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# Study of Process of Migrating the Concept of Business Intelligence from Web Based Computing to Cloud Based Computing

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**Keywords: Cloud, IaaS, SaaS, PaaS**

**Abstract:**

Cloud computing is a network of networked systems that offers clients on-demand services. Three distinct service models are used to describe cloud computing: Infrastructure as a Service (IaaS), Software as a Service (SaaS), and Platform as a Service (PaaS). A range of goods and services are offered to customers by various commercial entities. One of these models is available to cloud-based businesses. The model in this article explains how business intelligence assists clients in choosing a specific model for the needed service. A wide range of tools and applications for obtaining, storing, analyzing, and granting access to data are combined to form business intelligence (BI), which enables enterprise users to make more informed decisions.

Three phases are represented by the model: input, which receives and accepts query requests; processing, which involves matching requests with related models using the best-worst-first fit method; and output, which carries out requests or provides services in accordance with client demands. All kinds of clients will undoubtedly benefit from this model's assistance in using BI on the cloud effectively and unambiguously.

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## 1. Introduction:

A model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (such as networks, servers, storage, applications, and services) that can be quickly provisioned and released with little management effort or service provider interaction is called cloud computing. Cloud computing is a technology that uses the internet and central remote servers to maintain data and applications.

The term "service" refers to the fact that hardware and software are offered on demand and are paid for based on usage, meaning that the more you use, the more you pay. Cloud computing makes this possible. One of the three delivery models for cloud computing—known as the SPI model and established by NIST—can be easily separated apart. SPI is an acronym for software. SPI stands for Software, Platform and Infrastructure. Cloud computing can be visualized as a pyramid consisting of three sections National

### 1.1 Cloud Application

Applications are launched and interacted with via a web browser, hosted desktop, or remote client at the top of the cloud pyramid. Users never have to buy pricey software licenses for themselves, which is a distinguishing feature of commercial cloud computing apps. Rather, the expense is included in the monthly subscription charge. The hassle of software maintenance, continuous operation, and support is removed when a customer uses a cloud application because there is no need for the user to install and run the program on their own computer.

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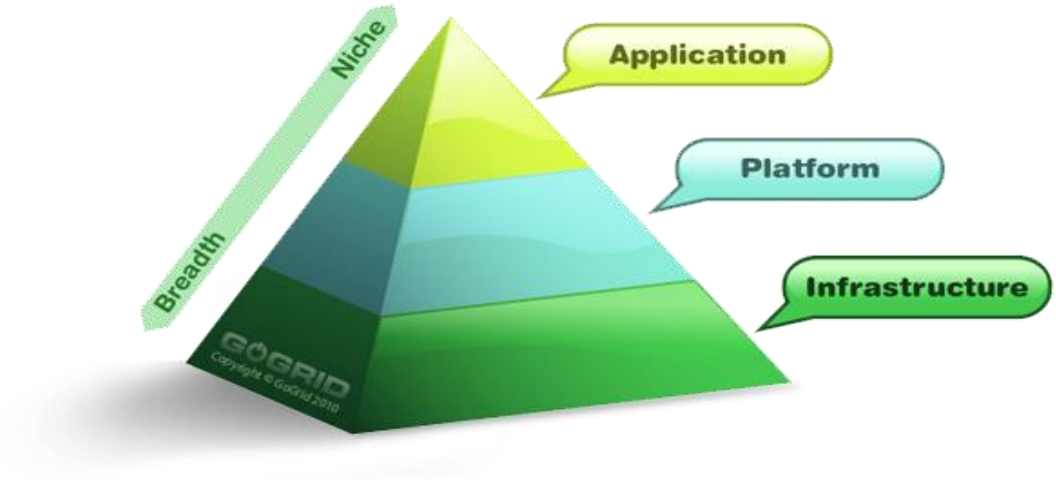


