## Firewall:

A firewall is a [network security](http://en.wikipedia.org/wiki/Network_security) system that controls the incoming and outgoing network traffic based on an applied rule set. A firewall establishes a barrier between a trusted, secure internal network and another network (e.g., the Internet) that is assumed not to be secure and trusted. Firewalls exist both as software to run on general purpose hardware and as a hardware appliance. Many hardware-based firewalls also offer other functionality to the internal network they protect, such as acting as a [DHCP](http://en.wikipedia.org/wiki/DHCP) server for that network.

### Types of Firewall:

There are different types of firewalls depending on where the communication is taking place, where the communication is intercepted and the state that is being traced.

 Network layer Firewall  [Application layer firewall](http://en.wikipedia.org/wiki/Application_layer_firewall)  [Proxy server](http://en.wikipedia.org/wiki/Proxy_server)

 [Network address translation](http://en.wikipedia.org/wiki/Network_address_translation)

##### Network layer Firewall:

Network layer firewalls, also called packet filters, operate at a relatively low level of the [TCP/IP](http://en.wikipedia.org/wiki/Internet_protocol_suite) [protocol stack](http://en.wikipedia.org/wiki/Protocol_stack), not allowing packets to pass through the firewall unless they match the established rule set. The firewall administrator may define the rules; or default rules may apply.

Network layer firewalls generally fall into two sub-categories,  [Stateful](http://en.wikipedia.org/wiki/Stateful_firewall) Firewalls

 [Stateless](http://en.wikipedia.org/wiki/Stateless_firewall) Firewalls

Stateful firewalls maintain context about active sessions, and use that "state information" to speed packet processing. Any existing network connection can be described by several properties, including source and destination IP address, UDP or TCP ports, and the current stage of the connection's lifetime (including session initiation, [handshaking,](http://en.wikipedia.org/wiki/Handshaking) [data](http://en.wikipedia.org/wiki/Data) transfer, or completion connection). If a packet does not match an existing connection, it will be evaluated according to the rule set for new connections. If a packet matches an existing connection based on comparison with the firewall's state table, it will be allowed to pass without further processing.

Stateless firewalls require less memory, and can be faster for simple filters that require less time to filter than to look up a session. They may also be necessary for filtering stateless network protocols that have no concept of a session. However, they cannot make more complex decisions based on what stage communications between hosts have reached.

##### [Application Layer Firewall](http://en.wikipedia.org/wiki/Application_layer_firewall):

Application-layer firewalls work on the application level of the TCP/IP stack (i.e., all browser traffic, or all [telnet](http://en.wikipedia.org/wiki/Telnet) or [ftp](http://en.wikipedia.org/wiki/Ftp) traffic), and may intercept all packets traveling to or from an application. They block other packets (usually dropping them without acknowledgment to the sender).

On inspecting all packets for improper content, firewalls can restrict or prevent outright the spread of networked [computer worms](http://en.wikipedia.org/wiki/Computer_worm) and [trojans.](http://en.wikipedia.org/wiki/Trojan_horse_%28computing%29) The additional inspection criteria can add extra latency to the forwarding of packets to their destination.

Application firewalls function by determining whether a process should accept any given connection. Application firewalls accomplish their function by hooking into socket calls to filter the connections between the application layer and the lower layers of the OSI model. Application firewalls that hook into socket calls are also referred to as socket

filters. Application firewalls work much like a packet filter but application filters apply filtering rules (allow/block) on a per process basis instead of filtering connections on a per port basis. Generally, prompts are used to define rules for processes that have not yet received a connection. It is rare to find application firewalls not combined or used in conjunction with a packet filter.

Also, application firewalls further filter connections by examining the process ID of data packets against a ruleset for the local process involved in the data transmission. The extent of the filtering that occurs is defined by the provided ruleset. Given the variety of software that exists, application firewalls only have more complex rulesets for the standard services, such as sharing services. These per process rulesets have limited efficacy in filtering every possible association that may occur with other processes.

##### [Proxy server](http://en.wikipedia.org/wiki/Proxy_server):

A proxy server running either on dedicated hardware or as software on a general-purpose machine may act as a firewall by responding to input packets (connection requests, for example) in the manner of an application, while blocking other packets. A proxy server is a gateway from one network to another for a specific network application, in the sense that it functions as a proxy on behalf of the network user.

