

1. Introduction

Cloud is analogical to internet. Cloud computing is internet based computing where virtual shared servers provided software, infrastructure, platform, devices and other

resources and hosting to customers on a pay-as-you-use basis. Cloud computing customers do not own the physical infrastructure rather they rent the usage from a third party provider. They use resources as a service for performing a task and pay only for what they are utilizing. IT organization vendors provide services to the customers which are in turn utilized by customers on pay-per-use basis. Customers can access these services provided by vendors using web-browser. Huge amount of data is stored in many cloud servers and the collection of servers forms a Data center.

The services provided by vendors can be classified in three models that actually depict how services are being provided to the customers. Service models are service oriented architecture that tells us about the different level of abstraction. They are as follows:-

1.1 Platform as a Service (PaaS)

PaaS supplies all the resources required to build applications and services completely by using internet without having to download or install software. PaaS services include application design, development and hosting. Other services include collaboration, web service integration, DB integration, security, scaling etc.

Users don't have to worry about purchasing hardware and software or hire experts for management of the software and hardware, it provides flexibility in installing software on system, scalability is another advantage of the PaaS. A downfall of the PaaS is the lack of interoperability and portability among providers.

1.2 Software as a Service (SaaS)

Software as a service is the model in which an application is hosted as a service to customers who access it via the internet. It provides us the facility of using different software application, operating system and resources without the need of installing them on your own machine, upgrading and buying licensees.

1.3 Infrastructure as Service (IaaS)

This model is responsible for providing virtualized computing resources, network resources with IaaS users assemble their own virtual cluster on which they are responsible for installing, maintaining and executing their own virtual cluster on which they are responsible for installing, maintaining and executing their own software stack. IaaS uses different tools for virtualizing and converting physical resources to logical resources that can be provisioned and published to customers as needed.

2. Classification of Cloud Computing Deployment Models

We can classify the cloud computing system in 4 categories, they are as follows:-

2.1 Public Cloud

In this deployment model services and infrastructures are made available to different types of customers and used publicly by general people/users. This type of cloud is managed by cloud services provider offering services to the consumers on pay-per-use

basis. Consumers are considered authorized by default, so security and privacy are big issues in it. Examples of public cloud are Amazon EC2, Google App Engine etc.

2.2 Private Cloud

In this type of cloud the computing resources are used and operated exclusively by one organization owning that cloud. It is more secured than public clouds because their users are trusted users inside the organization. Examples of private cloud are IBM cloud, Microsoft cloud, any private institutional cloud etc.

2.3 Community Cloud

In community model the infrastructure is shared by several organizations with the same policy and compliance considerations. This helps to further reduce cost as compared to a private cloud, as it is shared by large groups. Various state level government departments requiring access to the same data relating to roads, hospitals, electrical stations infrastructures use community model for gathering information.

2.4 Hybrid Cloud

This deployment model helps business to take advantage of secured applications and data hosting on private cloud, while still enjoying cost benefits. An organization may store sensitive client data in house on a private cloud application, but inter-connect that application to a billing application provided on a public cloud as a software service.

Table 1: Comparison of Cloud Computing Deployment models.

Deployment Model	Scope of Services	Managed by	Security Level
Public model	General public and large industry groups	Cloud service provider	low
Private model	Single organization	Single organization	high
Community model	Organization those share the same policy, mission and same security aspects	Several organization or Cloud service providers	high
Hybrid model	Organization and public	Organization and public	medium

5. Applications of Cloud Computing

Cloud Computing is one of the most dominant field of computing resources online because sharing and management of resources is easy using cloud. These properties have made it an active component in the following fields as follows:-

5.1 E-Learning

It is a new trend in the field of education that provides an attractive environment for students, faculty members, and researchers. Students, faculty members, researchers can connect to the cloud of their organization and access data and information from there.

5.2 Enterprise resource planning (ERP)

Use of Cloud in ERP comes into existence when the business of any organization grows. The work of managing applications, human resources, payroll etc becomes expensive and complex. To overcome it service providers can install ERP in the cloud itself.

5.3 E-Governance

Cloud computing can improve the functioning of a government by improving the way it provides the services to its citizens, institutions and cooperation with other governments. This can be done by expanding the availability of environment, making environment more scalable and customized. It also cut off the burden of managing, installing and upgrading applications.

Table 2: Different applications of cloud computing.

