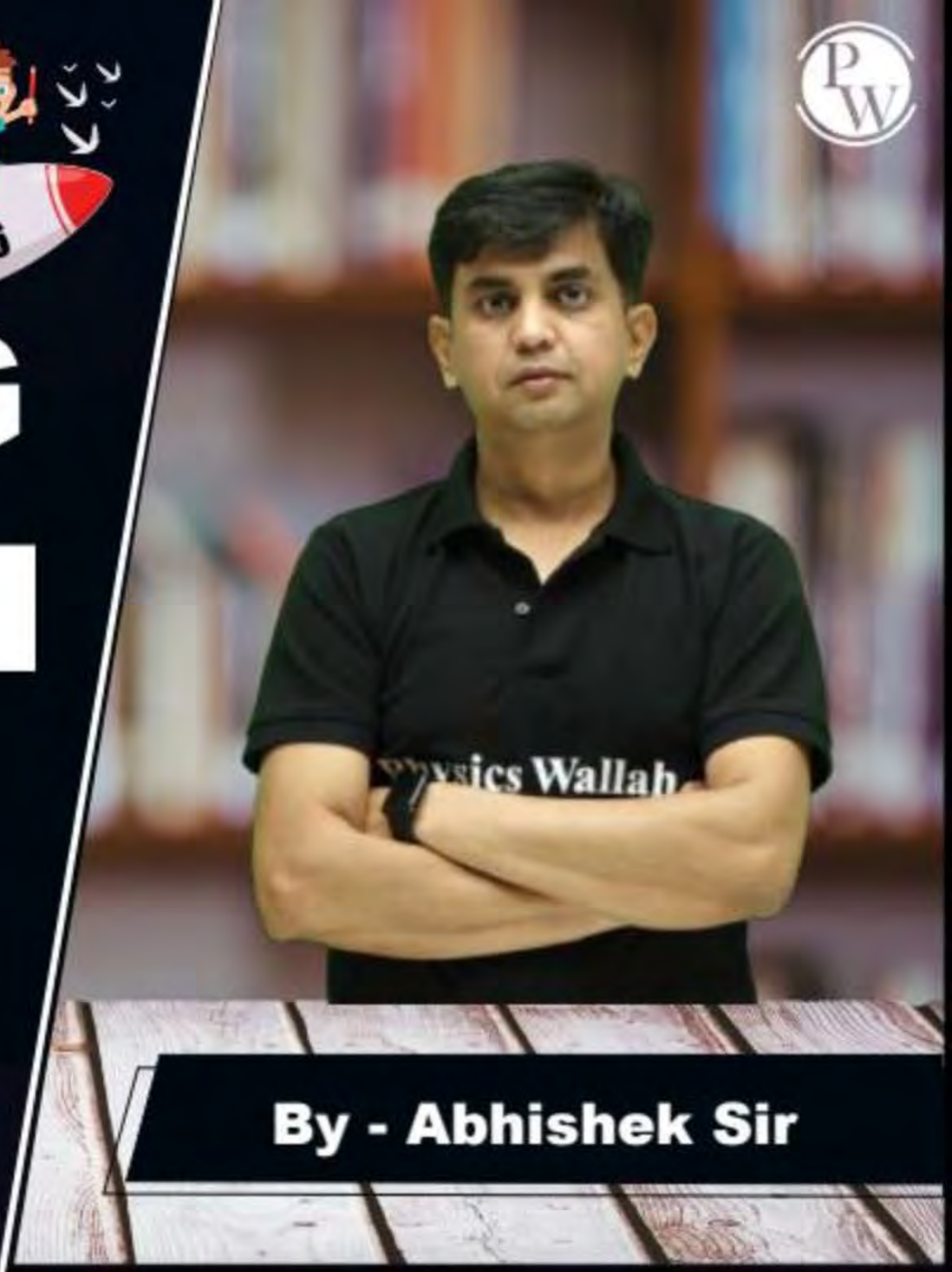
CS & IT ENGINEERING

Computer Network

Flow Control

Lecture No. - 04



By - Abhishek Sir

ABOUT ME

Hello, I'm Abhishek

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Recap of Previous Lecture

Topic Sliding Window Protocol

→ Noiseless

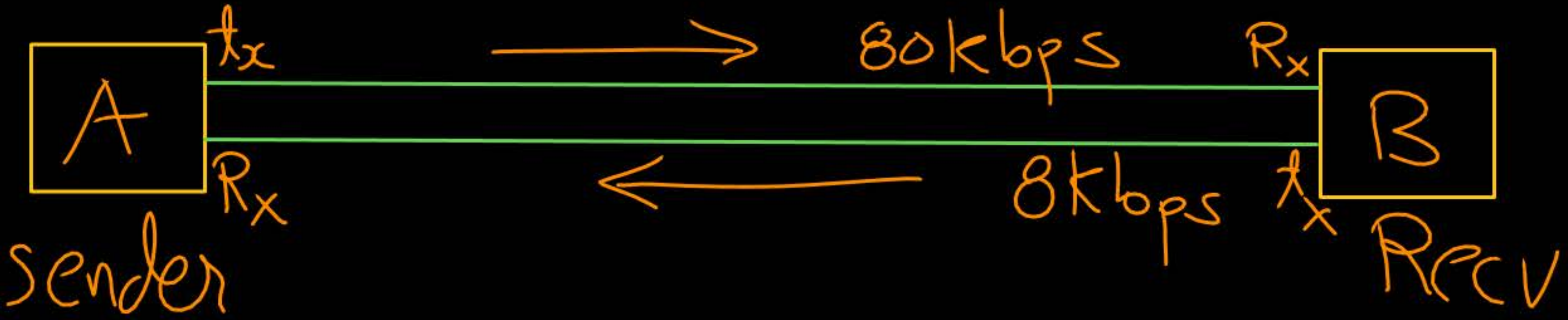
→ Not for Noisy

Topics to be Covered

- **Topic** Go Back N ARQ
- **Topic** Selective Repeat ARQ

[NAT] [GATE-2016][2 Mark]

#Q. A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds. Assuming no frame is lost, the sender throughput is ________ bytes/second.



