

Cloud Computing – An Introduction

subu
sangameswar

Cloud Computing – An Introduction

Subu Sangameswar

Kindle Ver 1.0

Publication Date Jun 2015

Contents

The Start

What is Cloud Computing?

Cloud Models

Deployment Model

Service Model

Factors for the Rise of Cloud Computing

Benefits

Challenges

Cloud Maturity Path

Framework for Migration

Identify preliminary set of candidate applications

Identify the type of cloud environment and the cloud model

Partner with the vendor

Partner with the business units

Think integration

Don't forget security

What about ROI?

Next Steps

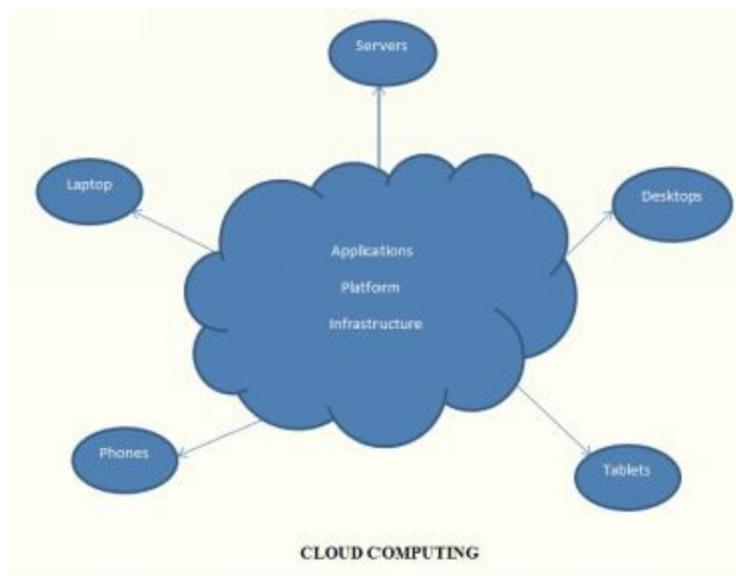
About the Author

The Start

This is a quick introduction to cloud computing. It is not comprehensive nor meant to be an exhaustive textbook but a way to get a basic understanding. It barely scratches the surface of most concepts but (hopefully) provides the foundation to build on the concepts. My effort has largely been to condense the various articles, research papers and other publicly available material and provide it as a primer; a pathway to the cloud.

What is Cloud Computing?

Cloud computing represents a significant evolution in information technology (IT) service offerings, creating a powerful and flexible way to access the latest technology services while still managing IT costs[1]. In simple terms, cloud computing means storing and accessing data and applications over the Internet instead of your computer's local hard drive. The cloud is just a metaphor for the Internet. Database, e-mail and business applications are usually the leading applications that businesses move to cloud once a decision to migrate is made.



Businesses large and small are moving quickly to adopt some form of cloud computing tools and services, recognizing a new technology that could reshape their competitive landscape. Some businesses choose to implement Software-as-a-Service (SaaS), where the business subscribes to an application it accesses over the Internet (example Salesforce.com). There's also Platform-as-a-Service (PaaS) which typically includes operating system, programming language execution environment, database, where a business can create its own custom applications for use by all in the organization (example AWS Elastic Beanstalk, Windows Azure). And then there is the Infrastructure-as-a-Service (IaaS), where vendors like Microsoft, Amazon, Google, and Rackspace provide a backbone that can be "rented out" by other companies. (example Netflix rents Amazon cloud to host the various streaming applications). We are slowly moving towards Desktop-as-a-Service, Data Warehouse-as-a-Service, Data Management-as-a-Service, Business Intelligence-as-a-Service; in fact, Everything-as-a-Service (EaaS) where every application can be rented or used as and when required from any device and from anywhere.

The concept of maximizing resource utilization by sharing is the foundation of cloud.

The cloud's ability to increase business speed and agility, lower costs, and enable new means of growth, innovation, and collaboration are the drivers for this fairly aggressive rate of adoption. Yet the main concerns about security, business continuity and compliance remain largely unresolved.

