# **Stop-and-wait**

The sender only sends one package, and then waits for the receiver to send an ACK before doing anything else. If an NAK is received then the server sends the packet again and waits for the response.

This protocol is very simple, there is never any confusion on what packets are outstanding, as there is only ever one in transmit, there is less timers to keep track of. Stop-and-wait works well on low latency or local networks, where packet loss is almost not existent and there is high bandwidth.

# **Pipe-lining**

This method comes in two generic forms ,Go-Back-N and Selective repeat.

This time we send multiple packets at a time regardless whether we received ACKs or NAKs. This means we have to increase the sequence number and buffer the packets in certain scenarios at either end.

Pipeline approach greatly improves performance over high latency connections like satellite internet connections. It reduces the waiting time of a process. Pipeline method on its own doesn’t have a specific way it deals with lost packets or ACKs arriving out of order.

# **Go-back-N**

This protocol utilizes the pipe-lining approach, the server keeps sending up to N packets which is specified by its window size. After it has sent all the packets its wait for ACKs/NACKs. When the server receives an ACK for the first sequence packet in its window, it moves by one, allowing it send one more packet. The receiver discards any packets that arrived out of order and re-sends an ACK for the most recent packet it received, this tells the server to “go back N” and resends the packets starting with the first packet in the window it didn’t receive an ACK for.

e.g server sends packets 1,2,3. Client receives 1 and 3, in that case it sends an ACK for 1 and discards 3, and re-sends ACK 1. The server will receive 2 ACKs for 1, telling it to go back, the server sends packet 2 and 3. If the client however receives packet 4 ( because the server moved the window), it will discard 4 and resend ACK 1 again, now the server will send 2 3 and 4.

# **The best approach and why:**

Go-Back-N is the best choice of out the 3. It clearly states its procedures and accounts for all scenarios ( like packet loss, ACK/NAK loss and so on). It implements pipe-lining, which is a significant performance advantage over Stop-and-wait protocol. The connection is utilized more than in stop-and-wait. The window concept in Go-back-N makes sure that all the packets arrive, although it means that packets end up being resent.