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Subject Name: **Cloud Computing**

Subject Code: **CS-8002**

Semester: **8th**

XII

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Subject Notes
CS 8002 - Cloud Computing

Unit-1

Historical Development

"Cloud computing" concepts date back to the 1950s when large-scale mainframes were made available to schools and corporations. The mainframe's colossal hardware infrastructure was installed in what could literally be called a "server room" (since the room would generally only be able to hold a single mainframe), and multiple users were able to access the mainframe via "dumb terminals" – stations whose sole function was to facilitate access to the mainframes. Due to the cost of buying and maintaining mainframes, an organization wouldn't be able to afford a mainframe for each user, so it became practice to allow multiple users to share access to the same data storage layer and CPU power from any station. By enabling shared mainframe access, an organization would get a better return on its investment in this sophisticated piece of technology figure 1.1.

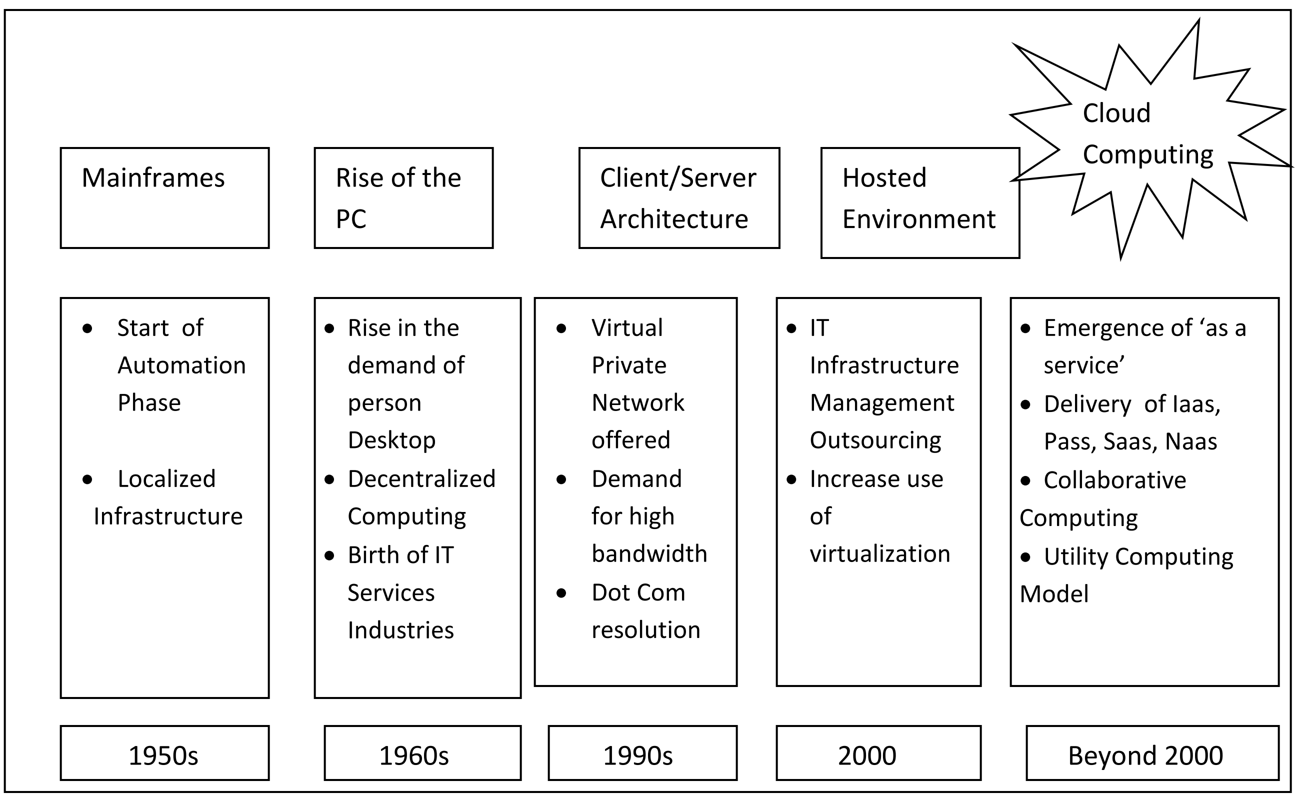

Figure: 1.1 History of Cloud Computing

A couple decades later in the 1970s, IBM released an operating system called VM that allowed admins on their System/370 mainframe systems to have multiple virtual systems, or "Virtual Machines" (VMs) on a single physical node. The VM operating system took the 1950s application of shared access of a mainframe to the next level by allowing multiple distinct compute environments to live in the same physical environment. Most of the basic functions of any virtualization software that you see nowadays can be traced back to this early VM OS: Every VM could run custom operating systems or guest operating systems that had their "own" memory, CPU, and hard drives along with CD-ROMs, keyboards and networking, despite the fact that all of those resources would be shared. "Virtualization" became a technology driver, and it became a huge catalyst for some of the biggest evolutions in communications and computing.

In the 1990s, telecommunications companies that had historically only offered single dedicated point–to-point data connections started offering virtualized private network connections with the same service quality as their dedicated services at a reduced cost. Rather than building out physical infrastructure to allow for more users to have their own connections, telco companies were able to provide users with shared access to the same physical infrastructure. This change allowed the telcos to shift traffic as necessary to allow for better network balance and more control over bandwidth usage. Meanwhile, virtualization for PC-based systems started in earnest, and as the Internet became more accessible, the next logical step was to take virtualization online figure 1.2.