Application	Services provided
E-learning	E-mail, simulation tools, files broadcasting, class recording, virtual classrooms, virtual labs, surveys, education forums
ERP Cloud	Supply chain and vendor, project and HR Management, customer Relationship management, finance and accounting
E-governance	Complaint resolution system, employee management system, E-police, E-court, payment and tax system, agriculture and food, industry and energy

Cloud-based services and applications

1. Healthcare

The health care environment is changing faster than ever before due to the demand of delivering higher quality medical services for less money, and increased competitiveness between health care services providers. Hospitals, research clinics, private health care institutions and doctors are looking for solutions to increase daily activities, efficiency and decrease their spending. Thus, cloud computing provides to the health care environment the opportunity to improve services for patients, to easily share information, to improve operational efficiency, and to streamline costs.

What advantages does cloud computing offer for the health care industry?

- 1. Collaboration.** In many cases specific information may be needed in two places, by different health services providers at the same time. Through cloud technologies, the information is synchronized and shared in real time.
- 2. Speed.** Cloud-based tools can upgrade and improve their features faster, less expensively and with minimal or no service interruption. Plus, cloud services enables faster access to important information for health services providers and their patients.
- 3. Mobility.** Each mobile app is backed up by a cloud infrastructure. By storing data and computing power in the cloud, health care services providers enable their staff to have access to information anywhere and anytime.
- 4. Security and privacy.** Cloud services providers are required to comply with many privacy standards such as HIPAA (Health Insurance Portability and Accountability Act). Today there are several managed cloud providers offering HIPAA compliance.
- 5. Decreased costs.** There is no need for the health care institution and doctors to invest in hardware infrastructure and maintenance because these concerns are already taken care of by the cloud computing providers.

Various applications in Healthcare

NetApp [*Real-time Clinical Data*]

[NetApp](#) is a hybrid cloud data services company. Its management platform delivers data in real time to help make clinical operations faster and more efficient through reduced EHR latency, quicker backup and restoration, easier accommodation of data/workload expansion and the streamlining of data management.

ClearData [*Data Protection*]

Designed to play well with other public clouds, [ClearDATA's](#) HIPAA-compliant cloud protects sensitive patient data via compliance safeguards, devops automation and healthcare expertise. The platform also powers critical applications and automatically detects changes in cloud accounts so the company can quickly respond to those changes in a variety of ways.

2. Energy systems

Reasons why cloud-based software should be used by companies to support their energy management practices-

1. Accessibility

Cloud-based systems allow users to access information with greater flexibility. By utilizing a cloud based system, users can store information from many different data acquisition systems and access and analyze this information from different sites with one application. In fact, such a system allows for easier portfolio management as it is possible to view all managed sites at once. Because managers are able to access information remotely, this also reduces on-site maintenance to only when absolutely necessary, saving time and cost in manual maintenance.

2. Cost Reduction in Man Power Resource Allocation

Not only do cloud services minimize costs of software development and maintenance but also direct monetary costs, the cost of time, and spent resources on maintaining in-house IT professionals and infrastructure on gathering, storing and analyzing energy data. This proves most beneficial for sectors that do not or cannot prioritize in-house energy management software experts.

3. Elasticity

Cloud-based systems allow for greater deployment flexibility, meaning that it is easy to either upgrade or downgrade resources which proves a great advantage for energy management systems compared to owned infrastructure. This allows the consumer to reduce or increase site data acquisition and maintenance much easier as demand dictates. For energy management specialists and consultants, this proves especially beneficial as clients change, more sites are easily implemented into the system for better-facilitated management.

4. Disaster Recovery

Every business possesses sensitive, important information that is crucial to business operations and must be protected. Cloud-based services are the simplest way to keep information backed up and safe. Specifically, it is cited that small businesses are twice as likely as larger companies to implement cloud-based backup and recovery solutions. This solution saves time and large up-front investments. With cloud-based energy management software, energy data and savings analysis is securely maintained and updated without much work from the customer.

Various applications in Energy Systems

E-DEMA” Cloud-based Energy Monitoring application

It is a modern ICT application for “Energy-Marketplace of the future”. In this pilot project the SWK use the extended-Grid-Platform from Digi to monitor the real-time price data of electricity, gas and water in a user friendly manner. The consumption data of the customer from energy

meters(Elektronischer Stromzähler)are collected using wireless technology, transmitted via the Digi Device Cloud and then visualized usingapps graphically(Display Smartphone), so they can be viewed by the customer in real time on a tablet computer, smart phone or any thin client device. Based on these data, the customers can then actively monitor and manage their consumption.

