**BASIS 🡺 Bangladesh Association of Software and Information Services (BASIS)**

ASCII

**ASCII** ([Listen](https://upload.wikimedia.org/wikipedia/commons/3/3b/En-us-ASCII.ogg)[**i**](https://en.wikipedia.org/wiki/File:En-us-ASCII.ogg)[/ˈæski/](https://en.wikipedia.org/wiki/Help:IPA_for_English) [***ass****-kee*](https://en.wikipedia.org/wiki/Help:Pronunciation_respelling_key)),[[1]](https://en.wikipedia.org/wiki/ASCII#cite_note-Mackenzie_1980-1):6 abbreviated from **American Standard Code for Information Interchange**, is a [character encoding](https://en.wikipedia.org/wiki/Character_encoding) standard (the [Internet Assigned Numbers Authority](https://en.wikipedia.org/wiki/Internet_Assigned_Numbers_Authority) (IANA) prefers the name **US-ASCII**[[2]](https://en.wikipedia.org/wiki/ASCII#cite_note-IANA_2007-2)). ASCII codes represent text in computers, [telecommunications equipment](https://en.wikipedia.org/wiki/Telecommunications_equipment), and other devices. Most modern character-encoding schemes are based on ASCII, although they support many additional characters.

Digital signature

A **digital signature** is a mathematical scheme for demonstrating the authenticity of digital messages or documents. A valid digital signature gives a recipient reason to believe that the message was created by a known sender ([authentication](https://en.wikipedia.org/wiki/Authentication)), that the sender cannot deny having sent the message ([non-repudiation](https://en.wikipedia.org/wiki/Non-repudiation)), and that the message was not altered in transit ([integrity](https://en.wikipedia.org/wiki/Data_integrity)).

Digital signatures are a standard element of most [cryptographic protocol](https://en.wikipedia.org/wiki/Cryptographic_protocol) suites, and are commonly used for software distribution, financial transactions, [contract management software](https://en.wikipedia.org/wiki/Contract_management_software), and in other cases where it is important to detect forgery or tampering.

## **Definition of Digital Signature[**[**edit**](https://en.wikipedia.org/w/index.php?title=Digital_signature&action=edit&section=2)**]**

*Main article:*[*Public-key cryptography*](https://en.wikipedia.org/wiki/Public-key_cryptography)

A digital signature scheme typically consists of three algorithms;

* A [*key generation*](https://en.wikipedia.org/wiki/Key_generation) algorithm that selects a *private key* [uniformly at random](https://en.wikipedia.org/wiki/Uniform_distribution_(discrete)) 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 the message, public key and signature, either accepts or rejects the message's claim to authenticity.

Two main properties are required. First, the authenticity of a signature generated from a fixed message and fixed private key can be verified by using the corresponding public key. Secondly, it should be computationally infeasible to generate a valid signature for a party without knowing that party's private key. A digital signature is an authentication mechanism that enables the creator of the message to attach a code that acts as a signature. The [Digital Signature Algorithm](https://en.wikipedia.org/wiki/Digital_Signature_Algorithm) (DSA), developed by the [National Institute of Standards and Technology](https://en.wikipedia.org/wiki/National_Institute_of_Standards_and_Technology), is one of [many examples](https://en.wikipedia.org/wiki/Digital_signature#Some_digital_signature_algorithms) of a signing algorithm.

In the following discussion, 1*n* refers to a [unary number](https://en.wikipedia.org/wiki/Unary_numeral_system).

Formally, a **digital signature scheme** is a triple of probabilistic polynomial time algorithms, (*G*, *S*, *V*), satisfying:

* *G* (key-generator) generates a public key, *pk*, and a corresponding private key, *sk*, on input 1*n*, where *n* is the security parameter.
* *S* (signing) returns a tag, *t*, on the inputs: the private key, *sk*, and a string, *x*.
* *V* (verifying) outputs *accepted* or *rejected* on the inputs: the public key, *pk*, a string, *x*, and a tag, *t*.

For correctness, *S* and *V* must satisfy

Pr [ (*pk*, *sk*) ← *G*(1*n*), *V*( *pk*, *x*, *S*(*sk*, *x*) ) = *accepted* ] = 1.[[8]](https://en.wikipedia.org/wiki/Digital_signature#cite_note-8)

A digital signature scheme is **secure** if for every non-uniform probabilistic polynomial time [adversary](https://en.wikipedia.org/wiki/Adversary_(cryptography)), *A*

Pr [ (*pk*, *sk*) ← *G*(1*n*), (*x*, *t*) ← *AS*(*sk*, · )(*pk*, 1*n*), *x* ∉ *Q*, *V*(*pk*, *x*, *t*) = *accepted*] < [negl](https://en.wikipedia.org/wiki/Negligible_function)(*n*),

where *AS*(*sk*, · ) denotes that *A* has access to the [oracle](https://en.wikipedia.org/wiki/Oracle_machine), *S*(*sk*, · ), and *Q* denotes the set of the queries on *S* made by *A*, which knows the public key, *pk*, and the security parameter, *n*. Note that we require any adversary cannot directly query the string, *x*, on *S*.[[9]](https://en.wikipedia.org/wiki/Digital_signature#cite_note-9)

## **How they work[**[**edit**](https://en.wikipedia.org/w/index.php?title=Digital_signature&action=edit&section=4)**]**

To create RSA signature keys, generate a RSA key pair containing a modulus, *N*, that is the product of two large primes, along with integers, *e* and *d*, such that *e d* [≡](https://en.wikipedia.org/wiki/Modular_arithmetic) 1 (mod φ(*N*)), where φ is the [Euler phi-function](https://en.wikipedia.org/wiki/Euler%27s_totient_function). The signer's public key consists of *N* and *e*, and the signer's secret key contains *d*.

To sign a message, *m*, the signer computes a signature, σ, such that σ ≡ *md* (mod *N*). To verify, the receiver checks that σ*e* ≡ *m* (mod *N*).

As noted earlier, this basic scheme is not very secure. To prevent attacks, one can first apply a [cryptographic hash function](https://en.wikipedia.org/wiki/Cryptographic_hash_function) to the message, *m*, and then apply the RSA algorithm described above to the result. This approach is secure assuming the hash function is a [random oracle](https://en.wikipedia.org/wiki/Random_oracle_model).

Most early signature schemes were of a similar type: they involve the use of a [trapdoor permutation](https://en.wikipedia.org/wiki/Trapdoor_permutation), such as the RSA function, or in the case of the Rabin signature scheme, computing square modulo composite, *n.* A trapdoor permutation family is a family of [permutations](https://en.wikipedia.org/wiki/Permutation), specified by a parameter, that is easy to compute in the forward direction, but is difficult to compute in the reverse direction without already knowing the private key ("trapdoor"). Trapdoor permutations can be used for digital signature schemes, where computing the reverse direction with the secret key is required for signing, and computing the forward direction is used to verify signatures.

Used directly, this type of signature scheme is vulnerable to a key-only existential forgery attack. To create a forgery, the attacker picks a random signature σ and uses the verification procedure to determine the message, *m*, corresponding to that signature.[[19]](https://en.wikipedia.org/wiki/Digital_signature#cite_note-19) In practice, however, this type of signature is not used directly, but rather, the message to be signed is first [hashed](https://en.wikipedia.org/wiki/Cryptographic_hash_function) to produce a short digest that is then signed. This forgery attack, then, only produces the hash function output that corresponds to σ, but not a message that leads to that value, which does not lead to an attack. In the random oracle model, this [hash-then-sign](https://en.wikipedia.org/wiki/Full_domain_hash) form of signature is existentially unforgeable, even against a [chosen-plaintext attack](https://en.wikipedia.org/wiki/Chosen-plaintext_attack).[[11]](https://en.wikipedia.org/wiki/Digital_signature#cite_note-lysythesis-11)[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)]

There are several reasons to sign such a hash (or message digest) instead of the whole document.

**For efficiency**

The signature will be much shorter and thus save time since hashing is generally much faster than signing in practice.

**For compatibility**

Messages are typically bit strings, but some signature schemes operate on other domains (such as, in the case of RSA, numbers modulo a composite number *N*). A hash function can be used to convert an arbitrary input into the proper format.

**For integrity**

Without the hash function, the text "to be signed" may have to be split (separated) in blocks small enough for the signature scheme to act on them directly. However, the receiver of the signed blocks is not able to recognize if all the blocks are present and in the appropriate order.

## **What are digital signatures?**

Digital signatures are like electronic “fingerprints.” In the form of a coded message, the digital signature securely associates a signer with a document in a recorded transaction. Digital signatures use a standard, accepted format, called [Public Key Infrastructure (PKI)](https://www.docusign.com/how-it-works/electronic-signature/digital-signature/digital-signature-faq#pki), to provide the highest levels of security and universal acceptance. They are a specific signature technology implementation of electronic signature (eSignature).

### **What’s the difference between a digital signature and an electronic signature?**

The broad category of electronic signatures (eSignatures) encompasses many types of electronic signatures. The category includes digital signatures, which are a specific technology implementation of electronic signatures. Both digital signatures and other eSignature solutions allow you to sign documents and authenticate the signer. However, there are differences in purpose, technical implementation, geographical use, and [legal](https://www.docusign.com/how-it-works/legality) and cultural acceptance of digital signatures versus other types of eSignatures.

In particular, the use of digital signature technology for eSignatures varies significantly between countries that follow open, technology-neutral eSignature laws, including the United States, United Kingdom, Canada, and Australia, and those that follow tiered eSignature models that prefer locally defined standards that are based on digital signature technology, including many countries in the European Union, South America, and Asia. In addition, some industries also support specific standards that are based on digital signature technology.

### **Want to sign online but don’t need a digital signature?**

[Learn more about electronic signatures](https://www.docusign.com/how-it-works/electronic-signature)

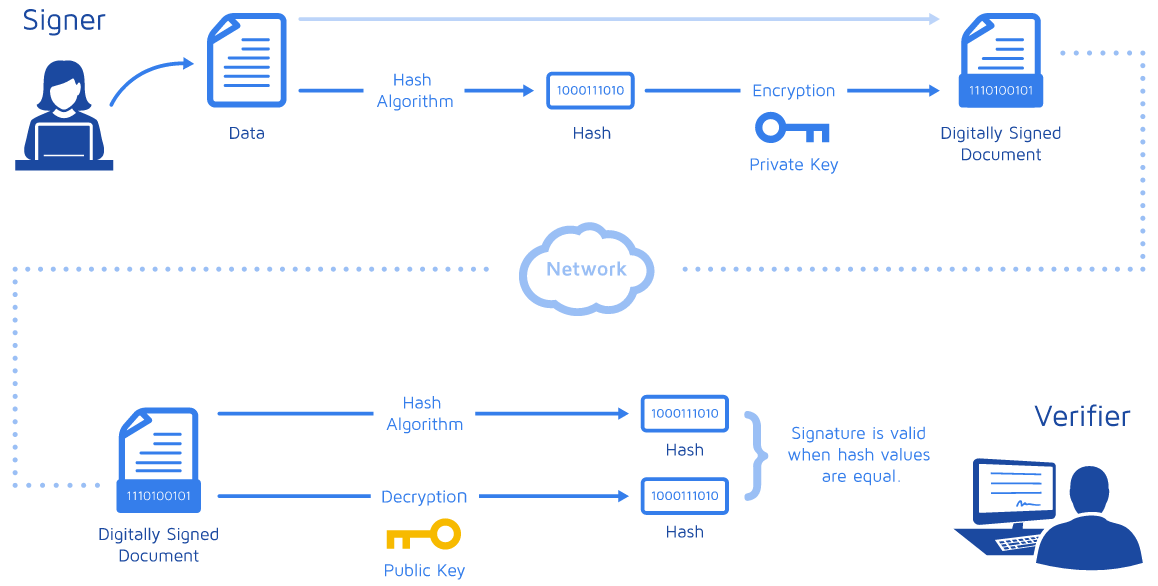
### **How do digital signatures work?**

Digital signatures, like handwritten signatures, are unique to each signer. Digital signature solution providers, such as DocuSign, follow a specific protocol, called [PKI](https://www.docusign.com/how-it-works/electronic-signature/digital-signature/digital-signature-faq#pki). PKI requires the provider to use a mathematical algorithm to generate two long numbers, called keys. One key is public, and one key is private.

When a signer electronically signs a document, the signature is created using the signer’s private key, which is always securely kept by the signer. The mathematical algorithm acts like a cipher, creating data matching the signed document, called a hash, and encrypting that data. The resulting encrypted data is the digital signature. The signature is also marked with the time that the document was signed. If the document changes after signing, the digital signature is invalidated.

As an example, Jane signs an agreement to sell a timeshare using her private key. The buyer receives the document. The buyer who receives the document also receives a copy of Jane’s public key. If the public key can’t decrypt the signature (via the cipher from which the keys were created), it means the signature isn’t Jane’s, or has been changed since it was signed. The signature is then considered invalid.

To protect the integrity of the signature, PKI requires that the keys be created, conducted, and saved in a secure manner, and often requires the services of a reliable [Certificate Authority (CA)](https://www.docusign.com/how-it-works/electronic-signature/digital-signature/digital-signature-faq#cert). Digital signature providers, like DocuSign, meet PKI requirements for safe digital signing.



digital signature

A digital signature (not to be confused with a [digital certificate](http://searchsecurity.techtarget.com/definition/digital-certificate)) is a mathematical technique used to validate the authenticity and integrity of a message, software or digital document.

digital certificate

A digital certificate is an electronic "passport" that allows a person, computer or organization to exchange information securely over the Internet using the [public key](http://searchsecurity.techtarget.com/definition/public-key) infrastructure ([PKI](http://searchsecurity.techtarget.com/definition/PKI)). A digital certificate may also be referred to as a [public key certificate](http://searchsecurity.techtarget.com/definition/public-key-certificate).

public key

In [cryptography](http://searchsoftwarequality.techtarget.com/definition/cryptography), a public key is a value provided by a designated authority as an [encryption](http://searchsecurity.techtarget.com/definition/encryption) [key.](http://searchsecurity.techtarget.com/definition/key) A system for using public keys is called a public key infrastructure ([PKI](http://searchsecurity.techtarget.com/definition/PKI)). The Public-Key Cryptography Standards ([PKCS](http://searchsecurity.techtarget.com/definition/Public-Key-Cryptography-Standards)) are a set of intervendor standard protocols for making possible secure information exchange on the Internet using a public key infrastructure (PKI).

cryptography

Cryptography is a method of storing and transmitting data in a particular form so that only those for whom it is intended can read and process it.

### **Symmetric Encryption**

Symmetric encryption is the oldest and best-known technique. A secret key, which can be a number, a word, or just a string of random letters, is applied to the text of a message to change the content in a particular way. This might be as simple as shifting each letter by a number of places in the alphabet. As long as both sender and recipient know the secret key, they can encrypt and decrypt all messages that use this key.

### **Asymmetric Encryption**

The problem with secret keys is exchanging them over the Internet or a large network while preventing them from falling into the wrong hands. Anyone who knows the secret key can decrypt the message. One answer is asymmetric encryption, in which there are two related keys--a key pair. A public key is made freely available to anyone who might want to send you a message. A second, private key is kept secret, so that only you know it.   
  
Any message (text, binary files, or documents) that are encrypted by using the public key can only be decrypted by applying the same algorithm, but by using the matching private key. Any message that is encrypted by using the private key can only be decrypted by using the matching public key.   
  
  
This means that you do not have to worry about passing public keys over the Internet (the keys are supposed to be public). A problem with asymmetric encryption, however, is that it is slower than symmetric encryption. It requires far more processing power to both encrypt and decrypt the content of the message.

public key certificate

A public key certificate is a digitally signed document that serves to validate the sender's authorization and name. The document consists of a specially formatted block of data that contains the name of the certificate holder (which may be either a user or a system name) and the holder's [public key](http://searchsecurity.techtarget.com/definition/public-key), as well as the [digital signature](http://searchsecurity.techtarget.com/definition/digital-signature) of a certification authority for authentication. The certification authority attests that the sender's name is the one associated with the public key in the document. A user ID packet, containing the sender's unique identifier, is sent after the certificate packet. There are different types of public key certificates for different functions, such as authorization for a specific action or delegation of authority. Public key certificates are part of a [public key infrastructure](http://searchsecurity.techtarget.com/definition/PKI) that deals with digitally signed documents. The other components are public key [encryption](http://searchsecurity.techtarget.com/definition/encryption), trusted third parties (such as the certification authority), and mechanisms for certificate publication and issuing.

# RAID - redundant array of independent disks

**RAID**is short for***r***edundant***a***rray of***i***ndependent***d***isks.

Originally, the term RAID was defined as ***r***edundant***a***rray of***i***nexpensive***d***isks, but now it usually refers to a ***r***edundant***a***rray of***i***ndependent***d***isks. RAID storage uses multiple disks in order to provide fault tolerance, to improve overall performance, and to increase [storage](http://www.webopedia.com/TERM/M/mass_storage.html) capacity in a system. This is in contrast with older storage devices that used only a single disk drive to store data.

RAID allows you to store the same data [redundantly](http://www.webopedia.com/TERM/R/redundant.html) (in multiple paces) in a balanced way to improve overall performance. RAID disk drives are used frequently on servers but aren't generally necessary for personal computers.

## *How RAID Works*

With RAID technology, data can be [mirrored](http://www.webopedia.com/TERM/D/data_mirroring.html) on one or more disks in the same array, so that if one disk fails, the data is preserved. Thanks to a technique known as [striping](http://www.webopedia.com/TERM/D/disk_striping.html) (a technique for spreading data over multiple disk drives), RAID also offers the option of reading or writing to more than one disk at the same time in order to improve performance.

In this arrangement, [sequential](http://www.webopedia.com/TERM/S/sequential_access.html) data is broken into segments which are sent to the various disks in the array, speeding up throughput. A typical RAID array uses multiple disks that appear to be a single device so it can provide more storage capacity than a single disk.

## *Standard RAID Levels*

RAID devices use many different architectures, called levels, depending on the desired balance between performance and fault tolerance. RAID levels describe how data is distributed across the drives. Standard RAID levels include the following:

### Level 0: Striped disk array without fault tolerance

Provides data striping (spreading out blocks of each file across multiple disk drives) but no redundancy. This improves performance but does not deliver fault tolerance. If one drive fails then all data in the array is lost.

### Level 1: Mirroring and duplexing

Provides disk mirroring. Level 1 provides twice the read transaction rate of single disks and the same write transaction rate as single disks.

### Level 2: Error-correcting coding

Not a typical implementation and rarely used, Level 2 stripes data at the bit level rather than the block level.

### Level 3: Bit-interleaved parity

Provides byte-level striping with a dedicated parity disk. Level 3, which cannot service simultaneous multiple requests, also is rarely used.

### Level 4: Dedicated parity drive

A commonly used implementation of RAID, Level 4 provides block-level striping (like Level 0) with a parity disk. If a data disk fails, the parity data is used to create a replacement disk. A disadvantage to Level 4 is that the parity disk can create write bottlenecks.

### Level 5: Block interleaved distributed parity

Provides data striping at the byte level and also stripe error correction information. This results in excellent performance and good fault tolerance. Level 5 is one of the most popular implementations of RAID.

### Level 6: Independent data disks with double parity

Provides block-level striping with parity data distributed across all disks.

### Level 10: A stripe of mirrors

Not one of the original RAID levels, multiple RAID 1 mirrors are created, and a RAID 0 stripe is created over these.

## *Non-Standard RAID Levels*

Some devices use more than one level in a hybrid or nested arrangement, and some vendors also offer non-standard proprietary RAID levels. Examples of non-standard RAID levels include the following:

### Level 0+1: A Mirror of Stripes

Not one of the original RAID levels, two RAID 0 stripes are created, and a RAID 1 mirror is created over them. Used for both replicating and sharing data among disks.

### Level 7

A trademark of Storage Computer Corporation that adds caching to Levels 3 or 4.

### RAID 1E

A RAID 1 implementation with more than two disks. Data striping is combined with mirroring each written stripe to one of the remaining disks in the array.

### RAID S

Also called Parity RAID, this is EMC Corporation's proprietary striped parity RAID system used in its Symmetrix storage systems.

# SAN (Storage Area Network)

A **storage area network** (**SAN**) is a network which provides access to consolidated, block level data**storage**. SANs are primarily used to enhance **storage**devices, such as disk arrays, tape libraries, and optical jukeboxes, accessible to servers so that the devices appear to the operating system as locally attached devices.

A **storage area network** (**SAN**) [[1]](https://en.wikipedia.org/wiki/Storage_area_network#cite_note-1) is a network which provides access to consolidated, [block level data storage](https://en.wikipedia.org/wiki/Block_device). SANs are primarily used to enhance storage devices, such as [disk arrays](https://en.wikipedia.org/wiki/Disk_array), [tape libraries](https://en.wikipedia.org/wiki/Tape_library), and [optical jukeboxes](https://en.wikipedia.org/wiki/Optical_jukebox), accessible to [servers](https://en.wikipedia.org/wiki/Server_(computing)) so that the devices appear to the [operating system](https://en.wikipedia.org/wiki/Operating_system) as [locally attached devices](https://en.wikipedia.org/wiki/Direct-attached_storage). A SAN typically has its own network of storage devices that are generally not accessible through the local area network (LAN) by other devices. The cost and complexity of SANs dropped in the early 2000s to levels allowing wider adoption across both enterprise and small to medium-sized business environments.

A SAN does not provide file abstraction, only block-level operations. However, [file systems](https://en.wikipedia.org/wiki/File_systems) built on top of SANs do provide file-level access, and are known as [shared-disk file systems](https://en.wikipedia.org/wiki/Shared-disk_file_system).

storage area network (SAN)

A storage-area network (SAN) is a dedicated high-speed [network](http://searchnetworking.techtarget.com/definition/network) (or [subnetwork](http://searchnetworking.techtarget.com/definition/subnetwork)) that interconnects and presents shared pools of [storage](http://searchstorage.techtarget.com/definition/storage) devices to multiple [servers](http://whatis.techtarget.com/definition/server).

A SAN moves storage resources off the common user network and reorganizes them into an independent, high-performance network. This allows each server to access [shared storage](http://whatis.techtarget.com/definition/shared-storage) as if it were a drive directly attached to the server. When a [host](http://searchnetworking.techtarget.com/definition/host) wants to access a storage device on the SAN, it sends out a [block](http://searchsqlserver.techtarget.com/definition/block)-based access request for the storage device.

A storage-area network is typically assembled using three principle components: [cabling](http://searchdatacenter.techtarget.com/definition/Network-Cabling-Tutorials), host bus adapters ([HBAs](http://searchstorage.techtarget.com/gDefinition/0,294236,sid5_gci1083748,00.html)) and [switches](http://searchtelecom.techtarget.com/definition/switch). Each switch and storage system on the SAN must be interconnected and the physical interconnections must support [bandwidth](http://searchenterprisewan.techtarget.com/definition/bandwidth) levels that can adequately handle peak data activities.

Storage-area networks are managed centrally, and Fibre Channel ([FC](http://searchstorage.techtarget.com/definition/Fibre-Channel)) SANs have the reputation of being expensive, complex and difficult to manage. The emergence of [iSCSI](http://searchstorage.techtarget.com/definition/iSCSI) has reduced these challenges by [encapsulating](http://searchnetworking.techtarget.com/definition/encapsulation) [SCSI](http://searchwindowsserver.techtarget.com/definition/Small-Computer-System-Interface-SCSI) commands into [IP](http://searchunifiedcommunications.techtarget.com/definition/Internet-Protocol) [packets](http://searchnetworking.techtarget.com/definition/packet) for transmission over an [Ethernet](http://searchnetworking.techtarget.com/definition/Ethernet) connection, rather than an FC connection. Instead of learning, building and managing two networks -- an Ethernet local-area network ([LAN](http://searchnetworking.techtarget.com/definition/local-area-network-LAN)) for user communication and an FC SAN for storage -- an organization can now use its existing knowledge and [infrastructure](http://searchdatacenter.techtarget.com/definition/infrastructure) for both LANs and SANs.

### **Virtual SAN**

A virtual storage-area network ([VSAN](http://searchstorage.techtarget.com/definition/virtual-storage-area-network)) is a [software-defined storage](http://searchsdn.techtarget.com/definition/software-defined-storage) offering that is implemented on top of a [hypervisor](http://searchservervirtualization.techtarget.com/definition/hypervisor) such as [VMware ESXi](http://searchvmware.techtarget.com/definition/VMware-ESXi) or [Microsoft Hyper-V](http://searchwindowsserver.techtarget.com/definition/Microsoft-Hyper-V-version-10). Virtual SANs yield a number of benefits such as ease of management and [scalability](http://searchdatacenter.techtarget.com/definition/scalability). For the most part, VSANs are hardware-[agnostic](http://whatis.techtarget.com/definition/agnostic). As long as the storage hardware is recognized and supported by the hypervisor, the hardware can be used by the VSAN (although each vendor has its own requirements).

### **Unified SAN**

Unified SAN is based around the concept of [unified storage](http://searchstorage.techtarget.com/definition/unified-storage), which exposes [file storage](http://searchstorage.techtarget.com/definition/file-storage) and [block storage](http://searchstorage.techtarget.com/definition/block-storage) through a single device (usually a modified [NAS appliance](http://searchstorage.techtarget.com/definition/NAS-Appliance)).

A unified SAN takes this concept a step further by exposing not only dedicated logical unit numbers ([LUNs](http://searchstorage.techtarget.com/definition/logical-unit-number)) -- like any other SAN -- but file system-based, NAS-like storage.

### **Converged SAN**

Storage-area networks are normally kept separate from Ethernet networks. A [converged](http://whatis.techtarget.com/definition/converged-storage) SAN uses a common network [infrastructure](http://searchdatacenter.techtarget.com/definition/infrastructure) for network and SAN traffic to eliminate [redundant](http://searchstorage.techtarget.com/definition/redundant) infrastructure, and to reduce cost and complexity.

SANs often make use of FC, while data networks are usually based on Ethernet. Converged SANs adopt Fibre Channel over Ethernet ([FCoE](http://searchstorage.techtarget.com/definition/FCoE-Fibre-Channel-over-Ethernet)), which encapsulates FC payloads into Ethernet frames. Converged SANs are almost always based on [10 Gigabit Ethernet](http://searchnetworking.techtarget.com/definition/10-Gigabit-Ethernet), and multiple network [ports](http://searchnetworking.techtarget.com/definition/port) are sometimes bonded together to increase [throughput](http://searchnetworking.techtarget.com/definition/throughput).

### **SAN pros and cons**

The main benefit to using a SAN is that raw storage is treated as a pool of resources that can be centrally managed and allocated on an as-needed basis. SANs are also highly scalable because additional capacity can be added as required.

The main disadvantages to SANs are cost and complexity. SAN hardware tends to be expensive, and building and managing a SAN requires a specialized skill set.

### **SAN vs. NAS**

The terms *SAN* and *NAS* are sometimes confused with one another because the acronyms are so similar. NAS consists of a storage appliance that is plugged directly into a network switch. Although there are exceptions, NAS appliances are often used as [file servers](http://searchnetworking.techtarget.com/definition/file-server).

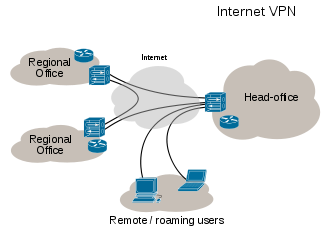
# VLAN(Virtual LAN)

A **virtual LAN** (**VLAN**) is any [broadcast domain](https://en.wikipedia.org/wiki/Broadcast_domain) that is [partitioned](https://en.wikipedia.org/wiki/Network_segmentation) and isolated in a [computer network](https://en.wikipedia.org/wiki/Computer_network) at the [data link layer](https://en.wikipedia.org/wiki/Data_link_layer) ([OSI layer 2](https://en.wikipedia.org/wiki/OSI_model#Layer_2:_Data_Link_Layer)).[[1]](https://en.wikipedia.org/wiki/Virtual_LAN#cite_note-1)[[2]](https://en.wikipedia.org/wiki/Virtual_LAN#cite_note-802.1Q_1.4-2) *LAN* is an abbreviation for [*local area network*](https://en.wikipedia.org/wiki/Local_area_network).

To subdivide a network into virtual LANs, one configures [network equipment](https://en.wikipedia.org/wiki/Network_equipment). Simpler equipment can partition only per physical port (if at all), in which case each VLAN is connected with a dedicated [network cable](https://en.wikipedia.org/wiki/Network_cable). More sophisticated devices can mark frames through [VLAN tagging](https://en.wikipedia.org/wiki/VLAN_tagging), so that a single interconnect ([*trunk*](https://en.wikipedia.org/wiki/Trunking)) may be used to transport data for multiple VLANs. Since VLANs share bandwidth, a VLAN trunk can use [link aggregation](https://en.wikipedia.org/wiki/Link_aggregation), [quality-of-service](https://en.wikipedia.org/wiki/Quality-of-service) prioritization, or both to route data efficiently.

VLANs allow [network administrators](https://en.wikipedia.org/wiki/Network_administrator) to group hosts together even if the hosts are not on the same network switch. This can greatly simplify [network design](https://en.wikipedia.org/wiki/Network_planning_and_design) and deployment, because VLAN membership can be configured through software. Without VLANs, grouping hosts according to their resource needs necessitates the labor of relocating [nodes](https://en.wikipedia.org/wiki/Node_(networking)) or rewiring [data links](https://en.wikipedia.org/wiki/Data_link).

# VPN(Virtual private network)



A **virtual private network** (**VPN**) extends a [private network](https://en.wikipedia.org/wiki/Private_network) across a public network, such as the [Internet](https://en.wikipedia.org/wiki/Internet). It enables users to send and receive data across shared or public networks as if their computing devices were directly connected to the private network. Applications running across the VPN may therefore benefit from the functionality, security, and management of the private network.[[1]](https://en.wikipedia.org/wiki/Virtual_private_network#cite_note-1)

VPNs may allow employees to securely access a corporate [intranet](https://en.wikipedia.org/wiki/Intranet) while located outside the office. They are used to securely connect geographically separated offices of an organization, creating one cohesive network. Individual Internet users may secure their [wireless](https://en.wikipedia.org/wiki/Wireless) transactions with a VPN, to circumvent geo-restrictions and censorship, or to connect to [proxy servers](https://en.wikipedia.org/wiki/Proxy_server) for the purpose of protecting personal identity and location. However, some Internet sites block access to known VPN technology to prevent the circumvention of their geo-restrictions.

A VPN is created by establishing a virtual [point-to-point](https://en.wikipedia.org/wiki/Point-to-point_(network_topology)) connection through the use of dedicated connections, virtual [tunneling protocols](https://en.wikipedia.org/wiki/Tunneling_protocols), or traffic [encryption](https://en.wikipedia.org/wiki/Encryption). A VPN available from the public Internet can provide some of the benefits of a [wide area network](https://en.wikipedia.org/wiki/Wide_area_network) (WAN). From a user perspective, the resources available within the private network can be accessed remotely.[[2]](https://en.wikipedia.org/wiki/Virtual_private_network#cite_note-2)

Traditional VPNs are characterized by a point-to-point topology, and they do not tend to support or connect [broadcast domains](https://en.wikipedia.org/wiki/Broadcast_domain), so services such as [Microsoft Windows](https://en.wikipedia.org/wiki/Microsoft_Windows) [NetBIOS](https://en.wikipedia.org/wiki/NetBIOS) may not be fully supported or work as they would on a [local area network](https://en.wikipedia.org/wiki/Local_area_network) (LAN). Designers have developed VPN variants, such as [Virtual Private LAN Service](https://en.wikipedia.org/wiki/Virtual_Private_LAN_Service) (VPLS), and [layer-2 tunneling protocols](https://en.wikipedia.org/wiki/Layer_2_Tunneling_Protocol), to overcome this limitation.

**Ashraf**

**Cache Memory ki?**

### **What SQL?** [**What is SQL (Structured Query Language)?**](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0ahUKEwi54uH0_7nRAhVDsI8KHVcWAD8QFggjMAI&url=http%3A%2F%2Fsearchsqlserver.techtarget.com%2Fdefinition%2FSQL&usg=AFQjCNE8aVkHxO_JX8LPUWLLuAu959zryA&sig2=P9jT0Bv0arg2P15G84OKEQ)

# What is SQL?

SQL (pronounced "ess-que-el") stands for Structured Query Language. SQL is used to communicate with a database. According to ANSI (American National Standards Institute), it is the standard language for relational database management systems. SQL statements are used to perform tasks such as update data on a database, or retrieve data from a database. Some common relational database management systems that use SQL are: Oracle, Sybase, Microsoft SQL Server, Access, Ingres, etc. Although most database systems use SQL, most of them also have their own additional proprietary extensions that are usually only used on their system. However, the standard SQL commands such as "Select", "Insert", "Update", "Delete", "Create", and "Drop" can be used to accomplish almost everything that one needs to do with a database. This tutorial will provide you with the instruction on the basics of each of these commands as well as allow you to put them to practice using the SQL Interpreter.

**LIFO, BIFO?**

**UNHCR ()**

**ASCII**

ASCII stands for **American Standard Code for Information Interchange**. Computers can only understand numbers, so an ASCII code is the numerical representation of a character such as 'a' or '@' or an action of some sort



**ASCII** abbreviated from **American Standard Code for Information Interchange**, is a [character encoding](https://en.wikipedia.org/wiki/Character_encoding) standard (the [Internet Assigned Numbers Authority](https://en.wikipedia.org/wiki/Internet_Assigned_Numbers_Authority) (IANA) prefers the name **US-ASCII**[[2]](https://en.wikipedia.org/wiki/ASCII#cite_note-IANA_2007-2)). ASCII codes represent text in computers, [telecommunications equipment](https://en.wikipedia.org/wiki/Telecommunications_equipment), and other devices. Most modern character-encoding schemes are based on ASCII, although they support many additional characters.

# Data center

A **data center** is a facility used to house computer systems and associated components, such as [telecommunications](https://en.wikipedia.org/wiki/Telecommunication) and [storage systems](https://en.wikipedia.org/wiki/Computer_data_storage). It generally includes redundant or backup [power supplies](https://en.wikipedia.org/wiki/Power_supply), redundant data communications connections, environmental controls (e.g., air conditioning, fire suppression) and various security devices. Large data centers are industrial scale operations using as much electricity as a small town.[[1]](https://en.wikipedia.org/wiki/Data_center#cite_note-NYT92212-1)[[2]](https://en.wikipedia.org/wiki/Data_center#cite_note-ReferenceDC2-2)

A **data center** is a facility that centralizes an organization's IT operations and equipment, and where it stores, manages, and disseminates its **data**. **Data centers** house a network's most critical systems and are vital to the continuity of daily operations.

A data center (sometimes spelled *datacenter*) is a centralized repository, either physical or [virtual](http://searchservervirtualization.techtarget.com/definition/virtual), for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business.

# RAID

**RAID** (originally **redundant array of inexpensive disks**, now commonly **array of independent disks**) is a data [storage virtualization](https://en.wikipedia.org/wiki/Storage_virtualization) technology that combines multiple physical [disk drive](https://en.wikipedia.org/wiki/Disk_drive) components into a single logical unit for the purposes of [data redundancy](https://en.wikipedia.org/wiki/Data_redundancy), performance improvement, or both.[[1]](https://en.wikipedia.org/wiki/RAID#cite_note-ostep-1-1)

Data is distributed across the drives in one of several ways, referred to as [RAID levels](https://en.wikipedia.org/wiki/Standard_RAID_levels), depending on the required level of [redundancy](https://en.wikipedia.org/wiki/Redundancy_(engineering)) and performance. The different schemas, or data distribution layouts, are named by the word RAID followed by a number, for example RAID 0 or RAID 1. Each schema, or RAID level, provides a different balance among the key goals: [reliability](https://en.wikipedia.org/wiki/Reliability_engineering), [availability](https://en.wikipedia.org/wiki/Availability), [performance](https://en.wikipedia.org/wiki/Computer_performance), and [capacity](https://en.wikipedia.org/wiki/Computer_data_storage#Capacity). RAID levels greater than RAID 0 provide protection against unrecoverable [sector](https://en.wikipedia.org/wiki/Disk_sector) read errors, as well as against failures of whole physical drives.

**RAID 0**

[RAID 0](https://en.wikipedia.org/wiki/RAID_0) consists of [striping](https://en.wikipedia.org/wiki/Data_striping), without [mirroring](https://en.wikipedia.org/wiki/Disk_mirroring) or [parity](https://en.wikipedia.org/wiki/Parity_bit). The capacity of a RAID 0 volume is the sum of the capacities of the disks in the set, the same as with a [spanned volume](https://en.wikipedia.org/wiki/Spanned_volume). There is no added redundancy for handling disk failures, just as with a spanned volume. Thus, failure of one disk causes the loss of the entire RAID 0 volume, with reduced possibilities of [data recovery](https://en.wikipedia.org/wiki/Data_recovery) when compared to a broken spanned volume. Striping distributes the contents of files roughly equally among all disks in the set, which makes concurrent read or write operations on the multiple disks almost inevitable and results in performance improvements. The concurrent operations make the [throughput](https://en.wikipedia.org/wiki/Throughput) of most read and write operations equal to the throughput of one disk multiplied by the number of disks. Increased throughput is the big benefit of RAID 0 versus spanned volume,[[13]](https://en.wikipedia.org/wiki/RAID#cite_note-Patterson_1994-13) at the cost of increased vulnerability to drive failures.

**RAID 1**

[RAID 1](https://en.wikipedia.org/wiki/RAID_1) consists of data mirroring, without parity or striping. Data is written identically to two drives, thereby producing a "mirrored set" of drives. Thus, any read request can be serviced by any drive in the set. If a request is broadcast to every drive in the set, it can be serviced by the drive that accesses the data first (depending on its [seek time](https://en.wikipedia.org/wiki/Seek_time)and [rotational latency](https://en.wikipedia.org/wiki/Rotational_latency)), improving performance. Sustained read throughput, if the controller or software is optimized for it, approaches the sum of throughputs of every drive in the set, just as for RAID 0. Actual read throughput of most RAID 1 implementations is slower than the fastest drive. Write throughput is always slower because every drive must be updated, and the slowest drive limits the write performance. The array continues to operate as long as at least one drive is functioning.[[13]](https://en.wikipedia.org/wiki/RAID#cite_note-Patterson_1994-13)

**RAID 2**

[RAID 2](https://en.wikipedia.org/wiki/RAID_2) consists of bit-level striping with dedicated [Hamming-code](https://en.wikipedia.org/wiki/Hamming_code) parity. All disk spindle rotation is synchronized and data is [striped](https://en.wikipedia.org/wiki/Data_striping) such that each sequential [bit](https://en.wikipedia.org/wiki/Bit) is on a different drive. Hamming-code parity is calculated across corresponding bits and stored on at least one parity drive.[[13]](https://en.wikipedia.org/wiki/RAID#cite_note-Patterson_1994-13) This level is of historical significance only; although it was used on some early machines (for example, the [Thinking Machines](https://en.wikipedia.org/wiki/Thinking_Machines_Corporation) CM-2),[[20]](https://en.wikipedia.org/wiki/RAID#cite_note-20) as of 2014 it is not used by any commercially available system.[[21]](https://en.wikipedia.org/wiki/RAID#cite_note-21)

**RAID 3**

[RAID 3](https://en.wikipedia.org/wiki/RAID_3) consists of byte-level striping with dedicated parity. All disk spindle rotation is synchronized and data is striped such that each sequential [byte](https://en.wikipedia.org/wiki/Byte) is on a different drive. Parity is calculated across corresponding bytes and stored on a dedicated parity drive.[[13]](https://en.wikipedia.org/wiki/RAID#cite_note-Patterson_1994-13) Although implementations exist,[[22]](https://en.wikipedia.org/wiki/RAID#cite_note-22) RAID 3 is not commonly used in practice.

**RAID 4**

[RAID 4](https://en.wikipedia.org/wiki/RAID_4) consists of block-level striping with dedicated parity. This level was previously used by [NetApp](https://en.wikipedia.org/wiki/NetApp), but has now been largely replaced by a proprietary implementation of RAID 4 with two parity disks, called [RAID-DP](https://en.wikipedia.org/wiki/RAID-DP).[[23]](https://en.wikipedia.org/wiki/RAID#cite_note-NetApp-23) The main advantage of RAID 4 over RAID 2 and 3 is I/O parallelism: in RAID 2 and 3, a single read/write I/O operation requires reading the whole group of data drives, while in RAID 4 one I/O read/write operation does not have to spread across all data drives. As a result, more I/O operations can be executed in parallel, improving the performance of small transfers.[[3]](https://en.wikipedia.org/wiki/RAID#cite_note-patterson-3)

**RAID 5**

[RAID 5](https://en.wikipedia.org/wiki/RAID_5) consists of block-level striping with distributed parity. Unlike RAID 4, parity information is distributed among the drives, requiring all drives but one to be present to operate. Upon failure of a single drive, subsequent reads can be calculated from the distributed parity such that no data is lost. RAID 5 requires at least three disks.[[13]](https://en.wikipedia.org/wiki/RAID#cite_note-Patterson_1994-13) RAID 5 implementations are susceptible to system failures because of trends regarding array rebuild time and the chance of drive failure during rebuild (see "Increasing rebuild time and failure probability" section, below).[[24]](https://en.wikipedia.org/wiki/RAID#cite_note-StorageForum-24) Rebuilding an array requires reading all data from all disks, opening a chance for a second drive failure and the loss of the entire array.[[25]](https://en.wikipedia.org/wiki/RAID#cite_note-Gillware_Data_Recovery-25) In August 2012, Dell posted an advisory against the use of RAID 5 in any configuration on Dell EqualLogic arrays and RAID 50 with "Class 2 7200 RPM drives of 1 TB and higher capacity" for business-critical data.[[26]](https://en.wikipedia.org/wiki/RAID#cite_note-26)

**RAID 6**

[RAID 6](https://en.wikipedia.org/wiki/RAID_6) consists of block-level striping with double distributed parity. Double parity provides fault tolerance up to two failed drives. This makes larger RAID groups more practical, especially for high-availability systems, as large-capacity drives take longer to restore. RAID 6 requires a minimum of four disks. As with RAID 5, a single drive failure results in reduced performance of the entire array until the failed drive has been replaced.[[13]](https://en.wikipedia.org/wiki/RAID#cite_note-Patterson_1994-13) With a RAID 6 array, using drives from multiple sources and manufacturers, it is possible to mitigate most of the problems associated with RAID 5. The larger the drive capacities and the larger the array size, the more important it becomes to choose RAID 6 instead of RAID 5.[[27]](https://en.wikipedia.org/wiki/RAID#cite_note-zdnet-27) RAID 10 also minimizes these problems.[[28]](https://en.wikipedia.org/wiki/RAID#cite_note-UREs-28)

# Database

A **database** is an organized collection of [data](https://en.wikipedia.org/wiki/Data_(computing)).[[1]](https://en.wikipedia.org/wiki/Database#cite_note-1) It is the collection of [schemas](https://en.wikipedia.org/wiki/Database_schema), [tables](https://en.wikipedia.org/wiki/Table_(database)), [queries](https://en.wikipedia.org/wiki/Query_language), reports, [views](https://en.wikipedia.org/wiki/View_(SQL)), and other objects. The data are typically organized to model aspects of reality in a way that supports [processes](https://en.wikipedia.org/wiki/Process_(computing)) requiring information, such as modelling the availability of rooms in hotels in a way that supports finding a hotel with vacancies.

