# Simulation and Implementation of Go-Back-N and Selective Repeat Sliding Window Protocols

## 1. Introduction

In computer networks, reliable data transfer is essential for ensuring that messages are delivered accurately and in the correct order. The Sliding Window Protocol is a fundamental technique used in the Data Link Layer and Transport Layer for efficient and reliable communication. It enables multiple frames to be transmitted before requiring an acknowledgment, thereby improving throughput and utilization of network bandwidth. Two common types of sliding window protocols are Go-Back-N (GBN) and Selective Repeat (SR).

## 2. Go-Back-N (GBN) Protocol

In Go-Back-N, the sender can send several frames before receiving an acknowledgment for the first one, but if an error occurs in any frame, all subsequent frames are retransmitted. The sender maintains a window of unacknowledged frames and uses cumulative acknowledgments. GBN is simple and efficient when the error rate is low but may result in redundant retransmissions under high error conditions.

Key Features:  
• Uses a single timer for the oldest unacknowledged frame.  
• Retransmits all frames from the error frame onward.  
• Suitable for reliable but low-error networks.

## 3. Selective Repeat (SR) Protocol

Selective Repeat improves efficiency by retransmitting only the erroneous or lost frames, rather than the entire sequence. Both sender and receiver maintain a window of frames, and acknowledgments are sent individually. This minimizes retransmission overhead and enhances performance on unreliable channels.

Key Features:  
• Independent acknowledgment for each frame.  
• Maintains buffers for out-of-order frames.  
• Higher complexity but better efficiency than GBN.

## 4. Wireshark Demonstration

To simulate and observe these protocols in peer-to-peer mode, network packets can be captured using Wireshark Packet Analyzer. The trace displays frame numbers, sequence numbers, acknowledgments, and retransmissions. This helps visualize sliding window behavior, packet loss, and retransmission patterns during communication between two nodes.

## 5. Extension to TCP Flow Control

The Transmission Control Protocol (TCP) implements a form of sliding window mechanism at the transport layer for flow control and congestion control. TCP dynamically adjusts the window size based on network conditions, ensuring efficient data flow without overwhelming the receiver. The concepts of cumulative ACKs and retransmissions in TCP are closely related to Go-Back-N and Selective Repeat principles, making these protocols foundational to modern network communication.