$\boxed{\text{Ans} = 2500}$

Solution:-

Packet Size = $\boxed{1000 \text{ bytes}}$ = $\boxed{8 * 10^3 \text{ bits}}$

Bandwidth = $\boxed{80 \text{ Kbps}}$ = $\boxed{8 * 10^4 \text{ bits / sec}}$

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{\cancel{8} * 10^3 \ \text{bi}\cancel{\text{ts}}}{\cancel{8} * 10^4 \ \text{bi}\cancel{\text{ts}} / \text{sec}} = \boxed{100 \text{ ms}}$$

$$\boxed{t_p = 100 \text{ ms}}$$

ACK Size = $\boxed{100 \text{ bytes}}$ = $\boxed{8 * 10^2 \text{ bits}}$

Bandwidth = $\boxed{8 \text{ Kbps}}$ = $\boxed{8 * 10^3 \text{ bits / sec}}$

$$t_{xA} = \frac{\text{ACK Size}}{\text{Bandwidth}} = \frac{\cancel{8} * 10^2 \ \cancel{\text{bits}}}{\cancel{8} * 10^3 \ \cancel{\text{bits}} / \text{sec}} = \boxed{100 \text{ ms}}$$

$$\text{Cycle time} = (t_x + t_p) + (t_{xA} + t_p) = \boxed{400 \text{ ms}}$$

$$= (100 + 100) + (100 + 100) \text{ ms}$$

$$\text{Throughput} = \frac{\text{Packet Size}}{\text{Cycle Time}} = \frac{1000 \text{ bytes}}{400 \text{ ms}} = \frac{10}{4} * 10^3 \text{ bytes/sec}$$

$$= \underbrace{2500 \text{ bytes / sec}}_{}$$

$$\eta = \frac{t_x}{\text{cycle time}} = \frac{100 \text{ ms}}{400 \text{ ms}} = \frac{1}{4}$$

$$\text{Throughput} = \eta * 80 \text{ kbps}$$

$$= \frac{1}{4} * 80 * 10^3 \text{ bits/sec} = \frac{10^4}{4} \text{ bytes/sec}$$

#Q. The distance between two stations M and N is L kilometers. All frames are K bits long. The propagation delay per kilometer is t seconds. Let R bits/second be the channel capacity. Assuming that processing delay is negligible, the minimum number of bits for the sequence number field in a frame for maximum utilization, when the sliding window is used, is

[GATE 2007]

Solution:-

$\underbrace{\text{Frame Size}} = \boxed{\text{K bits}}$

$\underbrace{\text{Bandwidth}} = \boxed{\text{R bits / sec}}$

$$t_x = \frac{\text{Packet Size}}{\text{Bandwidth}} = \frac{K \text{ bits}}{R \text{ bits/sec}} = \frac{K}{R} \text{ sec}$$

$\underbrace{\text{Distance}} = \boxed{\text{L Km}}$

$\underbrace{\text{Signal Speed}} = \boxed{\text{t Sec/Km}}$

$$t_p = \text{Distance} * \text{Signal Speed} = L \text{ km} * t \text{ sec/km} = Lt \text{ sec}$$

$$\text{Cycle time} = (t_x + 2 * t_p) = \left(\frac{K}{R} + 2Lt\right) \text{sec}$$

$$= \left(\frac{K + 2LtR}{R}\right) \text{sec}$$

For Sliding Window Protocol :

$$\text{Optimal Window Size} = \left\lceil \frac{\text{Cycle Time (RTT)}}{\text{Transmission delay}} \right\rceil = \left\lceil \frac{\left(\frac{K+2LtR}{R}\right)\text{sec}}{\frac{K}{R}\text{ sec}} \right\rceil$$

$$N = \left\lceil \frac{K+2LtR}{K} \right\rceil$$

Total number of sequences = Transmit Window Size $= N$

Minimum number of bits required for sequence number field

$$= \lceil \log_2 [\text{Total number of sequences}] \rceil \text{ bits}$$

$$= \lceil \log_2 (N) \rceil \text{ bits}$$

$$= \left\lceil \log_2 \left\lceil \frac{K+2LtR}{K} \right\rceil \right\rceil \text{ bits}$$

#Q. Host A is sending data to host B over a full duplex link. A and B are using the sliding window protocol for flow control. The send and receive window sizes are 5 packets each. Data packets (sent only from A to B) are all 1000 bytes long and the transmission time for such a packet is 50 microsecond. Acknowledgement packets (sent only from B to A) are very small and require negligible transmission time. The propagation delay over the link is 200 microsecond. What is the maximum achievable throughput in this communication?