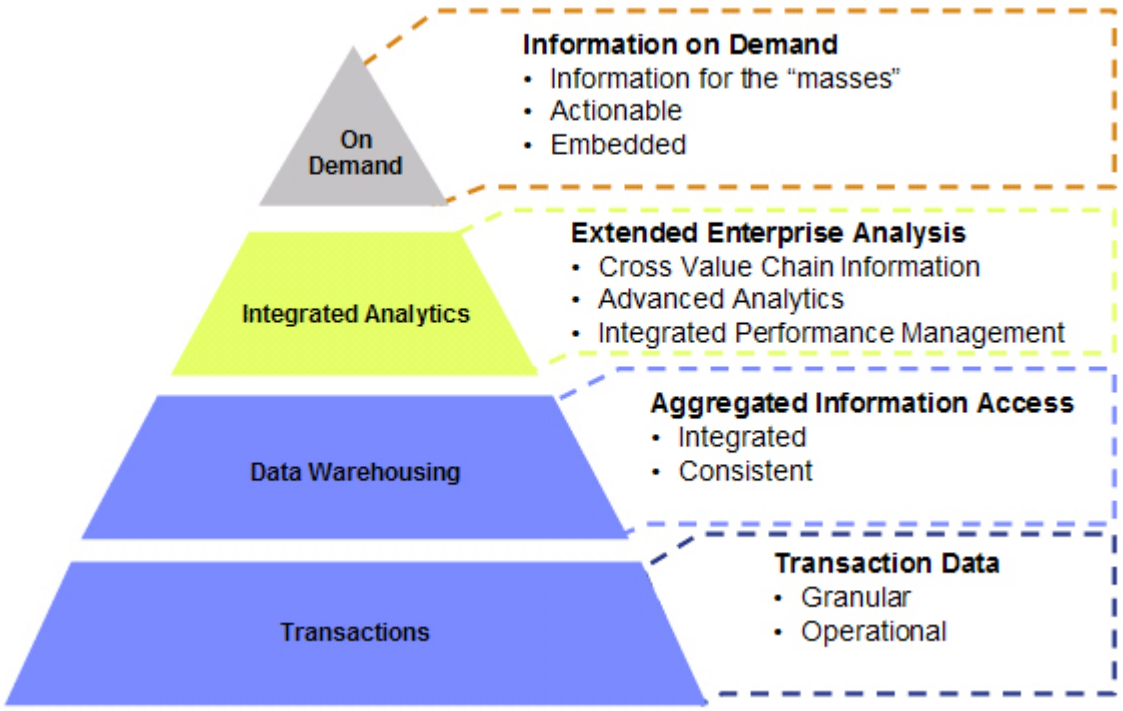


**Figure 1: Business Intelligence: From data to information on Demand**

Source:http://www.ibm.com/developerworks/data/library/techarticle/dm-0505cullen/index.html.

 

Essentially, the apps in this layer of the cloud computing pyramid provide web-based software as a service (SaaS). This layer's applications only provide the end user with what they can accomplish on their own.

Users are genuinely limited to the features and capabilities of the application in this section of the pyramid. Here are a few noteworthy businesses: Gmail, Hotmail, Quicken Online, and other public email services. This group includes many Software as a Service (SaaS) providers. The majority of retail customers make advantage of the services on this cloud layer. The user is limited to the pre-defined capabilities and cannot access any other features. Applications are made with GTD (getting things done) and user-friendliness in mind. One large cloud application/SaaS supplier is Sales Force.

- **Characteristics:**

Strengths: Sometimes free; easy to use; lots of different offerings; easy to access; good consumer adoption; proven business models

Weaknesses: You can only use the application as far as what it is designed for; no control or knowledge of underlying technology.

Examples : Gmail, Sales Force.

### 1.2 Cloud Platform

The cloud pyramid's middle tier offers a framework or computer platform as a service. In order to handle variations in demand, a cloud computing platform dynamically configures, reconfigures, and de-provisions servers. Actually, this is a distributed computing approach in which an application or infrastructure request is delivered by a number of services working together.

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The Cloud Computing Pyramid's middle layer enables developers to create apps that operate on the platform provider's infrastructure. Although it gives them less control, this relieves the developers of their worries around infrastructure scaling and environment configuration.


Fig: OVERVIEW APPLICATION PLATFORM

### 1.3 CLOUD PLATFORMS

The middle layer of the Cloud Computing Pyramid allows developers to build applications to run on the platform provider's infrastructure. This frees the developers from concerns about environment configuration and infrastructure scaling, but offers limited control.

#### 1.3.1 Cloud Platforms (PaaS)

The Cloud Platform layer, which is located in the middle of the Cloud Pyramid, gives users more flexibility and power than the Cloud Application layer, but there are still some limitations on what they can and cannot do. Furthermore, this layer offers a higher degree of complexity when it comes to controlling the frameworks that are contained within (such as Java or Ruby). This layer includes organizations and

products including Joyent, Google App Engine, Heroku, Engine Yard, Mosso (now part of Rackspace CloudSites), and force.com (a SalesForce development platform).

- **Characteristics:**

  Strengths- Great for developers with a particular niche target, upload a tightly configured applications and it simply “runs” within the platform’s framework; more control than a Cloud Application

  Weaknesses- Restricted to the platform’s ability only; hard to work “outside the box”; sometimes dependant on Cloud Infrastructure providers

- Company examples:
  1.Google App Engine

  2.Microsoft Azure

  3.Force.com (SalesForce)

**1.4 Cloud Infrastructure:**

The provision of IT infrastructure via virtualization is the cornerstone of the cloud architecture. A single physical piece of hardware can be divided by virtualization into separate, autonomous environments with scalable CPU, RAM, disk, and other components. The infrastructure consists of networks, servers, and other physical appliances that are provided as "cloud centers," "farms," or "web services" for the infrastructure. For robustness and extra capacity, these are then connected to one another.

