Chapter 1

Introduction

1.1 Background

As one of the fastest growing economies in the world, India seems to be at the forefront of most technological developments in Information Technology (IT) and cloud computing is no exception to it. Indian enterprises have been faced with ebbs and flows in workflow for the past few years and for this reason, various enterprises have started venturing away from self sufficiency in their way of conducting business to identifying specific processes that can be developed by some other entity in order to reduce costs and focus on their core business (Niehaves and Plattfaut, 2011). Cloud computing has been instrumental in meeting these requirements and has a particular advantage for a growing economy like India. First, it balances the constraints and flows in the workflow without significant impact to the bottom line. Second, the cloud allows an enterprise to focus on its core competencies by allowing the cloud provider to deal with all of the hassles involved with development, maintenance, storage, and upgrades of business applications. (Buyya, Yeo, Venugopal, Broberg and Brandic, 2009) assert that Cloud Computing offers billing-based Service Level Agreements (SLA) which can be used for operational management offering cost savings and streamlining business activities and processes.

One of the key benefits of cloud computing is the low capital investment and rapid time to market new ideas. This particularly encourages small and medium enterprises (SMEs) in the country, enabling new start-ups and small and medium businesses to start small and expand their business based on demand (Marston, Li, Bandyopadhyay, Zhang and Ghalsasi, 2010). Cloud Computing offers a variety of other benefits including agility, resource consolidation, business opportunities and green IT (Foster, Zhao, Raicu and Lu, 2008; Weinhardt, Anandasivam, Blau, Borissov, Meinl, Michalk and Stober, 2009; Schubert, Jeffery and Neidecker-Lutz, 2010).

In India, Cloud computing offers huge potential for the industries to grow. Cloud is opening up new windows of opportunities for Indian companies both from global as well as domestic opportunity stand point. There are ample of opportunities in every industry. Verticals such as retail, manufacturing, banking, financial, education, and healthcare are expected to rely heavily upon cloud services for better reach.

The small and medium-sized enterprises (SMEs) are more likely to embrace the cloud and its benefits. The reason being a cloud-based architecture drastically reduces the capital expenses, maintenance, and knowledge required by traditional IT systems. The cloud also offers potential cost savings to SMEs in a number of ways:

- Low barrier to entry, minimum risk, lower capital expenditure on hardware and software make cloud computing an extremely viable option.
- Cloud adoption can reduce the customer's need to hire and maintain a large in-house IT staff.
- Since most cloud services are metered and customers pay only for what they use, the costs may be lower than purchasing other forms of software to perform the same tasks.
- The shared nature of cloud services may provide a way for a business to access applications or computing power that would otherwise be unaffordable.
- Additionally, it offers various operational advantages such as removal of entry barriers, business continuity, mobile workforce, IT agility and faster returns on investments.

The potential for cost savings on computer hardware costs varies and is dependent on, for example, the nature of the individual organization's computing needs and how readily they can be served in the cloud. In some cases, data stored in the cloud may be more secure, since it is stored separately from the device. If a computer is lost, stolen, or malfunctions, the data remain secure.

In a typical cloud ecosystem, Infrastructure as a Service (IaaS) cloud provides the hardware infrastructure required for the new business on a pay per use basis, along with automated management. This enables faster deployment of new software services and due to the elasticity provided by Cloud, the new business can very quickly address the scalability needs of its customers. Cloud even enables self-employment. The entrepreneur can be a simple software developer who uses the Platform as a Service (PaaS) cloud to develop new cloud services without investing towards application development. Once the service is live, customers of the new business can be managed by using Software as a Service (SaaS) platform. Regional clouds which provide services to the customers located in nearby geographical regions may be much better able to meet the region specific requirements and may as such facilitate faster deployment of clouds in the regions.

