Future of Cloud Computing Architecture

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ABSTRACT
The paper describes the concepts of basic cloud computing characteristics, its architecture and stack diagram of future cloud architecture, Types of cloud, Delivery models in cloud, Design and implementation issues and its evolution with the time. Paper also represents the various stages that cloud architecture has gone through to be what it is today and with that reference, paper successfully depicts the future predictions of cloud computing architecture and its trends. Paper also describes a scenario where if you are a prospective investor looking forward to invest your time and money in evolving Cloud technology, then what are your options to achieve success.

Keywords: Cloud Computing, SaaS, PaaS, IaaS, Cloud Architecture, Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud

1. INTRODUCTION
In recent years, Cloud Computing has become an emerging technology that gains wide influence on IT systems. Cloud Computing is a distributed computing model for enabling service-oriented, on-demand network access to rapidly scalable resources. Such resources include infrastructure as a service (IaaS), development and runtime platforms as a service (PaaS), and software and business applications as a service (SaaS). Clients do not own the resources, yet applications and data are guaranteed to be available and ubiquitously accessible by means of Web services and Web APIs “in the Cloud” [1].

In *Cloud Computing* **t**he word cloud (also phrased as "the cloud") is used as a metaphor for "*the Internet*," so the phrase *cloud computing* means "a type of Internet-based computing," where different services — such as servers, storage and applications — are delivered to an organization's computers and devices through the Internet [2].

2. CLOUD COMPUTING CHARACTERISTICS
The five defining characteristics of cloud computing can be described as follow:

2.1 Dynamic computing infrastructure
Cloud computing requires a dynamic computing infrastructure. The foundation for the dynamic infrastructure is a standardized, scalable, and secure physical infrastructure. There should be levels of redundancy to ensure high levels of availability, but mostly it must be easy to extend as usage growth demands it, without requiring architecture rework and it must be virtualized.

2.2 IT service-centric approach
An IT Service Centric approach enables user adoption and business agility – the easier and faster a user can perform an administrative task the more expedient the business moves, reducing costs or driving revenue.

2.3 Self-service based usage model
Interacting with the cloud requires some level of user self-service. Best of breed self-service provides users the ability to upload, build, deploy, schedule, manage, and report on their business services on demand. Self-service cloud offerings must provide easy-to-use, intuitive user interfaces that equip users to productively manage the service delivery lifecycle.

2.4 Minimally or self-managed platform
In order for an IT team or a service provider to efficiently provide a cloud for its constituents, they must leverage a technology platform that is self-managed. Best-of-breed clouds enable self-management via software automation, leveraging the following capabilities:

- A provisioning engine for deploying services and tearing them down recovering resources for high levels of reuse.
- Mechanisms for scheduling and reserving resource capacity.
- Capabilities for configuring, managing, and reporting to ensure resources can be allocated and reallocated to multiple groups of users.

2.5 Consumption-based billing
Finally, cloud computing is usage-driven. Consumer’s pay for only what resources they use and therefore are charged or billed on a consumption-based model. Cloud computing platforms must provide mechanisms to capture usage information that enables chargeback reporting and/or integration with billing systems.

3. BASIC CLOUD ARCHITECTURE
Cloud architecture, the systems architecture of the software systems involved in the delivery of cloud computing, typically involves multiple *cloud components* communicating with each other over a loose coupling mechanism such as a messaging

queue. Elastic provision implies intelligence in the use of tight or loose coupling as applied to mechanisms such as these and others.

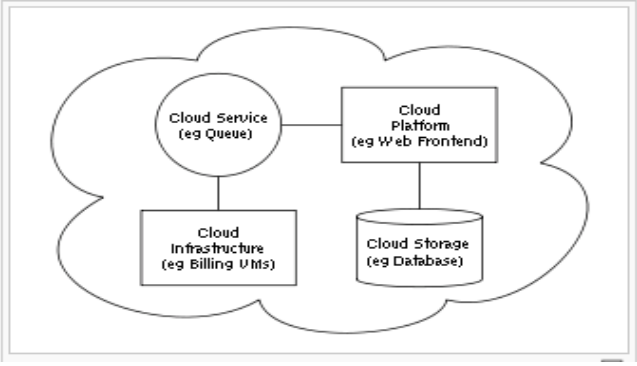


Figure 1: Basic Cloud Architecture

4. SERVICE MODELS

Cloud computing can be divided into three service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). An agency may procure any combination of these service models depending on their particular needs [3].

4.1 Software as a Service (SaaS)

Software as a Service is a delivery model where the software and the associated data is hosted in a cloud environment by a third party such as a cloud service provider (CSP). Typically the user, such as a staff member in an agency, accesses the software on demand using a browser on a computer or mobile device. The agency does not buy the software. Instead the CSP licenses the SaaS to the agency, which then enables multiple users to access the software [3].

4.2 Platform as a Service (PaaS)

Platform as a Service is a delivery model where a CSP provides an online software development platform for an organization such as an agency. The agency's developers use the CSP's computing environments, tools, and libraries to create, test, manage, and host software applications. By moving the entire development platform to the CSP, agencies can lessen the cost and management burden of application development [3].

