

Cloud Computing for Everyone

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In recent years, cloud computing has been an important growth area in the Information Technology (IT) industry. Generally, the word “cloud” refers to computing powers on the other end of a computer network. Almost always, we are talking about well-organized hardware, software, services, and know-how across the Internet for the purpose of reducing, supplementing, or complementing local computing resources. Cloud-based resources are not pinned down at any fixed location and can be floating anywhere on the Internet. Perhaps that is why the word *cloud* is used.

How did cloud computing emerge? Who needs it? For what purposes? Advantages and disadvantages? Why should I care? We’ll try to answer some of these questions here in this 7th article of the *computational thinking* (CT) series (past articles in aroundkent.net Vol. 13 to 18).

Computing Paradigms

In the early days, computers were large and expensive. They were housed and maintained by computer centers with highly trained staff. These are known as *mainframe* computers. Users accessed a mainframe by CRT-screen-and-keyboard *terminals* and shared its computing powers. Such terminals were connected to the computer center by physical cables and could display only characters, no bitmap graphics or mouse yet.

Miniaturization and large-scale integration of digital electronics brought rapid changes. The capacities of CPUs, memory units, and displays increased and their prices dropped at an astonishing rate. The Apple II and the IBM PC were among the first *personal computers* introduced back in the early 1980s. They started to shift computing from the mainframe paradigm to the

PC paradigm where users had the whole computer— hardware, software, storage and display—all to themselves.

Meantime, in the late 1980s, the Internet began to take shape. Based on the ARPANET (funded by the Advanced Research Projects Agency of the US Defense Department), the NSFnet, the US National Science Foundation’s network of universities and supercomputing centers, helped create an explosive number of local and regional networks governed by the Internet Protocol (IP). Eventually, the Internet became so dominant that it virtually eliminated all historical rivals, such as BITNET and DECnet.

In late 1991, the World-Wide Web (WWW), an Internet-based service, started to take root. The Internet and the Web quickly grew and became ubiquitous globally, affecting almost every aspect of our daily lives.

Computing thus entered the *Internet paradigm*, combining PCs, smartphones, the Internet, and the Web into a comprehensive computing environment. The new computing paradigm brought online email (hotmail, gmail for example), voice and video calls (Skype, Google Hangout for example), social networking (Facebook, Tweeter for example), Audio/Video sharing (Youtube, Vimeo for example), and much more. Many of these capabilities are free for individual users.

Cloud Computing

The stage was then set for the next computing paradigm, *cloud computing* (Figure 1), a confusing yet fascinating term. The *MIT Technology Review* article “*Who Coined ‘Cloud Computing’?*” traces the interesting history of the term. However, in short,

The notion of network-based computing dates to the 1960s, but many believe the first use of “cloud computing” in its modern context occurred on August 9, 2006, when then Google CEO Eric Schmidt introduced the term to an industry conference.

For a business, owning and operating all the computing hardware and software in-house can be expensive in terms of infrastructure, operation, management, maintenance, and upgrade. This is especially true for medium and small enterprises. The speed and bandwidth of the modern Internet make it possible to access and use remote (non-local) computing powers located somewhere across the Internet—that is *in the cloud*.



Figure 1: Reaching for the Cloud

This means people in a company can access all the computing powers in the cloud with a PC or a Chromebook.

A Closer Look at the Cloud

Technology companies, such as Amazon (AWS), Cisco, Google, IBM, Oracle, Microsoft (Azure), Apple (iCloud), CloudBees, Rackspace, SAP, Alibaba and many others, have the economy of size to supply cost-effective cloud computing services on the Internet. Subscribers of cloud computing, organizations or individuals, simply enjoy the computing power, usually for a reasonable fee. And the rented services are available 24×7, accessible anywhere on the Internet from a desktop, laptop, Chromebook, tablet, or smartphone. Reaching the cloud is simple. Usually you will use a Web browser such as Google Chrome, Firefox, Microsoft Edge, or Apple Safari and login to your cloud account.

For businesses large and small, cloud computing can be an attractive alternative to owning, staffing, and operating their own IT equipment in house. Promoters of cloud computing ask, “If you need milk, would you own a cow?” Just get the milk (the computing power you need) and let someone else worry about the cow (everything related to providing the milk).

Cloud service providers (CSPs) offer many types of products (Figure 2) including:

- *Cloud storage*—Distributed, virtual, reliable, and fault tolerant data storage easily accessible on the Internet/Web. Dropbox and Google Drive are well-known examples. Often, cloud storage is also combined with file sharing, management and/or system backup/restore functions.
- *Software as a service* (SaaS)—Software running on cloud servers accessible on-demand to subscribers, typically through a thin client via a Web browser. SaaS software performs office productivity (Microsoft Office 365 for example), customer relationship management, computer aided design, database management, human resource management, and many other tasks.
- *Platform as a service* (PaaS)—Virtual hardware-software servers, typically complete with operating system, application programming and execution environment, database, and Web server. Customers can control and use the platform as well as develop custom applications on it.
- *Infrastructure as a service* (IaaS)—Virtual IT data centers complete with maintained servers, storage, and network facilities. On such infrastructure, a customer can install operating systems and develop and deploy their own applications.