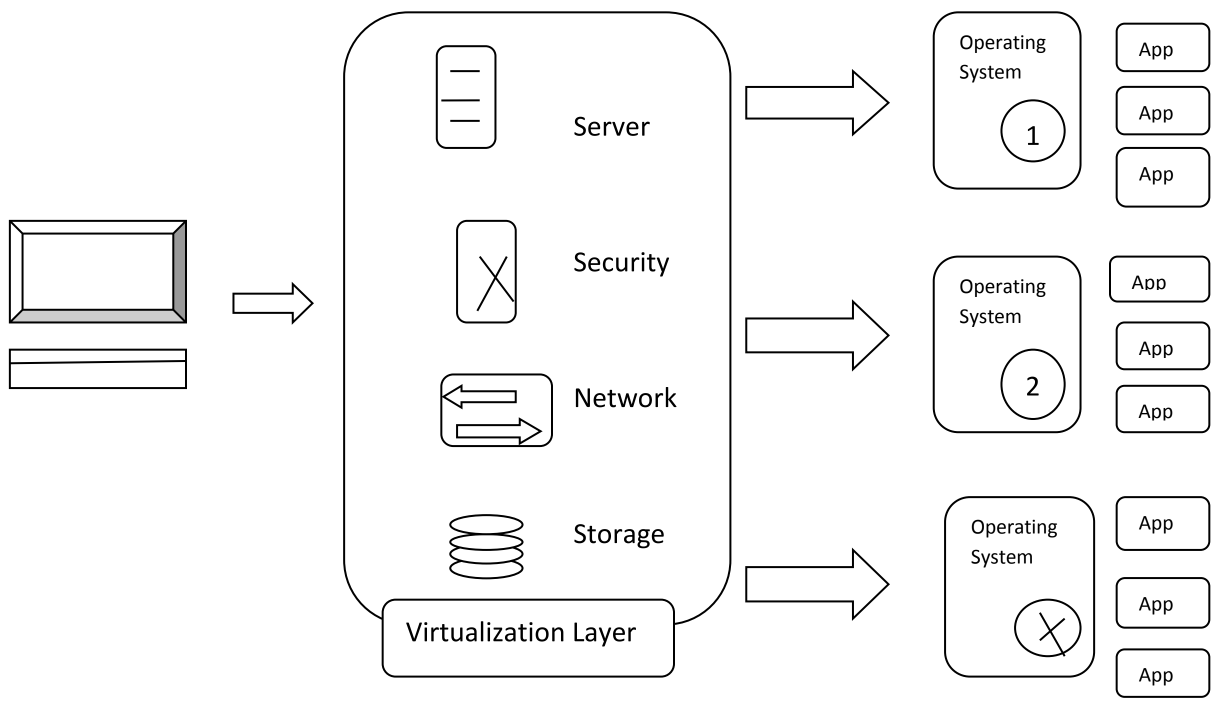

Figure: 1.2 Model Cloud Configuration

Vision of Cloud Computing

A cloud is simply a centralized technology platform which provides specific IT services to a selected range of users, offering the ability to login from anywhere, ideally from any device and over any connection, including the Internet.

Intercept IT believes that a true cloud computing service is one which removes the traditional barriers which exist between software applications, data and devices. In other words, it is the nirvana of computing from a user's perspective. no need to worry about location, device, or type of connection, all the data and the software applications required by the user are fully available and the experience remains consistent. The highest standards of data protection must be a given, whereby users do not have to think about protecting the integrity of the data they use and store.

Intercept IT provides a broad spectrum of both application delivery services to its clients, ranging from the design, implementation and management of private clouds, right through to the provision of hosted cloud solutions delivered via Intercept's own, cloud infrastructure.

Cloud Computing Principles

Here the top three key principles of cloud computing that struck me as making this topic very relevant, interesting and definitely the way of the future:

1: Abstraction

Cloud gives you just a few basic, but well- defined services and that's it. Take it or leave it. "Do you like our simple, RESTful foo interface? Fine, use it!", or: "Oh, you want your own special custom version? Sorry, we don't have it. Go away." It's that simple.

So the key point here is that well-defined abstraction layers between clouds and developers/users are the grease that lets both sides operate efficiently and completely independent of each other.

There are three layers of abstraction in clouds:

• Application as a Service (AaaS): This is what the end-user gets when they use a service like GMail, DropBox (please make an OpenSolaris version, thanks), the myriads of Facebook apps, SmugMug or even Adobe's online photoshop web service. AaaS services are very popular and there's really no reason to start a new application any other way today.

• Platform as a Service (PaaS): The abstraction layer here is some kind of developer environment, but the details of implementation (OS, Hardware, etc.) are completely hidden. You just get a programming language and some APIs/Libraries and off you go. This is what Zembly gives you (check it out and create your own Facebook app in minutes), or the Google App Engine. This is the development model of the future: Develop against the cloud, no need to know the details behind it.

• Infrastructure as a Service (IaaS): These are the Amazon S3s, EC2s, etc. and we recently introduced our own version of IaaS as the Sun Cloud (featuring open interfaces and a lot of Sun technology goodness under the hood.) In this model, you get access to a virtual server or virtual storage, treat them like real machines, but the physical details of what machine is in what rack or which disks you use are hidden from you.

2: Automation

Automation in the cloud means the developer/user is in complete, automatic control over their resources. No human interaction whatsoever, even from a developer/user perspective. Need more servers? Let the load-balancer tell the cloud how many more to provide. No need to wait for someone to unpack and cable your machine, no need to wait for your IT department to find the time to install. Everything is automatic.

Again, this is a win-win for both sides. While full automation reduces cost and complexity for the cloud provider, it puts the developer/user in control. Now you can reduce your time to market for your next rollout because you can do it yourself, fully automatic, and you don't need to call anybody, rely on someone else to set up stuff for you, or wait days until some minor hardware/software installation is completed.

3: Elasticity

In cloud computing, elasticity is defined as "the degree to which a system is able to adapt to workload changes by provisioning and de-provisioning resources in an autonomic manner, such that at each point in time the available resources match the current demand as closely as possible". Elasticity is a defining characteristic that differentiates cloud computing from previously proposed computing paradigms, such as grid computing. The dynamic adaptation of capacity, e.g., by altering the use of computing resources, to meet a varying workload is called "elastic computing".