4.3 Infrastructure as a Service (IaaS)

Infrastructure as a Service is a delivery model where CSPs provide the necessary hardware and software upon which a customer can build a customized computing environment. The CSP typically provides an unmanaged environment that enable the customer, such as an agency, to have any "guest" resources it needs installed: operating systems, software bundles, storage capabilities, etc. The agency retains full control of the computing environment and is responsible for configuring and maintaining the guest operating systems and associated applications and resources. The CSP, however, is responsible for maintaining all of the physical equipment [3].

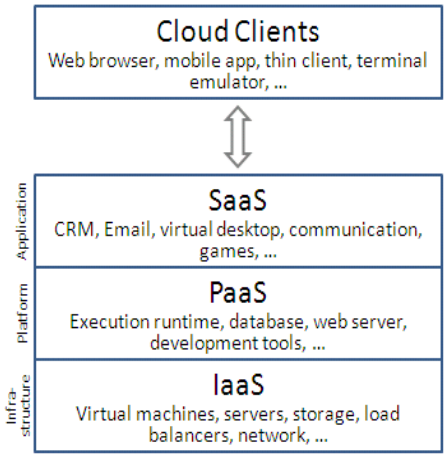


Figure 2: Service Model

5. DEPLOYMENT MODELS

Businesses can choose to deploy applications on Public, Private, Hybrid clouds or the newer Community Cloud. Here are some fundamentals of each to help with the decision-making process [4].

5.1 Public Cloud

A service provider who hosts the cloud infrastructure makes public clouds available to the general public. Generally, public cloud providers like Amazon AWS, Microsoft and Google own and operate the infrastructure and offer access over the Internet. With this model, customers have no visibility or control over where the infrastructure is located. It is important to note that all customers on public clouds share the same infrastructure pool with limited configuration, security protections and availability variances [4].

5.2 Private Cloud

Private cloud is cloud infrastructure dedicated to a particular organization. Private clouds allow businesses to host applications in the cloud, while addressing concerns regarding data security and control, which is often lacking in a public cloud environment. It is not shared with other organizations, whether managed internally or by a third-party, and it can be hosted internally or externally [4].

5.3 Hybrid Cloud

Hybrid Clouds are a composition of two or more clouds (private, community or public) that remain unique entities but are bound together offering the advantages of multiple deployment models. In a hybrid cloud, you can leverage third party cloud providers in either a full or partial manner; increasing the flexibility of computing. Augmenting a traditional private cloud with the resources of a public cloud can be used to manage any unexpected surges in workload [4].

5.4 Community Cloud

A community cloud is a is a multi-tenant cloud service model that is shared among several or organizations and that is governed, managed and secured commonly by all the participating organizations or a third party managed service provider. Community clouds are a hybrid form of private clouds built and operated specifically for a targeted group. These communities have similar cloud requirements and their ultimate goal is to work together to achieve their business objectives [4].

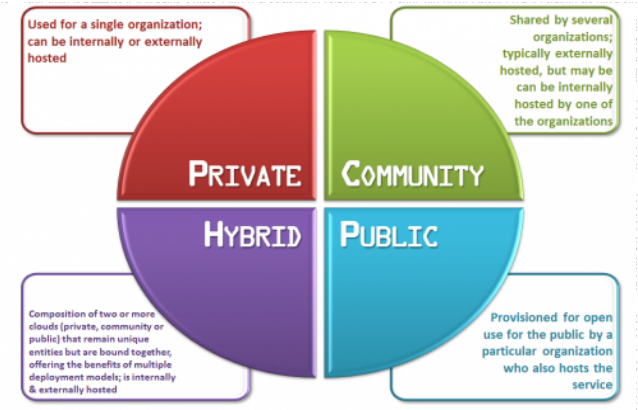


Figure 3: Deployment Models

6. EMERGENCE OF TECHNOLOGIES

Paper explains few technologies that dominate significant amount of time and also try to estimate dominant technologies in future.

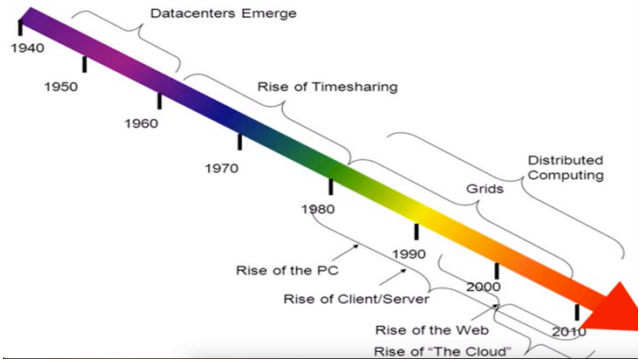


Figure 4: Emergence of technology part 1

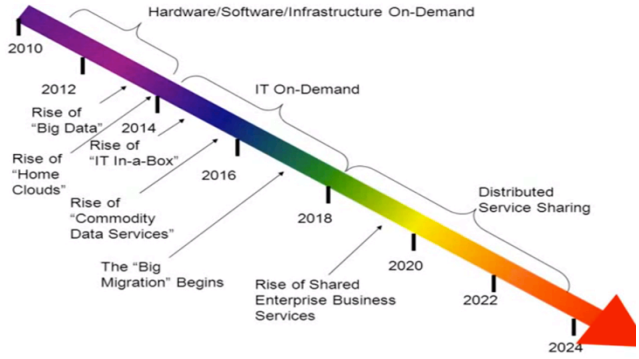


Figure 5: Emergence of technology part 2

7. PRESENT CLOUD COMPUTING ARCHITECTURE

Cloud computing is one of the fastest growing, and potentially most disruptive IT innovations for a generation.