[GATE 2003]

(A) $7.69 * 10^6$ bytes per sec

(B) $11.11 * 10^6$ bytes per sec

(C) $12.33 * 10^6$ bytes per sec

(D) $15.00 * 10^6$ bytes per sec

Ans: B

Solution:-

$\boxed{t_x = 50\ \mu s}$

$\boxed{t_p = 200\ \mu s}$

$\boxed{\text{Cycle time} = \underbrace{(t_x + 2 * t_p)} = \boxed{450\ \mu s}}$ $= 450 * 10^{-6}\ sec$

$\boxed{\text{Window Size (N)} = 5}$

$\boxed{\text{Packet Size} = 1000\ \text{bytes}}$

For Sliding Window ARQ :

$$\text{Throughput} = \frac{\text{Window Size} * \text{Packet Size}}{\text{Cycle Time}}$$

$$= \frac{5 * 1000 \text{ byte}}{450 * 10^{-6} \text{ sec}}$$

$$= \frac{100}{9} * 10^{6} \text{ bytes/sec}$$

$$= 11.11 * 10^{6} \text{ bytes/sec}$$

Example 8 :-

#Q. Consider two hosts A and B directly connected through point-to-point link using 'sliding window protocol' for flow control where transmit window size is 20 and acknowledgments are always piggybacked. Each packet transmission time is 2 seconds and one-way propagation delay of the link is 24 seconds. After transmitting all 20 frames in a cycle, what is the minimum time the sender will have to wait before starting transmission of the next frame ? (Ignore the processing and queuing delays at both the end.)

$\boxed{\text{Ans} = 12}$

Solution 8 :-

*TCP

Piggybacking :

→ ACK always present inside packet header

→ Packet header contains :

1. Sequence Number (k bits)
2. ACK Number (k bits)

$$\boxed{t_{x_A} = t_x}$$

CS-2009

$\boxed{\text{Sender Window Size (N)} = 20}$

$\boxed{t_x = 2 \text{ Sec}}$

$\boxed{t_p = 24 \text{ Sec}}$

Cycle Time $= (t_x + t_p) + (t_{xA} + t_p)$

$= (2+24) + (2+24)$ sec $= 52$ sec

minimum time the sender will have to wait $=$ [Cycle Time $- N * t_x$]

$= [52 - 20*2]$ sec

$= 12$ sec

Topic : Sliding Window Protocol

→ In case of, Noisy Channel

→ Types of Sliding Window Protocol :

1. Go Back N ARQ
2. Selective Repeat ARQ

Topic : Go Back N ARQ

→ Transmitter's transmitting window size = N

$(N > 1)$

→ Receiver's receiving window size = 1

Topic : Go Back N ARQ

→ Total number of sequences = (N+1) [0 to N]

Total number of sequences =
Transmitter's transmitting window size
+ Receiver's receiving window size

Sequence number ← (Frame number) mod (N+1)