Advantages and Disadvantages

Thus, we can say the term *Cloud Computing* usually refers to leased, usage-based, computing powers accessed via the Internet that supplement or replace in-house facilities.

Cloud computing has clear advantages and disadvantages, as compared to in-house solutions.

The top advantages are: less up-front investment, faster to set up and start, fewer IT personnel and equipment, more reliable and physically secure, global anytime access, easy information sharing and collaboration, and simple to scale up or down. Perhaps best of all, there can be much less bother and expense for hardware/software installation, operation, update, maintenance, security, and user help.

Disadvantages are: relying on cloud service providers for privacy and security, less in-house control of IT services, lower, often unpredictable, network speed (compared to in-house LAN), limitations of applications running remotely rather than locally.

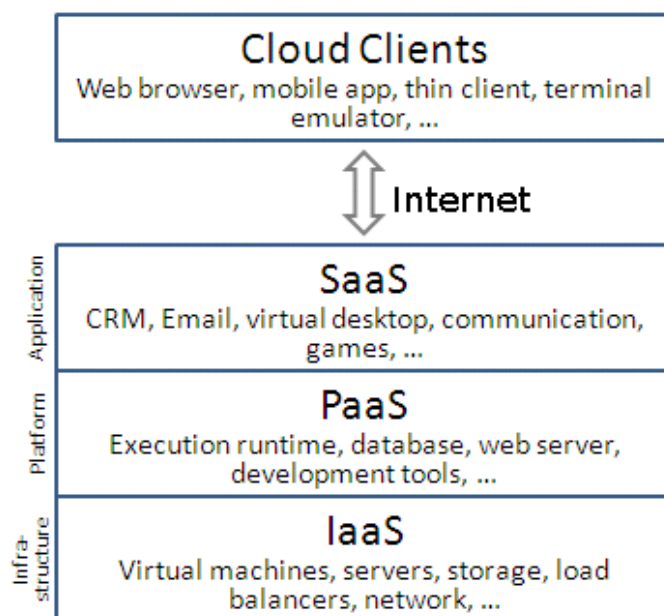


Figure 2: Cloud-Based Services

Cloud computing is a growing industry. It makes sense for the right tasks and can be cost effective and more convenient. Individuals and IT professionals will need to weigh the pros and cons and pick the right cloud solutions. Often, a combination of in-house platforms, private cloud, and public cloud can be the best choice. Free and open cloud software, such as FOSS-Cloud (foss-cloud.org) and others, makes it much easier to create your own cloud services.

Understanding cloud computing brings more computational thinking (CT) ideas to the fore such as:

- CT idea: *You don't have to bring it with you when you can access it from anywhere.*
- CT idea: *Physical locations are no longer so important or distancing.*
- CT idea: *A computer is almost useless without access to the Internet.*
- CT idea: *Data storage on the cloud has many advantages.*

Applying CT, we can rethink the modern airliners' voice and data recorders, commonly known as "black boxes." After an accident, locating or retrieving

the all-important black boxes often becomes difficult or even impossible. Why not use “*cloud black boxes*” (Figure 3) instead? Important data can be



Figure 3: Airliner to Cloud Communication

sent securely from planes in flight to cloud storage on a continuous basis. Hence, there won't be any need to search for the black boxes. With real-time data, we can better monitor airliners, control flights, and manage our airspace.

Cloud Services for Individuals

Perhaps the most well-known is Dropbox, a cloud storage service (Figure 4) started in 2008. According to a 2019 *CNBC Tech* article, “*Dropbox started with a couple of checks written for \$15,000—today it’s worth \$12 billion.*” The free *Dropbox Basic* plan provides 2.5 GB of storage for an individual user. You can easily upload/download files, place files in different folders, and manage them just like you can on your own hard drive. Plus, you can share selected files publicly, with specific people, or invite others to access your dropbox in allowable ways.

Dropbox saves your files securely with encryption. It also help you store and manage photos and videos. Additionally, you can automatically backup/restore your files, known as *file syncing*. You can add more storage space for a fee.