The move to cloud computing is being likened to the arrival of the personal computer, a move that changed the IT face of the industry, and how businesses use technology.

Within four years, worldwide spending on could computing technology is expected to reach almost $150 billion, according to analyst firm Gartner [5].

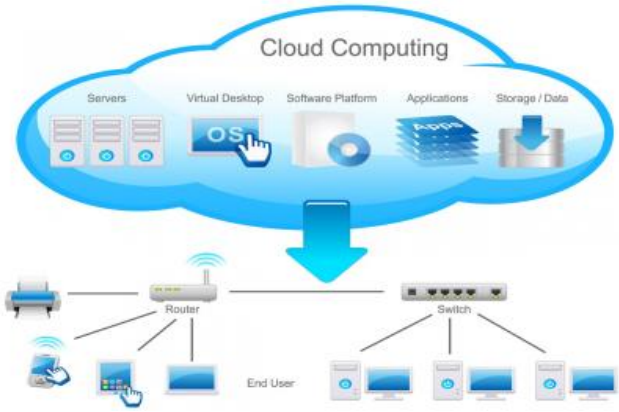


Figure 7: Present Cloud Architecture

8. ISSUES IN CLOUD COMPUTING

8.1 Design Level Issues

In this level of research, the key issues in creating an open architecture and in the development of heterogeneous platforms have been discussed [6].

8.1.1 Architectural Issues

It is essential to construct a CC architecture with the important features such as unification, scalability and reusability. But the development of such architecture may face additional challenges because of the emerging technologies and industry practices.

8.1.2 Platform Related Issues

Numerous platforms have emerged as an outcome of the increased demand in CC. Some literatures have addressed issues related to heterogeneous platforms.

Though a number of cloud platforms are available, each one provides its own interface for customers to interact with underlying infrastructures. But it becomes a great challenge for one cloud user to access the services when interacting with other clouds, because of heterogeneous software and incompatible interfaces.

8.2 Implementation Level Issues

The second level of this survey discusses on the various implementation issues in the CC environment. Under the implementation level, several business and technical issues in CC are discussed. The business issues are further divided into financial and reliability and security and performance issues are dealt under technical branch [6].

8.2.1 Business Related Issues

IT industry has recognized the impact of increasing concern over the growing datacenter energy cost and is taking necessary initiatives to curtail these costs and maximize energy efficiency and thereby protect the environment. Smart metering helps to mitigate power related costs and risks in the longer run. Energy efficiency and demand response play a vital role in meeting future energy needs. Since the approach aims at providing a globally concentrated effort to reduce energy consumption and uphold sustainability, certainly the contributions will be well recognized in the future

8.2.2 Technical Issues

In the cloud environment, there are several technical issues to be solved. The proposed paper addresses the two major technical issues in CC related to security and performance-based issues.
Security Issues mainly focus on issues araising from Technology and Service Level Agreement (SLA).

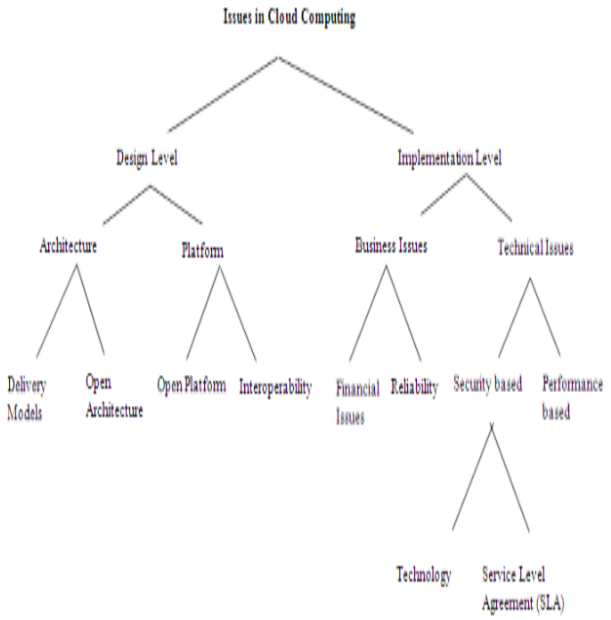


Figure 6: Design and Implementation Issues

9. CLOUD COMPUTING PREDICTIONS

Cloud computing is increasingly becoming the rule and not the exception for application deployment. Four or five years ago, cloud computing was very much a controversial and unproven concept. The benefits of cloud computing would result it, in becoming the default IT platform in the near future.

Paper presents with the list broken into two sections: Five end-user predictions and five vendor/cloud provider prognostications [7].

9.1 From User ‘s Perspective:

9.1.1 More Businesses Will Become Software Companies

The net effect of the ongoing shift to IT-wrapped products and services is that global IT spend will increase significantly as IT shifts from back-office support to frontline value delivery. The scale of IT will outstrip on-premises capacity and result in massive adoption of cloud computing.

