Cloud Adoption Model for Governments and Large Enterprises

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ABSTRACT

Cloud Computing has held organizations across the globe spell bound with its promise. As it moves from being a buzz word and hype into adoption, organizations are faced with question of how to best adopt cloud. Existing frameworks of cloud adoption look at different aspects of cloud but stop short of taking a view of the complete spectrum and suggesting a path.

Cloud Computing adoption requires that organizations have readiness on multiple dimensions including Governance, Process Analysis and Improvement, Application Rationalization and Modernization, and Hardware and Software Standardization. Readiness in turn determines how far organizations can go in their cloud programs with key milestones being Proof of Concepts, Infrastructure Service, Virtual Desktop, Platform Service and Enterprise Software as Service. Readiness and Milestones inform us about multiple stages in cloud adoption. The analysis also indicates that certain governance structures are most suitable for cloud adoption. The duration of cloud program for a large organization lies in years, even multiple five year plans.

Analyses of case studies indicate all these views and the systems modeling for enterprise software as service, in addition corroborates the likely duration of cloud program. For systems model we have used factors such as Total Non-Cloud Applications, Rationalization and Modernization Rate, Rate of Conversion into Enterprise Software as Service and Budget.

The proposed Cloud Computing Adoption Model can help organizations understand what capabilities they need to develop, where they are on the cloud adoption spectrum and how much time it could take to go to cloud.

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Prof Madnick was generous with his time to listen to my numerous status updates, sit through interim presentations, question my assumptions and thought process, and helped me stay focused. Allen shaped this research by ensuring academic rigor, thorough literature review, hours of thought provoking discussion, and sharing key resources. Allen also secured interviews with Large Financial Institution and Large AV Manufacturer, studied as part of this research, and made it a point to be present in each of those conversations.

I am grateful to the people from the organizations studied who agreed to speak with me, discuss about cloud computing in general and give information about cloud computing programs within their organizations. Their contribution forms the basis of the view that this thesis puts forth.

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Acronyms

CIA - Central Intelligence Agency
COTS - Commercial off The Shelf
DIA - Defense Intelligence Agency
DNI - Director of National Intelligence
EA - Enterprise Architecture
FBI - Federal Bureau of Investigation
FOC - Full Operating Capability
IaaS - Infrastructure as a Service
IC - Intelligence Community
IC ITE - Intelligence Community Information Technology Enterprise
ICT - Information and Communications Technology
IDA - Info-Communications Development Authority
IOC - Initial Operating Capability
LAM - Large AV Manufacturer
LFINT - Large Financial Institution
NDC - National Data Center
NGA - National Geospatial-Intelligence Agency
NIC - National Informatics Center
NIST - National Institute of Standards and Technology
NSA - National Security Agency
OS - Operating System
PaaS - Platform as a Service
PMO - Program Management Office
PoC - Proof of Concept
RFP - Request for Proposal
SaaS - Software as a Service
SHINE - Supply, Support and Maintenance of Service Wide Hosting Service
SOE - Standard ICT Operating Environment
TOE - Technology Organization Environment
UNDP - United Nations Development Program
USIC - United States Intelligence Community
WOG EA - Whole-of-Government Enterprise Architecture

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1 INTRODUCTION

The advent of Computing revolutionized postindustrial society and Cloud Computing shows signs of revolutionizing the information society. Cloud Computing has been very often portrayed and perceived as a new technology but it is also widely accepted as evolution of technologies such as client server architecture, World Wide Web, and networking. Some even call it mainframe 2.0.

In 1960s mainframes were used for computing and transaction processing with users accessing the computing resources through 'dumb terminals'. 1980s saw the advent of protocols for networking and client server architecture. "The ability to connect users to computing and data resources via standardized networks emerged as a key enabler of cloud computing" (The Defense Science Board). The World Wide Web and the Internet followed in the 1990s along with enablers such as web browsers. The decade also saw the emergence of application service providers, offering software packaged as service over the internet. Refer Figure 1 for graphic on evolution of computing.

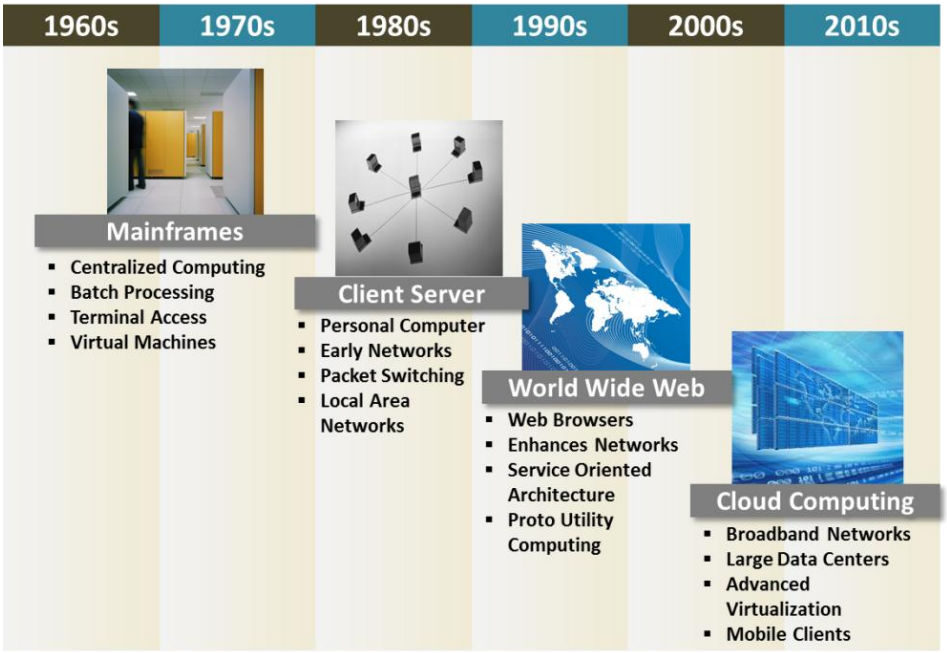

Figure 1: Evolution of Cloud Computing (The Defense Science Board)

"Cloud computing has been enabled by the availability of broadband networks and inexpensive end-user devices, as well as commodity computing nodes that can be simply interconnected and controlled, and virtualization to provide the appearance of isolating processes that share computers" (The Defense Science Board).

Given the evolutionary nature of Cloud Computing, it could mean different things and thus it is prudent to pay attention to definition of Cloud Computing.

"Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or cloud provider interaction" (Information Technology Laboratory - National Institute of Standards and Technology). NIST also lays down Essential Characteristics, Service Models, and Deployment Models as shown in Figure 2.

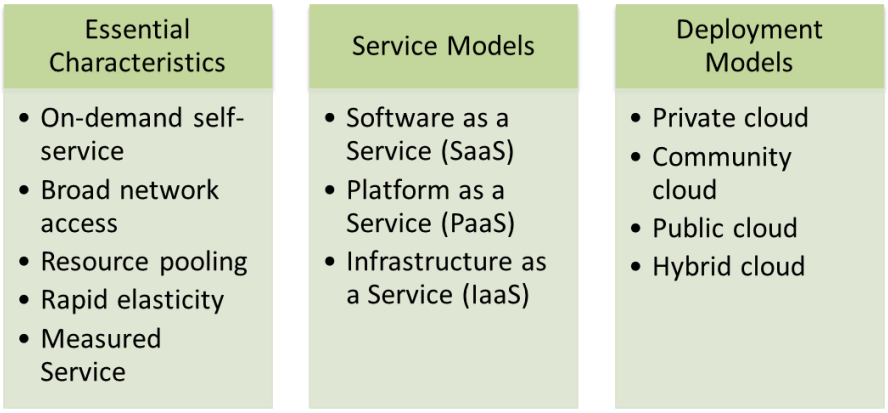

Figure 2: Essential Characteristics, Service Models, and Deployment Models of Cloud (NIST)

1.1 Cloud Computing Trends

Cloud Computing is one of the most talked about technology trends of the last decade. Enterprises claim to be on the path to being cloud centric, vendors speak about cloud strategy, and industry analysts spend their time following the cloud revolution.

All these can be taken as signs of hype, which might be tapering off as organizations get serious about cloud, and experience its true benefits and challenges. Industry and analysts alike expect cloud to become main-stream not immediately but over the course of next several years. Refer Figure 3 for Hype Cycle (Smith).