SMEs in India are now using online portals such as eBay, Amazon, flipkart and snapdeal to sell their products domestically and abroad. One of the reasons that SMEs look at e-commerce offerings through such portals is because of business convenience. These online platforms have allowed Indian SMEs to tap International customers in an extremely convenient, cost-effective, and profitable way. SMEs are one of the most aggressive segments in India to adopt cloud computing. SME's IT requirements are often not as complicated and extensive as those of large enterprises, meaning that they are more flexible enhancing their ability to leverage emerging technologies more readily than larger enterprises. Because of this, SMEs usually find it easier to outsource these functions to a cloud provider and focus on their core business.

It is important to note that while the scope of the cloud is expanding, it is not suited to every application. Service providers have taken note of it and are offering holistic solutions, positioning themselves as comprehensive cloud service providers. These companies are offering traditional services over the cloud such as Testing as a Service (TaaS). Indian service providers are also investing in creating new service offerings in all the areas of cloud, infrastructure, people,

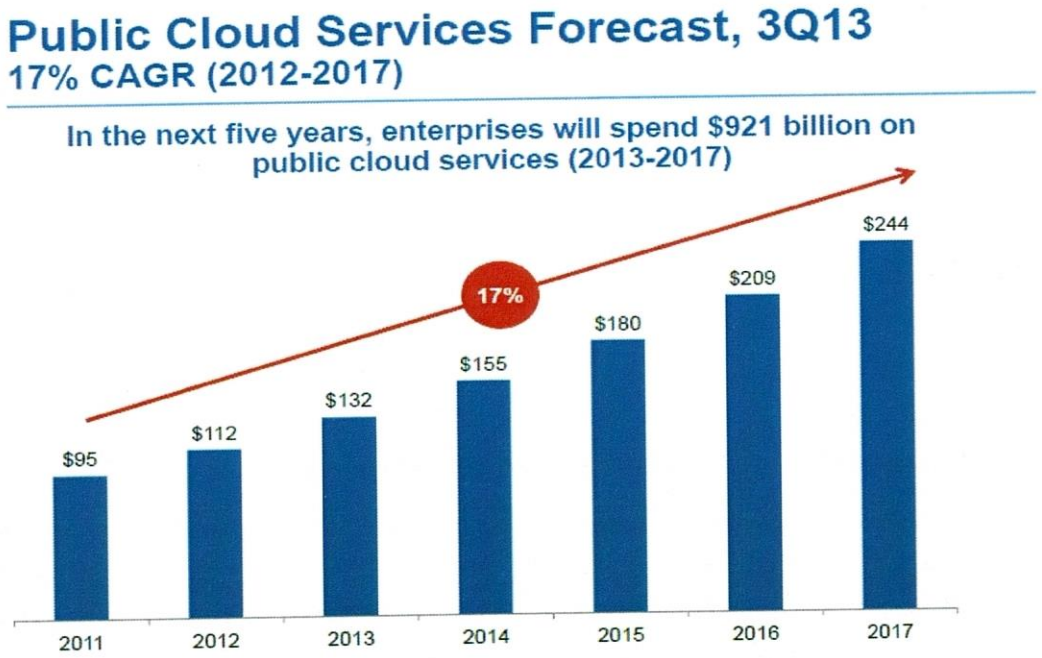
partners and data warehouses to support their cloud services and also building on its strengths.

However, the potential benefits of cloud computing for SMEs need to be weighed taking into account the organization's needs in terms of privacy, security, regulatory compliance, existing hardware/ infrastructure, quality of service requirements, and many other factors. Further, the process of interaction between the cloud service provider and the client and the resultant documentation of the terms and conditions of services needs to be examined and streamlined so that the prospective client feels confident enough to adopt the cloud.

1.2 Rationale for adoption of Cloud services in India

A trend that started a few years back, albeit in silos, social networking, cloud services, analytics and mobile computing, or SCAM, is now converging and will collectively account for 89 percent of new technology spending growth in 2014, says research firm IDC. The $110-billion technology services sector looking for new growth engines will be shouting SCAM in 2014. Research and analyst firm Gartner calls SCAM a 'nexus of forces'. SCAM business is expected to be worth $104 billion, contributing about a fourth of business software revenue by 2017, up from about 10 percent at present. Recent cloud researches have also shown that cloud computing is likely to expand at a much faster rate in the emerging markets than the developed world.