9.1.2 Application Developers Will Become More Important

If applications are becoming more central to business offerings, then those who create the applications become more important. The analyst firm RedMonk refers to this trend as "the developer as kingmaker," since developers are now crucial in business offering design and implementation. There's an enormous upwell of change in development practices, driven by the ongoing shift to open source and the adoption of agile and continuous delivery processes. This improves the productivity and creativity of developers, and it leads developers to release more interesting and important applications.

9.1.3 Application Workload Placement Decisions Will Continue to Shift to End Users

Gartner made a big splash last year when it forecast that CMOs will control more than 50 percent of IT spending by 2017. One cannot know, of course, how this forecast will turn out, but the two predictions above clearly reflect a similar perspective: When it comes to applications, end-users are increasingly in the driver's seat. The question is whether those business-oriented applications will be deployed on-premises or in the cloud.

9.1.4 Private Cloud Will Have Its Moment of Truth

For the past several years, IT organizations have acknowledged that cloud computing provides undoubted benefits, but security and privacy concerns necessitate that an internal cloud be implemented before "real" applications be deployed. Many of these private cloud initiatives have been extended processes, though, bogged down by budgeting, lengthy vendor assessments, employee skill building and, yes, internal politics.

9.1.5 Cloud Brokerage Will Come Into Focus

Just as private cloud computing will face some hard truths in 2014, so, too, will the vision of hybrid cloud computing as a single homogenous technology spanning internal data centers and external cloud environments hosted by the internal technology provider. The reality is that every enterprise will use multiple cloud environments delivered with heterogeneous platforms. The crucial need will be to create or obtain capabilities to manage the different cloud environments with a consistent management framework — i.e., cloud brokerage.

9.2 From Vendor's Perspective:

9.2.1 AWS Will Continues Its Torrid Pace of Innovation

One of the most striking things about Amazon is how rapidly it is evolving its service and how often is delivers new functionality. Sometimes the cloud service provider (CSP) industry resembles one of those movies in which one character speeds through a scene while all the other actors move at an agonizingly slow pace.

In 2014, expect many new AWS services and service offerings. In a recent set of posts on AWS hardware and software infrastructure, during its first years, AWS created a global, highly scaled infrastructure that reliably delivers foundation capabilities in computing, storage and networking.

Today, AWS can leverage those building blocks to create higher-level functionality targeted at emerging needs of its customers. For example, the just-announced AWS Kinesis event processing service uses EC2, Elastic Load Balancer, DynamoDB, and IAM as ingredients, along with Kinesis service-specific code, combined as part of a new recipe.

9.2.2 Google, Microsoft Will Get Serious About the Cloud

That unopposed free run will end in 2014. Both Google and Microsoft have AWS in their crosshairs and are rolling out serious competitive offerings, designed for an all-out *battle royal*. Both have, finally, recognized that their initial cloud offerings were inadequate. With Version 2.0, both companies deliver directly competitive cloud offerings.

9.2.3 The Importance of Ecosystem Will Become Clear

Nearly everyone has heard of the "network effect," which refers to the added value to a group of users when one more user joins. It's sometimes summed up as, "If there's just one fax machine, it's pretty much useless;" unless many people have fax machines you can send faxes to or receive faxes from, owning a fax machine doesn't provided much value. (It's a funny turn of events that we're pretty much back to the early state of affairs with fax machines — hardly anyone has one and, yes, the remaining ones aren't worth much).

With respect to technology platforms, there's a symbiotic relationship between the network effect of the number of users and the richness of the platform functionality. This often isn't based on — or not solely on — the capability of the platform itself but rather, the complementary third-party services or products. More users make a platform more attractive for third-party offerings, which make the platform more attractive for users deciding which platform to adopt.

9.2.4 VMware Will Realizes vCHS Is Critical to Its Future

VMware has been in a funny position with respect to cloud computing. Its undoubted platform advantages inside the corporate data center haven't been matched by a concomitant public cloud success. For whatever reason — or, perhaps, for a number of reasons — VMware's public CSP partners haven't been able to generate large adoption for the VMware flavor of cloud computing.

VMware is now taking another run at this, with an approach explicitly designed to extend and integrate on-premises environments into a VMware-directed hybrid cloud offering. Certainly, this approach holds a lot of promise. The capability to seamlessly transfer a workload from internal to external environments could solve a lot of headaches for IT organizations.

This approach, dubbed vCHS, can provide benefits beyond simple technology consistency, in that it would enable IT organizations to focus on one set of personnel skills, thereby reducing costs and complexity.

9.2.5 A Pricing Bloodbath Is Coming to the Public Cloud

Amazon has had a clear field to this point. Most of its competition has, in effect, competed on the wrong front, or at least chosen to try and differentiate on offering aspects about which most adopters are apathetic. One key difference between AWS and most of its competition is cost. While much of Amazon's competition has aligned its pricing with existing hosting models, requiring significant commitments in terms of both amount of resource and duration of contract, Amazon makes it easy to get started for a few dollars, with no commitment at all.

In effect, this has meant that Amazon is competing with itself — and, to its credit, it has reduced prices since it first launched AWS. That field of one is going to expand this year with the arrival of Microsoft and Google. The result will be a ferocious price war, with all three companies repeatedly dropping costs to maintain (Amazon) or attain (Microsoft and Google) market share. Not only is this a battle for market dominance, it reflects the nature of cloud computing: A capital-intensive industry in which maintaining high utilization is critical.