Example: Sun Cloud expands the business possibilities of the cloud model: You can choose to be the cloud (and we'll help you build it), you can choose to build the cloud (for others, out of our cloud components), you can build your own cloud (we'll help you build that, too) or you can just use it (the Sun Cloud). Just like we believe in open standards, we also believe in partnering, so no matter what your cloud business model is, Sun can help.

Characteristics of Cloud Computing as per NIST

Cloud technology is in the news quit often these days, but it still seems to be mysterious and confusing to the non-techie crowd. Cloud options are enticing various industries across the board, which is why it's important to know its essential characteristics as a software offering. Here are the five main characteristics that cloud computing offers businesses today.

1. **On-demand capabilities**:

A business will secure cloud-hosting services through a cloud host provider which could be your usual software vendor. You have access to your services and you have the power to change cloud services through an online control panel or directly with the provider. You can add or delete users and change storage networks and software as needed. Typically, you are billed with a monthly subscription or a pay-for-what-you-use scenario. Terms of subscriptions and payments will vary with each software provider.

2. **Broad network access:**

Your team can access business management solutions using their smart phones, tablets, laptops, and office computers. They can use these devices wherever they are located with a simple online access point. This mobility is particularly attractive for businesses so that during business hours or on off- times, employees can stay on top of projects, contracts, and customers whether they are on the road or in the office. Broad network access includes private clouds that operate within a company's firewall, public clouds, or a hybrid deployment.

3. **Resource pooling:**

The cloud enables your employees to enter and use data within the business management software hosted in the cloud at the same time, from any location, and at any time. This is an attractive feature for multiple business offices and field service or sales teams that are usually outside the office.

4. **Rapid elasticity:**

If anything, the cloud is flexible and scalable to suit your immediate business needs. You can quickly and easily add or remove users, software features, and other resources.

5. **Measured service:**

Going back to the affordable nature of the cloud, you only pay for what you use. You and your cloud provider can measure storage levels, processing, bandwidth, and the number of user accounts and you are billed appropriately. The amount of resources that you may use can be monitored and controlled from both your side and your cloud provider's side which provides transparency.

Cloud Computing Reference Model

•The NIST Cloud Computing Reference Architecture consists of five major actors. Each actor plays a role and performs a set of activities and functions. The reference architecture is presented as successive diagrams in increasing level of detail figure 1.3.

•Among the five actors, cloud brokers are optional, as cloud consumers may obtain service directly from a cloud provider.

1. Cloud Consumer:

Person or organization that maintains a business relationship with, and uses service from, Cloud Providers.

2. Cloud Provider:

Person, organization or entity responsible for making a service available to Cloud Consumers.

3. Cloud Auditor:

A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.

4. Cloud Broker:

An entity manages the use, performance and delivery of cloud services, and negotiates relationships between Cloud Providers and Cloud Consumers.

5. Cloud Carrier:

The intermediary that provides connectivity and transport of cloud services from Cloud Providers to Cloud Consumers.

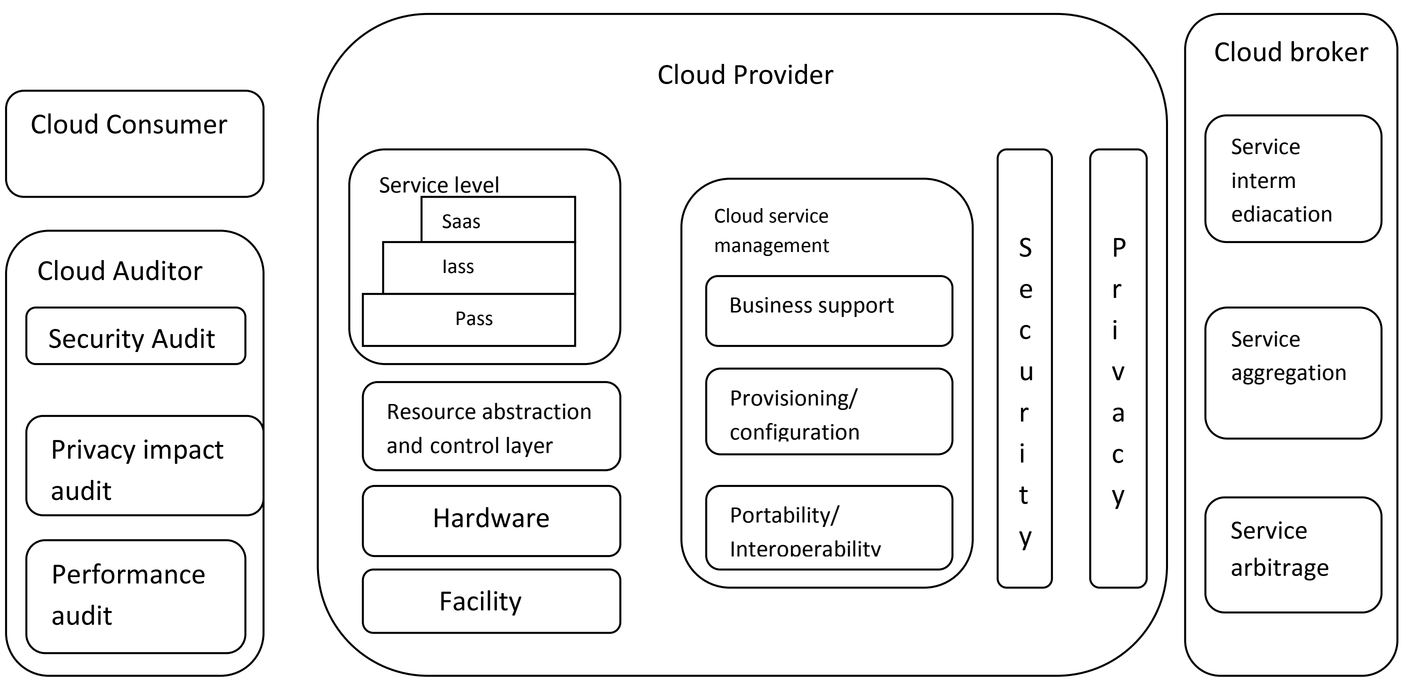

Figure: 1.3 NIST Cloud Reference Model

Cloud Computing Environments

More and more organizations are moving services, storage, email, collaboration and applications to the cloud. You need to decide whether to choose to support private, public or a hybrid cloud mix. What's the right mix of infrastructure (IaaS), platform (PaaS), and application (SaaS) environments for your organization? Where are the cost savings?

