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CSC 402

The File Transfer Protocol (FTP)

This is a standard [network protocol](https://en.wikipedia.org/wiki/Network_protocol) used for the transfer of [computer files](https://en.wikipedia.org/wiki/Computer_file) between [a client and server](https://en.wikipedia.org/wiki/Client%E2%80%93server_model) on a [computer network](https://en.wikipedia.org/wiki/Computer_network). FTP is built on a client-server model architecture using separate control and data connections between the client and the server. FTP users may authenticate themselves with a [clear-text](https://en.wikipedia.org/wiki/Clear_text) sign-in protocol, normally in the form of a username and password, but can connect anonymously if the server is configured to allow it. For secure transmission that protects the username and password, and encrypts the content, FTP is often [secured](https://en.wikipedia.org/wiki/File_Transfer_Protocol#Security) with [SSL/TLS](https://en.wikipedia.org/wiki/Transport_Layer_Security) ([FTPS](https://en.wikipedia.org/wiki/FTPS)) or replaced with [SSH File Transfer Protocol](https://en.wikipedia.org/wiki/SSH_File_Transfer_Protocol) (SFTP).

The first FTP client applications were [command-line programs](https://en.wikipedia.org/wiki/Command-line_interface) developed before [operating systems](https://en.wikipedia.org/wiki/Operating_system) had [graphical user interfaces](https://en.wikipedia.org/wiki/Graphical_user_interface), and are still shipped with most [Windows](https://en.wikipedia.org/wiki/Windows), [Unix](https://en.wikipedia.org/wiki/Unix), and [Linux](https://en.wikipedia.org/wiki/Linux) operating systems. Many FTP clients and automation utilities have since been developed for [desktops](https://en.wikipedia.org/wiki/Desktop_computer), servers, mobile devices, and hardware, and FTP has been incorporated into productivity applications, such as [HTML editors](https://en.wikipedia.org/wiki/HTML_editor).

The Simple Mail Transfer Protocol (SMTP)

This is a [communication protocol](https://en.wikipedia.org/wiki/Communication_protocol) for [electronic mail](https://en.wikipedia.org/wiki/Email) transmission. As an [Internet standard](https://en.wikipedia.org/wiki/Internet_standard), SMTP was first defined in 1982 by [RFC](https://en.wikipedia.org/wiki/Request_for_Comments) [821](https://tools.ietf.org/html/rfc821), and updated in 2008 by [RFC](https://en.wikipedia.org/wiki/Request_for_Comments) [5321](https://tools.ietf.org/html/rfc5321) to [Extended SMTP](https://en.wikipedia.org/wiki/Extended_SMTP) additions, which is the protocol variety in widespread use today. Mail servers and other [message transfer agents](https://en.wikipedia.org/wiki/Message_transfer_agent) use SMTP to send and receive mail messages. Proprietary systems such as [Microsoft Exchange](https://en.wikipedia.org/wiki/Microsoft_Exchange_Server) and [IBM Notes](https://en.wikipedia.org/wiki/IBM_Notes) and [webmail](https://en.wikipedia.org/wiki/Webmail) systems such as [Outlook.com](https://en.wikipedia.org/wiki/Outlook.com), [Gmail](https://en.wikipedia.org/wiki/Gmail) and [Yahoo! Mail](https://en.wikipedia.org/wiki/Yahoo!_Mail) may use non-standard protocols internally, but all use SMTP when sending to or receiving email from outside their own systems. SMTP servers commonly use the [Transmission Control Protocol](https://en.wikipedia.org/wiki/Transmission_Control_Protocol) on [port number](https://en.wikipedia.org/wiki/Port_number) 25.

User-level [email clients](https://en.wikipedia.org/wiki/Email_client) typically use SMTP only for sending messages to a mail server for relaying, and typically submit outgoing email to the mail server on port 587 or 465 as per [RFC 8314](https://tools.ietf.org/html/rfc8314). For retrieving messages, [IMAP](https://en.wikipedia.org/wiki/Internet_Message_Access_Protocol) and [POP3](https://en.wikipedia.org/wiki/Post_Office_Protocol) are standard, but proprietary servers also often implement proprietary protocols, e.g., [Exchange ActiveSync](https://en.wikipedia.org/wiki/Exchange_ActiveSync).