Cloud platforms and apps are built upon the infrastructure layer, which forms the base of the cloud pyramid. Cloud infrastructure providers give consumers total control over their environment by enabling them to build fully virtualized (or hybrid cloud/hardware) IT systems. Located at the base of the pyramid is Cloud Infrastructure providers like Amazon Web Services, GoGrid, and the Rackspace Cloud (specifically Rackspace CloudServers). Companies providing infrastructure

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enable Cloud Platforms and Cloud Applications. Most companies within this segment operate their own infrastructure, allowing them to provide more features, services and control than others within the Cloud Pyramid. Typically, vendors within the Cloud Infrastructure layer provide Windows or Linux servers that are virtualized so that they can be provisioned dynamically and on demand. Billing for these virtual machines (VMs) is typically done based on usage or configuration and on an hourly or sometimes monthly basis. Other types of common infrastructure components like hardware-based load balancing or firewalls and other services like storage (frequently scalable on-demand cloud storage) exist within this layer, providing a full assortment of network and infrastructure devices for an end-to-end solution environments.

- Offers full control of a company's infrastructure; not confined to "containers" or "applications" or restrictive instances
- Weaknesses

  Sometimes comes with a price premium; can be complex to build, manage and maintain (based on provider)
- Typical examples are
- GoGrid
- RackspaceCloud
- Amazon Web Services

### 1.5 Architecture of Cloud Computing

Like any other system, the architecture of cloud computing may be divided into two primary parts: front end and back end. Any application (such as a web browser) that

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makes use of cloud services can be considered the front end, as can the end user or client. The back end is the network of servers that house any kind of data storage system and computer application. Most people assume that any software that is sold on the market can have an endless amount of storage on the cloud. Various apps in the cloud are housed on separate server farms. The administration of servers is centralized in the cloud. A centralized server manages the system, maintains traffic flow, modifies needs, balances client supply, and prevents congestion. This server adheres to protocols, sometimes referred to as middleware. The cloud network's communication between them is managed by middleware.


Figure. Architecture of cloud computing

### 1.6 Cloud computing service model

**1.6.1 Software as a Service (SaaS):-** This is typically end user applications delivered on demand over a network on a pay per use basis. The software requires no client installation, just a browser and network connectivity. An example of SaaS is MicroSoft Office365. Until its launch, if a user required says Word, they would have to purchase it, install it, backup files etc. With Office365 Word can be acquired for

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small monthly fees, with no client installation, the files are automatically backed up, software upgrades are automatically received and the software can be accessed from anywhere. Decide you do not require Word anymore – stop paying the monthly fee. It is that simple. Classical Application software services such as Online shopping, Online chat, Gmail, face book.

**1.6.2 Platform as a Service** Used by software development companies to run their software products. Software products need physical servers to run on, with database software, often Web servers too. These are the entire platform that the application runs on. Building this yourself is a time consuming task and needs to be continually monitored and updated. PaaS provides all of the platform out of the box enabling software applications to be given to the platform which will execute them with no requirement for administration of the lower level components. Basically Framework services higher-level and rapid application development environments which abstract the underlying technology and provide for scalability.

**1.6.3 Infrastructure as a Service** This includes a wide range of functions, such as email servers, domain name servers, messaging systems, disk drives, individual servers, private networks, and different long-term storage devices. These can all be supplied as needed and frequently include paying license fees for the operating systems and related applications that are installed on the servers. With IaaS on demand, businesses may construct a whole computing infrastructure.

Basically System Infrastructure Services Hardware related ie raw compute, storage services, network services etc.

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### 1.7 Business Intelligences

"A collection of techniques, procedures, frameworks, and technology known as business intelligence (BI) converts unprocessed data into information that is both relevant and helpful. With the utilization of real-time data, it enables business users to make well-informed decisions that can outperform other companies. BI technology choices have historically revolved around essential capabilities like analytics and reporting, but as those features become more and more common, a whole new range of options are opening up. According to Forrester's BI study, businesses who stay ahead of the curve in terms of these emerging trends can secure a competitive edge within their respective industries as technology continues to advance.

The term "business intelligence" has many various definitions and points of view, but most of them agree that the main goal is to give decision-makers useful information. The phrase "Decision Support Systems" became more popular in the late 1970s and early 1980s, and ultimately, everything revolves around the ability to provide useful information for decision-making. View the figure below to see how technologies have evolved.