For other cloud providers, witnessing this competitive melee won't just be a jolly spectator sport. Every cloud provider is going to be confronted — on a daily and ongoing basis — with three deep-pocketed competitors one-upping each other every time they drop their prices. Inevitably, other CSPs will suffer collateral damage as potential customers bring the list prices of the big three into contract negotiations and expect them to match what they are offering. For those without low cost of capital and their own deep pockets, next year will be the beginning of a long, slow descent into a financial morass, solved only by industry consolidation or shuttering their offerings.

10. MAJOR VENDOR EMPHASIS

Paper gives an overview of ten different companies and their success rate in the field of Cloud Computing.

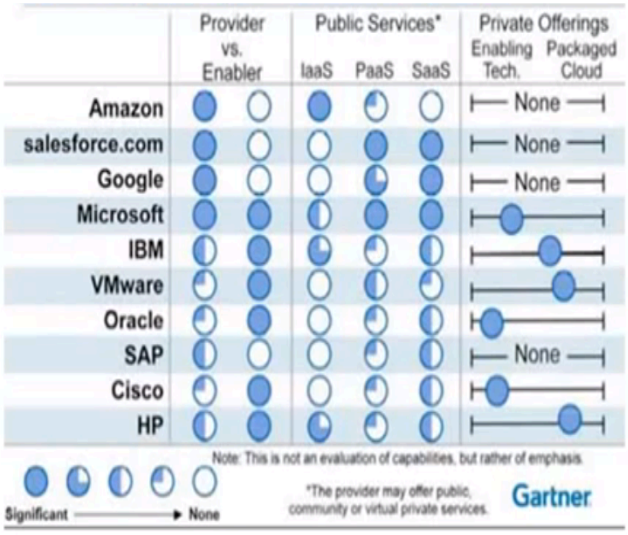


Figure 7: Summary of Major Vendor Emphasis

11. GROWTH OF CLOUD COMPUTING

In Figure 8, we can notice that Cloud Computing is a standard that is growing over a span of time and we can also witness that cloud computing in the coming years it will be a technology that is most in demand [8].

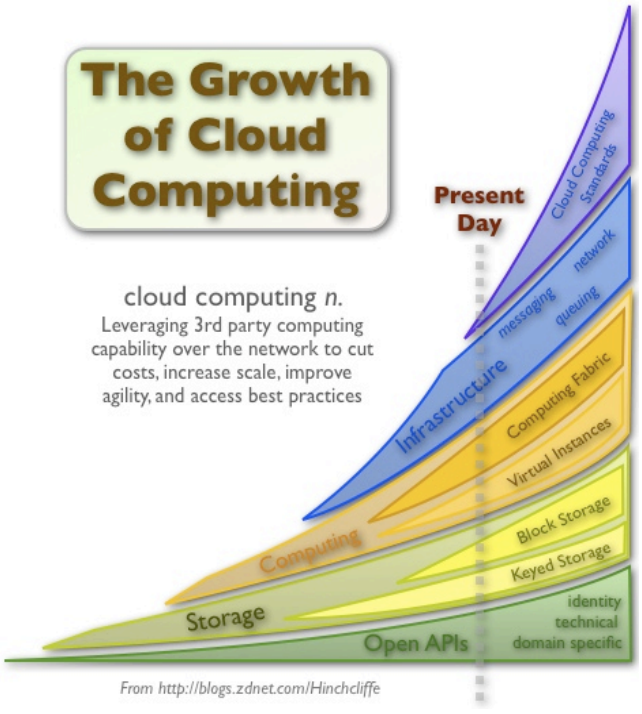


Figure 8: Growth of Cloud Computing

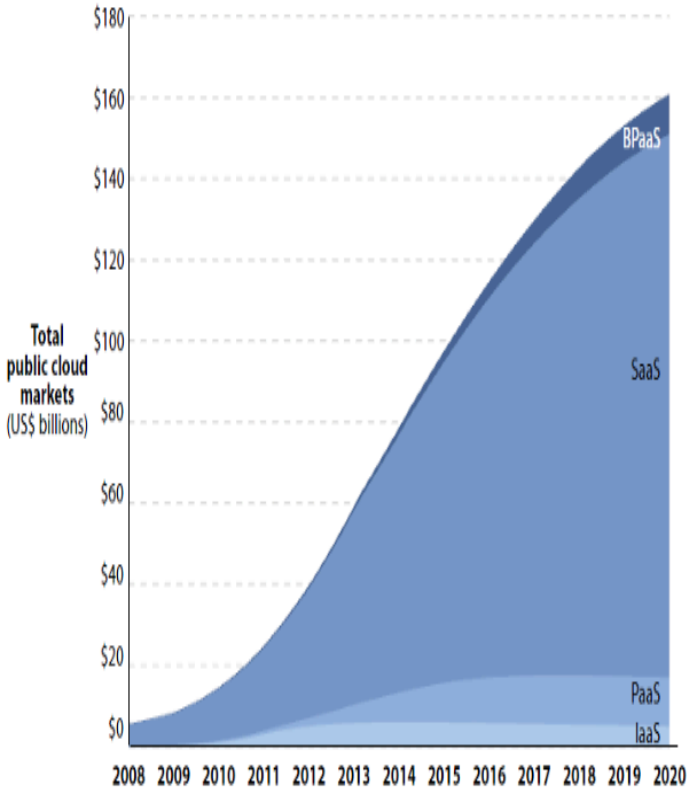
12. REVENUE FORECAST

The global cloud computing market will grow from a $40.7 billion in 2011 to $241 billion in 2020, according to Forrester Research.