The main characteristics[2] of a cloud can then be defined as

- on demand self-service – It is always available on demand and provisioned by the user as and when required
- broad network access – The computing resources are accessible over the network, supporting heterogeneous client platforms such as mobile devices and workstations
- resource pooling – It can service multiple customers from the same physical resources, by securely separating the resources on logical level using virtualization
- rapid elasticity – It is flexible to expand and support the increase and decrease of the business demand. Application will have exactly the capacity it needs at any point of time as resources can be provisioned and released on-demand

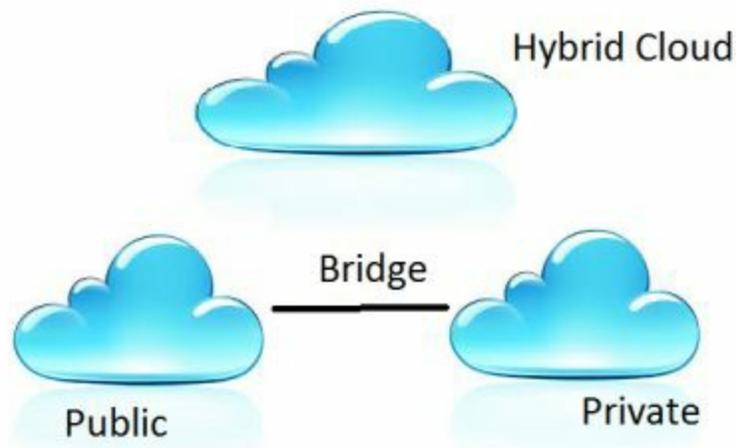
Cloud technology has veritably transformed the way people manage their lives and businesses, whether they're storing files in a Google Drive or purchasing a cloud-hosted business productivity suite. Gartner has predicted the demise[3] of traditional IT sourcing and a complete transition to cloud office systems in the very near future. Cloud has become the new style of elastically scalable, self-service computing, and both internal applications and external applications are being built on this new style.

Cloud Models

There is a huge range of cloud computing options. Cloud computing can be classified as public, private or hybrid based on the deployment model. It can be characterized as Software as a Service (email, games), Platform as a Service (database, web servers) and Infrastructure as a Service (virtual machines, storage, networks) if we use the service model description. One other way of looking at cloud solution is through the lens of Operating models: the customer owns and operates it; the cloud provider owns and operates it; or, the customer owns the solution but the provider operates it. Finally target models are one other option to view the cloud solutions - consumer versus enterprise, startup versus established business, small versus large business.

There are obvious distinctions between the needs of consumers and enterprises, which can be seen in the storage capacity needed, application support required, need for administrative tools and functionality, bandwidth availability to meet data volume, number of users, security features required, customer support, uptime and payment models^[4]. The fact is that cloud is about the consumption (and delivery) of services to be consumed by those that need them, and that development in the cloud is largely centered on how those services are composed into solutions to a wide range of problems essentially being labelled as 'EaaS - Everything as a Service'.

Deployment Model



Public Cloud

Public cloud is generally the most well-known and straightforward type of cloud computing. It is typically associated with convenience — it is easy for enterprises and developers to set up, use and access. Additionally, scalability is often a driving factor for businesses utilizing the public cloud.

Apart from the ease of set up and use, the main characteristics of a public cloud is the pay-per-use model with no long term contract requirements and flexibility for expansion. One big perceived disadvantage is the security. The public cloud often has a lower level of security and may be more susceptible to hacks especially when the cloud is hosted outside USA. Some public cloud providers also reserve the right to shift data around from one region to another without notifying the user — which may cause issues, legal and otherwise, for a company with strict data security policies.

This model is best suited for businesses where it is required to manage load spikes, utilize interim infrastructure for developing and testing applications, and manage applications which are consumed by many users that would otherwise require large investment in infrastructure from businesses.

Private cloud

A private cloud provides a higher degree of peace of mind by providing larger control on the infrastructure and tremendous value from a security point of view. Private clouds may be the best option for companies that must jump through a lot of regulatory hurdles or handle sensitive data, or for companies concerned over their own intellectual property being hosted on the public cloud.

The main use of private clouds is to create a more flexible, scalable infrastructure for internal IT operations, followed by the ability to connect more easily and in more significant ways with external partners, suppliers, and customers.

Managed private clouds are one specific form of this type of cloud computing: This service refers to clouds that, though specific to an individual business, receive some assistance (such as operating service monitoring and patching) from a third party. This allows for a company to select the custom cloud model that fits its needs while leveraging secure third-party help for maintenance.

The main features of private cloud computing are a) clouds that are not shared, b) more reliable due to strong service level agreement, and c) customized for the business need. The big downside factor is cost. It may also involve requiring IT skills to manage the environment. While private cloud may rack up costs due to increased management responsibilities and smaller economies of scale, it is worth weighing the risks vs the cost of security.