A **database management system** (**DBMS**) is a [computer software](https://en.wikipedia.org/wiki/Computer_software) application that interacts with the user, other applications, and the database itself to capture and analyze data. A general-purpose DBMS is designed to allow the definition, creation, querying, update, and administration of databases. Well-known DBMSs include [MySQL](https://en.wikipedia.org/wiki/MySQL), [PostgreSQL](https://en.wikipedia.org/wiki/PostgreSQL), [MongoDB](https://en.wikipedia.org/wiki/MongoDB), [Microsoft SQL Server](https://en.wikipedia.org/wiki/Microsoft_SQL_Server), [Oracle](https://en.wikipedia.org/wiki/Oracle_Database), [Sybase](https://en.wikipedia.org/wiki/Sybase), [SAP HANA](https://en.wikipedia.org/wiki/SAP_HANA), and [IBM DB2](https://en.wikipedia.org/wiki/IBM_DB2). A database is not generally [portable](https://en.wikipedia.org/wiki/Software_portability) across different DBMSs, but different DBMS can interoperate by using [standards](https://en.wikipedia.org/wiki/Technical_standard) such as [SQL](https://en.wikipedia.org/wiki/SQL) and [ODBC](https://en.wikipedia.org/wiki/ODBC) or [JDBC](https://en.wikipedia.org/wiki/JDBC) to allow a single application to work with more than one DBMS. Database management systems are often classified according to the [database model](https://en.wikipedia.org/wiki/Database_model) that they support; the most popular database systems since the 1980s have all supported the [relational model](https://en.wikipedia.org/wiki/Relational_model) as represented by the [SQL](https://en.wikipedia.org/wiki/SQL)language.[[*disputed*](https://en.wikipedia.org/wiki/Wikipedia:Disputed_statement)*–*[*discuss*](https://en.wikipedia.org/wiki/Talk:Database#All_SQL.3F)] Sometimes a DBMS is loosely referred to as a 'database'.

# SQL

SQL (pronounced "ess-que-el") stands for Structured Query Language. SQL is used to communicate with a database. According to **ANSI (American National Standards Institute)**, it is the standard language for relational database management systems. SQL statements are used to perform tasks such as update data on a database, or retrieve data from a database. Some common relational database management systems that use SQL are: Oracle, Sybase, Microsoft SQL Server, Access, Ingres, etc. Although most database systems use SQL, most of them also have their own additional proprietary extensions that are usually only used on their system. However, the standard SQL commands such as "Select", "Insert", "Update", "Delete", "Create", and "Drop" can be used to accomplish almost everything that one needs to do with a database. This tutorial will provide you with the instruction on the basics of each of these commands as well as allow you to put them to practice using the SQL Interpreter.

**SQL** (**Structured Query Language**[[6]](https://en.wikipedia.org/wiki/SQL#cite_note-Britannica-6)[[7]](https://en.wikipedia.org/wiki/SQL#cite_note-oed-US-7)[[8]](https://en.wikipedia.org/wiki/SQL#cite_note-IBM-SQL-8)[[9]](https://en.wikipedia.org/wiki/SQL#cite_note-MS-SQL-def-9)) is a special-purpose [domain-specific language](https://en.wikipedia.org/wiki/Domain-specific_language) used in programming and designed for managing data held in a [relational database management system](https://en.wikipedia.org/wiki/Relational_database_management_system) (RDBMS), or for stream processing in a [relational data stream management system](https://en.wikipedia.org/wiki/Relational_data_stream_management_system) (RDSMS).

Originally based upon [relational algebra](https://en.wikipedia.org/wiki/Relational_algebra) and [tuple relational calculus](https://en.wikipedia.org/wiki/Tuple_relational_calculus), SQL consists of a [data definition language](https://en.wikipedia.org/wiki/Data_definition_language), [data manipulation language](https://en.wikipedia.org/wiki/Data_manipulation_language), and [data control language](https://en.wikipedia.org/wiki/Data_control_language). The scope of SQL includes data insert, query, update and delete, [schema](https://en.wikipedia.org/wiki/Database_schema) creation and modification, and data access control. Although SQL is often described as, and to a great extent is, a [declarative language](https://en.wikipedia.org/wiki/Declarative_programming) ([4GL](https://en.wikipedia.org/wiki/4GL)), it also includes [procedural](https://en.wikipedia.org/wiki/Procedural_programming) elements.

# kothai asi

# ki kortesen?

# online, offline ki?

# The term "[online](https://en.wikipedia.org/wiki/Online_and_offline)" can refer to a state of connectivity.

# In computer technology and telecommunications, the term [offline](https://en.wikipedia.org/wiki/Offline) refers to a lack of connectivity.

# The terms "online" and "offline" have specific meanings in regard to computer technology and [telecommunications](https://en.wikipedia.org/wiki/Telecommunications) in which "online" indicates a state of connectivity, while "offline" indicates a disconnected state. Common [vernacular](https://en.wikipedia.org/wiki/Vernacular) extended from their computing and telecommunication meanings and refers specifically to an [Internet connection](https://en.wikipedia.org/wiki/Internet_connection). Lastly, in the area of human interaction and conversation, discussions taking place during a business meeting are "online", while issues that do not concern all participants of the meeting should be "taken offline"—continued outside of the meeting.

# What is WEB?

# A network of a complex system of interconnected elements

# keno ei job korben?

# SA-er ki kaj?

# soronarthi

# UN => soronarthi nia j deal kore?

# Barma 🡺 Rakhain 🡺 Thangar chor

# **The office of the Un**ited Nations High Commissioner for Refugees (UNHCR)** was created in 1950, during the aftermath of the Second World War, to help millions of Europeans who had fled or lost their homes.**

# Ora 11 jon - 11 jon keno?

# *Ora Egaro Jon* ([Bengali](https://en.wikipedia.org/wiki/Bengali_language): ওরা ১১ জন) is a 1972 [Bengali](https://en.wikipedia.org/wiki/Cinema_of_Bangladesh) historical drama film written by [Al Masood](https://en.wikipedia.org/w/index.php?title=Al_Masood&action=edit&redlink=1) and directed by [Chashi Nazrul Islam](https://en.wikipedia.org/wiki/Chashi_Nazrul_Islam), based on the [Bangladesh Liberation War](https://en.wikipedia.org/wiki/Bangladesh_Liberation_War). Director Islam and lead actor [Khasru](https://en.wikipedia.org/w/index.php?title=Khasru&action=edit&redlink=1) were both members of [Mukti Bahini](https://en.wikipedia.org/wiki/Mukti_Bahini) (liberation army).[[1]](https://en.wikipedia.org/wiki/Ora_Egaro_Jon#cite_note-1) It was the first movie of [Bangladesh](https://en.wikipedia.org/wiki/Bangladesh) after independence. It has been selected for preservation by the Bangladesh Film Archive.[[2]](https://en.wikipedia.org/wiki/Ora_Egaro_Jon#cite_note-2)

# apni kar board-a interview dite aisen?

# PM jokhon desh-a ase tokhon tar kono

Labor

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Security

**IP**

The Internet Protocol (IP) is the method or [protocol](http://searchnetworking.techtarget.com/definition/protocol) by which [data](http://searchdatamanagement.techtarget.com/definition/data) is sent from one computer to another on the [Internet](http://searchwindevelopment.techtarget.com/definition/Internet). Each computer (known as a [host](http://searchcio-midmarket.techtarget.com/definition/host)) on the Internet has at least one [IP address](http://searchwindevelopment.techtarget.com/definition/IP-address) that uniquely identifies it from all other computers on the Internet.

**IOT** => Internet of think

<https://www.slideshare.net/zubayer1984/introduction-to-iot-70013575?trk=v-feed>

The **Internet of things** (stylised **Internet of Things** or **IoT**) is the [internetworking](https://en.wikipedia.org/wiki/Internetworking) of physical devices, vehicles (also referred to as "connected devices" and "[smart devices](https://en.wikipedia.org/wiki/Smart_device)"), buildings, and other items—[embedded](https://en.wikipedia.org/wiki/Embedded_system) with [electronics](https://en.wikipedia.org/wiki/Electronics), [software](https://en.wikipedia.org/wiki/Software), [sensors](https://en.wikipedia.org/wiki/Sensor), actuators, and [network connectivity](https://en.wikipedia.org/wiki/Internet_access) that enable these objects to collect and exchange data.[[1]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-Linux_Things-1)[[2]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-Linux_21OSP-2)[[3]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-ITU-3) In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society."[[3]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-ITU-3) The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure,[[4]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-4) creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.[[5]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-5)[[6]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-6)[[7]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-7)[[8]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-8)[[9]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-9)[[10]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-10) When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of [cyber-physical systems](https://en.wikipedia.org/wiki/Cyber-physical_system), which also encompasses technologies such as [smart grids](https://en.wikipedia.org/wiki/Smart_grid), [smart homes](https://en.wikipedia.org/wiki/Smart_home), [intelligent transportation](https://en.wikipedia.org/wiki/Intelligent_transportation) and [smart cities](https://en.wikipedia.org/wiki/Smart_city). Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing [Internet](https://en.wikipedia.org/wiki/Internet) infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.[[11]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-11)

Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond [machine-to-machine](https://en.wikipedia.org/wiki/Machine_to_machine) (M2M) communications and covers a variety of protocols, domains, and applications.[[12]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-M2M-IoT-12) The interconnection of these embedded devices (including [smart objects](https://en.wikipedia.org/wiki/Smart_objects)), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid,[[13]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-Smart-IoT-13) and expanding to areas such as smart cities.[[14]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-14)[[15]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-15)

"Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, [biochip](https://en.wikipedia.org/wiki/Biochip) transponders on farm animals, electric clams in coastal waters,[[16]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-MolluSCAN_eye-16)automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring[[17]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-Erlich2015-17) or field operation devices that assist firefighters in [search and rescue](https://en.wikipedia.org/wiki/Search_and_rescue) operations.[[18]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-Definition-IoT-18) Legal scholars suggest to look at "Things" as an "inextricable mixture of hardware, software, data and service".[[19]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-19) These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.[[20]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-20) Current market examples include [home automation](https://en.wikipedia.org/wiki/Home_automation) (also known as smart home devices) such as the control and automation of lighting, heating (like [smart thermostat](https://en.wikipedia.org/wiki/Smart_thermostat)), ventilation, air conditioning (HVAC) systems, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens or refrigerators/freezers that use Wi-Fi for remote monitoring.

As well as the expansion of Internet-connected automation into a plethora of new application areas, IoT is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively. IoT is one of the platforms of today's Smart City, and Smart Energy Management Systems.[[21]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-InfoWorld-BigData-21)[[22]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-Internet_of_Things_Database-22)

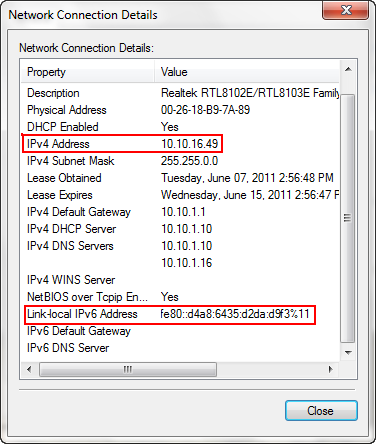
The concept of the Internet of Things was invented by and term coined by [Peter T. Lewis](https://en.wikipedia.org/wiki/Peter_T._Lewis) in September 1985 in a speech he delivered at a [U.S. Federal Communications Commission](https://en.wikipedia.org/wiki/Federal_Communications_Commission) (FCC) supported session at the [Congressional Black Caucus](https://en.wikipedia.org/wiki/Congressional_Black_Caucus) 15th Legislative Weekend Conference.[[23]](https://en.wikipedia.org/wiki/Internet_of_things#cite_note-:0-23)[[*better source needed*](https://en.wikipedia.org/wiki/Wikipedia:NOTRS)]

**IPV4, 6**

The **Internet Protocol version 4 (IPv4)** is a protocol for use on packet-switched **Link Layer networks**(e.g. **Ethernet**).  IPv4 provides an addressing capability of approximately 4.3 billion addresses.

The **Internet Protocol version 6 (IPv6)** is more advanced and has better features compared to IPv4.  It has the capability to provide an infinite number of addresses.  It is replacing IPv4 to accommodate the growing number of networks worldwide and help solve the IP address exhaustion problem.

One of the differences between IPv4 and IPv6 is the appearance of the IP addresses.  IPv4 uses four 1 byte decimal numbers, separated by a dot (i.e. **192.168.1.1**), while IPv6 uses hexadecimal numbers that are separated by colons (i.e. **fe80::d4a8:6435:d2d8:d9f3b11**).



Below is the summary of the differences between the IPv4 and IPv6:

|  |  |  |
| --- | --- | --- |
|  | **IPv4** | **IPv6** |
| No. of bits on IP Address | 32 | 128 |
| Format | decimal | hexadecimal |
| Capable of Addresses | 4.3 billion | infinite number |
| How to ping | ping XXX.XXX.XXX | ping6 |

Advantages of IPv6 over IPv4:

* IPv6 simplified the router’s task compared to IPv4.
* IPv6 is more compatible to mobile networks than IPv4.
* IPv6 allows for bigger payloads than what is allowed in IPv4.
* IPv6 is used by less than 1% of the networks, while IPv4 is still in use by the remaining 99%.

**Db Design**

**Database design** is the process of producing a detailed [data model](https://en.wikipedia.org/wiki/Data_model) of [database](https://en.wikipedia.org/wiki/Database). This data model contains all the needed logical and physical design choices and physical storage parameters needed to generate a design in a [data definition language](https://en.wikipedia.org/wiki/Data_definition_language), which can then be used to create a database. A fully attributed data model contains detailed attributes for each entity.

The term database design can be used to describe many different parts of the design of an overall [database system](https://en.wikipedia.org/wiki/Database_system). Principally, and most correctly, it can be thought of as the logical design of the base data structures used to store the data. In the [relational model](https://en.wikipedia.org/wiki/Relational_model) these are the [tables](https://en.wikipedia.org/wiki/Database_table) and [views](https://en.wikipedia.org/wiki/Database_view). In an [object database](https://en.wikipedia.org/wiki/Object_database) the entities and relationships map directly to object classes and named relationships. However, the term database design could also be used to apply to the overall process of designing, not just the base data structures, but also the forms and queries used as part of the overall database application within the [database management system](https://en.wikipedia.org/wiki/Database_management_system) (DBMS).[[1]](https://en.wikipedia.org/wiki/Database_design#cite_note-1)

The process of doing database design generally consists of a number of steps which will be carried out by the database designer. Usually, the designer must:

* Determine the data to be stored in the database.
* Determine the relationships between the different data elements.
* Superimpose a logical structure upon the data on the basis of these relationships.[[2]](https://en.wikipedia.org/wiki/Database_design#cite_note-Teorey.2C_T.J._2009-2)

Within the [relational model](https://en.wikipedia.org/wiki/Relational_model) the final step above can generally be broken down into two further steps, that of determining the grouping of information within the system, generally determining what are the basic objects about which information is being stored, and then determining the relationships between these groups of information, or objects. This step is not necessary with an [Object database](https://en.wikipedia.org/wiki/Object_database).[[2]](https://en.wikipedia.org/wiki/Database_design#cite_note-Teorey.2C_T.J._2009-2)

# Introduction to database design

This article/tutorial will teach the basis of relational database design and explains how to make a good database design. It is a rather long text, but we advise to read all of it. Designing a database is in fact fairly easy, but there are a few rules to stick to. It is important to know what these rules are, but more importantly is to know why these rules exist, otherwise you will tend to make mistakes!

Standardization makes your data model flexible and that makes working with your data much easier. Please, take the time to learn these rules and apply them! The database used in this article is designed with our database design and modeling tool [DeZign for Databases](http://www.datanamic.com/dezign/index.html).

A good database design starts with a list of the data that you want to include in your database and what you want to be able to do with the database later on. This can all be written in your own language, without any SQL. In this stage you must try not to think in tables or columns, but just think: "What do I need to know?" Don't take this too lightly, because if you find out later that you forgot something, usually you need to start all over. Adding things to your database is mostly a lot of work.

## **Identifying Entities**

The types of information that are saved in the database are called 'entities'. These entities exist in four kinds: people, things, events, and locations. Everything you could want to put in a database fits into one of these categories. If the information you want to include doesn't fit into these categories, than it is probably not an entity but a property of an entity, an attribute.

To clarify the information given in this article we'll use an example. Imagine that you are creating a website for a shop, what kind of information do you have to deal with? In a shop you sell your products to customers. The "Shop" is a location; "Sale" is an event; "Products" are things; and "Customers" are people. These are all entities that need to be included in your database.

But what other things are happening when selling a product? A customer comes into the shop, approaches the vendor, asks a question and gets an answer. "Vendors" also participate, and because vendors are people, we need a vendors entity.

|  |
| --- |
| Entities: types of information  *Figure 1: Entities: types of information.* |

## **Identifying Relationships**

The next step is to determine the relationships between the entities and to determine the cardinality of each relationship. The relationship is the connection between the entities, just like in the real world: what does one entity do with the other, how do they relate to each other? For example, customers buy products, products are sold to customers, a sale comprises products, a sale happens in a shop.

The cardinality shows how much of one side of the relationship belongs to how much of the other side of the relationship. First, you need to state for each relationship, how much of one side belongs to exactly 1 of the other side. For example: How many customers belong to 1 sale?; How many sales belong to 1 customer?; How many sales take place in 1 shop?

You'll get a list like this: (please note that 'product' represents a type of product, not an occurance of a product)

* Customers --> Sales; 1 customer can buy something several times
* Sales --> Customers; 1 sale is always made by 1 customer at the time
* Customers --> Products; 1 customer can buy multiple products
* Products --> Customers; 1 product can be purchased by multiple customers
* Customers --> Shops; 1 customer can purchase in multiple shops
* Shops --> Customers, 1 shop can receive multiple customers
* Shops --> Products; in 1 shop there are multiple products
* Products --> Shops; 1 product (type) can be sold in multiple shops
* Shops --> Sales; in 1 shop multiple sales can me made
* Sales --> Shops; 1 sale can only be made in 1 shop at the time
* Products --> Sales; 1 product (type) can be purchased in multiple sales
* Sales --> Products; 1 sale can exist out of multiple products

Did we mention all relationships? There are four entities and each entity has a relationship with every other entity, so each entity must have three relationships, and also appear on the left end of the relationship three times. Above, 12 relationships were mentioned, which is 4\*3, so we can conclude that all relationships were mentioned.

Now we'll put the data together to find the cardinality of the whole relationship. In order to do this, we'll draft the cardinalities per relationship. To make this easy to do, we'll adjust the notation a bit, by noting the 'backward'-relationship the other way around:

* Customers --> Sales; 1 customer can buy something several times
* Sales --> Customers; 1 sale is always made by 1 customer at the time

The second relationship we will turn around so it has the same entity order as the first. Please notice the arrow that is now faced the other way!

* Customers <-- Sales; 1 sale is always made by 1 customer at the time

Cardinality exists in four types: one-to-one, one-to-many, many-to-one, and many-to-many. In a database design this is indicated as: 1:1, 1:N, M:1, and M:N. To find the right indication just leave the '1'. If there is a 'many' on the left side, this will be indicated with 'M', if there is a 'many' on the right side it is indicated with 'N'.

* Customers --> Sales; 1 customer can buy something several times; 1:N.
* Customers <-- Sales; 1 sale is always made by 1 customer at the time; 1:1.

The true cardinality can be calculated through assigning the biggest values for left and right, for which 'N' or 'M' are greater than '1'. In thisexample, in both cases there is a '1' on the left side. On the right side, there is a 'N' and a '1', the 'N' is the biggest value. The total cardinality is therefore '1:N'. A customer can make multiple 'sales', but each 'sale' has just one customer.

If we do this for the other relationships too, we'll get:

* Customers --> Sales; --> 1:N
* Customers --> Products; --> M:N
* Customers --> Shops; --> M:N
* Sales --> Products; --> M:N
* Shops --> Sales; --> 1:N
* Shops --> Products; --> M:N

So, we have two '1-to-many' relationships, and four 'many-to-many' relationships.

|  |
| --- |
| http://www.datanamic.com/supimg/dez005-examplefirstrelationships.jpg  *Figure 2: Relationships between the entities.* |

Between the entities there may be a mutual dependency. This means that the one item cannot exist if the other item does not exist. For example, there cannot be a sale if there are no customers, and there cannot be a sale if there are no products.

The relationships Sales --> Customers, and Sales --> Products are mandatory, but the other way around this is not the case. A customer can exist without sale, and also a product can exist without sale. This is of importance for the next step.

### Recursive Relationships

Sometimes an entity refers back to itself. For example, think of a work hierarchy: an employee has a boss; and the bosschef is an employee too. The attribute 'boss' of the entity 'employees' refers back to the entity 'employees'.

In an ERD (see next chapter) this type of relationship is a line that goes out of the entity and returns with a nice loop to the same entity.

### Redundant Relationships

Sometimes in your model you will get a 'redundant relationship'. These are relationships that are already indicated by other relationships, although not directly.

In the case of our example there is a direct relationships between customers and products. But there are also relationships from customers to sales and from sales to products, so indirectly there already is a relationship between customers and products through sales. The relationship 'Customers <----> Products' is made twice, and one of them is therefore redundant. In this case, products are only purchased through a sale, so the relationships 'Customers <----> Products' can be deleted. The model will then look like this:

|  |
| --- |
| http://www.datanamic.com/supimg/dez005-redundantrelationships.jpg  *Figure 3: Relationships between the entities.* |

### Solving Many-to-Many Relationships

Many-to-many relationships (M:N) are not directly possible in a database. What a M:N relationship says is that a number of records from one table belongs to a number of records from another table. Somewhere you need to save which records these are and the solution is to split the relationship up in two one-to-many relationships.

This can be done by creating a new entity that is in between the related entities. In our example, there is a many-to-many relationship between sales and products. This can be solved by creating a new entity: sales-products. This entity has a many-to-one relationship with Sales, and a many-to-one relationship with Products. In logical models this is called an associative entity and in physical database terms this is called a link table or junction table.

|  |
| --- |
| many to many relationship  associative entity  *Figure 4: Many to many relationship implementation via associative entity.* |

In the example there are two many-to-many relationships that need to be solved: 'Products <----> Sales', and 'Products <----> Shops'. For both situations there needs to be created a new entity, but what is that entity?

For the Products <----> Sales relationship, every sale includes more products. The relationship shows the content of the sale. In other words, it gives details about the sale. So the entity is called 'Sales details'. You could also name it 'sold products'.

The Products <----> Shops relationship shows which products are available in which the shops, also known as 'stock'. Our model would now look like this:

|  |
| --- |
| http://www.datanamic.com/supimg/dez005-modelwithstockandsalesdetails.jpg  *Figure 5: Model with link tables Stock and Sales\_details.* |

## **Identifying Attributes**

The data elements that you want to save for each entity are called 'attributes'.

About the products that you sell, you want to know, for example, what the price is, what the name of the manufacturer is, and what the type number is. About the customers you know their customer number, their name, and address. About the shops you know the location code, the name, the address. Of the sales you know when they happened, in which shop, what products were sold, and the sum total of the sale. Of the vendor you know his staff number, name, and address. What will be included precisely is not of importance yet; it is still only about what you want to save.

|  |
| --- |
| an entity with several attributes  *Figure 6: Entities with attributes.* |

### Derived Data

Derived data is data that is derived from the other data that you have already saved. In this case the 'sum total' is a classical case of derived data. You know exactly what has been sold and what each product costs, so you can always calculate how much the sum total of the sales is. So really it is not necessary to save the sum total.

So why is it saved here? Well, because it is a sale, and the price of the product can vary over time. A product can be priced at 10 euros today and at 8 euros next month, and for your administration you need to know what it cost at the time of the sale, and the easiest way to do this is to save it here. There are a lot of more elegant ways, but they are too profound for this article.

## **Presenting Entities and Relationships: Entity Relationship Diagram (ERD)**

The Entity Relationship Diagram (ERD) gives a graphical overview of the database. There are several styles and types of ER Diagrams. A much-used notation is the 'crowfeet' notation, where entities are represented as rectangles and the relationships between the entities are represented as lines between the entities. The signs at the end of the lines indicate the type of relationship. The side of the relationship that is mandatory for the other to exist will be indicated through a dash on the line. Not mandatory entities are indicated through a circle. "Many" is indicated through a 'crowfeet'; de relationship-line splits up in three lines.

In this article we make use of [DeZign for Databases](http://www.datanamic.com/dezign/index.html) to design and present our database.

A 1:1 mandatory relationship is represented as follows:

|  |
| --- |
| http://www.datanamic.com/supimg/dez005-onetoonemandatory.jpg  *Figure 7: Mandatory one to one relationship.* |

A 1:N mandatory relationship:

|  |
| --- |
| one to many relationship  *Figure 8: Mandatory one to many relationship.* |

A M:N relationship is:

|  |
| --- |
| http://www.datanamic.com/supimg/dez005-manytomanymandatory.jpg  *Figure 9: Mandatory many to many relationship.* |

The model of our example will look like this:

|  |
| --- |
| relation/connection between two entities  *Figure 10: Model with relationships.* |

## **Assigning Keys**

### Primary Keys

A primary key (PK) is one or more data attributes that uniquely identify an entity. A key that consists of two or more attributes is called a composite key. All attributes part of a primary key must have a value in every record (which cannot be left empty) and the combination of the values within these attributes must be unique in the table.

In the example there are a few obvious candidates for the primary key. Customers all have a customer number, products all have a unique product number and the sales have a sales number. Each of these data is unique and each record will contain a value, so these attributes can be a primary key. Often an integer column is used for the primary key so a record can be easily found through its number.

Link-entities usually refer to the primary key attributes of the entities that they link. The primary key of a link-entity is usually a collection of these reference-attributes. For example in the Sales\_details entity we could use the combination of the PK's of the sales and products entities as the PK of Sales\_details. In this way we enforce that the same product (type) can only be used once in the same sale. Multiple items of the same product type in a sale must be indicated by the quantity.

In the ERD the primary key attributes are indicated by the text 'PK' behind the name of the attribute. In the example only the entity 'shop' does not have an obvious candidate for the PK, so we will introduce a new attribute for that entity: shopnr.

### Foreign Keys

The Foreign Key (FK) in an entity is the reference to the primary key of another entity. In the ERD that attribute will be indicated with 'FK' behind its name. The foreign key of an entity can also be part of the primary key, in that case the attribute will be indicated with 'PF' behind its name. This is usually the case with the link-entities, because you usually link two instances only once together (with 1 sale only 1 product type is sold 1 time).

If we put all link-entities, PK's and FK's into the ERD, we get the model as shown below. Please note that the attribute 'products' is no longer necessary in 'Sales', because 'sold products' is now included in the link-table. In the link-table another field was added, 'quantity', that indicates how many products were sold. The quantity field was also added in the stock-table, to indicate how many products are still in store.

|  |
| --- |
| primary keys and foreign keys  *Figure 11: Primary keys and foreign keys.* |

## **Defining the Attribute's Data Type**

Now it is time to figure out which data types need to be used for the attributes. There are a lot of different data types. A few are standardized, but many databases have their own data types that all have their own advantages. Some databases offerthe possibility to define your own data types, in case the standard types cannot do the things you need.

The standard data types that every database knows, and are most-used, are: CHAR, VARCHAR, TEXT, FLOAT, DOUBLE, and INT.

Text:

* CHAR(length) - includes text (characters, numbers, punctuations...). CHAR has as characteristic that it always saves a fixed amount of positions. If you define a CHAR(10) you can save up to ten positions maximum, but if you only use two positions the database will still save 10 positions. The remaining eight positions will be filled by spaces.
* VARCHAR(length) - includes text (characters, numbers, punctuation...). VARCHAR is the same as CHAR, the difference is that VARCHAR only takes as much space as necessary.
* TEXT - can contain large amounts of text. Depending on the type of database this can add up to gigabytes.

Numbers:

* INT - contains a positive or negative whole number. A lot of databases have variations of the INT, such as TINYINT, SMALLINT, MEDIUMINT, BIGINT, INT2, INT4, INT8. These variations differ from the INT only in the size of the figure that fits into it. A regular INT is 4 bytes (INT4) and fits figures from -2147483647 to +2147483646, or if you define it as UNSIGNED from 0 to 4294967296. The INT8, or BIGINT, can get even bigger in size, from 0 to 18446744073709551616, but takes up to 8 bytes of diskspace, even if there is just a small number in it.
* FLOAT, DOUBLE - The same idea as INT, but can also store floating point numbers. . Do note that this does not always work perfectly. For instance in MySQL calculating with these floating point numbers is not perfect, (1/3)\*3 will result with MySQL's floats in 0.9999999, not 1.

Other types:

* BLOB - for binary data such as files.INET - for IP addresses. Also useable for netmasks.

For our example the data types are as follows:

|  |
| --- |
| datatypes displayed in database diagram  *Figure 12: Data model displaying data types.* |

## **Normalization**

Normalization makes your data model flexible and reliable. It does generate some overhead because you usually get more tables, but it enables you to do many things with your data model without having to adjust it.

### Normalization, the First Form

The first form of normalization states that there may be no repeating groups of columns in an entity. We could have created an entity 'sales' with attributes for each of the products that were bought. This would look like this:

|  |
| --- |
| http://www.datanamic.com/supimg/dez005-normalization1nf_1.jpg  *Figure 13: Not in 1st normal form.* |

What is wrong about this is that now only 3 products can be sold. If you would have to sell 4 products, than you would have to start a second sale or adjust your data model by adding 'product4' attributes. Both solutions are unwanted. In these cases you should always create a new entity that you link to the old one via a one-to-many relationship.

|  |
| --- |
| In accordance with 1st normal form  *Figure 14: In accordance with 1st normal form.* |

### Normalization, the Second Form

The second form of normalization states that all attributes of an entity should be fully dependent on the whole primary key. This means that each attribute of an entity can only be identified through the whole primary key. Suppose we had the date in the Sales\_details entity:

|  |
| --- |
| to be normalized (primary key)  *Figure 15: Not in 2nd normal form.* |

This entity is not according the second normalization form, because in order to be able to look up the date of a sale, I do not have to know what is sold (productnr), the only thing I need to know is the sales number. This was solved by splitting up the tables into the sales and the Sales\_details table:

|  |
| --- |
| 2nd normal form  *Figure 16: In accordance with 2nd normal form.* |

Now each attribute of the entities is dependent on the whole PK of the entity. The date is dependent on the sales number, and the quantity is dependent on the sales number and the sold product.

### Normalization, the Third Form

The third form of normalization states that all attributes need to be directly dependent on the primary key, and not on other attributes. This seems to be what the second form of normalization states, but in the second form is actually stated the opposite. In the second form of normalization you point out attributes through the PK, in the third form of normalization every attribute needs to be dependent on the PK, and nothing else.

|  |
| --- |
| normalize  *Figure 17: Not in 3rd normal form.* |

In this case the price of a loose product is dependent on the ordering number, and the ordering number is dependent on the product number and the sales number. This is not according to the third form of normalization. Again, splitting up the tables solves this.

|  |
| --- |
| 3rd normal form  *Figure 18: In accordance with 3rd normal form.* |

### Normalization, More Forms

There are more normalization forms than the three forms mentioned above, but those are not of great interest for the average user. These other forms are highly specialized for certain applications. If you stick to the design rules and the normalization mentioned in this article, you will create a design that works great for most applications.

### Normalized Data Model

If you apply the normalization rules, you will find that the 'manufacturer' in de product table should also be a separate table:

|  |
| --- |
| data model after normalization  *Figure 19: Data model in accordance with 1st, 2nd and 3d normal form.* |

## **Glossary**

Attributes - detailed data about an entity, such as price, length, name  
  
Cardinality - the relationship between two entities, in figures. For example, a person can place multiple orders.  
  
Entities - abstract data that you save in a database. For example: customers, products.  
  
Foreign key (FK) - a referral to the Primary Key of another table. Foreign Key-columns can only contain values that exist in the Primary Key column that they refer to.  
  
Key - a key is used to point out records. The most well-known key is the Primary Key (see Primary Key).  
  
Normalization - A flexible data model needs to follow certain rules. Applying these rules is called normalizing.  
  
Primary key - one or more columns within a table that together form a unique combination of values by which each record can be pointed out separately. For example: customer numbers, or the serial number of a product.

**Normalization**

# Normalization in DBMS: 1NF, 2NF, 3NF and BCNF in Database

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

**Normalization** is a process of organizing the data in database to avoid data redundancy, insertion anomaly, update anomaly & deletion anomaly. Let’s discuss about anomalies first then we will discuss normal forms with examples.

## Anomalies in DBMS

There are three types of anomalies that occur when the database is not normalized. These are – Insertion, update and deletion anomaly. Let’s take an example to understand this.

**Example**: Suppose a manufacturing company stores the employee details in a table named employee that has four attributes: emp\_id for storing employee’s id, emp\_name for storing employee’s name, emp\_address for storing employee’s address and emp\_dept for storing the department details in which the employee works. At some point of time the table looks like this:

|  |  |  |  |
| --- | --- | --- | --- |
| emp\_id | emp\_name | emp\_address | emp\_dept |
| 101 | Rick | Delhi | D001 |
| 101 | Rick | Delhi | D002 |
| 123 | Maggie | Agra | D890 |
| 166 | Glenn | Chennai | D900 |
| 166 | Glenn | Chennai | D004 |

The above table is not normalized. We will see the problems that we face when a table is not normalized.

**Update anomaly**: In the above table we have two rows for employee Rick as he belongs to two departments of the company. If we want to update the address of Rick then we have to update the same in two rows or the data will become inconsistent. If somehow, the correct address gets updated in one department but not in other then as per the database, Rick would be having two different addresses, which is not correct and would lead to inconsistent data.

**Insert anomaly**: Suppose a new employee joins the company, who is under training and currently not assigned to any department then we would not be able to insert the data into the table if emp\_dept field doesn’t allow nulls.

**Delete anomaly**: Suppose, if at a point of time the company closes the department D890 then deleting the rows that are having emp\_dept as D890 would also delete the information of employee Maggie since she is assigned only to this department.

To overcome these anomalies we need to normalize the data. In the next section we will discuss about normalization.

## Normalization

Here are the most commonly used normal forms:

* First normal form(1NF)
* Second normal form(2NF)
* Third normal form(3NF)
* Boyce & Codd normal form (BCNF)

## First normal form (1NF)

As per the rule of first normal form, an attribute (column) of a table cannot hold multiple values. It should hold only atomic values.

**Example**: Suppose a company wants to store the names and contact details of its employees. It creates a table that looks like this:

|  |  |  |  |
| --- | --- | --- | --- |
| emp\_id | emp\_name | emp\_address | emp\_mobile |
| 101 | Herschel | New Delhi | 8912312390 |
| 102 | Jon | Kanpur | 8812121212  9900012222 |
| 103 | Ron | Chennai | 7778881212 |
| 104 | Lester | Bangalore | 9990000123  8123450987 |

Two employees (Jon & Lester) are having two mobile numbers so the company stored them in the same field as you can see in the table above.

This table is **not in 1NF**as the rule says “each attribute of a table must have atomic (single) values”, the emp\_mobile values for employees Jon & Lester violates that rule.

To make the table complies with 1NF we should have the data like this:

|  |  |  |  |
| --- | --- | --- | --- |
| emp\_id | emp\_name | emp\_address | emp\_mobile |
| 101 | Herschel | New Delhi | 8912312390 |
| 102 | Jon | Kanpur | 8812121212 |
| 102 | Jon | Kanpur | 9900012222 |
| 103 | Ron | Chennai | 7778881212 |
| 104 | Lester | Bangalore | 9990000123 |
| 104 | Lester | Bangalore | 8123450987 |

## Second normal form (2NF)

A table is said to be in 2NF if both the following conditions hold:

* Table is in 1NF (First normal form)
* No non-prime attribute is dependent on the proper subset of any candidate key of table.

An attribute that is not part of any candidate key is known as non-prime attribute.

**Example**: Suppose a school wants to store the data of teachers and the subjects they teach. They create a table that looks like this: Since a teacher can teach more than one subjects, the table can have multiple rows for a same teacher.

|  |  |  |
| --- | --- | --- |
| teacher\_id | subject | teacher\_age |
| 111 | Maths | 38 |
| 111 | Physics | 38 |
| 222 | Biology | 38 |
| 333 | Physics | 40 |
| 333 | Chemistry | 40 |

**Candidate Keys**: {teacher\_id, subject}  
**Non prime attribute**: teacher\_age

The table is in 1 NF because each attribute has atomic values. However, it is not in 2NF because non prime attribute teacher\_age is dependent on teacher\_id alone which is a proper subset of candidate key. This violates the rule for 2NF as the rule says “**no** non-prime attribute is dependent on the proper subset of any candidate key of the table”.

To make the table complies with 2NF we can break it in two tables like this:  
**teacher\_details table:**

|  |  |
| --- | --- |
| teacher\_id | teacher\_age |
| 111 | 38 |
| 222 | 38 |
| 333 | 40 |

**teacher\_subject table:**

|  |  |
| --- | --- |
| teacher\_id | subject |
| 111 | Maths |
| 111 | Physics |
| 222 | Biology |
| 333 | Physics |
| 333 | Chemistry |

Now the tables comply with Second normal form (2NF).

## Third Normal form (3NF)

A table design is said to be in 3NF if both the following conditions hold:

* Table must be in 2NF
* [**Transitive functional dependency**](http://beginnersbook.com/2015/04/transitive-dependency-in-dbms/) of non-prime attribute on any super key should be removed.

An attribute that is not part of any [**candidate key**](http://beginnersbook.com/2015/04/candidate-key-in-dbms/) is known as non-prime attribute.

In other words 3NF can be explained like this: A table is in 3NF if it is in 2NF and for each functional dependency X-> Y at least one of the following conditions hold:

* X is a [**super key**](http://beginnersbook.com/2015/04/super-key-in-dbms/) of table
* Y is a prime attribute of table

An attribute that is a part of one of the candidate keys is known as prime attribute.

**Example**: Suppose a company wants to store the complete address of each employee, they create a table named employee\_details that looks like this:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| emp\_id | emp\_name | emp\_zip | emp\_state | emp\_city | emp\_district |
| 1001 | John | 282005 | UP | Agra | Dayal Bagh |
| 1002 | Ajeet | 222008 | TN | Chennai | M-City |
| 1006 | Lora | 282007 | TN | Chennai | Urrapakkam |
| 1101 | Lilly | 292008 | UK | Pauri | Bhagwan |
| 1201 | Steve | 222999 | MP | Gwalior | Ratan |

**Super keys**: {emp\_id}, {emp\_id, emp\_name}, {emp\_id, emp\_name, emp\_zip}…so on  
**Candidate Keys**: {emp\_id}  
**Non-prime attributes**: all attributes except emp\_id are non-prime as they are not part of any candidate keys.

Here, emp\_state, emp\_city & emp\_district dependent on emp\_zip. And, emp\_zip is dependent on emp\_id that makes non-prime attributes (emp\_state, emp\_city & emp\_district) transitively dependent on super key (emp\_id). This violates the rule of 3NF.

To make this table complies with 3NF we have to break the table into two tables to remove the transitive dependency:

**employee table:**

|  |  |  |
| --- | --- | --- |
| emp\_id | emp\_name | emp\_zip |
| 1001 | John | 282005 |
| 1002 | Ajeet | 222008 |
| 1006 | Lora | 282007 |
| 1101 | Lilly | 292008 |
| 1201 | Steve | 222999 |

**employee\_zip table:**

|  |  |  |  |
| --- | --- | --- | --- |
| emp\_zip | emp\_state | emp\_city | emp\_district |
| 282005 | UP | Agra | Dayal Bagh |
| 222008 | TN | Chennai | M-City |
| 282007 | TN | Chennai | Urrapakkam |
| 292008 | UK | Pauri | Bhagwan |
| 222999 | MP | Gwalior | Ratan |

## Boyce Codd normal form (BCNF)

It is an advance version of 3NF that’s why it is also referred as 3.5NF. BCNF is stricter than 3NF. A table complies with BCNF if it is in 3NF and for every [**functional dependency**](http://beginnersbook.com/2015/04/functional-dependency-in-dbms/) X->Y, X should be the super key of the table.

**Example**: Suppose there is a company wherein employees work in **more than one department**. They store the data like this:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| emp\_id | emp\_nationality | emp\_dept | dept\_type | dept\_no\_of\_emp |
| 1001 | Austrian | Production and planning | D001 | 200 |
| 1001 | Austrian | stores | D001 | 250 |
| 1002 | American | design and technical support | D134 | 100 |
| 1002 | American | Purchasing department | D134 | 600 |

**Functional dependencies in the table above**:  
emp\_id -> emp\_nationality  
emp\_dept -> {dept\_type, dept\_no\_of\_emp}

**Candidate key**: {emp\_id, emp\_dept}

The table is not in BCNF as neither emp\_id nor emp\_dept alone are keys.

To make the table comply with BCNF we can break the table in three tables like this:  
**emp\_nationality table:**

|  |  |
| --- | --- |
| emp\_id | emp\_nationality |
| 1001 | Austrian |
| 1002 | American |

**emp\_dept table:**

|  |  |  |
| --- | --- | --- |
| emp\_dept | dept\_type | dept\_no\_of\_emp |
| Production and planning | D001 | 200 |
| stores | D001 | 250 |
| design and technical support | D134 | 100 |
| Purchasing department | D134 | 600 |

**emp\_dept\_mapping table:**

|  |  |
| --- | --- |
| emp\_id | emp\_dept |
| 1001 | Production and planning |
| 1001 | stores |
| 1002 | design and technical support |
| 1002 | Purchasing department |

**Functional dependencies**:  
emp\_id -> emp\_nationality  
emp\_dept -> {dept\_type, dept\_no\_of\_emp}

**Candidate keys**:  
For first table: emp\_id  
For second table: emp\_dept  
For third table: {emp\_id, emp\_dept}

This is now in BCNF as in both the functional dependencies left side part is a key.

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# keys in DBMS

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

Key plays an important role in relational database; it is used for identifying unique rows from table. It also establishes relationship among tables.

### Types of keys in DBMS

[**Primary Key**](http://beginnersbook.com/2015/04/primary-key-in-dbms/) – A primary is a column or set of columns in a table that uniquely identifies tuples (rows) in that table.

[**Super Key**](http://beginnersbook.com/2015/04/super-key-in-dbms/) – A super key is a set of one of more columns (attributes) to uniquely identify rows in a table.

[**Candidate Key**](http://beginnersbook.com/2015/04/candidate-key-in-dbms/) – A super key with no redundant attribute is known as candidate key

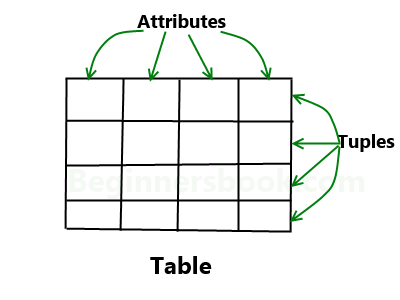
[**Alternate Key**](http://beginnersbook.com/2015/04/alternate-key-in-dbms/) – Out of all candidate keys, only one gets selected as primary key, remaining keys are known as alternate or secondary keys.

[**Composite Key**](http://beginnersbook.com/2015/04/composite-key-in-dbms/) – A key that consists of more than one attribute to uniquely identify rows (also known as records & tuples) in a table is called composite key.

[**Foreign Key**](http://beginnersbook.com/2015/04/foreign-key-in-dbms/) – Foreign keys are the columns of a table that points to the primary key of another table. They act as a cross-reference between tables.

# What is an attribute in DBMS? – Definition and explanation

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

You may hear this term often when dealing with [**Relational Database Management Systems (RDBMS)**](http://beginnersbook.com/2015/04/rdbms-concepts/). In RDBMS, a table organizes data in rows and columns. The columns are known as attributes whereas the rows are known as records.  
  
**Example**: A school maintains the data of students in a table named “student”. Suppose the data they store in table is student id, student name & student age. To do this they have had three columns in the table: **student\_id**, **student\_age**, **student\_name**. The table looks like this:

|  |  |  |
| --- | --- | --- |
| student\_id | student\_age | student\_name |
| 101 | 12 | Jon |
| 102 | 13 | Arya |
| 103 | 12 | Sansa |

Here student\_id, student\_age and student\_name are the **attributes**.

# RDBMS Concepts

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

**RDBMS** stands for relational database management system. A relational database has following major components: Table, Record / Tuple, Field & Column /Attribute.