Proxies make tampering with an internal system from the external network more difficult and misuse of one internal system would not necessarily cause a security breach exploitable from outside the firewall. Conversely, intruders may [hijack](http://en.wiktionary.org/wiki/Hijack) a publicly reachable system and use it as a proxy for their own purposes; the proxy then [masquerades](http://en.wikipedia.org/wiki/Spoofing_attack) as that system to other internal machines. While use of internal address spaces enhances security, [crackers](http://en.wikipedia.org/wiki/Security_cracking) may still employ methods such as [IP spoofing](http://en.wikipedia.org/wiki/IP_spoofing) to attempt to pass packets to a target network.

##### [Network Address Translation](http://en.wikipedia.org/wiki/Network_address_translation):

Firewalls often have [network address translation](http://en.wikipedia.org/wiki/Network_address_translation) (NAT) functionality, and the hosts protected behind a firewall commonly have addresses in the "private address range", as defined in [RFC 1918.](http://tools.ietf.org/html/rfc1918)

Firewalls often have such functionality to hide the true address of protected hosts. Originally, the NAT function was developed to address the limited number of IPv4 routable addresses that could be used or assigned to companies or individuals as well as reduce both the amount and therefore cost of obtaining enough public addresses for every computer in an organization. Hiding the addresses of protected devices has become an increasingly important defense against [network reconnaissance.](http://en.wikipedia.org/wiki/Vulnerability_scanner)

## Digital Signatures:

A digital signature is a mathematical scheme for demonstrating the authenticity of a digital message or document. A valid digital signature gives a recipient reason to believe that the message was created by a known sender, such that the sender cannot deny having sent the message ([authentication](http://en.wikipedia.org/wiki/Authentication) and [non-repudiation](http://en.wikipedia.org/wiki/Non-repudiation)) and that the message was not altered in transit ([integrity](http://en.wikipedia.org/wiki/Data_integrity)). Digital signatures are commonly used for software distribution, financial transactions, and in other cases where it is important to detect forgery or tampering.

Digital signatures are often used to implement [electronic signatures,](http://en.wikipedia.org/wiki/Electronic_signature) a broader term that refers to any electronic data that carries the intent of a signature, but not all electronic signatures use digital signatures. In some countries, including the United States, India, Brazil, and members of the [European Union,](http://en.wikipedia.org/wiki/European_Union) electronic signatures have legal significance.

A digital signature scheme typically consists of three algorithms;

 A [key generation](http://en.wikipedia.org/wiki/Key_generation) algorithm that selects a private key [uniformly at random](http://en.wikipedia.org/wiki/Uniform_distribution_%28discrete%29) from a set of possible private keys. The algorithm outputs the private key and a corresponding public key.

 A signing algorithm that, given a message and a private key, produces a signature.

 A signature verifying algorithm that, given a message, public key and a signature, either accepts or rejects the message's claim to authenticity.

### Applications of digital signatures:

##### Authentication:

Although messages may often include information about the entity sending a message, that information may not be accurate. Digital signatures can be used to authenticate the source of messages. When ownership of a digital signature secret key is bound to a specific user, a valid signature shows that the message was sent by that user. The importance of high confidence in sender authenticity is especially obvious in a financial context. For example, suppose a bank's branch office sends instructions to the central office requesting a change in the balance of an account. If the central office is not convinced that such a message is truly sent from an authorized source, acting on such a request could be a grave mistake.

##### Integrity:

In many scenarios, the sender and receiver of a message may have a need for confidence that the message has not been altered during transmission. Although encryption hides the contents of a message, it may be possible to change an encrypted message without understanding it. (Some encryption algorithms, known as [nonmalleable](http://en.wikipedia.org/wiki/Malleability_%28cryptography%29) ones, prevent this, but others do not.) However, if a message is digitally signed, any change in the message after signature invalidates the signature. Furthermore, there is no efficient way to modify a message and its signature to produce a new message with a valid signature, because this is still considered to be computationally infeasible by most cryptographic hash functions (see [collision resistance](http://en.wikipedia.org/wiki/Collision_resistance)).

