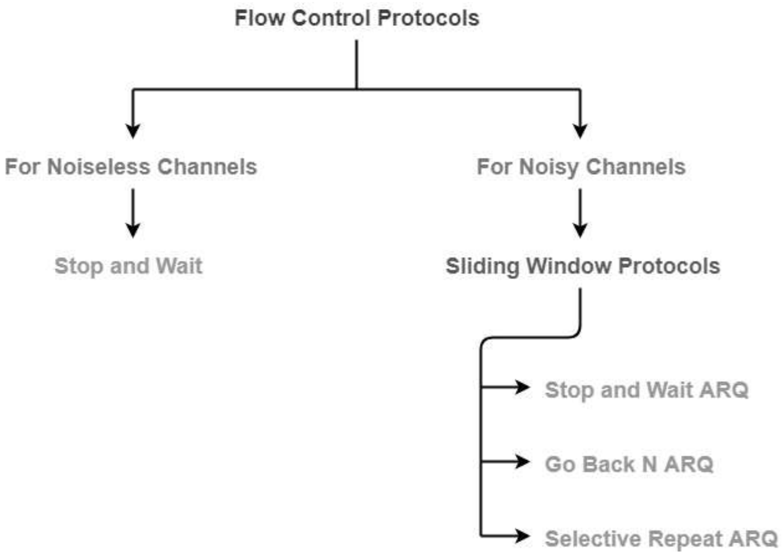
Sliding Window Protocol | Flow Control

Computer Networks

Flow Control Protocols-

In computer networking, there are various flow control protocols-



In this article, we will discuss about sliding window protocol.

Sliding Window Protocol-

- Sliding window protocol is a flow control protocol.
- It allows the sender to send multiple frames before needing the acknowledgements.
- Sender slides its window on receiving the acknowledgements for the sent frames.
- This allows the sender to send more frames.
- It is called so because it involves sliding of sender's window.

> Maximum number of frames that sender can send without acknowledgement
>
> = Sender window size

Optimal Window Size-

> In a sliding window protocol, optimal sender window size = 1 + 2a

Derivation-

We know,

$$\text{Efficiency } (\eta) = \frac{T_t}{T_t + 2 \times T_p}$$

To get 100% efficiency, we must have-

$$\eta = 1$$

$$T_t / (T_t + 2T_p) = 1$$

$$T_t = T_t + 2T_p$$

Thus,

- To get 100% efficiency, transmission time must be $T_t + 2T_p$ instead of T_t.
- This means sender must send the frames in waiting time too.
- Now, let us find the maximum number of frames that can be sent in time $T_t + 2T_p$.

We have-

- In time T_t, sender sends one frame.
- Thus, In time $T_t + 2T_p$, sender can send $(T_t + 2T_p) / T_t$ frames i.e. 1+2a frames.

Thus, to achieve 100% efficiency, window size of the sender must be 1+2a.

Required Sequence Numbers-

- Each sending frame has to be given a unique sequence number.
- Maximum number of frames that can be sent in a window = 1+2a.
- So, minimum number of sequence numbers required = 1+2a.

To have 1+2a sequence numbers,

Minimum number of bits required in sequence number field = $\lceil \log_2(1+2a) \rceil$

NOTE-

- When minimum number of bits is asked, we take the ceil.
- When maximum number of bits is asked, we take the floor.

Choosing a Window Size-

The size of the sender's window is bounded by-

1. Receiver's Ability-

- Receiver's ability to process the data bounds the sender window size.
- If receiver can not process the data fast, sender has to slow down and not transmit the frames too fast.

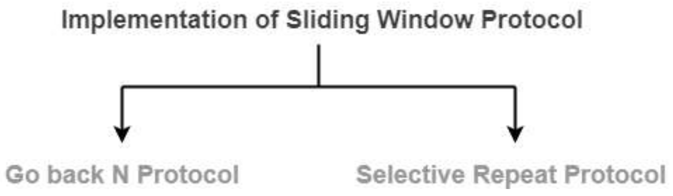
2. Sequence Number Field-

- Number of bits available in the sequence number field also bounds the sender window size.
- If sequence number field contains n bits, then 2^n sequence numbers are possible.
- Thus, maximum number of frames that can be sent in one window = 2^n.