**Table:**  
A table is a collection of data represented in rows and columns. For e.g. following table stores the information of students.

|  |  |  |  |
| --- | --- | --- | --- |
| **Student\_Id** | **Student\_Name** | **Student\_Addr** | **Student\_Age** |
| 101 | Chaitanya | Dayal Bagh, Agra | 27 |
| 102 | Ajeet | Delhi | 26 |
| 103 | Rahul | Gurgaon | 24 |
| 104 | Shubham | Chennai | 25 |

**Records / Tuple**:  
Each row of a table is known as record or it is also known as tuple. For e.g. The below row is a record.

|  |  |  |  |
| --- | --- | --- | --- |
| 102 | Ajeet | Delhi | 26 |

**Field**:  
The above table has four fields: Student\_Id, Student\_Name, Student\_Addr & Student\_Age.

**Column / Attribute**:  
Each attribute and its values are known as attributes in a database. For e.g. Set of values of Student\_Id field is one of the four columns of the Student table.

|  |
| --- |
| **Student\_Id** |
| 101 |
| 102 |
| 103 |
| 104 |

# ACID properties in DBMS

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

To ensure the integrity of data during a transaction (**A transaction is a unit of program that updates various data items, read more about it here**), the database system maintains the following properties. These properties are widely known as ACID properties:

* **Atomicity**: This property ensures that either all the operations of a transaction reflect in database or none. Let’s take an example of banking system to understand this: Suppose Account **A**has a balance of 400$ & **B**has 700$. Account **A**is transferring 100$ to Account **B**. This is a transaction that has two operations a) Debiting 100$ from A’s balance b) Creating 100$ to B’s balance. Let’s say first operation passed successfully while second failed, in this case A’s balance would be 300$ while B would be having 700$ instead of 800$. This is unacceptable in a banking system. Either the transaction should fail without executing any of the operation or it should process both the operations. The Atomicity property ensures that.
* **Consistency**: To preserve the consistency of database, the execution of transaction should take place in isolation (that means no other transaction should run concurrently when there is a transaction already running). For example account A is having a balance of 400$ and it is transferring 100$ to account B & C both. So we have two transactions here. Let’s say these transactions run concurrently and both the transactions read 400$ balance, in that case the final balance of A would be 300$ instead of 200$. This is wrong. If the transaction were to run in isolation then the second transaction would have read the correct balance 300$ (before debiting 100$) once the first transaction went successful.
* **Isolation**: For every pair of transactions, one transaction should start execution only when the other finished execution. I have already discussed the example of Isolation in the Consistency property above.
* **Durability**: Once a transaction completes successfully, the changes it has made into the database should be permanent even if there is a system failure. The recovery-management component of database systems ensures the durability of transaction.

# Functional dependency in DBMS

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

The attributes of a table is said to be dependent on each other when an attribute of a table uniquely identifies another attribute of the same table.

For example: Suppose we have a student table with attributes: Stu\_Id, Stu\_Name, Stu\_Age. Here Stu\_Id attribute uniquely identifies the Stu\_Name attribute of student table because if we know the student id we can tell the student name associated with it. This is known as functional dependency and can be written as Stu\_Id->Stu\_Name or in words we can say Stu\_Name is functionally dependent on Stu\_Id.

**Formally**:  
If column A of a table uniquely identifies the column B of same table then it can represented as A->B (Attribute B is functionally dependent on attribute A)

### Types of Functional Dependencies

* [**Trivial functional dependency**](http://beginnersbook.com/2015/04/trivial-functional-dependency-in-dbms/)
* [**non-trivial functional dependency**](http://beginnersbook.com/2015/04/non-trivial-functional-dependency-in-dbms/)
* [**Multivalued dependency**](http://beginnersbook.com/2015/04/multivalued-dependency-in-dbms/)
* [**Transitive dependency**](http://beginnersbook.com/2015/04/transitive-dependency-in-dbms/)

# Multivalued dependency in DBMS

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

Multivalued dependency occurs when there are more than one **independent** multivalued attributes in a table.

**For example**: Consider a bike manufacture company, which produces two colors (Black and white) in each model every year.

|  |  |  |
| --- | --- | --- |
| bike\_model | manuf\_year | color |
| M1001 | 2007 | Black |
| M1001 | 2007 | Red |
| M2012 | 2008 | Black |
| M2012 | 2008 | Red |
| M2222 | 2009 | Black |
| M2222 | 2009 | Red |

Here columns manuf\_year and color are independent of each other and dependent on bike\_model. In this case these two columns are said to be multivalued dependent on bike\_model. These dependencies can be represented like this:

bike\_model ->> manuf\_year

bike\_model ->> color

# Super key in DBMS

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

**Definition**: A super key is a set or one of more columns (attributes) to uniquely identify rows in a table. Often people get confused between super key and candidate key, so we will also discuss a little about candidate key here.

**How candidate key is different from super key?**  
Answer is simple – Candidate keys are selected from the set of super keys, the only thing we take care while selecting candidate key is: It should not have any redundant attribute. That’s the reason they are also termed as minimal super key.

Let’s take an example to understand this: **Employee table**

|  |  |  |
| --- | --- | --- |
| Emp\_SSN | Emp\_Number | Emp\_Name |
| 123456789 | 226 | Steve |
| 999999321 | 227 | Ajeet |
| 888997212 | 228 | Chaitanya |
| 777778888 | 229 | Robert |

**Super keys**:

* {Emp\_SSN}
* {Emp\_Number}
* {Emp\_SSN, Emp\_Number}
* {Emp\_SSN, Emp\_Name}
* {Emp\_SSN, Emp\_Number, Emp\_Name}
* {Emp\_Number, Emp\_Name}

All of the above sets are able to uniquely identify rows of the employee table.

**Candidate Keys**:  
As I stated above, they are the minimal super keys with no redundant attributes.

* {Emp\_SSN}
* {Emp\_Number}

Only these two sets are candidate keys as all other sets are having redundant attributes that are not necessary for unique identification.

[**Primary key**](http://beginnersbook.com/2015/04/primary-key-in-dbms/):  
Primary key is being selected from the sets of candidate keys by database designer. So Either {Emp\_SSN} or {Emp\_Number} can be the primary key.

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# Instance and schema in DBMS

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

**Definition of schema**: Design of a database is called the schema. Schema is of three types: Physical schema, logical schema and view schema.

The design of a database at physical level is called **physical schema**, how the data stored in blocks of storage is described at this level.

Design of database at logical level is called **logical schema**, programmers and database administrators work at this level, at this level data can be described as certain types of data records gets stored in data structures, however the internal details such as implementation of data structure is hidden at this level (available at physical level).

Design of database at view level is called **view schema**. This generally describes end user interaction with database systems.

To learn more about these schemas, refer [**3 level data abstraction architecture**](http://beginnersbook.com/2015/04/levels-of-abstraction-in-dbms/).

**Definition of instance**: The data stored in database at a particular moment of time is called instance of database. Database schema defines the variable declarations in tables that belong to a particular database; the value of these variables at a moment of time is called the instance of that database.

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# DBMS languages

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

Database languages are used for read, update and store data in a database. There are several such languages that can be used for this purpose; one of them is SQL (Structured Query Language).

**Types of DBMS languages:**  
**Data Definition Language (DDL)**: DDL is used for specifying the database schema. Let’s take SQL for instance to categorize the statements that comes under DDL.

* To create the database instance – [**CREATE**](http://beginnersbook.com/2014/05/sql-create-database-statement/)
* To alter the structure of database – **ALTER**
* To drop database instances – [**DROP**](http://beginnersbook.com/2014/05/sql-drop-database-statement/)
* To delete tables in a database instance – **TRUNCATE**
* To rename database instances – **RENAME**

All these commands specify or update the database schema that’s why they come under Data Definition language.

**Data Manipulation Language (DML)**: DML is used for accessing and manipulating data in a database.

* To read records from table(s) – [**SELECT**](http://beginnersbook.com/2014/05/sql-select-query/)
* To insert record(s) into the table(s) – **INSERT**
* Update the data in table(s) – [**UPDATE**](http://beginnersbook.com/2014/05/update-query-in-sql/)
* Delete all the records from the table – [**DELETE**](http://beginnersbook.com/2014/05/delete-query-in-sql/)

**Data Control language (DCL)**: DCL is used for granting and revoking user access on a database –

* To grant access to user – GRANT
* To revoke access from user – REVOKE

In practical data definition language, data manipulation language and data control languages are not separate language; rather they are the parts of a single database language such as SQL.

# Advantages of DBMS over file system

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

**Drawbacks of File system**:

* Data Isolation: Because data are scattered in various files, and files may be in different formats, writing new application programs to retrieve the appropriate data is difficult.
* Duplication of data – Redundant data
* Dependency on application programs – Changing files would lead to change in application programs.

## Advantage of DBMS over file system

There are several advantages of Database management system over file system. Few of them are as follows:

* No redundant data – Redundancy removed by data normalization
* Data Consistency and Integrity – data normalization takes care of it too
* Secure – Each user has a different set of access
* Privacy – Limited access
* Easy access to data
* Easy recovery
* Flexible

**Disadvantages of DBMS**:

* DBMS implementation cost is high compared to the file system
* Complexity: Database systems are complex to understand
* Performance: Database systems are generic, making them suitable for various applications. However this feature affect their performance for some applications

# Composite key in DBMS

BY CHAITANYA SINGH | FILED UNDER: [**DBMS**](http://beginnersbook.com/category/dbms/)

A key that consists of more than one attribute to uniquely identify rows (also known as records & tuples) in a table is called composite key. It is also known as compound key.

**Example: Table – Sales**

|  |  |  |  |
| --- | --- | --- | --- |
| cust\_Id | order\_Id | product\_code | product\_count |
| C01 | O001 | P007 | 23 |
| C02 | O123 | P007 | 19 |
| C02 | O123 | P230 | 82 |
| C01 | O001 | P890 | 42 |

Key in above table: {cust\_id, order\_id}  
This is a composite key as it consists of more than one attribute.

**Tista nodi kon bivage: Rangpur Division, Nirphamari Distict**

## **What are Cursors?**

A cursor is a temporary work area created in the system memory when a SQL statement is executed. A cursor contains information on a select statement and the rows of data accessed by it.

This temporary work area is used to store the data retrieved from the database, and manipulate this data. A cursor can hold more than one row, but can process only one row at a time. The set of rows the cursor holds is called the activeset.

There are two types of cursors in PL/SQL:

## Implicit cursors

These are created by default when DML statements like, INSERT, UPDATE, and DELETE statements are executed. They are also created when a SELECT statement that returns just one row is executed.

## Explicit cursors

They must be created when you are executing a SELECT statement that returns more than one row. Even though the cursor stores multiple records, only one record can be processed at a time, which is called as current row. When you fetch a row the current row position moves to next row.

Both implicit and explicit cursors have the same functionality, but they differ in the way they are accessed.

# Cursor (databases)

From Wikipedia, the free encyclopedia

In computer science, a [database](https://en.wikipedia.org/wiki/Database) **cursor** is a control structure that enables [traversal](https://en.wiktionary.org/wiki/traverse) over the [records](https://en.wikipedia.org/wiki/Database_record) in a database. Cursors facilitate subsequent processing in conjunction with the traversal, such as retrieval, addition and removal of database records. The database cursor characteristic of traversal makes cursors akin to the programming language concept of [iterator](https://en.wikipedia.org/wiki/Iterator).

Cursors are used by database programmers to process individual rows returned by [database system](https://en.wikipedia.org/wiki/Database_system) queries. Cursors enable manipulation of whole [result sets](https://en.wikipedia.org/wiki/Result_set) at once. In this scenario, a cursor enables the rows in a result set to be processed sequentially.

In SQL procedures, a cursor makes it possible to define a result set (a set of data rows) and perform complex logic on a row by row basis. By using the same mechanics, a SQL procedure can also define a result set and return it directly to the caller of the SQL procedure or to a client application.

A cursor can be viewed as a pointer to one row in a set of rows. The cursor can only reference one row at a time, but can move to other rows of the result set as needed.

## **Usage[**[**edit**](https://en.wikipedia.org/w/index.php?title=Cursor_(databases)&action=edit&section=1)**]**

To use cursors in SQL procedures, you need to do the following:

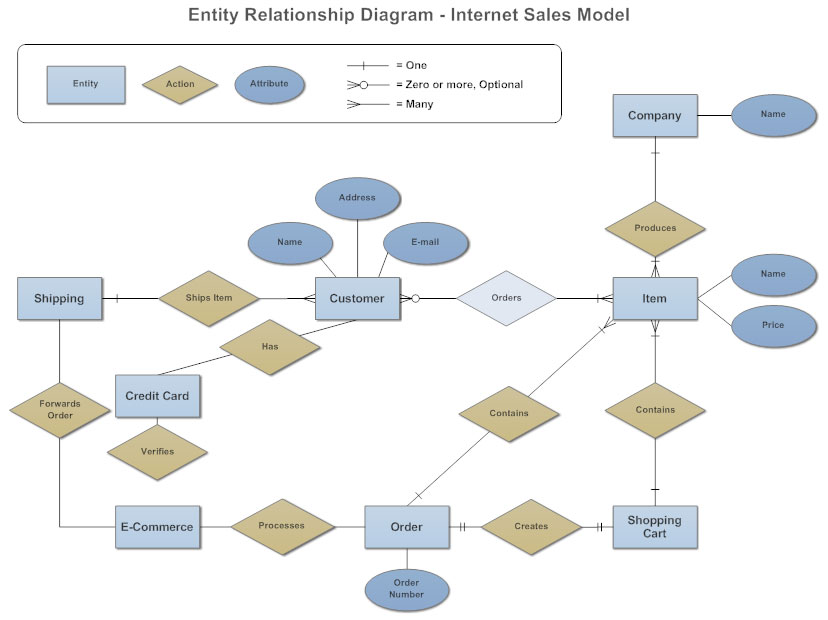
1. Declare a cursor that defines a result set.
2. Open the cursor to establish the result set.
3. Fetch the data into local variables as needed from the cursor, one row at a time.
4. Close the cursor when done.

**ER DIAGRAM**

# Entity Relationship Diagram

An entity relationship diagram (ERD) shows the relationships of entity sets stored in a database. An entity in this context is a component of data. In other words, ER diagrams illustrate the logical structure of databases.

At first glance an entity relationship diagram looks very much like a [flowchart](https://www.smartdraw.com/flowchart/). It is the specialized symbols, and the meanings of those symbols, that make it unique.

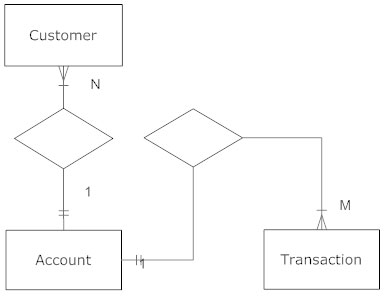
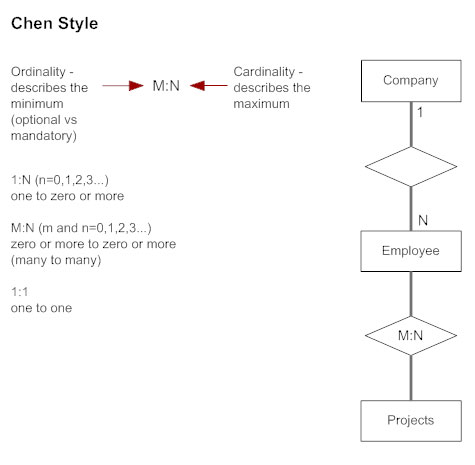
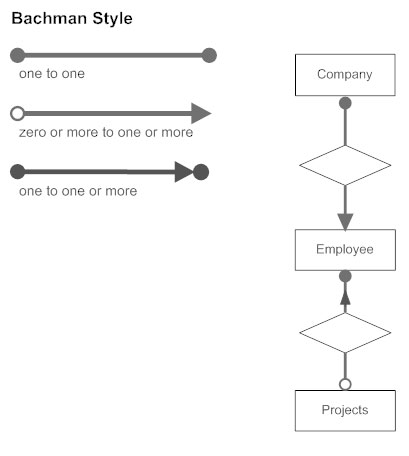
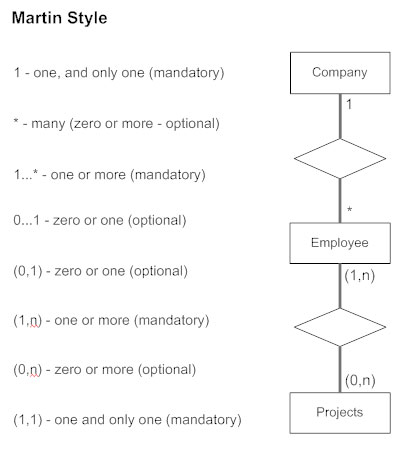


## **The History of Entity Relationship Diagrams**

Peter Chen developed ERDs in 1976. Since then Charles Bachman and James Martin have added some slight refinements to the basic ERD principles.

## **Structure of an Entity Relationship Diagram with Common ERD Notations**

An entity relationship diagram is a means of visualizing how the information a system produces is related. There are five main components of an ERD:

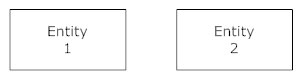
* **Entities**, which are represented by rectangles. An entity is an object or concept about which you want to store information.A weak entity is an entity that must defined by a foreign key relationship with another entity as it cannot be uniquely identified by its own attributes alone.
* **Actions**, which are represented by diamond shapes, show how two entities share information in the database.In some cases, entities can be self-linked. For example, employees can supervise other employees.  
  
* **Attributes**, which are represented by ovals. A key attribute is the unique, distinguishing characteristic of the entity. For example, an employee's social security number might be the employee's key attribute.   
  A multivalued attribute can have more than one value. For example, an employee entity can have multiple skill values.A derived attribute is based on another attribute. For example, an employee's monthly salary is based on the employee's annual salary.
* **Connecting lines**, solid lines that connect attributes to show the relationships of entities in the diagram.
* **Cardinality** specifies how many instances of an entity relate to one instance of another entity. Ordinality is also closely linked to cardinality. While cardinality specifies the occurrences of a relationship, ordinality describes the relationship as either mandatory or optional. In other words, cardinality specifies the maximum number of relationships and ordinality specifies the absolute minimum number of relationships.  
  There are many notation styles that express cardinality.  
  **Information Engineering Style**  
  **Chen Style**  
  **Bachman Style**  
  **Martin Style**  
  

## **Entity Relationship Diagram Uses**

When documenting a system or process, looking at the system in multiple ways increases the understanding of that system. ERD diagrams are commonly used in conjunction with a [data flow diagram](https://www.smartdraw.com/data-flow-diagram/) to display the contents of a data store. They help us to visualize how data is connected in a general way, and are particularly useful for constructing a relational database.

## **How to Create an Entity Relationship Diagram**

Here are some best practice tips for constructing an ERD:

* **Identify the entities.** The first step in making an ERD is to identify all of the entities you will use. An entity is nothing more than a rectangle with a description of something that your system stores information about. This could be a customer, a manager, an invoice, a schedule, etc. Draw a rectangle for each entity you can think of on your page. Keep them spaced out a bit.  
  
* **Identify relationships.** Look at two entities, are they related? If so draw a solid line connecting the two entities.
* **Describe the relationship.** How are the entities related? Draw an action diamond between the two entities on the line you just added. In the diamond write a brief description of how they are related.
* **Add attributes.** Any key attributes of entities should be added using oval-shaped symbols.
* **Complete the diagram.** Continue to connect the entities with lines, and adding diamonds to describe each relationship until all relationships have been described. Each of your entities may not have any relationships, some may have multiple relationships. That is okay.

## **Tips for Effective ER Diagrams**

1. Make sure that each entity only appears once per diagram.
2. Name every entity, relationship, and attribute on your diagram.
3. Examine relationships between entities closely. Are they necessary? Are there any relationships missing? Eliminate any redundant relationships. Don't connect relationships to each other.
4. Use colors to highlight important portions of your diagram.

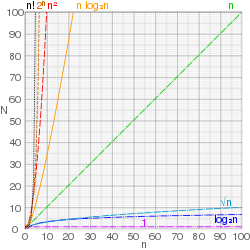
Security kivabe implement kora jai akta s/w?

**Time Complexity**

# Time complexity

From Wikipedia, the free encyclopedia

*"Running time" redirects here. For the film, see*[*Running Time (film)*](https://en.wikipedia.org/wiki/Running_Time_(film))*.*

[](https://en.wikipedia.org/wiki/File:Comparison_computational_complexity.svg)

Graphs of number of operations, N vs input size, n for common complexities, assuming a coefficient of 1

In [computer science](https://en.wikipedia.org/wiki/Computer_science), the **time complexity** of an [algorithm](https://en.wikipedia.org/wiki/Algorithm) quantifies the amount of time taken by an algorithm to run as a [function](https://en.wikipedia.org/wiki/Function_(mathematics)) of the length of the [string](https://en.wikipedia.org/wiki/String_(computer_science)) representing the input.[[1]](https://en.wikipedia.org/wiki/Time_complexity#cite_note-Sipser-1):226 The time complexity of an algorithm is commonly expressed using [big O notation](https://en.wikipedia.org/wiki/Big_O_notation), which excludes coefficients and lower order terms. When expressed this way, the time complexity is said to be described *asymptotically*, i.e., as the input size goes to infinity. For example, if the time required by an algorithm on all inputs of size *n* is at most 5*n*3 + 3*n* for any *n* (bigger than some *n0*), the asymptotic time complexity is O(*n*3).

Time complexity is commonly estimated by counting the number of elementary operations performed by the algorithm, where an elementary operation takes a fixed amount of time to perform. Thus, the amount of time taken and the number of elementary operations performed by the algorithm differ by at most a constant factor.

Since an algorithm's performance time may vary with different inputs of the same size, one commonly uses the [worst-case time complexity](https://en.wikipedia.org/wiki/Worst-case_complexity) of an algorithm, denoted as *T*(*n*), which is defined as the maximum amount of time taken on any input of size *n*. Less common, and usually specified explicitly, is the measure of [average-case complexity](https://en.wikipedia.org/wiki/Average-case_complexity). Time complexities are classified by the nature of the function *T*(*n*). For instance, an algorithm with *T*(*n*) = *O*(*n*) is called a *linear time algorithm*, and an algorithm with {\displaystyle \log T(n)=O(n^{\alpha })} for some constant {\displaystyle \alpha \geq 1} is said to be an *exponential time algorithm*.

## **Time Complexity comparison of Sorting Algorithms**

| **Algorithm** | **Data Structure** | **Time Complexity** | | |
| --- | --- | --- | --- | --- |
|  |  | **Best** | **Average** | **Worst** |
| [Quicksort](http://scanftree.com/Data_Structure/Quick-Sort) | Array | O(n log(n)) | O(n log(n)) | O(n^2) |
| [Mergesort](http://scanftree.com/Data_Structure/Merge-sort) | Array | O(n log(n)) | O(n log(n)) | O(n log(n)) |
| [Heapsort](http://scanftree.com/Data_Structure/Heap-sort) | Array | O(n log(n)) | O(n log(n)) | O(n log(n)) |
| [Bubble Sort](http://scanftree.com/Data_Structure/bubble-sort) | Array | O(n) | O(n^2) | O(n^2) |
| [Insertion Sort](http://scanftree.com/Data_Structure/Insertion-sort) | Array | O(n) | O(n^2) | O(n^2) |
| [Select Sort](http://en.wikipedia.org/wiki/Selection_sort) | Array | O(n^2) | O(n^2) | O(n^2) |
| [Bucket Sort](http://scanftree.com/Data_Structure/bucket-Sort) | Array | O(n+k) | O(n+k) | O(n^2) |
| [Radix Sort](http://scanftree.com/Data_Structure/radix-sort) | Array | O(nk) | O(nk) | O(nk) |

# Best, worst and average case

From Wikipedia, the free encyclopedia

|  |  |
| --- | --- |
| [https://upload.wikimedia.org/wikipedia/en/thumb/9/99/Question_book-new.svg/50px-Question_book-new.svg.png](https://en.wikipedia.org/wiki/File:Question_book-new.svg) | This article **needs additional citations for**[**verification**](https://en.wikipedia.org/wiki/Wikipedia:Verifiability). Please help [improve this article](https://en.wikipedia.org/w/index.php?title=Best,_worst_and_average_case&action=edit) by [adding citations to reliable sources](https://en.wikipedia.org/wiki/Help:Introduction_to_referencing_with_Wiki_Markup/1). Unsourced material may be challenged and removed. *(March 2009)* *(*[*Learn how and when to remove this template message*](https://en.wikipedia.org/wiki/Help:Maintenance_template_removal)*)* |

In [computer science](https://en.wikipedia.org/wiki/Computer_science), **best**, **worst,** and **average cases** of a given [algorithm](https://en.wikipedia.org/wiki/Algorithm) express what the [resource](https://en.wikipedia.org/wiki/Resource_(computer_science)) usage is *at least*, *at most* and *on average*, respectively. Usually the resource being considered is running time, i.e. [time complexity](https://en.wikipedia.org/wiki/Time_complexity), but it could also be memory or other resource.

### Sorting algorithms**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Best,_worst_and_average_case&action=edit&section=5)**]**

*See also:*[*Sorting algorithm § Comparison of algorithms*](https://en.wikipedia.org/wiki/Sorting_algorithm#Comparison_of_algorithms)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Algorithm** | **Data structure** | **Time complexity:Best** | **Time complexity:Average** | **Time complexity:Worst** | **Space complexity:Worst** |
| Quick sort | Array | O(*n* log(*n*)) | O(*n* log(*n*)) | O(*n*2) | O(1) |
| Merge sort | Array | O(*n* log(*n*)) | O(*n* log(*n*)) | O(*n* log(*n*)) | O(n) |
| Heap sort | Array | O(*n* log(*n*)) | O(*n* log(*n*)) | O(*n* log(*n*)) | O(1) |
| Smooth sort | Array | O(*n*) | O(*n* log(*n*)) | O(*n* log(*n*)) | O(1) |
| Bubble sort | Array | O(*n*) | O(*n*2) | O(*n*2) | O(1) |
| Insertion sort | Array | O(*n*) | O(*n*2) | O(*n*2) | O(1) |
| Selection sort | Array | O(*n*2) | O(*n*2) | O(*n*2) | O(1) |

* [Insertion sort](https://en.wikipedia.org/wiki/Insertion_sort) applied to a list of *n* elements, assumed to be all different and initially in random order. On average, half the elements in a list *A*1 ... *Aj* are less than element*Aj*+1, and half are greater. Therefore, the algorithm compares the (*j* + 1)th element to be inserted on the average with half the already sorted sub-list, so *tj* = *j*/2. Working out the resulting average-case running time yields a quadratic function of the input size, just like the worst-case running time.
* [Quicksort](https://en.wikipedia.org/wiki/Quicksort) applied to a list of *n* elements, again assumed to be all different and initially in random order. This popular [sorting algorithm](https://en.wikipedia.org/wiki/Sorting_algorithm) has an average-case performance of O(*n* log(*n*)), which contributes to making it a very fast algorithm in practice. But given a worst-case input, its performance degrades to O(*n*2). Also, when not implemented with the "shortest first" policy, the worst-case space complexity degrades to O(log(*n*)).

## **Popular sorting algorithms[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=4)**]**

While there are a large number of sorting algorithms, in practical implementations a few algorithms predominate. Insertion sort is widely used for small data sets, while for large data sets an asymptotically efficient sort is used, primarily heap sort, merge sort, or quicksort. Efficient implementations generally use a [hybrid algorithm](https://en.wikipedia.org/wiki/Hybrid_algorithm), combining an asymptotically efficient algorithm for the overall sort with insertion sort for small lists at the bottom of a recursion. Highly tuned implementations use more sophisticated variants, such as [Timsort](https://en.wikipedia.org/wiki/Timsort) (merge sort, insertion sort, and additional logic), used in Android, Java, and Python, and [introsort](https://en.wikipedia.org/wiki/Introsort) (quicksort and heap sort), used (in variant forms) in some [C++ sort](https://en.wikipedia.org/wiki/Sort_(C%2B%2B)) implementations and in .NET.

For more restricted data, such as numbers in a fixed interval, [distribution sorts](https://en.wikipedia.org/wiki/Sorting_algorithm#Distribution_sort) such as counting sort or radix sort are widely used. Bubble sort and variants are rarely used in practice, but are commonly found in teaching and theoretical discussions.

When physically sorting objects, such as alphabetizing papers (such as tests or books), people intuitively generally use insertion sorts for small sets. For larger sets, people often first bucket, such as by initial letter, and multiple bucketing allows practical sorting of very large sets. Often space is relatively cheap, such as by spreading objects out on the floor or over a large area, but operations are expensive, particularly moving an object a large distance – locality of reference is important. Merge sorts are also practical for physical objects, particularly as two hands can be used, one for each list to merge, while other algorithms, such as heap sort or quick sort, are poorly suited for human use. Other algorithms, such as [library sort](https://en.wikipedia.org/wiki/Library_sort), a variant of insertion sort that leaves spaces, are also practical for physical use.

### Simple sorts**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=5)**]**

Two of the simplest sorts are insertion sort and selection sort, both of which are efficient on small data, due to low overhead, but not efficient on large data. Insertion sort is generally faster than selection sort in practice, due to fewer comparisons and good performance on almost-sorted data, and thus is preferred in practice, but selection sort uses fewer writes, and thus is used when write performance is a limiting factor.

#### Insertion sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=6)**]**

*Main article:*[*Insertion sort*](https://en.wikipedia.org/wiki/Insertion_sort)

[*Insertion sort*](https://en.wikipedia.org/wiki/Insertion_sort) is a simple sorting algorithm that is relatively efficient for small lists and mostly sorted lists, and is often used as part of more sophisticated algorithms. It works by taking elements from the list one by one and inserting them in their correct position into a new sorted list.[[17]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-17) In arrays, the new list and the remaining elements can share the array's space, but insertion is expensive, requiring shifting all following elements over by one. [Shellsort](https://en.wikipedia.org/wiki/Sorting_algorithm#Shellsort) (see below) is a variant of insertion sort that is more efficient for larger lists.

#### Selection sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=7)**]**

*Main article:*[*Selection sort*](https://en.wikipedia.org/wiki/Selection_sort)

*Selection sort* is an [in-place](https://en.wikipedia.org/wiki/In-place_algorithm) [comparison sort](https://en.wikipedia.org/wiki/Comparison_sort). It has [O](https://en.wikipedia.org/wiki/Big_O_notation)(*n*2) complexity, making it inefficient on large lists, and generally performs worse than the similar [insertion sort](https://en.wikipedia.org/wiki/Insertion_sort). Selection sort is noted for its simplicity, and also has performance advantages over more complicated algorithms in certain situations.

The algorithm finds the minimum value, swaps it with the value in the first position, and repeats these steps for the remainder of the list.[[18]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-18) It does no more than *n* swaps, and thus is useful where swapping is very expensive.

### Efficient sorts**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=8)**]**

Practical general sorting algorithms are almost always based on an algorithm with average time complexity (and generally worst-case complexity) O(*n* log *n*), of which the most common are heap sort, merge sort, and quicksort. Each has advantages and drawbacks, with the most significant being that simple implementation of merge sort uses O(*n*) additional space, and simple implementation of quicksort has O(*n*2) worst-case complexity. These problems can be solved or ameliorated at the cost of a more complex algorithm.

While these algorithms are asymptotically efficient on random data, for practical efficiency on real-world data various modifications are used. First, the overhead of these algorithms becomes significant on smaller data, so often a hybrid algorithm is used, commonly switching to insertion sort once the data is small enough. Second, the algorithms often perform poorly on already sorted data or almost sorted data – these are common in real-world data, and can be sorted in O(*n*) time by appropriate algorithms. Finally, they may also be [unstable](https://en.wikipedia.org/wiki/Unstable_sort), and stability is often a desirable property in a sort. Thus more sophisticated algorithms are often employed, such as [Timsort](https://en.wikipedia.org/wiki/Timsort) (based on merge sort) or [introsort](https://en.wikipedia.org/wiki/Introsort) (based on quicksort, falling back to heap sort).

#### Merge sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=9)**]**

*Main article:*[*Merge sort*](https://en.wikipedia.org/wiki/Merge_sort)

*Merge sort* takes advantage of the ease of merging already sorted lists into a new sorted list. It starts by comparing every two elements (i.e., 1 with 2, then 3 with 4...) and swapping them if the first should come after the second. It then merges each of the resulting lists of two into lists of four, then merges those lists of four, and so on; until at last two lists are merged into the final sorted list.[[19]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-19) Of the algorithms described here, this is the first that scales well to very large lists, because its worst-case running time is O(*n* log *n*). It is also easily applied to lists, not only arrays, as it only requires sequential access, not random access. However, it has additional O(*n*) space complexity, and involves a large number of copies in simple implementations.

Merge sort has seen a relatively recent surge in popularity for practical implementations, due to its use in the sophisticated algorithm [Timsort](https://en.wikipedia.org/wiki/Timsort), which is used for the standard sort routine in the programming languages [Python](https://en.wikipedia.org/wiki/Python_(programming_language))[[20]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-20) and [Java](https://en.wikipedia.org/wiki/Java_(programming_language)) (as of [JDK7](https://en.wikipedia.org/wiki/JDK7)[[21]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-21)). Merge sort itself is the standard routine in [Perl](https://en.wikipedia.org/wiki/Perl),[[22]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-22) among others, and has been used in Java at least since 2000 in JDK1.3.[[23]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-mergesort_in_jdk13-23)[[24]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-jdk13_since_2000-24)

#### Heapsort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=10)**]**

*Main article:*[*Heapsort*](https://en.wikipedia.org/wiki/Heapsort)

*Heapsort* is a much more efficient version of [selection sort](https://en.wikipedia.org/wiki/Selection_sort). It also works by determining the largest (or smallest) element of the list, placing that at the end (or beginning) of the list, then continuing with the rest of the list, but accomplishes this task efficiently by using a data structure called a [heap](https://en.wikipedia.org/wiki/Heap_(data_structure)), a special type of [binary tree](https://en.wikipedia.org/wiki/Binary_tree).[[25]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-25) Once the data list has been made into a heap, the root node is guaranteed to be the largest (or smallest) element. When it is removed and placed at the end of the list, the heap is rearranged so the largest element remaining moves to the root. Using the heap, finding the next largest element takes O(log *n*) time, instead of O(*n*) for a linear scan as in simple selection sort. This allows Heapsort to run in O(*n* log *n*) time, and this is also the worst case complexity.

#### Quicksort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=11)**]**

*Main article:*[*Quicksort*](https://en.wikipedia.org/wiki/Quicksort)

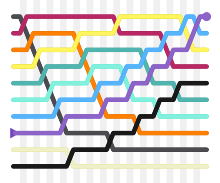
*Quicksort* is a [divide and conquer](https://en.wikipedia.org/wiki/Divide_and_conquer_algorithm) [algorithm](https://en.wikipedia.org/wiki/Algorithm) which relies on a *partition* operation: to partition an array an element called a *pivot* is selected.[[26]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-26)[[27]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-27) All elements smaller than the pivot are moved before it and all greater elements are moved after it. This can be done efficiently in linear time and [in-place](https://en.wikipedia.org/wiki/In-place_algorithm). The lesser and greater sublists are then recursively sorted. This yields average time complexity of O(*n* log *n*), with low overhead, and thus this is a popular algorithm. Efficient implementations of quicksort (with in-place partitioning) are typically unstable sorts and somewhat complex, but are among the fastest sorting algorithms in practice. Together with its modest O(log *n*) space usage, quicksort is one of the most popular sorting algorithms and is available in many standard programming libraries.

The important caveat about quicksort is that its worst-case performance is O(*n*2); while this is rare, in naive implementations (choosing the first or last element as pivot) this occurs for sorted data, which is a common case. The most complex issue in quicksort is thus choosing a good pivot element, as consistently poor choices of pivots can result in drastically slower O(*n*2) performance, but good choice of pivots yields O(*n* log *n*) performance, which is asymptotically optimal. For example, if at each step the [median](https://en.wikipedia.org/wiki/Median) is chosen as the pivot then the algorithm works in O(*n* log *n*). Finding the median, such as by the [median of medians](https://en.wikipedia.org/wiki/Median_of_medians) [selection algorithm](https://en.wikipedia.org/wiki/Selection_algorithm) is however an O(*n*) operation on unsorted lists and therefore exacts significant overhead with sorting. In practice choosing a random pivot almost certainly yields O(*n* log *n*) performance.

### Bubble sort and variants**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=12)**]**

Bubble sort, and variants such as the [cocktail sort](https://en.wikipedia.org/wiki/Cocktail_sort), are simple but highly inefficient sorts. They are thus frequently seen in introductory texts, and are of some theoretical interest due to ease of analysis, but they are rarely used in practice, and primarily of recreational interest. Some variants, such as the Shell sort, have open questions about their behavior.

#### Bubble sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=13)**]**

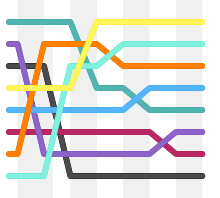
[](https://en.wikipedia.org/wiki/File:Bubblesort-edited-color.svg)

A bubble sort, a sorting algorithm that continuously steps through a list, [swapping](https://en.wikipedia.org/wiki/Swap_(computer_science)) items until they appear in the correct order.

*Main article:*[*Bubble sort*](https://en.wikipedia.org/wiki/Bubble_sort)

*Bubble sort* is a simple sorting algorithm. The algorithm starts at the beginning of the data set. It compares the first two elements, and if the first is greater than the second, it swaps them. It continues doing this for each pair of adjacent elements to the end of the data set. It then starts again with the first two elements, repeating until no swaps have occurred on the last pass.[[28]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-28) This algorithm's average time and worst-case performance is O(*n*2), so it is rarely used to sort large, unordered data sets. Bubble sort can be used to sort a small number of items (where its asymptotic inefficiency is not a high penalty). Bubble sort can also be used efficiently on a list of any length that is nearly sorted (that is, the elements are not significantly out of place). For example, if any number of elements are out of place by only one position (e.g. 0123546789 and 1032547698), bubble sort's exchange will get them in order on the first pass, the second pass will find all elements in order, so the sort will take only 2*n* time.

#### Shellsort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=14)**]**

[](https://en.wikipedia.org/wiki/File:Shell_sorting_algorithm_color_bars.svg)

A Shell sort, different from bubble sort in that it moves elements to numerous [swapping positions](https://en.wikipedia.org/wiki/Swap_(computer_science)).

*Main article:*[*Shell sort*](https://en.wikipedia.org/wiki/Shellsort)

*Shellsort* was invented by [Donald Shell](https://en.wikipedia.org/wiki/Donald_Shell) in 1959. It improves upon bubble sort and insertion sort by moving out of order elements more than one position at a time. The concept behind Shellsort is that both of these algorithms perform in O(k*n*) time, where k is the greatest distance between two out-of-place elements. This means that generally, they perform in O(*n*2), but for data that is mostly sorted, with only a few elements out of place, they perform faster. So, by first sorting elements far away, and progressively shrinking the gap between the elements to sort, the final sort computes much faster. One implementation can be described as arranging the data sequence in a two-dimensional array and then sorting the columns of the array using insertion sort.

The worst-case time complexity of Shell sort largely depends on the gap sequence used, and can range from O(*n*2) to O(*n* log2 *n*). Also, unlike efficient sorting algorithms, Shellsort does not require use of the [call stack](https://en.wikipedia.org/wiki/Call_stack), making it useful in [embedded systems](https://en.wikipedia.org/wiki/Embedded_system) where memory is at a premium.

#### Comb sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=15)**]**

*Main article:*[*Comb sort*](https://en.wikipedia.org/wiki/Comb_sort)

*Comb sort* is a relatively simple sorting algorithm originally designed by Wlodzimierz Dobosiewicz in 1980.[[29]](https://en.wikipedia.org/wiki/Sorting_algorithm#cite_note-BB-29) It was later rediscovered and popularized by Stephen Lacey and Richard Box with a [*Byte* Magazine](https://en.wikipedia.org/wiki/Byte_Magazine) article published in April 1991. Comb sort improves on [bubble sort](https://en.wikipedia.org/wiki/Bubble_sort). The basic idea is to eliminate *turtles*, or small values near the end of the list, since in a bubble sort these slow the sorting down tremendously. (*Rabbits*, large values around the beginning of the list, do not pose a problem in bubble sort)

### Distribution sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=16)**]**

*See also:*[*External sorting*](https://en.wikipedia.org/wiki/External_sorting)

*Distribution sort* refers to any sorting algorithm where data are distributed from their input to multiple intermediate structures which are then gathered and placed on the output. For example, both [bucket sort](https://en.wikipedia.org/wiki/Bucket_sort) and [flashsort](https://en.wikipedia.org/wiki/Flashsort) are distribution based sorting algorithms. Distribution sorting algorithms can be used on a single processor, or they can be a [distributed algorithm](https://en.wikipedia.org/wiki/Distributed_algorithm), where individual subsets are separately sorted on different processors, then combined. This allows [external sorting](https://en.wikipedia.org/wiki/External_sorting) of data too large to fit into a single computer's memory.

#### Counting sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=17)**]**

*Main article:*[*Counting sort*](https://en.wikipedia.org/wiki/Counting_sort)

Counting sort is applicable when each input is known to belong to a particular set, *S*, of possibilities. The algorithm runs in O(|*S*| + *n*) time and O(|*S*|) memory where *n* is the length of the input. It works by creating an integer array of size |*S*| and using the *i*th bin to count the occurrences of the *i*th member of *S* in the input. Each input is then counted by incrementing the value of its corresponding bin. Afterward, the counting array is looped through to arrange all of the inputs in order. This sorting algorithm often cannot be used because *S* needs to be reasonably small for the algorithm to be efficient, but it is extremely fast and demonstrates great asymptotic behavior as *n* increases. It also can be modified to provide stable behavior.

#### Bucket sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=18)**]**

*Main article:*[*Bucket sort*](https://en.wikipedia.org/wiki/Bucket_sort)

Bucket sort is a [divide and conquer](https://en.wikipedia.org/wiki/Divide_and_conquer_algorithm) sorting algorithm that generalizes [counting sort](https://en.wikipedia.org/wiki/Counting_sort) by partitioning an array into a finite number of buckets. Each bucket is then sorted individually, either using a different sorting algorithm, or by recursively applying the bucket sorting algorithm.

A bucket sort works best when the elements of the data set are evenly distributed across all buckets.

#### Radix sort**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Sorting_algorithm&action=edit&section=19)**]**

*Main article:*[*Radix sort*](https://en.wikipedia.org/wiki/Radix_sort)

*Radix sort* is an algorithm that sorts numbers by processing individual digits. *n* numbers consisting of *k* digits each are sorted in O(*n* · *k*) time. Radix sort can process digits of each number either starting from the [least significant digit](https://en.wikipedia.org/wiki/Least_significant_digit) (LSD) or starting from the [most significant digit](https://en.wikipedia.org/wiki/Most_significant_digit) (MSD). The LSD algorithm first sorts the list by the least significant digit while preserving their relative order using a stable sort. Then it sorts them by the next digit, and so on from the least significant to the most significant, ending up with a sorted list. While the LSD radix sort requires the use of a stable sort, the MSD radix sort algorithm does not (unless stable sorting is desired). In-place MSD radix sort is not stable. It is common for the [counting sort](https://en.wikipedia.org/wiki/Counting_sort) algorithm to be used internally by the radix sort. A [hybrid](https://en.wikipedia.org/wiki/Hybrid_algorithm) sorting approach, such as using [insertion sort](https://en.wikipedia.org/wiki/Insertion_sort) for small bins improves performance of radix sort significantly.

What is the difference between public and private IP address?

A public [IP address](https://www.iplocation.net/ip-address) is an IP address that can be accessed over the Internet. Like postal address used to deliver a postal mail to your home, a public IP address is the globally unique IP address assigned to a computing device. Your public IP address can be found at [What is my IP Address](https://www.iplocation.net/find-ip-address) page. Private IP address on the other hand is used to assign computers within your private space without letting them directly expose to the Internet. For example, if you have multiple computers within your home you may want to use private IP addresses to address each computer within your home. In this scenario, your router get the public IP address, and each of the computers, tablets and smartphones connected to your router (via wired or wifi) get a private IP address from your router via [DHCP](https://www.iplocation.net/dhcp) protocol.

Internet Assigned Numbers Authority (IANA) is the organization responsible for registering IP address ranges to organizations and Internet Service Providers (ISPs). To allow organizations to freely assign private IP addresses, the Network Information Center (InterNIC) has reserved certain address blocks for private use. The following IP blocks are reserved for private IP addresses.

|  |  |  |  |
| --- | --- | --- | --- |
| **Class** | **Starting IP Address** | **Ending IP Address** | **# of Hosts** |
| A | 10.0.0.0 | 10.255.255.255 | 16,777,216 |
| B | 172.16.0.0 | 172.31.255.255 | 1,048,576 |
| C | 192.168.0.0 | 192.168.255.255 | 65,536 |

## **What is public IP address?**

A public IP address is the address that is assigned to a computing device to allow direct access over the Internet. A web server, email server and any server device directly accessible from the Internet are candidate for a public IP address. A public IP address is globally unique, and can only be assigned to an unique device.