##### Non-repudiation:

[Non-repudiation,](http://en.wikipedia.org/wiki/Non-repudiation) or more specifically non-repudiation of origin, is an important aspect of digital signatures. By this property, an entity that has signed some information cannot at a later time deny having signed it. Similarly, access to the public key only does not enable a fraudulent party to fake a valid signature.

### Some digital signature algorithms:

 [RSA](http://en.wikipedia.org/wiki/RSA_%28algorithm%29)-based signature schemes, such as [RSA-PSS](http://en.wikipedia.org/wiki/RSA-PSS)  [DSA](http://en.wikipedia.org/wiki/Digital_Signature_Algorithm) and its [elliptic curve](http://en.wikipedia.org/wiki/Elliptic_curve_cryptography) variant [ECDSA](http://en.wikipedia.org/wiki/Elliptic_Curve_DSA)

 [ElGamal signature scheme](http://en.wikipedia.org/wiki/ElGamal_signature_scheme) as the predecessor to DSA, and variants [Schnorr signature](http://en.wikipedia.org/wiki/Schnorr_signature) and [Pointcheval–Stern signature algorithm](http://en.wikipedia.org/wiki/Pointcheval%E2%80%93Stern_signature_algorithm)

 [Rabin signature algorithm](http://en.wikipedia.org/wiki/Rabin_signature_algorithm)

 [Pairing](http://en.wikipedia.org/wiki/Pairing)-based schemes such as [BLS](http://en.wikipedia.org/wiki/Boneh%E2%80%93Lynn%E2%80%93Shacham)  [Undeniable signatures](http://en.wikipedia.org/wiki/Undeniable_signature)

 [Aggregate signature](http://en.wikipedia.org/w/index.php?title=Aggregate_signature&action=edit&redlink=1) - a signature scheme that supports aggregation: Given n signatures on n messages from n users, it is possible to aggregate all these signatures into a single signature whose size is constant in the number of users. This single signature will convince the verifier that the n users did indeed sign the n original messages.

 [Signatures with efficient protocols](http://en.wikipedia.org/wiki/Signatures_with_efficient_protocols) - are signature schemes that facilitate efficient cryptographic protocols such as [zero-knowledge proofs](http://en.wikipedia.org/wiki/Zero-knowledge_proofs) or [secure computation](http://en.wikipedia.org/wiki/Secure_computation).

## Digital Certificate:

 It is an electronic document used to prove ownership of a [public key.](http://en.wikipedia.org/wiki/Public_key) The certificate includes information about the key, information about its owner's identity, and the [digital](http://en.wikipedia.org/wiki/Digital_signature) [signature](http://en.wikipedia.org/wiki/Digital_signature) of an entity that has verified the certificate's contents are correct. If the signature is valid, and the person examining the certificate trusts the signer, then they know they can use that key to communicate with its owner.

 The most common use of a digital certificate is to verify that a user sending a message is who he or she claims to be, and to provide the receiver with the means to encode a reply. An individual wishing to send an encrypted message applies for a digital certificate from a Certificate Authority (CA). The CA issues an encrypted digital certificate containing the applicant's public key and a variety of other identification information. The CA makes its own public key readily available through print publicity or perhaps on the Internet.

 The recipient of an encrypted message uses the CA's public key to decode the digital certificate attached to the message, verifies it as issued by the CA and then obtains the

sender's public key and identification information held within the certificate. With this information, the recipient can send an encrypted reply.

The most widely used standard for digital certificates is X.509.

### Contents Of a Typical Digital Certificate:

 Serial Number: Used to uniquely identify the certificate.  Subject: The person, or entity identified.

 Signature Algorithm: The algorithm used to create the signature.

 Signature: The actual signature to verify that it came from the issuer.

 Issuer: The entity that verified the information and issued the certificate.  Valid-From: The date the certificate is first valid from.

 Valid-To: The expiration date.

 Key-Usage: Purpose of the public key (e.g. encipherment, signature, certificate signing...).

 Public Key: The public key.

 Thumbprint Algorithm: The algorithm used to [hash](http://en.wikipedia.org/wiki/Cryptographic_hash_function) the public key certificate.

 Thumbprint (also known as [fingerprint](http://en.wikipedia.org/wiki/Public_key_fingerprint)): The hash itself, used as an abbreviated form of the public key certificate.