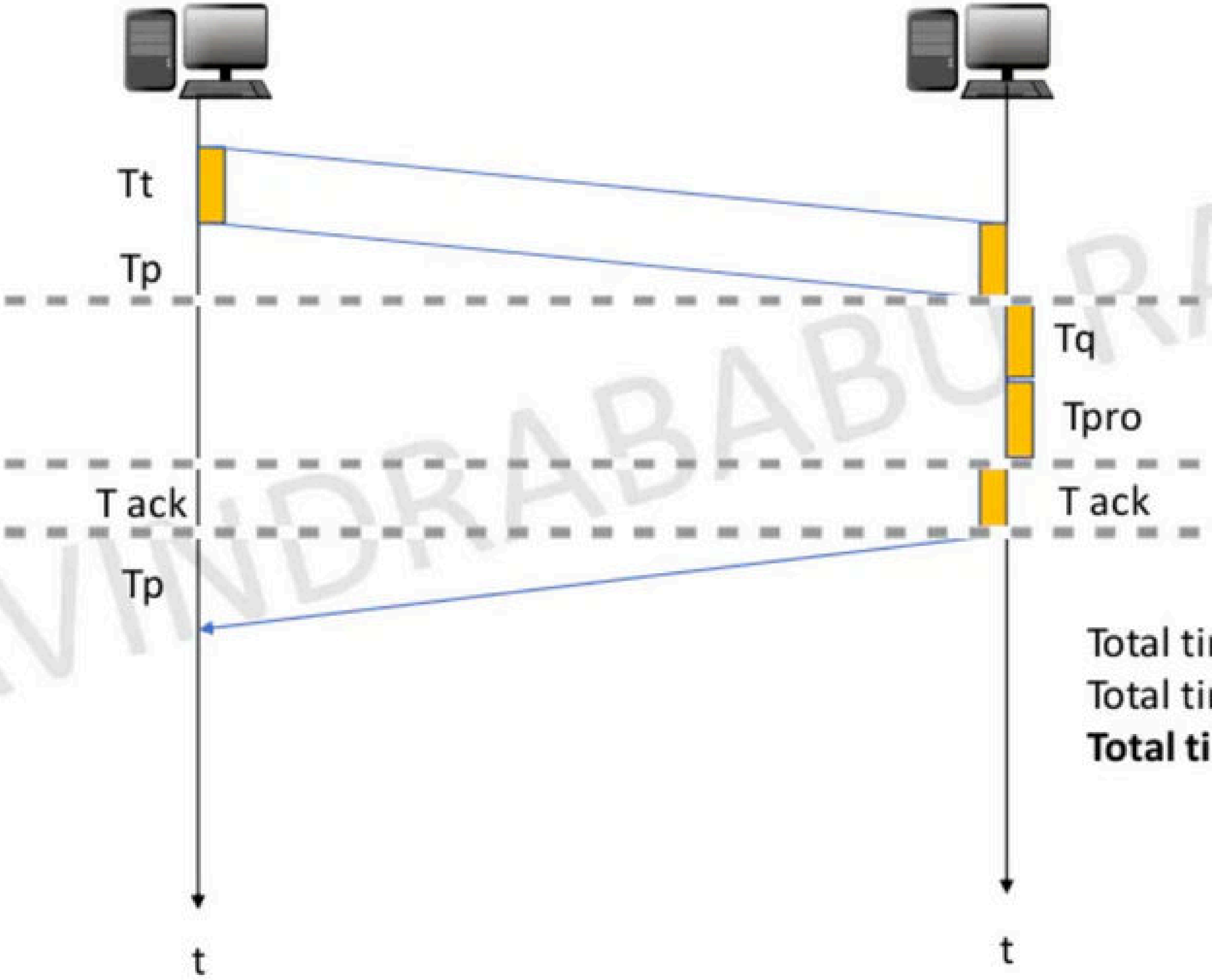


Tt
Tp
t
t



Tt
Tp
Tq
Tpro
t
t

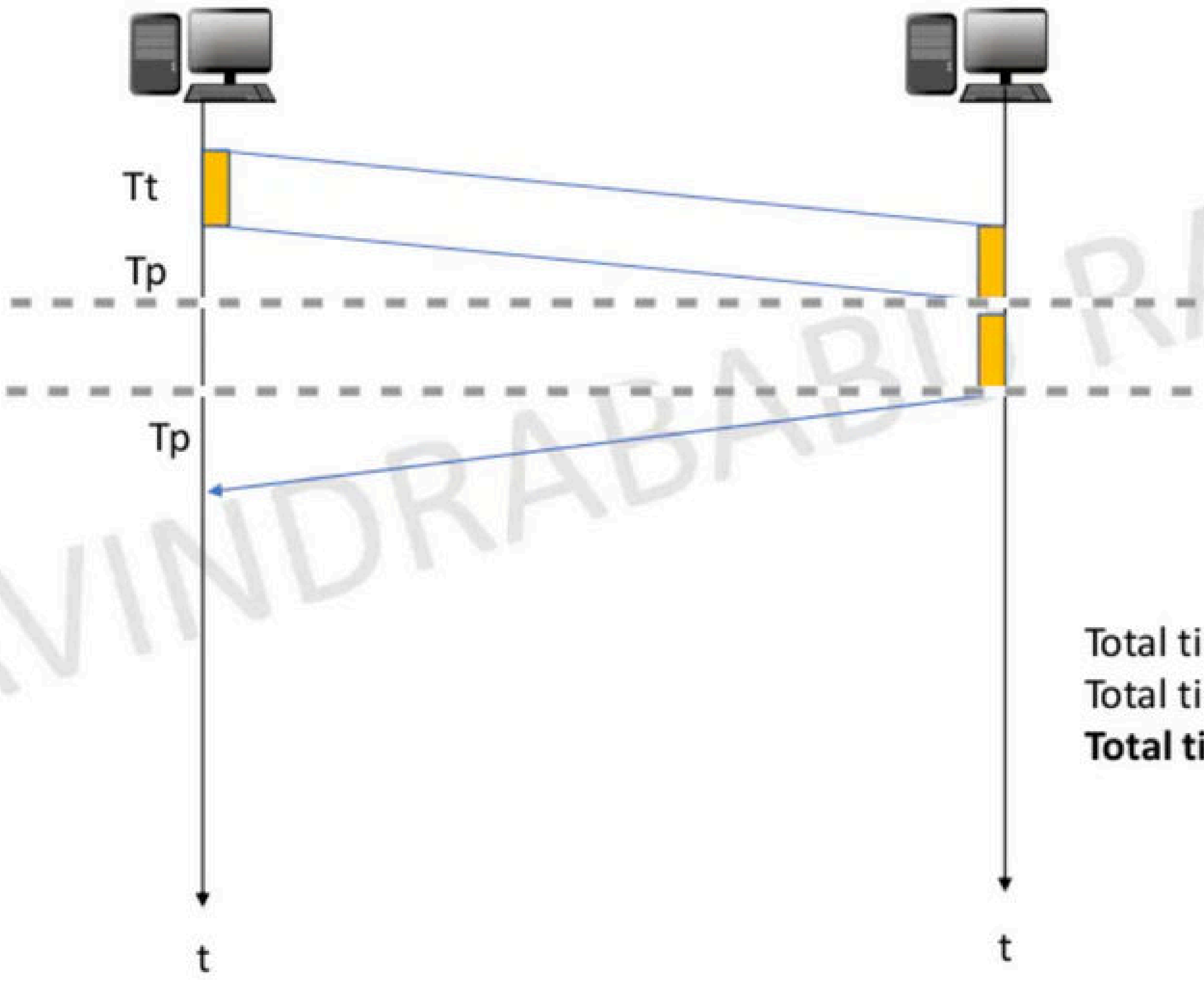

Tt
Tp
Tq
Tpro
T ack
T ack
Tp
t
t



$$\text{Total time} = T_t + T_p + \overset{0}{T_q} + \overset{0}{T_{pro}} + \overset{0}{T_{ack}} + T_p$$

$$\text{Total time} = T_t + T_p + T_p$$

$$\mathbf{Total\ time} = \mathbf{T_t + 2T_p}$$



0 0 0

Total time= Tt + Tp + Tq + Tpro + T ack + Tp

Total time= Tt + Tp + Tp

Total time= Tt + 2Tp

EFFICIENCY

$$\text{Efficiency}(\eta) = \frac{\text{Useful time}}{\text{Total cycle time}}$$

$$\boxed{\eta = \frac{Tt}{Tt + 2Tp}}$$

$$\eta = \frac{1}{1 + \frac{2Tp}{Tt}} \qquad a = \frac{Tp}{Tt}$$

$$\boxed{\eta = \frac{1}{1 + 2a}}$$

THROUGHPUT

Effective bandwidth
Or
Throughput
Or
Bandwidth utilization

$$= \frac{L}{Tt + 2Tp}$$

$$= \frac{L/B}{Tt + 2Tp} \times B$$

$$= \frac{Tt}{Tt + 2Tp} \times B$$

$$= \eta \times B$$

Throughput = Efficiency (η) x Bandwidth(B)

REVISION OF THE FORMULAE

1.) $Tt = \dfrac{\text{Length of data (bits)}}{\text{Bandwidth(bps)}} = \dfrac{L}{B}$

2.) $Tp = \dfrac{\text{distance of the link (d)}}{\text{Velocity(v)}}$

STOP AND WAIT