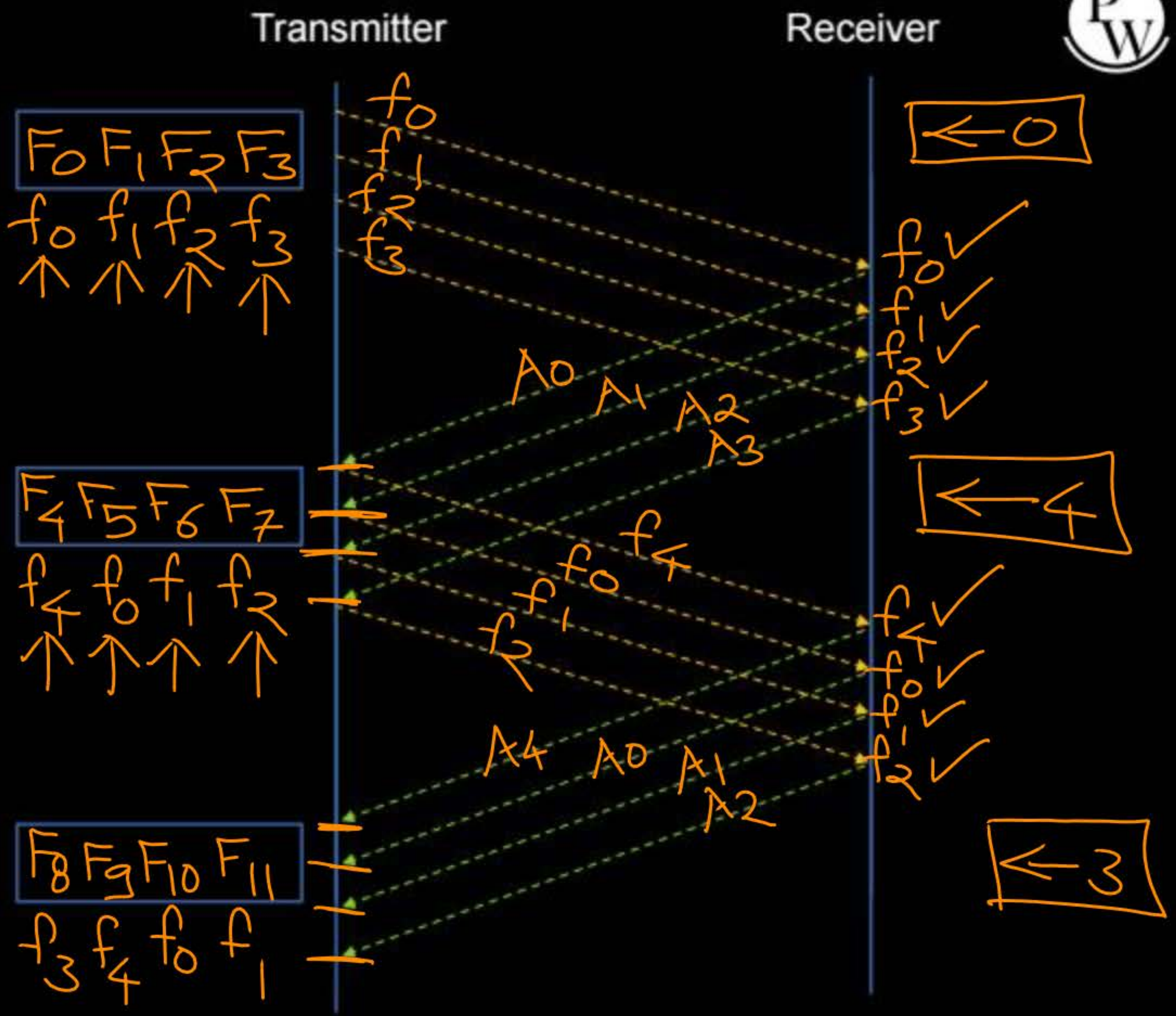
Topic : Go Back N ARQ

CASE I : $[N = 4]$

Go back 4 ARQ

Sequence Number = 0 to 4

Mod(5)