## **What is private IP address?**

A private IP address is the address space allocated by InterNIC to allow organizations to create their own private network. There are three IP blocks (1 class A, 1 class B and 1 class C) reserved for a private use. The computers, tablets and smartphones sitting behind your home, and the personal computers within an organizations are usually assigned private IP addresses. A network printer residing in your home is assigned a private address so that only your family can print to your local printer.

When a computer is assigned a private IP address, the local devices sees this computer via it's private IP address. However, the devices residing outside of your local network cannot directly communicate via the private IP address, but uses your router's public IP address to communicate. To allow direct access to a local device which is assigned a private IP address, a Network Address Translator (NAT) should be used.

What is an IP Address?

**I**nternet **P**rotocol Address (or IP Address) is an unique address that computing devices such as personal computers, tablets, and smartphones use to identify itself and communicate with other devices in the IP network. Any device connected to the IP network must have an unique IP address within the network. An IP address is analogous to a street address or telephone number in that it is used to uniquely identify an entity.

### **Dotted Decimals**

The traditional IP Addresses (known as IPv4) uses a 32-bit number to represent an IP address, and it defines both network and host address. A 32-bit number is capable of providing roughly 4 billion unique numbers, and hence IPv4 addresses running out as more devices are connected to the IP network. A new version of the [IP protocol (IPv6)](https://www.iplocation.net/ipv6-address) has been invented to offer virtually limitless number of unique addresses. An IP address is written in "dotted decimal" notation, which is 4 sets of numbers separated by period each set representing 8-bit number ranging from (0-255). An example of IPv4 address is 216.3.128.12, which is the IP address previously assigned to iplocation.net.

An IPv4 address is divided into two parts: network and host address. The network address determines how many of the 32 bits are used for the network address, and remaining bits for the host address. The host address can further divided into subnetwork and host number.

### **Class A, B, C and CIDR networks**

Traditionally IP network is classified as A, B or C network. The computers identified the class by the first 3 bits (A=000, B=100, C=110), while humans identify the class by first octet(8-bit) number. With scarcity of IP addresses, the class-based system has been replaced by **C**lassless **I**nter-**D**omain **R**outing (CIDR) to more efficiently allocate IP addresses.

|  |  |  |  |
| --- | --- | --- | --- |
| **Class** | **Network Address** | **Number of Hosts** | **Netmask** |
| CIDR | /4 | 240,435,456 | 240.0.0.0 |
| CIDR | /5 | 134,217,728 | 248.0.0.0 |
| CIDR | /6 | 67,108,864 | 252.0.0.0 |
| CIDR | /7 | 33,554,432 | 254.0.0.0 |
| A | /8 (1-126) | 16,777,216 | 255.0.0.0 |
| CIDR | /9 | 8,388,608 | 255.128.0.0 |
| CIDR | /10 | 4,194,304 | 255.192.0.0 |
| CIDR | /11 | 2,097,152 | 255.224.0.0 |
| CIDR | /12 | 1,048,576 | 255.240.0.0 |
| CIDR | /13 | 524,288 | 255.248.0.0 |
| CIDR | /14 | 262,144 | 255.252.0.0 |
| CIDR | /15 | 131,072 | 255.254.0.0 |
| B | /16 (128-191) | 65,534 | 255.255.0.0 |
| CIDR | /17 | 32,768 | 255.255.128.0 |
| CIDR | /18 | 16,384 | 255.255.192.0 |
| CIDR | /19 | 8,192 | 255.255.224.0 |
| CIDR | /20 | 4,096 | 255.255.240.0 |
| CIDR | /21 | 2,048 | 255.255.248.0 |
| CIDR | /22 | 1,024 | 255.255.252.0 |
| CIDR | /23 | 512 | 255.255.254.0 |
| C | /24 (192-223) | 256 | 255.255.255.0 |
| CIDR | /25 | 128 | 255.255.255.128 |
| CIDR | /26 | 64 | 255.255.255.192 |
| CIDR | /27 | 32 | 255.255.255.224 |
| CIDR | /28 | 16 | 255.255.255.240 |
| CIDR | /29 | 8 | 255.255.255.248 |
| CIDR | /30 | 4 | 255.255.255.252 |

Note: (1) 127 Network Address reserved for loopback test. (2) Class D (224-247, Multicast) and Class E (248-255, Experimental) are not intended to be used in public operation. 

### **Public and Private IP Addresses**

In order to maintain uniqueness within global namespace, the IP addresses are publicly registered with the **N**etwork **I**nformation **C**enter (NIC) to avoid address conflicts. Devices that need to be publicly identified such as web or mail servers must have a globally unique IP address, and they are assigned a public IP address. Devices that do not require public access may be assigned a private IP address, and make it uniquely identifiable within one organization. For example, a network printer may be assigned a private IP address to prevent the world from printing from it. To allow organizations to freely assign private IP addresses, the NIC has reserved certain address blocks for private use. A private network is a network that uses [RFC 1918](http://tools.ietf.org/html/rfc1918) IP address space. The following IP blocks are reserved for private IP addresses.

|  |  |  |
| --- | --- | --- |
| **Class** | **Starting IP Address** | **Ending IP Address** |
| A | 10.0.0.0 | 10.255.255.255 |
| B | 172.16.0.0 | 172.31.255.255 |
| C | 192.168.0.0 | 192.168.255.255 |

In addition to above classful private addresses, 169.254.0.0 through 169.254.255.255 addresses are reserved for Zeroconf (or APIPA, Automatic Private IP Addressing) to automatically create the usable IP network without configuration.

### **What is loopback IP address?**

The loopback IP address is the address used to access itself. The IPv4 designated **127.0.0.1** as the loopback address with the 255.0.0.0 [subnet mask](https://www.iplocation.net/subnet-mask). A loopback interface is also known as a virtual IP, which does not associate with hardware interface. On Linux systems, the loopback interface is commonly called **lo** or **lo0**. The corresponding hostname for this interface is called **localhost**.

The loopback address is used to test network software without physically installing a **N**etwork **I**nterface **C**ard (NIC), and without having to physically connect the machine to a TCP/IP network. A good example of this is to access the web server running on itself by using http://127.0.0.1 or http://localhost.

What is IPv6 Address?

**Internet Protocol Version 6 (or IPv6)** is a successor of [IPv4](https://www.iplocation.net/ip-address) Address standard developed by IETF, which is designed to solve IPv4 address exhaustion problem. IPv4 uses a 32-bit numbering scheme to represent an IP address, which has an address space of 232 or 4.3 billion. IPv6, on the other hand, uses 128-bit numbering scheme (2128) which has big enough address space for many decades to come. IPv6 is intended to replace the IPv4, but the introduction of CIDR (Classless Inter-Domain Routing) allocation scheme in 1993 within the IPv4 prolonged lifespan of IPv4 Addresses. With an anticipation of smartphones, tablets, smart appliances and other electronic devices joining Internet every day, IPv4 address space will eventually exhaust. As of May 2014 per [Google Statistics](https://www.google.com/intl/en/ipv6/statistics.html#tab=ipv6-adoption), 96% of Internet traffic is IPv4 and only 4% is represented by IPv6. IPv4 and IPv6 are not interoperable by design, so the transition from IPv4 to IPv6 require "transition mechanism" such as Stateless IP/ICMP Translation, Transport Relay, 6rd and other IPv6 transition mechanisms to make them interoperable.

## **IPv6 Address Types**

IPv6 addresses are classified into three categories: unicast, anycast and multicast addressing.

* **Unicast Address** - An unicast IP address is an identifier for a single network interface. An IPv6 packet sent to an unicast address is delivered to a single interface.
* **Anycast Address** - An anycast IP address is identifier for a set of interfaces assigned to a group but belonging to different nodes. An IPv6 packet sent to an anycast address is delivered to a single node closest to the sender identified by the routing algorithm.
* **Multicast Address** - A multicast IP address is identifier for a set of interfaces that may belong to differentn nodes. An IPv6 packet sent to a multicast address is delivered to all interfaces identified by the multicast address.

Unlike IPv4 addressing scheme, the IPv6 addressing scheme does not implement broadcast address. Instead, IPv6 implements multicast address to send packets to a group of nodes and avoids distributing to every nodes in the network. IPv6 also has a scope, which specifies which part of the network it's address is valid and unique.

## **Decimals with Colons**

The IPv6 addresses are comprised of 128-bits (or 8 groups of 4 hexadecimal digits separated by colons), with possibility of omitting zeros to abbreviate the full address. An example of IPv6 address may look like 2001:0db8:0012:0001:3c5e:7354:0000:5db1. For convenience, an IPv6 address can be represented in shorter notation by omitting leading zeros. The example address above can be also be represented as 2001:db8:12:1:3c5e:7354:0:5db1.

When abbreviating IPv6 address, the following rules apply:

* One or more leading zeros in any group of 8 hexadecimal digits can be removed. For example, 0012 can be written 12 and 0000 can be converted to 0. (see example above).
* Consecutive group of zeros are replaced with a double colon ::. The loopback address, 0000:0000:0000:0000:0000:0000:0000:0001 can be abbreviated to ::1.

## **What are the differences between IPv4 and IPv6?**

The IPv4 and IPv6 share a similar architecture, and they will coexist until IPv6 completely replaces the IPv4.

* IPv4 is represented by 32-bit number, and IPv6 is represented by 128-bit number. This translates to 4.3 billion address space for IPv4 and 340 trillion address space for IPv6.
* IPv4 is separated by 4 groups of 2 hexadecimal digits by a dot, whereas IPV6 is separated by 8 groups of 4 hexadecimal digits by a colon.
* IPv4 does not support short-hand notation, but IPv6 does by omitting leading zeros.

## **Why is IPv6 matter?**

With an explosive demand for smartphones, tablets and computers, more IP addresses are needed than IPv4 can support. There are over 7 billion people in the world with phones, tablets and computers each requiring an IP address. The IPv4 has an address space of 4.3 billion, which will soon exhaust. The transition from IPv4 to IPv6 is necessary, and they will coexist as they are not interoperable.

The users will not likely notice the difference or even notice it. With over 95% of IP addresses being IPv4, it will be quite some time before we'll see all devices communicating via IPv6.

What is a Subnet Mask?

An [IP address](https://www.iplocation.net/ip-address) has two components, the network address and the host address. A subnet mask separates the IP address into the network and host addresses (<network><host>). Subnetting further divides the host part of an IP address into a subnet and host address (<network><subnet><host>) if additional subnetwork is needed. Use the [Subnet Calculator](https://www.iplocation.net/subnet-calculator) to retrieve subnetwork information from IP address and Subnet Mask. It is called a subnet mask because it is used to identify network address of an IP address by perfoming a bitwise AND operation on the netmask.

A Subnet mask is a 32-bit number that masks an IP address, and divides the IP address into network address and host address. Subnet Mask is made by setting network bits to all "1"s and setting host bits to all "0"s. Within a given network, two host addresses are reserved for special purpose, and cannot be assigned to hosts. The "0" address is assigned a network address and "255" is assigned to a broadcast address, and they cannot be assigned to hosts.

Examples of commonly used netmasks for classed networks are 8-bits (Class A), 16-bits (Class B) and 24-bits (Class C), and classless networks are as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Class** | **Address** | **# of Hosts** | **Netmask (Binary)** | **Netmask (Decimal)** |
| CIDR | /4 | 240,435,456 | 11110000 00000000 00000000 00000000 | 240.0.0.0 |
| CIDR | /5 | 134,217,728 | 11111000 00000000 00000000 00000000 | 248.0.0.0 |
| CIDR | /6 | 67,108,864 | 11111100 00000000 00000000 00000000 | 252.0.0.0 |
| CIDR | /7 | 33,554,432 | 11111110 00000000 00000000 00000000 | 254.0.0.0 |
| A | /8 | 16,777,216 | 11111111 00000000 00000000 00000000 | 255.0.0.0 |
| CIDR | /9 | 8,388,608 | 11111111 10000000 00000000 00000000 | 255.128.0.0 |
| CIDR | /10 | 4,194,304 | 11111111 11000000 00000000 00000000 | 255.192.0.0 |
| CIDR | /11 | 2,097,152 | 11111111 11100000 00000000 00000000 | 255.224.0.0 |
| CIDR | /12 | 1,048,576 | 11111111 11110000 00000000 00000000 | 255.240.0.0 |
| CIDR | /13 | 524,288 | 11111111 11111000 00000000 00000000 | 255.248.0.0 |
| CIDR | /14 | 262,144 | 11111111 11111100 00000000 00000000 | 255.252.0.0 |
| CIDR | /15 | 131,072 | 11111111 11111110 00000000 00000000 | 255.254.0.0 |
| B | /16 | 65,534 | 11111111 11111111 00000000 00000000 | 255.255.0.0 |
| CIDR | /17 | 32,768 | 11111111 11111111 10000000 00000000 | 255.255.128.0 |
| CIDR | /18 | 16,384 | 11111111 11111111 11000000 00000000 | 255.255.192.0 |
| CIDR | /19 | 8,192 | 11111111 11111111 11100000 00000000 | 255.255.224.0 |
| CIDR | /20 | 4,096 | 11111111 11111111 11110000 00000000 | 255.255.240.0 |
| CIDR | /21 | 2,048 | 11111111 11111111 11111000 00000000 | 255.255.248.0 |
| CIDR | /22 | 1,024 | 11111111 11111111 11111100 00000000 | 255.255.252.0 |
| CIDR | /23 | 512 | 11111111 11111111 11111110 00000000 | 255.255.254.0 |
| C | /24 | 256 | 11111111 11111111 11111111 00000000 | 255.255.255.0 |
| CIDR | /25 | 128 | 11111111 11111111 11111111 10000000 | 255.255.255.128 |
| CIDR | /26 | 64 | 11111111 11111111 11111111 11000000 | 255.255.255.192 |
| CIDR | /27 | 32 | 11111111 11111111 11111111 11100000 | 255.255.255.224 |
| CIDR | /28 | 16 | 11111111 11111111 11111111 11110000 | 255.255.255.240 |
| CIDR | /29 | 8 | 11111111 11111111 11111111 11111000 | 255.255.255.248 |
| CIDR | /30 | 4 | 11111111 11111111 11111111 11111100 | 255.255.255.252 |

Subnetting an IP network is to separate a big network into smaller multiple networks for reorganization and security purposes. All nodes (hosts) in a subnetwork see all packets transmitted by any node in a network. Performance of a network is adversely affected under heavy traffic load due to collisions and retransmissions.

Applying a subnet mask to an IP address separates network address from host address. The network bits are represented by the 1's in the mask, and the host bits are represented by 0's. Performing a bitwise logical AND operation on the IP address with the subnet mask produces the network address. For example, applying the Class C subnet mask to our IP address 216.3.128.12 produces the following network address:

IP: 1101 1000 . 0000 0011 . 1000 0000 . 0000 1100 (216.003.128.012)

Mask: 1111 1111 . 1111 1111 . 1111 1111 . 0000 0000 (255.255.255.000)

---------------------------------------------

1101 1000 . 0000 0011 . 1000 0000 . 0000 0000 (216.003.128.000)

Subnetting Network 

Here is another scenario where subnetting is needed. Pretend that a web host with a Class C network needs to divide the network so that parts of the network can be leased to its customers. Let's assume that a host has a network address of 216.3.128.0 (as shown in the example above). Let's say that we're going to divide the network into 2 and dedicate the first half to itself, and the other half to its customers.

216 . 3 . 128 . (0000 0000) (1st half assigned to the web host)

216 . 3 . 128 . (1000 0000) (2nd half assigned to the customers)

The web host will have the subnet mask of 216.3.128.128 (/25). Now, we'll further divide the 2nd half into eight block of 16 IP addresses.

216 . 3 . 128 . (1000 0000) Customer 1 -- Gets 16 IPs (14 usable)

216 . 3 . 128 . (1001 0000) Customer 2 -- Gets 16 IPs (14 usable)

216 . 3 . 128 . (1010 0000) Customer 3 -- Gets 16 IPs (14 usable)

216 . 3 . 128 . (1011 0000) Customer 4 -- Gets 16 IPs (14 usable)

216 . 3 . 128 . (1100 0000) Customer 5 -- Gets 16 IPs (14 usable)

216 . 3 . 128 . (1101 0000) Customer 6 -- Gets 16 IPs (14 usable)

216 . 3 . 128 . (1110 0000) Customer 7 -- Gets 16 IPs (14 usable)

216 . 3 . 128 . (1111 0000) Customer 8 -- Gets 16 IPs (14 usable)

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255 . 255 . 255 . (1111 0000) (Subnet mask of 255.255.255.240)

You may use [Subnet Calculator](https://www.iplocation.net/subnet-calculator) to ease your calculation.

CIDR - Classless Inter Domain Routing 

**C**lassless **I**nter**D**omain **R**outing (CIDR) was invented to keep the Internet from running out of IP Addresses. The IPv4, a 32-bit, addresses have a limit of 4,294,967,296 (232) unique IP addresses. The classful address scheme (Class A, B and C) of allocating IP addresses in 8-bit increments can be very wasteful. With classful addressing scheme, a minimum number of IP addresses allocated to an organization is 256 (Class C). Giving 256 IP addresses to an organization only requiring 15 IP addresses is wasteful. Also, an organization requiring more than 256 IP addresses (let's say 1,000 IP addresses) is assigned a Class B, which allocates 65,536 IP addresses. Similarly, an organization requiring more than 65,636 (65,634 usable IPs) is assigned a Class A network, which allocates 16,777,216 (16.7 Million) IP addresses. This type of address allocation is very wasteful.

With CIDR, a network of IP addresses is allocated in 1-bit increments as opposed to 8-bits in classful network. The use of a CIDR notated address can easily represent classful addresses (Class A = /8, Class B = /16, and Class C = /24). The number next to the slash (i.e. /8) represents the number of bits assigned to the network address. The example shown above can be illustrated with CIDR as follows:

216.3.128.12, with subnet mask of 255.255.255.128 is written as

216.3.128.12/25

Similarly, the 8 customers with the block of 16 IP addresses can be

written as:

216.3.128.129/28, 216.3.128.130/28, and etc.

With an introduction of CIDR addressing scheme, IP addresses are more efficiently allocated to ISPs and customers; and hence there is less risk of IP addresses running out anytime soon. For detailed specification on CIDR, please review RFC 1519. With introduction of additional gaming, medical, applicance and telecom devices requiring static IP addresses in addition to more than 6.5 billion (July 2006 est.) world population, the IPv4 addresses with CIDR addressing scheme will eventually run out. To solve shortage of IPv4 addresses, the IPv6 (128-bit) address scheme was introduced in 1993.

What is a MAC Address?

MAC, **M**edia **A**ccess **C**ontrol, address is a globally unique identifier assigned to network devices, and therefore it is often referred to as hardware or physical address. MAC addresses are 6-byte (48-bits) in length, and are written in MM:MM:MM:SS:SS:SS format. The first 3-bytes are ID number of the manufacturer, which is assigned by an Internet standards body. The second 3-bytes are serial number assigned by the manufacturer.

MAC layer represents layer 2 of the [TCP/IP](https://www.iplocation.net/tcp-ip) (adopted from OSI Reference Model), where IP represents layer 3. MAC address can be thought of as supporting hardware implementation whereas IP address supports software implementation. MAC addresses are permanently burned into hardware by hardware manufacturer, but IP addresses are assigned to the network devices by a network administrator. [DHCP](https://www.iplocation.net/dhcp) relies on MAC address to assign IP addresses to network devices.

## **How do I find a MAC address of network device?**

Operating Systems support various command-line and GUI utilities to allow users to find MAC address of the system. On Unix variants including Solaris and Linux support ["ifconfig -a"](http://www.man-pages.net/man/man8/ifconfig.8.php), ["ip link list"](http://www.man-pages.net/man/man7/ip.7.php) or ["ip address show"](http://www.man-pages.net/man/man7/ip.7.php)command that displays MAC address of the  network device among other useful information. Windows including NT, 2000, XP and 2003 support ["ipconfig /all"](https://www.iplocation.net/ipconfig) command that displays MAC address. On a MacOS, one can find MAC address by opening "System Preferences", then selecting "Network".

What is Ethernet?

Ethernet is the most widely used local area network (LAN) technology, that defines wiring and signaling standards for the physical layer of TCP/IP. Ethernet was originally standardized as IEEE 802.3 with a data transmission rate of 10 Mb/s. Newer versions of Ethernet were introduced lately to offer higher data rates. Fast Ethernet and Gigabit Ethernet support data rates of 100 Mbps and 1 Gbps (1000 Mbps) respectively. An Ethernet LAN may use coaxial cable (10Base2), unshielded twisted pair wiring (10BaseT, 100BaseT and 1000BaseT), or fiber optic cable. Ethernet devices compete for access to the network using a protocol called Carrier Sense Multiple Access with Collision Detection (CSMA/CD). With prosperity of Internet, Wi-Fi, the wireless LAN technology standardized by IEEE 802.11, is used in hybrid with Ethernet LAN to offer portability.

## **2. Ethernet Standards**

IEEE 802.3 is the signaling standards for Ethernet, and IEEE 802.11 is the standards for Wi-Fi. The standards documents may be obtained free of charge at the following website: <http://standards.ieee.org/getieee802/>

What is a TCP/IP?

TCP/IP, **T**ransmission **C**ontrol **P**rotocol/**I**nternet **P**rotocol, is a suite of communications protocols used to interconnect network devices on the Internet. TCP/IP implements layers of protocol stacks, and each layer provides a well-defined network services to the upper layer protocol. TCP and IP are the two protocols used by TCP/IP, as well as the (higher) application, (lower) data link and (lower) physical layer protocols.

|  |  |
| --- | --- |
| **Layer** | **Protocols** |
| 5. Application | DNS, FTP, HTTP, IMAP, POP3, SMTP, SSH, Telnet, SSL, ... |
| 4. Transport | TCP, UDP, ... |
| 3. Network | IP (IPv4, IPv6), ICMP, ARP, ... |
| 2. Data Link | 802.3 (Ethernet), 802.11 (Wi-Fi), PPP, ... |
| 1. Physical | Ethernet (NIC), Wireless (NIC), Cat 5/RJ-45, ... |

What is DHCP?

DHCP, Dynamic Host Configuration Protocol, is a communications protocol that dynamically assigns unique [IP addresses](https://www.iplocation.net/ip-address) to network devices. As a network device joins or leaves an IP-based network, DHCP automatically renews or releases an IP address.

DHCP runs in a client/server mode, where server sets up a pool of available [IP addresses](https://www.iplocation.net/ip-address) for a network. A DHCP server also provides network gateway, [subnet masks](https://www.iplocation.net/subnet-mask), name server addresses and amount of time ("lease") that a given [IP address](https://www.iplocation.net/ip-address) will be valid. A DHCP client retrieve those parameters and use them to join the existing network.

DHCP allows network administrators centrally manage and automate the assignment of the IP addresses without having to worry about assigning duplicate addresses, making network administration a lot easier to manage.

MS-DOS Ipconfig Command Reference

Ipconfig is a MS-DOS command-line tool used to display and manage the network settings of your computer. Ipconfig is available on Windows machines, and it displays the current network connection details and [DHCP](https://www.iplocation.net/dhcp.php)client settings.

Ipconfig is an external MS-DOS command, and is available on Windows 95, Windows 98, ME, NT, 2000, XP and Windows Vista Operating Systems. On Windows 9x machines, a graphical tools such as winipconifg or winipcfg may be used instead. On Linux machine, the [ifconfig](http://www.topwebhosts.org/man/man8/ifconfig.8.php) command performs equivalent function.

C:\> ipconfig /?

USAGE:

ipconfig [/? | /all | /renew [adapter] | /release [adapter] |

/flushdns | /displaydns | /registerdns |

/showclassid adapter |

/setclassid adapter [classid] ]

where

adapter Connection name

(wildcard characters \* and ? allowed, see examples)

Options:

/? Display this help message

/all Display full configuration information.

/release Release the IP address for the specified adapter.

/renew Renew the IP address for the specified adapter.

/flushdns Purges the DNS Resolver cache.

/registerdns Refreshes all DHCP leases and re-registers DNS names

/displaydns Display the contents of the DNS Resolver Cache.

/showclassid Displays all the dhcp class IDs allowed for adapter.

/setclassid Modifies the dhcp class id.

The default is to display only the IP address, subnet mask and

default gateway for each adapter bound to TCP/IP.

For Release and Renew, if no adapter name is specified, then the IP address

leases for all adapters bound to TCP/IP will be released or renewed.

For Setclassid, if no ClassId is specified, then the ClassId is removed.

Examples:

> ipconfig ... Show information.

> ipconfig /all ... Show detailed information

> ipconfig /renew ... renew all adapters

> ipconfig /renew EL\* ... renew any connection that has its

name starting with EL

> ipconfig /release \*Con\* ... release all matching connections,

eg. "Local Area Connection 1" or

"Local Area Connection 2"

C:\>ipconfig /all

Windows IP Configuration

Host Name . . . . . . . . . . . . : topwebhosts

Primary Dns Suffix . . . . . . . :

Node Type . . . . . . . . . . . . : Hybrid

IP Routing Enabled. . . . . . . . : No

WINS Proxy Enabled. . . . . . . . : No

Ethernet adapter Wireless Network Connection:

Connection-specific DNS Suffix . :

Description . . . . . . . . . . . : Intel(R) PRO/Wireless LAN 2100 3B Mi

ni PCI Adapter

Physical Address. . . . . . . . . : 00-0C-F1-65-5B-70

Dhcp Enabled. . . . . . . . . . . : Yes

Autoconfiguration Enabled . . . . : Yes

IP Address. . . . . . . . . . . . : 192.168.1.100

Subnet Mask . . . . . . . . . . . : 255.255.255.0

Default Gateway . . . . . . . . . : 192.168.1.1

DHCP Server . . . . . . . . . . . : 192.168.1.1

DNS Servers . . . . . . . . . . . : 192.168.1.1

Lease Obtained. . . . . . . . . . : Thursday, February 08, 2007 2:27:17

PM

Lease Expires . . . . . . . . . . : Thursday, February 15, 2007 2:27:17

PM

Ethernet adapter Local Area Connection:

Media State . . . . . . . . . . . : Media disconnected

Description . . . . . . . . . . . : Intel(R) PRO/1000 MT Mobile Connecti

on

Physical Address. . . . . . . . . : 00-0D-60-FB-4E-E9

To learn the names of ethernet adapters that you can optionally specify with "ipconfig" command, you may simply type **ipconfig** command by itself. The command output displays all adapters by name that are available on your computer: e.g. "Local Area Connection", "Wireless Network Connection".

Ipconfig command is most often used to diagnose network problem on a Windows machine. If you're using DHCP, you may try releasing and renewing IP address by performing "ipconfig /release" and "ipconfig /renew" commands shown below.

C:\> ipconfig /release

Windows IP Configuration

No operation can be performed on Local Area Connection while it has its media di

sconnected.

Ethernet adapter Wireless Network Connection:

Connection-specific DNS Suffix . :

IP Address. . . . . . . . . . . . : 0.0.0.0

Subnet Mask . . . . . . . . . . . : 0.0.0.0

Default Gateway . . . . . . . . . :

Ethernet adapter Local Area Connection:

Media State . . . . . . . . . . . : Media disconnected

C:\> ipconfig /renew

Windows IP Configuration

Ethernet adapter Wireless Network Connection:

Connection-specific DNS Suffix . :

IP Address. . . . . . . . . . . . : 192.168.1.100

Subnet Mask . . . . . . . . . . . : 255.255.255.0

Default Gateway . . . . . . . . . : 192.168.1.1

To workaround DNS caching issue, you may perform "ipconfig /flushdns" to clear DNS cache value on your computer. DNS uses TTL (Time-To-Live) value which let the intermediate name servers to cache DNS information. If you changed your DNS settings, and your computer doesn't see the change immediately, you may perform "ipconfig /flushdns" to clear the DNS cache.

C:\> ipconfig /flushdns

Windows IP Configuration

Successfully flushed the DNS Resolver Cache.

## **FAQ:**

On Windows Vista machine, if you are getting an error "The requested operation requires elevation", you'll need to run Command Prompt as an administrator. To do this, you'll need to do the following:

**All Programs -> Accessories -> right click Command Prompt and click Run as administrator!**

What is IP Spoofing?

IP Spoofing is a technique used to gain unauthorized access to machines, whereby an attacker illicitly impersonate another machine by manipulating IP packets. IP Spoofing involves modifying the packet header with a forged (spoofed) source IP address, a checksum, and the order value. Internet is a packet switched network, which causes the packets leaving one machine may be arriving at the destination machine in different order. The receiving machine resembles the message based on the order value embedded in the IP header. IP spoofing involves solving the algorithm that is used to select the order sent values, and to modify them correctly.

What is the difference between a static and dynamic IP address?

An [IP address](https://www.iplocation.net/ip-address) is an address assigned to a device on the Internet. It is analogous to postal address where a letter is delivered, and an IP address is computer's address where internet traffic is delivered. An IP address is assigned to you by your Internet Service Provider (ISP). When you signup with your ISP, your ISP either assigns you a static IP address or a dynamic IP address depending on the contract. If you need to setup a web server or an email service, you'll need a static IP address. If you are just browsing an Internet, you may just get by with a dynamic IP address.

## **What is a static IP address?**

A static IP address is an address that is permanently assigned to you by your ISP (as long as your contract is in good standing), and does not change even if your computer reboots. A static IP address is usually assigned to a server hosting websites, and providing email, database and FTP services. A static IP address is also assigned to a commercial leased line, or public organization requiring same IP address each and every time. Since static IP address is assigned to you, you'll have to manually configure your machine (router or server) to use the static IP address assigned to you.

Static IP address Advantages

* Address does not change - good for web servers, email servers and other Internet servers.
* Use DNS to map domain name to IP address, and use domain name to address the static IP address. Similar can be achieved with Dynamic DNS for dynamic IP address, but it's not as clean as the static IP address.

Static IP address Disadvantages

* Expensive than dynamic IP address - ISPs generally charge additional fee for static IP addresses.
* Need additional security - Since same IP is assigned to a machine, hackers try brute force attack on the machine over period of time.

## **What is a dynamic IP address?**

A dynamic IP address is an IP address dynamically assigned to your computer by your ISP. Each time your computer (or router) is rebooted, your ISP dynamically assigns an IP address to your networking device using [DHCP protocol](https://www.iplocation.net/dhcp). Since your ISP dynamically assigns an IP address to a computing device on reboot, your device may not always receive the same IP address previous assigned to it. Even if your machine is always on and permanently connected, some ISPs do change IP address on-the-fly even though this is very rare. A sticky nature of DHCP generally reassigns same IP address to the same machine, it is not guaranteed to receive same IP address as IP pool may exhaust at times and lease time may expire. To find your dynamic IP address, you may visit [What is my IP address](https://www.iplocation.net/find-ip-address) page.

Dynamic IP address Advantages

* Cheaper than static IP address.
* Changing IP address gives more privacy.

Dynamic IP address Disadvantages

* Requires DHCP server to obtain an IP address.
* Non-static. Each time IP address changes, you may have to find you IP address again.

My IP address is hacked. What can I do?

Many readers of our website are contacting us for help on \*allegedly\* hacked [IP address](https://www.iplocation.net/ip-address), and remedies for getting it back. One of the user is telling us his IP address used to be 64.3.x.y in Dallas and now it's 67.72.x.y located in Utah (per ip lookup); and hence his IP address is stolen, and his computer is running very slow and acting abnormal.

For a non-computer person, this may sound like a user's IP address has been hacked but in reality your IP address cannot be hacked. Chances are that you're getting your IP address [dynamically](https://www.iplocation.net/static-vs-dynamic-ip-address) from your Service Provider whom may be servicing multiple areas. When you disconnect from your ISP and reconnect to the Internet, you're getting a new IP address from your Internet Service Provider and this IP address may or may not be the same as previously assigned. This does not mean you're sharing this IP address with someone else, as you've just assigned a new IP address and your old IP address may have been assigned to a new person in Utah. As ISPs servicing multiple cities, they may allocate their IP address how ever they desire, and this may cause location of IP address to be incorrectly shown. Getting an IP address that shows remote location (Utah) does not slow down your computer, or cause it to act abnormal.

If your computer is acting slow or behave abnormal, you may have spyware or virus on your computer. Slowness of your computer has nothing to do with your IP address. You may wish to scan your computer for virus, and remove them.

## **If someone knows my IP address, can they hack my computer?**

Depending on how your computer is connected to the Internet and the type of security in place, your computer may vulnerable for hack. In reality, chances of your computer being hacked from your known IP address is very unlikely. The trouble of hacker trying to gain access to your computer doesn't justify hacking into your computer unless you have billions of dollars in your bank account accessible from your personal computer. The most easiest way for hackers to gain access to your computer is through virus, not by attacking an IP address.

## **I have a static IP address. Can my computer (or server) hacked?**

Having a static IP address doesn't increase the chance of your server being hacked, but vulnerable software and configuration may allow hackers to randomly attack your computer. Hackers learn known vulnerability on certain types of software, and using known vulnerability hackers randomly attack machines. Servers directly connected to the Internet are more exposed than the personal computers sitting behind the router with firewall. Unless you're a network professional managing servers, chances of your personal computer hacked is very small. Again, the easiest way to hack into your computer is by through a rootkit or virus.

What is the difference between public and private IP address?

A public [IP address](https://www.iplocation.net/ip-address) is an IP address that can be accessed over the Internet. Like postal address used to deliver a postal mail to your home, a public IP address is the globally unique IP address assigned to a computing device. Your public IP address can be found at [What is my IP Address](https://www.iplocation.net/find-ip-address) page. Private IP address on the other hand is used to assign computers within your private space without letting them directly expose to the Internet. For example, if you have multiple computers within your home you may want to use private IP addresses to address each computer within your home. In this scenario, your router get the public IP address, and each of the computers, tablets and smartphones connected to your router (via wired or wifi) get a private IP address from your router via [DHCP](https://www.iplocation.net/dhcp) protocol.

Internet Assigned Numbers Authority (IANA) is the organization responsible for registering IP address ranges to organizations and Internet Service Providers (ISPs). To allow organizations to freely assign private IP addresses, the Network Information Center (InterNIC) has reserved certain address blocks for private use. The following IP blocks are reserved for private IP addresses.

|  |  |  |  |
| --- | --- | --- | --- |
| **Class** | **Starting IP Address** | **Ending IP Address** | **# of Hosts** |
| A | 10.0.0.0 | 10.255.255.255 | 16,777,216 |
| B | 172.16.0.0 | 172.31.255.255 | 1,048,576 |
| C | 192.168.0.0 | 192.168.255.255 | 65,536 |

## **What is public IP address?**

A public IP address is the address that is assigned to a computing device to allow direct access over the Internet. A web server, email server and any server device directly accessible from the Internet are candidate for a public IP address. A public IP address is globally unique, and can only be assigned to an unique device.

## **What is private IP address?**

A private IP address is the address space allocated by InterNIC to allow organizations to create their own private network. There are three IP blocks (1 class A, 1 class B and 1 class C) reserved for a private use. The computers, tablets and smartphones sitting behind your home, and the personal computers within an organizations are usually assigned private IP addresses. A network printer residing in your home is assigned a private address so that only your family can print to your local printer.

When a computer is assigned a private IP address, the local devices sees this computer via it's private IP address. However, the devices residing outside of your local network cannot directly communicate via the private IP address, but uses your router's public IP address to communicate. To allow direct access to a local device which is assigned a private IP address, a Network Address Translator (NAT) should be used.

System -> Server Configure ->

# The Difference Between the Internet and World Wide Web

***Many people use the terms Internet and World Wide Web (aka. the Web) interchangeably, but in fact the two terms are not synonymous. The Internet and the Web are two separate but related things.***

## *What is The Internet?*

Internet IconThe [Internet](http://www.webopedia.com/TERM/I/Internet.html) is a massive [network](http://www.webopedia.com/TERM/N/network.html) of networks, a networking infrastructure. It connects millions of computers together globally, forming a network in which any computer can communicate with any other computer as long as they are both connected to the Internet. Information that travels over the Internet does so via a variety of languages known as [protocols](http://www.webopedia.com/TERM/P/protocol.html).

## *What is The Web (World Wide Web)?*

Web IconThe [World Wide Web](http://www.webopedia.com/TERM/W/World_Wide_Web.html), or simply Web, is a way of accessing information over the medium of the Internet. It is an information-sharing model that is built on top of the Internet. The Web uses the HTTP protocol, only one of the languages spoken over the Internet, to transmit data. Web services, which use HTTP to allow applications to communicate in order to exchange business logic, use the the Web to share information. The Web also utilizes [browsers](http://www.webopedia.com/TERM/B/browser.html), such as [Internet Explorer](http://www.webopedia.com/TERM/I/Internet_Explorer.html) or [Firefox](http://www.webopedia.com/TERM/F/Firefox.html), to access Web documents called [Web pages](http://www.webopedia.com/TERM/W/web_page.html) that are linked to each other via [hyperlinks](http://www.webopedia.com/TERM/H/hyperlink.html). Web documents also contain graphics, sounds, text and video.

## *The Web is a Portion of The Internet*

The Web is just one of the ways that information can be disseminated over the Internet. The Internet, not the Web, is also used for [email](http://www.webopedia.com/TERM/E/e_mail.html), which relies on [SMTP](http://www.webopedia.com/TERM/S/SMTP.html), [Usenet](http://www.webopedia.com/TERM/U/USENET.html) news groups, [instant messaging](http://www.webopedia.com/TERM/I/instant_messaging.html) and [FTP](http://www.webopedia.com/TERM/F/FTP.html). So the Web is just a portion of the Internet, albeit a large portion, but the two terms are not synonymous and should not be confused.

# What’s the Difference Between an Intranet and the Internet?

There’s one major distinction between an intranet and the Internet: The Internet is an open, public space, while an intranet is designed to be a private space. An intranet may be accessible from the Internet, but as a rule it’s protected by a password and accessible only to employees or other authorized users.

From within a company, an intranet server may respond much more quickly than a typical Web site. This is because the public Internet is at the mercy of traffic spikes, server breakdowns and other problems that may slow the network. Within a company, however, users have much more bandwidth and network hardware may be more reliable. This makes it easier to serve high-bandwidth content, such as audio and video, over an intranet.

# HTTP and HTTPS: What do they do, and how are they different?

## **HTTP and HTTPS: What do they do, and how are they different?**

You click to check out at an online merchant. Suddenly your browser address bar says **HTTPS** instead of HTTP. What's going on? Is your credit card information safe?

Good news. Your information is safe. The website you are working with has made sure that no one can steal your information.

Instead of HyperText Transfer Protocol (HTTP), this website uses **HyperText Transfer Protocol Secure (**[**HTTPS**](https://www.instantssl.com/ssl-certificate-products/https.html)**)**.

Using HTTPS, the computers agree on a "code" between them, and then they scramble the messages using that "code" so that no one in between can read them. This keeps your information safe from hackers.

They use the "code" on a **Secure Sockets Layer (SSL)**, sometimes called Transport Layer Security (TLS) to send the information back and forth.

How does HTTP work? How is HTTPS different from HTTP? This tutorial will teach you about SSL, HTTP and HTTPS.

## **How Does HTTP Work?**

In the beginning, network administrators had to figure out how to share the information they put out on the Internet.

They agreed on a procedure for exchanging information and called it HyperText Transfer Protocol (HTTP).

Once everyone knew how to exchange information, intercepting on the Internet was not difficult. So knowledgeable administrators agreed upon a procedure to protect the information they exchanged. The protection relies on SSL Certificate to encrypt the online data. Encryption means that the sender and recipient agree upon a "code" and translate their documents into random-looking character strings.

The procedure for encrypting information and then exchanging it is called HyperText Transfer Protocol Secure (HTTPS).

With **HTTPS** if anyone in between the sender and the recipient could open the message, they still could not understand it. Only the sender and the recipient, who know the "code," can decipher the message.

Humans could encode their own documents, but computers do it faster and more efficiently. To do this, the computer at each end uses a document called an "SSL Certificate" containing character strings that are the keys to their secret "codes."

SSL certificates contain the computer owner's "public key."

The owner shares the public key with anyone who needs it. Other users need the public key to encrypt messages to the owner. The owner sends those users the SSL certificate, which contains the public key. The owner does not share the private key with anyone.

The security during the transfer is called the Secure Sockets Layer (SSL) and Transport Layer Security (TLS).

The procedure for exchanging public keys using [SSL Certificate](https://www.instantssl.com/ssl-certificate.html) to enable HTTPS, SSL and TLS is called Public Key Infrastructure (PKI).

**What is an SSL Certificate?**

SSL Certificates provide secure, encrypted communications between a website and an internet browser. **SSL** stands for Secure Sockets Layer, the protocol which provides the encryption. **SSL Certificates** are typically installed on pages that require end-users to submit sensitive information over the internet like credit card details or passwords. Example pages include payment pages, online forms and login pages.

Change Management ->

* 1. Request for change/add feature
  2. Analysis the change
  3. Design and Development / coding
  4. User Acceptance Test

user acceptance testing (UAT)

In software development, user acceptance testing (UAT) - also called beta testing, application testing, and [end user](http://whatis.techtarget.com/definition/end-user) testing - is a phase of software development in which the software is tested in the "real world" by the intended audience. UAT can be done by in-house testing in which volunteers or paid test subjects use the software or, more typically for widely-distributed software, by making the test version available for downloading and free trial over the Web. The experiences of the early users are forwarded back to the developers who make final changes before releasing the software commercially.

1. vendor-k requirement

2. UAT ->

3.

ghorer dorjar moto

LAN & internet connecting point - (router)

-

Static protocol

Dynamic protocol

**What is the difference between static and dynamic routing?**

Static routing is when you statically configure a router to send traffic for particular destinations in preconfigured directions. Dynamic routing is when you use a routing protocol such as OSPF, ISIS, EIGRP, and/or BGP to figure out what paths traffic should take. There are very few situations in the real world where you would use one method of routing exclusively. A typical network will use a dynamic protocol such as OSPF to determine the best routes within an enterprise, BGP to determine the best exit points to the rest of the Internet, and static routing to glue it all together with reasonable default routes, and to send specific traffic over specific paths for traffic engineering reasons. (Answered by Brandon Ross, VP of Operations, Sockeye Networks.)

# Geographic information system

A **geographic information system** (or *GIS*) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or [geographical data](https://en.wikipedia.org/wiki/Geographical_data). The [acronym](https://en.wikipedia.org/wiki/Acronym) GIS is sometimes used for [geographic information science (GIScience)](https://en.wikipedia.org/wiki/Geographic_information_science) to refer to the academic discipline that studies geographic [information systems](https://en.wikipedia.org/wiki/Information_system) and is a large domain within the broader academic discipline of [geoinformatics](https://en.wikipedia.org/wiki/Geoinformatics).[[1]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-1) What goes beyond a GIS is a [spatial data infrastructure](https://en.wikipedia.org/wiki/Spatial_data_infrastructure), a concept that has no such restrictive boundaries.

In general, the term describes any [information system](https://en.wikipedia.org/wiki/Information_systems) that integrates, stores, edits, analyzes, shares, and displays [geographic](https://en.wikipedia.org/wiki/Georeference) information. [GIS applications](https://en.wikipedia.org/wiki/GIS_applications) are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations.[[2]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-2)[[3]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Maliene_V.2C_Grigonis_V.2C_Palevi.C4.8Dius_V.2C_Griffiths_S_2011_1.E2.80.936-3) Geographic information science is the science underlying geographic concepts, applications, and systems.[[4]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-4)

GIS is a broad term that can refer to a number of different technologies, processes, and methods. It is attached to many operations and has many applications related to engineering, planning, management, transport/logistics, insurance, telecommunications, and business.[[3]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Maliene_V.2C_Grigonis_V.2C_Palevi.C4.8Dius_V.2C_Griffiths_S_2011_1.E2.80.936-3) For that reason, GIS and [location intelligence](https://en.wikipedia.org/wiki/Location_intelligence) applications can be the foundation for many location-enabled services that rely on analysis and visualization.

GIS can relate unrelated information by using location as the key index variable. Locations or extents in the Earth [space–time](https://en.wikipedia.org/wiki/Space%E2%80%93time) may be recorded as dates/times of occurrence, and x, y, and z [coordinates](https://en.wikipedia.org/wiki/Coordinate) representing, [longitude](https://en.wikipedia.org/wiki/Longitude), [latitude](https://en.wikipedia.org/wiki/Latitude), and [elevation](https://en.wikipedia.org/wiki/Elevation_(geography)), respectively. All Earth-based spatial–temporal location and extent references should be relatable to one another and ultimately to a "real" physical location or extent. This key characteristic of GIS has begun to open new avenues of scientific inquiry.

