An Extended and Granular Classification of Cloud's Taxonomy and Services

Shah Murtaza Rashid Al Masud

Abstract— ***In the recent time cloud computing has come forwarded as one of the most admired computing model in knowledge domain that concerns about the distributed information systems to support the whole world as a cloud community. Distributed, virtualization and service-oriented nature have given ascendancy to cloud computing to distinguish from its core descendants like grid computing, geographical information systems, and distributed system. Although cloud computing dominants the e-society, but it is still in under research, progress. The architecture of cloud's taxonomy and its services are very significant issues for cloudifications because every day some new advancements and developments are adjoined under its umbrella. In this paper we proposed an extended and granular classification of taxonomy for cloud computing and specified services that is a detailed ontology of cloud, which will be helpful for researchers and stakeholders in better understanding, developing, and implementing cloud technology and services to their lives.***

Index Terms: Cloud computing, Distributed system, Granular classification, Taxonomy.

I. INTRODUCTION

The increasing rate of cloud adoption, services and implementations per year in all around the world is very rapid and remarkable. Due to this important reason the overall behavior and functionaries of cloud computing (CC) are changing every day which influence the architecture, taxonomy of CC, and its services. Many hardware and software industries, such as IBM, Intel, Microsoft, Cisco, as well as other Internet technology industries, including Google and Amazon, Security Company, such as Semantic, knowledge groups and even several businesses, also those not technically oriented, want to explore the possibilities and benefits of CC are joining the development of cloud services [1]-[8]. Although there are huge scopes in developing, implementing, and updating CC but there is a lack of standardization of cloud computing services [2]-[3], [9], which makes interoperability when working with multiple services or migrating to new services difficult. The NIST (National Institute of Standards and Technology) proposed the following definition of cloud computing: "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability." [10]. Currently three service models are being differentiated- Software as a Service (SaaS), i.e. online applications, such as web-based email, Platform as a Service (PaaS), which allows customers to deploy their own applications, and Infrastructure as a Service (IaaS), which provides, for example, processing power or storage [11]. Service models offering by cloud service providers, and enterprise firms are varying from one another due to lack of taxonomic information which is essential for them.

Taxonomy Identifies and enumerates the components of cloud computing that are providing basic knowledge underpinning management and implementation of the cloud spectrum. Taxonomy is more than defining the fundamentals that provides a framework for understanding current cloud computing offerings and suggests what's to come [12]. There are many cloud's taxonomy [13]-[17] can be found which were not created by the perspective of enterprise IT, consumers of cloud services, management services, data governance and software. In this paper we proposed a complete, extended, and granular classification of cloud's taxonomy and services that will help academia, researchers, professionals, and stakeholders of information technology (IT) as well as enterprise to understand the world of cloud computing continuum. In our paper we proposed new layers of including the security and strategy issues which are equally important in computing and communication spheres and in advancement of this research field. A short comparative study of different cloud service provider and their systems based on our proposed cloud's taxonomy reference model is also presented in this paper. This paper is organized as follows: Section II introduces the background and related work. Section III defines the proposed extended taxonomical spectrum of cloud computing. Section IV explicates in detail about the proposed layers of CC and its services provided. Finally Section V concludes the paper.

II. RELATED STUDY

The recent evolution of CC is based on the areas of some other computing fields including distributed computing, grid computing, geographic information systems, cluster computing and many more. The progress towards clouding including architecture, models, taxonomy and its services is very speedy. Although the demands behind this technology is high, but however, there is no standard taxonomy, as everyone tries to define cloud computing and its services in their own ways. The users become newly conscious of the concerns, because their data, applications, and computing resources will no longer be under their control. So the users need such tools for

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transparency and mechanisms to monitor the status of their data and control over it.