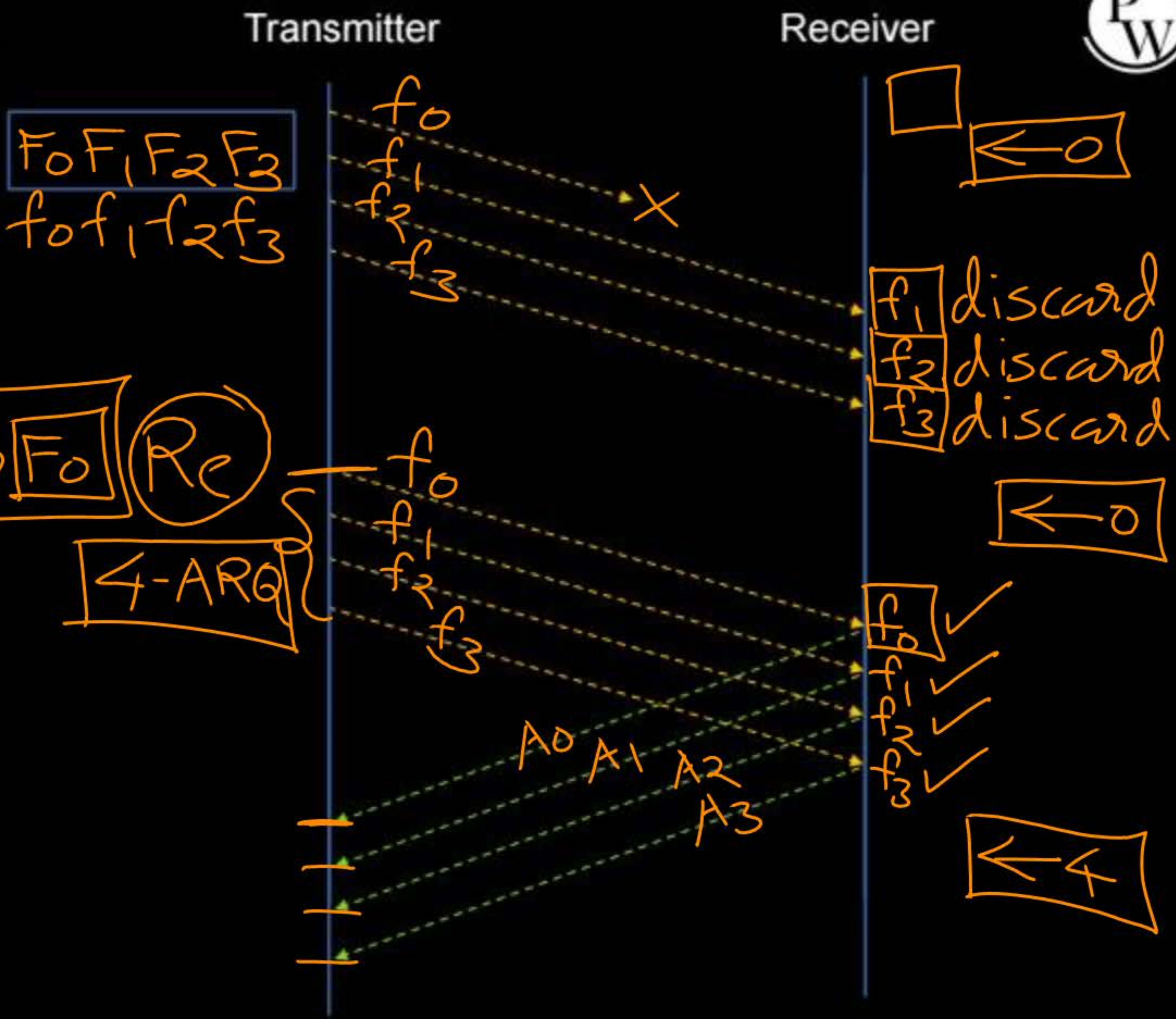
Topic : Go Back N ARQ

CASE II : N = 4

Go back 4 ARQ

Sequence Number = 0 to 4

→ Mod 5



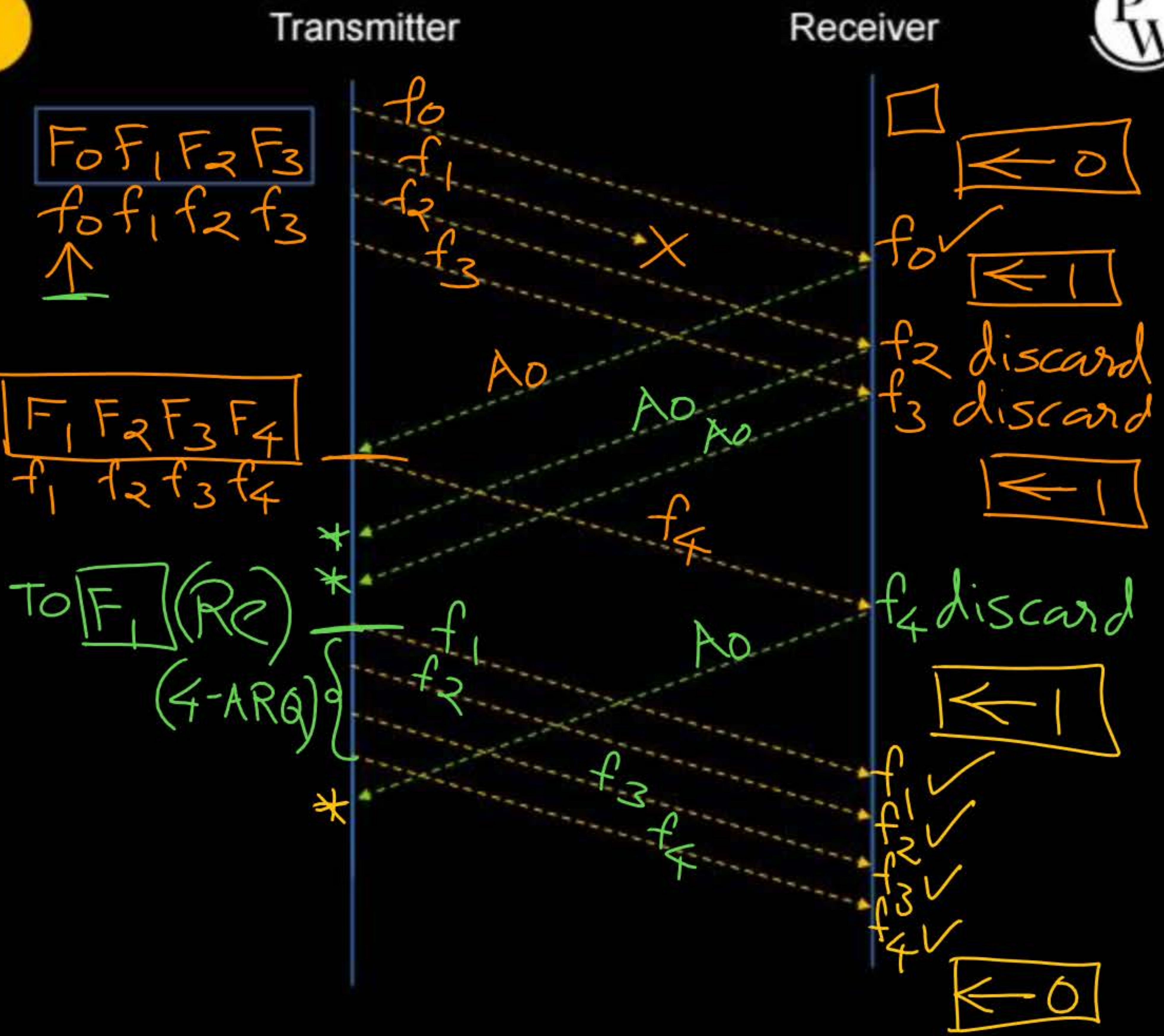
Topic : Go Back N ARQ

CASE III :

