Cloud computing

**Cloud computing**, also known as 'on-demand computing', is a kind of Internet-based computing, where shared resources, data and information are provided to computers and other devices on-demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources.[[1]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-1)[[2]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-2)Cloud computing and storage solutions provide users and enterprises with various capabilities to store and process their data in third-party [data centers](https://en.wikipedia.org/wiki/Data_center).[[3]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-cloudid-3) It relies on sharing of resources to achieve coherence and[economies of scale](https://en.wikipedia.org/wiki/Economies_of_scale), similar to a utility (like the [electricity grid](https://en.wikipedia.org/wiki/Electrical_grid)) over a network.[[4]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-nist-4) At the foundation of cloud computing is the broader concept of [converged infrastructure](https://en.wikipedia.org/wiki/Converged_infrastructure) and [shared services](https://en.wikipedia.org/wiki/Shared_services).

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort.



Cloud computing metaphor: For a user, the network elements representing the provider-rendered services are invisible, as if obscured by a cloud.

Characteristics[[edit](https://en.wikipedia.org/w/index.php?title=Cloud_computing&action=edit&section=7" \o "Edit section: Characteristics)]

Cloud computing exhibits the following key characteristics:

* **Agility** improves with users' ability to re-provision technological infrastructure resources.[*[wtf?](https://en.wiktionary.org/wiki/WTF%22%20%5Co%20%22wikt%3AWTF)*]
* **Cost** reductions claimed by cloud providers. A public-cloud delivery model converts capital expenditure to [operational expenditure](https://en.wikipedia.org/wiki/Operational_expenditure).[[39]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-39) This purportedly lowers [barriers to entry](https://en.wikipedia.org/wiki/Barriers_to_entry), as infrastructure is typically provided by a third party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained, with usage-based options and fewer IT skills are required for implementation (in-house).[[40]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-idc-40) The e-FISCAL project's state-of-the-art repository[[41]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-41) contains several articles looking into cost aspects in more detail, most of them concluding that costs savings depend on the type of activities supported and the type of infrastructure available in-house.
* [**Device and location independence**](https://en.wikipedia.org/wiki/Device_independence)[[42]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-yarmis-42) enable users to access systems using a web browser regardless of their location or what device they use (e.g., PC, mobile phone). As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.[[40]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-idc-40)
* [**Maintenance**](https://en.wikipedia.org/wiki/Software_maintenance) of cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places.
* [**Multitenancy**](https://en.wikipedia.org/wiki/Multitenancy) enables sharing of resources and costs across a large pool of users thus allowing for:
	+ **centralization** of infrastructure in locations with lower costs (such as real estate, electricity, etc.)
	+ **peak-load capacity** increases (users need not engineer for highest possible load-levels)
	+ **utilisation and efficiency** improvements for systems that are often only 10–20% utilised.[[43]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-amazon-43)[[44]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-44)
* [**Performance**](https://en.wikipedia.org/wiki/Computer_performance) is monitored, and consistent and loosely coupled architectures are constructed using [web services](https://en.wikipedia.org/wiki/Web_services) as the system interface.[[40]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-idc-40)[[45]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-45)[[46]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-Elsevier.com-46)
* [**Productivity**](https://en.wikipedia.org/wiki/Productivity) may be increased when multiple users can work on the same data simultaneously, rather than waiting for it to be saved and emailed. Time may be saved as information does not need to be re-entered when fields are matched, nor do users need to install application software upgrades to their computer.[[47]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-Smith2013-47)
* **Reliability** improves with the use of multiple redundant sites, which makes well-designed cloud computing suitable for [business continuity](https://en.wikipedia.org/wiki/Business_continuity) and [disaster recovery](https://en.wikipedia.org/wiki/Disaster_recovery).[[48]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-48)
* **Scalability and**[**elasticity**](https://en.wikipedia.org/wiki/Elasticity_%28cloud_computing%29) via dynamic ("on-demand") [provisioning](https://en.wikipedia.org/wiki/Provisioning) of resources on a fine-grained, self-service basis in near real-time[[49]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-vmstartuptime2012-49)[[50]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-50) (Note, the VM startup time varies by VM type, location, OS and cloud providers[[49]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-vmstartuptime2012-49)), without users having to engineer for peak loads.[[51]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-51)[[52]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-52)[[53]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-He_15.E2.80.9322-53) This gives the ability to scale up when the usage need increases or down if resources are not being used.[[54]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-54)
* [**Security**](https://en.wikipedia.org/wiki/Computer_security) can improve due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels. Security is often as good as or better than other traditional systems, in part because providers are able to devote resources to solving security issues that many customers cannot afford to tackle.[[55]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-55) However, the complexity of security is greatly increased when data is distributed over a wider area or over a greater number of devices, as well as in multi-tenant systems shared by unrelated users. In addition, user access to security [audit logs](https://en.wikipedia.org/wiki/Audit_log) may be difficult or impossible. Private cloud installations are in part motivated by users' desire to retain control over the infrastructure and avoid losing control of information security.

