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Software as a Service, Platform as a Service, Infrastructure as a Service − A Review

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Abstract

Cloud services have revolutionized the dynamics of IT industry. Cloud computing provides scalable and virtualized resources as services over the Internet. Cloud offers three types of services: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). This investigation encapsulates all these services from industry's point of view, identifies various cloud paradigms promising to deliver these services, and discusses pros & cons of these services. This write-up contributes to the knowledge of cloud services by reviewing the benefits and barriers in adopting cloud services, and also predicts the future of cloud services.

Keywords: Cloud Services, Software as a Service, Platform as a Service, Infrastructure as a Service, Services of Cloud Computing.

I. Introduction

Cloud computing is a model for enabling ubiquitous, 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. The cloud model promotes availability and is composed of five essential characteristics, three service models (Software as a Service, Platform as a Service & Infrastructure as a Service), and four deployment models (Public, Private, Hybrid & Community) (Mell P, 2011). The three service models of cloud computing are termed as delivery models(Kavitha Ms,2013) Cloud services are designed to provide easy, scalable access to applications, resources and services, and are fully managed by a cloud services provider. A cloud service can dynamically scale to meet the needs of its users. The service provider supplies the hardware and software necessary for the service, there's no need for a company to provision or deploy its own resources or allocate IT staff to manage the service. Examples of cloud services include online data storage and backup solutions, Web-based e-mail services, hosted office suites and document collaboration services, database processing, managed technical support services and more. (Online) (Sari RF et al,2013) (Ercolani,2013) (Iqbal W et al,2013) (Garg SK et al ,2013) (Garg SK et al ,2013) (Iwashita M et ql,2013) (Iwashita M et ql,2013) (Erl T ,2013) (Alwabel A et al,2013) (Voas J et al,2013) (Han Y , 2013) (Ranjan R et al,2013) (Han Y , 2013)
Clouds are commonly categorized into Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS), depending on what scalable abstraction and

virtualization is provided: the compute & data resources, a development platform or working software applications, respectively (Simmhan Y et al,2011) IaaS providers like Amazon offer the flexibility to deploy and operate any software environment by the utility, and this extends to the convenience of deploying and managing any security and privacy framework required by the utility. Limited security and coarse grained access control is provided for IaaS storage and compute services (Online). PaaS such as Microsoft Azure provides access control and identity management like Active Directory as platform services in the cloud (Online). These controls can be applied to cloud applications, enterprise service bus, and storage services. Service providers are starting to host Smart Grid applications such as power usage monitoring for consumers (Google PowerMeter, Microsoft Hohm), meter data management, demand response and outage detection for utilities (Silver Springs Utility IQ) (Online). Migrating existing utility software and security policies into IaaS may be easier compared to the application rewrite that would be required for PaaS and SaaS. On the other hand, software vendors have started providing new software stacks customized for smart grid utilities (Oracle Utilities, Microsoft SERA) that have the potential to be hosted on clouds (Online-Online). These may satisfy some of the regulatory requirements but sacrifice information integration from diverse sources. PaaS allows utilities to integrate their custom applications with platform access control and identity services, but may not provide the fine grained access control, audit tracing and regulatory compliance required by utilities. Most cloud vendors only provide a best effort at security and privacy of data and compute services with limited legal liability for non-compliance (Online). SaaS is a term that refers to software in a cloud (Reese, 2009). The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (*e.g.*, web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings (Mell P et al, 2009). With SaaS, the consumer pays for the software on a subscription level and does not need to install any software on his machine. The software, application, is instead accessed via the internet through a web browser (Hamrén O,2012)(Mather T et al,2009). An example of this is Google Docs (Online), a word processing application offered online. The user can access the application through a web browser, create documents and use all the features of the application.

Cloud services have become popular because they are affordable, convenient and provide ample storage space, but perhaps the biggest appeal of cloud services is their accessibility. You can access your documents, photos, videos and any other saved files from any device with internet access. With cloud services you can connect at home, work or on the go via a laptop, desktop, smartphone or other handheld device. Some of the world's largest tech companies have launched cloud services, including Apple, Amazon and Google. These tech giants, along with some notable up-and-comers, provide several storage tier plans tailored for both consumers and businesses. Microsoft Windows also offers cloud solutions. But unlike its competitors, Windows provides such a small, limited amount of free storage (with no option to upgrade) that it's

difficult to compete with the rest of the services in our lineup (Online (Chauhan S et al,2013) (Ergu D et al, 2013) *(*Leistikow et al , 2013*)* (Yoon e t al,2013) *(*Tan W *et al, 2013)* (Barreto L et al, 2013)(Qu H et al,2013) (Frey S et al,2013) (Hu YS et al,2013) (Li B et al, 2013) (Liang J et al,2013) (Goyal Sumit,2013) (Bojanova et al,2013) (Ranjan et al, 2013) (Goyal Sumit, 2013) (Ji H et al,2013) (Kuo JW,2013). This review investigates the services of cloud computing, discusses the benefits and challenges in adopting these cloud services.