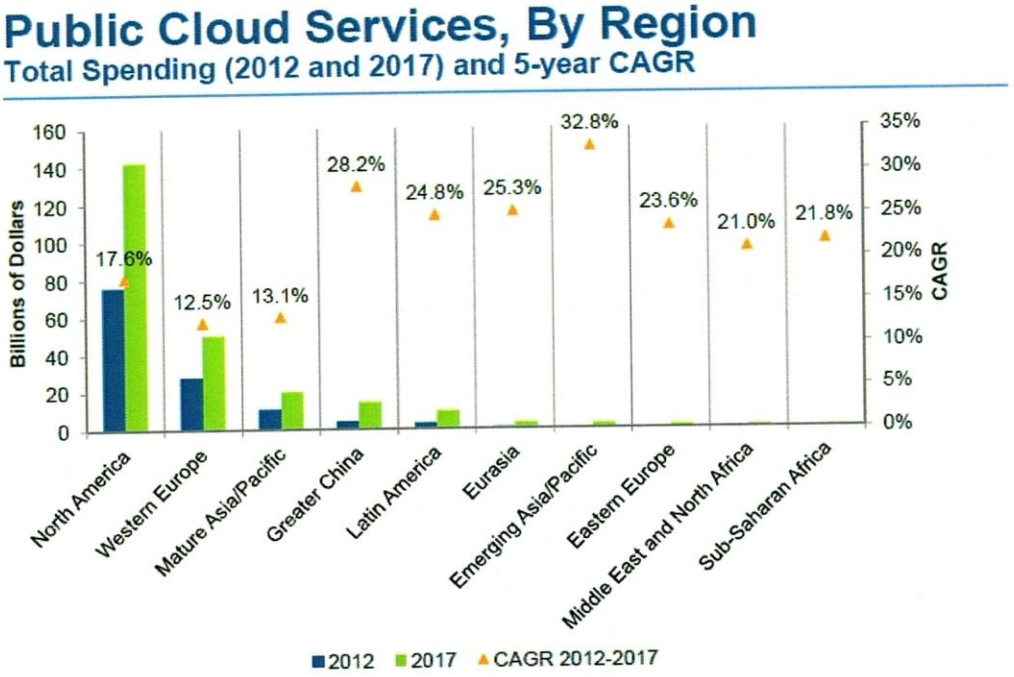
Public IT cloud services are projected to have a compound annual growth rate (CAGR) of 23.5 percent, over the 2013–2017 forecast period, five times that of the industry overall. The public cloud services market shall continue to grow at a CAGR of 17 percent from 2011 through 2017. The cloud market will grow from its estimated size of $95 billion in 2011 to $244 billion in 2017 (Cloud forecasts by Gartner, 2013).



(Source: Gartner, (G00248730), Public Cloud Services Forecast, September 2013)

Figure 1.1: Public Cloud Services Forecast

By 2017, public IT cloud services will drive 17 percent of the IT product spending and nearly half of all growth across five technology categories: applications, system infrastructure software, platform as a service (PaaS), servers, and basic services (International Data Corporation report, 2013).