There has been prior work reflecting the taxonomy of cloud computing. The taxonomy described by Cloud Computing Use Case Discussion Group [20] is categorized into three views, service developer, service provider and service consumers. This taxonomy is silent for the data governance like, interoperability, data migration. M. Crandell [18] defines a taxonomy based on product offerings. He divided the product offerings into three layers such as Application in the cloud (Salesforce and other SaaS vendors), Platform in the cloud (Googke's AppEngine, Moso, Heroku), Infrastructure in the cloud (Amazon Web Services, Flexiscale). This taxonomy is attractive for any company with an application that runs in a data center or with a hosted provider, that doesn't want to reinvent the wheel or pay a premium. P. Laird's [19] Cloud Vendor Taxonomy: This gives the classifications and vendors with that related groups. This taxonomy divides the cloud vendors into Infrastructure (Public Cloud, Private Cloud), Platform (Biz User Platforms, Dev Platform), Services (Billing, Security, Fabric Mgmt, System Integrators), and Applications. This taxonomy gives a visual map of the SaaS, PaaS, and cloud computing industries. This graphic shows the groupings of the "as a Service" terms that may encounter in the IT industry. Forrester's Cloud Taxonomy [21]: A cloud-taxonomy is categorizing cloud services by IT-Infrastructure vs. Business value and by the level of privacy. This taxonomy focuses on the dimension of privacy and business value. It focuses on the modes of cloud computing (Public Scale-Out Clouds, Public Server-Cloud, Virtual Private Scale-Out Clouds, Virtual Private Server Clouds, Private Clouds, Virtual Private SaaS, Public SaaS, PaaS, On-Premises, ASP Concepts etc). It is very important to endow with a clear understandable and more explicit view over cloud computing operations and applications. In order to represent CC suitably, we proposed an extended and granular classification of its taxonomy and ontology of services that will adjust, refine and extend those taxonomies discussed in this section, making it even more suitable and appropriate for CC.

III. AN EXTENDED CLOUD COMPUTING TAXONOMY

One of the major concerns of CC is to provide services are accessible anywhere in the world with the cloud appearing as a single point of access for all the computing needs of consumers at affordable cost, elastic scalability, high performance and security. This section details an extended taxonomy that illustrates various aspects of CC. One of the major aspects of CC is its mode. Modes of CC can be defined by four major categories. These are: public cloud, private cloud, hybrid cloud and community cloud. Cloud adoption and implementations rate in various regions increase dramatically every year that encourage the academia and researchers to think about the advancements of CS. Beside the major clouds mode of CC discussed before there are some other new trends highlighted in year 2011-2012, such as big data cloud, business cloud, mobile cloud, gamification cloud, medical cloud, education cloud, and government cloud [22]-[26]. Clouds mode and its recent advancements are shown in Fig 1.

A. Major Clouds Mode

1) Public Cloud: in public cloud the cloud infrastructure and resources are made available to the general public or a large industry group via web applications and services from third party organizations who share and selling resources and services.
2) Private Cloud. The cloud infrastructure, such as data and processes are processed and operated within single organization.
3) Hybrid Cloud. The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability.
4) Community Cloud. The cloud infrastructure and shared concerns, such as mission, security requirements, policy, or compliance considerations are shared by several organizations and supports a specific community.

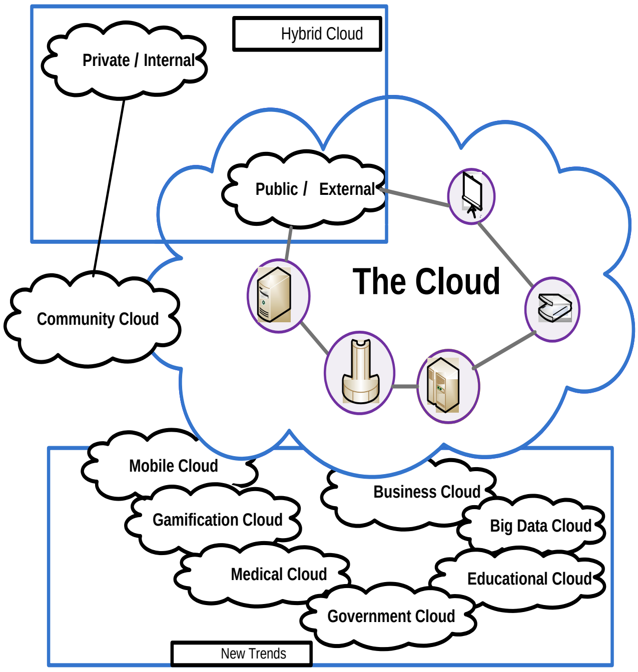

Fig 1. Clouds mode and its recent advancements.

B. Newly Proposed Mode

1) Big Data Cloud: The big data cloud enables an economical way to extract value from very large volumes of a wide variety of data by high-velocity capture, discovery, transformation, and analysis.
2) Business Cloud: Business-context clouds are anticipated to align directly with the industry verticals and offer unique solutions addressing the specific business and technical challenges in the individual sectors, such as healthcare and financial services.
3) Mobile Cloud: Mobile applications will continue to grow with the social capabilities and innovative mobility devices, which will drive the accelerated progress of cloud computing to empower the users and consumerization: anybody, anywhere, anytime, and any device. The mobile cloud will push many organizations to rethink their business models.