Cloud Computing as Complement: Enterprises see Cloud Computing as complementary to their existing infrastructure, not as replacement (Kisker). This affords them the flexibility to harness the benefits of cloud and reap returns on the investments that they have already made.

Increased Spending on Cloud: Governments, Public Sector and Private Enterprises alike are either gradually allowing Cloud Computing to percolate into their structure, processes and infrastructure or are initiating programs which help them build on their past programs and realize the benefits of cloud. It also means that they are allocating budgets or increasing spend on Cloud Computing related

programs. “Worldwide spending on public IT cloud services will be more than $40 billion in 2012 and is expected to approach $100 billion in 2016” (IDC).

PaaS Emerges Out of the Shadows: SaaS (e.g., Salesforce.com) and IaaS (e.g., Amazon EC2) have come to be recognized as key cloud services and there are expectations that PaaS (e.g., Salesforce.com Appexchange) offerings will grow “as the market moves up the software stack” (IDC).

Governments and Public Sector lag Private Sector: Government and the public sector are behind the private sector across all aspects of adopting cloud including developing strategy, proof of concept, and staged implementation (KPMG). Governments and public sector see security as a key concern to be addressed. Governments in Australia, Japan, Singapore, UK and US are pursuing or initiating cloud programs and these programs have been closely followed by industry analysts.

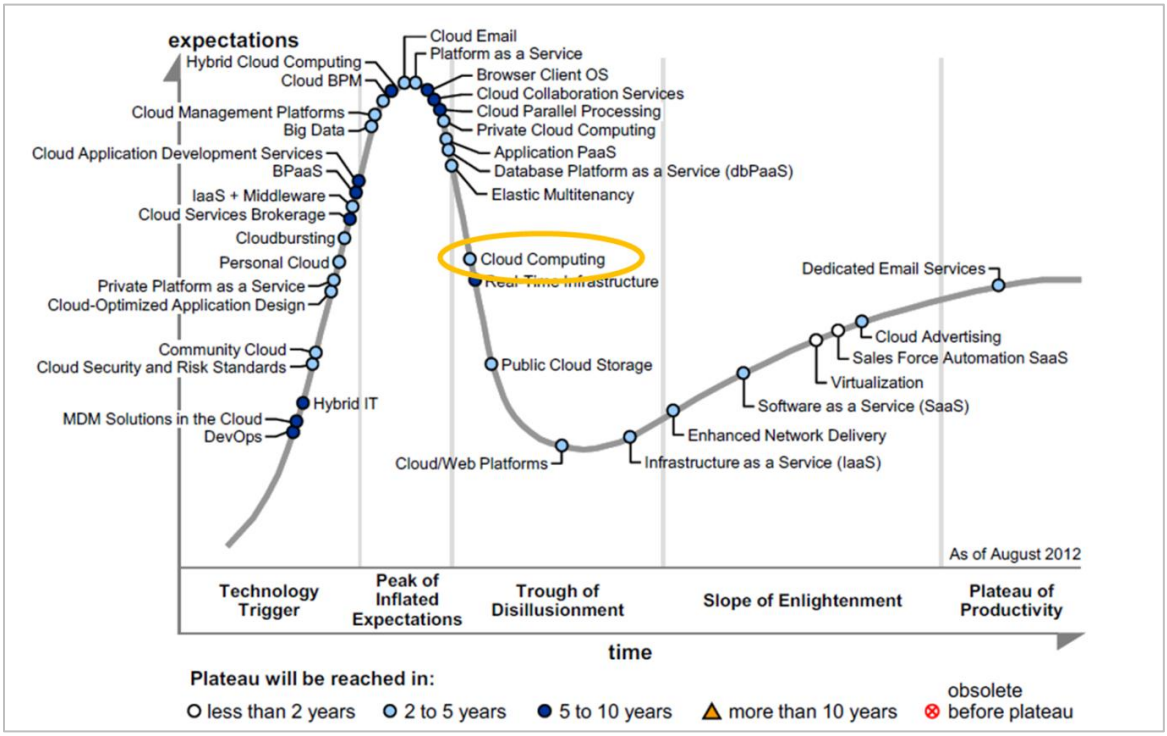

Figure 3: Hype Cycle for Cloud Computing 2012 (Smith)

1.2 CLOUD COMPUTING ADOPTION

Spurred on by industry trends, Cloud Computing - Cloud - has gradually found traction amongst small and medium businesses, large enterprises and now governments and public sector. New businesses increasingly look to start in the cloud. The efforts of enterprises and public sector are finding resonance amongst vendors across all cloud service categories. Cloud adoption is almost equally being driven from the top and bubbling up from the bottom.

BENEFITS

Governments, local authorities, public sector organizations, and entities cutting across for profit and nonprofit spectrum intend to become Faster, Better, and Cheaper when they go in for Cloud Computing.

Enterprises seek operational agility, improvement in business processes, higher business user satisfaction, lower costs, and infrastructure scalability from their cloud programs (Kisker). There might even be a perceptible change in expectations from cloud taking place as enterprises go through the process of cloud adoption as indicated in Figure 4.

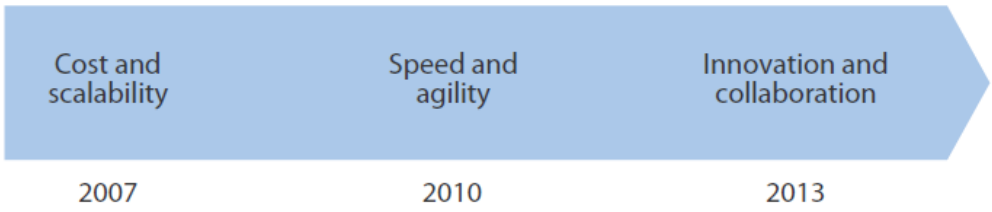

Figure 4: Cloud Agenda Evolution (Kisker)

Though governments and public sector have tempered expectations from cloud, the benefits which they look forward to are; transparency, reduced costs, and better interaction with citizens and suppliers (KPMG).

CHALLENGES

The adoption of cloud is all but a smooth ride. Cloud is a threat to traditional power and organizational structures in a firm as business units can bypass IT organization to procure required IT services viz., infrastructure, applications over cloud, a phenomena termed by firms as Shadow IT (groups within agencies setting up their own IT infrastructure or contracting independently with third party service providers). IT organizations in turn try to assert their presence through enforcement of policies. As a silver lining, progressive CIOs see cloud as an opportunity to convert the IT organization into a revenue center.

Other challenges in adoption of Cloud Computing are articulating a clear vision, creating a good business case, establishing quick wins, and having experienced resources. Security is a concern with almost every entity on cloud or looking to be in cloud.

1.3 CLOUD COMPUTING ADOPTION ISSUES AND STUDY OBJECTIVE

Cloud Computing is helping enterprises and public sector address issues of cost, efficiency, flexibility, and scalability among others but at the same time is also raising many questions.

How should government, public sector or a large enterprise go about adopting cloud? Is there a particular path to be followed? Are certain steps necessary to cloud adoption process? Do certain characteristics define organizations in the process of cloud adoption? Should certain competencies be

developed for successful move to cloud? How do different organizations at different stages of cloud adoption look different from each other? Are there any examples to refer to?

The objective of this thesis is to answer these questions by studying in depth large enterprises and governments which are either thinking of moving to the cloud or have taken steps to adopting cloud, identify any emerging patterns, explore drivers of cloud computing, and craft a model for cloud computing adoption.

I lay emphasis on governments because literature on cloud computing adoption with governments in perspective is lacking. Governments merit academic attention because they are complex institutions, largest employers across globe, and one of the biggest spenders on technology, but have not been at forefront of cloud computing.

1.4 THESIS STRUCTURE

This thesis is organized into seven chapters in addition to introductory Chapter 1. Chapter 2 lays out the research methodology to acquaint the reader with the multi-dimensional research conducted. Chapter 3 gives a snapshot of the literature survey including definitions of cloud computing, cloud computing adoption models and appropriate theoretical construct to organize the study. Chapter 4 contains detailed case studies of organizations studied. Chapter 5 contains inferences from the case studies, assessment of cloud programs of the organizations, and proposed model for cloud adoption for a large organization. Chapter 6 contains systems models of cloud adoption, simulation model for enterprise software as service and simulation results. Chapter 7 presents conclusion from the study and Chapter 8 identifies areas of future work.