Similar cloud storage and file sharing providers include Google Drive, Amazon Drive, Box, and others. Streaming services, freely available to the

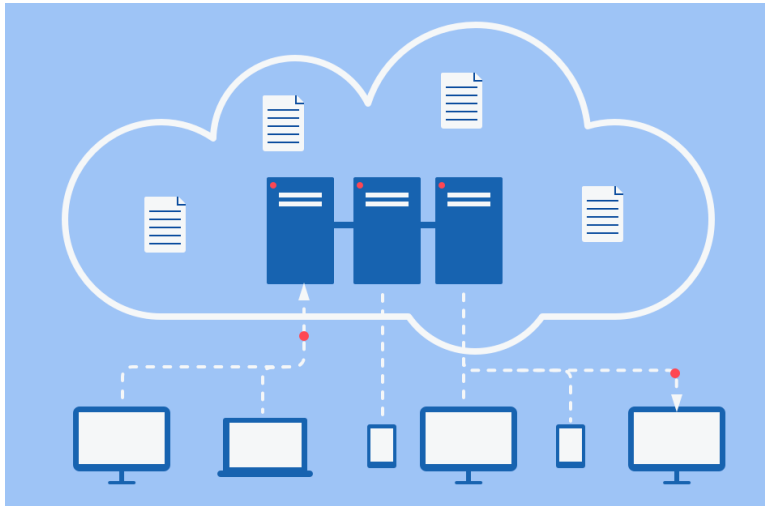


Figure 4: Cloud Data Storage

public to upload and share audio/video contents, include YouTube, Vimeo, Dailymotion, and more. Web-based email services and productivity suites provide individuals with email, document creation, and collaboration tools. Examples include Gmail, Outlook.com, and Google Workspace.

Cloud Applications for Companies

Increasingly companies are moving away from owning and operating their own computer centers toward relying on cloud-based services, including *Amazon Elastic Compute Cloud* and *Microsoft Azure Virtual Machines*. Here is a list of cloud applications popular with businesses:

- **Customer Relationship Management (CRM):** CRM systems help businesses manage their customer relationships, sales pipelines, and marketing efforts. Examples include Salesforce, HubSpot, and Microsoft Dynamics 365.
- **Enterprise Resource Planning (ERP):** ERP applications integrate various business functions like finance, HR, inventory, and supply chain management. Examples include SAP Business One, Oracle NetSuite, and Microsoft Dynamics 365 Finance and Operations.

- **Project Management and Collaboration:** These applications facilitate team collaboration, task management, and project tracking. Examples include Asana, Trello, and Microsoft Teams.
- **File Storage and Sharing:** Cloud storage services allow businesses to store, access, and share files securely across teams and devices. Examples include Google Drive, Dropbox, and Microsoft OneDrive.
- **Business Intelligence and Analytics:** These applications enable data analysis and visualization to gain insights into business performance. Examples include Tableau, Power BI, and Google Analytics.

Success of Cloud Computing

The future of cloud computing? Sky is the limit.

The trend is that all kinds of computing are increasingly using the cloud or become effective and useful because of the cloud. According to a Glob-Newswire article, “*the cloud computing market is to reach USD 2,321.1 Billion by 2032.*” And an April 2023 statista article stated “*The global revenue in the public cloud market was forecast to continuously increase between 2023 and 2027 by in total 356.2 billion U.S. dollars (+67.77 percent). According to this forecast in 2027, the revenue will have increased for the fourth consecutive year to 881.79 billion U.S. dollars.*” Here are five well-known cloud computing businesses:

- **Amazon Web Services (AWS):** AWS is a subsidiary of Amazon.com and has been a dominant player in the cloud computing market. It offers a wide range of services, including computing power, storage, and databases. As of 2021, AWS was the largest cloud computing provider in terms of market share.
- **Microsoft Azure:** Microsoft Azure is a cloud computing platform provided by Microsoft. It offers a comprehensive suite of services for building, deploying, and managing applications and services through Microsoft-managed data centers. Azure has experienced significant growth in recent years and has been competing closely with AWS for market share.
- **Google Cloud Platform:** Google Cloud Platform is the cloud computing service offered by Google. It provides a suite of cloud-based services,

including computing power, data storage, machine learning, and analytics. While Google Cloud Platform has been gaining market share, it generally ranked behind AWS and Azure in terms of size.

- **IBM Cloud:** IBM Cloud is the cloud computing platform offered by IBM. It provides a range of services, including infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS). IBM has been a longstanding player in the enterprise computing market, and its cloud services cater to businesses of various sizes.
- **Alibaba Cloud:** Alibaba Cloud, a subsidiary of Alibaba Group, is one of the leading cloud computing providers in China and has been expanding globally. It offers a broad range of cloud services, including data storage, database services, and artificial intelligence capabilities. Alibaba Cloud has been particularly influential in the Asian market.

As of May 2023, the market shares of these cloud computing business are estimated to be: Amazon Web Services (34%), Microsoft Azure (22%), Google Cloud Platform (9.5%), Alibaba Cloud (6%).

Finally

The world of computing advances with time:

**Mainframe Computing \implies PC Computing \implies Internet/Web
Computing \implies Cloud Computing**

Why not explore what's available that you, your business, or your company can use? When using the cloud, be extra careful about security and privacy of your data. Our other article "*Cyber Security—How Not to Be A Fish*" can be very helpful.