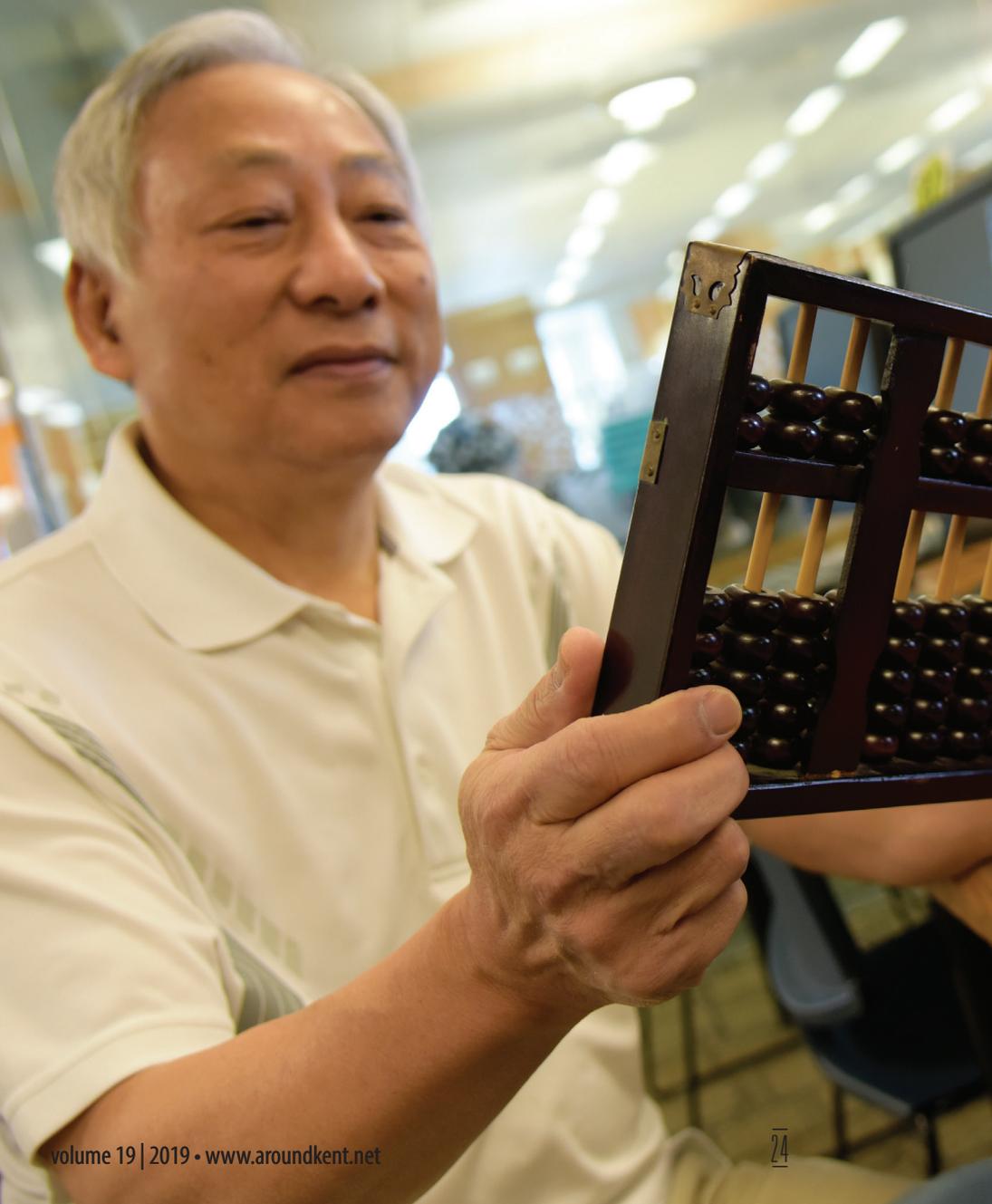


Cloud Computing For Everyone



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Introduction

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, smart-phones, 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, 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*.

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 24x7, 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 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.

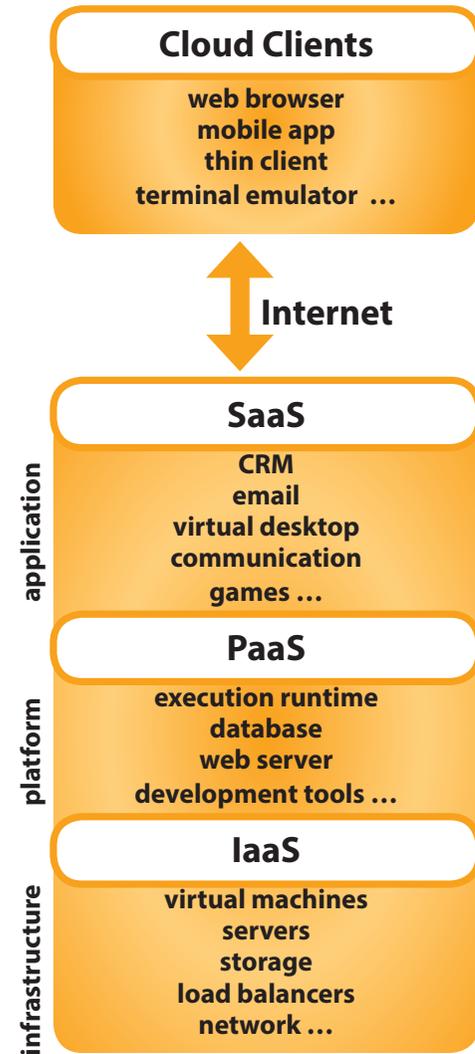
Software as a Service (SaaS) Software running on cloud servers accessible on-demand to subscribers, typically through a thin client via a Web browser. SaaS software performs office productivity (Microsoft Office 365 for example), customer relationship management, computer aided design, database management, 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.

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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.

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: You don't have to bring it with you when you can access it from anywhere.

CT: Physical locations are no longer so important or distancing.

CT: A computer is almost useless without access to the Internet.

CT: 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" instead? Important data can be 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.

Free Cloud Services for Individuals

Perhaps the most well-known is Dropbox, a cloud storage service started in 2008. According to a 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 public to upload and share audio/video contents, include YouTube, Vimeo, Dailymotion, and more.

Cloud-based services are increasingly being made available for businesses and individuals. These include tax return preparation, accounting, finance, task/project management, budgeting, photo/art processing, and many more, even interactive Web-based mathematics education (WME)—an early example of cloud-based expertise. For example, the *aroundKent Magazine* uses *issuu*, a digital discovery and publishing cloud platform, to store and share its extensive set of archived articles.

In summary, the world of computing advances with time:

Mainframe Computing → PC Computing → Internet/Web Computing → Cloud Computing

The future of cloud computing? Sky is the limit. According to Gartner, an IT research/advisory company, worldwide public cloud revenue is forecast to grow from \$305.8 billion (2018) to \$411.4 billion (2020). Why not explore what's available that you can use? When using the cloud, be extra careful about security and privacy of your data. A previous CT article on cyber security may be helpful.

I hope you find this article useful and please feel free to email your feedback to me at pwang@sofpower.com. ■

A Ph.D. and faculty member from MIT, Paul Wang became a Computer Science professor (Kent State University) in 1981, and served as a Director at the Institute for Computational Mathematics at Kent from 1986 to 2011. He retired in 2012 and is now professor emeritus at Kent State University and IT consultant.