Selective Repeat Protocol: A Visual Implementation

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1. Introduction

The Selective Repeat (SR) protocol is a sophisticated sliding window protocol designed for reliable data transfer over unreliable networks. It implements selective retransmission and out-of-order packet acceptance, making it effective in high-latency networks.

1.1 Core Principles

- **Individual Acknowledgment:** Each packet is acknowledged independently
- **Selective Retransmission:** Only lost packets are retransmitted
- **Out-of-Order Acceptance:** Packets can be received in any order
- **Buffer Management:** Stores out-of-order packets
- **Independent Windows:** Sender and receiver maintain separate windows

1.2 Key Components

- **Sender Window:** Contains packets that can be sent, slides forward as ACKs are received
- **Receiver Window:** Accepts packets in any order, maintains buffer for out-of-order packets
- **Acknowledgment System:** Individual ACKs, timeout mechanisms, and NACKs

2. Visual Implementation

This project implements the SR protocol through an interactive visualization using HTML5 Canvas, making complex concepts tangible and easier to comprehend.

2.1 Visual Elements

- **Network Representation:** Sender/Receiver pillars, moving packets, sliding window
- **State Indicators:** Packet status, window position, buffer contents, lost packet markers
- **Protocol Operations:** Packet transmission, acknowledgment process, error handling

> **Example:** When a packet is lost, visualization shows: red cross marking, timeout timer, retransmission process, and buffer filling.

3. Implementation Details

3.1 State Management

- **Packet States:** Waiting → In-transit → Received → Acknowledged
- **Window Management:** Dynamic size adjustment, sliding mechanism, sequence tracking
- **Buffer Operations:** Out-of-order storage, packet reordering, overflow prevention

3.2 Error Handling

- **Packet Loss Detection:** Timeout-based detection, visual indicators
- **Recovery Procedures:** Selective retransmission, buffer management, window adjustment

4. Educational Value

- **Visual Learning:** Intuitive understanding through animation
- **Protocol Analysis:** Performance observation, error handling demonstration
- **Practical Understanding:** Parameter effects, network condition impact

> **Future Enhancements:** Network congestion simulation, advanced error recovery, performance comparison, custom topology creation