2 RESEARCH METHODOLOGY

The introduction gave a flavor of the multiple dimensions of Cloud Computing including some of the questions which this thesis attempts to answer. Before we get into discussion of Cloud Computing and its adoption, it shall be worthwhile to review the study approach.

In this study an attempt has been made to broad base the research and use a multi-pronged approach. The study derives its insights from a combination of primary research, secondary research and systems modeling as depicted by Figure 5.

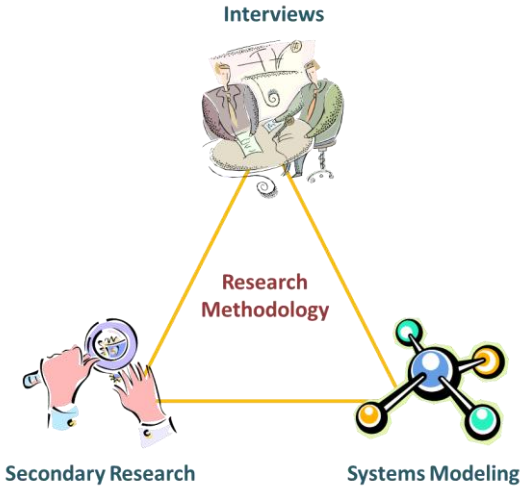

Figure 5: Research Methodology

Cloud Computing is a constantly evolving domain, and the very nature of this evolution necessitates starting with a definition of cloud computing. The author reviewed literature to identify a definition which could stand the test of time and change.

Identifying a definition was an important task, as the definition will determine what cloud can look like and how organizations can get to that. In addition industry experts were interviewed to develop broader understanding of evolution of cloud, adoption pattern and trends.

We also reviewed literature on cloud adoption and maturity models. Existing cloud adoption and maturity models provide a foundation for further cloud related work. Each of the models has been mapped on an evaluation matrix, and it informs us about the strengths and improvement opportunities of the models.

Perhaps the most important element of this study was identifying cloud adoption examples, creating case studies and drawing inferences. We were able to identify examples for different stages of cloud adoption. The examples are from large public enterprise and government categories. Each of these

examples was researched in detail by studying information available in working papers, on the internet, in reports published by Industry Analysts, in publications of the governments and associated agencies, in articles published in Journals of repute, and whitepapers published by enterprises associated with cloud computing. We looked at cloud adoption information, including IT initiatives for the last 10 years.

We interviewed (refer Appendix 9.1 for questionnaires used) key persons associated with cloud programs in each of these examples. They came from a mix of business and IT functions. The questions addressed a range of issues including business goals and strategy, execution and program management, benefit realization and measurement of success, and organizational readiness and risk mitigation from the perspective of cloud adoption.

Findings distilled from the case studies and accompanying analysis yielded an adoption model. The adoption model was created after identifying distinct characteristics for each of the accompanying stages, mapping characteristics to Adoption and Readiness dimensions, determining ballpark time associated with the stages and bringing a logical flow from one stage to another. The examples were examined through the lens of the adoption model by ranking them on each of the Adoption and Readiness dimensions. This examination yielded an Adoption Readiness matrix with the examples mapped with respect to each other.

Using information from case analysis, the organizations have also been mapped onto generic governance structures, as laid out by Weill (Weill and Ross, IT Governance: How Top Performers Manage IT Decision Rights for Superior Results). This mapping gives us clues about the governance model most suitable for cloud adoption.

As final part of the study, the adoption model and other insights were evaluated through systems modeling. Key parameters influencing the move to cloud, as evidenced by the examples, were mapped in stock flow diagrams (Infrastructure Service, Platform Service and Enterprise Software as Service), which contained balancing and reinforcing loops. Stock flow diagram for Enterprise Software as Service was developed into a systems model. Various simulations of different scenarios were run using the model and key inferences from the adoption model were tested.

The study concludes by summarizing the key findings and suggesting areas of further investigation and research.

3 LITERATURE REVIEW

Cloud has over the last few years conquered the consciousness of businesses and is gradually getting translated into action. Now-a-days there are mandates to go to cloud, programs which are centered on going to cloud, some enterprises are in the cloud to a great extent, and increasingly firms, especially in Small and Medium Business segment, are starting in the cloud. As cloud gets increasing traction, the literature is also developing. Cloud definitions present a logical starting point and of particular interest to this study is the literature on Cloud Maturity and Adoption Models.

3.1 CLOUD COMPUTING DEFINITIONS

Literature offers many Cloud Computing definitions. These definitions cover a spectrum of perspectives and come in various degrees of detail. Gartner's definition of cloud mentions about scalability, elasticity, and delivery as service. Forrester's definition indicates abstraction, scalability, hosting and billing. IDC has likened Cloud Computing to emerging IT model, and mentions real time delivery over the Internet. Communications of ACM differentiates between public and private clouds, and presents the view that cloud is data center hardware and software. NIST offers a definition which is detailed and talks about different types of computing resources, characteristics of Cloud Computing, and associated service modes and deployment models. For the purpose of this study we shall use the NIST definition of Cloud Computing. The definitions are given below.

Gartner: Style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies (Gartner).

Forrester: A pool of abstracted, highly scalable, and managed compute infrastructure capable of hosting end customer applications and billed by consumption (Staten).

IDC: An emerging IT development, deployment and delivery model, enabling real-time delivery of products, services and solutions over the Internet (i.e., enabling cloud services) (Gens).

Communications of the ACM: The data center hardware and software is cloud. When a cloud is made available in a pay-as-you-go manner to the general public, it is a public cloud; the service being sold is utility computing. Private cloud refers to internal data centers of a business or other organization, not made available to the general public, when they are large enough to benefit from the advantages of Cloud Computing (Armbrust).

NIST: Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or cloud provider interaction (Information Technology Laboratory - National Institute of Standards and Technology).

3.2 CLOUD ADOPTION MODELS

Organizations across business and public sector spectrum are either moving to the cloud or thinking about cloud. As this happens, literature has developed around Cloud Adoption Models. These models inform us about the multi-dimensional nature of Cloud Adoption and on closer examination also reveal the need for a comprehensive model to address the observed lacunae. Key Cloud Adoption models are discussed below.

(Alvarez, Staten and McKee) put forth the ideas that 'cloud strategy requires both private and public cloud services' and 'operational maturity is needed for cloud success'. It presents one maturity model each for private and public clouds. The private cloud maturity model, given in Figure 6, is made up of 'Acclimation' which is the familiarization phase for organizations, 'Strategic Consolidation' involves consolidating infrastructure through virtualization, 'Process Improvement' deals with standardizing processes and increasing efficiency, and 'Private Cloud' talks of meeting needs of the organization through virtualized resources.

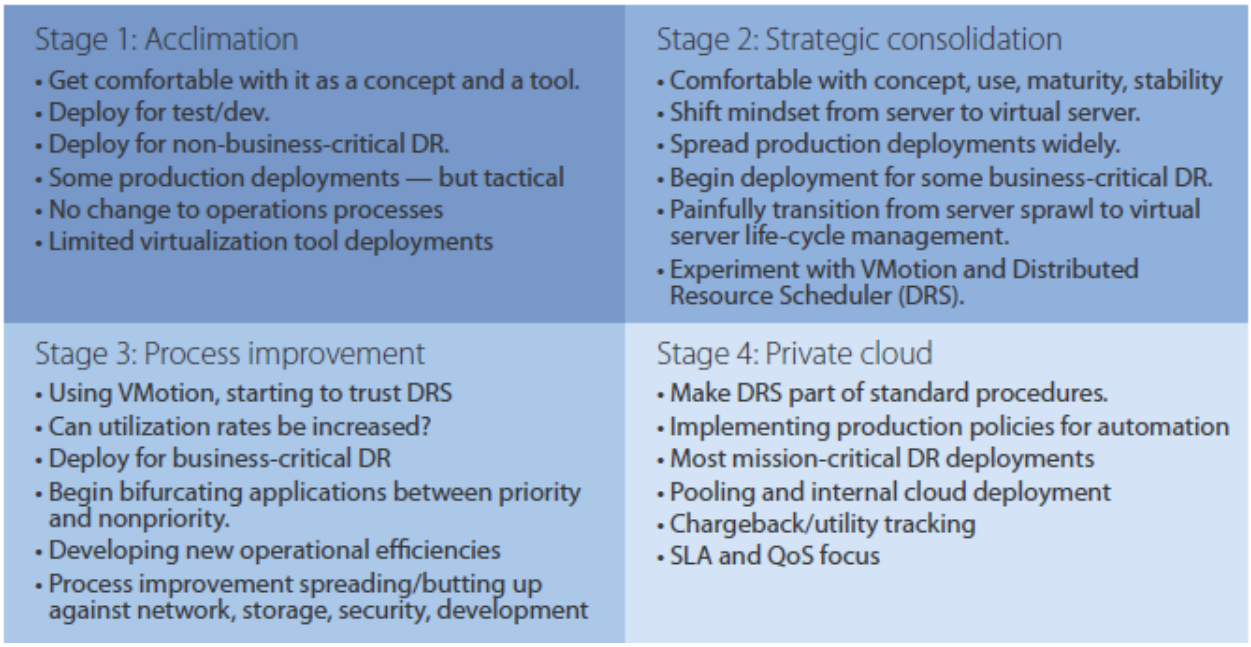

Figure 6: The Four Stages of Maturity for Private Cloud (Alvarez, Staten and McKee)