For n bits in sequence number field, Sender Window Size = min $(1+2a\ ,\ 2^n)$

Implementations of Sliding Window Protocol-

The two well known implementations of sliding window protocol are-



1. **Go back N Protocol**
2. **Selective Repeat Protocol**

Efficiency-

Efficiency of any flow control protocol may be expressed as-

$$\text{Efficiency } (\eta) = \frac{\text{Number of frames sent in one window}}{\text{Total number of frames that can be sent in one window}}$$

OR

$$\text{Efficiency } (\eta) = \frac{\text{Sender Window Size in the Protocol}}{\text{Optimal Sender Window Size}}$$

OR

$$\text{Efficiency } (\eta) = \frac{\text{Sender Window Size in the Protocol}}{1 + 2a}$$

Example-

In **Stop and Wait ARQ**, sender window size = 1.

Thus,

Efficiency of Stop and Wait ARQ = 1 / 1+2a

PRACTICE PROBLEMS BASED ON SLIDING WINDOW PROTOCOL-

Problem-01:

If transmission delay and propagation delay in a sliding window protocol are 1 msec and 49.5 msec respectively, then-

1. What should be the sender window size to get the maximum efficiency?
2. What is the minimum number of bits required in the sequence number field?
3. If only 6 bits are reserved for sequence numbers, then what will be the efficiency?

Solution-

Given-

- Transmission delay = 1 msec
- Propagation delay = 49.5 msec

Part-01:

To get the maximum efficiency, sender window size

= 1 + 2a

= 1 + 2 x (T_p / T_t)

= 1 + 2 x (49.5 msec / 1 msec)

= 1 + 2 x 49.5

= 100

Thus,

For maximum efficiency, sender window size = 100

Part-02:

Minimum number of bits required in the sequence number field

= $\lceil \log_2(1+2a) \rceil$

= $\lceil \log_2(100) \rceil$

= $\lceil 6.8 \rceil$

= 7

Thus,

Minimum number of bits required in the sequence number field = 7

Part-03:

If only 6 bits are reserved in the sequence number field, then-

Maximum sequence numbers possible = 2^6 = 64

Now,

Efficiency

= Sender window size in the protocol / Optimal sender window size

= 64 / 100

= 0.64

= 64%

Problem-02:

If transmission delay and propagation delay in a sliding window protocol are 1 msec and 99.5 msec respectively, then-

1. What should be the sender window size to get the maximum efficiency?
2. What is the minimum number of bits required in the sequence number field?
3. If only 7 bits are reserved for sequence numbers, then what will be the efficiency?

Solution-

Given-

- Transmission delay = 1 msec
- Propagation delay = 99.5 msec

Part-01:

To get the maximum efficiency, sender window size

= 1 + 2a

= 1 + 2 x (T_p / T_t)

= 1 + 2 x (99.5 msec / 1 msec)

= 1 + 2 x 99.5

= 200

Thus,

For maximum efficiency, sender window size = 200

Part-02:

Minimum number of bits required in the sequence number field

= $\lceil \log_2(1+2a) \rceil$

= $\lceil \log_2(200) \rceil$

= $\lceil 7.64 \rceil$

= 8

Thus,

Minimum number of bits required in the sequence number field = 8

Part-03:

If only 6 bits are reserved in the sequence number field, then-

Maximum sequence numbers possible = 2^7 = 128

Now,

Efficiency

= Sender window size in the protocol / Optimal sender window size

= 128 / 200

= 0.64

= 64%

To gain better understanding about sliding window protocol,

Watch this Video Lecture

Next Article- Practice Problems On Sliding Window Protocol

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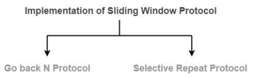
Summary



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Description	Sliding Window Protocols in computer networks are the flow control protocols. Go Back N and Selective Repeat are the implementations of sliding window protocol. Sliding Window Protocol allows the sender to send multiple frames before needing acknowledgements.
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