A. Software as a Service (SaaS)

Software is available through a number of different licensing models such as the commonly used perpetual licensing model and a relatively new licensing model called SaaS (Choudhary ,2013) (Ashta et al,2013). SaaS is a brand new selling strategy for enterprise software developers (Zhang J et al,2013) SaaS is emerging as a viable outsourcing option for clients interested in paying for the right to access a standardized set of business software functions through the network. SaaS model largely replaced the Application Service Providers (ASP) model, by creating an architecture that provides no mechanisms for customizing the software on the vendor side; all customization is done on the client side through standardized interfaces. The fact that vendors are not making any client-specific investments makes this outsourcing model quite intriguing. Several workers investigated client's side determinants and the SaaS model adoption, and drew on economic, strategic management and Information Systems theories to develop a theoretical framework. By integrating diverse literature streams, they were able to develop a more elaborate view of uncertainty arguing that some types uncertainty increase the propensity to adopt SaaS, while other types do not. Finally, it was argued that the maturity of the client's internal enterprise IT architecture plays an important role in SaaS adoption decisions (Xin et al,2008) (Dyche,2013)(O'Connor,2009) (AMR,2006) (Matthee,2006) (Matthee, 2013) (Jeong HY,2013) (Genez TA,2012) With the SaaS model, software applications are deployed on vendors' premises prior to a client's adoption. Clients do not purchase software or infrastructure (e.g., hardware and OS) upfront, but pay for their access to the services over time. Implementation cycle is shortened, since applications are already deployed on SaaS vendors' sites. The SaaS model also allows extensive cost savings in operating standard business components on a large scale. Accordingly, firms with high cost of capital may find the SaaS model more beneficial as it enables them to economize on fixed capital cost by spreading the service cost over time, allows faster time to value, and potentially brings significant cost savings (Sharpe et al,1995)

The SaaS model is becoming increasingly popular. The SaaS market is in the midst of a five-year period of 43 per cent average annual compound growth(RBC,2007)

. The two SaaS pioneers, Salesforce.com and Oracle, both signed up their millionth user by the end of 2007. Firms using SaaS reported substantial efficiency benefits from the adoption (Dubey et al,2007). Numerous SaaS conferences are held all year round by premier IT market research companies, and in some cases, SaaS user groups are formed that provide a platform for IT

professionals from client firms to exchange their experiences with SaaS and promote the adoption of this model through events, education, promotion, and so on. Despite such extensive exposure, concerns about data security, customization, integration, etc. are still major barriers to the adoption of SaaS. The new software architecture employed by SaaS also faces several technical challenges, and the underlying technology is going through rapid changes. Given multiple pros and cons, organizations may forgo rational calculations in favor of mimicking their successful peers (Loh et al, 1992) (DiMaggio,1983).

SaaS market has experienced a number of fits and starts since it rose to prominence in the late 1990s. In the last years of the Internet boom, high-profile ASPs entered the marketplace with promises to revolutionize the enterprise software landscape. These firms delivered complex enterprise software packages via a hosted model, generally with little or no specialized or proprietary IP. SaaS effectively redefines the software deployment model from packaged applications with upfront licensing fees and lengthy implementations to one that constitutes a dynamic, "pay-as-you-go" Internet delivered service relationship. This shift fundamentally changes the assumptions, relationships & partnerships, and value proposition between software vendors, clients & end-users, and third-party service providers. The SaaS firm changes the dynamics and definition of a software and service provider and merges these concepts into a single source entity. After its early development and shakeout period, the SaaS model is poised to undergo rapid growth and to play a very meaningful role in redefining the software industry. Today, the impact of software as a service is already being felt with companies performing well and changing the dynamics in certain software sectors. Large established IT firms are expressing renewed interest in this area, due in part to defensive maneuvers needed in reply to disruptive SaaS firms. As a result, the time is right for an in-depth analysis of the market and its implications on the new software industry (SIIA, 2004). Microsoft's quite popular and competitive cloud architecture named Windows Azure has entered the SaaS arena recently. Although, the IT giant isn't offering much suite of SaaS solutions in the current scenario, they will be soon transforming their other applications also as SaaS, while maintaining the hierarchy of the already existing local solutions. Coming to Microsoft's counterpart, Google also recently entered the SaaS movement and is promoting its SaaS services with the latest launch of their Google Apps Premier Edition (Online).

B. Benefits of SaaS

SaaS enables organizations to make their software applications run in a virtual environment. IT professionals no longer have to buy or purchase expensive software applications, which consume a lot of time while installing, and also requires huge sums of money. SaaS in cloud computing takes care of this make businesses viable enough to work in a virtual, flexible yet reliable cloud environment. Nevertheless, SaaS has brought considerable and productive changes in the booming business environment. The load on computer reduces to a great percentage if all the software applications are built and run on SaaS platform (Online).

With SaaS, the large up-front capital expense gets reduced to a huge percentage. This wouldn't have been possible if you had to purchase the expensive software from the market. All one requires to invest in is a reasonable monthly fee that organizations will have to pay for the latest version of their favorite software. Even the cost of upgrading your SaaS platform will be taken care by your SaaS provider.