The Private and Public Cloud models are made to come together at a 'Fifth Stage'. The model paints clear picture of what needs to be done but only of the technical side. It does not take into account organizational dynamics, governance structure, cultural change, and IT landscape among others. The model does not indicate how long it could take to execute a cloud program or key milestones.

(Mattoon, Hensle and Baty) have outlined their thinking on cloud adoption and maturity and elaborate on domains (Business & Strategy, Architecture, Infrastructure, Information, Projects / Portfolios / Services, Operations / Administration / Management, Organization, Governance; also

shown in Figure 7) which organizations need to progress in cloud adoption. They have outlined maturity and adoption spectrums. The model covers a number of aspects critical to cloud adoption but still misses out on key areas such as landscape rationalization, organizational change management, and has superficial reference to governance.

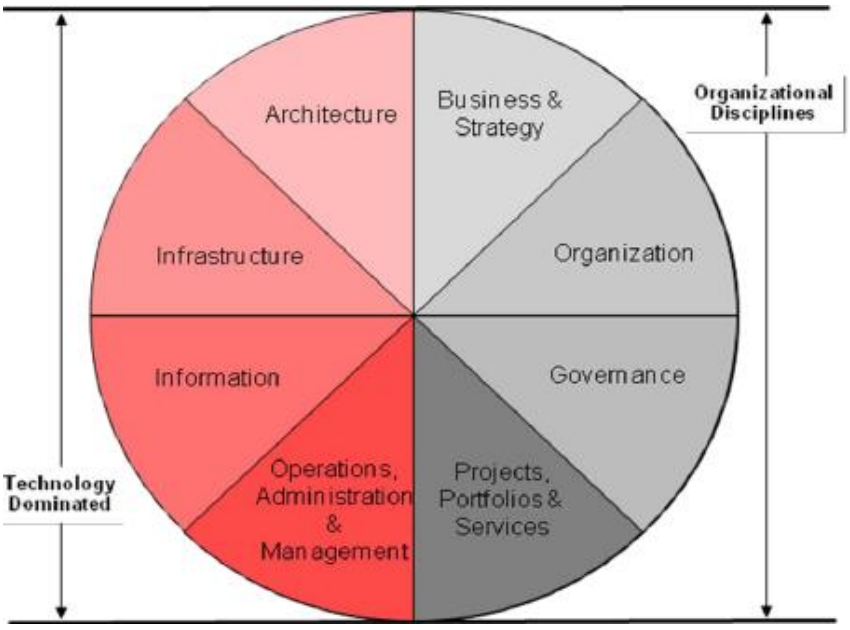

Figure 7: Cloud Maturity Model Domains (Mattoon, Hensle and Baty)

The model also does not lay out an indicative path for organizations to follow or think about, stages of adoption and milestones associated with each stage.

(Jadhwani) has created a five phase maturity model comprising Consolidation, Virtualization, Automation, Utility, and Cloud. The model, refer Figure 8, presents capabilities needed and the milestones to be achieved in every phase. The model takes a detailed look at technical aspects of cloud adoption but stops at that.

It does not consider executive awareness and support, standards definition, governance, process improvement and analysis, and change management among capabilities. It does not indicate non-technical milestones.

Step 1 Consolidation	Step 2 Virtualization	Step 3 Automation	Step 4 Utility	Step 5 Cloud
Consolidation & Modernization of Resources	Abstraction & Resource Pooling	Adaptive, Secure, & Repeatable	Self-Service & Metering	On-Demand & Scalable
Server Consolidation	Server & Storage Virtualization	Policy-Based Provisioning & Management	Service Metrics & Metering	IaaS, SaaS, PaaS
Tiered Storage Consolidation	Desktop Virtualization	ITIL-Based Repeatable Processes	Service Level Agreements (SLAs)	Service-Oriented Architecture
Consolidation of Network Services	Virtualized Network Services	Multi-Tier Security	Incident Response & Audit	Inter-Cloud Federation
Consolidation of Disparate Applications	Application Virtualization	Multi-Tier Data Recovery	Continuous Availability & Failover	Integration of Web 2.0 & Web Portals
Key Enabling Capabilities				
Consolidation	Virtualization	ITIL Service Management	DR & COOP	Cloud Internetworking
Modernization	Thin Client Computing	Network Security	Risk / Vulnerability Management	Integration
Power & Cooling	Green IT	Data Center Security	Situational Awareness	Provisioning
High Performance Computing	Data Duplication	Infrastructure Protection		

Figure 8: Cloud Computing Maturity Model (Jadhwani)

(Urquhart) writes about a five step model comprising consolidation of infrastructure, abstraction of data centers, provisioning automation, infrastructure as utility enabled by self-service and metering, and open marketplace for IT capabilities. The model proposed though not detailed, is sound on technical aspects of cloud but lacks perspective on executive support, governance, culture, existing technology landscape among others. It also does not indicate either the capabilities needed or milestones to be achieved in every step. There is no reference to time line either.

(Sorofman) has also put forth a five level cloud adoption model that includes infrastructure virtualization, taking virtualization to cloud, laying foundation in the form of governance etc., deployment of applications in the cloud, and dynamic allocation of workload across different utility clouds. Sorofman brings together virtualization, governance, policies, and deployment, but mixes up on the order. The model only pays lip service to governance and deployment and misses out aspects such as executive commitment, standards definition, rationalization and modernization, change management, and process improvement. There is no reference to capabilities and milestones.

Comparison of these models on criteria including Capabilities (needed for move to cloud), Technical Aspects (of cloud), Non-Technical Aspects (of cloud including executive support and governance), Milestones (associated with different stages of cloud adoption) and Timeline (for going to cloud including time for each of the stages) indicates that the models fail to address key aspects that should be covered in a Cloud Adoption or Maturity Model. Figure 9 below shows comparison of the models on criteria referred above.

Evaluation Criteria / Models	Capabilities	Technical Aspects	Non Technical Aspects	Milestones	Timelines
Forrester Research	!	✓	!	!	✗
Oracle Corporation	✓	!	!	✗	✗
Unicom	✓	✓	✗	✓	✗
CNET - James Urquhart	!	✓	✗	✗	✗
Dr. Dobb's - Jake Sorofman	!	!	!	✗	✗

Figure 9: Maturity Model Comparison

(R. Smith) has an interesting opinion saying that maturity model for cloud does not make sense. He contends that 'if the highest level of a Cloud Maturity Model is a measure of an organization's overall skills etc., it is more nebulous than NIRVANA'. He quotes ZapThink's Ron Schmelzer's 'Forget Maturity Models -- It's Time for an Agility Model' to make his point. The objective of a cloud adoption or a maturity model is to help think about the path to cloud, especially when it is so 'Cloudy' and evolving, and thus merits academic ink and professional thought.

3.3 Technology Organization Environment Framework

(Fleischer, Chakrabarti and Tornatzky) have put forth the TOE (Technology–Organization–Environment) framework. The framework explains that technological context, the organizational context, and the environmental context influence technology adoption decisions.

"The technological context includes all of the technologies that are relevant to the firm – both technologies that are already in use at the firm as well as those that are available in the marketplace but not currently in use. A firm's existing technologies are important in the adoption process because they set a broad limit on the scope and pace of technological change that a firm can undertake (Collins et al. 1988)" (Baker).