On the way to all of this growth are a few notable nuggets:

- For starters, the infrastructure as a service market will peak at $5.9 billion in global revenue in 2014 and then commoditization, price pressure and falling margins kick in. In other words, early wins by Amazon Web Services and Rackspace won't add up in the long run.
- Companies of all sizes will adopt software as a service. In 2011, SaaS will be a $21.2 billion market and grow to $92.8 billion in 2016. At that point SaaS comes closer to saturation.
- Business Process as a service will be notable, but face modest revenue.
- Virtualization will recede to the background as new technologies take over [9].

Here's a look at the big cloud picture through 2020:



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BPaaS ($)	0.15	0.23	0.35	0.53	0.80	1.26	1.95	2.93	4.28	6.00	7.66	9.08	10.02
SaaS ($)	5.56	8.09	13.40	21.21	33.09	47.22	63.19	78.43	92.75	105.49	116.39	125.52	132.57
PaaS ($)	0.05	0.12	0.31	0.82	2.08	4.38	7.39	9.80	11.26	11.94	12.15	12.10	11.91
IaaS ($)	0.06	0.24	1.02	2.94	4.99	5.75	5.89	5.82	5.65	5.45	5.23	5.01	4.78

Figure 9: CC Revenue Forecast

13. CLOUD COMPUTING: 10 WAYS IT WILL CHANGE BY 2020

Right now we are in the early days of cloud computing, with many organization's taking their first, tentative steps. But by 2020 cloud is going to be a major — and permanent — part of the enterprise-computing infrastructure.

Six years from now we are likely to see low-power processors crunching many workloads in the cloud, housed in highly automated datacenters and supporting massively federated, scalable software architecture [10].

13.1 Software Floats Away From Hardware

By 2020, if you were to ask a CIO to draw a map of their infrastructure, they would not be able to, says David Merrill, chief economist of Hitachi Data Systems. "He will be able to say 'here are my partner providers'," he says, but he will not be able to draw a diagram of his infrastructure.

This will be because it will be in a "highly abstracted space", where software is written in such a way that it goes through several filters before it interacts with hardware. This means that front-end applications, or applications built on top of a platform-as-a-service, will be hardware agnostic.

13.2 Modular Software

To take advantage of the huge armadas of hardware available via clouds, individual software applications are set to get larger and more complex as they are written to take advantage of scale.

With the growth in the size and complexity of individual programs, the software development process will place an emphasis on modular software — as in, large applications with components that can be modified without shutting down the program.

As a consequence, cloud applications will require a new programming mindset, especially as they interact with multiple clouds.

13.3 Social Software

Along with the modular shift, software could take on traits currently found in social-media applications like Facebook, says Merrill. Programs could form automatic, if fleeting, associations with bits of hardware and software according to their needs.

In other words, the infrastructure and software of a datacenter will mold itself around the task required, rather than the other way around. Developers will no longer need to worry about provisioning storage, a server and a switch, Merrill says: all of this will happen automatically.

13.4 Commodity Hardware Rules

By 2020 the transition to low-cost hardware will be in full swing as schemes such as the Open Compute Project find their way out of the datacenters of Facebook and Amazon Web Services and into facilities operated by other, smaller companies as well. "Servers and storage devices will look like replaceable sleds," says Frank Frankovsky, Facebook's VP of hardware design and supply chain, and chairman of the Open Compute Project.

By breaking infrastructure down into its basic components, replacements and upgrades can be done quickly, he says. The companies best placed to use this form of commoditized infrastructure are large businesses that operate huge datacenters. "I would say that between now and 2020, the fastest-growing sector of the market is going to be cloud service providers," Frankovsky says.

13.5 Low-power Processors and Cheaper Clouds

We're around a year away from low-power ARM chips coming to market with a 64-bit capability, and once that happens uptake should accelerate, as enterprise software will be developed for the RISC chips, allowing companies to use the power-thrifty processors in their datacenters, and thereby cut their electricity bills by an order of magnitude.

By 2020 it's likely that low-power chips will be everywhere. And it won't just be ARM — Intel, aware of the threat, is working hard on driving down the power used by its Atom chips, though most efforts in this area are targeted at mobile devices rather than servers. Facebook thinks ARM adoption is going to start in storage equipment then broaden to servers.

13.6 Faster Interconnects

The twinned needs of massively distributed applications and a rise in the core count of high-end processors will converge to bring super-fast interconnects into the datacenter.

Joseph Reger, chief technology officer of Fujitsu Technology Solutions, predicts that by 2020 we can expect communications in the datacenter to be "running at a speed in the low hundreds of gigabits per second".

13.7 Datacenters Become Ecosystems

The twinned technologies of abstracted software and commoditized hardware should combine to make datacenters function much more like ecosystems, with an over-arching system ruling equipment via software, with hardware controlled from a single point, but growing and shrinking according to workloads.

Automation of basic tasks, such as patching and updating equipment, will mean the datacenter "will become more like a biological system" he says, in the sense that changes and corrections are automatically made.