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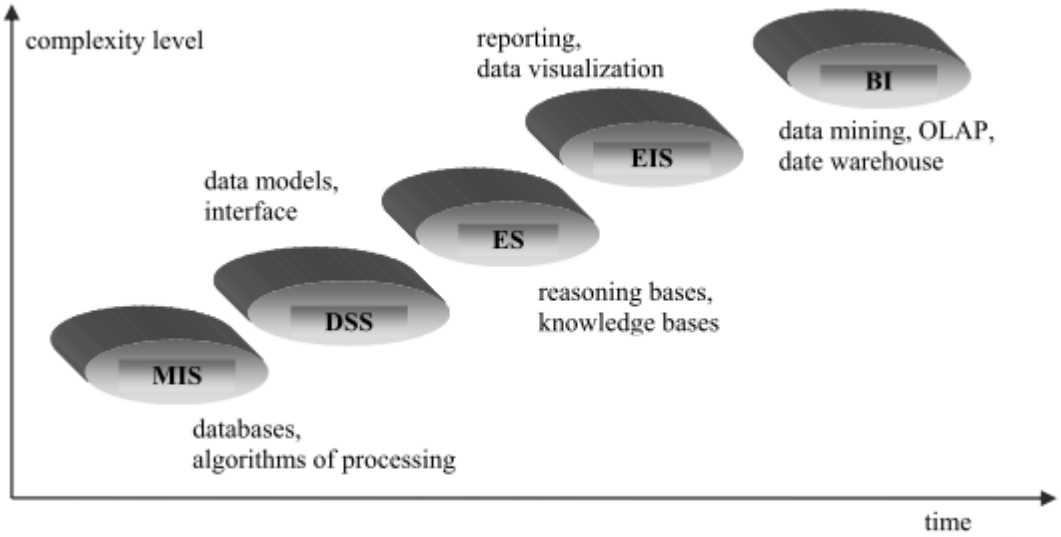
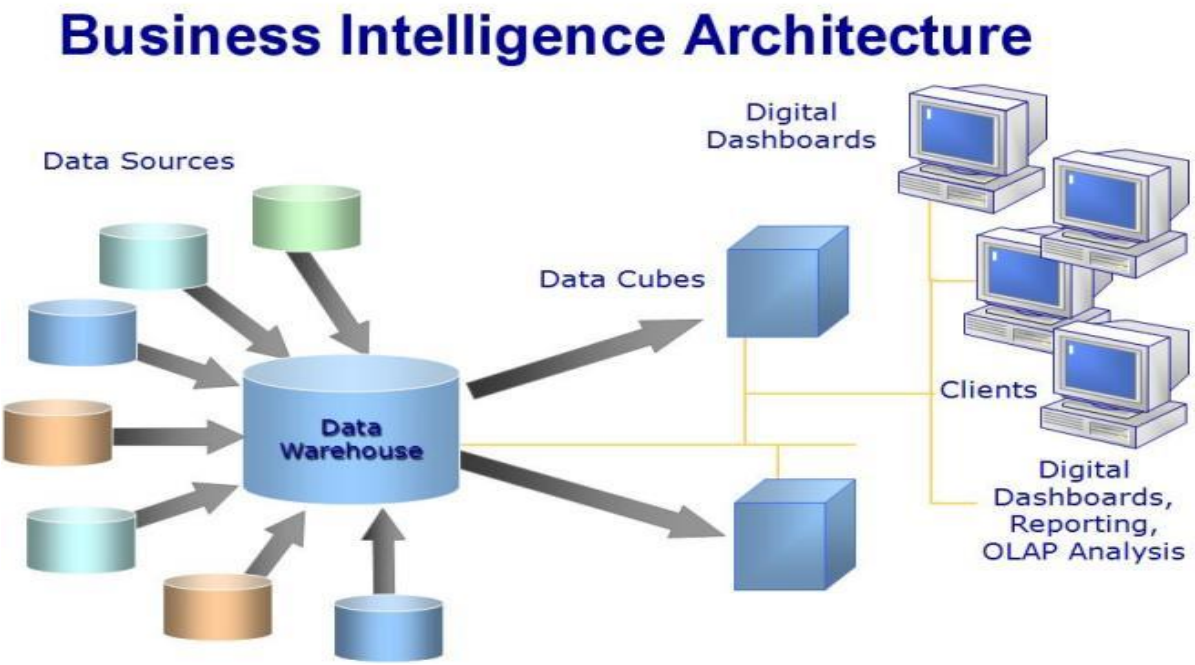



**Figure 1. Development of management information systems.**

Source: (Olszak, & Ziemba, 2004).

Source: http://ijikm.org/Volume2/IJIKMv2p135-148Olszak184.pdf

## 1.8. BI Architecture




Source: KSI

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### 1.9 Business Intelligence components

In most cases Business Intelligence involves the use of multidimensional analysis and reporting. By providing multidimensional analysis and reporting the company often builds a Company Data Warehouse to assemble the needed data.

However the term Business Intelligence covers at least the following five components that will be explained in more detail in the following:

1. Multidimensional analysis
2. Reporting
3. Data mining
4. Financial consolidation and budgeting
5. Key Performance Indicators

### 1.10 BI Cloud

By making the hardware, networking, security, and software required to build data marts and data warehouses on demand with a pay-as-you-go licensing and usage model available, the integration of business intelligence with cloud computing is expected to transform the economics of business intelligence. Integrating business intelligence with cloud computing can streamline business intelligence activities.

According to a recent Gartner survey, the most important drivers for investing in business intelligence are related to providing faster response to user's needs for data, decreasing costs, and enhancing the user's methods for data sharing and self-service. Cloud computing makes sense to business intelligence solutions only if it offers benefits to customers

 

Although there are many benefits of implementing business intelligence in cloud, there are many challenges which need to be addressed while implementing BI Cloud like security, performance, availability, integration, etc.

## 2. Cloud Models:

**2.1 Software as a Service (SaaS)**: Issue #1 here is password management. According to O'Neill, the primary danger associated with SaaS is probably using several passwords to access the same application because it provides apps from the cloud. "A company can choose to use a single sign-on method for both cloud and on-premise systems to address these problems. Users can use a single password to access both their own workstations and any cloud services by utilizing a single sign-on option. This strategy also lessens the instances of "dangling accounts," which are susceptible to misuse when individuals depart from companies."

