Chapter 5

Cloud Computing Ecosystem in India

5.1 Introduction

The cloud computing ecosystem in India can be categorized in to two parts; one ecosystem of Government of India cloud - Meghraj and associated State clouds and the other being the cloud offerings by the private cloud service providers. Recognizing the importance of cloud computing, the Government of India laid down its intent for adoption and promotion of cloud computing in India. Various policy initiatives have been initiated towards these objectives.

The importance of Cloud computing has been highlighted by National Policy on Information Technology, 2012 (NPIT 2012) which states that:

> *The bulk of Indian IT exports is still targeted towards North America and Europe. Besides, major IT hubs like Bangalore, Chennai, Hyderabad, Mumbai, Pune and NCR which account for nearly 90 percent of the total Industry in India are near saturated and face infrastructural challenges and human resource constraints for further expansion. This necessitates the absolute imperative for Indian IT and ITES Industry to diversify into Tier II and Tier III cities. Emerging technologies such as Mobile Technology, Localization, Virtualization, and Cloud Computing provide Indian IT / ITES industry a major opportunity to become partners in value creation and drive transformation domestically.*

National Telecom Policy, 2012 (NTP-2012) lays down the following strategies with reference to Cloud Services:

(i) To recognize that cloud computing will significantly speed up design and roll out of services, enable social networking and participative governance and e-Commerce on a scale which was not possible with traditional technology solutions.

(ii) To take new policy initiatives to ensure rapid expansion of new services and technologies at globally competitive prices by addressing the

concerns of cloud users and other stakeholders including specific steps that need to be taken for lowering the cost of service delivery.

(iii) To identify areas where existing regulations may impose unnecessary burden and take consequential remedial steps in line with international best practices for propelling nation to emerge as a global leader in the development and provision of cloud services to benefit enterprises, consumers and Central and State Governments.

NTP-2012 also recognizes the predominant role of the private sector and the consequent policy imperative of ensuring continued viability of service providers in a competitive environment. Pursuant to NTP-2012, these principles would guide decisions needed to strike a balance between the interests of users/ consumers, service providers and government revenue.

National Policy on Information Technology, 2012 (NPIT 2012) has included promoting innovation and R&D in cutting edge technologies and development of applications and solutions in areas like localization, location based services, mobile value added services, Cloud Computing, Social Media and Utility models as one of the objectives.

Based on various discussions and inputs provided by the Task Force and subsequent industry consultations, Department of Electronics and Information Technology (DeitY) (2013) has issued two reports on 'GI Cloud Strategic Direction Paper' and 'GI Cloud Adoption and Implementation Roadmap' with a focus to bring out the strategic direction and implementation roadmap of GI Cloud leveraging the existing or new infrastructure.

The Government of India has approved an ambitious 'Digital India' programme on 20 August, 2014 to transform India into digital empowered society and knowledge economy. Digital India aims to provide the much needed thrust to the nine pillars of growth areas, namely:

1. Broadband Highways
2. Universal Access to Mobile Connectivity
3. Public Internet Access Programme
4. e-Governance: Reforming Government through Technology
5. e-Kranti - Electronic Delivery of Services
6. Information for All
7. Electronics Manufacturing
8. IT for Jobs
9. Early Harvest Programmes

The vision areas of Digital India:

I Infrastructure as Utility to Every Citizen:

(i) High speed internet as a core utility shall be made available in all Gram Panchayats.

(ii) Cradle to grave digital identity - unique, lifelong, online and authenticable.

(iii) Mobile phone and bank account would enable participation in digital and financial space at individual level.

(iv) Easy access to a Common Service Centre within their locality.

(v) Shareable private space on a public cloud.

(vi) Safe and secure cyber-space in the country.

II Governance and Services on Demand:

(i) Seamlessly integrated across departments or jurisdictions to provide easy and a single window access to all persons.

(ii) Government services available in real time from online and mobile platforms.

(iii) All citizen entitlements to be available on the cloud to ensure easy access.

(iv) Government services digitally transformed for improving Ease of Doing Business.

(v) Making financial transactions above a threshold, electronic and cashless.