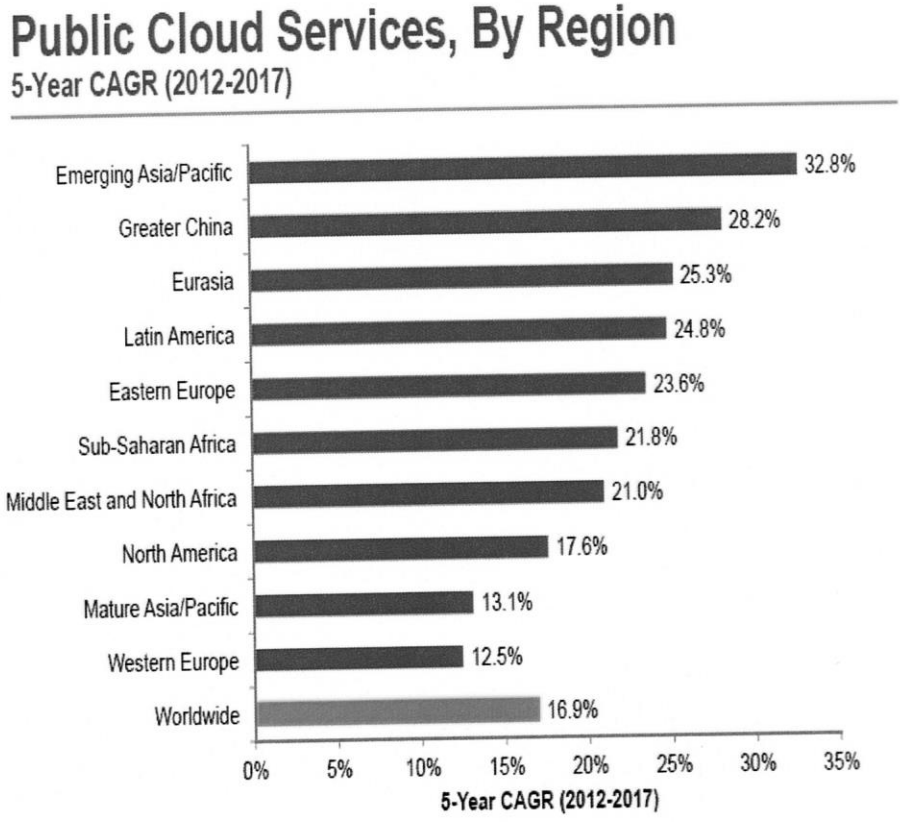


(Source: Gartner, (G00248730), Public Cloud Services Forecast, September 2013)

Figure 1.2: Public Cloud Services, By Region, Total Spending Forecast

Emerging Asia/Pacific (including India) has the highest projected growth of all regions, with a 32.8 percent CAGR, followed by Greater China (28.2 percent), Eurasia (25.3 percent) and Latin America (24.8 percent). The United States will remain the largest public IT cloud services market, although its share will decline from 56.9 percent in 2013 to 43.9 percent in 2017 while Western Europe, Latin America, and Asia/Pacific will each gain share throughout the forecast period.

The market for public cloud services in India is expected to expand at rates outpacing much of the rest of the world as depicted in figure below.



(Source: Gartner, (G00248730) Public Cloud Services Forecast, September 2013)

Figure 1.3: Public Cloud Services, By Region, 5 Year CAGR Forecast

The public cloud services market in India is on pace to grow 29.8 percent in 2014 to total $550 million, an increase of $127 million from an estimated 2013 revenue of $423 million., growing 30.3 percent from 2013 through 2014. Spending on software as a service (SaaS), the largest overall cloud market segment will total $218 million in 2014, followed by infrastructure as a service (IaaS), totally $76

million in 2014 and business process as a service (BPaaS), totally $73 million over the same period. From 2013 through 2017, $4 billion will be spent on cloud services in India, with an expected expenditure of $1.3 billion in 2017. BPaaS is expected to grow from $61.9 million in 2013 to $154 million in 2017. SaaS is expected to grow from $167 million in 2013 to $507 million in 2017, and IaaS is forecast to grow from $58 million in 2013 to $217 million in 2017. The Indian market is expected to be one of the fastest growing countries in Gartner's cloud forecast (Research report by Gartner, 2013).