## **History of development[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=1)**]**

The first known use of the term "geographic information system" was by [Roger Tomlinson](https://en.wikipedia.org/wiki/Roger_Tomlinson) in the year 1968 in his paper "A Geographic Information System for Regional Planning".[[5]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-5) Tomlinson is also acknowledged as the "father of GIS".[[6]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-6)

[](https://en.wikipedia.org/wiki/File:Snow-cholera-map.jpg)

[E. W. Gilbert](https://en.wikipedia.org/wiki/E._W._Gilbert)'s version (1958) of [John Snow](https://en.wikipedia.org/wiki/John_Snow_(physician))'s 1855 map of the [Soho](https://en.wikipedia.org/wiki/Soho) [cholera](https://en.wikipedia.org/wiki/Cholera) outbreak showing the clusters of cholera cases in the [London](https://en.wikipedia.org/wiki/London) epidemic of 1854

Previously, one of the first applications of spatial analysis in [epidemiology](https://en.wikipedia.org/wiki/Epidemiology) is the 1832 "*Rapport sur la marche et les effets du choléra dans Paris et le département de la*[*Seine*](https://en.wikipedia.org/wiki/Seine)".[[7]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-7) The French geographer Charles Picquet represented the 48 districts of the city of [Paris](https://en.wikipedia.org/wiki/Paris) by halftone color gradient according to the number of deaths by [cholera](https://en.wikipedia.org/wiki/Cholera) per 1,000 inhabitants. In 1854 [John Snow](https://en.wikipedia.org/wiki/John_Snow_(physician)) determined the source of a [cholera](https://en.wikipedia.org/wiki/Cholera) outbreak in [London](https://en.wikipedia.org/wiki/London) by marking points on a map depicting where the cholera victims lived, and connecting the cluster that he found with a nearby water source. This was one of the earliest successful uses of a geographic methodology in epidemiology. While the basic elements of [topography](https://en.wikipedia.org/wiki/Topography) and theme existed previously in [cartography](https://en.wikipedia.org/wiki/Cartography), the John Snow map was unique, using cartographic methods not only to depict but also to analyze clusters of geographically dependent phenomena.

The early 20th century saw the development of [photozincography](https://en.wikipedia.org/wiki/Photozincography), which allowed maps to be split into layers, for example one layer for vegetation and another for water. This was particularly used for printing contours – drawing these was a labour-intensive task but having them on a separate layer meant they could be worked on without the other layers to confuse the [draughtsman](https://en.wikipedia.org/wiki/Draughtsman). This work was originally drawn on glass plates but later [plastic film](https://en.wikipedia.org/wiki/Plastic_film) was introduced, with the advantages of being lighter, using less storage space and being less brittle, among others. When all the layers were finished, they were combined into one image using a large process camera. Once color printing came in, the layers idea was also used for creating separate printing plates for each color. While the use of layers much later became one of the main typical features of a contemporary GIS, the photographic process just described is not considered to be a GIS in itself – as the maps were just images with no database to link them to.

[Computer hardware](https://en.wikipedia.org/wiki/Computer_hardware) development spurred by [nuclear weapon](https://en.wikipedia.org/wiki/Nuclear_weapon) research led to general-purpose computer "mapping" applications by the early 1960s.[[8]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-map_printing_methods-8)

The year 1960 saw the development of the world's first true operational GIS in [Ottawa, Ontario](https://en.wikipedia.org/wiki/Ottawa,_Ontario), Canada by the federal Department of Forestry and Rural Development. Developed by Dr. [Roger Tomlinson](https://en.wikipedia.org/wiki/Roger_Tomlinson), it was called the [Canada Geographic Information System](https://en.wikipedia.org/wiki/Canada_Geographic_Information_System) (CGIS) and was used to store, analyze, and manipulate data collected for the [Canada Land Inventory](https://en.wikipedia.org/wiki/Canada_Land_Inventory) – an effort to determine the land capability for rural Canada by mapping information about [soils](https://en.wikipedia.org/wiki/Soil), agriculture, recreation, wildlife, [waterfowl](https://en.wikipedia.org/wiki/Waterfowl), [forestry](https://en.wikipedia.org/wiki/Forestry) and land use at a scale of 1:50,000. A rating classification factor was also added to permit analysis.

CGIS was an improvement over "computer mapping" applications as it provided capabilities for overlay, measurement, and [digitizing](https://en.wikipedia.org/wiki/Digitizing)/scanning. It supported a national coordinate system that spanned the continent, coded lines as [arcs](https://en.wikipedia.org/wiki/Directed_edge) having a true embedded [topology](https://en.wikipedia.org/wiki/Topology) and it stored the attribute and locational information in separate files. As a result of this, Tomlinson has become known as the "father of GIS", particularly for his use of overlays in promoting the spatial analysis of convergent geographic data.[[9]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Tomlinson-9)

CGIS lasted into the 1990s and built a large digital land resource database in Canada. It was developed as a [mainframe](https://en.wikipedia.org/wiki/Mainframe_computer)-based system in support of federal and provincial resource planning and management. Its strength was continent-wide analysis of complex [datasets](https://en.wikipedia.org/wiki/Data_set). The CGIS was never available commercially.

In 1964 Howard T. Fisher formed the Laboratory for Computer Graphics and Spatial Analysis at the [Harvard Graduate School of Design](https://en.wikipedia.org/wiki/Harvard_Graduate_School_of_Design) (LCGSA 1965–1991), where a number of important theoretical concepts in spatial data handling were developed, and which by the 1970s had distributed seminal software code and systems, such as SYMAP, GRID, and ODYSSEY – that served as sources for subsequent commercial development—to universities, research centers and corporations worldwide.[[10]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Fisher-10)

By the late 1970s two public domain GIS systems ([MOSS](https://en.wikipedia.org/wiki/Map_Overlay_and_Statistical_System) and [GRASS GIS](https://en.wikipedia.org/wiki/GRASS_GIS)) were in development, and by the early 1980s, M&S Computing (later [Intergraph](https://en.wikipedia.org/wiki/Intergraph)) along with Bentley Systems Incorporated for the [CAD](https://en.wikipedia.org/wiki/Computer-aided_design) platform, Environmental Systems Research Institute ([ESRI](https://en.wikipedia.org/wiki/ESRI)), [CARIS](https://en.wikipedia.org/wiki/Teledyne_CARIS) (Computer Aided Resource Information System), [MapInfo Corporation](https://en.wikipedia.org/wiki/MapInfo_Corporation) and ERDAS (Earth Resource Data Analysis System) emerged as commercial vendors of GIS software, successfully incorporating many of the CGIS features, combining the first generation approach to separation of spatial and attribute information with a second generation approach to organizing attribute data into database structures.[[11]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-wiki.osgeo.org-11)

In 1986, Mapping Display and Analysis System (MIDAS), the first desktop GIS product[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] was released for the [DOS](https://en.wikipedia.org/wiki/DOS) operating system. This was renamed in 1990 to MapInfo for Windows when it was ported to the [Microsoft Windows](https://en.wikipedia.org/wiki/Microsoft_Windows) platform. This began the process of moving GIS from the research department into the business environment.

By the end of the 20th century, the rapid growth in various systems had been consolidated and standardized on relatively few platforms and users were beginning to explore viewing GIS data over the [Internet](https://en.wikipedia.org/wiki/Internet), requiring data format and transfer standards. More recently, a growing number of [free, open-source GIS packages](https://en.wikipedia.org/wiki/List_of_GIS_software#Open_source_software) run on a range of operating systems and can be customized to perform specific tasks. Increasingly [geospatial data](https://en.wikipedia.org/wiki/Geospatial) and [mapping applications](https://en.wikipedia.org/wiki/Web_mapping) are being made available via the [world wide web](https://en.wikipedia.org/wiki/World_wide_web).[[12]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-12)

Several articles on the history of GIS have been published.[[13]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Foresman-13)[[14]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-GISGeography.com-14)

## **GIS techniques and technology[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=2)**]**

Modern GIS technologies use digital information, for which various digitized data creation methods are used. The most common method of data creation is [digitization](https://en.wikipedia.org/wiki/Digitizing), where a [hard copy](https://en.wikipedia.org/wiki/Hard_copy) map or survey plan is transferred into a digital medium through the use of a CAD program, and geo-referencing capabilities. With the wide availability of [ortho-rectified imagery](https://en.wikipedia.org/wiki/Orthophoto) (from satellites, aircraft, Helikites and UAVs), heads-up digitizing is becoming the main avenue through which geographic data is extracted. Heads-up digitizing involves the tracing of geographic data directly on top of the aerial imagery instead of by the traditional method of tracing the geographic form on a separate [digitizing tablet](https://en.wikipedia.org/wiki/Graphics_tablet) (heads-down digitizing).[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)]

### Relating information from different sources**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=3)**]**

GIS uses spatio-temporal ([space-time](https://en.wikipedia.org/wiki/Space-time)) location as the key index variable for all other information. Just as a relational database containing text or numbers can relate many different tables using common key index variables, GIS can relate otherwise unrelated information by using location as the key index variable. The key is the location and/or extent in space-time.

Any variable that can be located spatially, and increasingly also temporally, can be referenced using a GIS. Locations or extents in Earth space–time may be recorded as dates/times of occurrence, and x, y, and z [coordinates](https://en.wikipedia.org/wiki/Coordinate) representing, [longitude](https://en.wikipedia.org/wiki/Longitude), [latitude](https://en.wikipedia.org/wiki/Latitude), and [elevation](https://en.wikipedia.org/wiki/Elevation_(geography)), respectively. These GIS coordinates may represent other quantified systems of temporo-spatial reference (for example, film frame number, stream gage station, highway mile-marker, surveyor benchmark, building address, street intersection, entrance gate, water depth sounding, [POS](https://en.wikipedia.org/wiki/Point_of_sale) or [CAD](https://en.wikipedia.org/wiki/Computer-aided_design) drawing origin/units). Units applied to recorded temporal-spatial data can vary widely (even when using exactly the same data, see [map projections](https://en.wikipedia.org/wiki/Map_projection)), but all Earth-based spatial–temporal location and extent references should, ideally, be relatable to one another and ultimately to a "real" physical location or extent in space–time.

Related by accurate spatial information, an incredible variety of real-world and projected past or future data can be analyzed, interpreted and represented.[[15]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-15) This key characteristic of GIS has begun to open new avenues of scientific inquiry into behaviors and patterns of real-world information that previously had not been systematically [correlated](https://en.wikipedia.org/wiki/Correlation).

### GIS uncertainties**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=4)**]**

GIS accuracy depends upon source data, and how it is encoded to be data referenced. Land surveyors have been able to provide a high level of positional accuracy utilizing the [GPS](https://en.wikipedia.org/wiki/GPS)-derived positions.[[16]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-16) High-resolution digital terrain and aerial imagery,[[17]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-17) powerful computers and Web technology are changing the quality, utility, and expectations of GIS to serve society on a grand scale, but nevertheless there are other source data that affect overall GIS accuracy like paper maps, though these may be of limited use in achieving the desired accuracy.

In developing a digital topographic database for a GIS, [topographical maps](https://en.wikipedia.org/wiki/Topographical_map) are the main source, and [aerial photography](https://en.wikipedia.org/wiki/Aerial_photography) and [satellite imagery](https://en.wikipedia.org/wiki/Satellite_imagery) are extra sources for collecting data and identifying attributes which can be mapped in layers over a location facsimile of scale. The scale of a map and geographical rendering area representation type[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)] are very important aspects since the information content depends mainly on the scale set and resulting locatability of the map's representations. In order to digitize a map, the map has to be checked within theoretical dimensions, then scanned into a raster format, and resulting raster data has to be given a theoretical dimension by a [rubber](https://en.wikipedia.org/wiki/Rubber) sheeting/warping technology process.

A quantitative analysis of maps brings accuracy issues into focus. The electronic and other equipment used to make measurements for GIS is far more precise than the machines of conventional map analysis. All geographical data are inherently inaccurate, and these inaccuracies will propagate through GIS operations in ways that are difficult to predict.

### Data representation**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=5)**]**

*Main article:*[*GIS file formats*](https://en.wikipedia.org/wiki/GIS_file_formats)

GIS data represents real objects (such as roads, land use, elevation, trees, waterways, etc.) with digital data determining the mix. Real objects can be divided into two abstractions: discrete objects (e.g., a house) and continuous fields (such as rainfall amount, or elevations). Traditionally, there are two broad methods used to store data in a GIS for both kinds of abstractions mapping references: [raster images](https://en.wikipedia.org/wiki/Raster_images) and [vector](https://en.wikipedia.org/wiki/Vector_graphics). Points, lines, and polygons are the stuff of mapped location attribute references. A new hybrid method of storing data is that of identifying point clouds, which combine three-dimensional points with [RGB](https://en.wikipedia.org/wiki/RGB) information at each point, returning a "[3D color image](https://en.wikipedia.org/wiki/Anaglyph_3D)". GIS thematic maps then are becoming more and more realistically visually descriptive of what they set out to show or determine.

For a list of popular GIS file formats, such as [shapefiles](https://en.wikipedia.org/wiki/Shapefile), see [GIS file formats § Popular GIS file formats](https://en.wikipedia.org/wiki/GIS_file_formats#Popular_GIS_file_formats).

### Data capture**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=6)**]**

[](https://en.wikipedia.org/wiki/File:Field-Map_birdie.jpg)

Example of hardware for mapping ([GPS](https://en.wikipedia.org/wiki/GPS) and [laser rangefinder](https://en.wikipedia.org/wiki/Laser_rangefinder)) and data collection ([rugged computer](https://en.wikipedia.org/wiki/Rugged_computer)). The current trend for geographical information system (GIS) is that accurate mapping and data analysis are completed while in the field. Depicted hardware ([field-map](https://en.wikipedia.org/wiki/Field-map)technology) is used mainly for [forest inventories](https://en.wikipedia.org/wiki/Forest_inventory), monitoring and mapping.

Data capture—entering information into the system—consumes much of the time of GIS practitioners. There are a variety of methods used to enter data into a GIS where it is stored in a digital format.

Existing data printed on paper or [PET film](https://en.wikipedia.org/wiki/PET_film_(biaxially_oriented)) maps can be [digitized](https://en.wikipedia.org/wiki/Digitizer) or scanned to produce digital data. A digitizer produces [vector](https://en.wikipedia.org/wiki/Vector_graphics) data as an operator traces points, lines, and polygon boundaries from a map. [Scanning](https://en.wikipedia.org/wiki/Image_scanner) a map results in raster data that could be further processed to produce vector data.

[Survey](https://en.wikipedia.org/wiki/Surveying) data can be directly entered into a GIS from digital data collection systems on survey instruments using a technique called [coordinate geometry (COGO)](https://en.wikipedia.org/wiki/Analytic_geometry). Positions from a global navigation satellite system (GNSS) like [Global Positioning System](https://en.wikipedia.org/wiki/Global_Positioning_System) can also be collected and then imported into a GIS. A current trend in data collection gives users the ability to utilize [field computers](https://en.wikipedia.org/wiki/Rugged_computer) with the ability to edit live data using wireless connections or disconnected editing sessions. This has been enhanced by the availability of low-cost mapping-grade GPS units with decimeter accuracy in real time. This eliminates the need to post process, import, and update the data in the office after fieldwork has been collected. This includes the ability to incorporate positions collected using a [laser rangefinder](https://en.wikipedia.org/wiki/Laser_rangefinder). New technologies also allow users to create maps as well as analysis directly in the field, making projects more efficient and mapping more accurate.

[Remotely sensed](https://en.wikipedia.org/wiki/Remote_sensing) data also plays an important role in data collection and consist of sensors attached to a platform. Sensors include cameras, digital scanners and [lidar](https://en.wikipedia.org/wiki/Lidar), while platforms usually consist of aircraft and [satellites](https://en.wikipedia.org/wiki/Satellite). In England in the mid 1990s, hybrid kite/balloons called [Helikites](https://en.wikipedia.org/w/index.php?title=Helikites&action=edit&redlink=1) first pioneered the use of compact airborne digital cameras as airborne Geo-Information Systems. Aircraft measurement software, accurate to 0.4 mm was used to link the photographs and measure the ground. Helikites are inexpensive and gather more accurate data than aircraft. Helikites can be used over roads, railways and towns where UAVs are banned.

Recently with the development of [miniature UAVs](https://en.wikipedia.org/wiki/Miniature_UAV), aerial data collection is becoming possible with them. For example, the [Aeryon Scout](https://en.wikipedia.org/wiki/Aeryon_Scout)was used to map a 50-acre area with a [Ground sample distance](https://en.wikipedia.org/wiki/Ground_sample_distance) of 1 inch (2.54 cm) in only 12 minutes.[[18]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-18)

The majority of digital data currently comes from [photo interpretation](https://en.wikipedia.org/wiki/Photo_interpretation) of aerial photographs. Soft-copy workstations are used to digitize features directly from [stereo pairs](https://en.wikipedia.org/wiki/Stereoscopy) of digital photographs. These systems allow data to be captured in two and three dimensions, with elevations measured directly from a stereo pair using principles of [photogrammetry](https://en.wikipedia.org/wiki/Photogrammetry). Analog aerial photos must be scanned before being entered into a soft-copy system, for high-quality digital cameras this step is skipped.

Satellite [remote sensing](https://en.wikipedia.org/wiki/Remote_sensing) provides another important source of spatial data. Here satellites use different sensor packages to passively measure the reflectance from parts of the [electromagnetic spectrum](https://en.wikipedia.org/wiki/Electromagnetic_spectrum) or radio waves that were sent out from an active sensor such as radar. Remote sensing collects raster data that can be further processed using different bands to identify objects and classes of interest, such as land cover.

When data is captured, the user should consider if the data should be captured with either a relative accuracy or absolute accuracy, since this could not only influence how information will be interpreted but also the cost of data capture.

After entering data into a GIS, the data usually requires editing, to remove errors, or further processing. For vector data it must be made "topologically correct" before it can be used for some advanced analysis. For example, in a road network, lines must connect with nodes at an intersection. Errors such as undershoots and overshoots must also be removed. For scanned maps, blemishes on the source map may need to be removed from the resulting [raster](https://en.wikipedia.org/wiki/Raster_graphics). For example, a fleck of dirt might connect two lines that should not be connected.

### Raster-to-vector translation**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=7)**]**

Data restructuring can be performed by a GIS to convert data into different formats. For example, a GIS may be used to convert a satellite image map to a vector structure by generating lines around all cells with the same classification, while determining the cell spatial relationships, such as adjacency or inclusion.

More advanced data processing can occur with [image processing](https://en.wikipedia.org/wiki/Image_processing), a technique developed in the late 1960s by [NASA](https://en.wikipedia.org/wiki/NASA) and the private sector to provide contrast enhancement, false color rendering and a variety of other techniques including use of two dimensional [Fourier transforms](https://en.wikipedia.org/wiki/Fourier_transforms). Since digital data is collected and stored in various ways, the two data sources may not be entirely compatible. So a GIS must be able to convert [geographic data](https://en.wikipedia.org/wiki/Geographic_data) from one structure to another. In so doing, the implicit assumptions behind different ontologies and classifications require analysis.[[19]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-19) Object ontologies have gained increasing prominence as a consequence of [object-oriented programming](https://en.wikipedia.org/wiki/Object-oriented_programming) and sustained work by [Barry Smith](https://en.wikipedia.org/wiki/Barry_Smith_(academic_and_ontologist)) and co-workers.

### Projections, coordinate systems, and registration**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=8)**]**

*Main article:*[*Map projection*](https://en.wikipedia.org/wiki/Map_projection)

The earth can be represented by various models, each of which may provide a different set of coordinates (e.g., latitude, longitude, elevation) for any given point on the Earth's surface. The simplest model is to assume the earth is a perfect sphere. As more measurements of the earth have accumulated, the models of the earth have become more sophisticated and more accurate. In fact, there are models called [datums](https://en.wikipedia.org/wiki/Datum_(geodesy)) that apply to different areas of the earth to provide increased accuracy, like [NAD83](https://en.wikipedia.org/wiki/NAD83) for U.S. measurements, and the [World Geodetic System](https://en.wikipedia.org/wiki/World_Geodetic_System) for worldwide measurements.

## **Spatial analysis with geographical information system (GIS)[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=9)**]**

*Further information:*[*Spatial analysis*](https://en.wikipedia.org/wiki/Spatial_analysis)

GIS spatial analysis is a rapidly changing field, and GIS packages are increasingly including analytical tools as standard built-in facilities, as optional toolsets, as add-ins or 'analysts'. In many instances these are provided by the original software suppliers (commercial vendors or collaborative non commercial development teams), while in other cases facilities have been developed and are provided by third parties. Furthermore, many products offer software development kits (SDKs), programming languages and language support, scripting facilities and/or special interfaces for developing one's own analytical tools or variants. The website "Geospatial Analysis" and associated book/ebook attempt to provide a reasonably comprehensive guide to the subject.[[20]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-20) The increased availability has created a new dimension to [business intelligence](https://en.wikipedia.org/wiki/Business_intelligence) termed "[spatial intelligence](https://en.wikipedia.org/wiki/Spatial_intelligence_(business_method))" which, when openly delivered via intranet, democratizes access to geographic and social network data. [Geospatial intelligence](https://en.wikipedia.org/wiki/Geospatial_intelligence), based on GIS spatial analysis, has also become a key element for security. GIS as a whole can be described as conversion to a vectorial representation or to any other digitisation process.

### Slope and aspect**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=10)**]**

[Slope](https://en.wikipedia.org/wiki/Grade_(slope)) can be defined as the steepness or gradient of a unit of terrain, usually measured as an angle in degrees or as a percentage. [Aspect](https://en.wikipedia.org/wiki/Aspect_(geography)) can be defined as the direction in which a unit of terrain faces. Aspect is usually expressed in degrees from north. Slope, aspect, and surface curvature in terrain analysis are all derived from neighborhood operations using elevation values of a cell's adjacent neighbours.[[21]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Chang-21) Slope is a function of resolution, and the spatial resolution used to calculate slope and aspect should always be specified.[[22]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Longley2005-22) Authors such as Skidmore,[[23]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Skidmore1989-23) Jones[[24]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Jones1998-24) and Zhou and Liu[[25]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-zhou2003-25) have compared techniques for calculating slope and aspect.

The following method can be used to derive slope and aspect:

The elevation at a point or unit of terrain will have perpendicular tangents (slope) passing through the point, in an east-west and north-south direction. These two tangents give two components, ∂z/∂x and ∂z/∂y, which then be used to determine the overall direction of slope, and the aspect of the slope. The gradient is defined as a vector quantity with components equal to the partial derivatives of the surface in the x and y directions.[[26]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Hunter1997-26)

The calculation of the overall 3x3 grid slope *S* and aspect *A* for methods that determine east-west and north-south component use the following formulas respectively:

{\displaystyle \tan S={\sqrt {\left({\frac {\partial z}{\partial x}}\right)^{2}+\left({\frac {\partial z}{\partial y}}\right)^{2}}}}

{\displaystyle \tan A=\left({\frac {\left({\frac {-\partial z}{\partial y}}\right)}{\left({\frac {\partial z}{\partial x}}\right)}}\right)}

Zhou and Liu[[25]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-zhou2003-25) describe another formula for calculating aspect, as follows:

{\displaystyle A=270^{\circ }+\arctan \left({\frac {\left({\frac {\partial z}{\partial x}}\right)}{\left({\frac {\partial z}{\partial y}}\right)}}\right)-90^{\circ }\left({\frac {\left({\frac {\partial z}{\partial y}}\right)}{\left|{\frac {\partial z}{\partial y}}\right|}}\right)}

### Data analysis**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=11)**]**

It is difficult to relate [wetlands](https://en.wikipedia.org/wiki/Wetlands) maps to [rainfall](https://en.wikipedia.org/wiki/Rainfall) amounts recorded at different points such as airports, television stations, and schools. A GIS, however, can be used to depict two- and three-dimensional characteristics of the Earth's surface, subsurface, and atmosphere from information points. For example, a GIS can quickly generate a map with [isopleth](https://en.wikipedia.org/wiki/Isopleth)or [contour lines](https://en.wikipedia.org/wiki/Contour_line) that indicate differing amounts of rainfall. Such a map can be thought of as a rainfall contour map. Many sophisticated methods can estimate the characteristics of surfaces from a limited number of point measurements. A two-dimensional contour map created from the surface modeling of rainfall point measurements may be overlaid and analyzed with any other map in a GIS covering the same area. This GIS derived map can then provide additional information - such as the viability of [water power](https://en.wikipedia.org/wiki/Water_power) potential as a [renewable energy](https://en.wikipedia.org/wiki/Renewable_energy) source. Similarly, GIS can be used to compare other [renewable energy](https://en.wikipedia.org/wiki/Renewable_energy) resources to find the best geographic potential for a region.[[27]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-27)

Additionally, from a series of three-dimensional points, or [digital elevation model](https://en.wikipedia.org/wiki/Digital_elevation_model), isopleth lines representing elevation contours can be generated, along with slope analysis, [shaded relief](https://en.wikipedia.org/wiki/Shaded_relief), and other elevation products. Watersheds can be easily defined for any given reach, by computing all of the areas contiguous and uphill from any given point of interest. Similarly, an expected [thalweg](https://en.wikipedia.org/wiki/Thalweg) of where surface water would want to travel in intermittent and permanent streams can be computed from elevation data in the GIS.

### Topological modeling**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=12)**]**

A GIS can recognize and analyze the spatial relationships that exist within digitally stored spatial data. These [topological](https://en.wikipedia.org/wiki/Topological) relationships allow complex spatial modelling and analysis to be performed. Topological relationships between geometric entities traditionally include adjacency (what adjoins what), containment (what encloses what), and proximity (how close something is to something else).

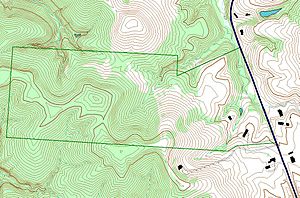
### Geometric networks**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=13)**]**

[Geometric networks](https://en.wikipedia.org/wiki/Geometric_networks) are linear networks of objects that can be used to represent interconnected features, and to perform special spatial analysis on them. A geometric network is composed of edges, which are connected at junction points, similar to [graphs](https://en.wikipedia.org/wiki/Graph_(discrete_mathematics)) in mathematics and computer science. Just like graphs, networks can have weight and flow assigned to its edges, which can be used to represent various interconnected features more accurately. Geometric networks are often used to model road networks and [public utility](https://en.wikipedia.org/wiki/Public_utility) networks, such as electric, gas, and water networks. Network modeling is also commonly employed in [transportation planning](https://en.wikipedia.org/wiki/Transportation_planning), [hydrology](https://en.wikipedia.org/wiki/Hydrology) modeling, and [infrastructure](https://en.wikipedia.org/wiki/Infrastructure)modeling.

### Hydrological modeling**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=14)**]**

GIS hydrological models can provide a spatial element that other hydrological models lack, with the analysis of variables such as slope, aspect and watershed or [catchment area](https://en.wikipedia.org/wiki/Catchment_area_(human_geography)).[[28]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Heywood-28) Terrain analysis is fundamental to hydrology, since water always flows down a slope.[[28]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Heywood-28) As basic terrain analysis of a [digital elevation model (DEM)](https://en.wikipedia.org/wiki/Digital_elevation_model) involves calculation of slope and aspect, DEMs are very useful for hydrological analysis. Slope and aspect can then be used to determine direction of surface runoff, and hence flow accumulation for the formation of streams, rivers and lakes. Areas of divergent flow can also give a clear indication of the boundaries of a catchment. Once a flow direction and accumulation matrix has been created, queries can be performed that show contributing or dispersal areas at a certain point.[[28]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Heywood-28) More detail can be added to the model, such as terrain roughness, vegetation types and soil types, which can influence infiltration and evapotranspiration rates, and hence influencing surface flow. One of the main uses of hydrological modeling is in [environmental contamination research](https://en.wikipedia.org/wiki/GIS_in_Environmental_Contamination).

### Cartographic modeling**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=15)**]**

[](https://en.wikipedia.org/wiki/File:Gislayers.jpg)

An example of use of layers in a GIS application. In this example, the forest cover layer (light green) is at the bottom, with the topographic layer over it. Next up is the stream layer, then the boundary layer, then the road layer. The order is very important in order to properly display the final result. Note that the pond layer was located just below the stream layer, so that a stream line can be seen overlying one of the ponds.

The term "cartographic modeling" was probably coined by [Dana Tomlin](https://en.wikipedia.org/wiki/Dana_Tomlin) in his PhD dissertation and later in his book which has the term in the title. Cartographic modeling refers to a process where several thematic layers of the same area are produced, processed, and analyzed. Tomlin used raster layers, but the overlay method (see below) can be used more generally. Operations on map layers can be combined into algorithms, and eventually into simulation or optimization models.

### Map overlay**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=16)**]**

The combination of several spatial datasets (points, lines, or [polygons](https://en.wikipedia.org/wiki/Polygons)) creates a new output vector dataset, visually similar to stacking several maps of the same region. These overlays are similar to mathematical [Venn diagram](https://en.wikipedia.org/wiki/Venn_diagram) overlays. A [union](https://en.wikipedia.org/wiki/Union_(set_theory))overlay combines the geographic features and attribute tables of both inputs into a single new output. An [intersect](https://en.wikipedia.org/wiki/Intersection_(set_theory)) overlay defines the area where both inputs overlap and retains a set of attribute fields for each. A [symmetric difference](https://en.wikipedia.org/wiki/Symmetric_difference) overlay defines an output area that includes the total area of both inputs except for the overlapping area.

Data extraction is a GIS process similar to vector overlay, though it can be used in either vector or raster data analysis. Rather than combining the properties and features of both datasets, data extraction involves using a "clip" or "mask" to extract the features of one data set that fall within the spatial extent of another dataset.

In raster data analysis, the overlay of datasets is accomplished through a process known as "local operation on multiple rasters" or "[map algebra](https://en.wikipedia.org/wiki/Map_algebra)," through a function that combines the values of each raster's [matrix](https://en.wikipedia.org/wiki/Matrix_(mathematics)). This function may weigh some inputs more than others through use of an "index model" that reflects the influence of various factors upon a geographic phenomenon.

### Geostatistics**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=17)**]**

*Main article:*[*Geostatistics*](https://en.wikipedia.org/wiki/Geostatistics)

[Geostatistics](https://en.wikipedia.org/wiki/Geostatistics) is a branch of statistics that deals with field data, spatial data with a continuous index. It provides methods to model spatial correlation, and predict values at arbitrary locations (interpolation).

When phenomena are measured, the observation methods dictate the accuracy of any subsequent analysis. Due to the nature of the data (e.g. traffic patterns in an urban environment; weather patterns over the [Pacific Ocean](https://en.wikipedia.org/wiki/Pacific_Ocean)), a constant or dynamic degree of precision is always lost in the measurement. This loss of precision is determined from the scale and distribution of the data collection.

To determine the statistical relevance of the analysis, an average is determined so that points (gradients) outside of any immediate measurement can be included to determine their predicted behavior. This is due to the limitations of the applied statistic and data collection methods, and interpolation is required to predict the behavior of particles, points, and locations that are not directly measurable.

[](https://en.wikipedia.org/wiki/File:Dem.jpg)

Hillshade model derived from a [Digital Elevation Model](https://en.wikipedia.org/wiki/Digital_Elevation_Model) of the [Valestra](https://en.wikipedia.org/w/index.php?title=Valestra&action=edit&redlink=1) area in the northern Apennines (Italy)

[Interpolation](https://en.wikipedia.org/wiki/Interpolation) is the process by which a surface is created, usually a raster dataset, through the input of data collected at a number of sample points. There are several forms of interpolation, each which treats the data differently, depending on the properties of the data set. In comparing interpolation methods, the first consideration should be whether or not the source data will change (exact or approximate). Next is whether the method is subjective, a human interpretation, or objective. Then there is the nature of transitions between points: are they abrupt or gradual. Finally, there is whether a method is global (it uses the entire data set to form the model), or local where an algorithm is repeated for a small section of terrain.

Interpolation is a justified measurement because of a spatial autocorrelation principle that recognizes that data collected at any position will have a great similarity to, or influence of those locations within its immediate vicinity.

[Digital elevation models](https://en.wikipedia.org/wiki/Digital_elevation_model), [triangulated irregular networks](https://en.wikipedia.org/wiki/Triangulated_irregular_network), edge-finding algorithms, [Thiessen polygons](https://en.wikipedia.org/wiki/Thiessen_polygons), [Fourier analysis](https://en.wikipedia.org/wiki/Fourier_analysis), [(weighted) moving averages](https://en.wikipedia.org/wiki/Weighted_moving_average), [inverse distance weighting](https://en.wikipedia.org/wiki/Inverse_distance_weighting), [kriging](https://en.wikipedia.org/wiki/Kriging), [spline](https://en.wikipedia.org/wiki/Spline_(mathematics)), and [trend surface analysis](https://en.wikipedia.org/wiki/Trend_estimation) are all mathematical methods to produce interpolative data.

### Address geocoding**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=18)**]**

*Main article:*[*Geocoding*](https://en.wikipedia.org/wiki/Geocoding)

Geocoding is interpolating spatial locations (X,Y coordinates) from street addresses or any other spatially referenced data such as [ZIP Codes](https://en.wikipedia.org/wiki/ZIP_Code), parcel lots and address locations. A reference theme is required to [geocode](https://en.wikipedia.org/wiki/Geocoding) individual addresses, such as a road centerline file with address ranges. The individual address locations have historically been interpolated, or estimated, by examining address ranges along a road segment. These are usually provided in the form of a table or database. The software will then place a dot approximately where that address belongs along the segment of centerline. For example, an address point of 500 will be at the midpoint of a line segment that starts with address 1 and ends with address 1,000. Geocoding can also be applied against actual parcel data, typically from municipal tax maps. In this case, the result of the geocoding will be an actually positioned space as opposed to an interpolated point. This approach is being increasingly used to provide more precise location information.

### Reverse geocoding**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=19)**]**

Reverse geocoding is the process of returning an estimated [street address](https://en.wikipedia.org/wiki/Street_address) number as it relates to a given coordinate. For example, a user can click on a road centerline theme (thus providing a coordinate) and have information returned that reflects the estimated house number. This house number is interpolated from a range assigned to that road segment. If the user clicks at the [midpoint](https://en.wikipedia.org/wiki/Midpoint) of a segment that starts with address 1 and ends with 100, the returned value will be somewhere near 50. Note that reverse geocoding does not return actual addresses, only estimates of what should be there based on the predetermined range.

### Multi-criteria decision analysis**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=20)**]**

Coupled with GIS, [multi-criteria decision analysis](https://en.wikipedia.org/wiki/Multi-criteria_decision_analysis) methods support decision-makers in analysing a set of alternative spatial solutions, such as the most likely ecological habitat for restoration, against multiple criteria, such as vegetation cover or roads. MCDA uses decision rules to aggregate the criteria, which allows the alternative solutions to be ranked or prioritised.[[29]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-Greene-29) GIS MCDA may reduce costs and time involved in identifying potential restoration sites.

### Data output and cartography**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=21)**]**

[Cartography](https://en.wikipedia.org/wiki/Cartography) is the design and production of maps, or visual representations of spatial data. The vast majority of modern cartography is done with the help of computers, usually using GIS but production of quality cartography is also achieved by importing layers into a design program to refine it. Most GIS software gives the user substantial control over the appearance of the data.

Cartographic work serves two major functions:

First, it produces graphics on the screen or on paper that convey the results of analysis to the people who make decisions about resources. Wall maps and other graphics can be generated, allowing the viewer to visualize and thereby understand the results of analyses or simulations of potential events. [Web Map Servers](https://en.wikipedia.org/wiki/Web_Map_Server) facilitate distribution of generated maps through web browsers using various implementations of web-based application programming interfaces ([AJAX](https://en.wikipedia.org/wiki/AJAX), [Java](https://en.wikipedia.org/wiki/Java_programming), [Flash](https://en.wikipedia.org/wiki/Adobe_Flash), etc.).

Second, other database information can be generated for further analysis or use. An example would be a list of all addresses within one mile (1.6 km) of a toxic spill.

### Graphic display techniques**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=22)**]**

Traditional maps are abstractions of the real world, a sampling of important elements portrayed on a sheet of paper with symbols to represent physical objects. People who use maps must interpret these symbols. [Topographic maps](https://en.wikipedia.org/wiki/Topographic_map) show the shape of land surface with [contour lines](https://en.wikipedia.org/wiki/Contour_line) or with [shaded relief](https://en.wikipedia.org/wiki/Cartographic_relief_depiction).

Today, graphic display techniques such as [shading](https://en.wikipedia.org/wiki/Shading) based on [altitude](https://en.wikipedia.org/wiki/Altitude) in a GIS can make relationships among map elements visible, heightening one's ability to extract and analyze information. For example, two types of data were combined in a GIS to produce a perspective view of a portion of [San Mateo County](https://en.wikipedia.org/wiki/San_Mateo_County), [California](https://en.wikipedia.org/wiki/California).

* The [digital elevation model](https://en.wikipedia.org/wiki/Digital_elevation_model), consisting of surface elevations recorded on a 30-meter horizontal grid, shows high elevations as white and low elevation as black.
* The accompanying [Landsat](https://en.wikipedia.org/wiki/Landsat) Thematic Mapper image shows a false-color infrared image looking down at the same area in 30-meter pixels, or picture elements, for the same coordinate points, pixel by pixel, as the elevation information.

A GIS was used to register and combine the two images to [render](https://en.wikipedia.org/wiki/Rendering_(computer_graphics)) the three-dimensional [perspective view](https://en.wikipedia.org/wiki/Perspective_view) looking down the [San Andreas Fault](https://en.wikipedia.org/wiki/San_Andreas_Fault), using the Thematic Mapper image pixels, but shaded using the elevation of the [landforms](https://en.wikipedia.org/wiki/Landform). The GIS display depends on the viewing point of the [observer](https://en.wikipedia.org/wiki/Observation) and time of day of the display, to properly render the shadows created by the sun's rays at that latitude, longitude, and time of day.

An archeochrome is a new way of displaying spatial data. It is a thematic on a 3D map that is applied to a specific building or a part of a building. It is suited to the visual display of heat-loss data.

### Spatial ETL**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=23)**]**

[Spatial ETL](https://en.wikipedia.org/wiki/Spatial_ETL) tools provide the data processing functionality of traditional [Extract, Transform, Load](https://en.wikipedia.org/wiki/Extract,_transform,_load) (ETL) software, but with a primary focus on the ability to manage spatial data. They provide GIS users with the ability to translate data between different standards and proprietary formats, whilst geometrically transforming the data en route. These tools can come in the form of add-ins to existing wider-purpose software such as [Microsoft Excel](https://en.wikipedia.org/wiki/Microsoft_Excel).

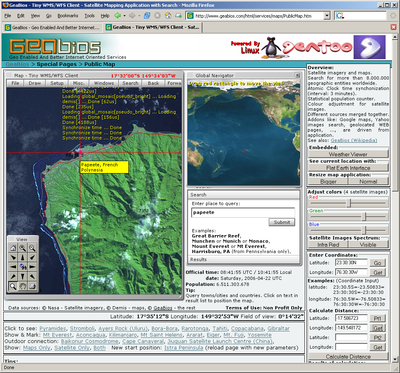
### GIS data mining**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=24)**]**

GIS or spatial [data mining](https://en.wikipedia.org/wiki/Data_mining) is the application of data mining methods to spatial data. Data mining, which is the partially automated search for hidden patterns in large databases, offers great potential benefits for applied GIS-based decision making. Typical applications include environmental monitoring. A characteristic of such applications is that spatial correlation between data measurements require the use of specialized algorithms for more efficient data analysis.[[30]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-30)

## **Applications[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=25)**]**

The implementation of a GIS is often driven by jurisdictional (such as a city), purpose, or application requirements. Generally, a GIS implementation may be custom-designed for an organization. Hence, a GIS deployment developed for an application, jurisdiction, enterprise, or purpose may not be necessarily [interoperable](https://en.wikipedia.org/wiki/Interoperability) or compatible with a GIS that has been developed for some other application, jurisdiction, enterprise, or purpose.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

GIS provides, for every kind of location-based organization, a platform to update geographical data without wasting time to visit the field and update a database manually. GIS when integrated with other powerful enterprise solutions like SAP[[31]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-31) and the Wolfram Language[[32]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-32) helps creating powerful [decision support system](https://en.wikipedia.org/wiki/Decision_support_system) at enterprise level.[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)][[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

[](https://en.wikipedia.org/wiki/File:GeaBiosOpenLaszloSatelliteMappingApplication2.PNG)

[GeaBios](https://en.wikipedia.org/wiki/GeaBios) – tiny [WMS](https://en.wikipedia.org/wiki/Web_Map_Service)/[WFS](https://en.wikipedia.org/wiki/Web_Feature_Service) client ([Flash](https://en.wikipedia.org/wiki/Adobe_Flash)/[DHTML](https://en.wikipedia.org/wiki/DHTML))

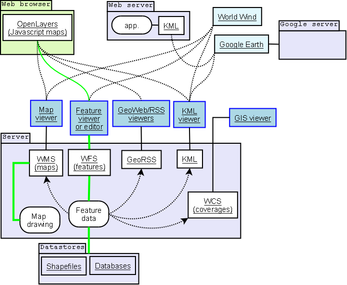
Many disciplines can benefit from GIS technology. An active GIS market has resulted in lower costs and continual improvements in the hardware and software components of GIS, and usage in the fields of science, government, [business](https://en.wikipedia.org/wiki/Business), and [industry](https://en.wikipedia.org/wiki/Industry), with applications including [real estate](https://en.wikipedia.org/wiki/Real_estate), [public health](https://en.wikipedia.org/wiki/Public_health), [crime mapping](https://en.wikipedia.org/wiki/Crime_mapping), [national defense](https://en.wikipedia.org/wiki/Defense_(military)), [sustainable development](https://en.wikipedia.org/wiki/Sustainable_development), [natural resources](https://en.wikipedia.org/wiki/Natural_resources), [climatology](https://en.wikipedia.org/wiki/Climatology),[[33]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-33)[[34]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-34) [landscape architecture](https://en.wikipedia.org/wiki/Landscape_architecture), [archaeology](https://en.wikipedia.org/wiki/Archaeology), regional and community planning, transportation and logistics. GIS is also diverging into [location-based services](https://en.wikipedia.org/wiki/Location-based_service), which allows GPS-enabled mobile devices to display their location in relation to fixed objects (nearest restaurant, gas station, fire hydrant) or mobile objects (friends, children, police car), or to relay their position back to a central server for display or other processing.

### Open Geospatial Consortium standards**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=26)**]**

*Main article:*[*Open Geospatial Consortium*](https://en.wikipedia.org/wiki/Open_Geospatial_Consortium)

The [Open Geospatial Consortium](https://en.wikipedia.org/wiki/Open_Geospatial_Consortium) (OGC) is an international industry consortium of 384 companies, government agencies, universities, and individuals participating in a consensus process to develop publicly available geoprocessing specifications. Open interfaces and protocols defined by OpenGIS Specifications support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT, and empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. Open Geospatial Consortium protocols include [Web Map Service](https://en.wikipedia.org/wiki/Web_Map_Service), and [Web Feature Service](https://en.wikipedia.org/wiki/Web_Feature_Service).[[35]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-35)

GIS products are broken down by the OGC into two categories, based on how completely and accurately the software follows the OGC specifications.

[](https://en.wikipedia.org/wiki/File:Geoservices_server_with_apps.png)

OGC standards help GIS tools communicate.

*Compliant Products* are software products that comply to OGC's OpenGIS Specifications. When a product has been tested and certified as compliant through the OGC Testing Program, the product is automatically registered as "compliant" on this site.

*Implementing Products* are software products that implement OpenGIS Specifications but have not yet passed a compliance test. Compliance tests are not available for all specifications. Developers can register their products as implementing draft or approved specifications, though OGC reserves the right to review and verify each entry.