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4) Gamification Cloud: The gamification cloud will make technology edutainmental, guide a participant with a path to mastery and autonomy, encourage users to involve in desired behaviors, and make use of humans' psychological predisposition to engage in gaming.
5) Educational Cloud: It will deal with the function of cloud computing technology to improve education and learning methodology.
6) Medical cloud: A new Cloud base platform has just been launched by the NHS in order to allow secure access to medical records. The idea is to speed up communication between patients, consultants and general practitioners through accessing files through the internet.
7) Government cloud: Governments around the world are actively looking into cloud computing as a means of increasing efficiency and reducing cost. For the government, two domains should also be considered: Enterprise (i.e. NGEN), and Tactical (i.e. CANES).

C. *Proposed Cloud's Taxonomy*

This proposed cloud's taxonomy is split into seven layers of CC, as shown in Fig 2. This includes application layer, software environment or development layer, software infrastructure layer, security layer, virtualization or software kernel layer, hardware infrastructure layer, and strategy layer. As proposed cloud consists of seven layers, this taxonomy illustrates each of them in depth. A scalable, robust and intelligent replication mechanism is crucial to the smooth operation of cloud computing. The sub-taxonomy, as shown in Fig 3, along with their meanings and services provided by each major layer is illustrated in Table 1.

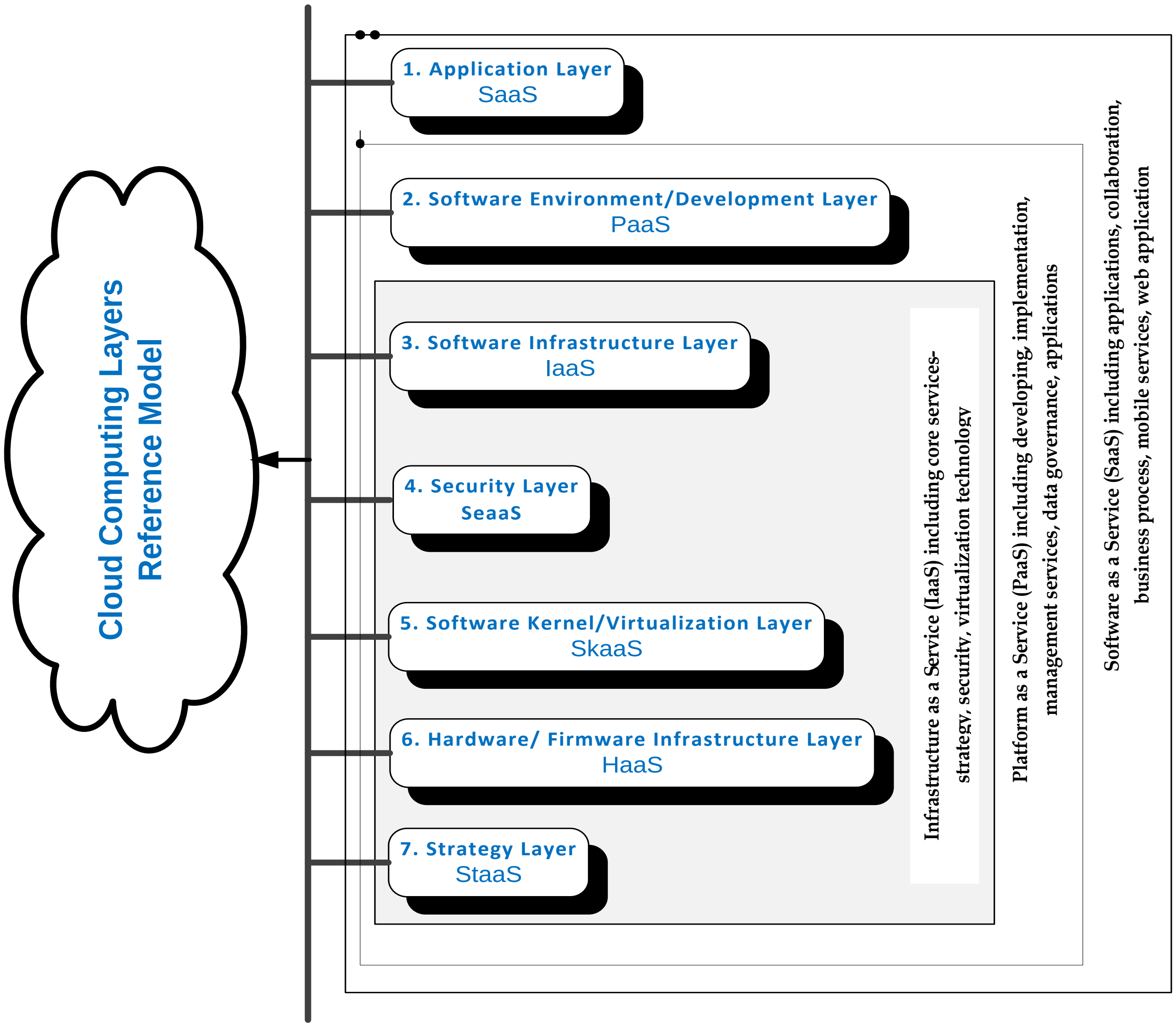

Fig 2. Proposed cloud's taxonomy. The layered figure represents the inter-dependency between the different layers in the cloud.

IV. ONTOLOGY OF PROPOSED CLOUD'S TAXONOMY AND SERVICES

CC systems fall into one of seven layers as mentioned earlier. Obviously, at the bottom of the cloud stack is the strategy layer which is the concrete planning and consulting layer, thereafter hardware layer which is the actual physical components of the system. Some cloud computing offerings have built their system on subleasing the hardware in this layer as a service.

At the top of the stack is the cloud application layer, which is the interface of the cloud to the common computer users through web browsers and thin computing terminals, where the top most layer of this stack is application layer. We closely examine the characteristics and limitations

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of each of the layers in the next seven subsections.

A. The Cloud Application Layer