• **Private Cloud:** Which services require the most agility and speed? What's the right balance of standard service offerings that will drive the most business value? Do you need to build an internal shared-service center? How does a private cloud implementation impact your data center architecture?

• **Public Cloud:** Which applications are most likely to move to public cloud delivery models? Will your organization bypass your IT department and get its applications from the cloud via software-as-service (SaaS) for a monthly pay-per-user-per-month subscription pricing model?

• **Hybrid Cloud:** Is hybrid cloud really the future? What level of flexibility do you need to customize, manage and monitor your applications? How will the cloud services brokerage role define future IT organizations?

Cloud Services Requirements

Today the cloud services have several deficiencies - which from an enterprise perspective are the basic requirements for them to consider cloud services.

1. Availability - with loss less DR

As a cloud service provider, there will be enormous pressure to minimize costs by optimally utilizing the entire IT infrastructure. The traditional Active-Passive DR strategy is very expensive and cost inefficient. Instead, service providers will have to create an Active-Active disaster recovery mechanism - where more than one data center will be active at all times and ensures that the data and services can be accessed by the customer from either of the data centers seamlessly.

2. Portability of Data & Applications

As applications are being written on standard platforms - Java, PHP, Python, etc. It should be possible to move the customer owned applications from one service provider to another. Customers should also take care to use only the open standards and tools, and avoid vendor specific tools. Azure or Google services offers several tools/applications/utilities which are valuable - but it also creates a customer locking - as the customer who uses these vendors specific tools cannot migrate to another service provider without rewriting the applications.

3. Data Security

Security is the key concern for all customers - since the applications and the data is residing in the public cloud; it is the responsibility of the service provider for providing adequate security. In my opinion security for customer data/applications becomes a key differentiator when it comes to selecting the cloud service provider. When it comes to IT security, customers tend to view the cloud service providers like they view banks. The service provider is totally responsible for user security, but there are certain responsibilities that the customer also needs to take.

4. Manageability

Managing the cloud infrastructure from the customer perspective must be under the control of the customer admin. Customers of Cloud services must be able to create new accounts, must be able to provision various services, do all the user account monitoring - monitoring for end user usage, SLA breaches, data usage monitoring etc. The end users would like to see the availability, performance and configuration/provisioning data for the set of infrastructure they are using in the cloud.

5. Elasticity

Customer on Cloud computing have a dynamic computing load. At times of high load, they need greater amount of computing resources available to them on demand, and when the work loads are low, the computing resources are released back to the cloud pool. Customer expects the service provider to charge them for what they have actually used in the process.

6. Federated System

Customers may have to buy services from several cloud service providers for various services - email from Google, online sales transaction services from Amazon and ERP from another vendor etc. In such cases customer want their cloud applications to interact with other services from several vendors to provide a seamless end to end IT services. In a federated environment there is potentially an infinite pool of resources. To build such a system, there should be inter-cloud framework agreements between multiple service providers, and adequate chargeback systems in place.

Cloud and dynamic infrastructure

For the architect employed with building out a cloud infrastructure, there are seven key requirements that need to be addressed when building their cloud strategy. These requirements include:

1. Heterogeneous Systems Support

Not only should cloud management solutions leverage the latest hardware, virtualization and software solutions, but they should also support a data center's existing infrastructure. While many of the early movers based their solutions on commodity and open source solutions like general x86 systems running open source Xen and distributions like CentOS, larger service providers and enterprises have requirements around both commodity and proprietary systems when building out their clouds. Additionally, cloud management providers must integrate with traditional IT systems in order to truly meet the requirements of the data center. Companies that don't support technologies from the likes of Cisco, Red Hat, NetApp, EMC, VMware and Microsoft will fall short in delivering a true cloud product that fits the needs of the data center.

2. Service Management

To productize the functionality of cloud computing, it is important that administrators have a simple tool for defining and metering service offerings. A service offering is a quantified set of services and applications that end users can consume through the provider — whether the cloud is private or public. Service offerings should include resource guarantees, metering rules, resource management and billing cycles. The service management functionality should tie into the broader offering repository such that defined services can be quickly and easily deployed and managed by the end user.

3. Dynamic Workload and Resource Management

In order for a cloud to be truly on-demand and elastic while consistently able to meet consumer service level agreements (SLAs), the cloud must be workload- and resource- aware. Cloud computing raises the level of abstraction to make all components of the data center virtualized, not just compute and memory. Once abstracted and deployed, it is critical that management solutions have the ability to create policies around workload and data management to ensure that maximum efficiency and performance is delivered to the system running in the cloud. This becomes even more critical as systems hit peak demand. The system must be able to dynamically prioritize systems and resources on-the-fly based on business priorities of the various workloads to ensure that SLAs are met.

4. Reliability, Availability and Security

While the model and infrastructure for how IT services are delivered and consumed may have changed with cloud computing, it is still critical for these new solutions to support the same elements that have always been important for end users. Whether the cloud serves as a test bed for developers prototyping new services and applications or it is running the latest version of a popular social gaming application, users expect it to be functioning every minute of every day. To be fully reliable and available, the cloud needs to be able to continue to operate while data remains intact in the virtual data center regardless if a failure occurs in one or more components. Additionally, since most cloud architectures deal with shared resource pools across multiple groups both internal and external, security and multi-tenancy must be integrated into every aspect of an operational architecture and process. Services need to be able to provide access to only authorized users and in this shared resource pool model the users need to be able to trust that their data and applications are secure.