(vi) Leveraging GIS for decision support systems and development.

III Digital Empowerment of Citizens:

(i) Universal digital literacy.

(ii) All digital resources universally accessible.

(iii) All Government documents/ certificates to be available on the cloud.

(iv) Availability of digital resources / services in Indian languages.

(v) Collaborative digital platforms for participative governance.

(vi) Portability of all entitlements for individuals through the cloud.

Scope of Digital India:

(i) to prepare India for a knowledge future,

(ii) on being transformative that is to realize IT (Indian Talent) + IT (Information Technology) = IT (India Tomorrow),

(iii) making technology central to enabling change,

(iv) on being an Umbrella Programme – covering many departments:

- The programme weaves together a large number of ideas and thoughts into a single, comprehensive vision, so that each of them is seen as part of a larger goal. Each individual element stands on its own, but is also part of the larger picture.
- The weaving together makes the Mission transformative in totality.

(v) The Digital India Programme will pull together many existing schemes which would be restructured and re-focused and implemented in a synchronized manner. The common branding of the programmes as Digital India highlights their transformative impact.

Approach and methodology:

i Ministries / Departments / States would fully leverage the Common and Support ICT Infrastructure established by the Government of India.

ii The existing/ ongoing e-Governance initiatives would be revamped to align them with the principles of Digital India. Scope enhancement, Process Reengineering, use of integrated & interoperable systems and

deployment of emerging technologies like cloud & mobile would be undertaken to enhance delivery of Government services to citizens.

iii States would be given flexibility to identify for inclusion additional state-specific projects, which are relevant to their socio-economic needs.

iv e-Governance would be promoted through a centralised initiative to the extent necessary, to ensure citizen centric service orientation.

v Successes would be identified and their replication promoted proactively.

vi Public Private Partnerships would be preferred wherever feasible.

vii Adoption of Unique ID would be promoted to facilitate identification, authentication and delivery of benefits.

viii Restructuring of NIC would be undertaken to strengthen the IT support to all government departments at the Centre and State levels.

ix The positions of Chief Information Officers (CIO) would be created in at least 10 key ministries so that various e-Governance projects could be designed, developed and implemented faster.

x DeitY would create necessary senior positions within the department for managing the programme.

xi Central Ministries / Departments and State Governments would have the overall responsibility for implementation of various Mission Mode and other projects under this Programme. Considering the need for overall aggregation and integration at the national level, it is considered appropriate to implement Digital India as a programme with well defined roles and responsibilities of each agency involved.

5.2 GI Cloud Eco-system

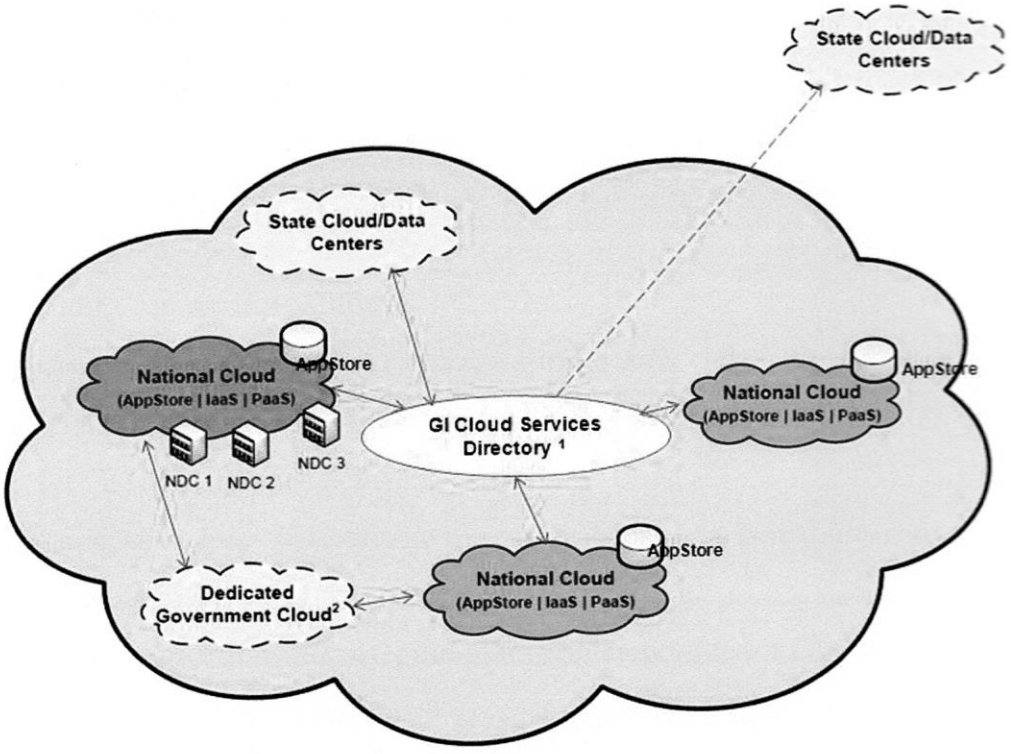
Government of India's objectives in adopting a cloud computing strategy is as follows:

- Optimum utilization of infrastructure,
- Speeding up the development and deployment of eGov applications,

- Easy replication of successful applications across States to avoid duplication of effort and cost in development of similar applications, and
- Availability of certified applications following common standards at one place.

The architectural vision of GI Cloud centres on a set of discrete cloud computing environments spread across multiple locations, built on existing or new (augmented) infrastructure, following a set of common protocols, guidelines and standards issued by the Government of India. This architecture uses the existing infrastructure of NeGP such as the National Data Centres (NDCs) and State Data Centres (SDCs), the network backbones available through State Wide Area Networks (SWAN), National Knowledge Network (NKN), NICNET and the middleware gateways e.g. National Service Delivery Gateway (NSDG), State Service Delivery Gateways (SSDG).

A schematic representation of the GI Cloud Environment is given below:



1 Single Portal for Service Delivery
2 Built by private cloud providers

(Source: DeitY Website)

Figure 5.1: GI Cloud Environment

The architecture of GI cloud is based on the creation of discrete cloud computing environments at the national and state levels termed as 'National Clouds' and 'State Clouds' respectively. While one of the National Cloud is built utilizing the infrastructure available under the NDCs, the other clouds at the national level are established with new or augmentation of existing data centres available at the state levels. Based on the demand assessment and taking into account security related considerations, government also engage the services of private cloud providers.

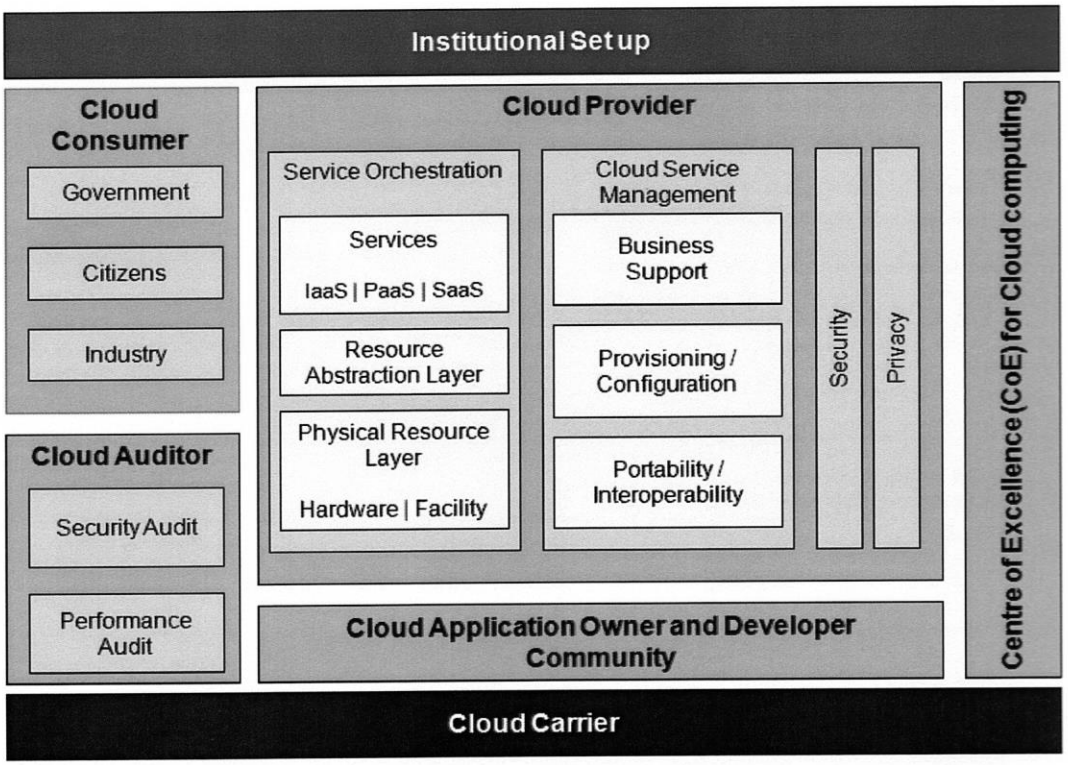
In line with the architectural vision, the figure here provides an overview of the GI Cloud wherein in addition to the establishment of multiple National Clouds; willing State Clouds built on state data centres can also become part of the GI Cloud environment and publish their cloud services in the GI Cloud Services Directory. There may be states and union territories with their own SDCs and State Clouds existing outside the GI Cloud. Over a period of time, the IT infrastructure across the country is expected to be consolidated and interconnected.