The most visible layer to the end-users of the cloud is its application layer. Services are provided in this layer is commonly known as Software as Service-SaaS. The sub-taxonomy we proposed for this layered taxonomy is: IcaaS= Interaction and collaboration as a Service, BpaaS=Business process as a Service, AaaS= Application as a Service, GaaS= Governance as a Service, MnaaS= Management as a Service, EaaS= Enterprise as Service, WaaS= Web application as a Service, and MbaaS= Mobile as a Service. Some other services are also offered by this taxonomy, such as data loader service, data replication service, data quality assessment and data quality services. Examples of the key providers are SalesForce.com (SFDC), NetSuite, Oracle, IBM, and Microsoft etc.

Web-portals are normally used to access the services provided by this layer. This model has recently proven to be attractive to many users, as it alleviates the burden of software maintenance and the ongoing operation and support costs. Furthermore, it exports the computational work from the users' terminal to data centers where the cloud applications are deployed. This in turn lessens the restrictions on the hardware requirements needed at the users' end, and allows them to obtain superb performance to some of their CPU intensive and memory-intensive workloads without necessitating huge capital investments in their local machines.

This model even simplifies the work of the providers of the cloud applications with respect to upgrading and testing the code, while protecting their intellectual property. Since a cloud application is deployed at the provider's computing infrastructure (rather than at the users' desktop machines:PCs), the developers of the application are able to roll smaller patches to the system and add new features without disturbing the users with requests to install major updates or service packs. Configuration and testing of the application in this model is arguably less complicated, since the deployment environment becomes restricted, i.e., the provider's data center. Even with respect to the provider's margin of profit, this model supplies the software provider with a continuous flow of revenue, which might be even more profitable on the long run. This model conveys several favorable benefits for the users and providers of cloud applications, and is normally referred to as Software as a Service (SaaS). Salesforce Customer Relationships Management (CRM) system [27] and Google Apps [28] are two examples of SaaS. As such, the body of research on SOA has numerous studies on compassable IT services which have direct application to providing and composing SaaS.

Our proposed ontology illustrates that cloud applications can be developed on the cloud software environments or infrastructure components (as discussed in the next two subsections). In addition, cloud applications can be composed as a service from other cloud services offered by other cloud systems.