Many businesses believe that private clouds are more secure than public ones, because the data remains within the company's existing infrastructure. However in the private cloud, the same risks that existed in the un-virtualized data center still hold true. Specifically, trusted insiders that have access to systems can view, tamper with, and steal unprotected data. Insider threats are not new, but as corporate data centers go virtual, the traditional access control mechanisms become less effective if the controls are not ported into the virtual realm.

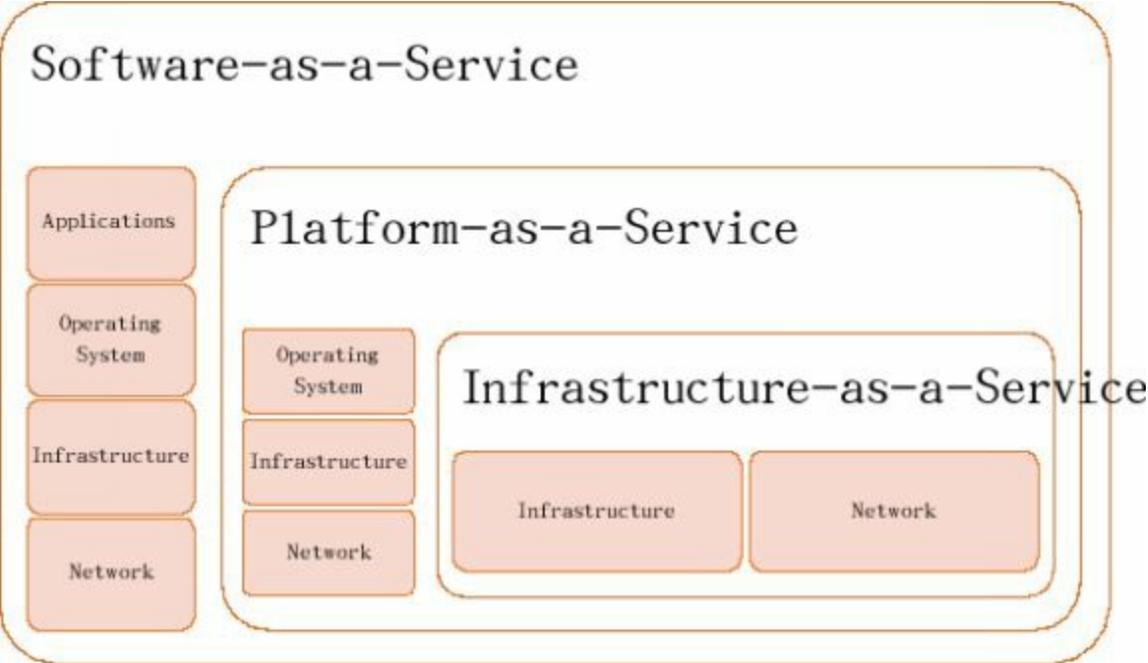
Hybrid Cloud

The hybrid cloud allows for a "mix and match" approach, enabling businesses to pick and choose various elements from either the public cloud or private cloud -- or a combination of the two — that make the most sense for their particular organization. For example, a company could host its ecommerce website — complete with customer credit card information — on a private cloud, but could also host its non-sensitive material (such as marketing collateral, etc.) on the public cloud.

A hybrid cloud provides a balance of convenience and security. It is usually flexible, scalable, and can be cost effective. It allows businesses to take advantage of secured applications and data hosting on a private cloud, while still enjoying cost benefits by keeping shared data and applications on the public cloud. This model is also used for handling cloud bursting, which refers to a scenario where the existing private cloud infrastructure is not able to handle load spikes and requires a fallback option to support the load.

Ultimately, hybrid clouds look to be a promising solution for the future.

Service Model



IaaS: Infrastructure-as-a-Service

The first major layer is Infrastructure-as-a-Service, or IaaS. It is also sometimes called as Hardware-as-a-Service.

In this form of cloud computing, the vendor provides virtualized computing resources over the Internet with highly scalable resources that can be adjusted on-demand. The vendor also provides hardware, software, servers, storage and other infrastructure components. They also host users' applications and handle tasks including system maintenance, backup and resiliency planning. This model is well-suited for businesses with workloads that are temporary, experimental or change unexpectedly. IaaS customers pay on a per-use basis, typically by the hour, week or month.