13.8 Clouds Consolidate

The internet rewards scale, and with the huge capital costs associated with running clouds, it seems likely that there will be a degree of consolidation in the cloud provider market.

Fierce competition between a few large providers could be a good thing, as it would still drive each of them to experiment with radical technologies. For example, in a bid to cut its internal networking costs and boost utilization, Google has recently moved its entire internal network to the software-defined networking OpenFlow standard, which looks set to shake up the industry as more people adopt it.

13.9 The Generational Shift

By 2020, a new generation of CIOs will have come into companies, and they will have been raised in a cloudy as-a-service world. There will be an expectation that things are available "as-a-service", Merrill says: "Our consumption model is changing as a generational issue."

13.10 Clouds Will Stratify

Today clouds are differentiated by whether they provide infrastructure-as-a-service, platform-as-a-service or software-as-a-service capabilities, but by 2020 more specialized clouds will have emerged.

Along with some large providers offering basic technologies like storage and compute, there will also be a broad ecosystem of more specific cloud providers, allowing companies to shift workloads to the cloud that would otherwise be dealt with by very specific (and typically very expensive) on-premise applications.

14. CLOUD COMPUTING HYPE CYCLE

This Hype Cycle encompasses technologies and standards that improve the security and reliability of the cloud-computing model, and trusted application and security services that are delivered by cloud services providers.

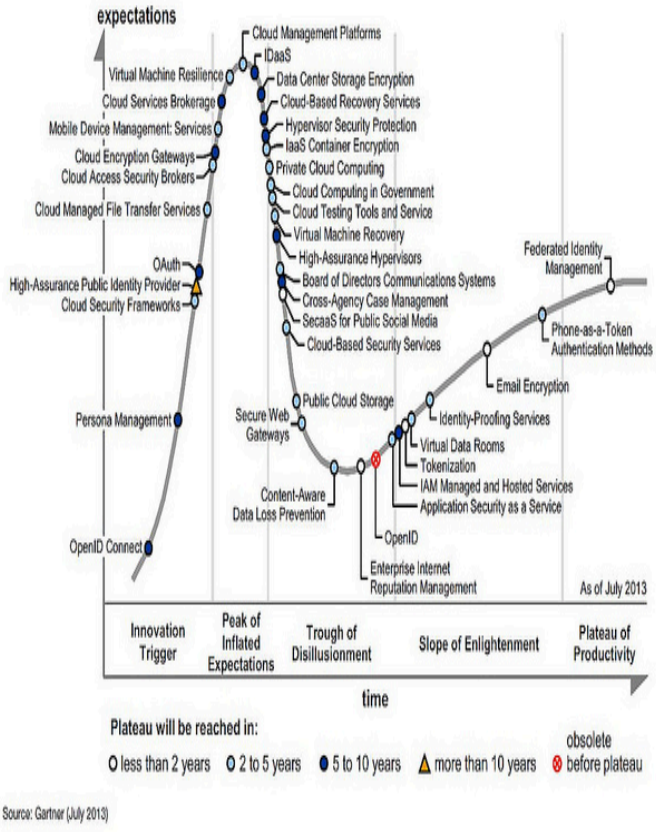


Figure 10: Hype Cycle for Cloud Computing, 2013

15. CLOUD COMPUTING PRIORITY MATRIX OVER THE YEARS

Gartner has been predicting for last five years that cloud computing will have a transformational impact in next 2 to 5 year [11].

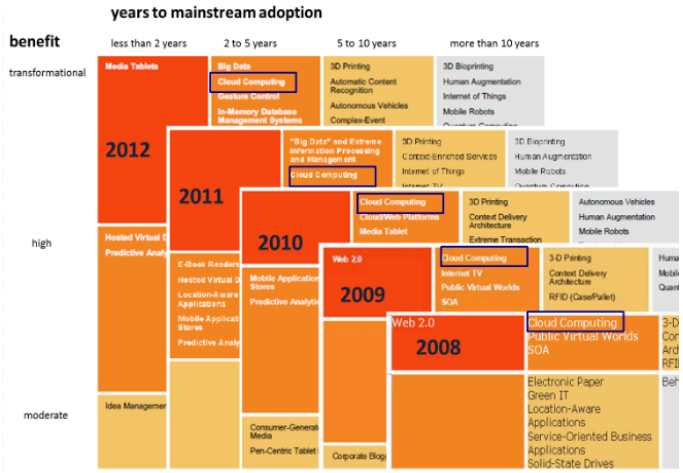


Figure 11: Priority Matrix

16. PAST, PRESENT & FUTURE

In Figure 12 we can witness Past, Present and Future of Cloud Technology for three decades starting from 1990 to 2020.

- From 1990 to 2000, Cloud1 is the notation used for E-Business Services.
- From 2000 to 2010, Cloud2 is the notation used for IT as a Service.
- From 2010 to 2020, Cloud3 is the notation used for everything as a Service [12].