1.3 Role of SMEs

Ministry of Micro, Small and Medium Enterprises (MSME) indicates that MSME sector has emerged as a highly vibrant and dynamic sector of the Indian economy over the last five decades. MSME's contribute nearly 8 percent of the country's GDP, 45 percent of the manufacturing output and 40 percent of the total exports of the country. The sector is estimated to employ about 69 million persons in over 26 million units throughout the country. There are over 6000 products ranging from traditional to high-tech items being manufactured by MSMEs. They are the nurseries for entrepreneurship and innovation. They provide the largest share of employment after agriculture. They are widely dispersed across the country and produce a diverse range of products and services to meet the needs of the local markets, the global market and the national and international value chains. MSMEs not only play crucial role in providing large employment opportunities at comparatively lower capital cost than large industries but also help in industrialization of rural & backward areas, thereby, reducing regional imbalances, assuring more equitable distribution of national income. MSMEs are complementary to large industries as ancillary units and this sector contributes enormously to the socio-economic development of the country.

Ministry of Micro, Small and Medium Enterprises defines the Micro, Small and Medium Enterprises (MSME) as given below:

Profile	Manufacturing Sector (Investment in plant and machinery)	Service Sector (Investment in Equipment)
Micro	≤ 25 lakh	≤ 10 lakh
Small	> 25 lakh and ≤ 5 crore	> 10 lakh and ≤ 2 crore
Medium	> 5 crore and ≤ 10 crore	> 2 crore and ≤ 5 crore

(Source: Ministry of Micro, Small and Medium Enterprises, 2014)

Figure 1.4: Definitions of Micro, Small and Medium Enterprises

A recent report by EY and ASSOCHAM (2014) says that SMEs will play a leading role in the adoption of social, mobile, analytics, and cloud (SMAC) in India, given the huge opportunity it opens up, not only to grow revenues by increased marketing to new customers, but also by bringing in operational efficiency and customer experience. The sector's contribution to India's GDP is expected to increase to 22 percent in 2020. Indian SMEs are expected to increase cloud adoption at a CAGR of 20 percent between 2012 and 2016. The demand for cloud services by SMEs is particularly high in the areas of disaster recovery, remote database management and e-mail hosting. Greater adoption of cloud is also leading to a significant shift in the number of providers offering cloud-based services. The total number of channel partners catering to SMEs in India increased by 10-15 percent year-on-year in 2013, while the number of cloud channel partners increased by 25-30 percent. Despite the advantages, adoption of SMAC technologies is slow and results from successful cases are facing criticism, as in the case of any new technology initiative including Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management (SCM). However, traditional models are being digitally displaced at very rapid pace.

A study by Nathan India, Federation of Indian Chambers of Commerce and Industry (FICCI) and Google India (2013) points out that SMEs, who use the web, fared much better than those that did not. On an average, web-enabled SMEs boasted of revenues 51 percent higher, 49 percent more profit, and customer bases 7 percent broader than their offline counterparts. The study

revealed significant opportunities both for India's booming SME sector, where fewer than 5 percent of all businesses even maintain a web presence, and for India's economy as small and medium enterprises are critical to the economic growth in India. According to the report, only 51 percent of online SMEs use the web to advertise and a mere 27 percent use it for e-commerce. But, with 95 percent of businesses yet to even establish a website; India is poised for big gains as more small enterprises come online.

However, to achieve the forecasted growth rates and to achieve these projected gains, it is imperative that a conducive market environment is provided by the policy makers and the impediments to cloud adoption are removed at the earliest.

1.4 Government of India Initiatives for adoption of Cloud

The Government of India has envisioned transforming the country into an empowered and inclusive knowledge-based society, using telecommunications as a platform. National Telecom Policy 2012 (NTP'2012) emphasizes that India is one of the fastest growing telecom markets in the world and the unprecedented increase in teledensity and sharp decline in tariffs in the Indian telecom sector have contributed significantly to the country's economic growth. Besides contributing to about 3 percent to India's GDP, Telecommunications, along with Information Technology, has greatly accelerated the growth of the economic and social sectors. In spite of the hurdles to adoption of cloud it is felt that the advent of technologies like cloud computing present a historic opportunity to catapult India's vaunted service delivery capabilities to a new level domestically as well globally.