IaaS is the most flexible cloud computing model providing true control over the infrastructure while allowing for automated deployment of servers, processing power, storage, and networking. Some of the biggest names in IaaS include Amazon, Microsoft, VMWare, Rackspace and Red Hat. While these companies have different specialties — some, like Amazon and Microsoft offer more services than just IaaS — they are connected by a desire to sell both the raw computing power and hosting your website.

PaaS: Platform-as-a-Service

The second major layer of the cloud is known as Platform-as-a-Service or PaaS, which is sometimes called the middleware^[5] and is a broad collection of application infrastructure (middleware) services (including application platform, integration, and business process management and database services). The underlying idea of this category is that all of your businesses' development can happen at this layer, saving both time and resources.

PaaS vendors offer a wide variety of solutions for developing and deploying applications over the Internet, such as virtualized servers and operating systems. This saves money on hardware and also makes collaboration easier for a scattered workforce. Web application management, application design, application hosting, storage, security, and application development collaboration tools all fall into this category.

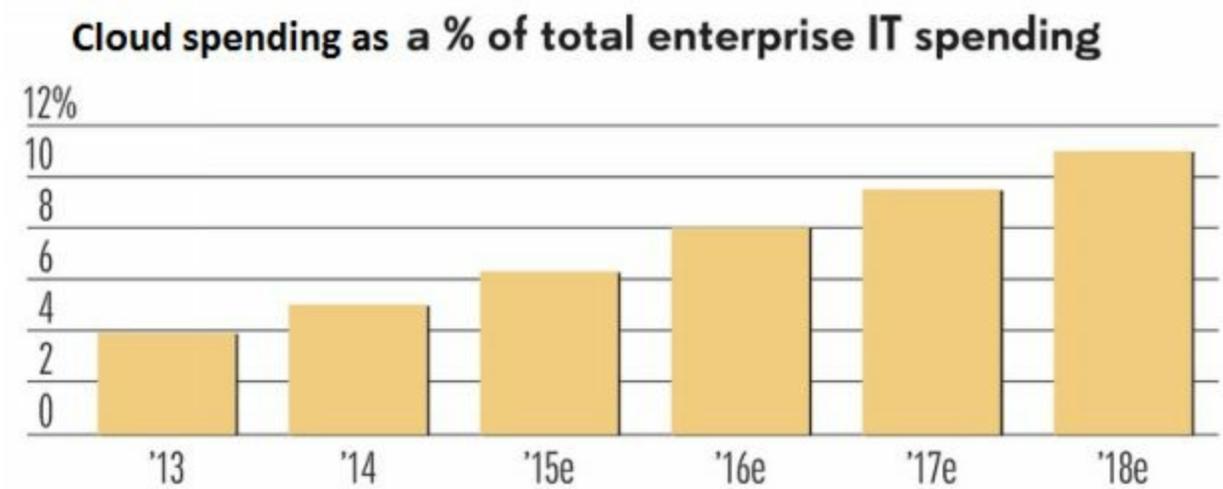
Some of the biggest PaaS providers today are Google App Engine, Microsoft Azure, Salesforce Heroku, and Engine Yard.

SaaS: Software-as-a-Service

The third and final layer of the cloud is Software-as-a-Service, or SaaS. In this delivery model, the software is licensed on a subscription basis and is centrally hosted. It is sometimes referred to as "on-demand software".

SaaS is one of the most known and first service offered by any vendor. Any application hosted on a remote server that can be accessed over the Internet using a thin client via a web browser is considered a SaaS. Salesforce is a common example of a CRM SaaS application.

Factors for the Rise of Cloud Computing



Source: Goldman Sachs (goldmansachs.com) Cloud

computing allows businesses to tap computing power as a utility[6] as the costs have dropped hundred fold in the ten years since the time cloud computing was introduced. Secondly there has been big advances in technology both in terms of computing power, virtualization and large-scale broadband availability.

Benefits

So, why should businesses consider cloud? What are the main advantages? The first and most common reason is the reduced cost that includes operational and capital cost.

Traditionally, organizations have hosted and built applications within their premises leading to a large infrastructure and capital cost. While this has not been a factor for large businesses, it definitely impacted small business as they had to come up with a large upfront cost and also hire skilled personnel. With the advent of cloud, businesses can simply provision the cloud as required. The capital costs can now be converted into operational costs and can be spread over a period of time and period of demand. This makes high-performance software available to the masses.