SaaS is based on an on-demand service, thus, organizations can avail its services as per their requirement to fit the staffing needs. Because SaaS applications are part of cloud computing architecture, it is highly reliable, more powerful, secure, and redundant hardware infrastructure. SaaS solutions are web-based; deployment is quick, rapid and quite easy. This also gives businesses an instant access to the all the software applications one require. SaaS platform is easily accessible as one can share and access any kind of information or data related to the software application at any point of the hour from anywhere in the world. All you need to have is a good and speedy Internet connection. Most of the SaaS applications are compatible with varied computer systems and telecommunication gadgets like smart phones etc. among others.

C. Challenges in SaaS Adoption

Some limitations slow down the acceptance of SaaS and prohibit it from being used in some cases: Lisserman (Lisserman,2010). reports since data are being stored on the vendor's servers, data security becomes an issue. SaaS applications are hosted in the cloud, far away from the application users. This introduces latency into the environment; so, for example, the SaaS model is not suitable for applications that demand response times in the milliseconds. Multi-tenant architectures, which drive cost efficiency for SaaS solution providers, limit customization of applications for large clients, inhibiting such applications from being used in scenarios (applicable mostly to large enterprises) for which such customization is necessary. Some business applications require access to or integration with customer's current data. When such data are large in volume or sensitive (e.g., end users' personal information), integrating them with remotely hosted software can be costly or risky, or can conflict with data governance regulations. Constitutional search/seizure warrant laws do not protect all forms of SaaS dynamically stored data. The end result is that a link is added to the chain of security where access to the data, and by extension, misuse of these data, are limited only by the assumed honesty of 3rd parties or government agencies able to access the data on their own recognizance (Arthur , 2010) (Adhikari, 2010) (Stallman, 2011) (Hill , 2009).
Switching SaaS vendors may involve the slow and difficult task of transferring very large data files over the Internet. Organizations that adopt SaaS may find they are forced into adopting new versions, which might result in unforeseen training costs or an increase in probability that a user might make an error. Relying on an Internet connection means that data are transferred to and from a SaaS firm at Internet speeds, rather than the potentially higher speeds of a firm's internal network (Gallaugher, 2013) (Schooler,2010) (McFarlan,1995) (McLellan et al,1995) (Mertz et al, 2007) (Nam et al, 1996) (Oh W , 2008) (Panzar et al, 1981)(Parmigiani , 2007) (Pedhazur et al, 1991) (Perry,1994) (Perry,1989) (Poppo et al, 1998) (Prahalad et al, 1990) (Pring,2005)

(Quinn,1999) It is believed that SaaS market growth will remain strong through 2015, when spending on the software is expected to hit $22.1 billion, according to Gartner (Online).

II. Platform as a Service (PaaS)

Platform as a Service, often simply referred to as PaaS, is a category of cloud computing that provides a platform and environment to allow developers build applications and services over the internet. PaaS services are hosted in the cloud and accessed by users simply via their web browser. PaaS allows users to create software applications using tools supplied by the provider. PaaS services can consist of preconfigured features that customers can subscribe to; they can choose to include the features that meet their requirements while discarding those that do not. Consequently, packages can vary from offering simple point-and-click frameworks where no client side hosting expertise is required to supply the infrastructure options for advanced development. The infrastructure and applications are managed for customers and support is available. Services are constantly updated, with existing features upgraded and additional features added. PaaS providers can assist developers from the conception of their original ideas to the creation of applications, and through to testing and deployment. This is all achieved in a managed mechanism. As with most cloud offerings, PaaS services are generally paid for on a subscription basis with clients ultimately paying just for what they use. Clients also benefit from the economies of scale that arise from the sharing of the underlying physical infrastructure between users, and that results in lower costs. The services offered by PaaS to its users are: operating system, server-side scripting environment, database management system, server software, support, storage, network access, hosting, tools for design and development. PaaS provides the architecture as well as the overall infrastructure to support application development. It is therefore ideal for the development of new applications that are intended for the web as well as mobile devices and PCs (Online).

A. Benefits of PaaS

Organizations don't have to invest in physical infrastructure. They don't need to purchase hardware themselves or employ the expertise to manage it. This leaves them free to focus on the development of applications. What's more, clients will only need to rent the resources they need rather than invest in fixed, unused and therefore wasted capacity. PaaS makes development possible for 'non-experts'. With some PaaS offerings anyone can develop an application. They can simply do this through their web browser utilizing one-click functionality. Salient examples of this are one-click blog software installs such as WordPress. PaaS provides flexibility. Clients can have control over the tools that are installed within their platforms and can create a platform that suits their specific requirements. They can 'pick and choose' the features they feel are necessary. Also, adaptability is easy for PaaS users. Features can be changed if circumstances dictate that they should. Teams in different locations can work together, as an internet connection and web browser are all that is required. Developers spread across several locations can work together on the same application build. PaaS providers offer data security, backup and recovery.

B. Challenges in PaaS Adoption

There are approximately three limitations that characterize the PaaS security platform:

- Information processing
- Information interactivity
- Storing data

Information processing refers to that stage when one is creating data so that it can be available to the local network or the web. Sometimes this data is so bulky that the creation process occurs live on the remote server. This increases the document's risk of being intercepted by others who are essential third-parties to its authorship. Luckily enough, PaaS can provide apps that reinforce the security of the document even in the process of 'open' processing on a shared server. It is critical to note that this platform provides great data protection in its stored format. Thus, one has to have doubts only when it is in the processing stage.