5. Integration with Data Center Management Tools

Many components of traditional data center management sill require some level of integration with new cloud management solutions even though the cloud is a new way of consuming IT. Within most data centers, a variety of tools are used for provisioning, customer care, billing, systems management, directory, security and much more. Cloud computing management solutions do not replace these tools and it is important that there are open application programming interfaces (APIs) that integrate into existing operation, administration, maintenance and provisioning systems (OAM&P) out of the box. These include both current virtualization tools from VMware and Citrix, but also the larger data center management tools from companies like IBM and HP.

6. Visibility and Reporting

The need to manage cloud services from a performance, service level, and reporting perspective becomes paramount to the success of the deployment of the service. Without strong visibility and reporting mechanisms the management of customer service levels, system performance, compliance and billing becomes increasingly difficult. Data center operations have the requirement of having real-time visibility and reporting capabilities within the cloud environment to ensure compliance, security, billing and charge backs as well as other instruments, which require high levels of granular visibility and reporting.

7. Administrator, Developer and End User Interfaces

One of the primary attributes and successes of existing cloud- based services on the market comes from the fact that self- service portals and deployment models shield the complexity of the cloud service from the end user. This helps by driving adoption and by decreasing operating costs as the majority of the management is offloaded to the end user. Within the self-service portal, the consumer of the service should be able to manage their own virtual data center, create and launch templates, manage their virtual storage, compute and network resources and access image libraries to get their services up and running quickly. Similarly, administrator interfaces must provide a single pane view into all of the physical resources, virtual machine instances, templates, service offerings, and multiple cloud users. On top of core interfaces, all of these features need to be interchangeable to developers and third parties through common APIs.

Cloud Adoption and rudiments

Cloud Adoption is a strategic move by organizations of reducing cost, mitigating risk and achieving scalability of data base capabilities. Cloud adoption may be up to various degrees in an organization, depending on the depth of adoption. In fact the depth of adoption yields insight into the maturity of best practices, enterprise-ready cloud services availability.

Organizations that go ahead with the strategic decision of adopting cloud-based technologies have to identify potential security thefts and controls, required to keep the data and applications in the cloud secured. Hence there is a need for compliance assessment during cloud adoption. The following measures are taken for compliance assessment to ensure security and accountability of data and applications in the cloud services:

- Matching the security requirements of the organization with the security capabilities of the cloud service provider
- Analyzing the security policies of the cloud service provider along with history of transparency and security related practices
- Proper understanding of the technical aspects of data and traffic flow
- Proper understanding and documentation of the roles and responsibilities of the cloud service provider
- Understanding of the certifications and compliances that can be leveraged from the cloud service provider

Key elements in adopting cloud:

Investment
One critical element of your business that requires a significant investment is your infrastructure. Looking to a cloud-based solution can allow you to focus your important resources on the business while leaving your infrastructure in the hands of an experienced team.

Scalability
As your business grows, the last thing you want to have to worry about is the ability of your infrastructure to scale. The key to finding and partnering with a cloud-based service is picking an organization that is devoted to improving their own capacity. Doing so will positively affect your ability to grow with limited interruption.

Predictable Expenses

Looking to a cloud-based service provider gives you the ability to predict and plan for a consistent expense. Even as you scale and grow, real-time insight allows you to precisely allocate funds towards growth initiatives.

Overview of Cloud Applications

1. ECG Analysis in Cloud

Our objective is to propose an architecturally generic Cloud-based system to accommodate multiple scenarios where patients need to be remotely monitored and recorded data must be analyzed by a computing system and become available to be visualized by specialists or by the patients themselves. Although our design and prototype are generic to accommodate several use cases, in this paper, we focus on one motivational case, namely: the monitoring of patients who suffer from cardiac arrhythmias, requiring continuous episode detection. Electrocardiogram (ECG) data from commodity wearable sensors are obtained in real-time and used to perform episode detection and classification figure 1.4.

The overall functionality of an ECG monitoring and analysis system involves the following steps:

1. A patient is equipped with a wireless ECG sensor attached to their body and a mobile device that is capable of communicating to the Internet;

2. The wireless ECG sensor module collects patient's data and forwards it the mobile device via Bluetooth without user intervention;

3. A client software in the mobile device transmits the data to the ECG analysis Web Service, which is hosted by a Cloud computing-based software stack. This communication can happen with a home wireless gate- way or directly via the mobile's data connectivity (e.g. mobile 3G network);

4. The analysis software carries out numerous computations over the received data taking the reference from the existing demographic data, and the patient's historic data. Computations concern comparison, classification, and systematic diagnosis of heartbeats, which can be time-consuming when done for long time periods for large number of users;

5. The software then appends the latest results to the patient's historic record maintained in private and secure Cloud-based storage, so that authenticated users can access it anytime from anywhere. Physicians will later interpret the features extracted from the ECG wave- form and decide whether the heartbeat belongs to the normal (healthy) sinus rhythm or to an appropriate class of arrhythmia;

6. The diagnosis results are disseminated to the patient's mobile device and/or monitor, their doctor and/or emergency services at predefined intervals;

7. The monitoring and computing processes are repeated according to user's preference, which may be hourly or daily over a long period of time.