The other technology reasons that justify cloud migration include

- Speed of deployment – Applications can be provisioned as needed and can be deployed instantaneously
- Adaptability to changing business needs – Businesses do not need to maintain the application as the vendor will automatically provide the updates and patches. If a particular vendor offering remains outdated, businesses can find other vendors and move on.
- Mobility - The cloud can be accessed from anywhere with an Internet connection lending to the business and its employees being able to log into the system to keep customers happy.
- Elasticity - Typically priced on a per user (named or concurrent) basis, cloud software is more scalable for businesses of varying size. This is especially evident when team structures change, and a business can simply add or remove users from the contract to optimize costs.

From the business perspective, the main benefits include ease of collaboration, traceability and improved business processes. One manager in a retail company summarized this as –

“..We can all go in and just see what’s going on. Whereas before I might be doing something and I might not think to tell people. But they could literally go in now and see for themselves. When people feel that they are engaged with things and they know what’s going on..., they feel they are part of something..”

Challenges

Data security

Security concerns continue to be the most common barriers to cloud adoption, with data loss and privacy being top concerns.

Clouds are designed to be both dynamic and on-demand, so data may reside anywhere within the cloud — possibly in multiple locations on shared devices. This ubiquity enables efficient use of the cloud's underlying assets, but it may present significant risks to the owners of the data depending upon the requirements of a wide variety of laws, regulations, and industry standards.

Cloud security also depends on the vendor reliability. Vendors who incorporate 128-bit encryption, intrusion detection systems, continuous monitoring, two-factor authentication, distributed grid architectures, redundant networking may be stronger in implementing checks and prevent big mishaps.

In general, you can model and predict your business in finite detail, but at the end of the day, it is often the unexpected that makes, breaks or sets the alarm.

Downtime and outages

Moving to cloud makes the business rely on the cloud vendor and network vendor for preventing downtime. A system outage, even when brief, can cause frustration, service bottlenecks, and even lost sales or contracts. The good news is that many cloud-based systems offer at least minimal offline capabilities and will automatically resync when the system comes back online.

Return on Investment □

Although many cloud advocates talk about cost-savings as the primary advantage of cloud migration, businesses need to measure the total cost of ownership to compute return on investment. Moving from on-premises system to cloud involves cost including migration cost.

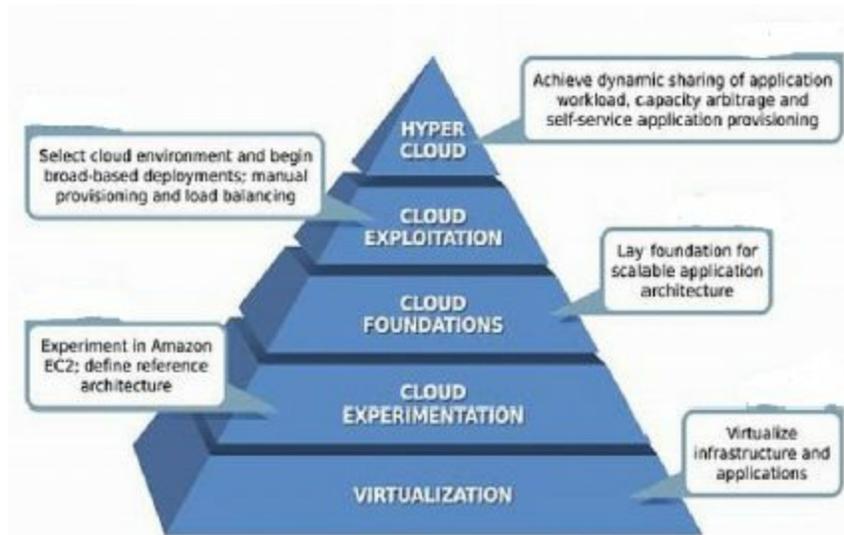
Vendor Lock in

The current cloud environment forces businesses to be locked in into a single vendors' environment and may involve unforeseen costs to move from vendor to vendor. Businesses need to assess and decide on the vendor and the services offered before signing any long term contract. In addition, businesses need to plan for training and migration in case of need to move from one vendor to another.

Lack of control

Businesses who are used to having a home grown system/environment will feel the lack of control when migrating to cloud. This is more of a comfort feeling. Sharing control with other players requires a change in mindset.