**2.1.2 Platform as a Service (PaaS)**: Issue #1 here is data encryption. PaaS can be inherently secure, but the risk is slow system performance. That's because data encryption is recommended before data is sent to PaaS cloud providers, O'Neill says. The risk is that encrypting every piece of data will also eat up consumer organizations' CPU cycles and slow things down. Still, any solution implemented should broker the connection to the cloud service and automatically encrypt "confidential user data such as home addresses, social security numbers or even medical records."

**2.1.3 Infrastructure as a Service (IaaS)**:

 

**Issue #1** here is rogue users. IaaS focuses on managing virtual machines, and the risks are little different than with other cloud types -- here, the main risk is rogue or unwarranted commandeering of services. IaaS requires governance and usage monitoring, and O'Neill recommends that enterprises establish cloud service governance frameworks that help prevent employees accessing information or services they are not permitted to use. It also prevents them from running up costs on virtual machines or setting up their own accounts to access services paid for by the organization.

### 3. Challenges Faced by Cloud:

The increasing range of options within the cloud computing niche has created a sense of confusion, particularly for businesses trying to evaluate which of these technologies is best suited for their operational requirements. The following is an attempt to dissect each of the cloud computing solutions— SaaS, IaaS & PaaS, easing the decision-making process for making the move to the cloud.

### 3.1 Decoding SaaS

This cloud computing format is often referred to as being a finished product. SaaS is quite common in the form of free email services we use. If you are using

Gmail, you are not hosting an email server. You are essentially using a free online email service being hosted by Google. As a SaaS cloud computing user, you are just accessing this service. You are the browser and the client. Just like this browser-client example, most SaaS applications are directed towards end-users in an organization.

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Just like using Gmail, the end users don't need to make much effort to get started or understand the platform. The provider can allocate what kind of resources should be provided to the end-users. The provider is responsible for sourcing the networking equipment, servers and software requirements.

### 3.2 Decoding IaaS

IaaS represents a slightly different spectrum of cloud computing. An IaaS user is essentially seeking to maintain some degree of control over the software-related environment without caring for the hardware or equipment part. An IaaS user doesn't want to spend resources on assembling servers or paying bills for maintaining servers in massive, chilled warehouses. Thus, the user requests these services from an IaaS provider who provides virtual use of such equipment for a fee. Most IaaS providers offer storage facility and other computing resources that a user can request on-the-go. Established IaaS providers include global brands like IBM and AMAZON

### 3.3 Decoding PaaS

PaaS is regarded as the mid-range or the halfway cloud-computing solution, delicately poised between IaaS and SaaS. Unlike SaaS, it isn't a packed, ready-to-use solution and unlike IaaS, it doesn't provide as much degree of control over the choice of software. PaaS is more oriented towards providing a customized cloud computing environment. It allows developers to use various tools for developing a platform that is best suited to an organization's requirement. Microsoft Windows Azure is one such example. It gives users a range of tools to create the kind of social

 

or mobile applications that can be conceptualized and created within the Azure environment and then run as per the user's preference.

## 4. Understanding Choosing Between SaaS, IaaS, PaaS with an Example

Following the introduction of numerous reforms, including federal government-sponsored regulations such as HIPAA, the healthcare sector is growing more structured. Hospitals and doctor's offices are looking more and more for software programs that can control every aspect of their operations, including billing and transaction processing. These medical facilities, together with their business partners (collectively referred to as "covered entities"), are subject to harsh financial and legal penalties if they fail to maintain compliance. Due of this, the majority of healthcare institutions currently aim to implement Healthcare Contract Management.

Systems where each option is essentially a software solution using PaaS, IaaS or SaaS. For instance, in a hospital, a hospital contract management software can be based on either of these three cloud computing offerings. When deciding between the three, the hospital should make a simple comparison of features, like:

### 4.1 SaaS:

- Offers software as the main service
- User gets a complete application package
- Users have limited range of choices, i.e. customization is compromised

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**4.2 IaaS:**

- Offers infrastructure as the main service
- Computing choices of user need should be well-defined
- Users can demand more storage or computing power

**4.3 PaaS:**

- Offers a user-friendly platform as the main service
- Allows users to develop applications and execute them
- Offers better security, database management and workflow management

- SaaS is best suited for end users who don't want to be bothered by software or hardware-related choices. A healthcare contract management system based on SaaS is perfect for a physician's office with limited billing/technical staff.
- IaaS offers options for decreasing/increasing computing capacity but this solicits the presence of developers.
- PaaS is ideally suited for expert application developers—not the best bet for service providers seeking to pay fixed fee for ready-to-use software solutions.

Examples of cloud-based services include customer self-scheduling, data storage, online payment, and accounting software. It's likely that you are utilizing the cloud without even knowing it (if you do know it, please take our current survey about the cloud on the right hand side), as some popular small business tools that are cloud-based include.