"The organizational context refers to the characteristics and resources of the firm, including linking structures between employees, intra-firm communication processes, firm size, and the amount of slack resources. There are several ways in which this context affects adoption and implementation decisions" (Baker).

"The environmental context includes the structure of the industry, the presence or absence of technology service providers, and the regulatory environment" (Baker). The TOE framework is given in Figure 10.

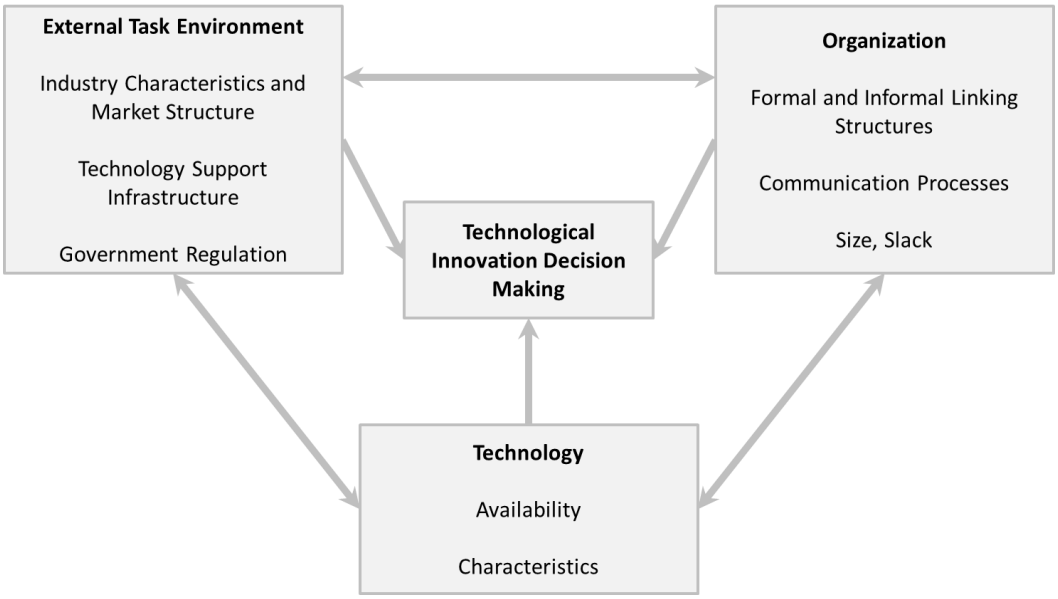

Figure 10: Technology Organization Environment Framework (Baker)

"TOE model has broad applicability and possesses explanatory power across a number of technological, industrial, and national/cultural contexts. It has been used to explain the adoption of electronic data interchange (EDI) (Kuan and Chau 2001), open systems (Chau and Tam 1997), enterprise systems (Ramdani et al. 2009), and a broad spectrum of general IS applications (Thong 1999)" (Baker).

TOE Framework has remained in its original form owing to its adaptability and flexibility for scholars to vary the factors for their research, instead of the framework itself (Baker). List of factors which have been placed in the framework are given in Appendix 9.2.

For this thesis, TOE Framework has been used to identify technological factors, organizational factors, and environmental context for cloud computing adoption for governments and large enterprises. The factors have been identified from analysis of case studies and there is some commonality with factors used by other scholars using TOE Framework.

4 CASE STUDIES ON CLOUD ADOPTION PROGRAMS IN INDUSTRY AND GOVERNMENTS

Case studies are fulcrum of this thesis and detailed case studies have been written on Large AV Manufacturer, Government of India, Large Financial Institution, Singapore Government, and US Intelligence Community. The case studies have been created from information gathered through interviews with IT and Business personnel of respective organizations and aggregation of data from secondary sources. TOE framework has been used to structure the case studies and the Technological and Organizational contexts form the boundary of thesis.

The interviews focused on multiple aspects of cloud adoption within an organizational context including organizational goals and strategy, execution and program management, benefits realization and measurement of success, and organizational readiness and risk mitigation.

Information gathered in interviews was supplemented by review of documents (including declassified documents) and articles on cloud adoption programs of the respective organizations. Publicly available videos of interviews also supplied valuable information.

4.1 CASE STUDY - LARGE AV MANUFACTURER

Large AV Manufacturer (LAM) is a world renowned manufacturer and marketer of audio and visual equipment. It is known for innovation and has gradually started diversifying into other businesses.

LAM runs lean technology operations with 100 IT personnel for every 10,000 employees. It has standardized its operations on SAP and PeopleSoft, and uses Microsoft applications such as Office, Exchange, Sharepoint and Link. It has tied up with a third party for co-locating its data center and uses Virtual Machines as needed. It has large customer service operations, employing hundreds of customer service representatives. Though the organization has standardized on Commercial off The Shelf (COTS) packages, business units do meet their specific requirements through custom packages. LAM has more than 100 applications and has a four to five year cadence for upgrades.

4.1.1 Getting Set Up for Cloud

GOVERNANCE

LAM is an organization driven by R&D and effective marketing of its products. Technology plays the role of an efficient enabler of LAM's business operations. The IT organization at LAM is centralized and has primary responsibility for taking decisions, implementing and maintaining technology solutions which enable business. Business goes to IT for technology needs.

STANDARDS

Central IT organization at LAM has pushed for uniformity in technology landscape and standards. Consequently LAM has standardized on SAP and PeopleSoft as its core business solutions and Microsoft for productivity and CRM solutions. It uses standard solutions in its contact centers too. There is minimal custom application development. Though standards are well accepted, business has the freedom to reach beyond the IT organization to meet their requirements.

4.1.2 Cloud Philosophy

LAM started thinking about aspects of cloud before cloud became a buzzword. Around 2010 LAM developed an understanding of different dimensions of cloud and gradually oriented itself towards cloud sans explicit mandate to go to cloud. As a result LAM has no specific objectives related to cloud. Calling it a Philosophy rather a Strategy, LAM has embedded cloud option in its technology adoption process and evaluates the options as part of the decision making process. The evaluation criteria (economics and technical complexity among others) drive the programs that become cloud programs. The decision to adopt cloud as a Philosophy was taken by IT organization in consultation with business.

4.1.3 Cloud Programs

MICROSOFT SOLUTIONS

LAM uses a number of Microsoft solutions including Office, Exchange, and Link. Historically different parts of the organization were on different version of the solutions. This led to interoperability and productivity issues, and the users resisted change of version.

LAM initiated a program to upgrade the solutions and encountered the decision to continue with the On Premise Microsoft solutions or subscribe to cloud based services provided by Microsoft. It evaluated the different options and settled for subscription service offered by Microsoft. The program was initiated in 2011 and completed in 2012.

Since the change was transformational for employees of the organization, LAM conducted a pilot phase with 150 employees drawn from different parts of the organization. Upon successful completion of the pilot, LAM moved lock, stock and barrel to Microsoft's subscription service on cloud. Among the benefits of cloud based services are standardization of Microsoft solutions across LAM and a change process for users. LAM's IT organization sees the cloud based services as being an enabler of their efforts at standardization.

LAM has an internal helpdesk to assist employees on issues with Microsoft solutions and is also actively promoting community based support for the solutions.

VIRTUAL DESKTOP

LAM evaluated Virtual Desktop, an individual user's interface stored on a remote server rather than locally (Rouse), for deployment across the organization and decided to pursue Virtual Desktop program. It conducted a pilot to determine feasibility of the program but encountered technical issues and didn't get very encouraging signals on business utility. LAM experienced that Microsoft operating systems were not best fit for Virtual Desktop, the use cases were very different across the organization, employees wanted to use the solutions that they were comfortable with, effort to resolve technical issues was very high, and there was no cost advantage. LAM didn't proceed any further with the program and has continued with desktops as we know them.

OTHER PROGRAMS

LAM is initiating a program to take its Human Capital Management solution to the cloud.

LAM evaluated storage in the cloud but determined that cloud based solutions might not meet desired service levels for more than 500 GB – 2 TB storage requirements. It has restricted use of cloud based storage to branch offices that have limited storage needs.