Cloud Maturity Path



Until recently, if businesses wanted to run business applications and manage their websites, they would need to buy servers and other pricy hardware, set up the network, get into the nitty-gritty details of virtualization in order to control local applications and have the technology for the business run smoothly. With the evolution of cloud many other options are opening up.

The general maturity path^[7] is as follows -

From the baseline of - *There is no Cloud approach. No elements of Cloud are being implemented to let us think virtualization* – is the first step in the maturity cycle.

Virtualization is the key building block for advancement of cloud based services. With virtualization, vendors can run multiple operating systems and applications on a single server while consolidating hardware to extract vastly higher productivity and saving up to fifty percent or more on overall IT costs. Business's also start with virtualization moving from silo'd computers.

The next step in the maturity cycle is experimentation. An awareness of cloud computing is established and some isolated groups start implementing elements of cloud computing. Yet there is no cohesive plan being followed.

From here, business mature to having a systematic approach to cloud computing essentially laying the foundation for including cloud in the enterprise architecture. There

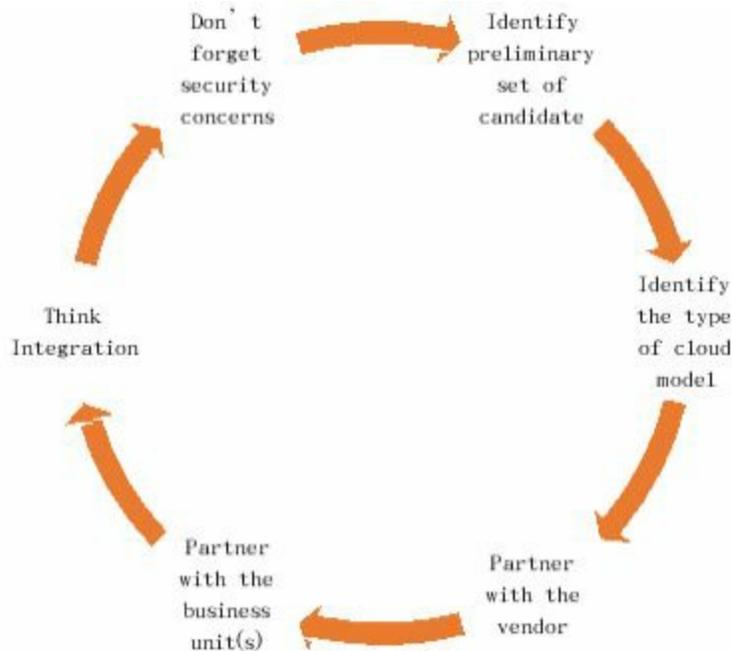
are governance structures in place and appropriate metrics and ROI are measured to justify cloud migration.

In the process of migration to fully cloud based system, businesses evolve to fully exploit cloud with a scalable architecture and integration with their existing environment. Metrics are measured and assets proactively maintained to ensure relevancy and correctness.

The biggest benefit of cloud may differ from one organization to the next and is usually directly tied to whatever issue is driving cloud adoption in the first place.

Framework for Migration

The main steps in planning the migration[8] is doing the due diligence. Putting in the extra effort to understand the technology landscape and the business requirements will provide the required foundation for a successful migration. Although migration of an application to a cloud will not solve all intrinsic application scalability or resiliency issues, businesses will be able to derive tangible financial and operational benefits in moving an application from legacy servers to a cloud.



Here is a framework you can use that will help with planning the migration –

- Identify preliminary set of candidate applications
- Identify the type of cloud model
- Partner with the vendor
- Partner with the business unit(s)
- Think Integration
- Don't forget security concerns

Identify preliminary set of candidate applications

Database, e-mail and business applications (ERP, CRM & industry-specific apps) are usually the leading candidates businesses evaluate to move to the cloud first. Some applications will be easier to move to a cloud while others will not be. The best strategy is to target the least critical section of the business' processes and data for migration to the cloud.

Applications that are critical to the overall operation do not make good initial candidates for cloud migration. Even the best laid plans can end up going out the window once things get rolling. The cost of interrupting critical operations is probably not worth the risk and experience may help develop a migration plan that has better certainty. Ask the following questions within your business units.