Information interactivity is the process of sharing data across the board. It goes through various PCs, seeps through networks and migrates through other devices like phones. It also finds its way through nodes that switch it from the access to the core layers. This interaction sometimes connects local networks that have confidential data with the free web where everybody gains access to the same. This is where the issues of security come in.

PaaS basically enables users to control the data through automated apps from their sources. If a client wants to view confidential data over the Internet, he or she may do so in a cloud environment where no one can hack. In a reverse situation, there can be firewalls all over, which restrict how much outsiders can view some data. This is where news sites use proxies to deny access to some information to people outside the home country such that they only see what matters to the rest of the world. Data storage signifies the hosting aspect of cloud computing. Thanks to the mechanisms in PaaS that endorse multiple applications to encrypt data in servers, many documents do not leak. However, this is hard to verify because data is always in shared servers. This has been a prominent issue in the entire cloud community but the advent of independent clouds even inside dedicated hosting platforms could help to overcome this issue (Chen et al, 2013) (Vouk et al, 2013) (Brender et al, 2013) (Kagadis et al, 2013)(Grewal et al, 2013) (Elhussein et al,2013) (Egwutuoha et al,2013)(Online).
The PaaS market is expected to reach $6.45 billon by 2016 and grow at a compound annual growth rate (CAGR) of almost 50%, with application infrastructure and middleware PaaS expected to grow the fastest(Online)(Online) (Ludwig et al,2013) (Cohen ,2013) (Huang et al, 2013) (Emison , 2013) (Chen X et al,2013)(Online)

III. Infrastructure as a Service (IaaS)

IaaS is one of the three fundamental service models of cloud computing alongside PaaS and SaaS. As with all cloud computing services, it provides access to computing resource in a virtualized environment, "The Cloud" across a public connection, usually the internet. In the case of IaaS the computing resource provided is specifically that of virtualized hardware, in other words, computing infrastructure. The definition includes such offerings as virtual server space, network connections, bandwidth, IP addresses and load balancers. Physically, the pool of hardware resource is pulled from a multitude of servers and networks usually distributed across numerous data centers, all of which the cloud provider is responsible for maintaining. The client, on the other hand, is given access to the virtualized components in order to build their own IT platforms.

In common with the other two forms of cloud hosting, IaaS can be utilized by enterprise consumers to create cost effective and easily scalable IT solutions where the complexities and expenses of managing the underlying hardware are outsourced to the cloud provider. If the scale of a business client's operations fluctuate, or they are looking to expand, they can tap into the cloud resource as and when they need it rather than purchase, install and integrate hardware themselves.

A. Benefits of IaaS

The following are salient examples of how IaaS can be utilized by an enterprise:

Enterprise infrastructure by internal business networks, such as private clouds and virtual local area networks, which utilize pooled server and networking resources and in which a business can store their data and run the applications they need to operate day-to-day. Expanding businesses can scale their infrastructure in accordance with their growth whilst private clouds (accessible only by the business itself) can protect the storage and transfer of the sensitive data that some businesses are required to handle.

Cloud hosting of websites on virtual servers are founded upon pooled resources from underlying physical servers. A website hosted in the cloud, for example, can benefit from the redundancy provided by a vast network of physical servers and on-demand scalability to deal with unexpected demands placed on the website.

Virtual Data Centers (VDC): a virtualized network of interconnected virtual servers, which can be used to offer enhanced cloud hosting capabilities, enterprise IT infrastructure or to integrate all of these operations within either a public or private cloud implementation.

Scalability: resource is available as and when the client needs it and, therefore, there are no delays in expanding capacity or the wastage of unused capacity.

No investment in hardware: the underlying physical hardware that supports an IaaS service is setup and maintained by the cloud provider saving the time and cost of doing so on the client side.

Utility style costing: the service can be accessed on demand and client only pays for the resource that they actually use.

Location independence: the service can usually be accessed from any location as long as there is an internet connection and the security protocol of the cloud allows it.

Physical security of data centre locations: services available through a public cloud or private clouds hosted externally with the cloud provider, benefit from the physical security afforded to the servers, which are hosted within a data centre.
No single point of failure: if one server or network switch, for example, were to fail, the broader service would be unaffected due to the remaining multitude of hardware resources and redundancy configurations. For many services if one entire data center were to go offline, never mind one server, the IaaS service could still run successfully (Online) (Xu X ,2102) (Moreno-Vozmediano et al, 2012) (Grundy et al, 2012) (Jin H et al, 2010) (Antonopoulos,2010)

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B. Challenges in IaaS Adoption

Primary factors (Chen et al, 2013) that limit company's interest in using a cloud-based IaaS solution are:

- Concerns about the security and confidentiality of organization's data.
- The lack of time and resources to sufficiently analyze the offerings and the providers.
- Uncertainty about the provider living up to their promises.
- Lack of confidence in a shared infrastructure.
- The provider is not capable of adding capacity in a dynamic enough fashion.
- Concerns about the security and confidentiality of data.
- Their lack of an internal strategy about IaaS.
- Their lack of personnel to design and implement the solutions.
- The relative immaturity of the technologies that would have to be installed and managed.
- The lack of significant enough cost savings.