Cloudcomputing Services ( Service models)

cloud-computing providers offer their "services" according to different models which happen to form a stack: infrastructure-, platform- and software-as-a-service]



Cloud-computing layers accessible within a stack

**Infrastructure as a service (IaaS)**

In the most basic cloud-service model - and according to the IETF (Internet Engineering Task Force) - providers of IaaS offer computers – physical or (more often) virtual machines – and other resources. IaaS refers to online services that abstract user from the detail of infrastructure like physical computing resources, location, data partitioning, scaling, security, backup etc. A[hypervisor](https://en.wikipedia.org/wiki/Hypervisor), such as [Xen](https://en.wikipedia.org/wiki/Xen), [Oracle VirtualBox](https://en.wikipedia.org/wiki/VirtualBox), [KVM](https://en.wikipedia.org/wiki/Kernel-based_Virtual_Machine), [VMware ESX/ESXi](https://en.wikipedia.org/wiki/VMware_ESX), or [Hyper-V](https://en.wikipedia.org/wiki/Hyper-V) runs the virtual machines as guests. Pools of hypervisors within the cloud operational system can support large numbers of virtual machines and the ability to scale services up and down according to customers' varying requirements. IaaS clouds often offer additional resources such as a virtual-machine [disk-image](https://en.wikipedia.org/wiki/Disk_image) library, raw [block storage](https://en.wikipedia.org/wiki/Block_storage), file or [object storage](https://en.wikipedia.org/wiki/Object_storage), firewalls, load balancers, IP addresses, [virtual local area networks](https://en.wikipedia.org/wiki/VLAN) (VLANs), and software bundles.[[59]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-DHAC-59) IaaS-cloud providers supply these resources on-demand from their large pools of equipment installed in [data centers](https://en.wikipedia.org/wiki/Data_centers). For [wide-area](https://en.wikipedia.org/wiki/Wide_area_network) connectivity, customers can use either the Internet or [carrier clouds](https://en.wikipedia.org/wiki/Carrier_cloud)(dedicated [virtual private networks](https://en.wikipedia.org/wiki/Virtual_private_network)).

To deploy their applications, cloud users install operating-system images and their application software on the cloud infrastructure. In this model, the cloud user patches and maintains the operating systems and the application software. Cloud providers typically bill IaaS services on a utility computing basis: cost reflects the amount of resources allocated and consumed.[[60]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-60)[[61]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-61)[[62]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-62)[[63]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-63)

**Platform as a service (PaaS)**

PaaS vendors offers a development environment to application developers. The provider typically develops toolkit and standards for development and channels for distribution and payment. In the PaaS models, cloud providers deliver a [computing platform](https://en.wikipedia.org/wiki/Computing_platform), typically including operating system, programming-language execution environment, database, and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers. With some PaaS offers like [Microsoft Azure](https://en.wikipedia.org/wiki/Microsoft_Azure) and [Google App Engine](https://en.wikipedia.org/wiki/Google_App_Engine), the underlying computer and storage resources scale automatically to match application demand so that the cloud user does not have to allocate resources manually. The latter has also been proposed by an architecture aiming to facilitate real-time in cloud environments.[[64]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-64)[[*need quotation to verify*](https://en.wikipedia.org/wiki/Wikipedia%3AVerifiability)] Even more specific application types can be provided via PaaS, such as media encoding as provided by services like bitcodin.com[[65]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-65) or media.io.[[66]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-66)

Some integration and data management providers have also embraced specialized applications of PaaS as delivery models for data solutions. Examples include **iPaaS** and**dPaaS**. iPaaS (Integration Platform as a Service) enables customers to develop, execute and govern integration flows.[[67]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-GartnerGlossary-67) Under the iPaaS integration model, customers drive the development and deployment of integrations without installing or managing any hardware or middleware.[[68]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-GartnerReferenceModel-68) dPaaS (Data Platform as a Service) delivers integration—and data-management—products as a fully managed service.[[69]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-ITBusinessEdge-69) Under the dPaaS model, the PaaS provider, not the customer, manages the development and execution of data solutions by building tailored data applications for the customer. dPaaS users retain transparency and control over data through [data-visualization](https://en.wikipedia.org/wiki/Data_visualization) tools.[[70]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-EnterpriseCIOForum-70)