### Web mapping**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=27)**]**

*Main article:*[*Web mapping*](https://en.wikipedia.org/wiki/Web_mapping)

In recent years there has been an proliferation of free-to-use and easily accessible mapping software such as the [proprietary](https://en.wikipedia.org/wiki/Proprietary_software) web applications [Google Maps](https://en.wikipedia.org/wiki/Google_Maps) and [Bing Maps](https://en.wikipedia.org/wiki/Bing_Maps), as well as the [free and open-source](https://en.wikipedia.org/wiki/Free_and_open-source_software) alternative [OpenStreetMap](https://en.wikipedia.org/wiki/OpenStreetMap). These services give the public access to huge amounts of geographic data.

Some of them, like Google Maps and [OpenLayers](https://en.wikipedia.org/wiki/OpenLayers), expose an [API](https://en.wikipedia.org/wiki/Application_programming_interface) that enable users to create custom applications. These toolkits commonly offer street maps, aerial/satellite imagery, geocoding, searches, and routing functionality. Web mapping has also uncovered the potential of [crowdsourcing](https://en.wikipedia.org/wiki/Crowdsourcing) geodata in projects like [OpenStreetMap](https://en.wikipedia.org/wiki/OpenStreetMap), which is a collaborative project to create a free editable map of the world.

### Adding the dimension of time**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=28)**]**

*See also:*[*Time geography*](https://en.wikipedia.org/wiki/Time_geography)

The condition of the Earth's surface, atmosphere, and subsurface can be examined by feeding satellite data into a GIS. GIS technology gives researchers the ability to examine the variations in Earth processes over days, months, and years. As an example, the changes in vegetation vigor through a growing season can be animated to determine when drought was most extensive in a particular region. The resulting graphic represents a rough measure of plant health. Working with two variables over time would then allow researchers to detect regional differences in the lag between a decline in rainfall and its effect on vegetation.

GIS technology and the availability of digital data on regional and global scales enable such analyses. The satellite sensor output used to generate a vegetation graphic is produced for example by the [Advanced Very High Resolution Radiometer](https://en.wikipedia.org/wiki/Advanced_Very_High_Resolution_Radiometer) (AVHRR). This sensor system detects the amounts of energy reflected from the Earth's surface across various bands of the spectrum for surface areas of about 1 square kilometer. The satellite sensor produces images of a particular location on the Earth twice a day. AVHRR and more recently the [Moderate-Resolution Imaging Spectroradiometer](https://en.wikipedia.org/wiki/Moderate-Resolution_Imaging_Spectroradiometer) (MODIS) are only two of many sensor systems used for Earth surface analysis. More sensors will follow, generating ever greater amounts of data.

In addition to the integration of time in environmental studies, GIS is also being explored for its ability to track and model the progress of humans throughout their daily routines. A concrete example of progress in this area is the recent release of time-specific population data by the [U.S. Census](https://en.wikipedia.org/wiki/U.S._Census). In this data set, the populations of cities are shown for daytime and evening hours highlighting the pattern of concentration and dispersion generated by North American commuting patterns. The manipulation and generation of data required to produce this data would not have been possible without GIS.

Using models to project the data held by a GIS forward in time have enabled planners to test policy decisions using [spatial decision support systems](https://en.wikipedia.org/wiki/Spatial_decision_support_system).

## **Semantics[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=29)**]**

Tools and technologies emerging from the [W3C's](https://en.wikipedia.org/wiki/World_Wide_Web_Consortium) [Data Activity](https://en.wikipedia.org/wiki/Semantic_Web) are proving useful for [data integration](https://en.wikipedia.org/wiki/Data_integration) problems in information systems. Correspondingly, such technologies have been proposed as a means to facilitate [interoperability](https://en.wikipedia.org/wiki/Interoperability) and data reuse among GIS applications.[[36]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-36)[[37]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-37) and also to enable new analysis mechanisms.[[38]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-38)

[Ontologies](https://en.wikipedia.org/wiki/Ontology_(computer_science)) are a key component of this semantic approach as they allow a formal, machine-readable specification of the concepts and relationships in a given domain. This in turn allows a GIS to focus on the intended meaning of data rather than its syntax or structure. For example, [reasoning](https://en.wikipedia.org/wiki/Reasoning) that a land cover type classified as *deciduous needleleaf trees* in one dataset is a [specialization](https://en.wikipedia.org/wiki/Specialization_(logic)) or subset of land cover type *forest* in another more roughly classified dataset can help a GIS automatically merge the two datasets under the more general land cover classification. Tentative ontologies have been developed in areas related to GIS applications, for example the hydrology ontology[[39]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-39) developed by the [Ordnance Survey](https://en.wikipedia.org/wiki/Ordnance_Survey) in the [United Kingdom](https://en.wikipedia.org/wiki/United_Kingdom) and the SWEET ontologies[[40]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-40) developed by [NASA](https://en.wikipedia.org/wiki/NASA)'s [Jet Propulsion Laboratory](https://en.wikipedia.org/wiki/Jet_Propulsion_Laboratory). Also, simpler ontologies and semantic metadata standards are being proposed by the W3C Geo Incubator Group[[41]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-41) to represent geospatial data on the web. [GeoSPARQL](https://en.wikipedia.org/wiki/GeoSPARQL) is a standard developed by the Ordnance Survey, [United States Geological Survey](https://en.wikipedia.org/wiki/United_States_Geological_Survey), [Natural Resources Canada](https://en.wikipedia.org/wiki/Natural_Resources_Canada), Australia's [Commonwealth Scientific and Industrial Research Organisation](https://en.wikipedia.org/wiki/Commonwealth_Scientific_and_Industrial_Research_Organisation) and others to support ontology creation and reasoning using well-understood OGC literals (GML, WKT), topological relationships (Simple Features, RCC8, DE-9IM), RDF and the [SPARQL](https://en.wikipedia.org/wiki/SPARQL) database query protocols.

Recent research results in this area can be seen in the International Conference on Geospatial Semantics[[42]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-42) and the Terra Cognita – Directions to the Geospatial Semantic Web[[43]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-43) workshop at the International Semantic Web Conference.

## **Implications of GIS in society[**[**edit**](https://en.wikipedia.org/w/index.php?title=Geographic_information_system&action=edit&section=30)**]**

*Main articles:*[*Neogeography*](https://en.wikipedia.org/wiki/Neogeography)*and*[*Public participation GIS*](https://en.wikipedia.org/wiki/Public_participation_GIS)

With the popularization of GIS in decision making, scholars have begun to scrutinize the social and political implications of GIS.[[44]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-44)[[45]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-45) GIS can also be misused to distort reality for individual and political gain.[[46]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-46)[[47]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-47) It has been argued that the production, distribution, utilization, and representation of geographic information are largely related with the social context and has the potential to increase citizen trust in government.[[48]](https://en.wikipedia.org/wiki/Geographic_information_system#cite_note-48) Other related topics include discussion on [copyright](https://en.wikipedia.org/wiki/Copyright), [privacy](https://en.wikipedia.org/wiki/Privacy), and [censorship](https://en.wikipedia.org/wiki/Censorship). A more optimistic social approach to GIS adoption is to use it as a tool for public participation.

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth’s surface. GIS can show many different kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships.   
  
With GIS technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using GIS, the same map could include sites that produce pollution, such as gas stations, and sites that are sensitive to pollution, such as wetlands. Such a map would help people determine which wetlands are most at risk.  
  
GIS can use any information that includes location. The location can be expressed in many different ways, such as latitude and longitude, address, or ZIP code. Many different types of information can be compared and contrasted using GIS. The system can include data about people, such as population, income, or education level. It can include information about the land, such as the location of streams, different kinds of vegetation, and different kinds of soil. It can include information about the sites of factories, farms, and schools, or storm drains, roads, and electric power lines.  
  
**Data and GIS**  
  
Data in many different forms can be entered into GIS. Data that are already in map form can be included in GIS. This includes such information as the location of rivers and roads, hills and valleys. Digital, or computerized, data can also be entered into GIS. An example of this kind of information is data collected by satellites that show land use—the location of farms, towns, or forests. GIS can also include data in table form, such as population information. GIS technology allows all these different types of information, no matter their source or original format, to be overlaid on top of one another on a single map.  
  
Putting information into GIS is called data capture. Data that are already in digital form, such as images taken by satellites and most tables, can simply be uploaded into GIS. Maps must be scanned, or converted into digital information.  
  
GIS must make the information from all the various maps and sources align, so they fit together. One reason this is necessary is because maps have different scales. A scale is the relationship between the distance on a map and the actual distance on Earth. GIS combines the information from different sources in such a way that it all has the same scale.

Often, GIS must also manipulate the data because different maps have different projections. A projection is the method of transferring information from Earth’s curved surface to a flat piece of paper or computer screen. No projection can copy the reality of Earth’s curved surface perfectly. Different types of projections accomplish this task in different ways, but all result in some distortion. To transfer a curved, three-dimensional shape onto a flat surface inevitably requires stretching some parts and squeezing other parts. A world map can show either the correct sizes of countries or their correct shapes, but it can’t do both. GIS takes data from maps that were made using different projections and combines them so all the information can be displayed using one common projection.   
  
**GIS Maps**  
  
Once all of the desired data have been entered into a GIS system, they can be combined to produce a wide variety of individual maps, depending on which data layers are included. For instance, using GIS technology, many kinds of information can be shown about a single city. Maps can be produced that relate such information as average income, book sales, and voting patterns. Any GIS data layer can be added or subtracted to the same map.   
  
GIS maps can be used to show information about number and density. For example, GIS can be used to show how many doctors there are in different areas compared with the population. They can also show what is near what, such as which homes and businesses are in areas prone to flooding.  
  
With GIS technology, researchers can also look at change over time. They can use satellite data to study topics such as how much of the polar regions is covered in ice. A police department can study changes in crime data to help determine where to assign officers.   
  
GIS often contains a large variety of data that do not appear in an onscreen or printed map. GIS technology sometimes allows users to access this information. A person can point to a spot on a computerized map to find other information stored in the GIS about that location. For example, a user might click on a school to find how many students are enrolled, how many students there are per teacher, or what sports facilities the school has.   
  
GIS systems are often used to produce three-dimensional images. This is useful, for example, to geologists studying faults.   
  
GIS technology makes updating maps much easier. Updated data can simply be added to the existing GIS program. A new map can then be printed or displayed on screen. This skips the traditional process of drawing a map, which can be time-consuming and expensive.  
  
People working in many different fields use GIS technology. Many businesses use GIS to help them determine where to locate a new store. Biologists use GIS to track animal migration patterns. City officials use GIS to help plan their response in the case of a natural disaster such as an earthquake or hurricane. GIS maps can show these officials what neighborhoods are most in danger, where to locate shelters, and what routes people should take to reach safety. Scientists use GIS to compare population growth to resources such as drinking water, or to try to determine a region’s future needs for public services like parking, roads, and electricity. There is no limit to the kind of information that can be analyzed using GIS technology.

# What is a Firewall?

A firewall is a security device that can be a software program or a dedicated network appliance. The main purpose of a firewall is to separate a secure area from a less secure area and to control communications between the two. Firewalls can perform a variety of other functions, but are chiefly responsible for controlling inbound and outbound communications on anything from a single machine to an entire network.

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## Software Firewalls

Software firewalls, also sometimes called personal firewalls, are designed to run on a single computer. These are most commonly used on home or small office computers that have broadband access, which tend to be left on all the time. A software firewall prevents unwanted access to the computer over a network connection by identifying and preventing communication over risky ports. Computers communicate over many different recognized ports, and the firewall will tend to permit these without prompting or alerting the user. For example, computers access Web pages over port 80 and use port 443 for secure Web communications. A home computer would expect to receive data over these ports. However, a software firewall would probably block any access from the Internet over port 421, over which it does not expect to receive data. Additionally, port 421 has been used by certain Trojans (a type of malware) in the past. Software firewalls can also detect "suspicious" activity from the outside. They can block access to a home computer from an outside address when activity matches certain patterns, like port scanning.

A software firewall also allows certain programs on the user's computer to access the Internet, often by express permission of the user. Windows Update, antivirus software, and Microsoft Word are a few programs that a user might legitimately expect to access the Internet. However, a program called gator.exe that is attempting to access the Internet when it shouldn't be running might be reason for concern, so the user could decline access for this program. This is a useful feature when spyware, adware or some type of malware is suspected.

Some software firewalls also allow configuration of trusted zones. These permit unlimited communication over a wide variety of ports. This type of access may be necessary when a user starts a VPN client to reach a corporate intranet.

One drawback to software firewalls is that they are software running on a personal computer operating system. If the underlying operating system is compromised, then the firewall can be compromised as well. Since many other programs also run on a home computer, malicious software could potentially enter the computer through some other application and compromise the firewall. Software firewalls also rely heavily upon the user making the right decisions. If someone using a software firewall mistakenly gives a keylogger or a Trojan permission to access the Internet, security on that machine is compromised even though there is nothing wrong with the firewall itself.

There are many different brands of software firewalls, each with their own features. Some examples include ZoneAlarm, BlackICE, and Kerio.

## Hardware Firewalls

Hardware firewalls are more complex. They also have software components, but run either on a specially engineered network appliance or on an optimized server dedicated to the task of running the firewall. The operating system underlying a hardware firewall is as basic as possible and very difficult to attack. Since no other software runs on these machines, and configuration takes a little more thought than clicking on an "allow" prompt, they are difficult to compromise and tend to be extremely secure.

A hardware firewall is placed between a network, such as a corporation, and a less secure area, such as the Internet. Firewalls also can separate more secure networks from less secure networks, such as one corporate location within a larger corporate structure. Versions of hardware firewalls are available to home users who want stronger protection from potential Internet attacks. There are many different default configurations for these devices - some allow no communications from the outside and must be configured, using rules, others (like those available for the home market) are already configured to block access over risky ports. Rules can be as simple as allowing port 80 traffic to flow through the firewall in both directions, or as complex as only allowing 1433 (SQL server) traffic from a specific IP address outside of the network through the firewall to a single IP address inside the network.

Firewalls are also used for Network Address Translation (NAT). This allows a network to use private IP addresses that are not routed over the Internet. Private IP address schemes allow organizations (or even household networks) to limit the number of publicly routed IP addresses they use, reserving public addresses for Web servers and other externally accessed network equipment. NAT allows administrators to use one public IP address for all of their users to access the Internet - the firewall is "smart" enough to send the requests back to the requesting workstation's internal IP. NAT also allows users inside a network to contact a server using a private IP while users outside the network must contact the same server using an external IP.

In addition to port and IP address rules, firewalls can have a wide variety of functionality. They can also act as caching servers, VPNs, routers, and more. Some examples of hardware firewalls are CheckPoint, Cisco PIX, SonicWall, Contivity from Nortel, and Linksys (for the home market).

Firewalls are vital to network management. Without this control over computer and network access, large networks could not store sensitive data intended for selective retrieval. Firewalls are also very important for home broadband users - without a home version of one of these products, your personal data is at risk.

# What is an Internet Service Provider?

n Internet Service Provider (ISP) is the industry term for the company that is able to provide you with access to the Internet, typically from a computer. If you hear someone talking about the Internet and they mention their "provider," they're usually talking about their ISP.

Your ISP makes the Internet a possibility. In other words, you can have shiny computer with a built-in modem and could have a router for networking, but without a subscription with an ISP, you won't have a connection to the Internet.

For the typical homeowner or apartment dweller, the ISP is usually a "cable company" that, in addition or offering a TV subscription, also offers an Internet subscription. You don't get both for the price of one, however. You can get just cable TV or just high-speed Internet, or both.

An ISP is your gateway to the Internet and everything else you can do online. The second your connection is activated and set up, you'll be able to send emails, go shopping, do research and more. The ISP is the link or conduit between your computer and all the other "servers" on the Internet. You may feel like you're talking to your mom directly through email, but in reality it's more "indirectly." Your email goes from your computer, to the ISP computers/servers, where it's sent along to its destination through other servers on the network.

Of course, that's its "electronic" path: the transmission is still virtually instantaneous.

Every home or organization with Internet access has an ISP. The good news is, we don't all have to have the same provider to communicate with each other and we don't have to pay anything extra to communicate with someone who has a different ISP.

Whereas just about anyone can have a website, not everyone can be an ISP. It takes money, infrastructure and a lot of very smart technicians. Your ISP maintains miles of cabling, employs hundreds of technicians and maintains network services for its hundreds of thousands of subscribers. Depending on where you live, you typically have a choice of ISPs.

## Types of ISPs

In the 1990s, there were three types of ISPs: dial-up services, high-speed Internet (also referred to as "broadband") offered by cable companies, and DSL (Digital Line Subscribers) offered by phone companies. By 2013, dial-up services were rare (even though they were cheap), because they were very slow...and the other ISP options were typically readily available and much, much faster.

## DSL and Cable.

Two of the leading DSL ISPs have been Verizon and AT&T. But in the last few years (from 2013), DSL has been on the decline, while cable-based ISPs, like Comcast and Time Warner, have been growing. Why the change? It's because the phone companies have been getting more into the lucrative smartphone business, and selling annual contracts for cellular service along with...smartphone Internet capabilities.

That's left a lot of the broadband business for the cable companies.

## Fiber Internet: On its way to you?

With DSL dropping out of the picture, there's room for a new technology and it's already here in some areas: it's called fiber, or fiber optical, broadband. Supposedly, fiber is hundreds times FASTER than cable or DSL. That's especially exciting news (if it's true and available) to companies, and gamers and households with a lot of simultaneous wireless usage going on.

Verizon (yes, they are downplaying DSL) now offers FiOS in select areas (put an "f" before "eye" and the "os"-sound in "most"). FiOS stands for fiber optic services, and it claims to have superfast Internet connection speeds.

And for all of us not in the Kansas area, Google launched Google Fiber in 2013, which offers incredibly ultra-fast Internet speed. Other companies (and communities) are teaming up to bring the next generation of broadband to you.

# What is a Dialup Internet Service

Dialup internet service is a service that allows connectivity to the internet through a standard telephone line. By connecting the telephone line to the modem in your computer and inserting the other end into the phone jack, and configuring the computer to dial a specific number provided by your [internet service provider](http://whatismyipaddress.com/isp) (ISP) you are able to access the internet on your computer.

Dial up internet service is provided through several ISP. The majority of internet service providers give you a set of telephone numbers either national or local that allows you to dial into a network that feeds into the internet. This allows you to receive and send email, search the World Wide Web, participate in chat rooms and plenty of other features the web has to offer.

In order to get a dial up internet service a person must definitely have a computer and even more important a modem. There are different types of modems, and most of them are inexpensive to purchase. You can have an internal modem installed in a free slot of your computer, or you can have an external modem that's hooked up to the computer through cables. A telephone line is linked to the modem.

The modem whether external or internal is controlled by software on the computer. With Microsoft Windows operating system that software is the Network Connection utility which allows you to connect to the internet. How? In the Network Connection utility you have to set up ISP profile so that the modem knows what phone number to dial so that you can connect to the internet.

Once you have found an internet service provider and joined you must choose a password and username. Why? When the modem dials the phone number you are given by your ISP, a connection is made, and then information is swap between the modem and the remote server. A remote server is the computer and related software that is established to handle users who want to access a network remotely. The username and password you choose for the modem allows access to the dial up gateway to the internet. The gateway to the internet is a network that allows entry into another network.

If you are looking for an inexpensive internet service dial up is the way to go. Not only is it the cheapest but also the slowest type of access you can get. Since the bandwidth is limited it will take some time for the modem to send and receive information. It will be slow loading web pages, listening to music and watching videos online. There are all kinds of software available that can help speed up your dial up internet.

With dial up internet you cannot use the phone and search the web at the same time. How come? Remember while one end of the telephone is linked to the modem the other end is in the phone outlet. There are internet services available that allows you to use the phone at the same time and be online.

So as you can see dial up internet has its pros and its cons. If you are looking for a inexpensive internet service and don't mind not being able to talk on the phone and use the web at the same time then dial up is definitely for you!

# What is Broadband?

Broadband Internet service truly is the most used form of Internet access because of its high access speeds; it is offered in four different forms, DSL (or Digital Subscriber Line), also fiber-optic, cable, and satellite. The old [dial-up](http://whatismyipaddress.com/dialup) connection is the only non-broadband internet service available, and even though it is cheaper, most Internet users are moving towards the faster broadband Internet connection.

## DSL

The DSL (or Digital Subscriber Line) internet service makes its connection by utilizing unused telephone wires that cause no interruption to your telephone service. The speed you experience with a DSL connection varies with your distance from the switching station. Your speed will be slower the further away you are and faster the closer you are to the switching station and this may be a deciding factor when you attempt to select between a DSL line and a cable connection.

Asymmetric digital subscriber line

**Asymmetric digital subscriber line (ADSL)** is a type of [digital subscriber line](https://en.wikipedia.org/wiki/Digital_subscriber_line) (DSL) technology, a data communications technology that enables faster data transmission over [copper](https://en.wikipedia.org/wiki/Copper) [telephone lines](https://en.wikipedia.org/wiki/Telephone_line) rather than a conventional [voiceband](https://en.wikipedia.org/wiki/Voiceband) [modem](https://en.wikipedia.org/wiki/Modem) can provide. ADSL differs from the less common [symmetric digital subscriber line](https://en.wikipedia.org/wiki/Symmetric_digital_subscriber_line) (SDSL). In ADSL, [Bandwidth](https://en.wikipedia.org/wiki/Bandwidth_(computing)) and [bit rate](https://en.wikipedia.org/wiki/Bit_rate) are said to be asymmetric, meaning greater toward the customer premises ([downstream](https://en.wikipedia.org/wiki/Downstream_(networking))) than the reverse ([upstream](https://en.wikipedia.org/wiki/Upstream_(networking))). Providers usually market ADSL as a service for consumers for [Internet access](https://en.wikipedia.org/wiki/Internet_access) for primarily [downloading](https://en.wikipedia.org/wiki/Download) content from the Internet, but not serving content accessed by others.

## Cable

The broadband cable connection is provided by the local cable TV provider. Here the cable Internet connection speed varies with the number of users on the service at a specific point in time. Given a specific geographical area, users of the broadband cable service share the connection bandwidth which slows the speed the more users are on the system. This will occur at the peak times for example late in the evenings after the work day is over when many people will be accessing the Internet. Somewhat misleadingly, often the cable company would estimate connection speeds that are based on the thinking that you are using the service. But that is clearly not the case.

## Fiber-Optic

The newest broadband service is fiber-optic, which is the fastest Internet connection thus far. However, this type of Internet service is still in its infancy as its service areas are quite limited and because the laying down of the fiber-optic cable takes a while to complete. Wherever it is available, the cost not only competes with that of DSL and cable, but it provides a much faster connection than both of those services.

## Satellite

The last and slowest broadband service is provided by satellite. Although this is a good replacement for dial-up for those people living in remote rural areas, the installation costs are quite high, but the ongoing monthly charges are competitive to both cable and DSL.

There are many advantages to the DSL and cable broadband service. It provides greater bandwidth than other Internet access forms, and that makes it easier for the computer user to multitask with several applications performing in the background while you surf the web. It is possible for you to surf the web while listening to audio.

The networking of computers in the home is made easier with a broadband connection, by either using wireless or wired modems.

The cost of broadband service is higher annually than the cheaper dial-up version by $100 to $500, but given the advantages and ease of a broadband connection, it is well worth the cost.

A broadband connection allows you to play many popular computer games that rely on a fast Internet connection.

Broadband connection, unlike the old dial-up internet connection, will not engage your phone line when in use. In fact, having a broadband connection makes it possible for you to obtain an Internet phone service so you will no longer need the traditional phone line at all.

Another great benefit of a broadband connection is that you are constantly connected to the Internet. You are quickly able to connect with your work's intranet and email in a matter of seconds.

Many people considering between these broadband Internet service options generally narrow the search to the most popular services which are DSL and cable. A good approach when researching your options would be to ask those in the area you are considering, which service they are using and how it is working for them.

Even though cable broadband Internet service offers a speedy internet connection, this fast speed will not be realized if the connection itself cannot be relied on. For example, the cable connection you receive depends on the shared bandwidth, the number of users on the system at any time, and the latency on the network.

The bandwidth is just one factor that determines the Internet connection's speed. It is a measure of the quantity of data that enters the network over a period of time, and is measured in bps, or bits per second. The greater the data flow, the better the network Internet connection. In broadband connections the supported data rates are generally 300 Kbps and higher, as opposed to the old dial-up maximum of 53Kbps.

Latency is another factor that affects the cable Internet connection's speed. Latency refers to delays incurred in the network data processing. A network is described as low latency if it experiences only small delay times, and high latency if it suffers with long delays. When the latency becomes excessive, data transmission causes a bottleneck that prevents addition data from coming through and this effectively reduces cable's Internet connection bandwidth. So even though the cable bandwidth of your Internet connection is set, its effectiveness can be reduced by bottlenecks of data and a high number of users on the system .

Again, with a broadband DSL connection, the connection speed of the Internet can be severely reduced by the distance a subscriber is located from the switching station. The further away the subscriber is from the switching station, the slower the Internet connection.

Once installed, a broadband connection is always on. The connection is maintained with the use of a cable or DSL modem. These connect the computer to the cable outlet on the wall, in the case of the cable internet connection; or the DSL modem to the phone line. Only when these connections become unplugged, will the Internet connection be lost.

Unlike the old dial-up service, you will not be dialing a specific phone number to gain access to the Internet. With a broadband service, access to the Internet is given by simply double clicking your Internet browser icon of choice (this is usually on your desktop - Internet Explorer, Firefox, Netscape etc.); your default web page will open and you can immediately start surfing the web. The whole process should take no more than about 10 to 15 seconds, depending on the computer's speed itself and baring any issues of slowness.

* [What is ISDN Internet Service?](http://whatismyipaddress.com/isdn)

# What is ISDN?

ntegrated Service Digital Network, or ISDN, is the original high-speed internet service. It sparked the high-speed internet development between service providers during the 1990's and, of course, revolutionized internet use. Much like its predecessor, the dial-up internet service, ISDN utilizes a phone line. In fact, it set the standard for telephone data service.

ISDN internet service was the improvement upon dial-up, and it also paved the way for DSL and cable-modem internet service thereafter. It can be considered the step of internet evolution that lies between dial-up and DSL/Cable. Modernizing internet use and bringing high-speed access inside the home, ISDN became the standard by which rival broadband internet service providers competed. Although ISDN internet service still exists, like the dial-up connection it is being replaced by faster and cheaper services that the broadband companies are providing. Regardless, broadband high-speed internet service is still compared with ISDN today since they both represent the standard of their times.

ISDN internet service is basically a telephone-based network system that operates by a circuit switch, or dedicated line. It can transmit data and phone conversations digitally over normal telephone wires. This makes it both faster and of higher quality than dial-up internet service. During the 1990's this revolutionized the way people did business. No longer would you have to miss a call in order to access your internet, or shut down the internet to make a telephone call. As such, ISDN internet service made video teleconferencing not only possible, but very popular at this time as well.

There are two different types, or lines, of ISDN internet service. The first is a basic rate ISDN line. Called a Basic Rate Interface (BRI), this line has two data, or bearer, channels that operate at 64 kbit/sec. Two or more ISDN-BRI lines can be combined as well, yielding speeds of 256 kbit/sec. Combining these lines is common for video conferencing use or for transmitting data at higher speeds. The second type of ISDN line is called a primary rate line, or Primary Rate Interface (PRI). This line had 23 bearer channels and has a total speed of 1,544 kbit/sec. It is used mostly for telephone communication rather than data transmission, particularly within companies that have large, private telephone exchange systems operating inside their business.

The advantages of having ISDN internet service definitely lies in the data lines themselves. Not only do you have constant data speed via these lines, each bearer channel runs at 64 kbit/sec with the ability to be combined to reach greater speeds. ISDN internet serviced also allows for multiple data transmission, so telephone calls and data downloading are no longer mutually exclusive. The disadvantages, however, is that the digital clarity of ISDN voice communication and its speedy data transmission come at an extra cost. ISDN is billed like a phone line, but with an added cost for service. And although its operational distance from the ISDN central office is greater than that for DSL, its terminal adaptor (similar to a modem) is more expensive than DSL or cable modems. While this equipment and service continue to remain costly, it is leaving the way open for other internet services, like broadband, to quickly replace ISDN's share of the marketplace.

# What is Wireless Internet Service?

Broadband internet service is a form of high speed internet access. In fact, the name "broadband" has come to be synonymous with high speed internet use in general. Since speed is measured by bit rate, the number of bits processed per unit of time, broadband internet service is defined as being 256 kbit/s (kilobits per second) or faster. Broadband typically downloads at a much faster speed than that, however. As a result, broadband internet service is categorized into two different connection groups: Tier 1 (T1) broadband connections range from 1.544 Mbit/s to 2.048 Mbit/s, and Tier 3 (T3) broadband connections range from 44.736 Mbit/s to 159.2 Gbit/s. With these rates of data transmission, broadband represents an evolution from the original high speed internet service, Integrated Services Digital Network (ISDN), and is by far a significant improvement upon the original internet service, dial-up.

The latest development in broadband internet service is the incorporation of wireless capabilities. Wireless broadband internet service is exactly what the name implies: it is your high speed internet access without cables or wires. The versatility of wireless internet, and its potential for increasing productivity by users, has consumers demanding the service at an increasing rate. They want it in their home, at their office, even at their local coffee shop or bistro. Hence the development of wireless broadband internet service: it is a packaged internet service deal that provides the ability to access the internet wirelessly from any location within the service's coverage area.

## Wireless Broadband Network

A term you may recognize in association with wireless broadband internet service includes wireless network. A wireless network is a single broadband internet arrangement established for your home or office. It requires several pieces of equipment that are all one-time cost items: a wireless transceiver, such as a wireless card or antenna, and a wireless router. In addition, you will have to purchase the broadband service, which is a continual expense. You cannot utilize your wireless broadband tools without an ongoing broadband service. Together, the wireless devices and the broadband internet service make up your wireless broadband network. When employed, the network will send data to your broadband internet connection via these wireless tools that utilize a special wireless technology (known as Wi-Fi). As a result you will be able to access the internet from anywhere inside the coverage area, as determined by the location of your wireless router.

## Wireless Broadband Service

Wireless broadband internet service is growing in popularity for locations outside the home or office as well. When considering broadband, another term you may recognize is wireless internet service. Although often used interchangeably with wireless network, the two do not mean the same thing. Wireless broadband internet service generally refers to a package deal that combines both the wireless technology and broadband service, and to which you can subscribe to. It differs from the wireless network in two ways: 1) it includes both technology and service, whereas having a wireless network necessitates your having to buy both, and 2) it is generally used in larger locations outside the home or office, such as the downtown area of a city or a college campus.

Areas that provide wireless broadband internet service are known as hotspots. Starbucks Coffee and Borders Books are two common retailers that feature internet hotspots. Downtown areas in larger cities and major airports are two common public areas that also feature internet hotspots. They all provide wireless broadband internet service. The service is mostly utilized by laptop computers and handheld devices that are "wireless ready", meaning they are capable of connecting to the internet via internal or external wireless devices or cards. However, they require a paid subscription to the broadband service intended especially for this wireless use.

## Wireless Broadband Mobile

Wireless internet connectivity in cell phones is growing in popularity as well. Cell phones, and other devices featuring windows mobile applications, are now all being designed with advanced wireless technology. This allows them the ability to connect to a wireless broadband internet service, or to the internet via their own cellular phone network. EDGE and EVDO are two of the more popular next-generation mobile system technologies utilized by cellular phone developers.

**EDGE** (Enhanced Data rates for GSM Evolution) was introduced into the North American via GSM (Global Systems Mobile) networks in 2003 and is now available worldwide. EDGE increases data transmission rates and improves transmission reliability in mobile devices that use it. More importantly, it allows the mobile device to connect to the Internet wirelessly, but its download speed is significantly slower than other mobile wireless technologies. EDGE transmits data at approximately 236.8 kbit/s, which is below the standard for a broadband connection. However, its theoretical maximum speed is 473.6 kbit/s, so it still considered a wireless broadband technology.

**EVDO** (Evolution-Data Optimized) is significantly faster than EDGE. It transmits data via radio signals, and for this reason is classified as a wireless broadband technology. It is employed in mobile devices around the world via CDMA (Code Division Multiple Access) networks: cellular networks that achieve high data transmission speeds and support a vast number of users.

**WiMAX** is an emerging wireless broadband technology whose download speeds are approximately 10 mbit/s. It is expected to be within the 40 mbit/s range by next year. There is currently only one major WiMAX provider due to the fact that it must be run on it own network: it cannot utilize GSM or CDMA networks as EDGE and EVDO do. However there are plans for widespread WiMax commercial deployment by 2010, and will be marketed as a significantly advanced wireless alternative to Cable and DSL internet services.

**LTE** (Long-Term Evolution) is a high-speed wireless communication technology used for cell phones and mobile data devices such as tablets. LTE is designed to allow up to 300 Mbps download and up to 75 Mbps upload with latency as low a 5ms. LTE works on multiple frequency bands often varying by country.

## ISDN: Integrated Services Digital Network.

## ISDN: Integrated Services Digital Network.

ISDN is basically a telephone line made of copper wiring that provides extremely fast data transmissions. There are two types of ISDN: B-channel and D-channel.

B-channel is used for the transfer of data, video, voice or any other multimedia. It runs at 64 kbps (kilobytes per second). D-channel ISDN runs at 16 kbps or at 64 kbps, depending on how you set it up. The D-channel is used primarily to switch your equipment in the ISDN network and the equipment at your ISDN site. Depending on the size of the corporation, the ISDN network can slow down a bit when more people are on the network downloading video, music or applications. Corporations also use this kind of connection for their video conferencing and for remote access to their computer networks.

## T1 lines.

Corporations will also use "T1" technology to obtain fast Internet speeds for their businesses. A T1 line can carry 24 digitized voice channels and a data rate of 1.544 megabits per second, as well as carry about 60 times the amount of data per second that the typical home modem can.

The typical cost of a T1 line can be more than 10 times the cost of home Internet service, depending on the service provider. To the average person, that may sound like a lot for Internet service, but businesses don't give it a second thought. Not only are they already used to paying more for most business versions of everything—they HAVE to have a fast and reliable Internet connection for their company to run efficiently.

The truth is that even a medium-size company needs more speed than that, so there are options beyond T1.

A T3 connection delivers a much faster Internet connection for companies. A T3 line can transmit 43.23 megabits per second, which is the equivalent of 28 T1s.

## Optical carrier.

A lot of companies looking for an even faster connection turn to a technology called OC1. The "OC" stands for optical carrier, because it uses fiber optics instead of copper telephone wiring. The number describes how many multiples of 51.84 mbs (megabits per second) it can carry. The speed of OC1 technology is not so much faster than a T3, but one advantage is that it gets you close to OC3 speeds. OC3 delivers 155.52 mbs.

For large companies that require even more speed, OC12 is optimal—for its speed, signal strength and reliability.

Of course, the faster you want to go, the more you have to be willing to pay. As with anything else in business, to get more services that allow you to do more, the more you have to be willing to pay for them. But generally, that's better for your business, allowing you to be more efficient and, hopefully, more successful.

# What is DHCP?

As long as you're learning about your IP address, you should learn a little about something called DHCP—which stands for Dynamic Host Configuration Protocol. Why bother? Because it has a direct impact on millions of IP addresses, most likely including yours.

DHCP is at the heart of assigning you (and everyone) their IP address. The key word in DHCP is protocol—the guiding rules and process for Internet connections for everyone, everywhere. DHCP is consistent, accurate and works the same for every computer. Remember that without an IP address, you would not be able to receive the information you requested. As you've learned (by reading IP: 101), your IP address tells the Internet to send the information that you requested (Web page, email, data, etc.) right to the computer that requested it.

## Those incredible protocols

There are more than one billion computers in the world, and each individual computer needs its own IP address whenever it's online. The TCP/IP protocols (our computers' built-in, internal networking software) include a DHCP protocol. It automatically assigns and keeps tabs of IP addresses and any "subnetworks" that require them. Nearly all IP addresses are dynamic, as opposed to "static" IP addresses that never change.

DHCP is a part of the "application layer," which is just one of the several TCP/IP protocols. All of the processing and figuring out of what to send to whom happens virtually instantly.

## Clients and servers

The networking world classifies computers into two distinctive categories: 1) individual computers, called "hosts," and 2) computers that help process and send data (called "servers"). A DHCP server is one computer on the network that has a number of IP address at its disposal to assign to the computers/hosts on that network. If you use a cable company for Internet access, making them your Internet Service Provider, they likely are your DHCP server.

## Permission slips

Think of getting an IP address as similar to obtaining a special permission slip from the DHCP server to use the Internet. In this scenario, you are the DHCP client—whenever you want to go on the Internet, your computer automatically requests an IP address from the network's DHCP server. If there's one available, the DHCP server sends a response containing an IP address to your computer.

## How DHCP works

The key word in DHCP is "dynamic." Because instead of having just one fixed and specific IP address, most computers will be assigned one that is available from a subnet or "pool" that is assigned to the network. The Internet isn't one big computer in one big location. It's an interconnected network of networks, all created to make one-on-one connections between any two clients that want to exchange information.

One of the features of DHCP is that it provides IP addresses that "expire." When DHCP assigns an IP address, it actually leases that connection identifier to the user's computer for a specific amount of time. The default lease is five days.

Here is how the DHCP process works when you go online:

1. Your go on your computer to connect to the Internet.
2. The network requests an IP address (this is actually referred to as a DHCP discover message).
3. On behalf of your computer's request, the DHCP server allocates (leases) to your computer an IP address. This is referred to as the DHCP offer message.
4. Your computer (remember—you're the DHCP client) takes the first IP address offer that comes along. It then responds with a DHCP request message that verifies the IP address that's been offered and accepted.
5. DHCP then updates the appropriate network servers with the IP address and other configuration information for your computer.
6. Your computer (or whatever network device you're using) accepts the IP address for the lease term.

Typically, a DHCP server renews your lease automatically, without you (or even a network administrator) having to do anything. However, if that IP address's lease expires, you'll be assigned a new IP address using the same DHCP protocols.

Here's the best part: You wouldn't even be aware of it, unless you happened to check your IP address. Your Internet usage would continue as before. DHCP takes place rather instantly, and entirely behind the scenes. We, as everyday, ordinary computer users, never have to think twice about it. We just get to enjoy this amazing and instantaneous technology that brings the Internet to our fingertips when we open our browsers. I guess you could say DHCP stands for "darn handy computer process"...or something like that.

# Dynamic IP vs Static IP

Static IP address versus Dynamic: Should It Matter to You?

When you sign up with an Internet Service Provider you will either end up with a static IP address or a dynamic IP address, depending on the nature of your account. In this article, you'll learn the difference between the two.

But also, you'll find out what type of IP address you have, why you have it and how it works. And if you decide you'd rather switch sides, for reasons you'll learn about here, you can look into making that change.

## IP address basics.

But first, a quick review. An IP address (the IPv4 version, which is the most common) consists of a string of numbers, separated by periods (dots). Each IP address is separated into four segments by three periods. Here's an example: 10.48.29.12

You can learn more about IP addresses in our the [Learning Center](http://whatismyipaddress.com/learning/ip-addresses).

If you're connected to the Internet, your computer will show an IP addresses...the one that identifies the computer you're using at that moment. (NOTE: it identifies only the computer, not the computer user.)

Haven't you ever marveled how the Internet knows how to get information directly to your computer? It's not magic: your IP address is the key (along with many other factors).

For the purposes of this article, we'll put you at home on your computer and talk about the IP address you likely use most often.

So here's the question: Is the IP address you use at home static or dynamic?

## It's pretty simple, actually.

Static. Stand. Stable. Yes, static IP addresses don't change.

The prefix dyna means "power": however, dynamic IP addresses aren't more powerful, but they do have the power to change (or be changed).

Most IP addresses assigned today by Internet Service Providers to customers are dynamic IP addresses. It's more cost effective for the ISP and you.

## You feeling dynamic?

You can go to our home page—whatismyIPaddress.com—then click on "Learn More About This IP," which is at the bottom of the map you'll see.

You'll be taken to a page that has details on your active IP address, including whether it's static or dynamic! Cool!

## Is your IP address static?

If your IP address at home is static, it means that it will remain the same every time you connect...from home.

Just keep in mind that an IP address doesn't travel with you. If you took your laptop to a coffee shop and used their wireless network, that IP address would be different.

But at home, it would always be the same if it's the static type.

Generally, a static IP address is assigned by request and for a fee by an IT administrator at work, or by you at home. Here are the advantages of a static IP address:

* Businesses are better suited for it than residences.
* It's also better for dedicated services such as mail, FTP and VPN servers.
* It's good for creating or hosting computer servers.
* It makes it easier for geolocation services to accurately assess where you are.

Because of these advantages, it shouldn't be a surprise to learn that it costs more to get one.

Also, it takes some good technical skills to set it up. And remember, if for some reason you wanted a different IP address at home, you wouldn't be able to get one—although there are ways to "mask" any IP address using a Virtual Private Network (VPN).

## Is your IP address dynamic?

You'll read most everywhere that a dynamic IP address can change "at any time." True, but not likely. The fact is, even if you have a dynamic IP address it's possible that it won't change for months on end.

And if it does, it's not really a big deal. Why? Because ultimately all an IP address does is keep you connected. There are a few more reasons you can feel good about a dynamic IP address:

* It doesn't cost you anything extra.
* It's carefree, automatic and reliable with little work on your end.
* Geolocation might be less accurate, if that matters to you.
* For your ISP, it's the most efficient use of IP addresses.

The "dynamic" part comes from something called DHCP, or Dynamic Host Control Protocol. It all happens in the background. Technically, your computer or device "leases" (at no extra charge) an IP address to get connected.

Is there a drawback? It's possible that your upload and download speeds would be faster if you had a static IP address, but you'll likely get used to the service and speeds you get. Besides, you could possibly increase your speed with a plan upgrade.

Also, you couldn't set up a reliable server with a changeable IP address. But most of us don't care about that.

## Change isn't always bad.

As you can see, a dynamic IP address is the "standard" for most Internet connections. Static IP addresses are requested by people who want more control and say in their connection, and more capabilities with it.

Chances are that's not you. If you're not planning to host websites or setup servers, your reliable and sometimes changing dynamic IP address should be just fine.

# Why Does Your IP Address Change Now and Then?

For most of us who are everyday computer users, our IP addresses are provided by an Internet Service Provider (ISP), typically a cable company such as Cox Communications, Time-Warner Cable or a phone company such as AT&T. Once you set up an account with an ISP, they will automatically assign you a unique IP address.

The ISP will likely have to visit your home to install your connection, and then you'll be ready to hook up your computer and modem to their network to go on the Internet. You'll know that everything's working once you open an Internet browser to do a search on Google or to send an email—and everything works just fine. If it doesn't work at first, you might have to work with your ISP's technical department to get everything straightened out.

Luckily for most of us, all of this technical stuff happens in the background. That is, technology is so sophisticated these days, it doesn't take too long to get everything working, and it doesn't take too much effort on our part. Your computer's networking hardware, your modem and the entire TCP/IP networking software built into your computer sorts it all out. It's almost "plug and play."

## About "your" IP address.

And one of the first things you might do with a new connection is to see what your new IP address is. Make a note of the IP address—but don't get too attached because most likely, your ISP is called a dynamic IP address, which means it's subject to change on you. (Not that it will, but it can.) If it weren't a dynamic IP address, it would be referred to as a staticIP address...unchanging.

## So, why the need for change?

It's strictly a matter of numbers. There are millions and millions of computer users everywhere around the world and they are connected to the Internet at any one time. Some people are on the Internet often, others only now and then and sometimes for just a few minutes to send an email.

As mentioned earlier, everyone who is online needs a unique IP address. Assigning a permanent, static IP to every ISP subscriber would have been very expensive, when you take into account all the logistics involved. And with the current generation of IP addresses (technically called IPv4), the number of static IP address would have run out fairly quickly.

So the Internet world introduced the concept of dynamic IP addresses. That allowed ISPs to provide their subscribers an IP address that might change if needed. In essence, that IP address is borrowed or "leased" to you whenever you go online.

That also allowed static IP addresses to be reserved for businesses and other entities with large networks that didn't want the hassle of tracking different IP addresses for their companies. (The IT departments can distinguish the computers on their network in other ways.)

Most of the time, you'll find that your IP address doesn't change...even though technically it is classified as a dynamic IP address. For instance, as I write this article, my dynamic IP address hasn't changed over the past three months. But there was an occasion when it did—when I switched routers.

Dynamic IP addresses make it easier for your ISP if you're an ordinary computer user. If you decide to move across town, you can still keep your ISP, and they don't have to go through the hassle and account work of rerouting your "permanent"/static IP address. Instead, you're simply automatically assigned a dynamic IP address that's available when you move.