Developed for a higher cloud-stack layer, the flexibility of the applications is however limited and this may restrict the developers' ability to optimize their applications' performance. Despite all the advantageous benefits of this model, several deployment issues hinder its wide adoption, specifically, the security and availability of the cloud are two of the major issues in this model, and they are currently avoided by the use of lenient service level agreements (SLA). Agreed with all the arguments, limitations, and disadvantages in application layer we proposed another two new layers, such as strategy planning layer and security layer, into the taxonomy of CC that will help the researchers to solve the problems related to flexibility, availability, and security.

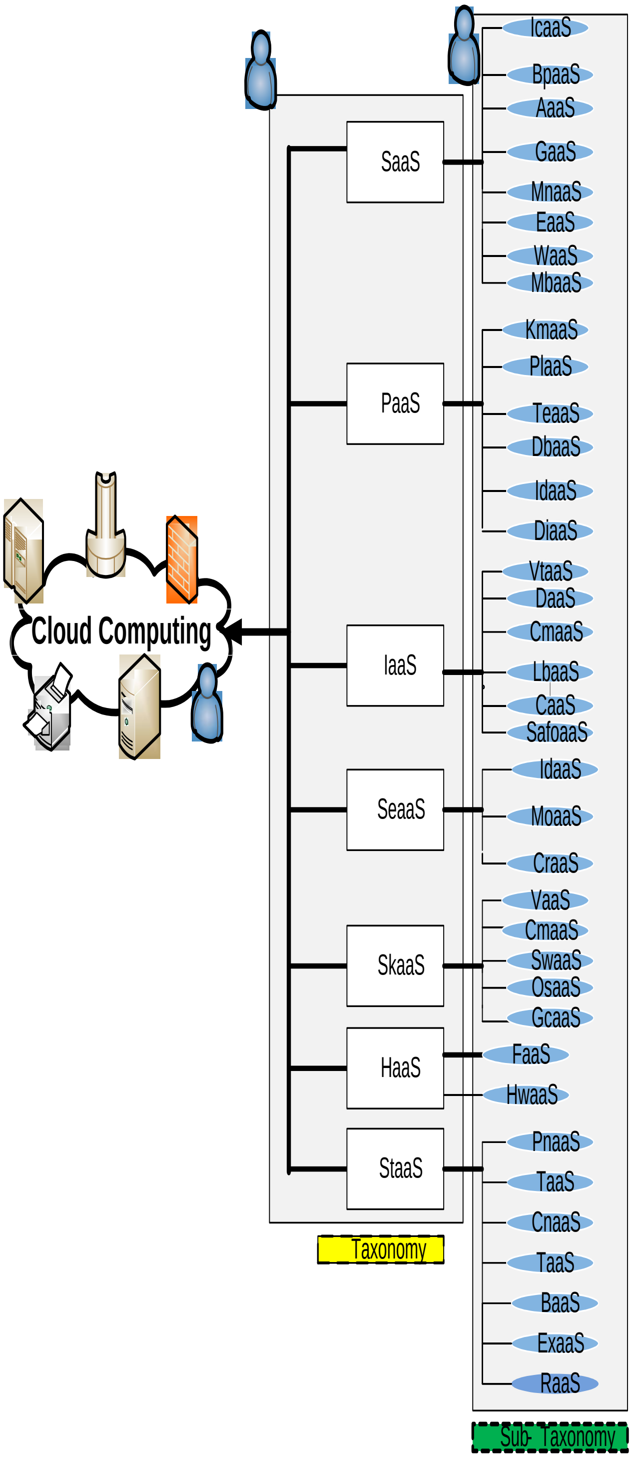

Fig 3. Proposed cloud's sub-taxonomy according to services provided. It also represents all the constituents related to each layer of cloud taxonomy.

Table 1: An extended and granular classification of proposed cloud's taxonomy and services

