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Transmission Control Protocol

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Protocol stack	
Abbreviation	TCP
Developer(s)	Vint Cerf and Bob Kahn
Introduction	1974
Based on	Transmission Control Program
OSI layer	Transport layer (4)
RFC(s)	RFC 9293

The **Transmission Control Protocol** (**TCP**) is one of the main protocols of the Internet protocol suite. It originated in the initial network implementation in which it complemented the Internet Protocol (IP). Therefore, the entire suite is commonly referred to as TCP/IP. TCP provides reliable, ordered, and error-checked delivery of a stream of octets (bytes) between applications running on hosts communicating via an IP network. Major internet applications such as the World Wide Web, email, remote administration, and file transfer rely on TCP, which is part of the Transport layer of the TCP/IP suite. SSL/TLS often runs on top of TCP.

TCP is connection-oriented, and a connection between client and server is established before data can be sent. The server must be listening (passive open) for connection requests from clients before a connection is established. Three-way handshake (active open), retransmission, and error detection adds to reliability but lengthens latency. Applications that do not require reliable data stream service may use the User Datagram Protocol (UDP) instead, which provides a connectionless datagram service that prioritizes time over reliability. TCP employs network congestion avoidance. However, there are vulnerabilities in TCP, including denial of service, connection hijacking, TCP veto, and reset attack.

Historical origin

In May 1974, Vint Cerf and Bob Kahn described an internetworking protocol for sharing resources using packet switching among network nodes.[1] The authors had been working with Gérard Le Lann to incorporate concepts from the French CYCLADES project into the new network.[2] The specification of the resulting protocol, RFC 675 (*Specification of Internet Transmission Control Program*), was written by Vint Cerf, Yogen Dalal, and Carl Sunshine, and published in December 1974.[3] It contains the first attested use of the term *internet*, as a shorthand for *internetwork*.

A central control component of this model was the *Transmission Control Program* that incorporated both connection-oriented links and datagram services between hosts. The monolithic Transmission Control Program was later divided into a modular architecture consisting of the *Transmission Control Protocol* and the *Internet Protocol*. This resulted in a networking model that became known informally as *TCP/IP*, although formally it was variously referred to as the Department of Defense (DOD) model, and ARPANET model, and eventually also as the *Internet Protocol Suite*.

In 2004, Vint Cerf and Bob Kahn received the Turing Award for their foundational work on TCP/IP.[4][5]

Network function

The Transmission Control Protocol provides a communication service at an intermediate level between an application program and the Internet Protocol. It provides host-to-host connectivity at the transport layer of the Internet model. An application does not need to know the particular mechanisms for sending data via a link to another host, such as the required IP fragmentation to accommodate the maximum transmission unit of the transmission medium. At the transport layer, TCP handles all handshaking and transmission details and presents an abstraction of the network connection to the application typically through a network socket interface.

At the lower levels of the protocol stack, due to network congestion, traffic load balancing, or unpredictable network behavior, IP packets may be lost, duplicated, or delivered out of order. TCP detects these problems, requests re-transmission of lost data, rearranges out-of-order data and even helps minimize network congestion to reduce the occurrence of the other problems. If the data still remains undelivered, the source is notified of this failure. Once the TCP receiver has reassembled the sequence of octets originally transmitted, it passes them to the receiving application. Thus, TCP abstracts the application's communication from the underlying networking details.

TCP is used extensively by many internet applications, including the World Wide Web (WWW), email, File Transfer Protocol, Secure Shell, peer-to-peer file sharing, and streaming media.

TCP is optimized for accurate delivery rather than timely delivery and can incur relatively long delays (on the order of seconds) while waiting for out-of-order messages or re-transmissions of lost messages. Therefore, it is not particularly suitable for real-time applications such as voice over IP. For such applications, protocols like the Real-time Transport Protocol (RTP) operating over the User Datagram Protocol (UDP) are usually recommended instead.[6]