The Internet Protocol (IP)

This is the principal [communications protocol](https://en.wikipedia.org/wiki/Communications_protocol) in the [Internet protocol suite](https://en.wikipedia.org/wiki/Internet_protocol_suite) for relaying [datagrams](https://en.wikipedia.org/wiki/Datagram) across network boundaries. Its [routing](https://en.wikipedia.org/wiki/Routing) function enables [internetworking](https://en.wikipedia.org/wiki/Internetworking), and essentially establishes the [Internet](https://en.wikipedia.org/wiki/Internet). IP has the task of delivering [packets](https://en.wikipedia.org/wiki/Packet_(information_technology)) from the source [host](https://en.wikipedia.org/wiki/Host_(network)) to the destination host solely based on the [IP addresses](https://en.wikipedia.org/wiki/IP_address) in the packet [headers](https://en.wikipedia.org/wiki/Header_(computing)). For this purpose, IP defines packet structures that [encapsulate](https://en.wikipedia.org/wiki/Encapsulation_(networking)) the data to be delivered. It also defines addressing methods that are used to label the datagram with source and destination information.

Historically, IP was the [connectionless](https://en.wikipedia.org/wiki/Connectionless_communication) datagram service in the original [Transmission Control Program](https://en.wikipedia.org/wiki/Transmission_Control_Program) introduced by [Vint Cerf](https://en.wikipedia.org/wiki/Vint_Cerf" \o "Vint Cerf) and [Bob Kahn](https://en.wikipedia.org/wiki/Bob_Kahn) in 1974, which was complemented by a connection-oriented service that became the basis for the [Transmission Control Protocol](https://en.wikipedia.org/wiki/Transmission_Control_Protocol) (TCP). The Internet protocol suite is therefore often referred to as TCP/IP.

The first major version of IP, [Internet Protocol Version 4](https://en.wikipedia.org/wiki/IPv4) (IPv4), is the dominant protocol of the Internet. Its successor is [Internet Protocol Version 6](https://en.wikipedia.org/wiki/IPv6) (IPv6), which has been in increasing [deployment](https://en.wikipedia.org/wiki/IPv6_deployment) on the public Internet since c. 2006.

The User Datagram Protocol (UDP)

In [computer networking](https://en.wikipedia.org/wiki/Computer_network), the User Datagram Protocol (UDP) is one of the core members of the [Internet protocol suite](https://en.wikipedia.org/wiki/Internet_protocol_suite). The protocol was designed by [David P. Reed](https://en.wikipedia.org/wiki/David_P._Reed) in 1980 and formally defined in [RFC](https://en.wikipedia.org/wiki/Request_for_Comments) [768](https://tools.ietf.org/html/rfc768). With UDP, computer applications can send messages, in this case referred to as [datagrams](https://en.wikipedia.org/wiki/Datagram), to other hosts on an [Internet Protocol](https://en.wikipedia.org/wiki/Internet_Protocol) (IP) network. Prior communications are not required in order to set up [communication channels](https://en.wikipedia.org/wiki/Communication_channel) or data paths.

UDP uses a simple [connectionless communication](https://en.wikipedia.org/wiki/Connectionless_communication) model with a minimum of protocol mechanisms. UDP provides [checksums](https://en.wikipedia.org/wiki/Checksum) for data integrity, and [port numbers](https://en.wikipedia.org/wiki/Port_numbers) for addressing different functions at the source and destination of the datagram. It has no [handshaking](https://en.wikipedia.org/wiki/Handshaking) dialogues, and thus exposes the user's program to any [unreliability](https://en.wikipedia.org/wiki/Reliability_(computer_networking)) of the underlying network; there is no guarantee of delivery, ordering, or duplicate protection. If error-correction facilities are needed at the network interface level, an application may use [Transmission Control Protocol](https://en.wikipedia.org/wiki/Transmission_Control_Protocol) (TCP) or [Stream Control Transmission Protocol](https://en.wikipedia.org/wiki/Stream_Control_Transmission_Protocol) (SCTP) which are designed for this purpose.

UDP is suitable for purposes where error checking and correction are either not necessary or are performed in the application; UDP avoids the overhead of such processing in the [protocol stack](https://en.wikipedia.org/wiki/Protocol_stack). Time-sensitive applications often use UDP because dropping packets is preferable to waiting for packets delayed due to [retransmission](https://en.wikipedia.org/wiki/Retransmission_(data_networks)), which may not be an option in a [real-time system](https://en.wikipedia.org/wiki/Real-time_system).