	Cloud 1 E-business Services			Cloud 2 IT as a Service		Cloud 3 Everything as a Service	
	1990	1995	2000	2005	2010	2015	2020
Primary forcing function	▪ Internet based supply chain integration and e-commerce			▪ Consumerized internet services ▪ Low cost IT		▪ Pervasive business and consumer services	
technology orientation	▪ Web based app design ▪ EAI & message bus Integration ▪ Internal protocols ▪ 3-tier architecture			▪ Web 2.0 & SCA app design ▪ Virtualization ▪ Cloudbased technology platforms		▪ Data oriented, context aware services ▪ Vertical and horizontal cloud ecosystems	
IT organization design	▪ Organized around technology domains ▪ Technology-centric			▪ Organized around service supply chain ▪ Service-centric		▪ Organized around value networks ▪ Service-centric	

Figure 12: Past, Present & Future of Cloud Computing

17. NEW STACK EMERGING

There is a new stack emerging, so we have Testing-as-Service, Management/Governance-as-a-Service, Application-as-a-Service and few others. What's you take away from here is that the segmentation of the market is kind of moving away from very broad strokes and very broad categories and a particular set of things where there is a lot of organization's and there is lots about leadership better in those particular segments you know such as Infrastructure-as-a-Service and Process-as-a-Service so becomes kind of focus discipline into itself, so its very difficult kind of to take everything and anything into categories these days.

There is a lot to close cross-pollination between the ways in which one can categorize technology, so we think stack like this going to be a bit more apt going forward in terms of how we are going to look at cloud computing.

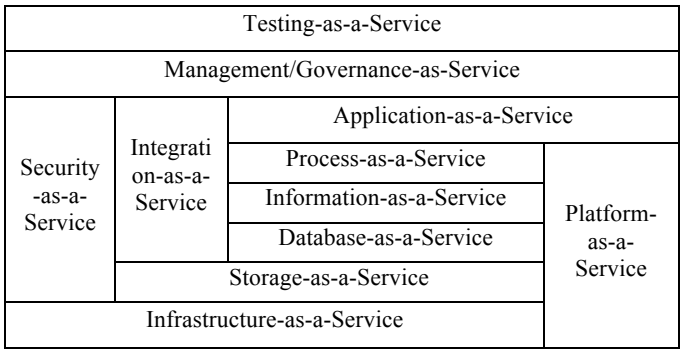


Figure 13:Future Cloud Computing Stack

18. DESIGN ISSUES

Table 1, represents the design issues, challenges and solutions for various deployment and service models in Cloud.

Table 1: Design Level Issues in Cloud Computing

Issues	Context						Challenges faced	Suggested Solution
	Service Models			Deployment Models				
	SaaS	*PaaS*	*IaaS*	*Private*	*Public*	*Hybrid*		
Open Architecture	√	√	√	√	√		Creating suitable and configurable provisioning platform to support all types of resources	Cloud Computing Open Architecture (CCOA) is a platform available to provide cloud offerings to its enterprise consumer users.
Delivery Models	√	√	√	√	√		Efficient and appropriate delivery architecture models required to be implemented for different applications	CC delivery architecture models for different applications (e.g. *SaaS for GoogleApps, IaaS for Microsoft Azure*) are available. Further, the efficiency are determined by applying suitable metrics
Open Platform			√		√	√	Unified environment is widely preferred by many users in order to deploy and develop large-scale applications	Some open source platforms (e.g. *Eucalyptus*) exist for the research community for further exploration.
Inter-operability	√		√	√	√		Unified method to interact with heterogeneous clouds	A generic interface (e.g. *g-Eclipse*, a framework for Grid computing) enables the users to access the heterogeneous clouds

19. IMPLEMENTATION ISSUES

Table 2, illustrates the Implementation issues, challenges for various deployment and service models in Cloud.

Table 2: Implementation Level Issues in Cloud Computing

Issues	Context						Challenges faced	Suggested Solution
	Service Models			Deployment Models				
	SaaS	*PaaS*	*IaaS*	*Private*	*Public*	*Hybrid*		
Financial	√	√	√		√		Increase in data center energy costs may lead to poor energy utilization	Smart metering approach is preferred to reduce energy consumption and promote sustainability
Reliability	√	√	√		√		Selection of appropriate service provider	Trust and Reputation models facilitate the customer to choose a provider
Security	√	√	√		√		Security will be the main concern across distinct technologies	It is the need of the hour to invent proper tools and protocols for the purpose
Performance			√	√	√		Interferences and idle instances contribute to poor performance.	Measurement analysis can be carried in order to optimize the performance.

20. WHERE TO INVEST TIME & MONEY

There are several things one must keep in mind if investing his/her time and money in the Cloud Technology.

- Focus on reorganization and outplacement of data.
- Focus on Platform-as-a-Service and Service Companies that are good at Platform-as-a-Service.
- Focus on centralized trust, including moving to identity management models.
- SOA patterns and technology find new value in the cloud.
- Continued focus on mobile computing.
- Home Clouds (e.g. iCloud) create a new track of application and appliance development.
- Rise of "Cloud Aggregator".

21. CONCLUSION & FUTURE WORK

In a way to have an appropriate Futuristic model and architecture for Cloud Computing, we have successfully illustrated the basic idea of what is Cloud Computing, different deployment and service models of Cloud Computing, emergence of cloud computing, Design and Implementation level issues faced during evolution of Cloud, various predictions from users and vendors point of view, forecasted revenue for Cloud Computing till 2020, different ways in which cloud will change by 2020, Hype Cycle, Priority Matrix and New stack diagram of Cloud Computing along with entrepreneur's view of investing time and money in Cloud.

The future work will be to identify a suitable model to address some of the key points highlighted in this paper.

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