## A final word: Wi-Fi.

Finally, remember that every time you use a laptop computer on a Wi-Fi (wireless) network, you're switching IP addresses. You'll be using the IP address of whatever network you're on.

That's because the IP address of "your" computer doesn't belong to your computer—it belongs to the network you're connected to. Your computer is just borrowing it for a while.

That's why you'd have a different IP address at a coffee shop than the IP address you'd have at a hotel on the corner. Different networks, different IP addresses.

And that's why you shouldn't get too attached to your IP address.

# What is Network Address Translation?

Network Address Translation (NAT) is the process where a network device, usually a firewall, assigns a public address to a computer (or group of computers) inside a private network. The main use of NAT is to limit the number of public IP addresses an organization or company must use, for both economy and security purposes.

The most common form of network translation involves a large private network using addresses in a private range (10.0.0.0 to 10.255.255.255, 172.16.0.0 to 172.31.255.255, or 192.168.0 0 to 192.168.255.255). The private addressing scheme works well for computers that only have to access resources inside the network, like workstations needing access to file servers and printers. Routers inside the private network can route traffic between private addresses with no trouble. However, to access resources outside the network, like the Internet, these computers have to have a public address in order for responses to their requests to return to them. This is where NAT comes into play.

Internet requests that require Network Address Translation (NAT) are quite complex but happen so rapidly that the end user rarely knows it has occurred. A workstation inside a network makes a request to a computer on the Internet. Routers within the network recognize that the request is not for a resource inside the network, so they send the request to the firewall. The firewall sees the request from the computer with the internal IP. It then makes the same request to the Internet using its own public address, and returns the response from the Internet resource to the computer inside the private network. From the perspective of the resource on the Internet, it is sending information to the address of the firewall. From the perspective of the workstation, it appears that communication is directly with the site on the Internet. When NAT is used in this way, all users inside the private network access the Internet have the same public IP address when they use the Internet. That means only one public addresses is needed for hundreds or even thousands of users.

Most modern firewalls are stateful - that is, they are able to set up the connection between the internal workstation and the Internet resource. They can keep track of the details of the connection, like ports, packet order, and the IP addresses involved. This is called keeping track of the state of the connection. In this way, they are able to keep track of the session composed of communication between the workstation and the firewall, and the firewall with the Internet. When the session ends, the firewall discards all of the information about the connection.

There are other uses for Network Address Translation (NAT) beyond simply allowing workstations with internal IP addresses to access the Internet. In large networks, some servers may act as Web servers and require access from the Internet. These servers are assigned public IP addresses on the firewall, allowing the public to access the servers only through that IP address. However, as an additional layer of security, the firewall acts as the intermediary between the outside world and the protected internal network. Additional rules can be added, including which ports can be accessed at that IP address. Using NAT in this way allows network engineers to more efficiently route internal network traffic to the same resources, and allow access to more ports, while restricting access at the firewall. It also allows detailed logging of communications between the network and the outside world.

Additionally, NAT can be used to allow selective access to the outside of the network, too. Workstations or other computers requiring special access outside the network can be assigned specific external IPs using NAT, allowing them to communicate with computers and applications that require a unique public IP address. Again, the firewall acts as the intermediary, and can control the session in both directions, restricting port access and protocols.

NAT is a very important aspect of firewall security. It conserves the number of public addresses used within an organization, and it allows for stricter control of access to resources on both sides of the firewall.

# What is VPN?

A Virtual Private Network (VPN) is a network technology that creates a secure network connection over a public network such as the Internet or a private network owned by a service provider. Large corporations, educational institutions, and government agencies use VPN technology to enable remote users to securely connect to a private network.

A VPN can connect multiple sites over a large distance just like a Wide Area Network (WAN). VPNs are often used to extend intranets worldwide to disseminate information and news to a wide user base. Educational institutions use VPNs to connect campuses that can be distributed across the country or around the world.

In order to gain access to the private network, a user must be authenticated using a unique identification and a password. An authentication token is often used to gain access to a private network through a personal identification number (PIN) that a user must enter. The PIN is a unique authentication code that changes according to a specific frequency, usually every 30 seconds or so.

## Protocols

There are a number of VPN protocols in use that secure the transport of data traffic over a public network infrastructure. Each protocol varies slightly in the way that data is kept secure.

**IP security** (IPSec) is used to secure communications over the Internet. IPSec traffic can use either transport mode or tunneling to encrypt data traffic in a VPN. The difference between the two modes is that transport mode encrypts only the message within the data packet (also known as the payload) while tunneling encrypts the entire data packet. IPSec is often referred to as a "security overlay" because of its use as a security layer for other protocols.

**Secure Sockets Layer** (SSL) and **Transport Layer Security** (TLS) use cryptography to secure communications over the Internet. Both protocols use a "handshake" method of authentication that involves a negotiation of network parameters between the client and server machines. To successfully initiate a connection, an authentication process involving certificates is used. Certificates are cryptographic keys that are stored on both the server and client.

**Point-To-Point Tunneling Protocol** (PPTP) is another tunneling protocol used to connect a remote client to a private server over the Internet. PPTP is one of the most widely used VPN protocols because of it's straightforward configuration and maintenance and also because it is included with the Windows operating system.

**Layer 2 Tunneling Protocol** (L2TP) is a protocol used to tunnel data communications traffic between two sites over the Internet. L2TP is often used in tandem with IPSec (which acts as a security layer) to secure the transfer of L2TP data packets over the Internet. Unlike PPTP, a VPN implementation using L2TP/IPSec requires a shared key or the use of certificates.

VPN technology employs sophisticated encryption to ensure security and prevent any unintentional interception of data between private sites. All traffic over a VPN is encrypted using algorithms to secure data integrity and privacy. VPN architecture is governed by a strict set of rules and standards to ensure a private communication channel between sites. Corporate network administrators are responsible for deciding the scope of a VPN, implementing and deploying a VPN, and ongoing monitoring of network traffic across the network firewall. A VPN requires administrators to be continually be aware of the overall architecture and scope of the VPN to ensure communications are kept private.

## Advantages & Disadvantages

A VPN is a inexpensive effective way of building a private network. The use of the Internet as the main communications channel between sites is a cost effective alternative to expensive leased private lines. The costs to a corporation include the network authentication hardware and software used to authenticate users and any additional mechanisms such as authentication tokens or other secure devices. The relative ease, speed, and flexibility of VPN provisioning in comparison to leased lines makes VPNs an ideal choice for corporations who require flexibility. For example, a company can adjust the number of sites in the VPN according to changing requirements.

There are several potential disadvantages with VPN use. The lack of Quality of Service (QoS) management over the Internet can cause packet loss and other performance issues. Adverse network conditions that occur outside of the private network is beyond the control of the VPN administrator. For this reason, many large corporations pay for the use of trusted VPNs that use a private network to guarantee QoS. Vendor interoperability is another potential disadvantage as VPN technologies from one vendor may not be compatible with VPN technologies from another vendor. Neither of these disadvantages have prevented the widespread acceptance and deployment of VPN technology.

# What is a Proxy Server?

A proxy server is a computer that offers a computer network service to allow clients to make indirect network connections to other network services. A client connects to the proxy server, then requests a connection, file, or other resource available on a different server. The proxy provides the resource either by connecting to the specified server or by serving it from a cache. In some cases, the proxy may alter the client's request or the server's response for various purposes.

## Web proxies

A common proxy application is a caching Web proxy. This provides a nearby cache of Web pages and files available on remote Web servers, allowing local network clients to access them more quickly or reliably.

When it receives a request for a Web resource (specified by a URL), a caching proxy looks for the resulting URL in its local cache. If found, it returns the document immediately. Otherwise it fetches it from the remote server, returns it to the requester and saves a copy in the cache. The cache usually uses an expiry algorithm to remove documents from the cache, according to their age, size, and access history. Two simple cache algorithms are Least Recently Used (LRU) and Least Frequently Used (LFU). LRU removes the least-recently used documents, and LFU removes the least-frequently used documents.

Web proxies can also filter the content of Web pages served. Some censorware applications - which attempt to block offensive Web content - are implemented as Web proxies. Other web proxies reformat web pages for a specific purpose or audience; for example, Skweezer reformats web pages for cell phones and PDAs. Network operators can also deploy proxies to intercept computer viruses and other hostile content served from remote Web pages.

A special case of web proxies are "CGI proxies." These are web sites which allow a user to access a site through them. They generally use PHP or CGI to implement the proxying functionality. CGI proxies are frequently used to gain access to web sites blocked by corporate or school proxies. Since they also hide the user's own IP address from the web sites they access through the proxy, they are sometimes also used to gain a degree of anonymity.

You may see references to four different types of proxy servers:

### Transparent Proxy

This type of proxy server identifies itself as a proxy server and also makes the original IP address available through the http headers. These are generally used for their ability to cache websites and do not effectively provide any anonymity to those who use them. However, the use of a transparent proxy will get you around simple IP bans. They are transparent in the terms that your IP address is exposed, not transparent in the terms that you do not know that you are using it (your system is not specifically configured to use it.)

### Anonymous Proxy

This type of proxy server identifies itself as a proxy server, but does not make the original IP address available. This type of proxy server is detectable, but provides reasonable anonymity for most users.

### Distorting Proxy

This type of proxy server identifies itself as a proxy server, but make an incorrect original IP address available through the http headers.

### High Anonymity Proxy

This type of proxy server does not identify itself as a proxy server and does not make available the original IP address.

# Can You Be Tracked Down Just by Your IP Address?

It's probably the number one concern most of us have about our IP address: Can somebody track me down just by knowing my IP address? After all, the IP address that first pops up whenever you go to "WhatIsMyIPAddress.com" is actually linked directly to the computer you're using.

With privacy and spying so much in the news, it's no wonder so many of us are asking that question.

So what is the answer? It varies, depending on a lot of circumstances, but in general, the answer to the big question is...probably not.

In other words, the most information that the average curious person can find out about you with only your IP address (and nothing else) is what region, city and town you are in when you're on the Internet. They won't know anything about you (such as your name, etc.) or the computer you're using.

And actually, what they'll find out isn't really about YOU, more than it is about your online connection. That is, it doesn't know WHO is using a certain IP address—they can only find out, in general, where that computer is.

**Go to our Home Page right now and you'll see what your IP address says about your location, in real time (meaning "right now").**

If you're in your home or apartment, it might show a location several miles away, or even 25 miles away.

But if you're in a coffee shop or airport, it won't show your home address—it will show the general area of your location. And again, these "geo-locaters" can only guess at where you are while you're linked to some network that is linked to the Internet.

## But can you be tracked?

However, if an online computer user were doing something illegal (according to the laws in place), an agency might seek legal permission to contact the Internet Service Provider for information. With a subpoena in hand, they could ask the ISP to provide the online account holder's name and address. (Again, that would identify the person who pays the Internet service monthly bill, but not every individual who might have access to that account.)

But for 99% of us, that's an extreme case.

## Staying safe online.

You have to admit one thing, though—it is a little unnerving to realize that someone who has your IP address (or captured it at one time) has a pretty good idea of the region or city you live in. It can feel somewhat intrusive.

But keep in mind that it's not as if our names and addresses are listed in some public Internet phone book that's handed out.

In fact, the Internet is very anonymous in many ways. Most of the time, you give away your identity by establishing relationships, business and personal, online.

So, if you don't want someone zeroing in on your IP address, make it a habit not to be so quick to give up your name and address online, especially to people or companies you don't know very well.

Most people on the Internet are fair and honest, but there are plenty of others who aren't. Be smart online, just the way you are (we hope) in everyday life. Don't trust anybody with personal information until you know them well enough to trust them.

See [your IP address information](http://whatismyipaddress.com/).  
Try using [this tool](http://whatismyipaddress.com/ip-lookup) to look up any IP address.

# What is Wi-Fi?

First, let's get a couple of points out of the way: Wi-Fi, which rhymes with the outdated term "hi-fi," has nothing in common with its soundalike. Hi-fi stood for "high-fidelity" and was used to describe a phonograph/radio system with excellent sound.

Wi-Fi, by comparison, does not stand for "wireless fidelity" and has nothing to do with sound. In fact, it really doesn't stand for anything! It simply represents wireless networking technology that allows you to go on the Internet without having to plug in any cables.

There's an organization called the Wi-Fi Alliance that actually owns the Wi-Fi trademark and controls or dictates the technology behind it.

Wi-Fi is everywhere these days, from people's homes to airports, hotels, libraries and just about every other place where people use their computers or wireless devices (laptops, smartphones and iPads/tablets).

Here are the main advantages of setting up a wireless network in your home:

* You can "connect" any and every computer in your home to your network without having to string cables/wires throughout the house.
* That means you can go on the Internet in any room from a laptop, desktop or smartphone.
* You can set up an access password that allows a visitor to log in to your network and will keep others from logging in without your permission...or knowledge.
* All it takes is a small, affordable piece of hardware called a "router" and some time to get things working.

Some well-known brands of routers are Belkin, Linksys and Netgear. You'll find plenty of information on routers online.

The good news is, you can set up a wireless network in your home pretty easily and quickly these days. It starts with your computer and grows from there. Here are some of the things you should know as you start your own network:

**Start with your main computer:** A wireless network needs to be set up. That's right: Even though your network will eventually be "wireless," to set it up you'll need to use your existing physical connection to the Internet.

A router comes with special software that has to be loaded on your computer. The software sets up the connection needed between your computer, modem and Internet Service Provider&emdash;and once everything is ready to go, you'll be able to invite and allow others devices to join your wireless network.

**Safety and security.** The wireless network broadcasts over a small area, but it has no boundaries. A next-door neighbor could easily be aware of your wireless network. That is, anyone close by with a wireless-enabled device might be able to see that a wireless network is nearby. However, without the password you create, they will not be able to access it or use it.

There are also security settings (which come with the router software) that will prevent hackers from intercepting your signal.

Wireless with wires. One more thing: Your "wireless" router has couple of wires, at least two. One is the electrical cord for power; the other is a cable (typically an Ethernet cable) with a connector that looks like a large telephone jack and that plugs into your modem. (If your router is a modem too, it will connect to your computer.)

That may sound funny, but the "wireless" feature has to do with the devices that will be able to connect wirelessly with the router.

**Modem:** You probably have a modem now&emdash;it's an important part of a wireless network. You need your modem to connect your computer to the Internet, and you'll still need it because your router works with your modem (or, you'll be replacing your modem with a device that is both a modem AND router).

A "wireless" router. Just as a mailman delivers mail to different addresses on your street, the router, once it's set up, will deliver an Internet connection (back and forth) for any computer or device with "wireless" capability.

**Generation gap.** Most electronic/computer stores carry a selection of routers. As with other technologies (cell phones, computers), routers have gone through several "generations" of development. As of 2013, most stores advertised "wireless-N" routers as the most common generation, with "wireless-ac" advertised as the "next" generation. (Before "N" came Wireless-G and Wireless-B.) As you might guess, the new generation tends to be better and, in this case, faster.

You'll also see routers that come with the designation "2.4 GHz" and/or "5 GHz" (gigahertz), which are the radio wave signals a router emits. What? Radio waves? Yes! That's how the signal is sent throughout your house and received by compatible wireless devices. If a router is both 2.4 and 5 GHz, it will be called a "dual band" router.

As with anything else related to technology, it helps to do some research and ask plenty of questions of salespeople and people you know. With the wireless network fundamentals you just read about, you should be able find the wireless system that will work best for you.

# Systems development life cycle

# The systems development life cycle (SDLC), also referred to as the application development life-cycle, is a term used in [systems engineering](https://en.wikipedia.org/wiki/Systems_engineering), [information systems](https://en.wikipedia.org/wiki/Information_system) and [software engineering](https://en.wikipedia.org/wiki/Software_engineering) to describe a process for planning, creating, testing, and deploying an information system.[[1]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-1) The systems development life-cycle concept applies to a range of hardware and software configurations, as a system can be composed of hardware only, software only, or a combination of both.[[2]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-2)

# https://upload.wikimedia.org/wikipedia/commons/thumb/7/7e/SDLC-Maintenance-Highlighted.png/240px-SDLC-Maintenance-Highlighted.png

## **Phases[**[**edit**](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit&section=3)**]**

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| https://upload.wikimedia.org/wikipedia/en/thumb/f/f2/Edit-clear.svg/40px-Edit-clear.svg.png | This article may **require**[**cleanup**](https://en.wikipedia.org/wiki/Wikipedia:Cleanup) to meet Wikipedia's [quality standards](https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style). The specific problem is: parts of this section appear to be unfinished and half-written/typed Please help [improve this article](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit) if you can. *(July 2015)* *(*[*Learn how and when to remove this template message*](https://en.wikipedia.org/wiki/Help:Maintenance_template_removal)*)* |

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| [https://upload.wikimedia.org/wikipedia/en/thumb/9/99/Question_book-new.svg/50px-Question_book-new.svg.png](https://en.wikipedia.org/wiki/File:Question_book-new.svg) | This section **needs additional citations for**[**verification**](https://en.wikipedia.org/wiki/Wikipedia:Verifiability). Please help [improve this article](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit) by [adding citations to reliable sources](https://en.wikipedia.org/wiki/Help:Introduction_to_referencing_with_Wiki_Markup/1). Unsourced material may be challenged and removed. *(September 2010)* *(*[*Learn how and when to remove this template message*](https://en.wikipedia.org/wiki/Help:Maintenance_template_removal)*)* |

The system development life cycle framework provides a sequence of activities for system designers and developers to follow. It consists of a set of steps or phases in which each phase of the SDLC uses the results of the previous one.

The SDLC adheres to important phases that are essential for developers, such as [planning](https://en.wikipedia.org/wiki/Planning), [analysis](https://en.wikipedia.org/wiki/Analysis), [design](https://en.wikipedia.org/wiki/Design), and [implementation](https://en.wikipedia.org/wiki/Implementation), and are explained in the section below. It includes evaluation of present system, information gathering, feasibility study and request approval. A number of SDLC models have been created: waterfall, fountain, spiral, build and fix, rapid prototyping, incremental, synchronize and stabilize. The oldest of these, and the best known, is the waterfall model: a sequence of stages in which the output of each stage becomes the input for the next. These stages can be characterized and divided up in different ways, including the following:[[7]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-7)

* **Preliminary analysis**: The objective of phase 1 is to conduct a preliminary analysis, propose alternative solutions, describe costs and benefits and submit a preliminary plan with recommendations.

Conduct the preliminary analysis: in this step, you need to find out the organization's objectives and the nature and scope of the problem under study. Even if a problem refers only to a small segment of the organization itself, you need to find out what the objectives of the organization itself are. Then you need to see how the problem being studied fits in with them.

Propose alternative solutions: In digging into the organization's objectives and specific problems, you may have already covered some solutions. Alternate proposals may come from interviewing employees, clients, suppliers, and/or consultants. You can also study what competitors are doing. With this data, you will have three choices: leave the system as is, improve it, or develop a new system.

Describe the costs and benefits.

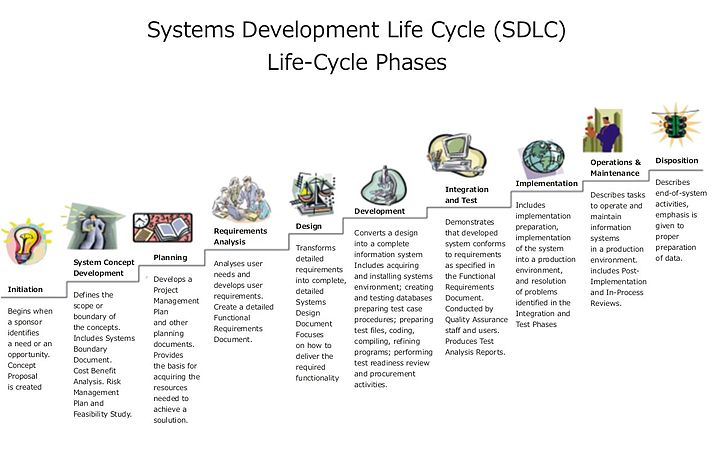
* **Systems analysis, requirements definition**: Defines project goals into defined functions and operation of the intended application. It is the process of gathering and interpreting facts, diagnosing problems and recommending improvements to the system. Analyzes end-user information needs and also removes any inconsistencies and incompleteness in these requirements.

A series of steps followed by the developer are:[[8]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-8)

1. Collection of Facts: End user requirements are obtained through documentation, client interviews, observation and questionnaires,
2. Scrutiny of the existing system: Identify pros and cons of the current system in-place, so as to carry forward the pros and avoid the cons in the new system.
3. Analyzing the proposed system: Solutions to the shortcomings in step two are found and any specific user proposals are used to prepare the specifications.

* **Systems design**: Describes desired features and operations in detail, including screen layouts, [business rules](https://en.wikipedia.org/wiki/Business_rule), [process diagrams](https://en.wikipedia.org/wiki/Process_Diagram), [pseudocode](https://en.wikipedia.org/wiki/Pseudocode) and other documentation.
* **Development**: The real code is written here.
* **Integration and testing**: Brings all the pieces together into a special testing environment, then checks for errors, bugs and interoperability.
* **Acceptance, installation, deployment**: The final stage of initial development, where the software is put into production and runs actual business.
* **Maintenance**: During the maintenance stage of the SDLC, the system is assessed to ensure it does not become obsolete. This is also where changes are made to initial software. It involves continuous evaluation of the system in terms of its performance.
* **Evaluation**: Some companies do not view this as an official stage of the SDLC, while others consider it to be an extension of the maintenance stage, and may be referred to in some circles as post-implementation review. This is where the system that was developed, as well as the entire process, is evaluated. Some of the questions that need to be answered include: does the newly implemented system meet the initial business requirements and objectives? Is the system reliable and fault-tolerant? Does the system function according to the approved functional requirements? In addition to evaluating the software that was released, it is important to assess the effectiveness of the development process. If there are any aspects of the entire process, or certain stages, that management is not satisfied with, this is the time to improve. Evaluation and assessment is a difficult issue. However, the company must reflect on the process and address weaknesses.
* **Disposal:** In this phase, plans are developed for discarding system information, hardware and software in making the transition to a new system. The purpose here is to properly move, archive, discard or destroy information, hardware and software that is being replaced, in a manner that prevents any possibility of unauthorized disclosure of sensitive data. The disposal activities ensure proper migration to a new system. Particular emphasis is given to proper preservation and archival of data processed by the previous system. All of this should be done in accordance with the organization's security requirements.[[9]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-9)

In the following example (see picture) these stages of the systems development life cycle are divided in ten steps from definition to creation and modification of IT work products:

[](https://en.wikipedia.org/wiki/File:Systems_Development_Life_Cycle.jpg)

The tenth phase occurs when the system is disposed of and the task performed is either eliminated or transferred to other systems. The tasks and work products for each phase are described in subsequent chapters.[[10]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-US_DJ03-10)

Not every project will require that the phases be sequentially executed. However, the phases are interdependent. Depending upon the size and complexity of the project, phases may be combined or may overlap.[[10]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-US_DJ03-10)

### System investigation**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit&section=4)**]**

The system investigates the IT proposal. During this step, we must consider all current priorities that would be affected and how they should be handled. Before any system planning is done, a [feasibility study](https://en.wikipedia.org/wiki/Feasibility_study) should be conducted to determine if creating a new or improved system is a viable solution. This will help to determine the costs, benefits, resource requirements, and specific user needs required for completion. The development process can only continue once management approves of the recommendations from the feasibility study.[[11]](https://en.wikipedia.org/wiki/Systems_development_life_cycle#cite_note-11)

Following are different components of the feasibility study:

* [Operational feasibility](https://en.wikipedia.org/wiki/Feasibility_study#Operational_feasibility)
* [Economic feasibility](https://en.wikipedia.org/wiki/Feasibility_study#Economic_Feasibility)
* [Technical feasibility](https://en.wikipedia.org/wiki/Feasibility_study#Technical_Feasibility)
* Human factors feasibility
* [Legal/Political feasibility](https://en.wikipedia.org/wiki/Feasibility_study#Legal_feasibility)

### System analysis**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit&section=5)**]**

The goal of [system analysis](https://en.wikipedia.org/wiki/Systems_analysis) is to determine where the problem is, in an attempt to fix the system. This step involves [breaking down](https://en.wikipedia.org/wiki/Work_breakdown_structure) the system in different pieces to analyze the situation, analyzing project goals, breaking down what needs to be created and attempting to engage users so that definite requirements can be defined.

### Design**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit&section=6)**]**

In [systems design](https://en.wikipedia.org/wiki/Systems_design), the design functions and operations are described in detail, including screen layouts, business rules, process diagrams and other documentation. The output of this stage will describe the new system as a collection of modules or subsystems.

The design stage takes as its initial input the requirements identified in the approved requirements document. For each requirement, a set of one or more design elements will be produced as a result of interviews, workshops, and/or prototype efforts.

Design elements describe the desired system features in detail, and generally include functional hierarchy diagrams, screen layout diagrams, tables of business rules, business process diagrams, pseudo-code, and a complete entity-relationship diagram with a full data dictionary. These design elements are intended to describe the system in sufficient detail, such that skilled developers and engineers may develop and deliver the system with minimal additional input design.

### Environments**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit&section=7)**]**

Environments are controlled areas where systems developers can build, distribute, install, configure, test, and execute systems that move through the SDLC. Each environment is aligned with different areas of the SDLC and is intended to have specific purposes. Examples of such environments include the:

* *Development environment*, where developers can work independently of each other before trying to merge their work with the work of others,
* *Common build environment*, where merged work can be built, together, as a combined system,
* *Systems integration testing environment*, where basic testing of a system's integration points to other upstream or downstream systems can be tested,
* *User acceptance testing environment*, where business stakeholders can test against their original business requirements,
* *Production environment*, where systems finally get deployed to, for final use by their intended end users.

### Testing**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Systems_development_life_cycle&action=edit&section=8)**]**

The code is tested at various levels in [software testing](https://en.wikipedia.org/wiki/Software_testing). Unit, system and user acceptance testings are often performed. This is a grey area as many different opinions exist as to what the stages of testing are and how much, if any iteration occurs. Iteration is not generally part of the waterfall model, but the means to rectify defects and validate fixes prior to deployment is incorporated into this phase.

The following are types of testing that may be relevant, depending on the type of system under development:

* *Defect testing* the failed scenarios, including [defect tracking](https://en.wikipedia.org/wiki/Defect_tracking)
* [Path testing](https://en.wikipedia.org/wiki/Model-based_testing)
* [Data set testing](https://en.wikipedia.org/wiki/Test_data)
* [Unit testing](https://en.wikipedia.org/wiki/Unit_testing)
* [System testing](https://en.wikipedia.org/wiki/System_testing)
* [Integration testing](https://en.wikipedia.org/wiki/Integration_testing)
* [Black-box testing](https://en.wikipedia.org/wiki/Black-box_testing)
* [White-box testing](https://en.wikipedia.org/wiki/White-box_testing)
* [Regression testing](https://en.wikipedia.org/wiki/Regression_testing)
* [Automation testing](https://en.wikipedia.org/wiki/Automation_testing)
* [User acceptance testing](https://en.wikipedia.org/wiki/User_acceptance_testing)
* [Software performance testing](https://en.wikipedia.org/wiki/Software_performance_testing)

# SOLID (object-oriented design)

# In [computer programming](https://en.wikipedia.org/wiki/Computer_programming), SOLID (single responsibility, open-closed, Liskov substitution, interface segregation and dependency inversion) is a [mnemonic](https://en.wikipedia.org/wiki/Mnemonic) [acronym](https://en.wikipedia.org/wiki/Acronym) introduced by [Michael Feathers](https://en.wikipedia.org/w/index.php?title=Michael_Feathers&action=edit&redlink=1) for the "first five principles" named by [Robert C. Martin](https://en.wikipedia.org/wiki/Robert_C._Martin)[[1]](https://en.wikipedia.org/wiki/SOLID_(object-oriented_design)#cite_note-ub-old-web-solid-1)[[2]](https://en.wikipedia.org/wiki/SOLID_(object-oriented_design)#cite_note-ub-solid-2) in the early 2000s[[3]](https://en.wikipedia.org/wiki/SOLID_(object-oriented_design)#cite_note-metz-presentation-2009-3) that stands for five basic principles of [object-oriented programming](https://en.wikipedia.org/wiki/Object-oriented_programming) and [design](https://en.wikipedia.org/wiki/Object-oriented_design). The intention is that these principles, when applied together, will make it more likely that a [programmer](https://en.wikipedia.org/wiki/Computer_programmer) will create a system that is easy to [maintain](https://en.wikipedia.org/wiki/Software_maintenance) and extend over time.[[3]](https://en.wikipedia.org/wiki/SOLID_(object-oriented_design)#cite_note-metz-presentation-2009-3) The principles of SOLID are guidelines that can be applied while working on software to remove [code smells](https://en.wikipedia.org/wiki/Code_smell) by providing a framework through which the programmer may [refactor](https://en.wikipedia.org/wiki/Code_refactoring) the software's [source code](https://en.wikipedia.org/wiki/Source_code) until it is both legible and extensible. It is part of an overall strategy of [agile](https://en.wikipedia.org/wiki/Agile_software_development) and [Adaptive Software Development](https://en.wikipedia.org/wiki/Adaptive_Software_Development).[[3]](https://en.wikipedia.org/wiki/SOLID_(object-oriented_design)#cite_note-metz-presentation-2009-3)

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| **SOLID** |
| **Principles** |
| * [Single Responsibility](https://en.wikipedia.org/wiki/Single_responsibility_principle) * [Open/closed](https://en.wikipedia.org/wiki/Open/closed_principle) * [Liskov substitution](https://en.wikipedia.org/wiki/Liskov_substitution_principle) * [Interface segregation](https://en.wikipedia.org/wiki/Interface_segregation_principle) * [Dependency inversion](https://en.wikipedia.org/wiki/Dependency_inversion_principle) |

# Solid-state drive

*This article is about flash-based, DRAM-based, and other solid-state storage. For removable USB solid-state storage, see*[*USB flash drive*](https://en.wikipedia.org/wiki/USB_flash_drive)*. For compact flash memory cards, see*[*Memory card*](https://en.wikipedia.org/wiki/Memory_card)*. For software-based secondary storage, see*[*RAM drive*](https://en.wikipedia.org/wiki/RAM_drive)*.*

*"Electronic disk" redirects here. For other uses, see*[*Electronic disk (disambiguation)*](https://en.wikipedia.org/wiki/Electronic_disk_(disambiguation))*.*

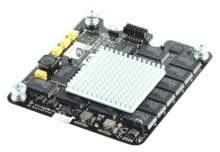
*"SSD" redirects here. For other uses, see*[*SSD (disambiguation)*](https://en.wikipedia.org/wiki/SSD_(disambiguation))*.*

[](https://en.wikipedia.org/wiki/File:Vertex_2_Solid_State_Drive_by_OCZ-top_oblique_PNr%C2%B00307.jpg)

A 2.5-inch SSD, often found in [laptops](https://en.wikipedia.org/wiki/Laptop) and [desktop computers](https://en.wikipedia.org/wiki/Desktop_computer)

[](https://en.wikipedia.org/wiki/File:RamSan-400.jpg)

A rackmount SSD storage appliance based on [DDR SDRAM](https://en.wikipedia.org/wiki/DDR_SDRAM)

[](https://en.wikipedia.org/wiki/File:Hp-io-accelerator-isometric.gif)

A PCI-attached [IO Accelerator](https://en.wikipedia.org/wiki/IO_Accelerator) SSD

[](https://en.wikipedia.org/wiki/File:Ddrdrive_x1.jpg)

A [PCI-Express-](https://en.wikipedia.org/wiki/PCI_Express), DRAM- and NAND-based SSD that uses an external power supply to effectively make the DRAM non-volatile

[](https://en.wikipedia.org/wiki/File:14-06-11-ssd-RalfR-N3S_7886-03.jpg)

An [mSATA](https://en.wikipedia.org/wiki/MSATA) SSD with an external enclosure

A **solid-state drive** (**SSD**, also known as a **solid-state disk**[[1]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-whatisssd-1)[[2]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-2)[[3]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-3)) is a [solid-state storage](https://en.wikipedia.org/wiki/Solid-state_storage) device that uses [integrated circuit](https://en.wikipedia.org/wiki/Integrated_circuit) assemblies as [memory](https://en.wikipedia.org/wiki/Computer_storage) to store data [persistently](https://en.wikipedia.org/wiki/Persistence_(computer_science)). SSD technology primarily uses electronic interfaces compatible with traditional [block](https://en.wikipedia.org/wiki/Block_(data_storage)) input/output (I/O) [hard disk drives](https://en.wikipedia.org/wiki/Hard_disk_drive) (HDDs), which permit simple replacements in common applications.[[4]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-SNIA-101-4) Additionally, new I/O interfaces, like [SATA Express](https://en.wikipedia.org/wiki/SATA_Express) and [M.2](https://en.wikipedia.org/wiki/M.2) have been designed to address specific requirements of the SSD technology.

SSDs have no moving mechanical components. This distinguishes them from traditional [electromechanical](https://en.wikipedia.org/wiki/Electromechanical) [magnetic disks](https://en.wikipedia.org/wiki/Magnetic_disk) such as [hard disk drives](https://en.wikipedia.org/wiki/Hard_disk_drive) (HDDs) or [floppy disks](https://en.wikipedia.org/wiki/Floppy_disk), which contain spinning [disks](https://en.wikipedia.org/wiki/Disk_storage) and movable [read/write heads](https://en.wikipedia.org/wiki/Disk_read-and-write_head).[[5]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-STEC-5) Compared with electromechanical disks, SSDs are typically more resistant to physical shock, run silently, have lower [access time](https://en.wikipedia.org/wiki/Access_time), and lower [latency](https://en.wikipedia.org/wiki/Latency_(engineering)).[[6]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-dell-study-6) However, while the price of SSDs has continued to decline over time (24 cents per gb as of 2017),[[7]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-7)[[8]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-SSD_prices_in_steady.2C_substantial_decline-8) consumer-grade SSDs are (as of 2017) still roughly four times more expensive per unit of storage than consumer-grade HDDs.[[9]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-9)

As of 2015, most SSDs use MLC [NAND-based flash memory](https://en.wikipedia.org/wiki/NAND_flash), which is a type of [non-volatile memory](https://en.wikipedia.org/wiki/Non-volatile_memory) that retains data when power is lost. For applications requiring fast access but not necessarily data persistence after power loss, SSDs may be constructed from [random-access memory](https://en.wikipedia.org/wiki/Random-access_memory) (RAM). Such devices may employ batteries as integrated power sources to retain data for a certain amount of time after external power is lost.[[4]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-SNIA-101-4)

[Hybrid drives](https://en.wikipedia.org/wiki/Hybrid_drive) or [solid-state hybrid drives](https://en.wikipedia.org/wiki/Solid-state_hybrid_drive) (SSHDs) combine the features of SSDs and HDDs in the same unit, containing a large hard disk drive and an SSD cache to improve performance of frequently accessed data.[[10]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-WD_Black_SSHD_-_CNET_Reviews-10)[[11]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-11)[[12]](https://en.wikipedia.org/wiki/Solid-state_drive#cite_note-12)

# SSD vs. HDD: What's the Difference?

## **HDD and SSD Explained**

The traditional spinning hard drive is the basic nonvolatile storage on a computer. That is, information on it doesn't "go away" when you turn off the system, as is the case with data stored in RAM. A hard drive is essentially a metal platter with a magnetic coating that stores your data, whether weather reports from the last century, a high-definition copy of the Star Wars trilogy, or your digital music collection. A read/write head on an arm accesses the data while the platters are spinning.

An SSD does functionally everything a hard drive does, but data is instead stored on interconnected flash memory chips that retain the data even when there's no power present. The chips can either be permanently installed on the system's motherboard (as on some small laptops and ultraportables), on a PCI Express (PCIe) card (in some high-end workstations and an increasing number of bleeding-edge consumer systems), or in a box that's sized, shaped, and wired to slot in for a laptop or desktop's hard drive (common on everything else). These flash memory chips are of a different type than is used in USB thumb drives, and are typically faster and more reliable. SSDs are consequently more expensive than USB thumb drives of the same capacities.

Note: We'll be talking primarily about internal drives in this story, but almost everything applies to external hard drives as well. External drives come in both large desktop and compact portable form factors, and SSDs are gradually becoming a larger part of the external market.

# Network Time Protocol (NTP)

# Network Time Protocol (NTP) is a [protocol](http://searchnetworking.techtarget.com/definition/protocol) used to synchronize computer clock times in a [network](http://searchnetworking.techtarget.com/definition/network). It belongs to and is one of the oldest parts of the [TCP/IP](http://searchnetworking.techtarget.com/definition/TCP-IP) protocol suite. The term *NTP* applies to both the protocol and the [client-server](http://searchnetworking.techtarget.com/definition/client-server) programs that run on computers.

# computer network

# In information technology, a computer network, also called a data network, is a series of points, or [nodes](http://searchnetworking.techtarget.com/definition/node), interconnected by communication paths for the purpose of transmitting, receiving and exchanging data, voice and video traffic.

# network node

# In a communications network, a network node is a connection point that can receive, create, store or send data along distributed network routes. Each network node -- whether it's an endpoint for data transmissions or a redistribution point -- has either a programmed or engineered capability to recognize, process and forward transmissions to other network nodes.

protocol

# In information technology, a protocol is the special set of rules that end points in a telecommunication connection use when they communicate. Protocols specify interactions between the communicating entities.

TCP/IP (Transmission Control Protocol/Internet Protocol)

# TCP/IP (Transmission Control Protocol/Internet Protocol) is the basic communication language or protocol of the Internet. It can also be used as a communications protocol in a private network (either an [intranet](http://searchwindevelopment.techtarget.com/definition/intranet) or an [extranet](http://searchenterprisewan.techtarget.com/definition/extranet)). When you are set up with direct access to the Internet, your computer is provided with a copy of the TCP/IP program just as every other computer that you may send messages to or get information from also has a copy of TCP/IP.

client/server (client/server model, client/server architecture)

Client/server is a program relationship in which one program (the [client](http://searchenterprisedesktop.techtarget.com/definition/client)) requests a service or resource from another program (the [server](http://whatis.techtarget.com/definition/server)).

Although the client/server model can be used by programs within a single computer, it is a more important concept for [networking](http://searchnetworking.techtarget.com/definition/networking).  In this case, the client establishes a connection to the server over a local area network ([LAN](http://searchnetworking.techtarget.com/definition/local-area-network-LAN)) or wide-area network ([WAN](http://searchenterprisewan.techtarget.com/definition/WAN)), such as the [Internet](http://searchwindevelopment.techtarget.com/definition/Internet). Once the server has fulfilled the client's request, the connection is terminated. Your Web [browser](http://searchwindevelopment.techtarget.com/definition/browser) is a client program that has requested a service  from a server; in fact, the service and resouce the server provided is the delivery of this Web [page](http://searchsoa.techtarget.com/definition/page).

client

# A client is the requesting program or user in a [client/server](http://searchnetworking.techtarget.com/definition/client-server) relationship. For example, the user of a Web browser is effectively making client requests for pages from servers all over the Web. The browser itself is a client in its relationship with the computer that is getting and returning the requested HTML file. The computer handling the request and sending back the HTML file is a [server](http://whatis.techtarget.com/definition/server).

server

A server is a computer [program](http://searchsoftwarequality.techtarget.com/definition/program) that provides services to other computer programs (and their users) in the same or other computers. The computer that a server program runs in is also frequently referred to as a server. That machine may be a [dedicated server](http://searchsoa.techtarget.com/definition/dedicated-server) or used for other purposes as well.

In the [client/server](http://searchnetworking.techtarget.com/definition/client-server) programming model, a server program awaits and fulfills requests from [client](http://searchenterprisedesktop.techtarget.com/definition/client) programs, which may be running in the same or other computers. A given application in a computer may function as a [client](http://searchenterprisedesktop.techtarget.com/definition/client) with requests for services from other programs and also as a *server* of requests from other programs.

Servers are often categorized in terms of their purpose. A [Web server](http://whatis.techtarget.com/definition/Web-server), for example, is a computer program that serves requested [HTML](http://searchsoa.techtarget.com/definition/HTML) pages or files. A Web *client* is the requesting program associated with the user. The Web [browser](http://searchwindevelopment.techtarget.com/definition/browser) in your computer is a client that requests HTML files from Web servers.

Here are a few types of servers, among a great number of other possibilities:

An [application server](http://searchsqlserver.techtarget.com/definition/application-server) is a program in a computer in a [distributed](http://searchcio-midmarket.techtarget.com/definition/distributed) [network](http://searchnetworking.techtarget.com/definition/network) that provides the business logic for an application program.

A [proxy server](http://whatis.techtarget.com/definition/proxy-server) is software that acts as an intermediary between an endpoint device, such as a computer, and another server from which a user or client is requesting a service.

A [mail server](http://searchsoa.techtarget.com/definition/mail-server) is an application that receives incoming e-mail from local users (people within the same [domain](http://searchsoa.techtarget.com/definition/domain)) and remote senders and forwards outgoing e-mail for delivery.

A [virtual server](http://searchnetworking.techtarget.com/definition/virtual-server) is a program running on a shared server that is configured in such a way that it seems to each user that they have complete control of a server.

A [blade server](http://searchdatacenter.techtarget.com/definition/blade-server) is a server chassis housing multiple thin, modular electronic circuit boards, known as [server blades](http://searchdatacenter.techtarget.com/definition/server-blade). Each blade is a server in its own right, often dedicated to a single application.

A [file server](http://searchnetworking.techtarget.com/definition/file-server) is a computer responsible for the central storage and management of [data](http://searchdatamanagement.techtarget.com/definition/data) files so that other computers on the same network can access them.

A [policy server](http://searchsecurity.techtarget.com/definition/policy-server) is a security component of a [policy](http://searchmobilecomputing.techtarget.com/definition/policy)-based network that provides [authorization](http://searchsoftwarequality.techtarget.com/definition/authorization) services and facilitates tracking and control of files.

local area network (LAN)

# A local area network (LAN) is a group of computers and associated devices that share a common communications line or wireless link to a server. Typically, a LAN encompasses computers and peripherals connected to a server within a distinct geographic area such as an office or a commercial establishment. Computers and other mobile devices use a LAN connection to share resources such as a printer or network storage.

WAN (wide area network)

# A wide area network (WAN) is a geographically distributed private telecommunications [network](http://searchnetworking.techtarget.com/definition/network) that interconnects multiple local area networks ([LANs](http://searchnetworking.techtarget.com/definition/local-area-network-LAN)). In an enterprise, a WAN may consist of connections to a company's headquarters, branch offices, [colocation](http://searchsoa.techtarget.com/definition/collocation) facilities, cloud services and other facilities. Typically, a [router](http://searchnetworking.techtarget.com/definition/router) or other multifunction device is used to connect a LAN to a WAN. Enterprise WANs allow users to share access to applications, services and other centrally located resources. This eliminates the need to install the same application server, firewall or other resource in multiple locations, for example.

A virtual private network ([VPN](http://searchenterprisewan.techtarget.com/definition/virtual-private-network)) facilitates connectivity between WAN sites. An [IPsec VPN](http://searchmidmarketsecurity.techtarget.com/definition/Ipsec) is more commonly used in continuously open site-to-site connections, such as those between branch offices and headquarters locations. An [SSL VPN](http://searchsecurity.techtarget.com/definition/SSL-VPN) is often the preferred choice for enabling remote access for individual users because the data transmitted from users across the WAN is encrypted. Direct [fiber optic](http://searchnetworking.techtarget.com/definition/fiber-optic) links are also used to connect sites on a WAN – and they almost always offer greater performance, reliability and security than VPNs, but they are cost-prohibitive for most enterprises to procure and operate.

### **Types of WAN connections**

WAN connections can include wired and wireless technologies. Wired WAN services can include [multiprotocol label switching](http://searchenterprisewan.techtarget.com/definition/Multiprotocol-Label-Switching), T1s, [Carrier Ethernet](http://searchtelecom.techtarget.com/definition/Carrier-Ethernet) and commercial broadband internet links. [Wireless WAN](http://searchenterprisewan.techtarget.com/definition/wireless-WAN) technologies can include cellular data networks like [4G](http://searchmobilecomputing.techtarget.com/definition/4G) LTE, as well as public [Wi-Fi](http://searchmobilecomputing.techtarget.com/definition/Wi-Fi) or [satellite](http://searchnetworking.techtarget.com/definition/satellite-Internet-connection) networks.