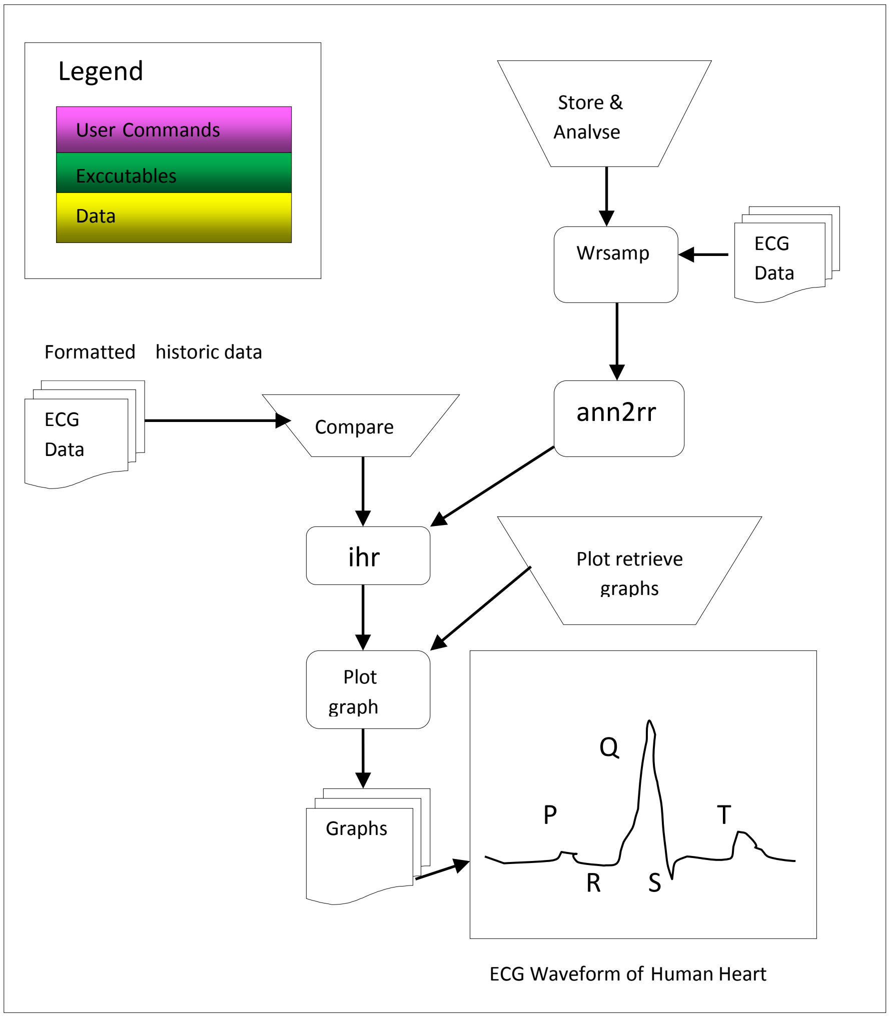

Figure: 1.4 Steps of ECG Cloud Analysis

Task Name	Description
wrsamp	Reads the raw data to produce a binary file with specified sample frequency, gain, format, etc
ann2rr	Creates an annotation file from ECG data; creates RR interval series from ECG annotation files
ihr	Reads an annotation file and produces an instantaneous heart rate signal
Plot Graph	Plots the graphs of the heart rate signal, RR interval, etc.

Table 1.1: ECG Component Analysis

2. Protein structure prediction

Protein structure prediction is one of the most important and yet difficult processes for modern computational biology and structural bioinformatics. The practical role of protein structure prediction becomes even more important in the face of dynamically growing number of protein sequences obtained through the translation of DNA sequences coming from large-scale sequencing projects. Protein structure prediction refers to the computational procedure that delivers a three-dimensional structure of a protein based on its amino acid sequence. Modeling complex protein structures is still challenging. We have designed and developed scalable system, called Cloud4PSP, which enables predictions of 3D protein structures with the use of Warecki-Znamirowski method in Microsoft Azure public cloud. Scalability of the system is provided by Microsoft Azure cloud platform. The platform allows creating and publishing user's applications that can be scaled up (vertical scalability) or scaled out (horizontal scalability).

Case Study 1: Protein Disorder in Completely Sequenced Organisms

The goal of this study is to collect evidence for three hypotheses on protein disorder: (1) it is more useful to picture disorder as a distinct phenomenon than as an extreme example of protein flexibility; (2) there are many very different flavors of protein disorder, but it is advantageous to recognize just two main types, namely, well structured and disordered; (3) nature uses protein disorder as a tool to adapt to different environments. We predicted protein disorder both on an in-house compute grid and on a compute grid manually setup in the OpenNebula cloud service provided by the CSC Finland.

Data and tool (the PPMI) images for grid nodes in the cloud were downloaded from http://predictprotein.org/. The PPMI image was extended with a grid client, and a separate machine instance was used as grid master. PredictProtein for the local grid was installed from the main Debian repository. Required databases (28 GB) were included on a data disk image for cloud machine instances. Input to PredictProtein jobs consisted of protein sequences (in total less than 1 GB). Grid job submissions to the local and the cloud grid were manually adjusted according to available resources. Over 9 million disorder predictions were made over the course of the past few years.

Case Study 2: Comprehensive In Silico Mutagenesis of Human Proteome

This project aims at providing information about the functional effect of every possible point mutation in all human proteins, that is, for the replacement of 19*N amino acids for a protein with N residues. Overall, this generated 300 million human sequence variants (point mutants). The method SNAP predicted the effect of each variant, that is, each “nonsynonymous single nucleotide polymorphisms” (nsSNPs) upon protein function. These predictions are useful for several reasons.

First, the study of all possible mutations in human will provide the background against which we can assess the effect of mutations that are actually observed between people. This is crucial for both the advance toward personalized medicine and health and the understanding of human diversity and variation. Second, our computation provides quick “look-up” answers available for all the important variants that are observed and implied in important phenotypes. The only way to cover those lookups is by precomputing all the possible changes. SNAP can take advantage of PredictProtein results for faster processing. With the PredictProtein packages presented here, a solution was built in the form of a public Amazon Machine Image (AMI, ami-3f5f8156) that allows running PredictProtein on the Amazon Elastic Compute Cloud (EC2). We extended an Ubuntu-based StarCluster AMI with PredictProtein and its required databases (28 GB). Because every protein can be computed independently, we formed a grid job out of each protein and used the Grid Engine (GE) to distribute work on the machine instances.