- Is cloud for prototyping or production?
- What is the leading candidate application that can be seamlessly moved?
- How many users will this application impact?
- Is this a common application that would benefit from migrating (example – email) or a specific functionality that will result in cost savings (example – HR Functionality)

Applications suited for cloud -

- Applications used by a group of mobile workers to manage their time and activity, and that contribute only limited information to the company's broad management information databases.
- Applications that are run infrequently but require significant computing resources when they run.
- Development, testing and prototyping of application changes, even if the final applications will be run on your own infrastructure.

Application not suited for cloud

- Applications that involve extremely sensitive data, particularly where there is a regulatory or legal risk involved in any disclosure. These will at minimum require special treatment if they are to be run in a cloud service.
- Applications that run on legacy platforms that are typically not supported (or may not be supported in the long run) by cloud providers

Identify the type of cloud environment and the cloud model

The next step in migrating to a cloud is to fully understand your existing architecture. This will help know what cloud options will be most useful to your business. The potential cloud configuration may encompass broad sections of your architecture or it may take advantage of cloud services designed to meet specific needs and address specific problems. Selecting a cloud model and an environment will depend on the business policies of privacy, compliance and general nature of the data and applications. Ask the following questions –

- What type of cloud is best suited?
- How does the cloud model fit within the current architecture?
- How do I link cloud to my current strategic plans for Services-Oriented Architecture, Disaster Recovery, etc.?
- Can I leverage different type of cloud environment for different business needs?

The notion that businesses must be confined to a limited and closed set of cloud choices is as silly as saying they can only make one type of product or sell through a single distribution channel. As with every other type of business operation or asset, companies need and want to have a wide range of cloud-computing choices to match up with their various requirements

Partner with the vendor

Asking the vendors about their development process, the technology behind the scenes, how and where they set up their data centers, and how they manage code and releases is the other critical step of the process.

Have you developed a methodology to evaluate potential cloud vendors[9]? How secure is the vendor and what is your level of comfort that your business's data is sufficiently managed according to internal and regulatory control standards? There are many questions to ponder before you migrate to cloud. Here's a general template that you can use to start the conversation with a vendor.

System

- Which cloud services do you provide
- Where is your data center located
- What's your downtime history

Security

- How secure is your cloud?
- Where is your data center located and what safety measures are implemented?
- What happens if you lose my data?
- Do you use a data-centric, file-level encryption for securing data?

Pricing

- What is your pricing structure? Please provide a break-down of costs for installation (setup), maintenance, add-ons, support.
- What about annual maintenance costs?
- Are there (hidden) costs for management, training?

Support

- What customer support services do you offer?
- Is the customer support available 24/7 and from all locations?
- Is the support based on a named person?

Vendor

- What is your financial status?
- How big is the team?
- Will I be assigned a specific named person or will I need to reach out to a

generic support group?

Contract

- Is this a pay-as-you-go or do I sign a long term contract?
- If there is a contract, what do I need to terminate it (if required)?
- Do you provide a 'free' time for evaluation?

Performance

- What is the SLA?

Disputes

- In case of disputes, what is the jurisdiction?

It is important to partner with vendors who bring innovation, not just deliver what you've signed up for. Cultivate a relationship with the vendor where you can lean on your vendor for strategic guidance, business case development, workload prioritization and more.

Partner with the business units

Adopting cloud systems represents a shift in organizational norms and culture[10]. One organizational factor that impacts cloud adoption is the IT managers' *fear of losing control of their IT environment*. Another organizational factor impacting adoption is increased traceability and auditability. Traceability enables the usage of every information service within an organization to be tracked while auditability ensures that companies conform to internal and external constraints.

Hence getting the buy-in from the business units is an important step in the migration path. You should plan to spend time helping the business understand the new technology and to adjust and adapt to the new environment. Cloud services also require a different governance approach. Procurement and contracting processes often need to be altered requiring greater business leader engagement. Everyone needs to be in sync on how solutions are selected and implemented. To overcome security and privacy concerns, Special consideration should be paid on how the data is stored and accessed. Locked-down processes should be implemented to ensure data confidentiality.

More time will be required from the business to engage them closely during the implementation process to manage stakeholder expectations. It is critical to be transparent keeping business leaders and others informed of schedules, outages – timing, impacts, and duration.

Think integration

Thinking ahead about an integration plan is critical. Because the cloud is made for a “best of breed” approach, you should plan for a more diverse vendor base and a hybrid IT environment. The complexities associated with expansive hybrid environments mandates solid planning. Having a single point of contact to manage will set the stage for well-orchestrated and productive interactions within your network of providers. Regular meetings should be planned with vendors to ensure that proper data protection or governance procedures are in place and that systems are implemented in a risk free environment.

