Overview of TCP/IP

TCP/IP (Transmission Control Protocol/Internet Protocol) is a set of communication protocols used to connect computers and other network devices to the Internet. It is a suite of protocols that provides end-to-end data communication over IP networks.

Architecture of TCP/IP:

1. Application Layer: The Application Layer is the top layer of the TCP/IP architecture and is responsible for supporting communication between applications and the network. Protocols such as HTTP (Hypertext Transfer Protocol), FTP (File Transfer Protocol), SMTP (Simple Mail Transfer Protocol), and Telnet are all part of the Application Layer.

2. Transport Layer: The Transport Layer is responsible for end-to-end communication between devices and is responsible for the reliable delivery of data packets. This layer provides two protocols, TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). TCP provides a reliable, connection-oriented service for applications that require reliable data transmission, while UDP provides a connectionless, unreliable service that is suitable for applications that require fast, efficient data transmission.

3. Internet Layer: The Internet Layer is responsible for routing data packets between networks and is responsible for providing a unique address (IP address) for each device connected to the network. The main protocol used in this layer is the Internet Protocol (IP), which is responsible for routing data packets to their correct destination.

4. Network Access Layer: The Network Access Layer is the lowest layer of the TCP/IP architecture and is responsible for transmitting data over the physical network. This layer includes protocols such as Ethernet, Wi-Fi, and Bluetooth.

Adaptation of TCP Window:

The TCP (Transmission Control Protocol) window is the amount of data that a sender can transmit without receiving an acknowledgment from the receiver. The TCP window is used to control the flow of data between sender and receiver, preventing the sender from overwhelming the receiver with too much data.

The TCP window is adaptive, which means that it can be adjusted dynamically based on network conditions.

There are two main mechanisms for adapting the TCP window:

1. Slow Start: When a new TCP connection is established, the sender starts with a small window size and gradually increases it as packets are successfully transmitted and acknowledged. This process is called slow start, and it allows the sender to probe the network for the optimal window size without overwhelming the receiver.

2. Congestion Control: The TCP window size is also adjusted dynamically in response to network congestion. When the network becomes congested, packets are dropped, and the sender receives a notification in the form of a TCP segment with the congestion indication flag set. The sender then reduces the window size to prevent further congestion and retransmits the dropped packets.

Improvement in TCP Performance:

There are several techniques that can be used to improve TCP (Transmission Control Protocol) performance:

1. Window Scaling: Window Scaling is a technique that allows the TCP window to be increased beyond its default maximum value of 65,535 bytes. This technique is particularly useful for high-speed networks, where a larger window size is needed to achieve optimal performance.

2. Fast Retransmit and Fast Recovery: Fast Retransmit and Fast Recovery are techniques that allow TCP to quickly recover from packet loss without waiting for a retransmission timeout. When the sender detects the loss of a packet, it immediately retransmits the packet and reduces the window size to prevent further congestion. The receiver then acknowledges the retransmitted packet, and the sender increases the window size to resume normal transmission.

Selective Acknowledgment (SACK): Selective Acknowledgment (SACK) is a technique that allows the receiver to acknowledge multiple packets at once, rather than waiting for individual packets to be acknowledged. This technique can improve TCP performance by reducing the number of retransmissions and improving network efficiency.

3. Congestion Control Algorithms: There are several congestion control algorithms that can be used to optimize TCP performance in different network conditions. Examples include TCP Vegas, which uses a different approach to congestion detection and control than traditional TCP congestion control algorithms, and TCP Westwood, which uses a more accurate estimation of available bandwidth.

4. Explicit Congestion Notification (ECN): Explicit Congestion Notification (ECN) is a technique that allows routers to signal congestion to TCP senders before packets are dropped. This technique can improve TCP performance by allowing the sender to reduce the window size before congestion causes packet loss.

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