Go back 4 ARQ

Sequence Number = 0 to 4

* ignore, no action



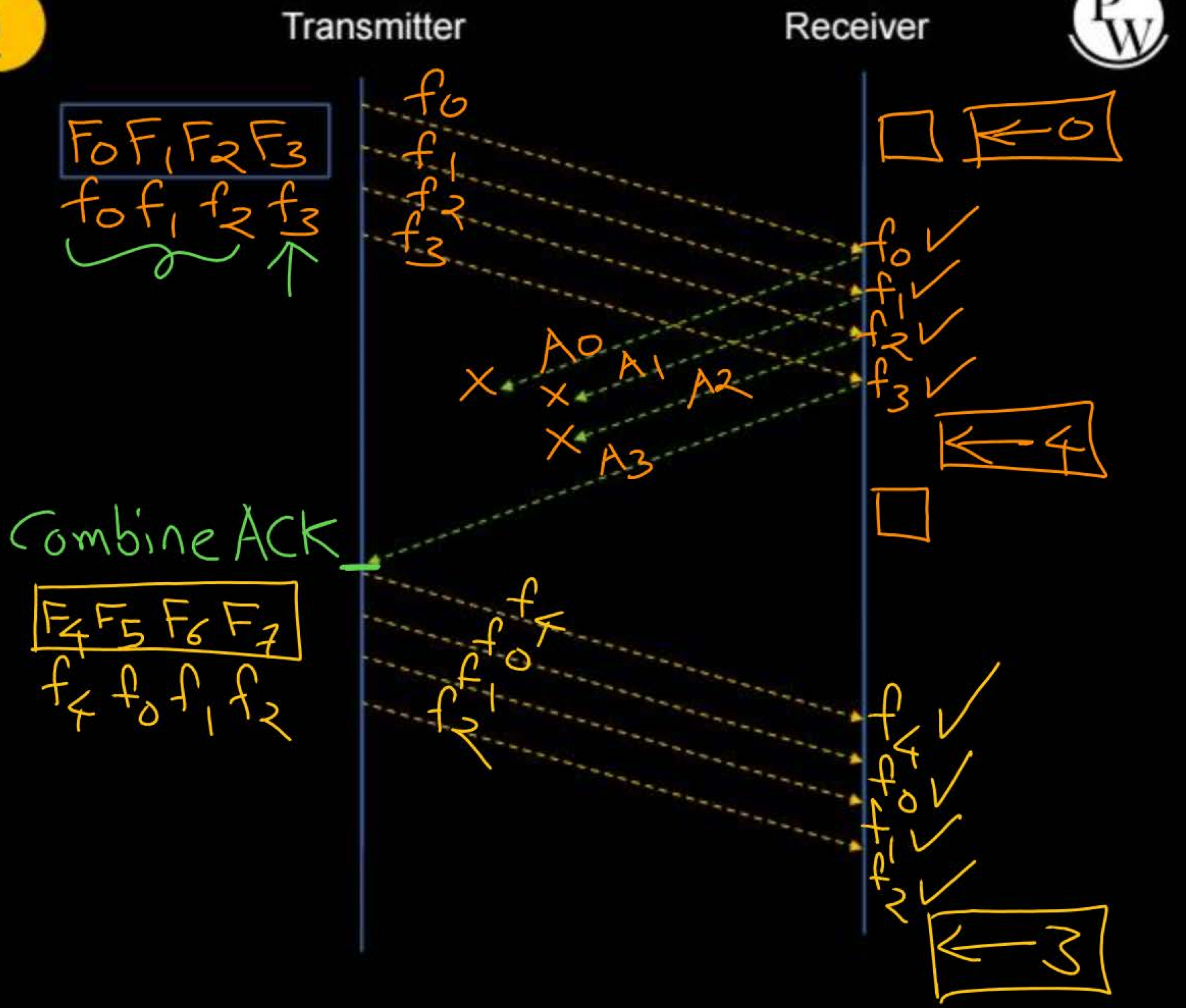
Topic : Go Back N ARQ

CASE IV : $N = 4$

Go back 4 ARQ

Sequence Number = $\boxed{0 \text{ to } 4}$

* Cummulative ACK



Topic : Go Back N ARQ

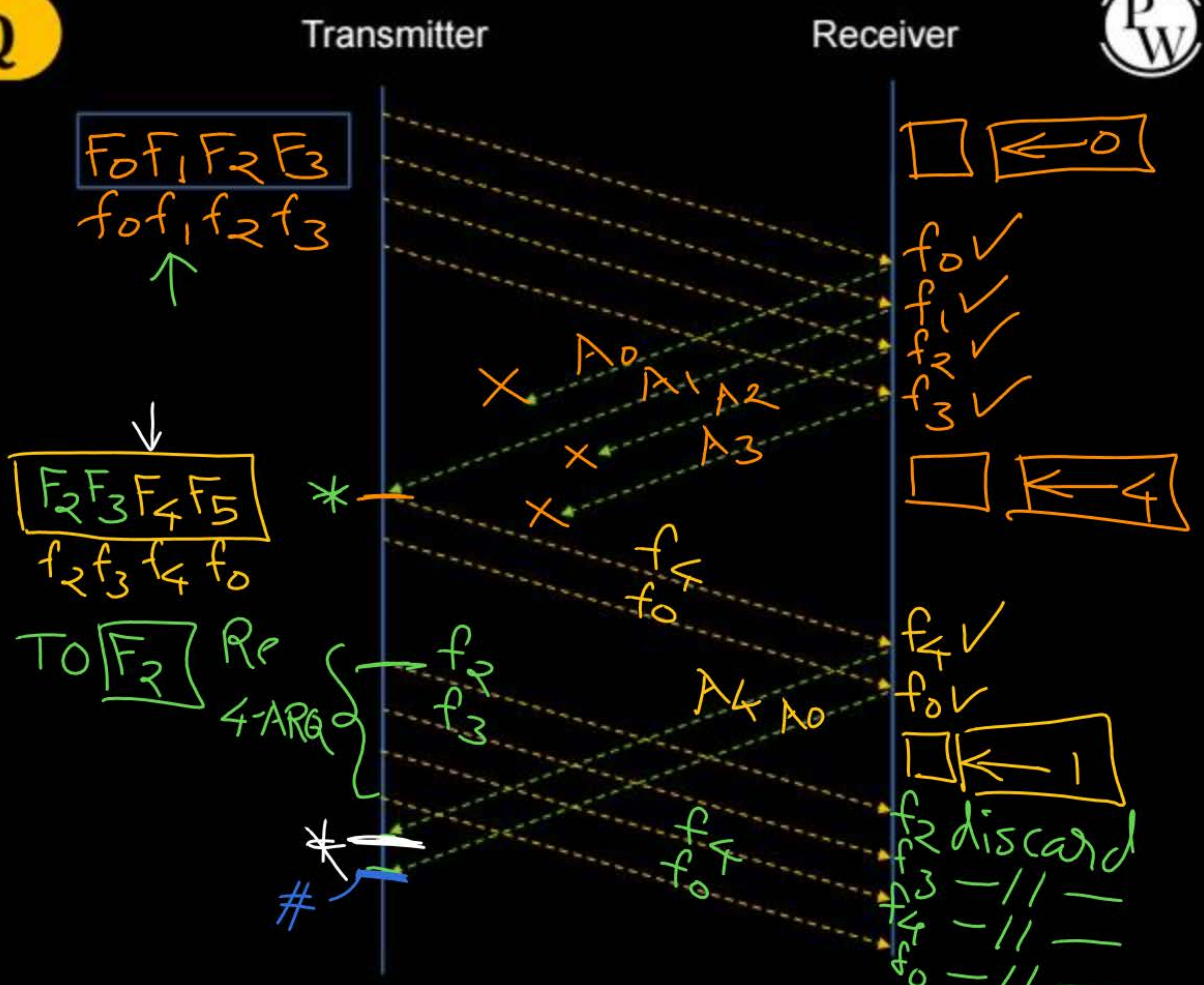
CASE V :