The application of cloud computing in smart grid status monitoring

the amount of state data such as the status of primary and secondary equipment, real-time online data, basic information,inspection records, test data and operationdata will be increasing greatly in the environment of smart grid. This is beyond the reach of the traditional condition monitoringapplication. Here is the architecture of cloud computing platform of the status data proposed to meet the needs of smart grid condition monitoring. For this purpose a software package Hadoop cluster technology, suitable for condition monitoring of smart gridis used.In this project a lab demonstration is realized which shows the use of cloud computing for accessing theinsulator conditionof the power system network.

3. Transportation systems

Modern Vehicles are progressively equipped with an outsized quantity of **sensors, actuators, and communication devices** (mobile devices, GPS devices, and embedded computers).In explicit, various vehicles have possessed powerful sensing, networking, communication, and processing capabilities,and can communicate with alternative vehicles or exchange data with the external environments over varied protocols,including communications protocol, TCP/IP, SMTP, WAP, and Next Generation Telematics Protocol (NGTP). As a result, several innovative telematics services, like remote security for disabling engine and remote identification, are developed to reinforce drivers' safety, convenience, and delight.The advances in cloud computing and web of things (IoT) have provided a promising chance to additional address the increasing transportation problems, like **significant traffic, congestion, and vehicle safety**. within the past few years, researchers have planned many models that use cloud computing for implementing intelligent transportation systems (ITSs). for instance, a replacement conveyance cloud design referred to as ITS-Cloud was planned to enhance vehicle-to-vehicle communication and road safety.

Various applications in Transport Systems

Intelligent Parking Cloud Service:

an intelligent parking cloud service that collects and analyzes geographic location information, parking availability information, parking space reservation and order information,traffic information and vehicle information through sensor detection and the clouds is needed.