According to Cisco research (Online) by 2013, service revenues from IaaS are forecasted to be approximately $15.6 billion out of total cloud revenues of $35.4 billion. IaaS has the potential to accelerate growth and deliver massive new revenue streams, while moving service providers up the value chain. It can provide better return on investments through high-margin multi-tenancy services, improved ability to create new competitive offerings, and open market opportunities with enterprise consumers.

IV. Conclusion

Cloud computing provides promising services to the clients. Clients can use these services on-demand and at some cost. Cloud computing offers three types of services, which are: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). This study was planned to review the services of cloud computing. SaaS allows client to run a software application over the internet without having to install it on his own computer, thus making things simpler and reducing maintenance costs. PaaS provides on-demand services, which include a computing platform and solution stack as a service to the clients. The service provider provides tools and libraries, hosting, servers, databases, storage, networks, user interaction process and

frameworks to the software developers. IaaS provides infrastructure to the organizations on a rented basis related to servers, computers, networking devices, hardware and software. This review discusses the benefits and challenges of cloud services. It is believed that these cloud services will be widely accepted by business organizations to carter their IT needs in the coming time and will redefine the new standards and protocols of cloud computing.

References

i. Adhikari R. (2010). Why Richard Stallman takes no shine to chrome. LinuxInsider, (15 December 2010).
ii. Alwabel A, Walters R and Wills G. (2013). Towards a volunteer cloud architecture. In: Computer Performance Engineering (pp. 248-251). Springer Berlin Heidelberg.
iii. AMR Research. (2006). The future of enterprise applications.
iv. Antonopoulos N. (2010). Cloud computing. L. Gillam (Ed.). Springer.
v. Arthur C. (14.12.2010). Google's Chrome OS means losing control of the data, warns GNU founder Richard Stallman | Technology | guardian.co.uk. Guardian.
vi. Ashta A and Patel J. (2013). Software as a service: An opportunity for disruptive innovation in the microfinance software market? Journal of Innovation Economics, Vol. (1), pp. 55-82.
vii. Barreto L, Siqueira F, Fraga J and Feitosa E. (2013, June). An Intrusion Tolerant Identity Management Infrastructure for Cloud Computing Services. In: Proceedings of the 2013 IEEE 20th International Conference on Web Services (pp. 155-162). IEEE Computer Society.
viii. Bojanova I, Zhang J and Voas J. (2013). Cloud computing. IT Professional, Vol. 15(2), pp. 12-14.
ix. Brender N and Markov I. (2013). Risk perception and risk management in cloud computing: Results from a case study of Swiss companies. International Journal of Information Management, Vol. 33(5), pp. 726-733.
x. Chauhan S, Raman A and Singh NP. (2013). A comparative cost analysis of on premises IT infrastructure and cloud-based email services in an Indian business school. International Journal of Cloud Applications and Computing, Vol.3 (2), pp. 21-34.
xi. Chen CH, Lin HF, Chang HC, Ho PH and Lo CC. (2013). An analytical framework of a deployment strategy for cloud computing services: A case study of academic websites. Mathematical Problems in Engineering.
xii. Chen X, Shiohara K and Tazumi H. (2013, June). Designing Formulas for Creating a Healthcare Cloud Service Based on a Formula Calculation Platform Service. In: The 8th International Conference on Internet and Web Applications and Services (pp. 187-193).
xiii. Choudhary V. (2007). Comparison of software quality under perpetual licensing and software as a service. Journal of Management Information Systems, Vol. 24(2), pp. 141-165.
xiv. Cohen B. (2013). PaaS: New opportunities for cloud application development. Computer, Vol. 46(9), pp. 0097-100.