Deriving from the architectural vision, GI Cloud is envisaged to include the following components:

- Cloud computing platforms
- Common platform to host and run applications - eGov AppStore
- GI Cloud Services Directory that will act as the single window or portal for GI Cloud service delivery
- Integrated infrastructure acting as a backbone for delivering cloud services
- Common set of protocols, guidelines and standards for GI Cloud
- The institutional mechanism consisting of an Empowered Committee and Architecture Management Office
- Centre of Excellence for cloud computing

The Conceptual Reference Model of NIST has been referenced for depicting the high-level eco-system of GI Cloud. The eco-system of the GI Cloud identifies the major actors, their activities and roles in the envisaged cloud computing environment.

The GI Cloud eco-system defines eight key actors in the envisaged GI Cloud Environment (as defined under the section 'GI Cloud Architecture'). These actors include: the Institutional Set up, Cloud Consumer, Cloud Provider, Cloud Auditor, Cloud Carrier, Centre of Excellence (CoE) for Cloud Computing and Cloud Application Owner and Developer Community.



(Source: DeitY Website)

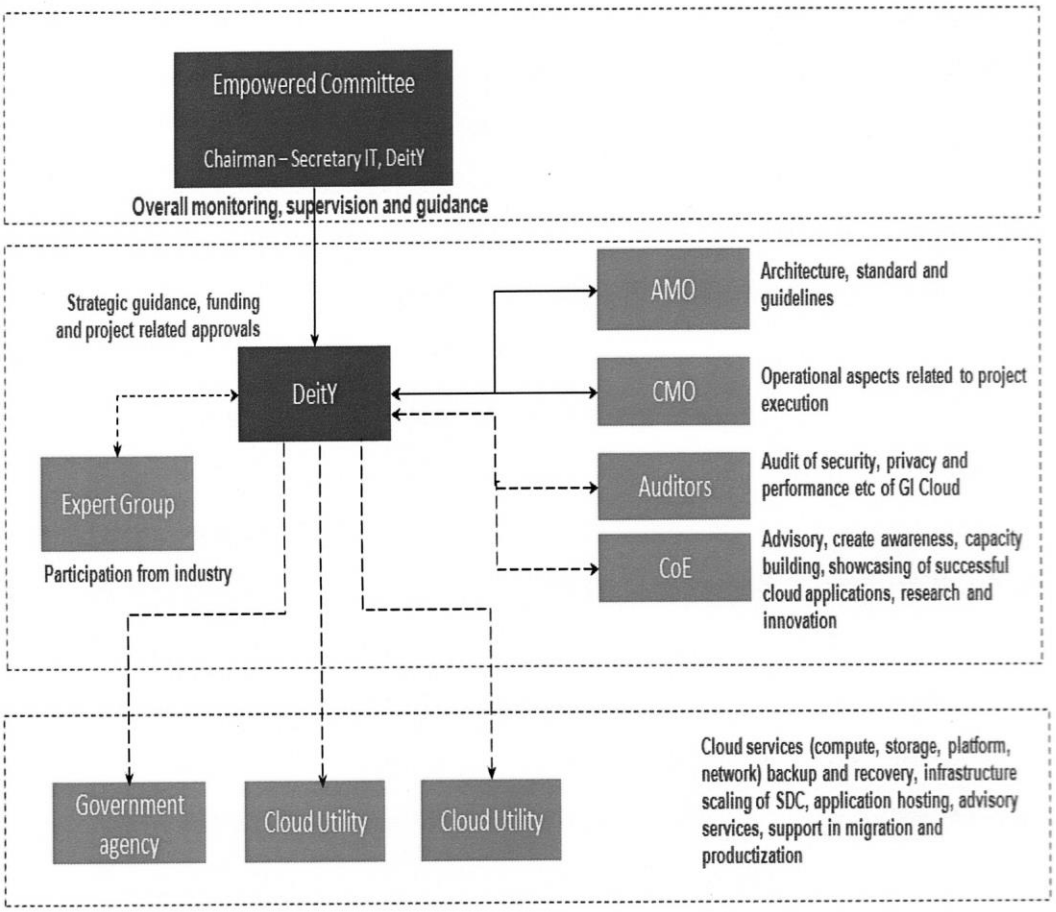
Figure 5.2: GI Cloud Eco-System

Each of these actors is an entity (a person or an organization) or a community that participates in the eco-system, and has specific roles and performs specific tasks.

5.2.1 The Institutional Set up

The institutional set up for GI Cloud is represented in the figure and consists of the following:

- Empowered Committee
- Architecture Management Office (AMO)
- DeitY is the administrative department responsible for implementation and monitoring of the entire GI Cloud initiative. DeitY will be assisted by Expert Group, CoE, Auditors, Cloud Management Office etc.



(Source: DeitY Website)

Figure 5.3: GI Cloud Institutional Set up

5.2.1.1 The Empowered Committee