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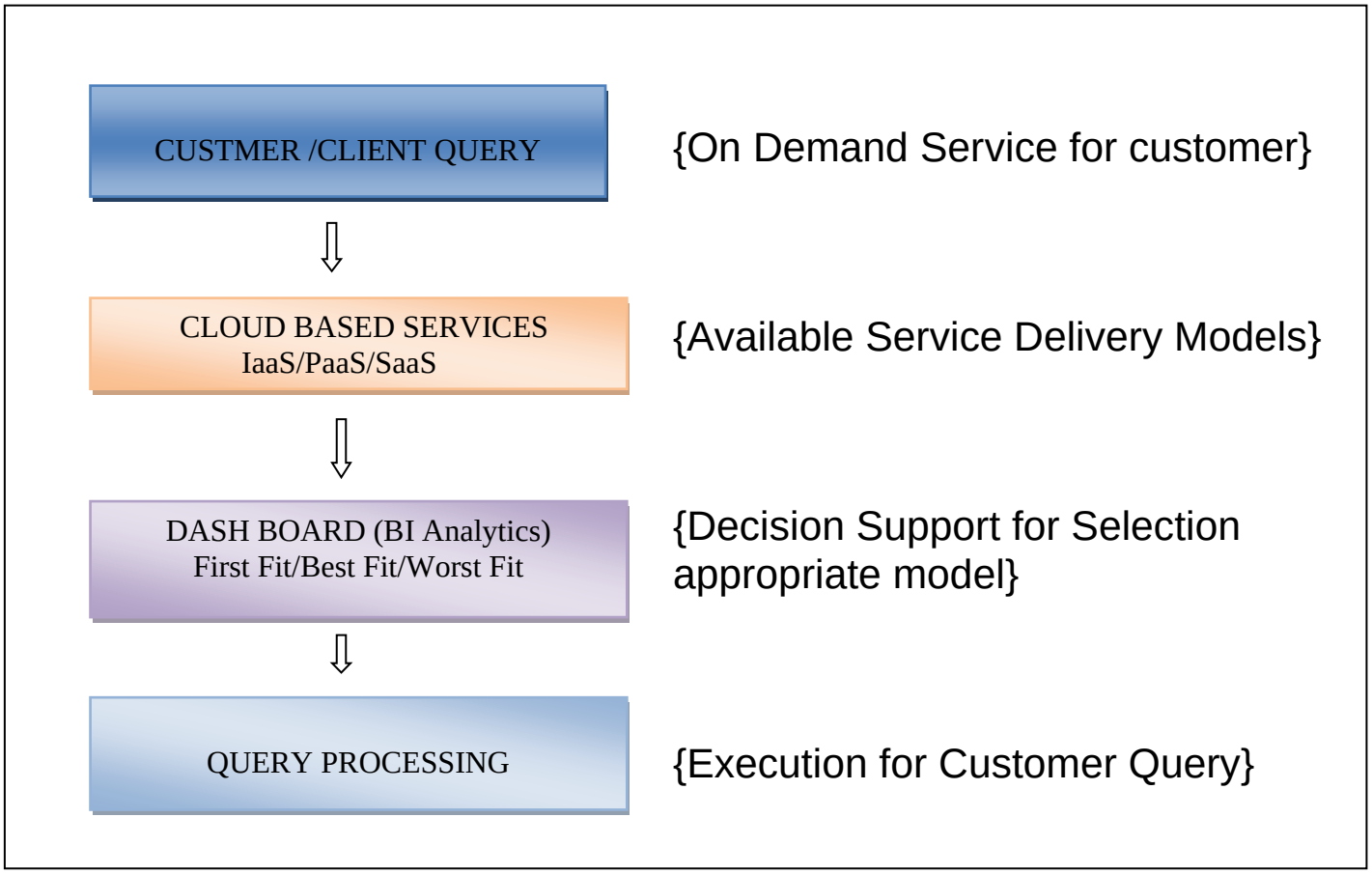
**5. Cloud computing Model using BI:**




### 5.1. CUSTMER /CLIENT QUERY

Like the challenges the customers are facing for the services available the query of the customer is first identified as the customer demand on priority. The query has to be classified and required model which need the query to be process is matched in the next phase.

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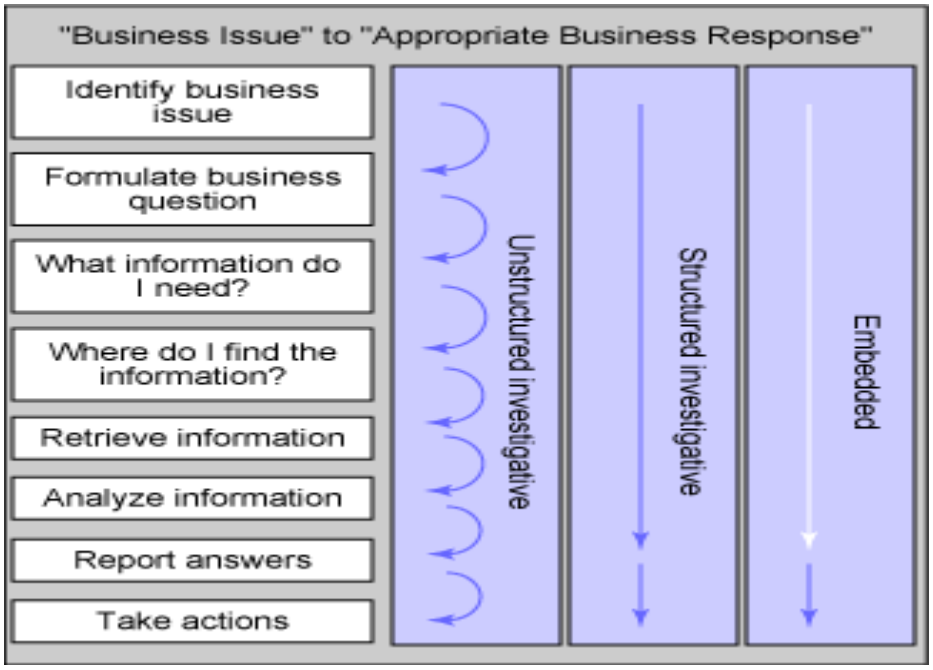