xv. DiMaggio PJ and Powell WW. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. American Sociological Review Vol. 48, pp. 147-160.
xvi. Dubey A and Wagle D. (2007). Delivering Software as a Service. The McKinsey Quarterly.
xvii. Dyche J. (2013). Data-as-a-service explained and defined. SearchDataManagement.com. [Online] [Accessed 1.11.2013].
xviii. Egwutuoha IP, Schragl D and Calvo R. (2013). A brief review of cloud computing, challenges and potential solutions. Parallel & Cloud Computing, Vol. 2(1), pp. 7.
xix. Elhussein K and Babiker M. (2013, August). Smart phones as system integration development tools: (Android SCL simulation environment as prototype). In: Computing, Electrical and Electronics Engineering (ICCEEE), 2013 International Conference on (pp. 280-286). IEEE.
xx. Emison JM. (2013). Change platform. Information Week, pp. 1363.
xxi. Ercolani G (2013). Cloud computing services potential analysis. An integrated model for evaluating Software as a Service. Cloud Computing, pp. 77-80.
xxii. Ergu D, Kou G, Peng Y, Shi Y and Shi Y. (2013). The analytic hierarchy process: task scheduling and resource allocation in cloud computing environment. The Journal of Supercomputing, pp.1-14.
xxiii. Erl T. (2013). Cloud computing: Concepts, technology & architecture. Prentice Hall.
xxiv. Espiner T. (2013). Cloud providers shrug off liability for security. http://www.zdnet.co.uk/news/compliance/2010/02/12/cloud-providers-shrug-off-liability-for-security-40037148/,ZDNet UK. [Online] [Accessed 1.11.2013].
xxv. Frey S, Lüthje C, Huwwa V and Reich C. (2013, May). Fuzzy controled QoS for scalable cloud computing services. In: Cloud Computing 2013, The 4th International Conference on Cloud Computing, GRIDs, and Virtualization (pp. 150-155).
xxvi. Gallaugher J. (2013). Information Systems: A manager's guide to harnessing technology". Flat World Knowledge.
xxvii. Garg SK, Vecchiola C and Buyya R (2013). Mandi: A market exchange for trading utility and cloud computing services. The Journal of Supercomputing, pp. 1-22.
xxviii. Genez TA, Bittencourt LF and Madeira ER. (2012, April). Workflow scheduling for SaaS/PaaS cloud providers considering two SLA levels. In: Network Operations and Management Symposium (NOMS), 2012 IEEE (pp. 906-912). IEEE.
xxix. Goyal Sumit. (2013). Perils of cloud based enterprise resource planning. Advances In Asian Social Science, Vol. 3(4), pp. 880-881.
xxx. Goyal Sumit. (2013). Public or Private: Which cloud computing model suits your business? International Journal Of Distributed And Cloud Computing, Vol. 1(1), pp. 42-44.
xxxi. Grewal RK and Pateriya PK. (2013). A rule-based approach for effective resource provisioning in hybrid cloud environment. In: New Paradigms in Internet Computing (pp. 41-57). Springer Berlin Heidelberg.
xxxii. Grundy J, Kaefer G, Keong J and Liu A. (2012). Guest Editors' Introduction: Software engineering for the cloud. Software, IEEE, Vol. 29(2), pp. 26-29.
xxxiii. Hamrén O. (2012). Mobile phones and cloud computing. M.S. Thesis.
xxxiv. Han Y. (2013). IaaS cloud computing services for libraries: Cloud storage and virtual machines. OCLC Systems & Services, Vol. 29(2), pp. 87-100.

xxxv. Han Y. (2013). On the clouds: a new way of computing. Information Technology and Libraries, Vol. 29(2), pp. 87-92.
xxxvi. Hill BM. (1.2.2009). Show Me the Code. Revealing Errors.
xxxvii. http://aws.amazon.com/ec2/S [Online] [Accessed 1.11.2013].
xxxviii. http://cloud-services-review.toptenreviews.com/ [Online] [Accessed 26.10.2013].
xxxix. http://www.ashtonmetzler.com/The%20Adoption%20of%20IaaS.pdf [Online] [Accessed 26.10.2013].

xl. http://www.cisco.com/en/US/solutions/collateral/ns341/ns991/ns995/IaaS_BDM_WP.pdf [Online] [Accessed 28.10.2013].
xli. http://www.cloudcomputing-news.net/news/2013/may/08/paas-market-hit-65bn-2016-says-new-report/ [Online] [Accessed 28.10.2013].

xlii. http://www.cloudreviews.com/blog/benefits-of-software-as-a-service [Online] [Accessed 27.10.2013].
xliii. http://www.cloudtweaks.com/2012/09/is-paas-enough-to-serve-as-a-security-platform-for-cloud-computing/ [Online] [Accessed 28.10.2013].

xliv. http://www.computerworld.com/s/article/9225590/Gartner_SaaS_market_to_grow_17.9_to_14.5B [Online] [Accessed 1.11.2013].

xlv. http://www.interoute.com/what-iaas [Online] [Accessed 27.10.2013].

xlvi. http://www.interoute.com/what-paas [Online] [Accessed 1.11.2013].

xlvii. http://www.microsoft.com/enterprise/industry/power-utilities/ [Online] [Accessed 28.10.2013].
xlviii. http://www.microsoft.com/windowsazure [Online] [Accessed 28.10.2013].
xlix. http://www.oracle.com/us/industries/utilities/ [Online] [Accessed 28.10.2013].
l. http://www.salesforce.com/paas/overview/ [Online] [Accessed 26.10.2013].
li. http://www.silverspringnet.com/products/utilityiq apps.html [Online] [Accessed 29.10.2013].
lii. http://www.webopedia.com/TERM/C/cloud_services.html [Online] [Accessed 28.10.2013].
liii. https://drive.google.com/ [Online] [Accessed 28.10.2013].
liv. Hu YS, Nan X, Sengupta P, Lippincott-Schwartz J and Cang H. (2013). Accelerating 3B single-molecule super-resolution microscopy with cloud computing. Nature Methods, Vol. 10(2), pp. 96-97.
lv. Huang B, Xu Y, Yuan M and Wu G. (2013). Formal behavior modeling: business processes based on cloud platform. Journal of Networks, Vol. 8(6), pp. 1417-1424.
lvi. Iqbal W and Yousaf S (2013). Formal modeling of agent based cloud computing services using Petri nets. VFAST Transactions on Software Engineering, Vol.1 (2), pp. 1-6.
lvii. Iwashita M and Tanimoto S. (2013, July). Consideration of Billing Management Method for Cloud Computing Services. In: Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD), 2013 14th ACIS International Conference on (pp. 394-399). IEEE.