3.) $\eta = \dfrac{1}{1 + 2a}$

$a = \dfrac{Tp}{Tt}$

4.) Throughput = Efficiency (η) x Bandwidth(B)

5.) Round Trip Time (RTT) = 2 X Tp

REMEMBER

Whenever data has **K**,
K= 1024

Whenever data has **M**,
M=1024 X 1024

Whenever data has **G**,
G=1024 X 1024 X 1024

Whenever Bandwidth has **K**,
K= 1000 = 10^3

Whenever Bandwidth has **M**,
M= 10^6

Whenever Bandwidth has **G**,
G= 10^9

Problems on Stop and wait

1.) Tt = 1ms Tp = 1ms

$$\eta = \frac{1}{1+2a} = \frac{1}{3} = 0.33 \text{ or } 30\%$$

2.) Tt = 2ms Tp = 1ms

$$\eta = \frac{1}{1+2a} = \frac{1}{2} = 0.5 \text{ or } 50\%$$

Problems on Stop and wait

1.) Tt = 1ms Tp = 1ms

$$\eta = \frac{1}{1+2a} = \frac{1}{3} = 0.33 \text{ or } 30\%$$

2.) Tt = 2ms Tp = 1ms

$$\eta = \frac{1}{1+2a} = \frac{1}{2} = 0.5 \text{ or } 50\%$$

So, if we want the efficiency to be atleast 50 % then,

$\eta >= 0.5$

$$\frac{Tt}{Tt + 2Tp} >= \frac{1}{2}$$

$2Tt >= Tt + 2Tp$

$\boxed{Tt >= 2Tp}$

Or we can say that,

$$\frac{L}{B} >= 2Tp$$

$\boxed{L >= 2Tp * B}$

Question:

Given, bandwidth = 4 Mbps, Tp = 1ms, What is the length of the packet so as to achieve at least 50% efficiency?