- What is the mode and cadence of contact with the vendor?

Don't forget security

Within the business environment, Privileged[11] users are usually a small percentage[12] (about nine or ten percent) of the total users yet they can cause massive damages if their login credentials are stolen and taken over by hackers. So, depending on the sensitivity of the data, the profile of the user, the intended use of the data and other factors, specific policies should be put into place to manage session authentication, data distribution control and other threats.

- What sensitive data does the business have that needs to be protected?
- Has the business classified and inventoried that data?
- Who has access to sensitive data - internally and externally?
- Who is responsible for protecting the data?
- Who is responsible for the oversight of the vendors who manage the data?

The application owner, cloud vendor and the IT department – must understand that security is now a joint responsibility. Authentication and authorization remain the responsibility of the business at the application level. The cloud vendor remains responsible for security controls, identification and correction of system vulnerabilities, and defense against specific cloud-oriented attacks, consistent with the level of service selected.

What about ROI?

Conventional return on investment (ROI) formulas don't always work in the cloud[\[13\]](#). Applying these methods leads to confusing, if not deceptive, results

The hard measures of ROI are based on savings incurred from various projects as well as revenue impacts on the business. Much of this is evident in the first phases of cloud computing, and can be relatively easily captured. Instead of investing \$x in a new server infrastructure, the business spends \$y a month on cloud which is very low compared to \$x. While this is easy to comprehend, the long-term gains from cloud are not so easily measured. For example, how do you attach numbers to increased agility within the business, since process changes can be made more easily without the need for back-end programming of systems? This requires a new form of thinking.

The ROI models should be built around four key dimensions[\[14\]](#) - time, cost, quality and margin. Here are few questions that a business should ask.

- How much is the savings on *time to implement*?
- How much is in the cost of implementation and maintenance?
- What about the measures on quality of the output?
- Is there a direct impact to the margins - bottom line?
- How do you measure the intangible benefits?

It is important to think strategically and look for ways to measure process improvements that deliver business gains than just pore over outdated models.

Next Steps

Migrating your business systems to the cloud is a big decision. All the factors should be considered and the decision should be based on a strong business case. The cloud may not be the right choice for every business and for every application. But by and large, businesses find that cloud technology optimizes their core processes, saves costs and gives them new freedom to collaborate, conduct business on the go, and stay synced in real time.

About the Author

Subu is an avid technologist and has over twenty years of experience in software, programming and data analysis. Subu's credentials include architecture, design and development of many different data initiatives in various industries and government agencies. He can be reached at srsworld@duggl.com

- [1] <http://www.deloitte.com/multifiledownload?solutionName=deloitte.com&fileIds=dc3ff26c73612310VgnVCM2000001b56f00aSTFL>
- [2] <http://www.thoughtsoncloud.com/2014/01/cloud-computing-defined-characteristics-service-levels/>
- [3] <http://www.cloudcomputing-news.net/news/2014/oct/09/cloud-underpins-majority-tech-trends-2015-gartner-analysts-find/>
- [4] <https://mozy.co.uk/system/resources/W1siZiIsIjIwMTQvMDEvMDcvMTVfNTVfMjRfMjE5X0lEQ19DbG91ZF90>
- [5] <http://www.gartner.com/it-glossary/platform-as-a-service-paas>
- [6] The Launch Pad – Randall Stross
- [7] <http://www.oracle.com/technetwork/topics/entarch/oracle-wp-cloud-maturity-model-r3-0-1434934.pdf>
- [8] https://www.cisco.com/en/US/services/ps2961/ps10364/ps10370/ps11104/Migration_of_Enterprise_Apps_to_Cloud.html
- [9] <http://www.entrepreneur.com/article/226845>
- [10] <http://www.staff.science.uu.nl/~vlaan107/ecis/files/ECIS2013-0710-paper.pdf>
- [11] Users are administrators, super-users and/or users who have more access to systems than normal users
- [12] <http://www.forbes.com/sites/sungardas/2015/05/12/7-common-misconceptions-about-security-threats-in-cloud-computing/>
- [13] <http://www.cioinsight.com/it-strategy/cloud-virtualization/5-key-takeaways-about-cloud-roi.htm#sthash.BP6yVXWV.dpuf>
- [14] <http://www.opengroup.org/cloud/whitepapers/ccroi/kpis.htm>