We used StarCluster to automate grid setup on the EC2. Because a lot of CPU power was needed, the “Cluster Compute Eight Extra Large Instance” was chosen. This instance type is especially crafted for big data with a lot of CPU power. One instance has 60.5 GB memory, 88 EC2 Compute Units (2x Intel Xeon E5-2670, eight-core-architecture “Sandy Bridge”), and 3370 GB instance storage. The sequence variants were analyzed based on the human reference proteome from the National Center for Biotechnology Information (build 37.3, proteins, 21MB). We processed 29,036 sequences with 16,618,608 residues. This amounted to predicting the functional effect of 315,753,552 individual amino acid changes.

3. Gene Expression Data Analysis

Gene-expression profiling using DNA microarrays can analyze multiple gene markers simultaneously. Consequently, it is widely used for cancer prediction. Informative genes can be extracted for predicting cancer/non-cancer class or type of diagnosis. The former is more interesting for biologists due to the fact that distinguishing sub category of a cancer is a difficult task. Moreover, the accuracy of diagnosis at early stages is vital, while most cancer treatments like chemotherapy kill both cancer and non cancer cells, and seriously weaken the human defense system. And most of these drugs have both long-term and short-term side effects.

Classification methods either result in the identification of simple rules for class discovery or the identification of highly related genes to a specific cancer. Recently, there have been a number of investigations for class discovery of gene expression data sets using machine learning techniques: Decision Tree [3, 11], Support Vector Machines (SVM) [4, 14] and k-Nearest Neighbor (k-NN) [2]. How- ever, gene expression data sets have a unique characteristic: they have high-dimensional features with few samples (also known as”the curse of dimensionality”). Typically, ma- chine learning methods cannot avoid the over-fitting problem in this situation. Additionally, when the search space is vast, most common machine learning techniques could not find a suitable solution in a reasonable time frame.

XCS overview

The eXtended Classifier system (XCS) [20] is the most successful learning classifier systems based on an accuracy model. Figure 1.5, describes the general architecture of the XCS model. XCS maintains a population of classifiers and each classifier consist of a condition-action-prediction rule, which maps input features to the output signal (or class).

A ternary representation of the form 0, 1, # (where # is don’t care) for the condition and 0, 1 for the action can be used. In addition, real encoding can also be used to accurately describe the environment states. Input, in the form of data instances (a vector of features or genes), is passed to the XCS. A match set [M] is created consisting of rules (classifiers) that can be “triggered” by the given data instance. A covering operator is used to create new matching classifiers when [M] is empty. A prediction array is calculated for [M] that contains an estimation of the corresponding rewards for each of the possible actions. Based on the values in the prediction array, an action, a (the out- put signal), is selected. In response to a, the reinforcement mechanism is invoked and the prediction, p, prediction error, E, accuracy, k, and fitness, F, of the classifier are up- dated.

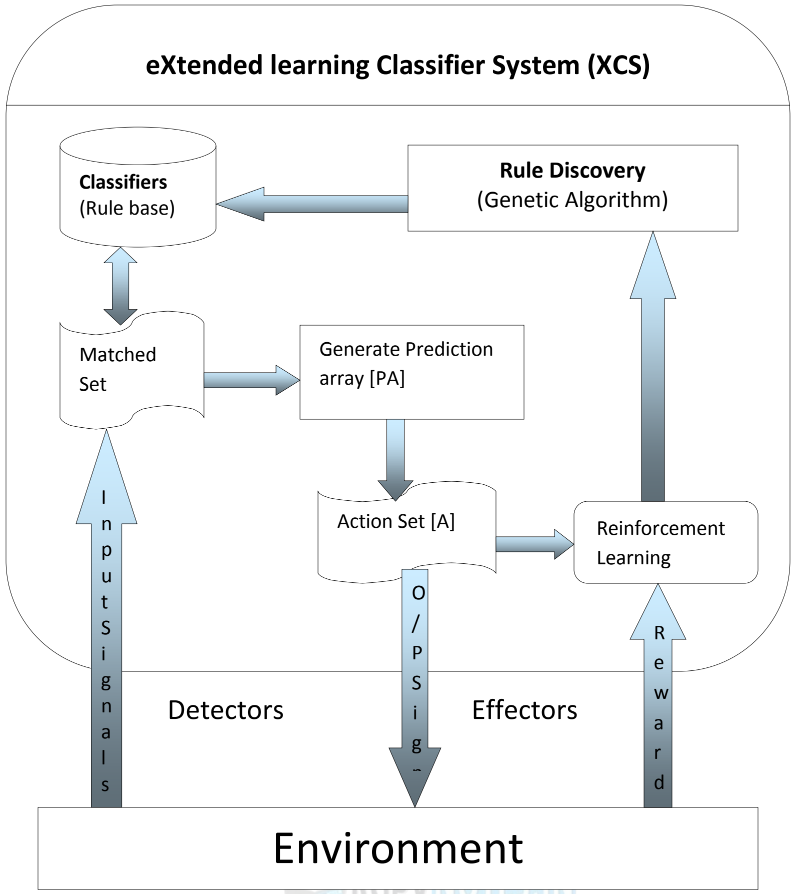

Figure: 1.5 XCS Architecture

4. Satellite Image Processing

PCI Geomatics is at the forefront of one of the most challenging applications of Cloud Computing: high volume processing of Earth Observation imagery. To play a significant role in the emerging high speed computing industry as it relates to imagery, PCI has invested significantly in developing technology that is innovative, nimble, portable, scalable, automated, and most of all optimized for high speed performance.

Cloud Computing Features	Benefit/Challenge
Reduced cost	**Benefit:** Optimize the costs by paying only for what an organization uses (Large capital expenses are not required, pay incrementally)
Increased storage	**Challenge**: Transferring large amounts of imagery is time consuming and costly. I/O is a specific issue that is more challenging to EO industry.
Highly automated	**Benefit:** Software can be maintained automatically. Cloud services include guaranteed machine up times and redundancy.