LAM is uniquely placed when it comes to adopting cloud. It is of mid to mid-large size, has had predominantly organic growth, does not have big development operations, has a largely uniform landscape composed of COTS applications, and technology strategy decision making is concentrated in the IT organization. It has embedded cloud as an option in the decision making process. If cloud solutions come out on top in evaluation and work during proof of concept, LAM goes ahead with adoption of cloud solutions but does not adopt cloud based on a mandate. Wherever LAM has adopted cloud, it has been a public cloud solution.

4.2 CASE STUDY – GOVERNMENT OF INDIA

India has a Federal – State governance structure such as that in USA. The Federal Government is elected for a period of five years and is responsible for economic, defense, external affairs and domestic administration among others. India comprises 31 states, each administered by a State Government elected for a period of five years.

India has become synonymous with information technology by virtue of having helped global organizations transform their operations and performance through more efficient and effective use of technology. While Indian industry too has followed the lead of global firms, federal and state governments, and local authorities in India have been laggards in adopting technology, let alone Cloud Computing. Albeit late, the State is waking up to the potential of Cloud Computing.

4.2.1 Cloud Computing Adoption in Federal and State Governments in India

"The Department of Information Technology, Government of India is planning to set up a national cloud-based network to connect all state data centers. These centers will be designed to deliver

services such as government-to-citizen and government business services through the internet" (CXOtoday News Desk).

The Federal Government has invited proposals from IT vendors to set up and maintain private clouds in every state. At present data centers are operational in 16 states in India (CXOtoday News Desk).

CDAC, a federal government agency, has established a private cloud environment to offer basic cloud services such as Infrastructure, Platform, and Software service to Government and SMEs. Some state governments have utilized CDAC services for SaaS (CDAC).

But these efforts are piecemeal, lack clear policy direction, suffer from insufficient resources and absence of push to adopt new technology. Taking cognizance of the advantages that Cloud Computing promises, disadvantages of maintaining status quo, and Cloud Computing efforts of governments across the world the Federal Government of India has set up a Working Group (PTI) to provide direction on Cloud Computing adoption across Government of India.

The direction that the Working Group provides shall in all likelihood become the blueprint for state governments to follow. The Working Group is supposed to come up with a report on Cloud Computing within the next few months detailing the optimal scope, benefits, adoption model and the roadmap.

4.2.2 Current Technology Adoption and Governance Model in Federal Government of India

Federal Government of India is organized into ministries and departments. As per the present structure, each of the ministries and associated departments is free to meet their technology requirements themselves. The ministries seek the services of National Informatics Center (NIC), Government of India's Technology Services arm or contract with third party service providers such IBM and Accenture. It is estimated that ministries split the application development work evenly between NIC and third party vendors. The amount of work going to NIC has gradually come down from almost 100% in early 1980s.

Different ministries and departments have seen explosive growth in their IT needs. Since they do lot of IT procurement on their own, they also take the lead in managing the programs. For these programs NIC is consulted by the departments. NIC also has technical people deputed to the departments.

DEPARTMENT AND NIC BUDGETS

Initially departments and ministries didn't have budgets and sourced all their requirements from NIC. Over time departments and ministries have come to have their own budgets. Department of Information Technology has a budget of $500 MN of which about $150 MN is allocated to NIC. It

spends the budgeted amount on acquiring capital equipment, hiring resources from industry and organizational administration.

4.2.3 Federal Government of India Technology Setup

NIC started as a UNDP project in 1976 and was instituted as a Government of India department in 1977. NIC provides technology consulting, implementation, and maintenance services to end user organizations which are government departments and ministries. It also acts as catalyst of IT adoption and provides cradle to grave IT solutions and services to government entities.

NIC sets up and manages networks, data centers, computing platforms and end user applications for Government of India. NIC is present across India and has 3000 employees.

DATA CENTERS

NIC operates four data centers called National Data Centers (NDC), two in Delhi and one each in Hyderabad and Pune. An additional center is being planned for Bhubaneswar. Pune and Hyderabad data centers have 100 and 60 racks (computers used as servers and designed to be installed on a rack) respectively. The larger data center in Delhi has 480 racks. NIC has also set up smaller or mini data centers in 31 state capitals. Not data centers in true sense, these facilities have at least some data center components. The state data centers have 10-30 racks each.

State governments have also set up state level data centers. These are typically of 30-100 rack capacity. NIC has been a technology consultant for these efforts.

NIC has very recently started using virtualization. Otherwise NIC servers are typically shared machines with multiple applications running on them. The more recent data center in Delhi uses VMware, Microsoft based hypervisor and open source tools. 30-40% of the machines in data centers run on Linux.

Access to services provided by different departments over the Internet has necessitated 24*7 availability of systems. In NIC's experience such availability is best provisioned through the NDCs. NDCs have brought certain level of centralization and enabled service billing.

NETWORK

NIC provides network connectivity within and between cities. National level network operated by NIC for Government of India is called NICNET. NICNET is the backbone for federal government and covers every ministry, department, state capital, and district. It has 60,000 nodes. Parallel state wide area networks have been set up within states. State wide networks connect the state capitals, districts and sub districts.

NIC set up VSAT based network in 1987. There are 1200 VSATs in India. Since high bandwidths are not possible on VSAT, it is used only as back-up and for connectivity in Northeast. The major centers are

connected through 2.5 Gig or 10 Gig lines. NIC is also setting up National Knowledge Network (nkn.in) which will connect all higher education institutions through a high speed network. NKN shall eventually connect 700 institutions.

Some departments and ministries also have their own networks. Railways and Oil & Gas Ministry are examples. Departments also contract out network services to providers such as Tata Communications. Different agencies are also involved in setting up National Optical Fiber Network that shall provide connectivity up to village level.

APPLICATION LANDSCAPE

Federal government of India technology landscape is littered with legacy applications. Many of these are in languages such as Cobol. In addition there are no standards in use across departments and ministries.

SERVICES

NIC provides services to departments and ministries in shared services mode. NIC has set up and manages video conferencing network which includes 1000 studios across India. Government of India also has 300,000 NIC email users.

SERVICE CONSUMERS

Government departments have moved from total dependence on NIC to meeting significant portion of their IT needs themselves. In many cases systems are developed by departments on their own. The departments get their own systems and keep their systems in the data centers in co-location mode. Though many services are made available by NIC, they are not used by the departments.

Departments use the Data Centers as facilities for locating their own infrastructure and don't use the services provided by NIC to a great extent. Though the departments can use the resources such as switching, routing, storage, compute, enterprise monitoring provided by NIC they still choose to bring their own, creating duplicate resources. Departments avoid using shared sources.

4.3 CASE STUDY – LARGE FINANCIAL INSTITUTION

The Large Financial Institution (LFINT) is a leading financial services provider serving some of the world's biggest institutions. Its services span the investment spectrum, including investment management, research and trading, and investment servicing.

LFINT started its cloud program in 2009 spurred by the financial crisis of 2008. Prior to 2008 it didn't need, among others, the flexibility and capacity afforded by cloud platform. As an example, during the crisis of 2008 financial institutions demanded reports on derivatives positions in minutes, whereas historically it had been only 1 week. This placed significant demand on LFINT processing capacity, which was not easy to come by as applications took anywhere between 3 months to 1 year to go live.

LFINT's landscape was characterized by 800 applications, developed over the time and many of them with overlapping functionality. LFINT had heterogeneous data centers with many best-of-breed systems. It worked with three major technology partners in 1990 but by 2009, it had 150 tech partners. All these contributed to slow response times in a fast paced environment, bloated expenditure as opposed to cost efficiency, and operational complexity juxtaposed against need for simplicity.

LFINT's cloud journey did start in 2009 but the stepping stones to a successful program were laid even earlier and started with the reorganization of its governance structure.

4.3.1 Getting set up for Cloud

At the turn of the 20th century LFINT went through Euro conversions, Y2K and significant growth in business. That period also saw LFINT start with the process of presenting a seamless view to its customers to better respond to global business opportunities and take advantage of e-business. The office of CIO initiated significant IT governance changes to support the vision of seamless view (Weill and Woodham, State Street Corporation: Evolving IT Governance).

IT GOVERNANCE

Historically, LFINT's IT organization had been highly decentralized. A small, central IT organization provided network services, data center operations, and transaction processing for mutual funds, pension funds, and global operations. Major business units had a self-contained IT operation responsible for operations. Only a small number of infrastructure services, such as the communications network, were provided centrally (Weill and Ross, IT Governance: How Top Performers Manage IT Decision Rights for Superior Results).