Question:

Given, bandwidth = 4 Mbps, Tp = 1ms, What is the length of the packet so as to achieve at least 50% efficiency?

$L >= 2Tp * B$

$L >= 2*10^{-3}*4*10^{6}$

$L >= 8*10^{3}$ bits

Therefore, Length of packet must be at least 8000 bits so as to achieve at least 50 % efficiency.

SOMETHINGS THAT CAN BE SAID ABOUT EFFICIENCY

$$\eta = \frac{1}{1 + \frac{2Tp}{Tt}}$$

$$\eta = \frac{1}{1 + \frac{2(d/v)}{(L/B)}}$$

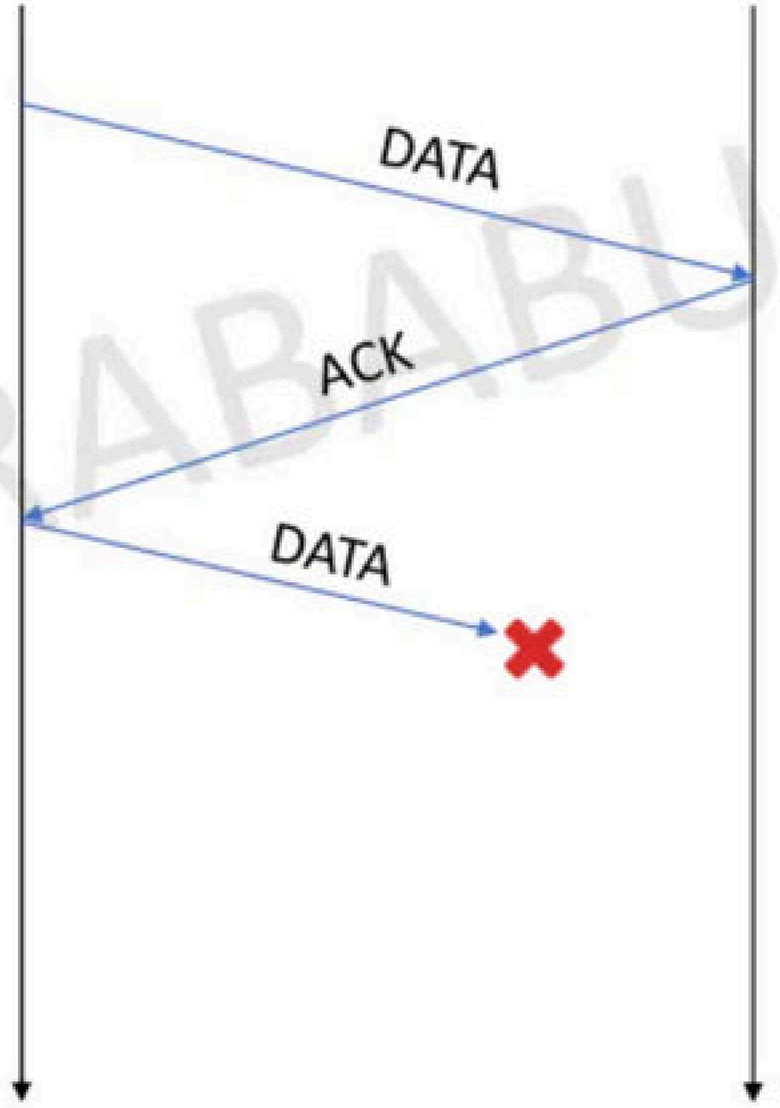
As we can see that,