**Fig. Business Intelligence Analytic techniques.**

**5.2. Cloud based services:** Simply said, cloud service models indicate the kinds of services that can be offered to clients. Various models can accomplish various corporate goals and are tailored to meet a variety of needs. If you conduct a basic search on the internet, you can come across numerous results for "Cloud * as a Service," where * might stand for any of the following: desktop, security, data, software, platform, infrastructure, IT, testing, hardware, computing, database, storage, etc.

As though there are currently three models available. The fundamental components of the cloud are these delivery models, which have features like multi-tenancy, measurable service, on-demand self-service, ubiquitous networks, and quick elasticity.

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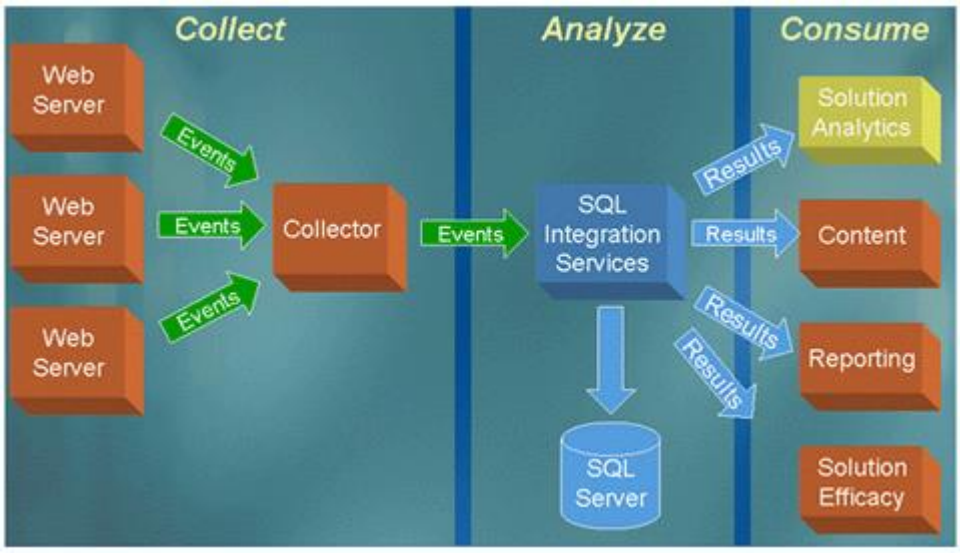
**5.2.1 IaaS** - the unit you are gaining is a computer/server. Consequently, IaaS can be thought of as a "physical server box". Renting a real box from RackSpace or SoftLayer is one way to illustrate this. The vendor is in charge of the box's hardware, networking, virtualization operating system, and hard drives (should they fail). As seen in the screenshot above, you have the ability to handle anything else including remote desktop to the box. IaaS is offered by Windows Azure as a virtual machine role, which allows you to upload and administer a Windows Server 2008 R2 image.

**5.2.2 PaaS** - the unit you are gaining is an application/framework. Therefore PaaS is a "hosted application/framework/tools that you can leverage to build something on. That application is configured on IIS/SQL Server etc and runs on a hardware/virtual system that the vendor manages. An example of PaaS would be Windows Azure (excluding the VM Role) services like web role, worker role, Reporting Services etc.

**5.2.3 SaaS** - the unit you are gaining is business functionality. For example, Gmail is a type of a SaaS mail provider because you don't have to manage any service yourself and its all done by the vendor (Google in this example).



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SOURCE: web solution platform (http://msdn.microsoft.com/en-us/library/aa479376.aspx)

### 5.3 Dashboard:

This method aids in decision-making by helping to choose the best model—IaaS, PaaS, or SaaS—based on the needs of the client. According to an IDC survey released at the end of the previous year, respondents said that performance was the biggest obstacle to cloud adoption, second only to security and availability.

Several organizations have created tools to assess and compare performance under various scenarios, giving buyers insight into the relative performance levels of various cloud providers. While individual vendors have begun to provide their own monitoring dashboards (Salesforce has its Trust Dashboard while Amazon has its CloudWatch dashboard, for example), buyers are increasingly looking for third-party tools that give a neutral insight into vendor performance.