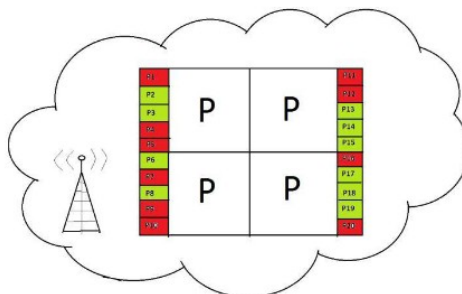


Fig 2 intelligent parking system

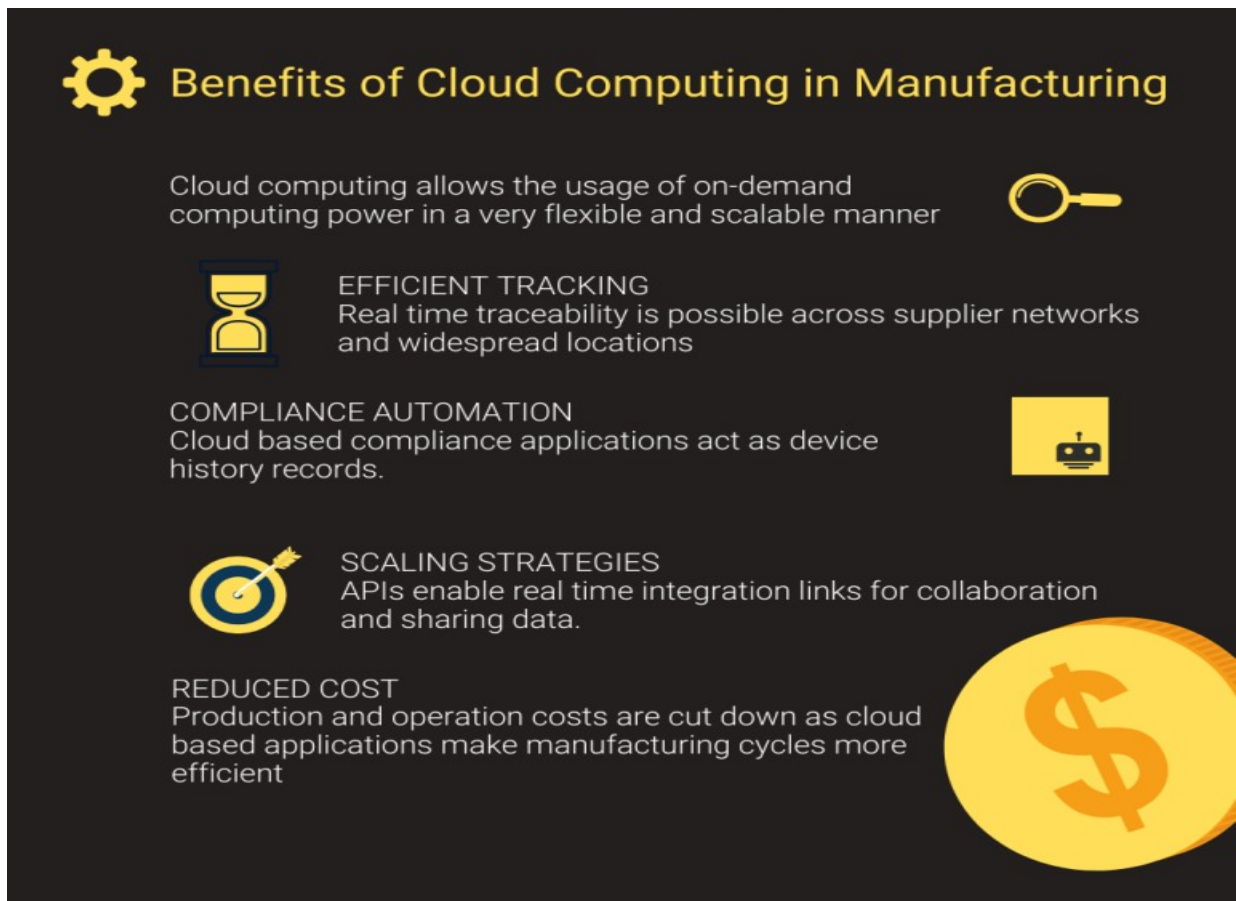
Trucking

In the trucking industry, businesses need to keep track of their fleets to stay competitive. A combination of cloud computing and GPS technology allows fleet managers to get real-time information on every truck in transit.

Railroads and Airlines

Private transportation companies like railroads and airlines manage passengers and routes through cloud technology. They can inform travelers of delays and available seats using real-time data. Company staff get to perform their jobs more efficiently through faster ticket scanning and information lookup.

4. Manufacturing industry



Product Development Is Easier with Cloud Collaboration Tools

Cloud collaboration tools make life a lot easier for people working in the manufacturing industry in many ways, especially during a product development stage. With cloud collaboration tools, you can access services, applications, and data remotely from any device, anywhere, at any time. Those advantages mean manufacturers can create a seamless product development environment, lower the cost

of developing a product, and reduce the time it takes to get a product to market. So, ultimately, cloud collaboration tools can improve manufacturing companies' productivity and profits.

Machines Can Be Monitored in Real-time with Cloud Computing

Via cloud-based [Internet of Things](#) platforms, manufacturers can receive data for specific machinery in real-time. By having instant access to crucial operational metrics like capacity utilization, inventory data, scheduling plans, job orders, and overall equipment effectiveness, you can monitor your machines' performance and solve any issues quickly. So, the cloud enables manufacturers to avoid potential inaccuracies and delays in manufacturing processes.

Supply Chain Management Is More Efficient with Cloud Computing

[Supply chains](#) are often volatile, so it is critical that manufacturing companies have real-time visibility of all aspects of the chain. That is easier to do than ever before, thanks to cloud computing tools. You will be able to connect with anyone along the supply chain in real-time, 24 hours a day, seven days a week. Furthermore, the scope for scaling operations up and down via the cloud enables manufacturing companies to mitigate market demand volatility.

Data Is More Secure in the Cloud

From employees' personal information to company finances, it is essential that all data is secure and does not fall into the wrong hands. All cloud computing tools provide some degree of encryptions and deterrents, but private clouds are the most robust. If you utilize private cloud tools in your manufacturing business, you ensure all of your data is secure from outsiders.

5. Government

Flexibility

Cloud computing offers government agencies more flexibility than traditional IT infrastructures. [With a cloud service provider](#), there are no more worries about limited resources, buying and housing servers and hardware, updating software, or data protection. Using the cloud makes it easy to add and change services without the hassle of adding or removing digital space.

Cost Savings

One major benefit of cloud computing is the money it saves. By utilizing the cloud when more space or computing is needed, the cost of additional servers and hardware is eliminated, cutting the overhead of any project significantly. Additionally, once systems are moved to the cloud, there's no need to house hefty, heat-producing servers, reducing the amount of money and energy spent keeping those machines running and cool.