$d \uparrow \quad \eta \downarrow$ So, Stop and Wait is good for LANs

$L \uparrow \quad \eta \uparrow$ Good for big packets

PROBLEMS WITH STOP AND WAIT

PROBLEM 1: Data packet lost

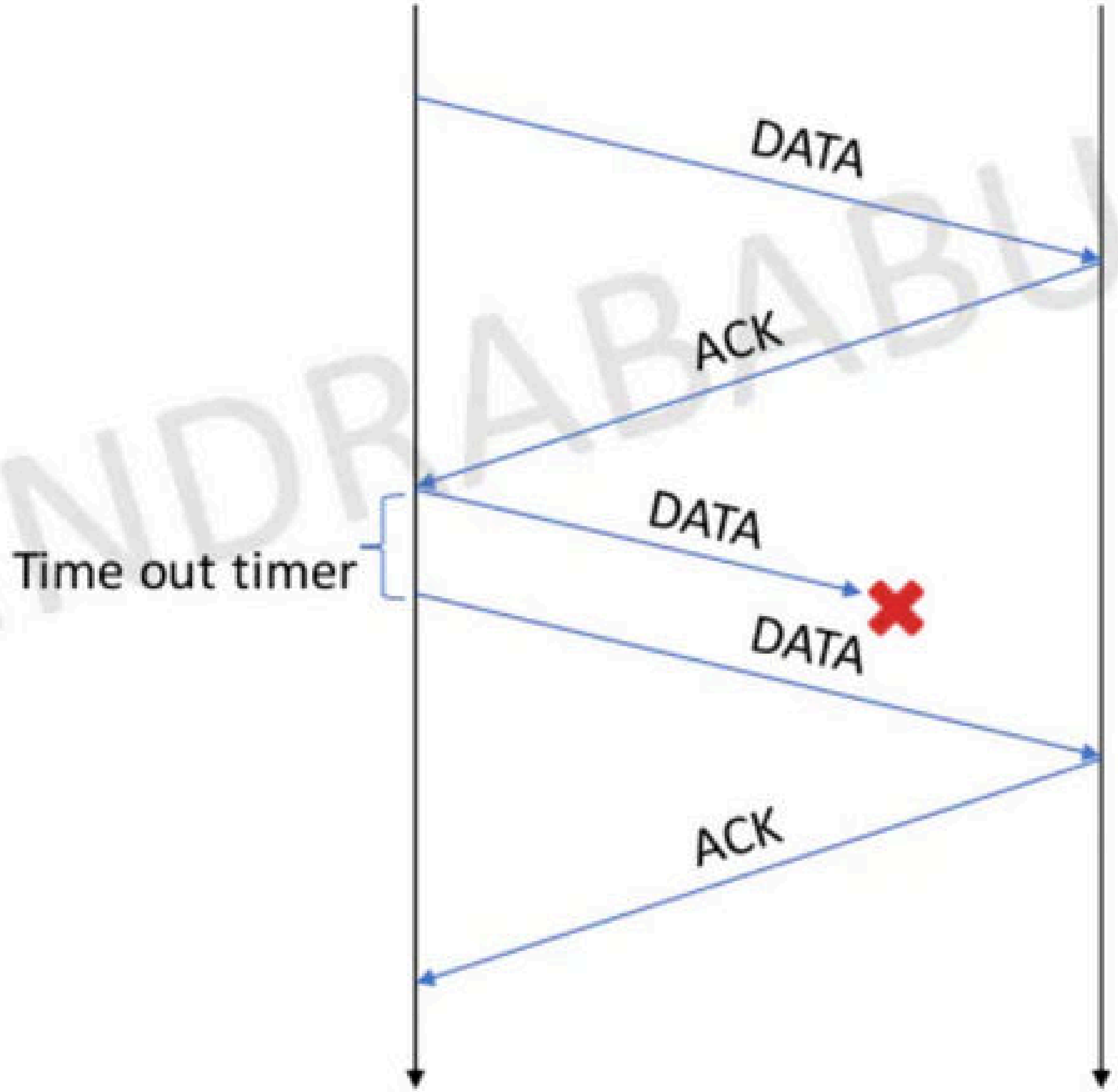


SENDER THINKS THAT
RECEIVER IS BUSY

RECEIVER THINKS SENDER DID
NOT SEND THE DATA

PROBLEMS WITH STOP AND WAIT

PROBLEM 1: Data packet lost



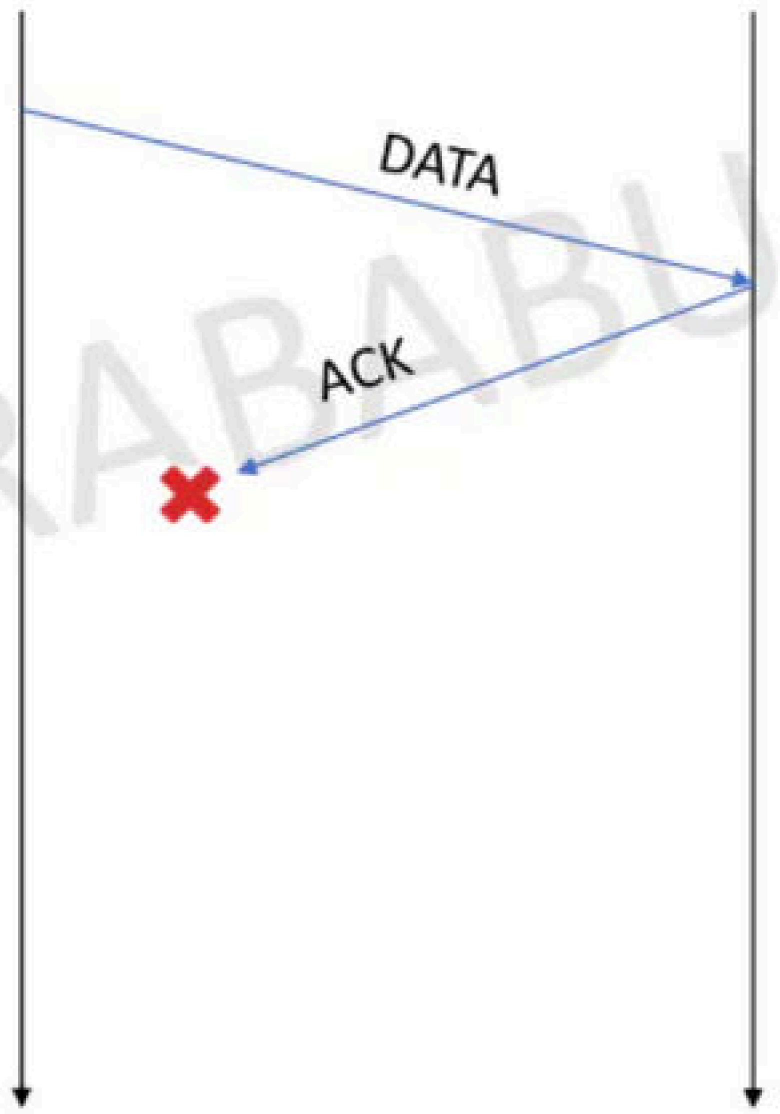
SOLUTION

So, to solve this issue the sender
Waits for time known as **Time out Timer**
And resends the packet.