The Government had already approved the National e-Governance Plan (NeGP) on 18th May, 2006. The National e-Governance Plan, takes a holistic view of e-Governance initiatives across the country, integrating them into a collective vision, a shared cause. Around this idea, a massive countrywide infrastructure reaching down to the remotest of villages is evolving, and large-scale digitization of records is taking place to enable easy, reliable access over the internet. The

ultimate objective is to bring public services closer home to citizens, as articulated in the Vision Statement of NeGP:

> *Make all Government services accessible to the common man in his locality, through common service delivery outlets, and ensure efficiency, transparency, and reliability of such services at affordable costs to realize the basic needs of the common man.*

In order to utilize and harness the benefits of Cloud Computing, Government of India has embarked upon a very ambitious and important initiative - "GI Cloud" which has been coined as 'Meghraj'. Phase-I of GI cloud has been approved at Rs. 99 crores and it has been inaugurated on 4th February, 2014. Objectives of GI cloud are to optimise utilization of infrastructure, implementation of IaaS, PaaS & SaaS in a flexible manner, speeding up the development and deployment of eGov Apps, and to enable delivery of "Cloud Services on Demand" and rapid replication of successful applications. The focus of this initiative is also to evolve a strategy and implement various components including governance mechanism to ensure proliferation of Cloud in government. Formulation of the Cloud Policy is one of the primary steps that will facilitate large scale adoption of cloud by government. However, the focus is specifically on adaptation of cloud in the working of Government.

While the GI Cloud initiative will focus on setting up an eco-system for cloud adoption by the Government, leveraging the existing infrastructure, Department of Electronics and Information Technology (DeitY) has established a separate Working Group headed by Shri. Kris Gopalakrishnan to work on enabling cloud services in India covering aspects like jurisdiction, cross-border data flow, data security, data location.

Further, Government of India (GoI) has approved the setting up of National Optical Fibre Network (NOFN) on 25th October, 2011 to provide connectivity to 2,50,000 Gram Panchayats of the country which would ensure broadband connectivity with adequate bandwidth. This is to be achieved utilizing

the existing optical fibre and extending it to the Gram Panchayats. For this purpose, GoI has set up Bharat Broadband Network Limited (BBNL) on 25th February, 2012 as a Public Sector Undertaking for the establishment, management and operation of NOFN. Services like Government to Citizens (G2C), Business to Business (B2B), Peer to Peer (P2P), Business to Consumer (B2C) etc. covering e-education, remote health monitoring, e-governance, weather, agriculture etc. can be accessed by common man through NOFN. Such services may be built on top of the cloud infrastructure.

Ministry of Micro, Medium and Small Enterprise (MSME) has launched a project on 21st March, 2014 by the name 'Badal' which is a cloud computing platform to provide cloud-based services (software, IT platforms and IT infrastructure) to the MSMEs. This project is aimed to enable MSMEs to increase their efficiency, improve their production processes, manufacturing capabilities, quality and competitiveness and reduce their costs on IT infrastructure by way of access to latest computing technology, software and server by sharing the IT infrastructure facilitated by government.

The Government of India has also approved a programme by the name 'Digital India' on 20th August, 2014. Even though India is known as a powerhouse of software, the availability of electronic government services to citizens is still comparatively low. The National e-Governance Plan approved in 2006 has made a steady progress through Mission Mode Projects (MMP) and Core ICT Infrastructure, but greater thrust is required to ensure effective progress in electronics manufacturing and e-Governance in the country. The Digital India vision provides the intensified impetus for further momentum and progress for this initiative and to promote inclusive growth that covers electronic services, products, devices, manufacturing and job opportunities. India in the 21st Century needs to strive to meet the aspirations of its citizens where government and its services reach the doorsteps of citizens and contribute towards a long-lasting positive impact. The vision of Digital India aims to transform the country into a digitally empowered society and knowledge economy. The programme is

proposed to be implemented in phases from 2014 till 2018. The Digital India is transformational in nature and is expected to ensure that Government services are available to citizens electronically. It would also bring in public accountability through a Unique ID, mandated delivery of government's services electronically and e-Pramaan based on authentic and standard based interoperable and integrated government applications and data basis.