lviii. Iwashita M, Tanimoto S and Fujinoki Y. (2013, June). Approaches to analyze requirements of billing management for cloud computing services. In: Computer and Information Science (ICIS), 2013 IEEE/ACIS 12th International Conference on (pp. 17-22). IEEE.

lix. Jeong HY and Choi HG. (2013). The web service framework for SaaS in cloud computing environment. Applied Mechanics and Materials, Vol. 300, pp. 664-667.

lx. Ji H, Yang QJ and Han XM. (2013, January). Product platform design services architecture and key technologies based on cloud computing. In: The 19th International Conference on Industrial Engineering and Engineering Management (pp. 1293-1305). Springer Berlin Heidelberg.

lxi. Jin H, Ibrahim S, Bell T, Gao W, Huang D and Wu S. (2010). Cloud types and services. In: Handbook of cloud computing (pp. 335-355). Springer US.

lxii. Johnson PE (2013). A review of "Cloud computing for libraries" breeding, M.(2012). Chicago, IL: ALA TechSource. Journal of Access Services, Vol. 10(1), pp. 71-73.

lxiii. Kagadis GC, Kloukinas C, Moore K, Philbin J, Papadimitroulas P, Alexakos C and Hendee WR. (2013). Cloud computing in medical imaging. Medical Physics, Vol.40, pp. 070901.

lxiv. Kavitha MS and Damodharan P (2013). Software as a service in cloud computing. International Journal on Advanced Computer Theory and Engineering, Vol.1 (2), pp. 119-122.

lxv. Kuo JW (2013). Multiple media devices through a gateway server or services to access cloud computing service storage. U.S. Patent 20,130,219,006, issued August 22, 2013.

lxvi. Leistikow R and Tavangarian D. (2013, March). Secure picture data partitioning for cloud computing services. In: Advanced Information Networking and Applications Workshops (WAINA), 2013 27th International Conference on (pp. 668-671). IEEE.

lxvii. Li B and Liu F. (2013). Cloud and data center performance [Guest Editorial]. Network, IEEE, Vol. 27(4).

lxviii. Liang J and Jin H. (2013). Integrating local e-governments of China to provide better public services based on cloud computing. In: LISS 2012 (pp. 893-898). Springer Berlin Heidelberg.

lxix. Lisserman M. (2010). SaaS and the everlasting security concerns. Forrester Research, (20 December 2010).

lxx. Loh L and Venkatraman N. (1992). Diffusion of information technology outsourcing: Influence sources and the Kodak effect. Information Systems Research Vol. 3(4), pp 334-378.

lxxi. Ludwig B and Coetzee S. (2013). Implications of security mechanisms and Service Level Agreements (SLAs) of Platform as a Service (PaaS) clouds for geoprocessing services. Applied Geomatics, pp. 1-8.

lxxii. Mather T, Kumaraswamy S and Latif S (2009). Cloud security and privacy: An enterprise perspective on risks and compliance. Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

lxxiii. Matthee TF. (2011). Make, buy or rent decision for information systems in the heavy engineering industry/Matthee, TF (Doctoral dissertation).

lxxiv. McFarlan FW and Nolan RL. (1995). How to manage an it outsourcing alliance. Sloan Management Review, pp. 9-23.