Platform as a Service (PaaS) the consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

**Software as a service (SaaS)**

In the software as a service (SaaS) model, users gain access to application software and databases. Cloud providers manage the infrastructure and platforms that run the applications. SaaS is sometimes referred to as "on-demand software" and is usually priced on a pay-per-use basis or using a subscription fee.[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed%22%20%5Co%20%22Wikipedia%3ACitation%20needed)*]

In the SaaS model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. Cloud users do not manage the cloud infrastructure and platform where the application runs. This eliminates the need to install and run the application on the cloud user's own computers, which simplifies maintenance and support. Cloud applications differ from other applications in their scalability—which can be achieved by cloning tasks onto multiple [virtual machines](https://en.wikipedia.org/wiki/Virtual_machines) at run-time to meet changing work demand.[[71]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-hamdaqa-71) [Load balancers](https://en.wikipedia.org/wiki/Load_balancer) distribute the work over the set of virtual machines. This process is transparent to the cloud user, who sees only a single access-point. To accommodate a large number of cloud users, cloud applications can be [*multitenant*](https://en.wikipedia.org/wiki/Multitenant), meaning that any machine may serve more than one cloud-user organization.

The pricing model for SaaS applications is typically a monthly or yearly flat fee per user,[[72]](https://en.wikipedia.org/wiki/Cloud_computing%22%20%5Cl%20%22cite_note-Chou-72) so prices become scalable and adjustable if users are added or removed at any point.[[73]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-73)

Proponents claim that SaaS gives a [business](https://en.wikipedia.org/wiki/Business) the potential to reduce IT operational costs by outsourcing hardware and software maintenance and support to the cloud provider. This enables the business to reallocate IT operations costs away from hardware/software spending and from personnel expenses, towards meeting other goals. In addition, with applications hosted centrally, updates can be released without the need for users to install new software. One drawback of SaaS comes with storing the users' data on the cloud provider's server. As a result,[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed%22%20%5Co%20%22Wikipedia%3ACitation%20needed)*] there could be unauthorized access to the data. For this reason, users are increasingly[*[quantify](https://en.wikipedia.org/wiki/Wikipedia%3AManual_of_Style/Dates_and_numbers%22%20%5Co%20%22Wikipedia%3AManual%20of%20Style/Dates%20and%20numbers)*] adopting intelligent third-party [key-management](https://en.wikipedia.org/wiki/Key_management) systems to help secure their data.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)]

Software as a Service (SaaS) known as on-demand software, it provides the software service to the consumer hosted on cloud.

Cloud clients

Users access cloud computing using networked client devices, such as [desktop computers](https://en.wikipedia.org/wiki/Desktop_computers), [laptops](https://en.wikipedia.org/wiki/Laptop), [tablets](https://en.wikipedia.org/wiki/Tablet_computer) and [smartphones](https://en.wikipedia.org/wiki/Smartphones) and any Ethernet enabled device such as Home Automation Gadgets. Some of these devices  – *cloud clients* – rely on cloud computing for all or a majority of their applications so as to be essentially useless without it. Examples are [thin clients](https://en.wikipedia.org/wiki/Thin_clients) and the browser-based [Chromebook](https://en.wikipedia.org/wiki/Chromebook). Many cloud applications do not require specific software on the client and instead use a web browser to interact with the cloud application. With [Ajax](https://en.wikipedia.org/wiki/Ajax_%28programming%29) and [HTML5](https://en.wikipedia.org/wiki/HTML5) these [Web user interfaces](https://en.wikipedia.org/wiki/Web_user_interface) can achieve a similar, or even better, [look and feel](https://en.wikipedia.org/wiki/Look_and_feel) to native applications. Some cloud applications, however, support specific client software dedicated to these applications (e.g., [virtual desktop](https://en.wikipedia.org/wiki/Desktop_virtualization) clients and most email clients). Some legacy applications (line of business applications that until now have been prevalent in thin client computing) are delivered via a screen-sharing technology.

