Cloud Computing

This article is part of the Digitalization Applications 101 Technology Training Course, which provides a comprehensive understanding on the basic concepts of digitalization terminologies, technologies and its applications in the steel industry. The course was developed by the Digitalization Applications Technology Committee as an introductory course to educate industry personnel in digitalization.

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Cloud computing is one of the key pillars of digital transformation. This document defines cloud computing, reviews the history and technologies used, and provides examples of applications used in the metals industry.

A 2011 National Institute of Standards and Technology (NIST) publication defines cloud computing as "… 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 or service provider interaction. This cloud model is composed of five essential characteristics, three service models and four deployment models."[1]

The five essential characteristics referenced in this definition include on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service.

The three basic service models of cloud computing are software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS). Subsequent to the publication of the above definition, additional derivative "as-a-service" models have been introduced including anything as a service (XaaS), malware as a service (MaaS), database as a service (DBaaS) and many more.

The four deployment models referenced are private cloud, community cloud, public cloud and a hybrid cloud.

History

The history of cloud computing can be traced back to efforts by the Advanced Research Projects Agency Network in 1966. This government-funded initiative looked to enable access between remote computers through the use of network packets.[2] One of the inspirations for this effort was the concept of an Intergalactic Computer Network proposed by computer scientist J.C.R. Licklider in a 1963 memo. Further work by the Defense Advanced Research Projects Agency and Stanford University in the 1970s resulted in the creation of Transmission Control Protocol (TCP) and the Internet Protocol (IP), most often seen as TCP/IP. TCP/IP as an approach won over Token-Ring and other competitors of the time. With these networking fundamentals in place, time-share systems in the 1970s and 80s flourished, and many equipment manufacturers developed networking features primarily between their own equipment.

In the 1990s, the term "cloud" began to appear in discussion of networking and program and data sharing. A 1994 *Wired* magazine article referenced "the entire cloud out there" in regard to a distributed programming language.[3] An internal Compaq document in 1995 referenced "cloud computing."[4]

Amazon's 2006 release of Elastic Cloud Computing drove the term cloud computing into the popular lexicon.

Technologies/Implementations

Over the course of years, many technologies emerged to provide the underlying infrastructure to

support the proliferation of cloud computing. This included improvements in communication networks with high bandwidth, fiber optics, wireless and satellite capabilities. Continual increases in computing power (Moore's Law) made data center equipment (i.e., central processing unit (CPU), storage, cooling) smaller, faster and more efficient. Virtualization provided the important ability to share, maximize and expand on-demand resource utilization. Arguably, the most import enabling technology was the development of networking fundamentals like TCP/IP that enabled the fast, secure and accurate transmission of data between remote systems.

The combined technologies discussed above allowed for the development of deployment and service models that are part of the NIST definition of cloud computing.

Fig. 1 shows the three main deployment models for cloud computing: a public cloud, a private cloud and a hybrid cloud. The fourth type, community cloud, is a derivative of the hybrid cloud. Many variables influence the choice of cloud environment including cost, security, data concerns, workforce, type of business and others. The following are some basic definitions and considerations.

Public Cloud — Services are shared by multiple organizations and accessed over the internet. Virtualization is often used to build the services. The public cloud companies maintain and manage the information technology (IT) infrastructure required.

Private Cloud — Cloud services used by a single organization that are not exposed to the public. The individual organization is responsible for the management of the IT environment. Private clouds can be on-premise or off-premise and can even be provided through a public cloud as shown in Fig. 1.

Hybrid Cloud — Hybrid clouds are designed to use the best attributes of the public and private environments to meet the organization's needs. An enterprise's confidential data can be stored securely in a private cloud, while client-facing systems could be maintained in a public cloud environment.

The current convention is to refer to applications and resources offered in the cloud as services. The three main offerings of cloud services are infrastructure as a service, platform as a service and software as a service. Fig. 2 depicts the three main cloud services, and includes some well-known examples of each. There are many other "as-a-service" offerings now available; however, they generally fit into one of the following models.

Infrastructure as a Service — Clients lease network, storage and computing power from a third-party data center. Storage, CPU and network capability can be available on demand, self-provisioned and tracked.

Platform as a Service — Clients access development tools, operating systems, databases and other environments.

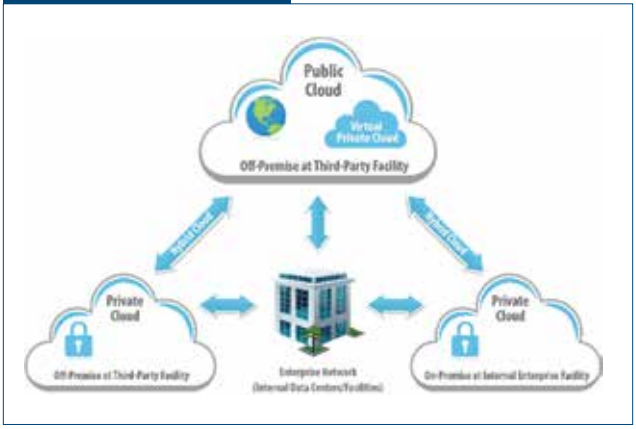
Software as a Service — Probably the most familiar of cloud services. Clients access applications over the internet or private network.