Go back 4 ARQ

Sequence Number = 0 to 4

*Combine ACK

Individual ACK



Topic : Go Back N ARQ

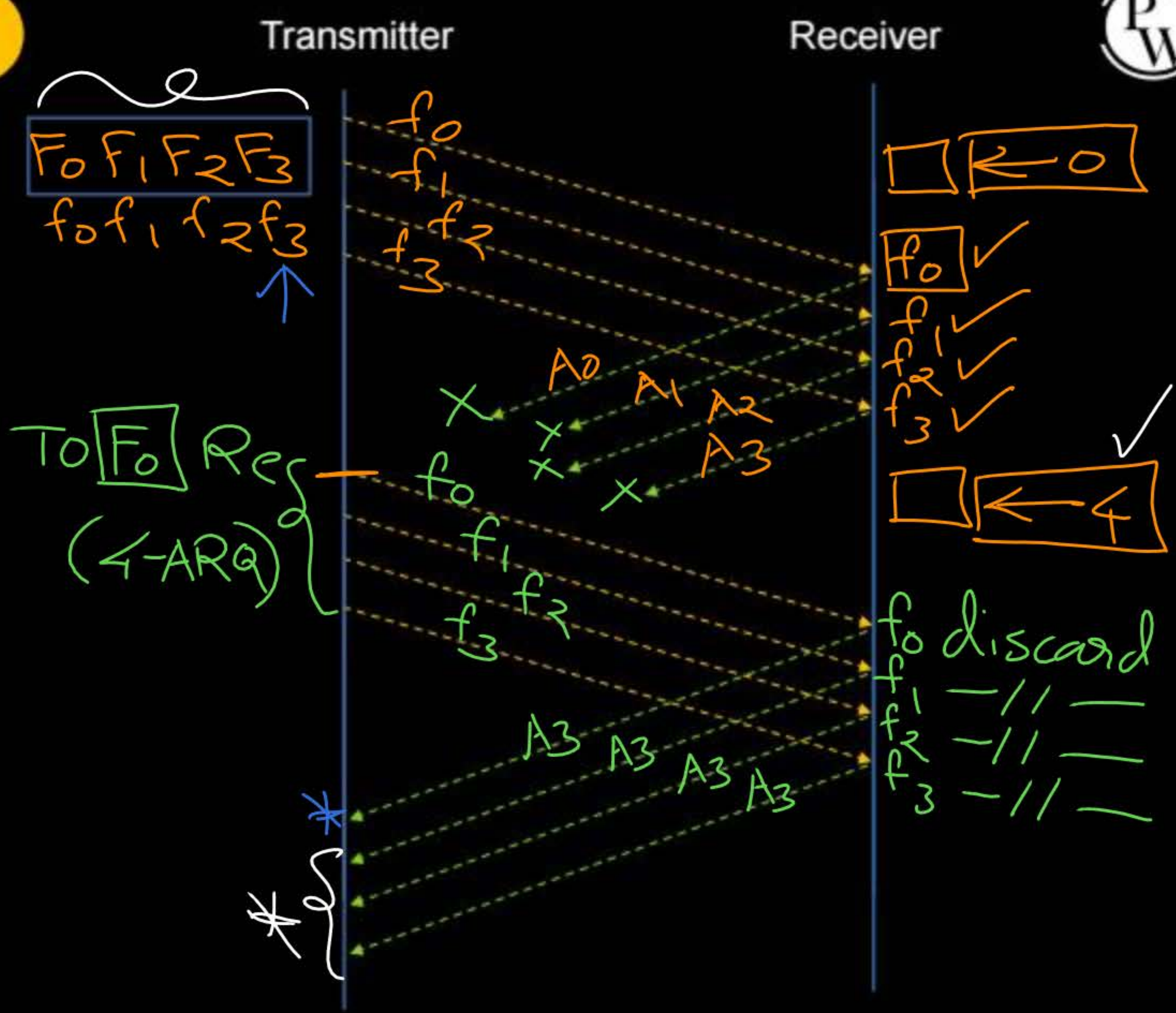
CASE VI :