The Empowered Committee for GI Cloud is a committee with decision making and approval authority formed under the Chairmanship of Secretary, DeitY, with representation from Central/State ministries and other government entities. The Empowered Committee is serviced by DeitY. Major functions of the Empowered Committee include the following:

- Setting vision
- Providing strategic and regulatory direction and guidance to all the stakeholders

- Laying down common set of guidelines and standards for GI Cloud
- Dispute resolution and timely intervention as and when required

5.2.1.2 Department of Electronics and IT (DeitY)

It is envisaged that DeitY will primarily have three functions - policy and strategic direction, operational management, architecture guidelines and standards creation. Separate specialized units have been established such as the Architecture Management Office (AMO) to assist in formulation of architecture guidelines and standards and Cloud Management Office (CMO) responsible for management and monitoring of the entire GI Cloud initiative. DeitY functions under the strategic guidance of the Empowered Committee and has the following major functions:

- Policy formulation and enforcement
- Steer the GI Cloud initiative
- Demand assessment for the GI Cloud
- Provide seed funding to the agencies for establishment of the National Clouds and the Cloud Utilities
- Monitoring and supervision of the operations of AMO and CMO
- Other approvals related to project execution and funding
- Approval where required for hosting applications on the eGov AppStore
- Capacity building, change management and awareness creation exercise
- Creation of CoE for GI Cloud

Cloud Management Office (CMO)

The CMO acts as a Program Management Office of DeitY and closely works with AMO, the government agency and the respective Cloud Utilities to ensure smooth implementation and operations of the GI Cloud eco-system. The CMO reports directly to DeitY and helps in co-ordination, management and monitoring of the entire GI Cloud initiative. Major functions of CMO include the following:

- Handling of day-to-day operational aspects related to project execution
- Defining the operational model for all Cloud Utilities