IT Staff Availability

Going to the cloud frees the IT department to work on other projects because the cloud service provider takes care of regular maintenance and updates, as well as security checks and procedures.

Collaboration

The cloud simplifies collaboration between government agencies. Names and credentials can be assigned to data or documents, and only those individuals can gain access. More than just sharing documents, the cloud also allows government employees and contractors to access documents from anywhere in the world, as long as there's internet access to reach the cloud.

Application of Cloud Computing in Government Management

Sharing of E-Government Data Based on Cloud Computing

In the era of big data, data has gradually become an important resource in the process of continuous collection and processing. Under the trend of increasing openness and sharing of various kinds of data, “open and Shared” as the core mode of thinking has gradually entered the public view, which is not only reflected in the economic field, but also in various government departments.

Full Sample Analysis of E-Government Based on Cloud Computing

With the extensive and in-depth development of big data, it has changed the way of thinking of human beings with a "big" beyond imagination. The traditional method of problem solving, sampling analysis, has been subjected to a violent impact.

6. Education

BENEFITS OF CLOUD COMPUTING FOR INSTITUTIONS AND STUDENTS-

Personalized Learning: Cloud computing affords opportunities for greater student choice in learning. Using an Internet-connected device, students can access a wide array of resources and software tools that suit their learning styles and interests.

Reduced Costs: Cloud-based services can help institutes reduce costs and accelerate the use of new technologies to meet evolving educational needs. Students can use office applications for free without having to purchase, install and keep these applications up to date on their computers. It also provides the facility of Pay per use for some applications.

Accessibility: Availability of the services is the most important and desired by the user using the education cloud. 24 x 7 is the availability that is needed by this system without failure. From anywhere one can login and access the information.

Improved administrative efficiency of schools and universities: Colleges and the administrative staff can focus on the core functions of the institution instead of futile efforts on IT infrastructure and the applications set-up.

No Extra Infrastructure: Colleges and governments are now free to focus on their goals that is making more research facilities available to the students and making the environment global in spite of wasting time on worrying about the buildings, labs, teachers etc.

Higher quality of education delivered anytime, anywhere: Courses with updated content can be delivered consistently across all locations.

Standardisation of content: Courses delivered over cloud through a central location will lead to a standard content delivery to multiple remote virtual classrooms.

Collaboration: Students and Colleges can collaborate on studies, projects using collaboration solutions.

Agility to rollout new courses: Cloud-enabled technologies ensure rapid access to infrastructure services thereby rendering agility in rolling out newer products.

Improved administrative efficiency of schools and universities: Teachers and the administrative staff can focus on the core functions of the institution instead of futile efforts on IT infrastructure and the applications set-up.

Scalability: Scalable systems on cloud to provision big data platform for research and analysis.

Go Green: Education cloud will surely reduce the carbon footprint.

CLOUD SERVICES WITH APPLICATIONS IN EDUCATION

CLOUD-BASED OFFICE SUITES Cloud-based office suites, also known as online office suites or cloud-based collaboration tools in real time, are office suites that are provided as SaaS services. Among the most popular cloud office suites, used in education, are Google Apps for Work, Office 365, Zoho Office Suite, Apple Productivity Apps, Amazon WorkDocs, Thinkfree Online, Live Documents.

Applications for communication—e-mail, instant messaging (IM), online conferences, forums, and others. They enrich the possibilities for communication (synchronous and asynchronous) between participants in the learning process and offer new and more engaging forms for active connection in real time. Options for adding comments to shared documents allow students to share ideas, seek help or advice in difficult tasks.

Calendars and tools for contacts management. Users can manage upcoming and ongoing events and meetings via calendars. Personal calendars enhance management of users' individual tasks. Shared calendars can support learning process and all activities taking place in educational institutions. They can be used for planning and notification of different events and creating weekly, monthly or annual classes' schedules. Shared calendars may help students organize collaborative work on group projects more effectively. On the other hand, teachers can use and share calendars with their colleagues

to define schedules of meetings and events, educational activities and tasks with deadlines and support their timely execution.

Classroom is an educational application, part of Google Apps, which allows teachers to create, assign and collect students' individual assignments (9). Teachers create courses (classes) and make assignments for individual or group work. They can add files from local computers, Google Drive, YouTube or a link to any Web page, since via Classroom there is integration between Google Docs, Google Drive and Gmail. Teachers can view tasks during the process of their performance, make comments, send feedback with recommendations or reviews to help students and evaluate them.