No.	Taxonomy	Sub-Taxonomy	Service provided
1	Application layer SaaS= software as a Service	IcaaS= Interaction and collaboration as a Service BpaaS=Business process as a Service AaaS= Application as a Service GaaS= Governance as a Service MnaaS= Management as a Service EaaS= Enterprise as Service WaaS= Web application as a Service MbaaS= Mobile as a Service	accounting, collaboration, customer relationship management (CRM), management information systems (MIS), enterprise resource planning (ERP), invoicing, human resource management (HRM), content management (CM) and service desk management
2	Software environment or development layer PaaS= Platform as a Service	PlaaS= Programming language as a Service TsaaS= Testing as a Service DbaaS= Database as a Service IfaaS= Information and data management as a Service DiaaS= Development and integration as a Service KmaaS= Knowledge management as a Service	application design, application development, testing, deployment and hosting as well as application services such as team collaboration, web service integration and marshalling, database integration, security, scalability, storage, persistence, state management, application versioning, application instrumentation and developer community facilitation
3	Software infrastructure layer IaaS: Infrastructure as a Service	SafoaaS=Supported application framework and operating system resources as a Service CaaS= Computational resources and development tools as a Service DaaS= Data storage as a Service CmaaS= Communication as a service VtaaS= Virtualization technology as a Service LbaaS= Load balancing as a Service	computation, data storage and network communication
4	Security layer SeaaS=Security as a Service	IdaaS= Identification as a Service MoaaS= Monitoring as a Service CraaS= Correlation as a Service	Virus protection, cryptography, monitoring management, privacy, identification, digital signature, recognition, authentication
5	virtualization or software kernel layer SkaaS= Software kernel as a Service	Vaas= Virtualization as a Service Cmaas= Clustering middleware as a Service OsaaS= Operating system kernel or system software as a Service SwaaS= Software kernel as a Service GcaaS= Grid computing application as a Service	OS kernel, hypervisor, virtual machine monitor and/or clustering middleware, customarily, grid computing applications, virtual memory management
6	Hardware infrastructure layer HaaS= Hardware as a Service	HwaaS= Hardware management as a Service FaaS= Facility as a Service	Hardware facility, infrastructure support
7	Strategy layer StaaS= Strategy as a Service	PnaaS= Planning as a Service TaaS= Transformation as a Service CnaaS= Consulting as a Service BaaS= Budgeting analysis as a Service TaaS= Timing estimation as a Service ExaaS= Experts providing as a Service RaaS= Rules and regulations as a Service	Planning, transformation, consulting

B. Cloud Software Environment Layer

The second layer in our proposed cloud taxonomy is the cloud software environment layer. It is the big idea to provide developers with a platform including all the systems and environments comprising the end-to-end life cycle of developing, testing, deploying and hosting of sophisticated web applications as a service delivered by a cloud based, namely Platform as a Service-PaaS. It provides an easier way to develop business application and various services over the internet. Creating and maintaining an infrastructure is the most time consuming work in the on premises systems. Well, PaaS was invented to solve exactly this problem.

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Key examples are GAE, Microsoft's Azure, Salesforce.com etc

The service provided by cloud systems in this layer is commonly referred to as PaaS. The sub-taxonomy provided in this layer is PlaaS= Programming language as a Service, TsaaS= Testing as a Service, DbaaS= Database as a Service, IfaaS= Information and data management as a Service, DiaaS= Development and integration as a Service, KmaaS= Knowledge management as a Service.

One example of service provided by this layer is SalesForce Apex language [29] that allows the developers of the cloud applications to design, along with their applications' logic, their page layout, workflow, and customer reports. Developers reap several benefits from developing their cloud application for a cloud programming environment, including automatic scaling and load balancing, as well as integration with other services (e.g. authentication services, email services, user interface) provided to them through the PaaS-provider. In such a way, much of the overhead of developing cloud applications is alleviated and is handled at the environment level. Furthermore, developers have the ability to integrate other services to their applications on-demand. This in turn makes the cloud application development a less complicated task, accelerates the deployment time and minimizes the logic faults in the application. In this respect, a Hadoop [30] deployment on the cloud would be considered a cloud software environment, as it provides its applications' developers with a programming environment, i.e. map reduce framework for the cloud. Similarly, Yahoo's Pig [31], a high-level language to enable processing of very large files on the hadoop environment may be viewed as an open-source implementation of the cloud platform layer. As such, cloud software environments facilitate the process of the development of cloud applications.

C. Cloud Software Infrastructure Layer

All the layers in CC are interrelated, and inter-depended. The cloud software infrastructure layer provides fundamental resources to other higher-level layers, such as SaaS and PaaS; which can be used to construct new cloud software environments or cloud applications. Our proposed taxonomy reflects the fact that the two highest levels in the cloud stack can bypass the cloud infrastructure layer in building their system.