WANs over wired network connections remain the preferred medium for most enterprises, but wireless WAN technologies, based on the 4G [LTE](http://searchmobilecomputing.techtarget.com/definition/Long-Term-Evolution-LTE) standard, are gaining traction.

WAN infrastructure may be privately owned or leased as a service from a third-party service provider, such as a [telecommunications carrier](http://whatis.techtarget.com/definition/carrier-network), internet service provider, private IP network operator or cable company. The service itself may operate over a dedicated, private connection -- often backed by a [service-level agreement](http://searchitchannel.techtarget.com/definition/service-level-agreement) -- or over a shared, public medium like the internet. [Hybrid WANs](http://searchnetworking.techtarget.com/definition/hybrid-WAN) employ a combination of private and public network services.

Internet

# The Internet, sometimes called simply "the Net," is a worldwide system of computer networks - a network of networks in which users at any one computer can, if they have permission, get information from any other computer (and sometimes talk directly to users at other computers). It was conceived by the Advanced Research Projects Agency (ARPA) of the U.S. government in 1969 and was first known as the [ARPANet](http://searchnetworking.techtarget.com/definition/ARPANET). The original aim was to create a network that would allow users of a research computer at one university to "talk to" research computers at other universities. A side benefit of ARPANet's design was that, because messages could be routed or rerouted in more than one direction, the network could continue to function even if parts of it were destroyed in the event of a military attack or other disaster.

Today, the Internet is a public, cooperative and self-sustaining facility accessible to hundreds of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called [TCP/IP](http://searchnetworking.techtarget.com/definition/TCP-IP) (for Transmission Control Protocol/Internet Protocol). Two recent adaptations of Internet technology, the [intranet](http://searchwindevelopment.techtarget.com/definition/intranet) and the [extranet](http://searchenterprisewan.techtarget.com/definition/extranet), also make use of the TCP/IP protocol.

For most Internet users, electronic mail ([email](http://searchmobilecomputing.techtarget.com/definition/e-mail)) practically replaced the postal service for short written transactions. People communicate over the Internet in a number of other ways including  Internet Relay Chat ([IRC](http://searchexchange.techtarget.com/definition/Internet-Relay-Chat)), [Internet telephony](http://searchunifiedcommunications.techtarget.com/definition/Telephony), [instant messaging](http://searchunifiedcommunications.techtarget.com/definition/instant-messaging), video chat or [social media](http://whatis.techtarget.com/definition/social-media).

The most widely used part of the Internet is the [World Wide Web](http://searchcrm.techtarget.com/definition/World-Wide-Web) (often abbreviated "WWW" or called "the Web"). Its outstanding feature is [hypertext](http://searchsoa.techtarget.com/definition/hypertext), a method of instant cross-referencing. In most Web sites, certain words or phrases appear in text of a different color than the rest; often this text is also underlined. When you select one of these words or phrases, you will be transferred to the site or page that is relevant to this word or phrase. Sometimes there are buttons, images, or portions of images that are "clickable." If you move the pointer over a spot on a Web site and the pointer changes into a hand, this indicates that you can click and be transferred to another site.

Using the Web, you have access to billions of pages of information. Web browsing is done with a Web [browser](http://searchwindevelopment.techtarget.com/definition/browser), the most popular of which are [Chrome](http://searchconsumerization.techtarget.com/definition/Google-Chrome-browser), [Firefox](http://searchsoa.techtarget.com/definition/Firefox) and [Internet Explorer](http://searchenterprisedesktop.techtarget.com/definition/Internet-Explorer). The appearance of a particular Web site may vary slightly depending on the browser you use. Also, later versions of a particular browser are able to render more "bells and whistles" such as animation, [virtual reality](http://whatis.techtarget.com/definition/virtual-reality), sound, and music files, than earlier versions.

The Internet has continued to grow and evolve over the years of its existence. [IPv6](http://searchenterprisewan.techtarget.com/definition/IPv6), for example, was designed to anticipate enormous future expansion in the number of available [IP addresses](http://searchwindevelopment.techtarget.com/definition/IP-address). In a related development, the Internet of Things ([IoT](http://whatis.techtarget.com/definition/Internet-of-Things)) is the burgeoning environment in which almost any entity or object can be provided with a [unique identifier](http://whatis.techtarget.com/definition/unique-identifier-UID) and the ability to transfer data automatically over the Internet.

hypertext

# Hypertext is the organization of information units into connected associations that a user can choose to make. An instance of such an association is called a [link](http://searchsoa.techtarget.com/definition/link) or hypertext link. (And the highlighted word "link" in the previous sentence is an example of a hypertext link.)

# Hypertext was the main concept that led to the invention of the World Wide Web, which is, after all, nothing more (or less) than an enormous amount of information content connected by an enormous number of hypertext links.

Internet of Things (IoT)

# The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with [unique identifiers](http://whatis.techtarget.com/definition/unique-identifier-UID) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

A [thing](http://whatis.techtarget.com/definition/thing-in-the-Internet-of-Things), in the Internet of Things, can be a person with a heart monitor implant, a farm animal with a [biochip transponder](http://searchsecurity.techtarget.com/definition/injectable-ID-chip), an automobile that has built-in [sensors](http://whatis.techtarget.com/definition/sensor) to alert the driver when tire pressure is low -- or any other natural or man-made object that can be assigned an [IP address](http://searchunifiedcommunications.techtarget.com/definition/Internet-Protocol) and provided with the ability to transfer data over a network.

IoT has evolved from the convergence of [wireless](http://searchmobilecomputing.techtarget.com/definition/wireless) technologies, micro-electromechanical systems ([MEMS](http://searchcio-midmarket.techtarget.com/definition/micro-electromechanical-systems)), [microservices](http://searchsoa.techtarget.com/definition/microservices) and the internet. The convergence has helped tear down the silo walls between operational technology ([OT](http://whatis.techtarget.com/definition/operational-technology)) and information technology ([IT](http://searchdatacenter.techtarget.com/definition/IT)), allowing unstructured [machine-generated data](http://internetofthingsagenda.techtarget.com/definition/machine-data) to be analyzed for insights that will drive improvements.

Kevin Ashton, cofounder and executive director of the Auto-ID Center at MIT, first mentioned the Internet of Things in a presentation he made to Procter & Gamble in 1999. Here’s how Ashton explains the potential of the Internet of Things:

unique identifier (UID)

# A unique identifier (UID) is a numeric or alphanumeric string that is associated with a single entity within a given system. UIDs make it possible to address that entity, so that it can be accessed and interacted with.

Here are a few examples of UIDs:

* A Uniform Resource Identifier ([URI](http://searchsoa.techtarget.com/definition/URI)) is a unique identifier that makes content addressable on the Internet by uniquely targeting items, such as text, video, images and applications.
* A Uniform Resource Locator ([URL](http://searchnetworking.techtarget.com/definition/URL)) is a particular type of URI that targets Web pages so that when a browser requests them, they can be found and served to users.
* A Universal Unique Identifier ([UUID](http://searchsoa.techtarget.com/definition/UUID)) is a 128-bit number used to uniquely identify some [object](http://searchsoa.techtarget.com/definition/object) or entity on the Internet.
* A global unique identifier ([GUID](http://searchcio-midmarket.techtarget.com/definition/GUID)) is a number that Microsoft programming generates to create a unique identity for an entity such as a Word document.
* A bank identifier code ([BIC](http://searchfinancialapplications.techtarget.com/definition/BIC-bank-identifier-code)) is a unique identifier for a specific financial institution.
* A unique device identifier ([UDID](http://whatis.techtarget.com/definition/unique-device-identifier-UDID)) is a 40-character string assigned to certain [Apple](http://whatis.techtarget.com/definition/Apple) devices including the [iPhone](http://searchmobilecomputing.techtarget.com/definition/iPhone), [iPad](http://searchmobilecomputing.techtarget.com/definition/iPad-2), and [iPod](http://searchmobilecomputing.techtarget.com/definition/iPod) Touch.
* An service set identifier ([SSID](http://searchmobilecomputing.techtarget.com/definition/service-set-identifier)) is a sequence of characters that uniquely names a wireless local area network ([WLAN](http://searchmobilecomputing.techtarget.com/definition/wireless-LAN)).
* A national provider identifier ([NPI](http://searchhealthit.techtarget.com/definition/national-provider-identifier-NPI)) is a unique ten-digit identification number required by [HIPAA](http://searchdatamanagement.techtarget.com/definition/HIPAA) for all health care providers in the United States.

# Lazy loading

# Lazy loading is a [design pattern](https://en.wikipedia.org/wiki/Design_pattern_(computer_science)) commonly used in computer programming to defer initialization of an object until the point at which it is needed. It can contribute to efficiency in the program's operation if properly and appropriately used. The opposite of lazy loading is eager loading.

### Lazy initialization**[**[**edit**](https://en.wikipedia.org/w/index.php?title=Lazy_loading&action=edit&section=2)**]**

*Main article:*[*Lazy initialization*](https://en.wikipedia.org/wiki/Lazy_initialization)

With lazy initialization, the object to be lazily loaded is originally set to null, and every request for the object checks for null and creates it "on the fly" before returning it first, as in this C# example:

**private** int myWidgetID;

**private** Widget myWidget = **null**;

**public** Widget MyWidget

{

**get**

{

**if** (myWidget == **null**)

{

myWidget = Widget.Load(myWidgetID);

}

**return** myWidget;

}

}

Or with the [null-coalescing operator](https://en.wikipedia.org/wiki/Null_coalescing_operator) '??'

**private** int myWidgetID;

**private** Widget myWidget = **null**;

**public** Widget MyWidget

{

**get** { **return** myWidget = myWidget ?? Widget.Load(myWidgetID); }

}

# Proxy server

# In [computer networks](https://en.wikipedia.org/wiki/Computer_network), a proxy server is a [server](https://en.wikipedia.org/wiki/Server_(computing)) (a computer system or an application) that acts as an [intermediary](https://en.wikipedia.org/wiki/Intermediary) for requests from [clients](https://en.wikipedia.org/wiki/Client_(computing)) seeking resources from other servers.[[1]](https://en.wikipedia.org/wiki/Proxy_server#cite_note-1) A client connects to the proxy server, requesting some service, such as a file, connection, web page, or other resource available from a different server and the proxy server evaluates the request as a way to simplify and control its complexity. Proxies were invented to add structure and [encapsulation](https://en.wikipedia.org/wiki/Encapsulation_(networking)) to distributed systems.[[2]](https://en.wikipedia.org/wiki/Proxy_server#cite_note-2)Today, most proxies are web proxies, facilitating access to content on the [World Wide Web](https://en.wikipedia.org/wiki/World_Wide_Web) and providing anonymity.

# Diagram of two computers connected only via a proxy server. The first computer says to the proxy server: "ask the second computer what the time is".

# Server (computing)

In [computing](https://en.wikipedia.org/wiki/Computing), a **server** is a [computer program](https://en.wikipedia.org/wiki/Computer_program) or a [device](https://en.wikipedia.org/wiki/Computer) that provides functionality for other programs or devices, called "[clients](https://en.wikipedia.org/wiki/Client_(computing))". This [architecture](https://en.wikipedia.org/wiki/Systems_architecture) is called the [client–server model](https://en.wikipedia.org/wiki/Client%E2%80%93server_model), and a single overall computation is distributed across multiple processes or devices. Servers can provide various functionalities, often called "services", such as sharing data or [resources](https://en.wikipedia.org/wiki/System_resource) among multiple clients, or performing computation for a client. A single server can serve multiple clients, and a single client can use multiple servers. A client process may run on the same device or may connect over a network to a server on a different device.[[1]](https://en.wikipedia.org/wiki/Server_(computing)#cite_note-1) Typical servers are [database servers](https://en.wikipedia.org/wiki/Database_server), [file servers](https://en.wikipedia.org/wiki/File_server), [mail servers](https://en.wikipedia.org/wiki/Mail_server), [print servers](https://en.wikipedia.org/wiki/Print_server), [web servers](https://en.wikipedia.org/wiki/Web_server), [game servers](https://en.wikipedia.org/wiki/Game_server), and [application servers](https://en.wikipedia.org/wiki/Application_server).[[2]](https://en.wikipedia.org/wiki/Server_(computing)#cite_note-2)

Client–server systems are today most frequently implemented by (and often identified with) the [request–response](https://en.wikipedia.org/wiki/Request%E2%80%93response) model: a client sends a request to the server, which performs some action and sends a response back to the client, typically with a result or acknowledgement. Designating a computer as "server-class hardware" implies that it is specialized for running servers on it. This often implies that it is more powerful and reliable than standard [personal computers](https://en.wikipedia.org/wiki/Personal_computer), but alternatively, large [computing clusters](https://en.wikipedia.org/wiki/Computing_cluster) may be composed of many relatively simple, replaceable server components.

|  |  |  |
| --- | --- | --- |
| **Server type** | **Purpose** | **Clients** |
| [Application server](https://en.wikipedia.org/wiki/Application_server) | Hosts [web apps](https://en.wikipedia.org/wiki/Web_app) (computer programs that run inside a [web browser](https://en.wikipedia.org/wiki/Web_browser)) allowing users in the network to run and use them, without having to install a copy on their own computers. Unlike what the name might imply, these servers need not be part of the [world wide web](https://en.wikipedia.org/wiki/World_wide_web); any [local network](https://en.wikipedia.org/wiki/Local_network) would do. | Computers with a web browser |
| [Catalog server](https://en.wikipedia.org/wiki/Catalog_server) | Maintains an index or table of contents of information that can be found across a large distributed network, such as computers, users, files shared on file servers, and web apps. [Directory servers](https://en.wikipedia.org/wiki/Directory_server) and [name servers](https://en.wikipedia.org/wiki/Name_server) are examples of catalog servers. | Any computer program that needs to find something on the network, such a [Domain member](https://en.wikipedia.org/wiki/Windows_domain) attempting to log in, an [email client](https://en.wikipedia.org/wiki/Email_client) looking for an email address, or a user looking for a file |
| [Communications server](https://en.wikipedia.org/wiki/Communications_server) | Maintains an environment needed for one communication endpoint (user or devices) to find other endpoints and communicate with them. It may or may not include a directory of communication endpoints and a presence detection service, depending on the openness and security parameters of the network | Communication endpoints (users or devices) |
| [Computing server](https://en.wikipedia.org/wiki/Supercomputer) | Shares vast amounts of computing resources, especially [CPU](https://en.wikipedia.org/wiki/Central_processing_unit) and [random-access memory](https://en.wikipedia.org/wiki/Random-access_memory), over a network. | Any computer program that needs more CPU power and RAM than a personal computer can probably afford. The client must be a networked computer; otherwise, there would be no client–server model. |
| [Database server](https://en.wikipedia.org/wiki/Database_server) | Maintains and shares any form of [database](https://en.wikipedia.org/wiki/Database) (organized collections of data with predefined properties that may be displayed in a table) over a network. | [Spreadsheets](https://en.wikipedia.org/wiki/Spreadsheet), [accounting software](https://en.wikipedia.org/wiki/Accounting_software), [asset management software](https://en.wikipedia.org/wiki/Digital_asset_management) or virtually any computer program that consumes well-organized data, especially in large volumes |
| [Fax server](https://en.wikipedia.org/wiki/Fax_server) | Shares one or more [fax machines](https://en.wikipedia.org/wiki/Fax_machine) over a network, thus eliminating the hassle of physical access | Any fax sender or recipient |
| [File server](https://en.wikipedia.org/wiki/File_server) | Shares [files](https://en.wikipedia.org/wiki/Computer_file) and [folder](https://en.wikipedia.org/wiki/Computer_folder), storage space to hold files and folders, or both, over a network | Networked computers are the intended clients, even though local programs can be clients |
| [Game server](https://en.wikipedia.org/wiki/Game_server) | Enables several computers or gaming devices to play [multiplayer games](https://en.wikipedia.org/wiki/Multiplayer_game) | Personal computers or [gaming consoles](https://en.wikipedia.org/wiki/Video_game_console) |
| [Mail server](https://en.wikipedia.org/wiki/Mail_server) | Makes [email](https://en.wikipedia.org/wiki/Email) communication possible in the same way that a [post office](https://en.wikipedia.org/wiki/Post_office) makes [snail mail](https://en.wikipedia.org/wiki/Snail_mail) communication possible | Senders and recipients of email |
| [Media server](https://en.wikipedia.org/wiki/Media_server) | Shares [digital video](https://en.wikipedia.org/wiki/Digital_video) or [digital audio](https://en.wikipedia.org/wiki/Digital_audio) over a network through [media streaming](https://en.wikipedia.org/wiki/Streaming_media) (transmitting content in a way that portions received can be watched or listened as they arrive, as opposed downloading a whole huge file and then using it) | User-attended personal computers equipped with a monitor and a speaker |
| [Print server](https://en.wikipedia.org/wiki/Print_server) | Shares one or more [printers](https://en.wikipedia.org/wiki/Printer_(computing)) over a network, thus eliminating the hassle of physical access | Computers in need of printing something |
| [Sound server](https://en.wikipedia.org/wiki/Sound_server) | Enables computer programs of a computer to play sound and record sound, individually or cooperatively | Computer programs of the same computer |
| [Proxy server](https://en.wikipedia.org/wiki/Proxy_server) | Acts as an [intermediary](https://en.wikipedia.org/wiki/Intermediary) between a client and a server, accepting incoming traffic from the client and sending it to the server. Reasons for doing so includes content control and filtering, improving traffic performance, preventing unauthorized network access or simply routing the traffic over a large and complex network. | Any networked computer |
| [Web server](https://en.wikipedia.org/wiki/Web_server) | Hosts [web pages](https://en.wikipedia.org/wiki/Web_page). A web server is what makes [world wide web](https://en.wikipedia.org/wiki/World_wide_web) possible. Each [website](https://en.wikipedia.org/wiki/Website) has one or more web servers. | Computers with a web browser |

Almost the entire structure of the [Internet](https://en.wikipedia.org/wiki/Internet) is based upon a [client–server](https://en.wikipedia.org/wiki/Client%E2%80%93server) model. High-level [root nameservers](https://en.wikipedia.org/wiki/Root_nameserver), [DNS](https://en.wikipedia.org/wiki/Domain_Name_System), and routers direct the traffic on the internet. There are millions of servers connected to the Internet, running continuously throughout the world[[7]](https://en.wikipedia.org/wiki/Server_(computing)#cite_note-8) and virtually every action taken by an ordinary [Internet](https://en.wikipedia.org/wiki/Internet) user requires one or more interactions with one or more server. There are exceptions that do not use dedicated servers; for example [peer-to-peer file sharing](https://en.wikipedia.org/wiki/File_sharing), some implementations of [telephony](https://en.wikipedia.org/wiki/Telephony) (e.g. pre-Microsoft [Skype](https://en.wikipedia.org/wiki/Skype)).

# Domain Name System

The **Domain Name System** (**DNS**) is a [hierarchical](https://en.wikipedia.org/wiki/Hierarchical) decentralized naming system for computers, services, or other resources connected to the [Internet](https://en.wikipedia.org/wiki/Internet) or a private network. It associates various information with [domain names](https://en.wikipedia.org/wiki/Domain_name) assigned to each of the participating entities. Most prominently, it translates more readily memorized domain names to the numerical [IP addresses](https://en.wikipedia.org/wiki/IP_address) needed for locating and identifying computer services and devices with the underlying network protocols. By providing a worldwide, distributed [directory service](https://en.wikipedia.org/wiki/Directory_service), the Domain Name System is an essential component of the functionality of the Internet, that has been in use since the 1980s.

The Domain Name System delegates the responsibility of assigning domain names and mapping those names to Internet resources by designating [authoritative name servers](https://en.wikipedia.org/wiki/Authoritative_name_server) for each domain. Network administrators may delegate authority over [sub-domains](https://en.wikipedia.org/wiki/Sub-domain) of their allocated name space to other name servers. This mechanism provides distributed and fault tolerant service and was designed to avoid a single large central database.

The Domain Name System also specifies the technical functionality of the [database](https://en.wikipedia.org/wiki/Database) service that is at its core. It defines the DNS protocol, a detailed specification of the data structures and data communication exchanges used in the DNS, as part of the [Internet Protocol Suite](https://en.wikipedia.org/wiki/Internet_Protocol_Suite). Historically, other directory services preceding DNS were not scalable to large or global directories as they were originally based on text files, prominently the [HOSTS.TXT](https://en.wikipedia.org/wiki/HOSTS.TXT) resolver.

The Internet maintains two principal [namespaces](https://en.wikipedia.org/wiki/Namespace), the domain name hierarchy[[1]](https://en.wikipedia.org/wiki/Domain_Name_System#cite_note-rfc1034-1) and the [Internet Protocol](https://en.wikipedia.org/wiki/Internet_Protocol) (IP) [address spaces](https://en.wikipedia.org/wiki/Address_space).[[2]](https://en.wikipedia.org/wiki/Domain_Name_System#cite_note-rfc781-2) The Domain Name System maintains the domain name hierarchy and provides translation services between it and the address spaces. Internet [name servers](https://en.wikipedia.org/wiki/Name_server) and a communication [protocol](https://en.wikipedia.org/wiki/Network_protocol) implement the Domain Name System.[[3]](https://en.wikipedia.org/wiki/Domain_Name_System#cite_note-rfc1035-3) A DNS name server is a server that stores the DNS records for a domain; a DNS name server responds with answers to queries against its database.

The most common types of records stored in the DNS database are for Start of Authority (SOA), [IP addresses](https://en.wikipedia.org/wiki/IP_address) (A and AAAA), [SMTP](https://en.wikipedia.org/wiki/SMTP) [mail exchangers](https://en.wikipedia.org/wiki/Mail_exchanger) (MX), [name servers](https://en.wikipedia.org/wiki/Name_server) (NS), pointers for [reverse DNS lookups](https://en.wikipedia.org/wiki/Reverse_DNS_lookup) (PTR), and [domain name aliases](https://en.wikipedia.org/wiki/Domain_name_alias) (CNAME). Although not intended to be a general purpose database, DNS can store records for other types of data for either automatic lookups, such as [DNSSEC](https://en.wikipedia.org/wiki/DNSSEC) records, or for human queries such as *responsible person* (RP) records. As a general purpose database, the DNS has also been used in combating [unsolicited email](https://en.wikipedia.org/wiki/Unsolicited_email) (spam) by storing a [real-time blackhole list](https://en.wikipedia.org/wiki/Real-time_blackhole_list). The DNS database is traditionally stored in a structured [zone file](https://en.wikipedia.org/wiki/Zone_file).

# Simple Mail Transfer Protocol

**Simple Mail Transfer Protocol** (**SMTP**) is an [Internet standard](https://en.wikipedia.org/wiki/Internet_standard) for [electronic mail](https://en.wikipedia.org/wiki/Email) (email) transmission. First defined by [RFC 821](https://tools.ietf.org/html/rfc821)in 1982, it was last updated in 2008 with [Extended SMTP](https://en.wikipedia.org/wiki/Extended_SMTP) additions by [RFC 5321](https://tools.ietf.org/html/rfc5321), which is the protocol in widespread use today.

Although electronic [mail servers and other mail transfer agents](https://en.wikipedia.org/wiki/Message_transfer_agent) use SMTP to send and receive mail messages, user-level client mail applications typically use SMTP only for sending messages to a mail server for [relaying](https://en.wikipedia.org/wiki/Message_transfer_agent). For retrieving messages, client applications usually use either [IMAP](https://en.wikipedia.org/wiki/Internet_Message_Access_Protocol) or [POP3](https://en.wikipedia.org/wiki/Post_Office_Protocol).

SMTP communication between mail servers uses port 25. [Mail clients](https://en.wikipedia.org/wiki/Email_client) on the other hand, often submit the outgoing emails to a mail server on port 587. Despite being deprecated, mail providers sometimes still permit the use of nonstandard port 465 for this purpose.

SMTP connections secured by [SSL](https://en.wikipedia.org/wiki/Transport_Layer_Security), known as [SMTPS](https://en.wikipedia.org/wiki/SMTPS), can be made using [STARTTLS](https://en.wikipedia.org/wiki/Opportunistic_TLS).[[1]](https://en.wikipedia.org/wiki/Simple_Mail_Transfer_Protocol#cite_note-1)

Although 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)) use their own non-standard protocols to access mail box accounts on their own mail servers, all use SMTP when sending or receiving email from outside their own systems.

# Internet Message Access Protocol

In computing, the **Internet Message Access Protocol** (**IMAP**) is an [Internet standard](https://en.wikipedia.org/wiki/Internet_standard) [protocol](https://en.wikipedia.org/wiki/Protocol_(computing)) used by [e-mail clients](https://en.wikipedia.org/wiki/E-mail_client) to retrieve [e-mail](https://en.wikipedia.org/wiki/E-mail) messages from a [mail server](https://en.wikipedia.org/wiki/Mail_server) over a [TCP/IP](https://en.wikipedia.org/wiki/Internet_protocol_suite) connection.[[1]](https://en.wikipedia.org/wiki/Internet_Message_Access_Protocol#cite_note-Network.2B_Guide_to_Networks-1) IMAP is defined by [RFC 3501](https://tools.ietf.org/html/rfc3501).

IMAP was designed with the goal of permitting complete management of an [email box](https://en.wikipedia.org/wiki/Email_box) by multiple email clients, therefore clients generally leave messages on the server until the user explicitly deletes them. An IMAP server typically listens on [port number](https://en.wikipedia.org/wiki/Port_number) 143. IMAP over [SSL](https://en.wikipedia.org/wiki/Secure_Sockets_Layer) (**IMAPS**) is assigned the port number 993.

Virtually all modern e-mail clients and [servers](https://en.wikipedia.org/wiki/Server_(computing)) support IMAP. IMAP and the earlier [POP3](https://en.wikipedia.org/wiki/POP3) (Post Office Protocol) are the two most prevalent standard protocols for email retrieval,[[2]](https://en.wikipedia.org/wiki/Internet_Message_Access_Protocol#cite_note-Red_Hat-2) with many [webmail](https://en.wikipedia.org/wiki/Webmail) service providers such as [Gmail](https://en.wikipedia.org/wiki/Gmail), [Outlook.com](https://en.wikipedia.org/wiki/Outlook.com) and [Yahoo! Mail](https://en.wikipedia.org/wiki/Yahoo!_Mail) also providing support for either IMAP or POP3.

# Post Office Protocol

# In computing, the Post Office Protocol (POP) is an [application-layer](https://en.wikipedia.org/wiki/Application_layer) [Internet standard](https://en.wikipedia.org/wiki/Internet_standard) [protocol](https://en.wikipedia.org/wiki/Protocol_(computing)) used by local [e-mail clients](https://en.wikipedia.org/wiki/E-mail_client) to retrieve [e-mail](https://en.wikipedia.org/wiki/E-mail) from a remote [server](https://en.wikipedia.org/wiki/Mail_server) over a [TCP/IP](https://en.wikipedia.org/wiki/Internet_protocol_suite) connection.[[1]](https://en.wikipedia.org/wiki/Post_Office_Protocol#cite_note-Network.2B_Guide_to_Networks-1) POP has been developed through several versions, with version 3 (POP3) being the last standard in common use before largely being made obsolete by the more advanced [IMAP](https://en.wikipedia.org/wiki/Internet_Message_Access_Protocol) as well as [webmail](https://en.wikipedia.org/wiki/Webmail).

# SQL injection

**SQL injection** is a [code injection](https://en.wikipedia.org/wiki/Code_injection) technique, used to [attack](https://en.wikipedia.org/wiki/Attack_(computing)) data-driven applications, in which nefarious [SQL](https://en.wikipedia.org/wiki/SQL) statements are inserted into an entry field for execution (e.g. to dump the database contents to the attacker).[[1]](https://en.wikipedia.org/wiki/SQL_injection#cite_note-1) SQL injection must exploit a [security vulnerability](https://en.wikipedia.org/wiki/Security_vulnerability) in an application's software, for example, when user input is either incorrectly filtered for [string literal](https://en.wikipedia.org/wiki/String_literal) [escape characters](https://en.wikipedia.org/wiki/Escape_sequence) embedded in SQL statements or user input is not [strongly typed](https://en.wikipedia.org/wiki/Strongly-typed_programming_language) and unexpectedly executed. SQL injection is mostly known as an attack [vector](https://en.wikipedia.org/wiki/Vector_(malware)) for websites but can be used to attack any type of SQL database.

SQL injection attacks allow attackers to spoof identity, tamper with existing data, cause repudiation issues such as voiding transactions or changing balances, allow the complete disclosure of all data on the system, destroy the data or make it otherwise unavailable, and become administrators of the database server.

In a 2012 study, it was observed that the average web application received 4 attack campaigns per month, and retailers received twice as many attacks as other industries.[[2]](https://en.wikipedia.org/wiki/SQL_injection#cite_note-2)

1. [What is a cookie?](http://whatismyipaddress.com/cookie)

An **HTTP cookie** (also called **web cookie**, **Internet cookie**, **browser cookie** or simply **cookie**) is a small piece of data sent from a website and stored on the user's computer by the user's [web browser](https://en.wikipedia.org/wiki/Web_browser) while the user is browsing. Cookies were designed to be a reliable mechanism for websites to remember [stateful](https://en.wikipedia.org/wiki/Program_state) information (such as items added in the shopping cart in an online store) or to record the user's browsing activity (including clicking particular buttons, [logging in](https://en.wikipedia.org/wiki/Access_control), or recording which pages were visited in the past). They can also be used to remember arbitrary pieces of information that the user previously entered into form fields such as names, addresses, passwords, and credit card numbers.

Other kinds of cookies perform essential functions in the modern web. Perhaps most importantly, **authentication cookies** are the most common method used by web servers to know whether the user is logged in or not, and which account they are logged in with. Without such a mechanism, the site would not know whether to send a page containing sensitive information, or require the user to authenticate themselves by logging in. The security of an authentication cookie generally depends on the security of the issuing website and the user's [web browser](https://en.wikipedia.org/wiki/Comparison_of_web_browsers#Vulnerabilities), and on whether the cookie data is encrypted. Security vulnerabilities may allow a cookie's data to be read by a [hacker](https://en.wikipedia.org/wiki/Hacker_(computer_security)), used to gain access to user data, or used to gain access (with the user's credentials) to the website to which the cookie belongs (see [cross-site scripting](https://en.wikipedia.org/wiki/Cross-site_scripting) and [cross-site request forgery](https://en.wikipedia.org/wiki/Cross-site_request_forgery) for examples).[[1]](https://en.wikipedia.org/wiki/HTTP_cookie#cite_note-1)

The tracking cookies, and especially [third-party tracking cookies](https://en.wikipedia.org/wiki/HTTP_cookie#Third-party_cookie), are commonly used as ways to compile long-term records of individuals' browsing histories – a potential [privacy concern](https://en.wikipedia.org/wiki/Internet_privacy#HTTP_cookies) that prompted European[[2]](https://en.wikipedia.org/wiki/HTTP_cookie#cite_note-2) and U.S. lawmakers to take action in 2011.[[3]](https://en.wikipedia.org/wiki/HTTP_cookie#cite_note-eulaw-3)[[4]](https://en.wikipedia.org/wiki/HTTP_cookie#cite_note-4) European law requires all websites targeting [European Union](https://en.wikipedia.org/wiki/European_Union) member states gain "informed consent" from users before storing non-essential cookies on their device.

1. [What is a firewall?](http://whatismyipaddress.com/firewall)

In [computing](https://en.wikipedia.org/wiki/Computing), a **firewall** is a [network security](https://en.wikipedia.org/wiki/Network_security) system that monitors and controls the incoming and outgoing network traffic based on predetermined security rules.[[1]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-1) A firewall typically establishes a barrier between a trusted, secure internal network and another outside network, such as the Internet, that is assumed not to be secure or trusted.[[2]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-Oppliger_1997_94-2) Firewalls are often categorized as either *network firewalls* or *host-based firewalls*. Network firewalls filter traffic between two or more networks; they are either [software appliances](https://en.wikipedia.org/wiki/Software_appliance) running on general purpose hardware, or hardware-based [firewall computer appliances](https://en.wikipedia.org/wiki/Computer_appliance#Types_of_appliances). Host-based firewalls provide a layer of software on one host that controls network traffic in and out of that single machine.[[3]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-3)[[4]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-4) Firewall appliances may also offer other functionality to the internal network they protect, such as acting as a [DHCP](https://en.wikipedia.org/wiki/DHCP)[[5]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-5)[[6]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-6) or [VPN](https://en.wikipedia.org/wiki/VPN)[[7]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-7)[[8]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-8)[[9]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-9)[[10]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-10) server for that network.[[11]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-11)[[12]](https://en.wikipedia.org/wiki/Firewall_(computing)#cite_note-12)

1. [What is a subnet?](http://whatismyipaddress.com/subnet)

# Subnetwork

A **subnetwork** or **subnet** is a logical subdivision of an [IP network](https://en.wikipedia.org/wiki/IP_network).[[1]](https://en.wikipedia.org/wiki/Subnetwork#cite_note-1) The practice of dividing a network into two or more networks is called **subnetting**.

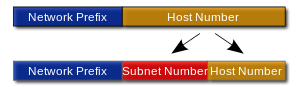
Computers that belong to a subnet are addressed with a common, identical, most-significant bit-group in their [IP address](https://en.wikipedia.org/wiki/IP_address). This results in the logical division of an IP address into two fields, a network or routing prefix and the "rest" field or host identifier. The rest field is an identifier for a specific [host](https://en.wikipedia.org/wiki/Host_(network)) or network interface.

The routing prefix may be expressed in [CIDR notation](https://en.wikipedia.org/wiki/CIDR_notation) written as the first address of a network, followed by a slash character (*/*), and ending with the bit-length of the prefix. For example, 192.168.1.0/24 is the prefix of the [Internet Protocol Version 4](https://en.wikipedia.org/wiki/IPv4) network starting at the given address, having 24 bits allocated for the network prefix, and the remaining 8 bits reserved for host addressing. The [IPv6](https://en.wikipedia.org/wiki/IPv6) address specification 2001:db8::/32 is a large address block with 296 addresses, having a 32-bit routing prefix.

For IPv4, a network may also be characterized by its **subnet mask**, which is the [bitmask](https://en.wikipedia.org/wiki/Bitmask) that when applied by a [bitwise AND](https://en.wikipedia.org/wiki/Bitwise_AND) operation to any IP address in the network, yields the routing prefix. Subnet masks are also expressed in [dot-decimal notation](https://en.wikipedia.org/wiki/Dot-decimal_notation) like an address. For example, 255.255.255.0 is the network mask for the 192.168.1.0/24 prefix.

Traffic is exchanged (*routed*) between subnetworks with special gateways ([routers](https://en.wikipedia.org/wiki/Router_(computing))) when the routing prefixes of the source address and the destination address differ. A router constitutes the logical or physical boundary between the subnets.

The benefits of subnetting an existing network vary with each deployment scenario. In the address allocation architecture of the Internet using [Classless Inter-Domain Routing](https://en.wikipedia.org/wiki/Classless_Inter-Domain_Routing) (CIDR) and in large organizations, it is necessary to allocate address space efficiently. It may also enhance routing efficiency, or have advantages in network management when subnetworks are administratively controlled by different entities in a larger organization. Subnets may be arranged logically in a hierarchical architecture, partitioning an organization's network address space into a tree-like routing structure.



1. [What is a Web browser?](http://whatismyipaddress.com/web-browser)

# Web browser

A **web browser** (commonly referred to as a **browser**) is a [software application](https://en.wikipedia.org/wiki/Software_application) for retrieving, presenting and traversing information resources on the [World Wide Web](https://en.wikipedia.org/wiki/World_Wide_Web). An *information resource* is identified by a [Uniform Resource Identifier](https://en.wikipedia.org/wiki/Uniform_Resource_Identifier) (URI/URL) that may be a [web page](https://en.wikipedia.org/wiki/Web_page), image, video or other piece of content.[[1]](https://en.wikipedia.org/wiki/Web_browser#cite_note-1) [Hyperlinks](https://en.wikipedia.org/wiki/Hyperlinks) present in resources enable users easily to navigate their [browsers](https://en.wikipedia.org/wiki/Browse) to related resources.

Although browsers are primarily intended to use the World Wide Web, they can also be used to access information provided by [web servers](https://en.wikipedia.org/wiki/Web_server) in [private networks](https://en.wikipedia.org/wiki/Private_network) or files in [file systems](https://en.wikipedia.org/wiki/File_system).

The most popular web browsers are [Google Chrome](https://en.wikipedia.org/wiki/Google_Chrome), [Microsoft Edge](https://en.wikipedia.org/wiki/Microsoft_Edge) (preceded by [Internet Explorer](https://en.wikipedia.org/wiki/Internet_Explorer)),[[2]](https://en.wikipedia.org/wiki/Web_browser#cite_note-2)[[3]](https://en.wikipedia.org/wiki/Web_browser#cite_note-3)[[4]](https://en.wikipedia.org/wiki/Web_browser#cite_note-4) [Safari](https://en.wikipedia.org/wiki/Safari_(web_browser)), [Opera](https://en.wikipedia.org/wiki/Opera_(web_browser)) and [Firefox](https://en.wikipedia.org/wiki/Firefox_(web_browser)).

1. [What is Ping?](http://whatismyipaddress.com/ping)
2. [What is a Web beacon?](http://whatismyipaddress.com/web-beacon)
3. [What is a User Agent?](http://whatismyipaddress.com/user-agent)
4. [What is Port?](http://whatismyipaddress.com/port)
5. [What is Port Forwarding?](http://whatismyipaddress.com/port-forwarding)
6. [What is a Traceroute](http://whatismyipaddress.com/traceroute)
7. [What is a Gateway?](http://whatismyipaddress.com/gateway)
8. [What is SIP?](http://whatismyipaddress.com/sip)
9. [What is SMTP?](http://whatismyipaddress.com/smtp)
10. [What is a Distributed Denial of Service Attack?](http://whatismyipaddress.com/ddos-attack)
11. [What are HTTP and HTML?](http://whatismyipaddress.com/http-html)
12. [What are data packets?](http://whatismyipaddress.com/data-packets)
13. [What is Dynamic DNS?](http://whatismyipaddress.com/dynamic-dns)
14. [What is FTP?](http://whatismyipaddress.com/ftp)
15. [What is PPP and PPPoE?](http://whatismyipaddress.com/ppp-pppoe)
16. [What does Link-Local Mean?](http://whatismyipaddress.com/link-local)
17. [What is Cryptography?](http://whatismyipaddress.com/cryptography)
18. [Mom, I need a "gaming" computer!](http://whatismyipaddress.com/gaming-pc)
19. [What is a gaming mouse?](http://whatismyipaddress.com/gaming-mouse)
20. [Get ready to buy a computer](http://whatismyipaddress.com/buying-computer)
21. [How much memory do you need?](http://whatismyipaddress.com/more-memory)
22. [How to speed up your slow PC](http://whatismyipaddress.com/faster-pc)
23. [How to clean up an email inbox](http://whatismyipaddress.com/inbox-cleanup)
24. [Learning to love the Cloud](http://whatismyipaddress.com/cloud-storage)
25. [When bad things happen to good computers](http://whatismyipaddress.com/viruses-malware)
26. [Did you know your computer has a name?](http://whatismyipaddress.com/computer-name)
27. [Should you buy a Mac or PC?](http://whatismyipaddress.com/mac-pc)
28. [Solve your basic computer problems](http://whatismyipaddress.com/computer-problems)
29. [Why you might want a password manager](http://whatismyipaddress.com/password-manager)
30. [A guide to buying a wireless router](http://whatismyipaddress.com/wireless-terms)
31. [Privacy tools for Google and Facebook](http://whatismyipaddress.com/privacy-tools)
32. [How to make Google Chrome more secure](http://whatismyipaddress.com/chrome-secure)
33. [How does anti-spam software protect you?](http://whatismyipaddress.com/antispam-software)
34. [Which websites protect your privacy?](http://whatismyipaddress.com/website-privacy)
35. [What is the Cloud?](http://whatismyipaddress.com/the-cloud)
36. [What's the difference between a router and a modem?](http://whatismyipaddress.com/router-modem)
37. [How to get more performance from your router](http://whatismyipaddress.com/router-ideas)
38. [Want your own website? Get a host](http://whatismyipaddress.com/hosting)
39. [How to report spam](http://whatismyipaddress.com/report-spam)
40. [Keeping your Router Safe](http://whatismyipaddress.com/router-problems)
41. [What is a Browser History?](http://whatismyipaddress.com/browser-history)
42. [What is a Router?](http://whatismyipaddress.com/router)
43. [What is Broadband Modem?](http://whatismyipaddress.com/broadband-modem)
44. [What are Data Caps?](http://whatismyipaddress.com/data-caps)
45. [Ten Tips for Taking Better Care of Your Laptop](http://whatismyipaddress.com/laptop-tips)
46. [Have you heard about USB-C?](http://whatismyipaddress.com/usb-c)
47. [What Is Hacking?](http://whatismyipaddress.com/hacking)
48. [Seven Scary Things Hackers Can Do to Your Computer](http://whatismyipaddress.com/hacking-targets)
49. [Signs You've Been Hacked](http://whatismyipaddress.com/hacking-signs)
50. [What to Do If You've Been Hacked](http://whatismyipaddress.com/hacked)
51. [Ashley Madison, hacked cars and more](http://whatismyipaddress.com/drivers-cheaters)
52. [Hackers are targeting small businesses](http://whatismyipaddress.com/smbusiness-hackers)
53. [Countries hacking other countries](http://whatismyipaddress.com/countries-hack)
54. [Home Depot got hacked? What does it mean?](http://whatismyipaddress.com/hackers-shopping)
55. [How do hackers get into computer systems?](http://whatismyipaddress.com/hacking-basics)
56. [A close look at the Home Depot hack](http://whatismyipaddress.com/homedepot-hack)
57. [Protect your company from hackers](http://whatismyipaddress.com/security-mistakes)
58. [Companies fight back against hackers](http://whatismyipaddress.com/fighting-back)
59. [What was the Heartbleed Bug virus?](http://whatismyipaddress.com/heartbleed)
60. [Five ways to keep hackers away](http://whatismyipaddress.com/beating-hackers)
61. [What is a hacktivist?](http://whatismyipaddress.com/hacktivist)
62. [Recent Fitbit and Time Warner Cable hack](http://whatismyipaddress.com/fitbit-twc)
63. [What is Scareware?](http://whatismyipaddress.com/scareware)
64. [What is Ransomware?](http://whatismyipaddress.com/ransomware)
65. [What is Vishing?](http://whatismyipaddress.com/vishing)
66. [What is MaaS?](http://whatismyipaddress.com/maas)
67. [What are hubs, routers and gateways?](http://whatismyipaddress.com/network-devices)
68. [How Internet firewalls work](http://whatismyipaddress.com/firewalls-work)
69. [What is Net Neutrality?](http://whatismyipaddress.com/net-neutrality)
70. [The ABCs of Encryption](http://whatismyipaddress.com/abc-encryption)
71. [What is a home server?](http://whatismyipaddress.com/home-server)
72. [What you should know about ports](http://whatismyipaddress.com/computer-ports)
73. [What is encryption?](http://whatismyipaddress.com/encryption)
74. [What is quantum computing?](http://whatismyipaddress.com/quantum-computing)
75. [The basics of network wireless security](http://whatismyipaddress.com/wireless-security)
76. [Computer "cookies" for the modern age](http://whatismyipaddress.com/new-cookies)
77. [What is Wi-Fi?](http://whatismyipaddress.com/wi-fi)
78. [How to optimize a home network](http://whatismyipaddress.com/home-network)
79. [How your emails get to someone's computer](http://whatismyipaddress.com/sending-email)
80. [How do our emails get from here to there?](http://whatismyipaddress.com/email-basics)
81. [How do businesses get fast Internet connections?](http://whatismyipaddress.com/corporate)
82. [What is an email header?](http://whatismyipaddress.com/email-header)
83. [What is spam?](http://whatismyipaddress.com/spam-botnet)
84. [You've Never Seen a Hotspot Like This](http://whatismyipaddress.com/link-nyc)
85. [The Weak Link in Computer Security](http://whatismyipaddress.com/weak-link)
86. [What is a Mail Server?](http://whatismyipaddress.com/mail-server)
87. [What is a Web Server?](http://whatismyipaddress.com/web-server)
88. [What is a DHCP?](http://whatismyipaddress.com/dhcp)
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