1.5 Need of the study

Everything in cloud computing is delivered as service, so it is essential to ensure quality of service (QoS) in cloud. Specifically, in an effort to deliver QoS guaranteed services in cloud computing environment, the relationship among the maximal number of customers, the minimal service resources and the highest level of services is required to be explored. In a cloud computing solutions, it is possible to specify compute, network, and storage requirements, to be shared by tenants in the same infrastructure. But, due to dynamic nature of virtualization environment and the workloads (Virtual Machine and software stack), performance becomes unpredictable affecting the quality of service available to the end customer. The balancing act between resource utilization and workload performance in a cloud environment affects both the cloud service provider (CSP) and the stakeholders of a cloud service - cloud customer and the end user.

QoS is perceived by users based on various key parameters like high availability (guaranteed access to data), performance (throughput), security, resiliency, reliability, self-service portals, response time and customer support, metering and billing accuracy, support in compliance of regulations etc. Perception of quality is dependent on benchmarking of services to the end user as against the logical expectations. There have been several instances of outages in public clouds resulting in failure to meet these quality requirements. Hence, there is a need for cross portfolio integration and a framework for ensuring quality of service. Since cloud environments tend to be highly dynamic with network, compute and storage resources in a constant state of flux, the QoS of a cloud service should be monitored and managed at multiple layers from Network to

Application. CSPs also need to specify and ensure quality of service on their entire service portfolio.

The end customers of cloud largely depend on a fast and reliable connection to the Internet to access Cloud. This makes the quality of the cloud services highly reliant on the capabilities of the users' network connection. Further, in the absence of network connectivity, access to the services becomes impossible, necessitating offline data synchronization, which in many ways backtracks on many of the advantages that cloud services offer. Therefore, the expected quality of services from cloud computing services is highly dependent on telecom quality of services.

Service level agreements (SLA) is an important aspect of cloud computing (Wu and Buyya, 2010; Jamkhedkar, Lamb and Heileman, 2011). The terms and conditions of contract between the cloud service provider and its client are defined in SLA. The SLA is a legally binding contract negotiated and agreed between a customer and a service provider stating the QoS guarantees required by cloud customer typically including response time, throughput, error rate, availability etc. It may include other non-functional requirements such as timeliness, scalability and other terms and conditions as well. Service provider is required to execute service requests from a customer within negotiated quality of service requirements for a given price. SLAs also contain the remedies or compensation the service provider is willing to provide to the service consumer in case of failure to perform as per agreed guarantees. Surprising as it may sound, there are cloud service providers who do not provide any SLAs that cover performance guarantees and remedies in case of failures. However, for any business critical cloud deployments it is absolutely necessary for service consumers to negotiate appropriate SLAs.

Service level agreement being a legal entity between the client and cloud service provider serves as the benchmarking or comparison tool for the prospective client to evaluate various service providers. The parameters to be

included in the SLA are being researched across the World and the list of such parameters is ever increasing. Extensive researches are also being done for ranking of different cloud service providers available in a particular market.

The decision to go for a particular service provider shall be greatly facilitated for a prospective client if unambiguous and comparable SLA parameters are readily available from different service providers as per his requirements. This will also help new service providers to market their services to the prospective clients by offering competitive services which in turn will greatly enhance the overall market economy. Presently, there is no such mechanism and it becomes a difficult task for a prospective cloud client to evaluate different available cloud service providers.

Implementation of Cloud Services in India is relevant considering the various cost benefits cloud computing offers to the companies helping them to achieve economies of scale. The implementation strategies of cloud services for Government organizations and other strategic networks are also required to be defined and steps are already being taken by the Government of India in this regard.

To accelerate the growth of cloud services and to ensure more number of SMEs come under the cloud umbrella and enjoy the benefits offered by Cloud, the present public cloud computing market in India is required to be studied so as to understand the expectations of clients and particularly of SMEs with respect to the service level agreement for faster adoption of cloud in India. The present study is aimed towards these goals.