This is stop and wait + timeout timer
Which is known as **"Stop and wait ARQ"**
ARQ stands for Automatic Repeat Request

PROBLEMS WITH STOP AND WAIT

PROBLEM 2: Acknowledgement lost

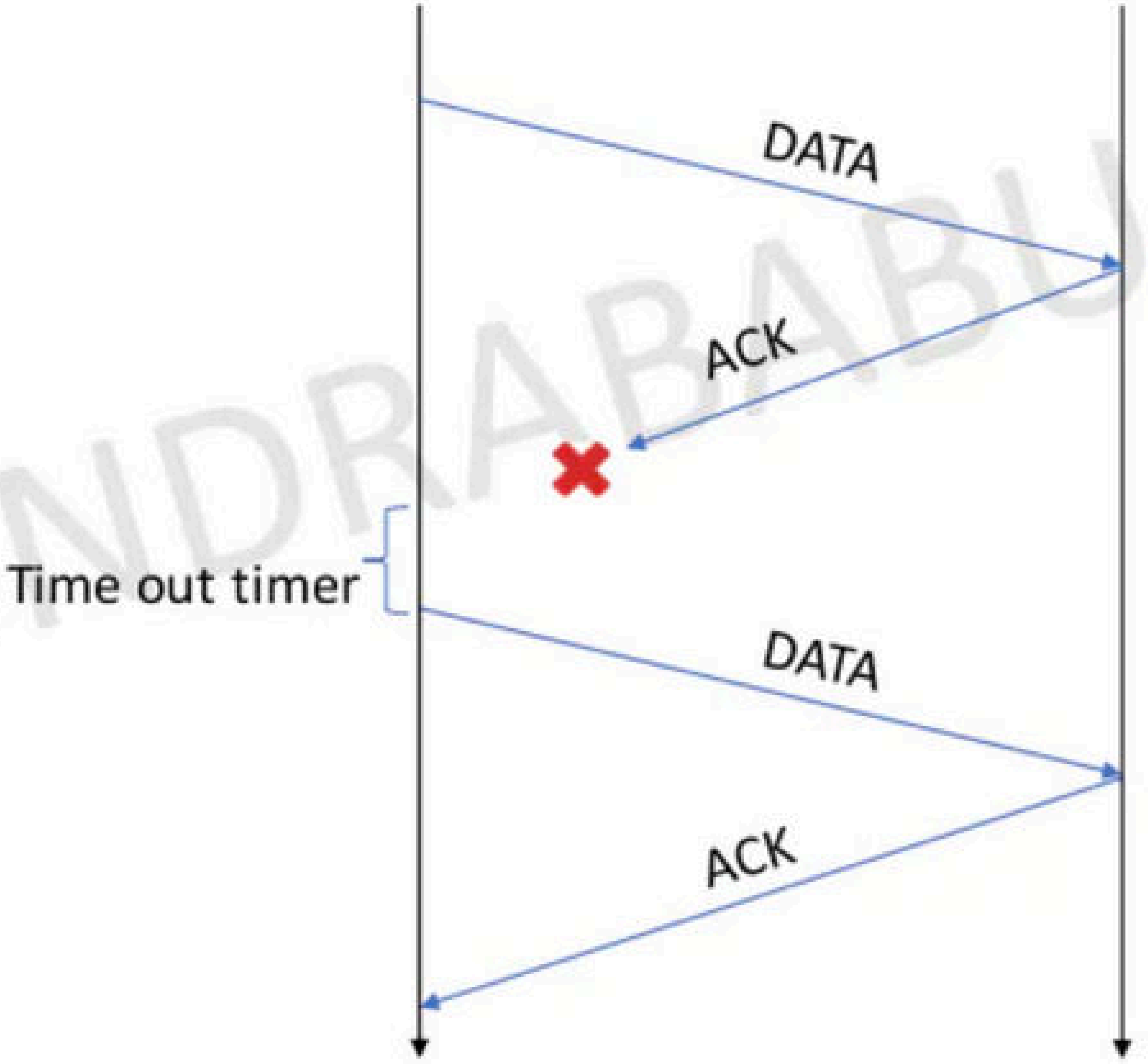


SENDER THINKS THAT
RECEIVER HAS NOT RECEIVED THE PACKET

RECEIVER THINKS SENDER HAS RECEIVED ACK

PROBLEMS WITH STOP AND WAIT