Cloud services offered in this layer can be categorized into: computational resources that is computing, data storage, and communications. Virtual machines (VMs) are the most common form for providing computational resources to cloud users at this layer, where the users get finer granularity flexibility since they normally get super-user access to their VMs, and can use it to customize the software stack on their VM for performance and efficiency. Often, such services are dubbed Infrastructure as a Service (IaaS). Our proposed sub-taxonomy for this layer is: SafoaaS=Supported application framework and operating system resources as a Service, CaaS= Computational resources and development tools as a Service, DaaS= Data storage as a Service, CmaaS= Communication as a service, VtaaS= Virtualization technology as a Service, LbaaS= Load balancing as a Service. Virtualization is the enabler technology for this cloud component, which allows the users unprecedented flexibility in configuring their settings while protecting the physical infrastructure of the provider's data center. Data storage allows users to store their data at remote disks and access them anytime from any place. Communication becomes a vital component of the cloud infrastructure. Consequently, cloud systems are obliged to provide some communication capability that is service-oriented, configurable, schedulable, predictable, and reliable. These implementations have borrowed their fundamental ideas from proceeding research and production systems. Some examples of data storage systems are: distributed file systems (e.g., GFS [32]), replicated relational databases (RDBMS) (e.g., Bayou [33]) and key value stores (e.g., Dynamo [34]). Example of commercial DaaS-systems are Amazon's S3 [35] and EMC Storage Managed Service [36]. Several research papers and articles [37], [38], [39] have investigated the various architectural design decisions, protocols and solutions needed to provide QoS communications as a service. One recent example of systems that belong to CaaS is Microsoft Connected Service Framework (CSF) [40].

D. Security Layer

Usually security is the focal concern in terms of data, infrastructure and virtualization etc. Corporate information is not only a competitive asset, but it often contains information of customers, consumers and employees that, in the wrong hands, could create a civil liability and possibly criminal charges. Many discussion around cloud computing are centered on privacy, confidentially, the isolation of data from application logic. Typically, Security as a Service involves applications such as anti-virus software delivered over the Internet but the term can also refer to security management provided in-house by an external organization.

In our proposed taxonomy services are provided in this layer is named as Security as a service (SeaaS) that is an outsourcing model for security management. Sub-taxonomy proposed for this layered taxonomy is: IdaaS= Identification as a Service, MoaaS= Monitoring as a Service, CraaS= Correlation as a Service. The key challenges of cloud security are performance, risk management, governance, design and deployability. Building a trust between various cloud stakeholders (users, corporations, network, service providers, etc.) is a major consideration. Security as a Service product vendors include Cisco, McAfee, Panda Software, Symantec, Trend Micro and VeriSign [41]-[42].

E. Software Kernel Layer

This cloud layer provides the basic software management for the physical servers that compose the cloud. In our proposed taxonomy services provided by this layer is named as software kernel as a service (SkaaS). Proposed sub-taxonomy for this layered taxonomy in this paper is: Vaas= Virtualization as a Service, Cmaas= Clustering middleware as a Service, OsaaS= Operating system kernel or system software as a Service, SwaaS= Software kernel as a Service, GcaaS= Grid computing application as a Service. Software kernels at this level can be implemented as an OS kernel, hypervisor, and virtual machine monitor and/or clustering middleware. Customarily, grid computing applications were deployed and run on this layer on several interconnected clusters of machines. However, due to the absence of a virtualization abstraction in grid computing, jobs were closely tied to the actual hardware infrastructure and providing migration, check pointing and load balancing to the applications at this level was always a complicated task. The two most successful grid middleware that harness the physical resources to provide a successful deployment environment for Grid applications were arguably Globus [43] and Condor [44]. Grid computing micro-economics models [45] have the concern to study the issues of pricing, metering and supply-demand equilibrium of the computing resources in the realm of cloud computing. Those grid economic models could further assist in the transition from the current offering of cloud computing to a national infrastructure for utility computing. The scientific community has also addressed the quest of building grid portals and gateways for grid environments through several approaches [46], [47], [48], [49], [50], [51]. Such approaches and portal design experiences are further essential for the development of usable portals and interfaces for the cloud at different software layers.