Beginning in 2002, the IT organization changed from separately structured services located by business unit to one federated IT organization supporting the whole enterprise. To balance the enterprise wide and business unit needs, the IT organization was realigned horizontally and vertically. IT services such as infrastructure and data management, provided enterprise wide horizontal services. Horizontal services were grouped together creating a centralized infrastructure delivered to business via shared services (Weill and Woodham, State Street Corporation: Evolving IT Governance).

Budgeting changed from small funding of central services and businesses independently assigning funding for business priorities to enterprise wide IT budget management (Weill and Woodham, State Street Corporation: Evolving IT Governance).

LFINT also reworked the responsibilities of the architecture group. Architecture group had been responsible for overall architecture framework, identifying and setting technology standards. Its responsibility was expanded to include review of all projects to ensure compliance with standards (Weill and Woodham, State Street Corporation: Evolving IT Governance).

The current governance structure includes Board (successor to management committee) which comprises direct reports to CEO. Operations (both business and IT operations) reports to CEO and CIO reports to operations. Risk committee reports to CEO and board of directors.

APPLICATION DEVELOPMENT

Prior to 2008, though the governance process had been centralized, businesses still enjoyed high degree of freedom in development of applications. Post 2008, development has been centralized including Toll Gate process, requiring projects to meet standards and requirements at specified approval points before the projects can proceed to the next stage and are approved.

But the Toll Gate process too has evolved and adjusted over time to drive results. The Toll Gate process allows for enforcement of standards and relook at projects if too much time or resources have been spent.

BUSINESS TRANSFORMATION

LFINT has been working on transforming its business operations. The business operations program is continuing and precedes the cloud program. Business transformation program is concerned with identifying efficiency opportunities in processes, reducing manual intervention, automating the processes, and restricting the manual intervention to exception processing. Business Transformation is now seen as an integral part of the cloud program.

4.3.2 Cloud Program

Against a difficult economic environment LFINT used the financial crisis of 2008 as a lever to redefine its business technology strategy and initiated a comprehensive cloud adoption program. The goals which LFINT set for cloud program were:

- Reduced time to market of new information services
- Faster information processing and risk assessment
- Enhanced security through automation of transactions
- Faster provisioning of capacity
- Cost reduction including 'more efficient, lower-cost software development'

LFINT's cloud program had IT focus initially but evolved to have business needs at the center and now is also closely tied in with business process improvement.

4.3.3 Cloud Roadmap

PLANNING

LFINT spent 18 months planning for move to cloud. An exhaustive and time consuming planning stage was necessitated by the nature of program which was an enterprise wide move with a large scope and no precedents to lean on. Further, LFINT divided its cloud move into three layers: compute

(computing resources for development, testing and running applications), data (resources comprising storage, databases and operating systems) and desktops (PCs, laptops and mobile devices running Windows 7).

- Application Rationalization - A very critical part of planning was application rationalization. LFINT decommissioned some applications, consolidated redundant applications, partially or completely refactored some applications and left some applications alone. It thus created an optimized portfolio in preparation for move to cloud.

  Architecture group had tried to limit the number of different technologies prior to 2008 and it was used by cloud program as an input.

- Proof of Concept - LFINT conducted two PoC (Proof of Concept) phases. In the first phase use cases were tested in isolation (three different PoCs for the three different layers -compute, data and desktop) and in the second phase the complete system (compute, data and desktop integrated) was tested. It was a progressive complexity PoC model. The use cases were on infrastructure, security and audit etc., (e.g., how to audit in cloud).

  For PoC, LFINT went for wide participation such as Application Support and Administration. There were 30 groups that had to be approved in this matter. LFINT created 400 use cases and whittled the number down to 150. LFINT wanted to see if these could be accomplished on the cloud (Albinus).

  The PoCs enabled LFINT to evaluate technologies, assess risk involved and discard technologies which didn't meet acceptance criteria. Diverse set of risk elements were tested and included recovery, auditability, back up. For every critical technology, LFINT identified at least two vendors. The POC process took 12 months.

- External Review - LFINT and its IT leaders had to submit to an external review with industry experts. LFINT spoke with regulators and auditors, to make sure that they were aware of the program (Albinus).

- Build vs. Buy – LFINT evaluated a number of technologies for its cloud program. It chose to buy some solutions off the shelf and build some of the solutions itself. LFINT went for a combination of both since it chose not to rely on a single vendor for solutions for a cloud project this large and complex (Albinus).

DEPLOYMENT

LFINT has chosen private cloud deployment model on grounds of security, standard enforcement and deployment automation.

It has six major data centers in the United States, Europe and Asia, including three backup facilities. The company has built its initial private cloud services from a disaster recovery facility in Massachusetts. LFINT partitioned off part of its data center for "massive racks of commodity servers" that can be treated as a single entity, providing cloud services and virtual desktops (Brodkin).

LFINT had computing infrastructure like any other firm. Over time it used technologies such as virtualization to increase the utilization of existing infrastructure. LFINT had virtualized about 65% of its environment before the cloud program. It deployed new tools for provisioning, change control, load balancing, a common security framework and various types of instrumentation to enable multi-tenant infrastructure (Brodkin).

LFINT has deployed the cloud platform over a period of 12 months starting 2011. For deployment to cloud, it chose applications which were high volume, and driven by customer demand and changes in market place.

Most of the existing infrastructure has been refactored into platform as a service but certain legacy applications continue to be on legacy hardware. For platform as a service the logic has been decomposed into web services to use full services entitlement framework.

- Compute – The development and production environments are standardized clusters of x86 servers (Babcock). LFINT is moving many of its workloads from high-end proprietary UNIX servers to commodity Linux boxes, and is increasingly embracing virtualization and automation tools to create a cloud-like infrastructure (Brodkin).
- Data – LFINT is moving to manage data virtually. Database appliances (storage, database and operating system) come with 40 TB of space and automated provisioning of schemas. LFINT has standardized on Exadata rack appliance and replaced six layer technology. LFINT uses DB2 and Oracle as databases and Teradata for warehousing, and plans to move all databases to standardized databases appliances.
- Desktops – LFINT provides Windows 7 over the cloud as thin client. The client can be accessed over Desktops and Mobile devices.

Simultaneously, LFINT has contracted with IBM for managing its data center and outsourced maintenance of applications to WIPRO, technology firm based out of Bangalore, India. LFINT also trained WIPRO on refactoring and used them in application rationalization and refactoring exercise. LFINT now focusses on application design and architecture.

During deployment, LFINT followed a parallel model and work was spread across infrastructure, data center (rack, fiber etc), and platform (reusable services). New applications go live only on cloud right away. There are about 50 applications on cloud and 200 are in various stages of deployment.

TRAINING

LFINT provided training to teams whose jobs had changed. Since infrastructure changed, infrastructure team was provided training on managing cloud platform and since development tools and documents changed, application teams were trained on new development platform.

4.3.4 Adoption Challenges

Cultural change has been and continues to be an important aspect of the cloud program. One of the key factors in the length of the program being what it is, has been culture (Albinus).The dimensions of change at LFINT are transformation in jobs in IT and business, evolution of transaction processing from manual to automated exception based processes, acceptance of open source solutions as credible alternatives to solutions provided by big name vendors, and loss of teams or authority.

One of the artifacts cited by LFINT was resistance showed by legal team on the issue of adopting open source software. Legal team's recommendation was to stick with established vendors to de-risk the cloud program as opposed to deploy well accepted open source software solutions as part of the cloud program.

LFINT has used a combination of tools to guide the organization through this extensive change. The common tools used are: group meetings, town hall meetings, and frequent communications. LFINT has also had unflinching commitment from executive leadership and business heads on change. It also identified Cloud Champions to catalyze change, especially in development communities.

4.3.5 Adoption Enablers

PMO (Program Management Office)

Cloud PMO is located out of company headquarters. PMO assessed existing application landscape, managed application rationalization exercise, and created the program and schedule. PMO has been instrumental in making the services variable and secure for business lines to use. The benefits are being seen in New Products and Faster Time to Market.

Center of Excellence

On the business side, centers of excellence work across the organization on process standardization and best practices adoption. They use online tools for collaboration, sharing information and measurement. There are about 20 centers of excellence (e.g., for pricing and NAV calculation) which are aligned along functions. Centers of excellence also provided SMEs to define new application use cases.