- Assistance in management of disbursal of funds
- Conduct follow-ups, monitoring progress and regular reporting to the Empowered Committee
- Participate in Empowered Committees and other stakeholder forums as needed to ensure alignment with GI Cloud strategy

Architecture Management Office (AMO)

In order to assist DeitY to realize the complete architecture vision of GI Cloud and ensure standardisation across technology, platform and standards the AMO has been established. The AMO will define and implement architecture guidelines and standards specific to GI Cloud. Major functions of AMO include the following:

- Developing the GI Cloud reference architecture
- Defining guidelines for new application development, architecture, standards, RFP, SLA, contract management, etc in consultation with industry and based on international best practices

5.2.1.3 GI Cloud Expert Group

In addition to the Empowered Committee and the various units supporting DeitY, It is proposed to create a 'GI Cloud Expert Group' with experts from the industry to deliberate on the standards/ guidelines prepared by AMO. Major functions of the Expert Group include the following:

- Assistance in development of policies/ guidelines
- Providing inputs in development / implementation of the GI Cloud components
- The expert group will also provide inputs in the various capacity building exercises to be conducted as part of the GI Cloud initiative

5.2.2 The Cloud Consumer

The Cloud Consumer is the principal stakeholder that uses or consumes the GI Cloud services. The Cloud Consumer browses the GI Cloud Services Directory, requests the appropriate service, sets up service contract with the

respective cloud provider and uses or consumes the service. Based on the services consumed from the GI Cloud, the cloud consumer may need to arrange for payments. Consumers of the envisaged GI Cloud include citizens, government departments, line departments and agencies at the central and state levels.

5.2.3 The Cloud Provider

The Cloud Provider is an entity that is responsible for operating the respective cloud environment and makes available GI Cloud services to interested parties. Responsibilities of the cloud provider include the following:

- Acquiring and maintaining infrastructure required for providing services
- Implementing measures for adherence to cloud standards
- Operating the respective cloud computing environment
- Protecting the security and privacy at required levels
- Providing cloud computing services and service elastic workloads based on the requirement of cloud consumers
- Adhering to service level agreement (SLA)
- Issuing bills and collect payments
- Executing contract management
- Forecasting demand for cloud services
- Following the government of India laid policy guidelines and standards

The Cloud Utilities will act as the service providers of the GI Cloud through the respective cloud computing environments at the national level. It is envisaged that Cloud Utilities will be independent entities and will sustain themselves by earning profits. Major role of the Cloud Utilities for other clouds at national level includes the following:

- Acquiring or using existing infrastructure for set up (including the respective eGov AppStores)
- Running, operating and managing entire operations
- Provisioning of services (IaaS, PaaS and SaaS)

- Identification and selection of application for hosting on the respective eGov AppStores
- Developing new applications and provide them as service
- Providing support services for application development
- Training of staff and handholding after cloud migration

5.2.4 The Cloud Auditor

The remedial actions and steps based on the audit reports shall be taken for which responsibilities of the Cloud Auditor are as follows:

- Conducting independent audit of security, privacy and performance of GI Cloud
- Risk and compliance assessment to determine alignment to regulatory mandates
- Publishing independent audit report
- Certifying the cloud environments as per Government of India defined norms and guidelines

5.2.5 The Cloud Carrier

The Cloud Carrier acts as an intermediary and provides the network connectivity backbone for transport of cloud services between cloud consumers and cloud providers of GI Cloud.

5.2.6 The Centre of Excellence for Cloud Computing

As the concept of cloud computing is new and ICT capacity is low in Government agencies, Centres of Excellence (CoE) are essential for realising the cloud computing vision of the Government. The CoE's role is crucial in terms of capability building, providing advisory and spreading awareness within the Government about cloud and its benefits apart from international collaboration and coordinating research and development in this area. The CoE has also been entrusted with the task of housing the Architecture Management Office (AMO). The role of the CoEs is to provide the following services:

- Advisory Services: This includes providing advisory services to various departments and agencies at central and state level for migration of the existing applications and development of new applications using the cloud computing technologies. The activities also include the following:
  - Providing strategic advice in the design and implementation of cloud-based applications to the government departments and states
  - Design cloud roadmap for the government departments and agencies
  - Supporting the central and state governments in designing large cloud computing projects cutting across departments and ministries, developing models and framework for monitoring and evaluation of projects, etc.
- Awareness Creation: This includes creation of awareness of cloud computing across the Government departments and agencies in central and state level. The activities also include:
  - Showcasing of successful cloud technologies and applications
  - Conducting workshops, orientation sessions etc.
- Capacity Building: This includes establishing an institutional framework, engaging personnel with required skill sets and experience and upgrading internal skill sets through training. The activities also include the following:
  - Institutional capacity building
  - Developing institutional partnerships and knowledge management
  - Training and change management programmes, etc.
- Research and innovation: This includes research and development activities into critical areas of cloud computing like inter-operability, data portability, standards, etc. The activities also include the following:
  - Collaboration and liaison with international research bodies and agencies like NIST, etc.
  - Developing expertise in various cloud platforms, establishing SLAs, porting different applications on different platforms making these platforms interoperable with each other
  - Creating the best practices and guidelines

5.2.7 Cloud Application Owners and Developer Community

Cloud Application Owners and Developer Community are government or private entities and communities that provide or develop reusable cloud ready applications that can be hosted on the GI Cloud environment for use by the consumers of GI Cloud.

5.3 Cloud services offerings by private cloud service providers

The Cloud computing market in India is growing rapidly and gaining importance. While new, innovative and successful vendors are emerging, traditional vendors are also investing massively in developing and acquiring on demand solutions. In the SaaS segment, the strongest markets in terms of size and growth are Content, Communication and Collaboration (CCC), Customer Relationship Management (CRM), Integration-as-a-Service, Enterprise Resource Planning (ERP), and Supply Chain Management (SCM). The use of SaaS, PaaS and IaaS has been evolving during the past years and has become increasingly popular.

Numerous information technology firms in India are moving aggressively into cloud services, across all three service models (SaaS, PaaS, and IaaS). Some are "pure play" cloud specialists—cloud services are their core or only offerings while others are providing umbrella services offering a wide spectrum of services all clubbed together.

When cloud computing and its new delivery model surfaced a few years ago, information technology companies in India feared that traditional sources of revenue such as application development, application maintenance and implementation would be massively impacted. It's true that there has been some impact to traditional service industry revenues; but the cloud has also opened up new revenue opportunities for Indian service providers. Indian information technology companies are smartly converting the cloud threat into an opportunity – by delivering traditional services via cloud, developing new products, capabilities and strategies. India's IT industry leaders have responded to the growth of customers' interest in cloud computing by developing their own

cloud offerings. The firms have portrayed themselves as experts at assisting clients in their transition to the cloud. The firms' services include integration of IT operations across in-house data centres and cloud infrastructure, movement ("migration") of data to the cloud, and development of customized applications, disaster recovery (DR) services, compute services and managed hoisting services amongst numerous other offerings. IT companies have also exemplified another route to success in the cloud market: partnering with multinational market leaders.

Indian service providers are 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. Also, the service providers are expecting a bulk of its revenue to come from small and medium businesses (SMEs), especially in emerging markets. Service providers have taken note and are offering holistic solutions, positioning themselves as comprehensive cloud service providers. These companies are launching several products that would focus on the SME segment. Traditional services are also being offered over the cloud such as Testing-as-a-Service. This in turn is helping service providers in increasing revenues from the cloud.

Large enterprises in the telecom sector are also exploring the agility offered by cloud environments. The telecom service providers are leveraging technology to offer hosted Software applications to the small and large enterprises on a pay-as-you-go model. Witnessing the vast potential of cloud environment to fast-track service delivery, some of the operators have also forged strategic partnerships to start a spectrum of cloud offerings including a software applications portfolio.

The GI Cloud specifically focuses on setting up an eco-system for cloud adoption by the Government. However, for private cloud offerings there is no generalised and documented eco-system in place. Many cloud service providers are offering services which can be compared by the prospective customers and used as per their needs.