F. Hardware and Firmware Layer

The sixth layer of the cloud stack in our proposed ontology is the actual physical hardware and switches that form the backbone of the cloud. In this regard, users of this layer of the cloud are normally big enterprises with huge IT requirements in need of subleasing Hardware as a Service (HaaS). For that, the HaaS provider operates, manages and upgrades the hardware on behalf of its consumers, for the life-time of the sublease. This model is advantageous to the enterprise users, since they do not need to invest in building and managing data centers. Meanwhile, HaaS providers have the technical expertise as well as the cost-effective infrastructure to host the systems. In HaaS model, the vendor allows customers to license the hardware directly. According to Nicholas Carr [52], “the idea of buying IT hardware - or even an entire data center - as a pay-as-you-go subscription service that scales up or down to meet your needs. In this paper this taxonomy is further divided into some other sub-taxonomy. These are HwaaS= Hardware management as a Service, and FaaS= Facility as a Service

One of the early examples HaaS is Morgan Stanley’s sublease contract with IBM in 2004 [53]. PXE [54] and UBoot [55] are examples of remote bootstrap execution environments that allow the system administrator to stream a binary image to multiple remote machines at boot-time. One example of such systems is IBM Kittyhawk [56], a research project that uses UBoot to script the boot sequence of thousands of remote Bluegene/P nodes over the network. Other examples of challenges that arise at this cloud layer include data center management, scheduling, and power-consumption optimizations.

G. Strategy Layer

In our proposed granular classification of cloud taxonomy, strategy layer is the bottom layer of cloud’s stack. As we understand the cloud is first and foremost a business decision. Cloud Strategy Assessment is a formal and scoped series of business and IT engagements. Focused on identifying and linking business objectives and long term goals to cloud computing solutions, this service creates the vision for how to transform your business and gain greater value from people, processes, and technology. Key Activities in cloud strategy are: identify opportunities for cloud and where to start, deliver a clear and concise picture of cloud computing and how it may benefit your business Goals, high-level strategy and recommendations for approaching CC. Service provided in this taxonomy is Strategy as a service (StaaS). Sub-taxonomy we proposed for this layered taxonomy is: PnaaS= Planning as a Service, TaaS= Transformation as a Service , CnaaS= Consulting as a Service, BaaS= Budgeting analysis as a Service, TaaS= Timing estimation as a Service, ExaaS= Experts providing as a Service, and RaaS= Rules and regulations as a Service. One example of such system is Oracle consulting cloud strategy assessment [57]. Europe has large open source communities and a strong background in open source development and provisioning. Nonetheless, as the European Software Strategy industry report [58] [59] indicates, many of the open source technologies developed in Europe are exploited by US companies [60].

In this section, we outlined our proposed cloud ontology and described the different layers of our classification and the relationships between them and their services. We also identified the users of each cloud layer. In addition, Iweexplicated the challenges and trade-offs encountered by the providers of the cloud services at each level of the stack. Some of the commercial cloud systems discussed earlier in our proposed ontology of cloud taxonomy is exemplified in Table II.

Table II: Examples of existing commercial cloud system according to the proposed taxonomy

No.	Layers presented in proposed taxonomy	Examples of Commercial Cloud Systems
1	Application layer SaaS= software as a Service	Google Apps and Salesforce Customer Relation Management (CRM) system
2	Software environment or development layer PaaS= Platform as a Service	Google App Engine and Salesforce Apex System

3	Software infrastructure layer IaaS: Infrastructure as a Service	Computational Resources: Amazon's EC2, Enomalism Elastic Cloud. Storage: Amazon's S3, EMC Storage Managed Service. Communication: Microsoft Connected Service Framework (CSF).
4	Security layer SeaaS=Security as a Service	Security as a Service product vendors include Cisco, McAfee, Panda Software, Symantec, Trend Micro and VeriSign.
5	virtualization or software kernel layer SkaaS= Software kernel as a Service	Grid and Cluster Computing Systems like Globus and Condor.
6	Hardware infrastructure layer HaaS= Hardware as a Service	IBM-Morgan Stanley's Computing Sublease, and IBM's Kittyhawk Project.
7	Strategy layer StaaS= Strategy as a Service	Truffle Capital (2007), Oracle strategy, DG Information Society and Media

V. CONCLUSION

Cloud computing is a very contemporary area in research ground and researchers are showing their attention, importance, and interest on it. Even though it is very important for the cloud world for distributing and sharing resources and services, but it has been identified that the areas of standardization and interoperability need to evolve. Improved interoperability and clear standards will not only make it easier to develop new cloud services, but it will also make entering the cloud less risky, and hence more attractive, for companies. The proposed taxonomy captures in a forthright way the concepts of cloud computing, and is therefore very appropriate for understanding cloud computing for cloudification. Having a clear taxonomy enables us to clearly identify the category our problem falls in. This proposed taxonomy will provide researchers and developers the ideas on the current cloud systems, motivation, hype, and challenges.

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