PROBLEM 2: Acknowledgement lost



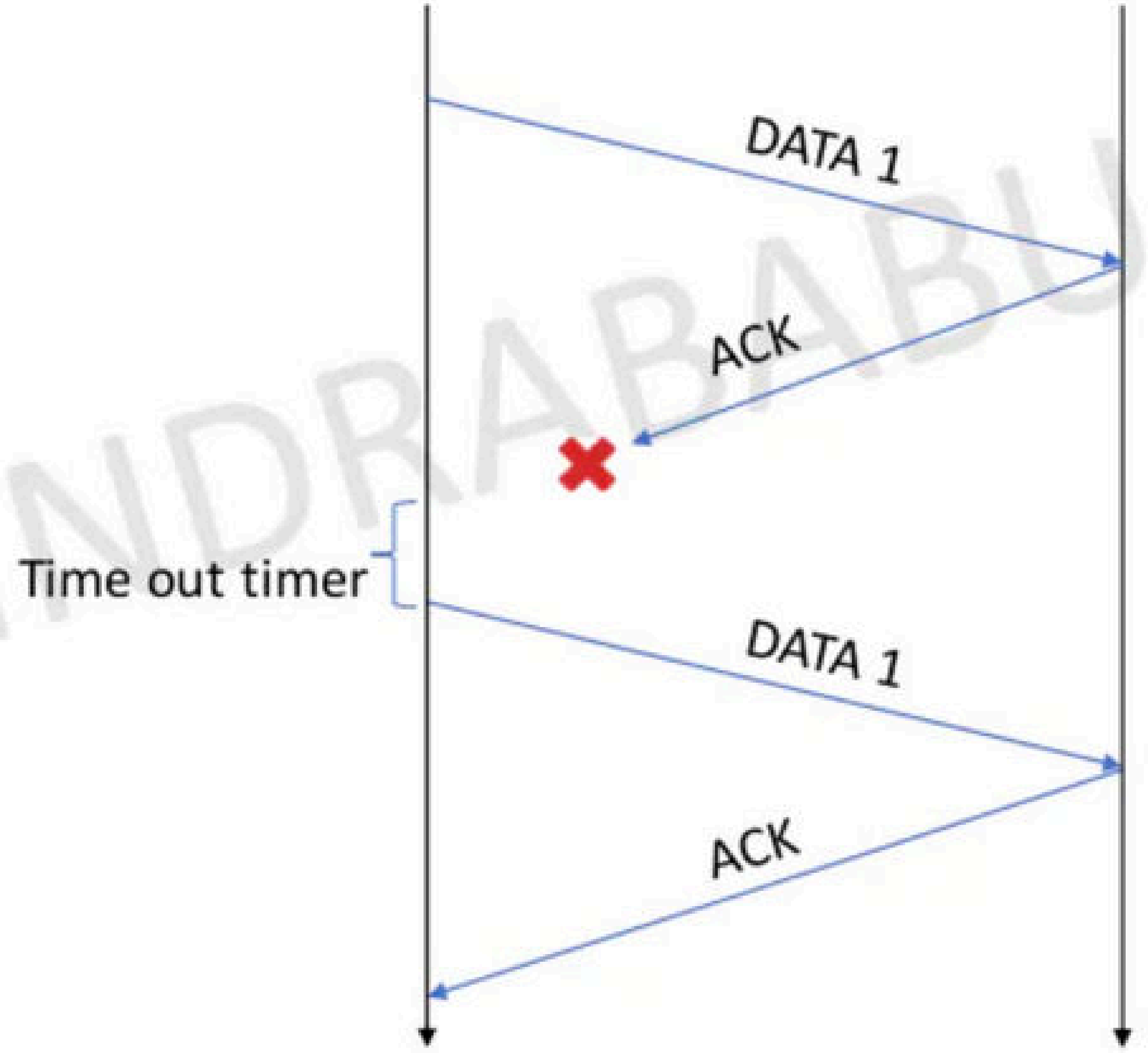
SENDER WAITS FOR TIMEOUT TIMER AND RESENDS THE PACKET

RECEIVER THINKS SENDER HAS SENT NEW DATA PACKET.

THIS IS **DUPLICATE PACKET PROBLEM**

PROBLEMS WITH STOP AND WAIT

PROBLEM 2: Acknowledgement lost



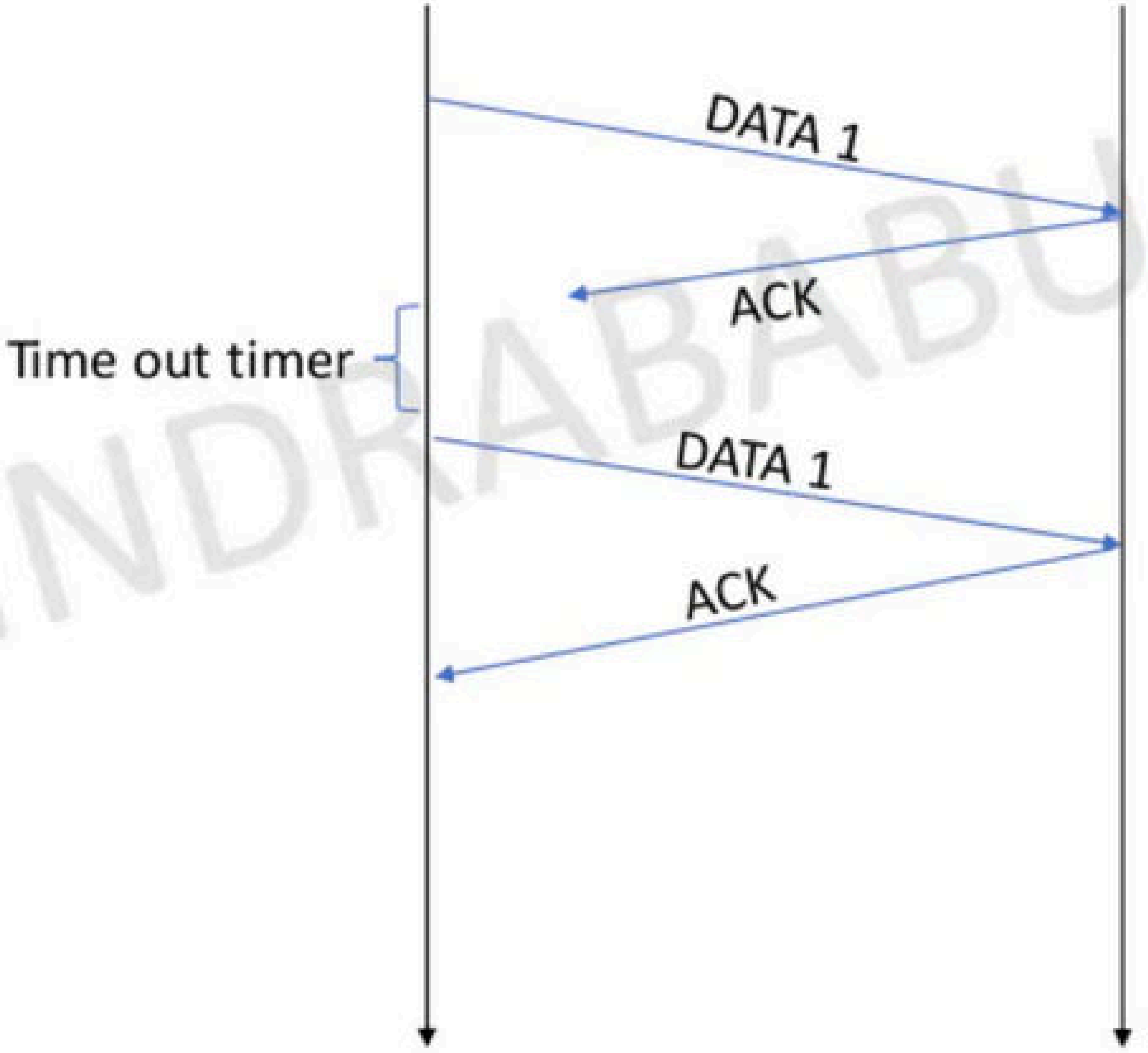
SOLUTION :