Flexibility	**Benefit:** Ability to add/remove computing resources as required, often automatically based on demand.
More mobility	**Benefit:** Simplified, easily accessible management consoles that can be managed/ viewed from anywhere.
Allows IT to shift focus	**Benefit:** No longer having to worry about constant server updates and other computing issues – IT can focus on innovation.

Table 1.2: Cloud Computing Featured

- **System Deployment**

The GXL system can be deployed on the Cloud much in the same way a non-cloud based GXL system. The main difference is that there is no need to purchase any physical hardware in order to configure a GXL system that can achieve the stated throughput requirements. PCI's non- Cloud based GXL systems are typically deployed on desktop or rack mounted systems, which include a certain set of hardware specifications, including (PCI would specify which hardware to purchase):

- CPU / GPU
- RAM
- Disk Storage
- UPS
- File Server
- Network Switch
- Operating System

- **Large volume processing on the Cloud**

PCI Geomatics has successfully deployed its GXL System to the Amazon Cloud to process large volumes of imagery for one of its customers. The following terminology is key to understanding the GXL Cloud system and how it is deployed to the Amazon Cloud.

Gluster:Main Data Repository (where data is stored, accessed by GXL system)

License Server: Central node which contains all s/w licenses, dbase for GXL, QA tools

Processing Nodes: Cloud based instances (virtual machines) that get allocated for processing, on demand

S3:Amazon Simple Storage Service – used for data storage (in the case of GXL, Gluster is the preferred method over S3 for data storage, due to more efficient handling of I/O

EC2: Elastic Computing – management console within Amazon Cloud Services for adding/removing computing resources

Instance: A virtual machine – Amazon provides standard configurations that range in processing capability (i.e. Micro, Small, Large, Extra Large)

5. CRM and ERP

Customer relationship management applications were among the first solutions businesses decided to migrate to cloud-based environment. Now, more companies are doing the same with ERP software, according to a recent TechTarget report. The news source explained that moving these apps to the cloud is driven by organizational demands and the cloud is an ideal choice to support such initiatives because of its cost-effectiveness.

Other industry professionals believe CRM and ERP business solutions are even more effective in a cloud-based setting. Mark Walker, technical services vice president at Scribe Software, said companies with cloud-based apps can improve the pacing of how they run their operations, the news source reported. Walker also said that organizations with these systems in place can provide better customer service by having data available to them immediately.

Business 2 Community's Thomas Stone also believes that ERP and CRM applications are given new life in cloud-based environments. The writer explained, however, that large ERP, CRM and HR deployments may still need to run on-site, but information from these platforms can be placed in the cloud for data analysis. Other apps created for customers are also ideal candidates for the cloud.

Some businesses are eager to launch most or all of their enterprise applications in the cloud simultaneously. This approach may work for smaller businesses, but according to Stone, medium and large organizations may want to implement their applications over time to determine their effectiveness. The main goal of migrating to the cloud should be to implement apps with minimal impact.

"There are many ways to use cloud computing and it's important to understand where the biggest benefits may be gained," Stone explained. "Portions of the infrastructure may be moved to the cloud over time allowing you to begin to see a return on your investment early in the restructuring of your computing resources."

But yet some of us need to care what's obscured; the folks tasked with building out a cloud environment need to know what's hidden in the cloud in order to build out an infrastructure that will support such a dynamic, elastic environment.

It is the obscuring of the infrastructure that makes cloud seems so simple. Because we're hiding all the moving parts that need to work in concert to achieve such a fluid environment it appears as if all you need is virtualization and voila! The rest will take care of itself.

But without a dynamic infrastructure supporting all the virtualized applications and, in many cases, infrastructure such an environment is exceedingly difficult to build.

Social networking

Social network platforms have rapidly changed the way that people communicate and interact. They have enabled the participation in digital communities as well as the representation, documentation and exploration of social relationships.

Social networks help boost internet usability by storing heavy multimedia content in cloud storage systems. Videos and photographs are the most popular content on social media, which essentially use up the maximum space allocated to them. They have the capacity to slow down applications and servers with all of their resource demands. Cloud computing vendors such as Salesforce and Amazon nowadays provide varied services including Customer Relationship Management (CRM) and Enterprise

Resource Planning (ERP). As they deliver these things through cloud servers, **clients can use the flexibility and scalability of the system** without purchasing standalone software or hardware.

Apart from data storage, the social networks are now also using clouds for various other tasks. For example, this can be **ideal for big data analytics.** One of the benefits of using cloud systems is that **users can access vast amount of structured and even non-structured data** easily. Just take a look at the much-improved analytics provided by sites like Facebook, especially for its business users.

Another way cloud computing becomes helpful is by **reducing the cost of data backup and recovery in case of a disaster.** If the data is only stored in one central location, it becomes much riskier. If something happens there, it is almost impossible to recover the data. But through cloud they remain accessible through shared resources across the globe. This is especially useful for social networks as the store personal data of its users, and so cannot afford to lose even one part of it.

Overall, it can be said that cloud computing has several usages, and some of them are still being discovered. For instance, in the near future, **personal secure clouds are likely to gain ground.** New age social networks and messaging apps such as Snapchat thrive on privacy and they will eventually utilize such resources to offer a more secure and faster service to its users.

Cloud Computing and Social Network Sites are among some of the most controversially discussed developments in recent years. The opportunities of using powerful computing resources on demand via the web are considered as a possible driver for the growth of the world economy. Cloud is a reality and will remain the most distinguished technological breakthrough, transforming the way business is done.

Web Resources:

http://computer.howstuffworks.com/cloud-computing/cloud-computing2.htm

https://www.ibm.com/blogs/cloud-computing/2014/02/top-7-most-common-uses-of-cloud-computing/

http://www.pewinternet.org/2008/09/12/use-of-cloud-computing-applications-and-services/

https://www.hindawi.com/journals/bmri/2013/398968/

http://zti.polsl.pl/w3/dmrozek/science/cloud4psp.htm