Go back 4 ARQ

Sequence Number = 0 to 4

*Combine Ack

*Ignore, No Action

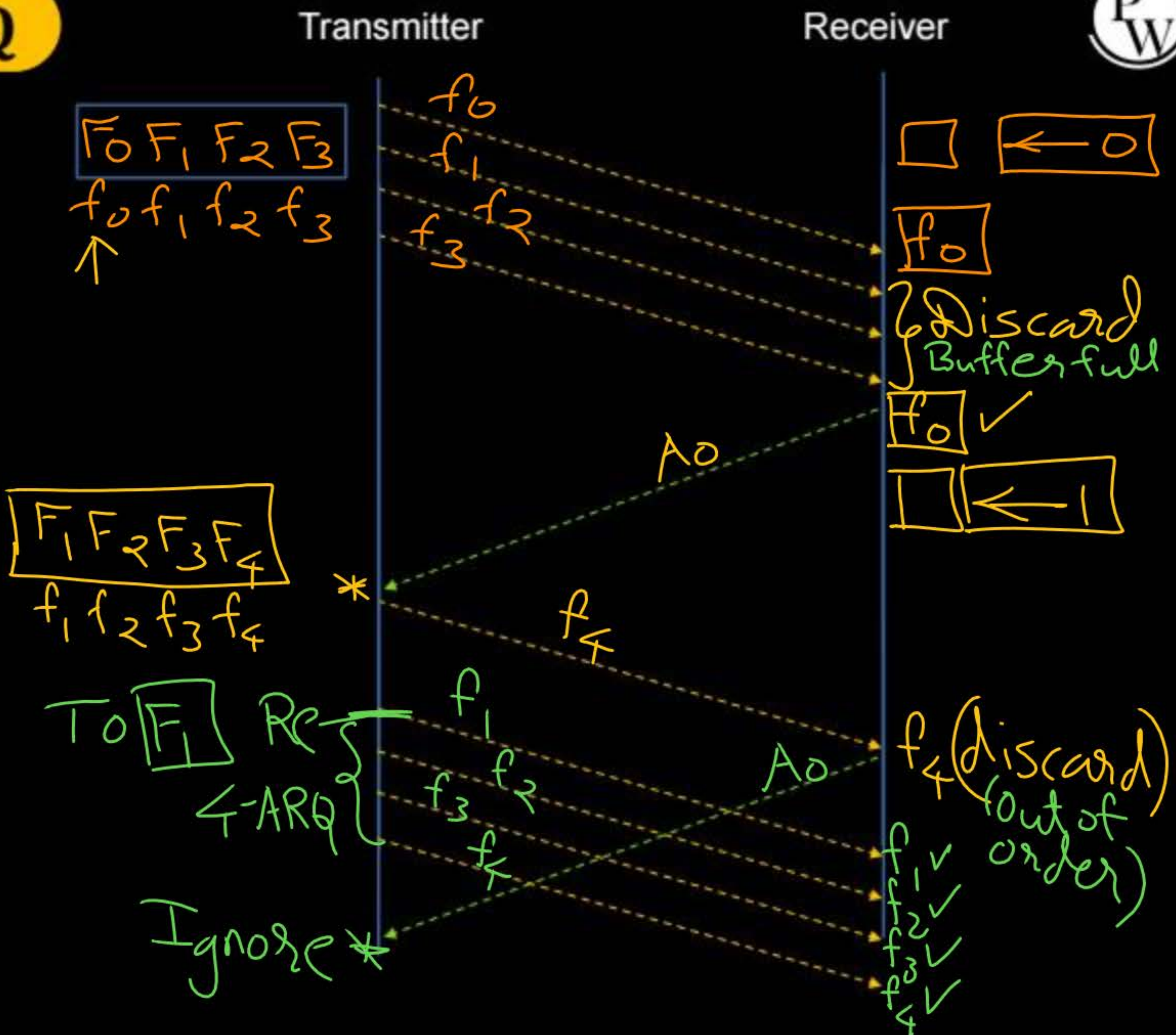


Topic : Go Back N ARQ

CASE VII :

Go back 4 ARQ

Sequence Number = $\boxed{0 \text{ to } 4}$



Topic : Go Back N ARQ

→ Transmitter transmit N frames without any acknowledgment

→ Receiver transmit "individual acknowledgment"
[for every successfully received frame]

→ "Cumulative (combine) acknowledgment" may exist.
[Acknowledges more than one frame]

Topic : Go Back N ARQ

→ Whenever transmitter gets time-out or received NACK, it retransmit all N frames [those resides in transmitting window]

→ Receiver discard the frame which is out of order, and send ACK of the frame which is correctly received recently

Example 9 :- [H.W.]

#Q. Consider host A wants to send a file to Station B using go-back-N (window size 3) flow control strategy. The file is divided into 7 packets. If every 4th packet that A transmits gets lost (but no ACKs from B ever get lost), then what is the number of packets that A will transmit for sending the file to B ?

2 mins Summary

Topic Go Back N ARQ

Topic ~~Selective Repeat ARQ~~

THANK - YOU

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