SENDER SENDS DATA PACKET WITH **SEQUENCE NUMBERS**

STOP AND WAIT + TO TIMER + SEQ NUMBER

PROBLEMS WITH STOP AND WAIT

PROBLEM 3: Acknowledgement Delayed

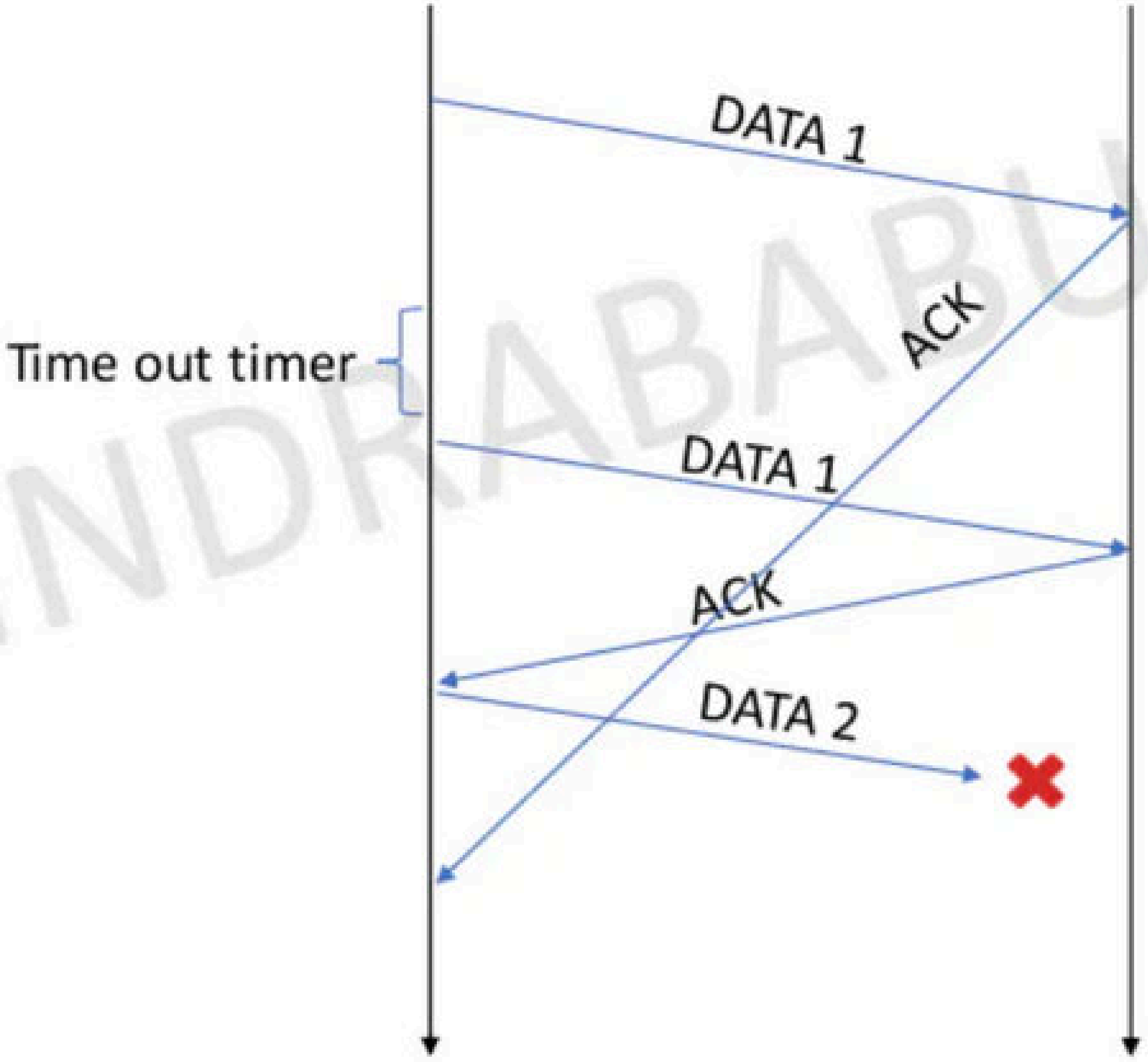


ACKNOWLEDGEMENT IS DELAYED FOR DATA 1 AND THE PACKET IS RESENT BY THE SENDER BY WAITING FOR TO TIMER

RECEIVER SENDS THE ACK FOR THE RESENT DATA 1 PACKET

PROBLEMS WITH STOP AND WAIT

PROBLEM 3: Acknowledgement Delayed



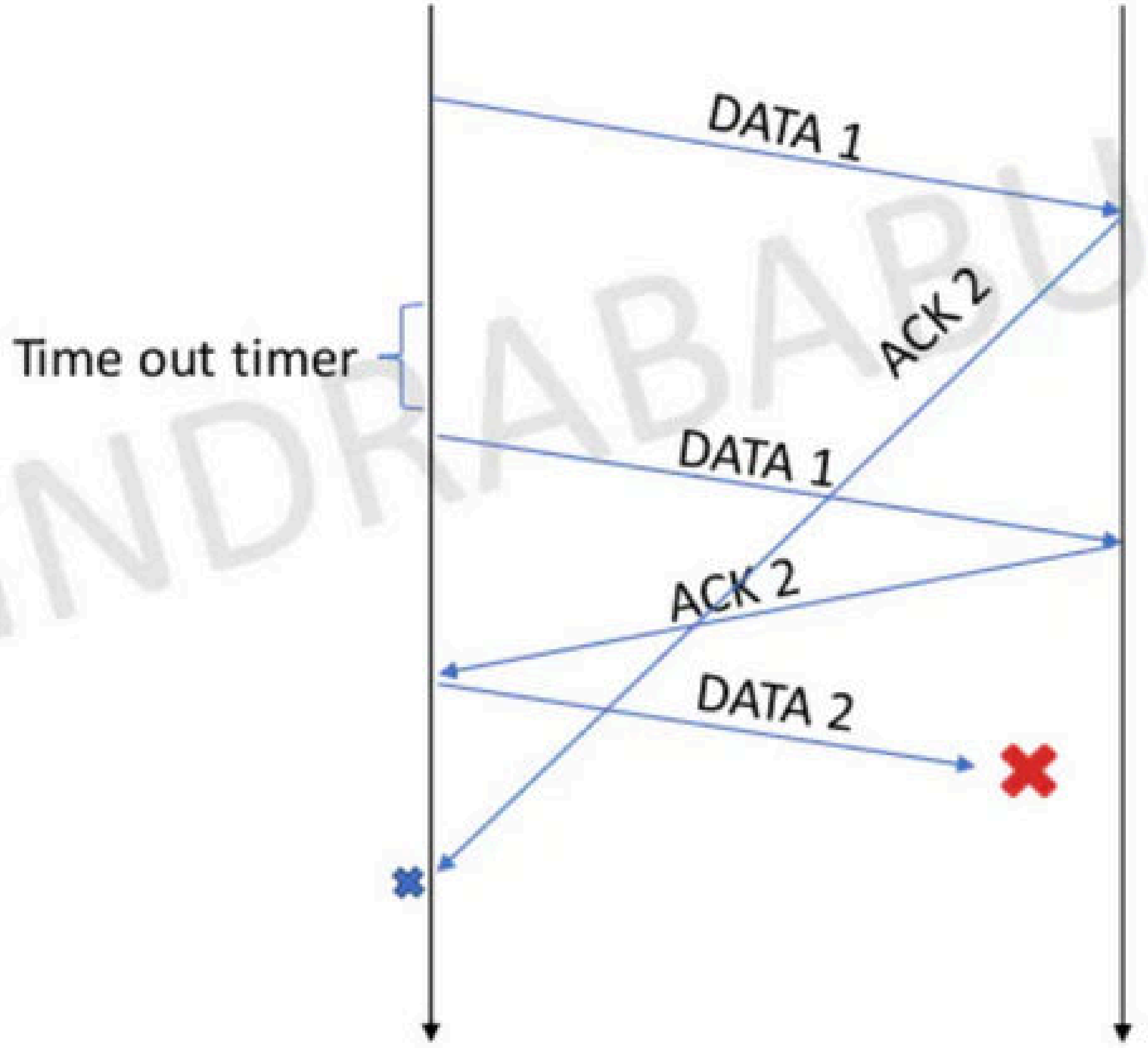
NOW, IMAGINE DATA 2 PACKET IS SENT AND GETS LOST.

AND THE DELAYED ACK IS RECEIVED NOW

DUE TO THIS WHAT HAPPENS IS,
SENDER THINKS THIS IS AN ACK FOR DATA 2
BUT THE RECEIVER NEVER RECEIVED DATA 2
PACKET !
THIS IS **MISSING PACKET PROBEM**

PROBLEMS WITH STOP AND WAIT

PROBLEM 3: Acknowledgement Delayed



SOLUTION:
ACK NUMBER WILL BE SENT BY RECEIVER
ACK NUMBER = SEQUENCE NO + 1

QUESTION : Suppose sender wants to send 10 packets to receiver and every 4^{th} packet is lost
How many packets will be sent in total?

SOLUTION:

Packets to be sent : 1 2 3 4 5 6 7 8 9 10

As per the given scenario :1 2 3 4 4 5 6 7 7 8 9 10 10

Total transmissions = 13

Question:
Suppose while sending packets to destination there is error probability of 0.2 .
If we are sending 400 packets over this channel. How many Packets would be sent?

Packets sent would be :

400+400(0.2) +80(0.2).....

If we are sending n packets with p error probability, then,

Packets sent would be,

$= (n+np+np^{2}\ldots\ldots\ldots)$

$= n(1+p+p^{2+\cdots})$

$=n(1/1-p)$