Example Applications

The following are two examples of metals industry companies using cloud computing in their operations. Each example identifies the type of cloud and services used, the challenges encountered and the benefits received.

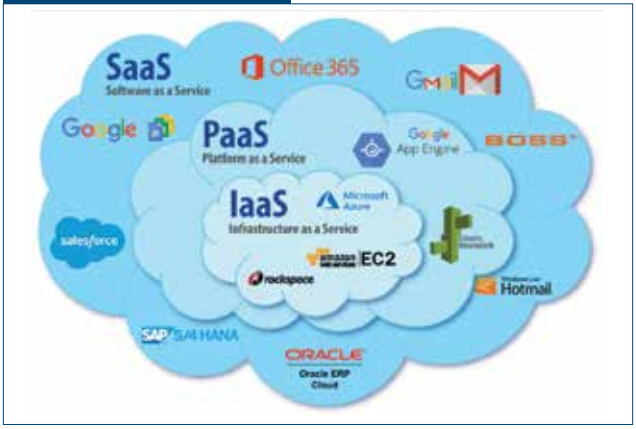
Metal Producer Spinout — A multi-plant metal producer spinout needed to replace all enterprise systems

Figure 1



Cloud computing deployment models.

Figure 2



Three types of cloud services.

quickly. They developed a solution using IaaS, PaaS and SaaS, residing on public, private and hybrid clouds. Challenged with a short timeline, tight budget and a small staff, the cloud solution provided strong functionality with a low initial cost outlay, and included a built-in support and a maintenance infrastructure.

The cloud services used: IaaS-hosted enterprise resource planning (ERP), PaaS ERP development and business intelligence (BI) tools, SaaS maintenance/asset management, time and attendance, raw material optimization, and disaster recovery/business continuity (DR/BC).

Challenges included performance and reliability issues tied to an internet service provider. Some vendors were excluded due to inadequate service level agreements. One SaaS offering did not meet expectations, but the contract had to be honored.

The company was able to deploy the necessary enterprise systems quickly. Systems were robust, reliable and supportable with a small staff. The resultant security and controls features were much stronger, leveraging the expertise of the vendors, than could have been accomplished with the limited internal staff.

Big Data — Big Analytics Projects — Multiple steel companies are using cloud computing capabilities to conduct trials. When successful, those projects are scaled and expanded to additional facilities. A big data — big analytics project was initiated to improve a rolling mill setup model. Data was transmitted to a private cloud platform, where analytics and artificial intelligence modeling were invoked to generate mill setup parameters. The new parameters were transferred back to the on-premise control system.

The cloud services used: PaaS — BI, database and visualization tools; SaaS — modeling application; and expert support.

Challenges including finding viable operational problems that could be addressed through cloud computing in an economical manner. Finding internal resources to execute the project was also difficult.

Cost savings were recognized by using the PaaS BI and database tools. Getting process data and tools into the cloud allowed for a geographically diverse team to collaborate on the analysis and model building.

Summary

Cloud computing is one of the central pillars of the digital transformation phenomenon. Many well-known components of digital transformation use, or are based on, cloud computing platforms. Cloud computing is certainly ubiquitous. People interact every day with cloud-based systems whether they realize it or not — from the storage on their phones to global positioning system to smart speakers in their homes.

The varied deployment models of cloud computing provide great flexibility to meet economic, security, collaborative and other requirements of users. Solutions can be provided on a public, private or hybrid cloud, each having unique pros and cons.

The ability to provision software, infrastructure and platform services on the cloud has been a game changer in terms of costs and delivery time. Within 15 minutes of a call to any major cloud provider, one can have a complete technology stack setup to host a website, collect and analyze data, or to spin-up a contract management system. The ability to load operating systems, databases and development platforms can be included in the costs. Many of the SaaS offerings are robust and reliable due to continual use and exercise by many users.

As of this writing, there are more examples of IT solutions using cloud computing over operational technology projects. Understanding the economics of cloud computing for specific applications is important. Dropbox, a file hosting service, migrated from a third-party public cloud to their own private cloud for a purported US$75 million per year savings.

The use of cloud computing continues to grow. The ability to work from wherever you are, ensuring the security and integrity of data, and consistent, stable access to important systems are more important now than ever.

References

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