**Cloud computing types**

**Private cloud**

Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party, and hosted either internally or externally.[[4]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-nist-4) Undertaking a private cloud project requires a significant level and degree of engagement to virtualize the business environment, and requires the organization to reevaluate decisions about existing resources. When done right, it can improve business, but every step in the project raises security issues that must be addressed to prevent serious vulnerabilities. Self-run data centers[[74]](https://en.wikipedia.org/wiki/Cloud_computing%22%20%5Cl%20%22cite_note-74) are generally capital intensive. They have a significant physical footprint, requiring allocations of space, hardware, and environmental controls. These assets have to be refreshed periodically, resulting in additional capital expenditures. They have attracted criticism because users "still have to buy, build, and manage them" and thus do not benefit from less hands-on management,[[75]](https://en.wikipedia.org/wiki/Cloud_computing%22%20%5Cl%20%22cite_note-iwpc-75) essentially "[lacking] the economic model that makes cloud computing such an intriguing concept".[[76]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-76)[[77]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-77)

**Public cloud**

A cloud is called a "public cloud" when the services are rendered over a network that is open for public use. Public cloud services may be free.[[78]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-78) Technically there may be little or no difference between public and private cloud architecture, however, security consideration may be substantially different for services (applications, storage, and other resources) that are made available by a service provider for a public audience and when communication is effected over a non-trusted network. Generally, public cloud service providers like Amazon AWS, Microsoft and Google own and operate the infrastructure at their [data center](https://en.wikipedia.org/wiki/Data_center) and access is generally via the Internet. AWS and Microsoft also offer direct connect services called "AWS Direct Connect" and "Azure ExpressRoute" respectively, such connections require customers to purchase or lease a private connection to a peering point offered by the cloud provider.[[40]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-idc-40)

**Hybrid cloud**

Hybrid cloud is a composition of two or more clouds (private, community or public) that remain distinct entities but are bound together, offering the benefits of multiple deployment models. Hybrid cloud can also mean the ability to connect collocation, managed and/or dedicated services with cloud resources.[[4]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-nist-4)

[Gartner, Inc.](https://en.wikipedia.org/wiki/Gartner) defines a hybrid cloud service as a cloud computing service that is composed of some combination of private, public and community cloud services, from different service providers.[[79]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-79) A hybrid cloud service crosses isolation and provider boundaries so that it can't be simply put in one category of private, public, or community cloud service. It allows one to extend either the capacity or the capability of a cloud service, by aggregation, integration or customization with another cloud service.

Varied use cases for hybrid cloud composition exist. For example, an organization may store sensitive client data in house on a private cloud application, but interconnect that application to a business intelligence application provided on a public cloud as a software service.[[80]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-80) This example of hybrid cloud extends the capabilities of the enterprise to deliver a specific business service through the addition of externally available public cloud services. Hybrid cloud adoption depends on a number of factors such as data security and compliance requirements, level of control needed over data, and the applications an organization uses.[[81]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-81)

Another example of hybrid cloud is one where IT organizations use public cloud computing resources to meet temporary capacity needs that can not be met by the private cloud.[[82]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-82) This capability enables hybrid clouds to employ cloud bursting for scaling across clouds.[[4]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-nist-4) Cloud bursting is an application deployment model in which an application runs in a private cloud or data center and "bursts" to a public cloud when the demand for computing capacity increases. A primary advantage of cloud bursting and a hybrid cloud model is that an organization only pays for extra compute resources when they are needed.[[83]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-83) Cloud bursting enables data centers to create an in-house IT infrastructure that supports average workloads, and use cloud resources from public or private clouds, during spikes in processing demands.[[84]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-84)

The specialized model of hybrid cloud, which is built atop heterogeneous hardware, is called "Cross-platform Hybrid Cloud". A cross-platform hybrid cloud is usually powered by different CPU architectures, for example, x86-64 and ARM, underneath. Users can transparently deploy and scale applications without knowledge of the cloud's hardware diversity.[[85]](https://en.wikipedia.org/wiki/Cloud_computing#cite_note-85) This kind of cloud emerges from the raise of ARM-based system-on-chip for server-class computing.

How to build a FREE Private Cloud using Microsoft Technologies

to build your own cloud using Microsoft components, then besides having hardware (which in most cases would become your performance and expansion limiting factor) you need to MS Hypervisor ( Hyper-V ) tool from windows server or use windows azure.

Microsoft Azure

Microsoft Azure (formerly Windows Azure ) is a [cloud computing](https://en.wikipedia.org/wiki/Cloud_computing) service created by [Microsoft](https://en.wikipedia.org/wiki/Microsoft) for building, testing, deploying, and managing applications and services through a global network of Microsoft-managed [data centers](https://en.wikipedia.org/wiki/Data_center). It provides [software as a service (SaaS)](https://en.wikipedia.org/wiki/Software_as_a_service), [platform as a service (PaaS)](https://en.wikipedia.org/wiki/Platform_as_a_service) and [infrastructure as a service (IaaS)](https://en.wikipedia.org/wiki/Infrastructure_as_a_service) and supports many different [programming languages](https://en.wikipedia.org/wiki/Programming_language), tools and frameworks, including both Microsoft-specific and third-party software and systems.