lxxv. McLellan KL, Marcolin BL and Beamish PW. (1995). Financial and strategic motivations behind is outsourcing. Journal of Information Technology, Vol. 10, pp. 299-321.
lxxvi. Mell P and Grance T (2011). The NIST definition of cloud computing (draft). NIST special publication, 800(145), 7.
lxxvii. Mell P and Grance T. (2009). Effectively and securely using the cloud computing paradigm. NIST, Information Technology Lab.
lxxviii. Mertz SA, Eid T and Eschinger C. (2007). Market trends: Software as a service in the enterprise application software markets, Worldwide, Gartner, Stamford, CT.
lxxix. Mitchell ET. (2013). Cloud-based services for your library: A lita guide. Neal Schuman Publication.
lxxx. Moreno-Vozmediano R, Montero R and Llorente I. (2012). Key challenges in cloud computing to enable the future internet of services. Internet Computing, IEEE, Vol. 17(4), pp. 18-25.
lxxxi. Nam K, Rajagopalan S, Rao HR and Chaudhury A (1996). A two-level investigation of information systems outsourcing. Communications of the ACM Vol. 39(7), pp. 36-44.
lxxxii. O'Connor S. (2009). How indigenous software companies price their product and service offerings: An exploratory investigation (Doctoral dissertation, Waterford Institute of Technology).
lxxxiii. Oh W. (2008). Firm Characteristics and Allocation of It Budget to Outsourcing. In: Information Technology Outsourcing, S. Rivard and B.A. Aubert (eds.). Armonk, NY: M. E. Sharpe Inc., pp. 99-118.
lxxxiv. Panzar JC and Willig RD. (1981). Economies of scope. The American Economic Review, Vol. 71(2), pp. 268- 272.
lxxxv. Parmigiani AE. (2007). Why do firms both make and buy? An investigation of concurrent sourcing. Strategic Management Journal, Vol. 28, pp. 285-311.
lxxxvi. Pedhazur EJ and Schmelkin LP. (1991). Measurement, Design, and Analysis. Erlbaum: Hillsdale, NJ.
lxxxvii. Perry DE. (1994). Dimensions of software evolution. In: International Conference on Software Maintenance, H.A.M.A.M. Georges (ed.), Victoria, B.C., Canada: IEEE Computer Society Press, pp. 296--303.
lxxxviii. Perry MK. (1989). Vertical integration: Determinants and effects. In: Handbook of Industrial Organization, R.Schmalensee and R. Willig (eds.). NORTH-HOLLAND, Amsterdam: Elsevier Ltd., pp. 103–255.
lxxxix. Poppo L and Zenger T. (1998). Testing alternative theories of the firm: Transaction Cost, Knowledge-Based, and Measurement Explanations for Make-or-Buy Decisions in Information Services. Strategic Management Journal, Vol.19, pp. 853-877.
xc. Prahalad CK and Hamel G. (1990). The core competence of the corporation. Harvard Business Review, Vol. 68(3), pp. 79-91.
xci. Pring B. (2005). Adoption of software as a service is happening outside of CRM. Gartner Inc., Stamford, CT.
xcii. Qu H and Ynjiun PW (2013). Hand held bar code readers or mobile computers with cloud computing services. U.S. Patent 20,130,142,444, issued June 6, 2013.
xciii. Quinn JB. (1999). Strategic Outsourcing: Leveraging Knowledge Capabilities," Sloan Management Review. Vol. 40(4), pp. 9-21.

xciv. Ranjan R and Zhao L. (2013). Peer-to-peer service provisioning in cloud computing environments. The Journal of Supercomputing, pp. 1-31.
xcv. Ranjan R, Buyya R and Nepal S. (2013). Model-driven provisioning of application services in hybrid computing environments. Future Generation Computer Systems. Vol. 29(5), pp. 1211-1215.
xcvi. RBC. (2007). SaaS Primer—An emerging asset class. RBC Capital Markets, New York, NY.
xcvii. Reese G. (2009). Cloud Application Architectures. O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.
xcviii. Sari RF and Indrawan P (2013). Cloud computing services in mobile devices using android face detector API and rest communication. In: The 3rd International Conference on Digital Information Processing and Communications (ICDIPC2013) (pp. 529-537). The Society of Digital Information and Wireless Communication.
xcix. Schooler R. (2010). Tile processors: Many-core for embedded and cloud computing. In: Workshop on high performance embedded computing.
c. Sharpe S and Nguyen HH. (1995). Capital market imperfections and the incentive to lease. Journal of Financial Economics, Vol. 39(2-3), pp. 271-294.
ci. SIIA and TRIPLETREE Industry Analysis Series (2004). Software as a service: Changing the paradigm in the software industry.
cii. Simmhan Y, Kumbhare AG, Cao B and Prasanna V. (2011, July). An analysis of security and privacy issues in smart grid software architectures on clouds. In: Proceedings of the IEEE International Conference on Cloud Computing (CLOUD), pp. 582-589.
ciii. Stallman R. (20.9.2011). Who does that server really serve? GNU, Boston Review.
civ. Tan W, Sun Y, Lu G, Tang A and Cui L. (2013). Trust services-oriented multi-objects workflow scheduling model for cloud computing. In: Pervasive Computing and the Networked World (pp. 617-630). Springer Berlin Heidelberg.
cv. Voas J, Bojanova I and Zhang J. (2013). Cloud computing. IT Professional, Vol. 15(2), pp. 0012-14.
cvi. Vouk MA, Averitt SF, Dreher P, Kekas DH, Kurth A, Hoit MI and Wright D. (2013). Constructing next generation academic cloud services. International Journal of Cloud Computing, Vol. 2(2), pp. 104-122.
cvii. Walterbusch M, Martens B and Teuteberg F. (2013). Evaluating cloud computing services from a total cost of ownership perspective. Management Research Review, Vol. 36(6), pp. 613-638.
cviii. Xin M and Levina N. (2008, December). Software-as-a-service model: Elaborating client-side adoption factors. In: Proceedings of the 29th International Conference on Information Systems, R. Boland, M. Limayem, B. Pentland,(eds), Paris, France.
cix. Xu X. (2012). From cloud computing to cloud manufacturing. Robotics and computer-integrated manufacturing, Vol. 28(1), pp. 75-86.
cx. Yoon YB, Oh J and Lee BG. (2013). The establishment of security strategies for introducing cloud computing. KSII Transactions on Internet and Information Systems (TIIS), Vol. 7(4), pp. 860-877.
cxi. Zhang J, Niu B and Fei Q. (2013, July). Optimal strategy when selling Software-as-a-Service. In: Service Systems and Service Management (ICSSSM), 2013 10th International Conference on (pp. 267-272). IEEE.