Some interesting players in the space include:

#### 5.3.1 CloudKick

Supporting Rackspace, Amazon EC2, Linode, GoGrid, Slicehost, RimuHosting, and VPS.NET, CloudKick enables users to control cloud infrastructure from multiple different vendors from one dashboard which allows both monitoring and management of an infrastructure setup.

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Built upon the open-source Libcloud API that CloudKick also helped develop under the guidance of the Apache Software Foundation Incubator, CloudKick's commercial services range from $99 to $599/month depending on the number of servers. Cloudkick also offers customized packages for customers with larger or more specific needs.

### 5.3.2 CloudSleuth

Still in beta, CloudSleuth is a cloud performance visualization tool that runs a benchmark Java e-commerce application to measure response time across various cloud providers.It deploys the identical application to different cloud providers and then measures performance from locations across the U.S. and internationally. CloudSleuth returns metrics about both response time and availability.

### 5.3.3 CloudHarmony

CloudHarmony is another beta product that provides what it calls a Cloud Speedtest to provide a benchmark performance figure for various cloud providers.

### 5.3.4 Cloudstone

Cloudstone is a tool that spun out of a research project at UC Berkeley. More than a benchmarking service itself, it has created an open-source framework for testing cloud performance. The research team built a selection of tools for generating various load levels and testing the performance under those loads across various cloud providers.

 

### 5.3.5 ServerDensity

More than a benchmarking tool, ServerDensity is a product that offers the ability to measure CPU load, memory, processes, disk usage, network traffic. Using a generic application or workload bundle, however, one could use ServerDensity's reporting engine to run comparative tests across multiple cloud providers.

### 5.3.6 Cloud CMP

Microsoft Research and Duke University collaborated to build CloudCMP. The Cloud CMP project created several measuring domains and evaluated several cloud providers using those evaluation criteria. In the process, it has yielded fascinating cost/performance measures for several applications distributed across various providers in addition to empirical bottom line performance outcomes. So far, the research team has produced a single report covering several cloud providers.

### 5.3.7 CloudStatus

CloudStatus is a VMware company that aims to "provide an independent view of the health and performance of the most popular cloud services on the web." Currently in beta, CloudStatus thus far measures only Amazon Web Services and Google App Engine for both availability and performance.

### 5.3.8 BitCurrent

In late June, BitCurrent conducted a benchmarking study. The study evaluated force.com, Google App Engine, and the IaaS options from Amazon, Rackspace, and Terremark at the platform level. Since cloud performance is a dynamic domain and

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near real-time status is the only practical means of continuous performance monitoring, this is essentially an academic study conducted once.

There is also uncertainty about how cloud performance offers will manage to maintain their independence to maintain neutrality while still developing a sustainable and successful business. The fact that this list includes a number of university-developed tools suggests that, from a research standpoint, the majority of the independent performance measurements.

Benefits of Business Intelligence Integration with Cloud Computing As per a survey conducted by Gartner, the primary motivators for investing in business intelligence (BI) are to enhance user methods for data sharing and self-service, save costs, and respond to users' data needs more quickly. The main benefits of implementing business intelligence in cloud computing include lower cost, multiple redundant sites, and scalable provisioning of resources, which in turn allow for business continuity, disaster recovery and on-demand performance improvements.

### 5.3.9 Lower cost

By implementing BI on the cloud, businesses would save money on both software and hardware purchases and maintenance. To set up BI Infrastructure, businesses don't need to spend a lot of money on gear, software, licenses, or training. Paying for resources would only be necessary if they used or needed them. As a result, less money would be spent needlessly during the period when no one is using the application or computer resources.

### 5.3.10 Multiple redundant sites

Keeping the solution available for as long as feasible is one of the main priorities of

 

business intelligence specialists. Having several sites that provide redundancy is one method to accomplish this. This feature is made possible by the geographically distributed locations of cloud computing providers.

### 5.3.11 Scalable provisioning of resources

The amount of work that BI solutions must complete in a given day varies. As a result, some servers may be idle at some times, while others may be operating at their maximum capacities in terms of processing, memory, or I/O. Cloud computing allows resources to dynamically scale up and down based on needs.

### 5.3.12 On-demand performance improvement

When customers want to increase their data warehousing capabilities without compromising everyday operations, this is one of the most frequent issues with BI solutions. Due to the significant costs associated with new hardware, storage, licenses, and labor-intensive migration to the new environment, this operation is typically quite complex. By utilizing current hardware and software resources, this issue might be resolved for users almost instantly and transparently through the usage of BI in the cloud.

### 5.3.13 Usage billing

By using cloud computing, companies pay for a service as they use or pay on a monthly or yearly basis. With this policy, the expenses move from Capital Expenditure (CapEx) to Operational Expenditure (OpEx).

### 5.3.14 Fast deployment

The platforms may be up and running in a matter of minutes, ready to configure applications and begin filling the data warehouse, saving a significant amount of time

 

compared to the lengthy process of setting up and installing the necessary hardware and software.

### 5.3.15 Easy maintenance

The majority of the firmware, updates, and upgrades that are required for hardware and software are handled by the cloud computing provider. Additionally, there is significantly less maintenance required on client computers because these apps are accessed through internet browsers.

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