Risk Mitigation

To minimize risks associated with a new platform, new applications are being moved to cloud first. Other applications have been refactored and are being tested before they go to cloud. Legacy applications continue to be on legacy platform.

LFINT evaluated a number of technologies which could fulfill its needs. It tested the best possible alternatives and chose the technologies which fit its context and goals the best.

PROCESS IMPROVEMENT

Move to cloud has been supported by regularly occurring business process reengineering and continuous improvement.

CHANGE CHAMPIONS

Right through the program, commitment shown by executive leadership and business unit heads has been key to change management. Business unit heads have been pushing the change as they see economic benefits and positive change in eventual work quality.

LFINT has identified Cloud Champions in development communities who work with larger teams to disseminate information and help each other. They use collaboration tools to work with each other. Classroom training is also conducted for development communities. These communities and Cloud Champions are based in multiple countries.

4.3.6 Current State of Cloud

LFINT has fully functional private cloud which is used for providing services internally and to customers. As of 2012, 50 applications have moved completely to cloud, and 200 are being tested for move to cloud. LFINT has handed over management of its data center to IBM and also procured the services of WIPRO for application maintenance and development. Other highlights are:

- Reusable Service - LFINT's application landscape evolved as departmental silos but now LFINT is moving towards providing all applications in the form of reusable services including business requirements and use cases.
- No More Silos – The typical technology stack at LFINT was split into six layers earlier with each managed by different set of vendors. The vendors applied patches, did testing and made them available for production, but in their own domains. Cloud has broken down those silos condensing the layers into infrastructure, platform and enterprise software.
- Standardization – LFINT has set Java as a primary language, but Microsoft .Net languages will also be used in the future. Connections between systems are being simplified and standardized, an overall security framework imposed, and standard Web technologies and languages used where appropriate, all to simplify and speed development

  The development environment and production environment are standardized clusters of x86 servers. They frequently rely on Linux and other open source code, and they're managed as a pool of resources (Babcock).
- Rules for Future Software Development - LFINT IT has laid down 10 rules that shall govern future software development. Among others, these rules include using certain pieces of vetted open source code and implementing a standard, parallelizable method of accessing database systems (Babcock).

4.3.7 Measurement Metrics and Benefits

LFINT expects to achieve $600 million in savings by moving to private cloud by the end of 2014. Some of these savings are expected to come from changes in business processes and operations as well as IT, but a significant chunk is likely to come from the reduced cost of developing software. The savings consist of some one-time savings and some recurring savings, as in the case of software development. But over the 2011-2014 period, they will amount to $600 million (Babcock). Other benefits are:

- Reduced Provisioning Time - LFINT reduced provisioning time (amount of time needed to deploy a server for meeting any business need) from earlier 6 months to 6 minutes, using virtual machines and spare server capacity. LFINT did manual virtualization earlier but real benefit of virtualization was realized with automated virtualization and automated provisioning.
- Higher Utilization – Utilization rate of servers before cloud was 20% which increased to 50% after cloud based provisioning through infrastructure management tools. This increase in utilization was at no incremental cost. LFINT runs up to 100 virtual machines per server. LFINT buys capacity in the form of rack based servers. Server capacity is used for development, testing and business recovery.
- Reuse of Applications – LFINT has moved to creating and maintaining central copy of applications which find significant reuse, such as security. Security policies and code are applied centrally and applications don't have to build it in. LFINT sees up to 50% reuse of code
- Standardized Development - LFINT is standardizing development on private cloud leading to easier code sharing that reduces amount of code to be written. Target is to drastically reduce the amount of code that is to be written by 30-40% and reduce test time by 30%. Development has constituted 20%-25% of LFINT's annual IT budget that was over $1 billion in 2010 (Babcock).
- Time to Market – LFINT is using its new found agility to offer new services to its customers. One example cited by LFINT is delivering data-warehousing services to its customers in SaaS mode. It uses the cloud capacity and ability to provision services quickly for customers.

  LFINT has been faster in introducing data management services for customers and thus faster time to market for its services.
- Enhanced Security - Automated provisioning of user IDs reduces the number of IDs required for accessing applications. It also enables measurement of privilege access. Firewalls can be set up in much lesser time especially OS level firewalls.

4.3.8 Future Plans

Phase II of Transformation begins in 2013 and will run through to 2015. LFINT also wants to move from 99.5% availability to Five Nines.

4.4 CASE STUDY –SINGAPORE GOVERNMENT

Singapore is recognized as one of the premier business centers in the world, ably supported by one of the best infrastructure across the globe. Singapore government has played central role in development of this infrastructure and is now bringing the 'Best' philosophy home.

Singapore Government announced plans in 2011 (IDA of Singapore) to adopt cloud and awarded tender in 2012 (IDA of Singapore) for implementation of cloud. Singapore Government's cloud program is part of Singapore e-Government Masterplan 2011 - 2015 (IDA of Singapore).

eGov2015 is about building an interactive environment where the Government, the private sector and the people work together seamlessly, through the enabling power of communication technologies. The outlined vision of a Collaborative Government is expected to be achieved through:

- Co-creating For Greater Value (IDA of Singapore)
- Connecting For Active Participation (IDA of Singapore)
- Catalyzing Whole-of-Government Transformation (IDA of Singapore)

'Catalyzing Whole-of-Government Transformation' comprises investment in a government private cloud (or G-Cloud) to provide a resilient and secure ICT environment, where government agencies may purchase computing resources on demand and pay based on actual usage (IDA of Singapore).

Before getting into specifics of G-Cloud it's important to understand the technology adoption background in Singapore Government and the role being played by different agencies.

MINISTRIES AND DEPARTMENTS

The Ministries (e.g., Ministry of Defense - MINDEF, Ministry of Education - MOE, Ministry of Home Affairs - MHA) and Departments of Singapore Government are responsible for efficient and effective governance of Singapore, in the process catalyzing development, providing services to its citizens, and facilitating a business friendly environment.

In Singapore Government, the Ministries and Departments are users of technology and work through Info-Communications Development Authority (IDA) of Singapore on technology strategy, procuring technology, managing programs and vendors, and sustaining the technology platforms.

INFO-COMMUNICATIONS DEVELOPMENT AUTHORITY OF SINGAPORE (IDA)

IDA is the telecom regulator for Singapore and also acts as Singapore Government's CIO. It is the driver behind adoption of Cloud Computing and all other cross government programs in Singapore. IDA was set up in 2000 and essentially took over the responsibilities of the National Computing Board. IDA is responsible for:

- Information technology strategy and implementation for all the ministries
- Drafting RFPs and evaluating vendors
- Formulating contracts and conducting negotiations
- Managing vendors and overseeing technology operations

The Ministries and Departments work through IDA and but in some cases the ministries or departments do go ahead and create or procure applications on their own.

CROSS GOVERNMENT PROGRAMS

G-Cloud program officially came into being in 2011 (IDA of Singapore) but it intends to build in large part on other Singapore Government programs and the salient ones are:

- Standard ICT Operating Environment (SOE)
- Whole-of-Government Enterprise Architecture (WOG EA)
- Supply, Support and Maintenance of Service Wide Hosting Service (SHINE)

4.4.1 Standard ICT Operating Environment (SOE)

Singapore Government initiated the SOE project with the aim to standardize the desktop, messaging and network environment for the public sector (IDA of Singapore). Consortiums were evaluated over two stage tendering process (including two pre-qualification stages). The SD 1.3 billion (1 USD = 1.24 SD) contract for SOE was awarded to oneMeridian consortium, led by HP EDS in February 2008 (IDA of Singapore).

“A core aspect of SOE was the development of central services. It was supposed to revamp 12 existing service-wide infrastructures and introduce 10 new central infrastructures in the areas of network infrastructure, desktop services, messaging and collaboration. One example of these services is the automated delivery of software and security patches, applications and services to each individual public officer” (IDA of Singapore).

As part of SOE, two Singapore Network Operations Centers (GNOCs) were commissioned in October 2008 and June 2009. The GNOCs deliver all central services 24*7 and are equipped with monitoring capabilities (IDA of Singapore).

The deployment of SOE is still a work in progress despite the completion deadline of March 31 2011, having long since passed. Under the SOE project, more than 70,000 public officers from over 90 government agencies have migrated to the same messaging infrastructure and standard desktop systems to date (Kwang).

4.4.2 Whole-of-Government Enterprise Architecture (WOG EA)

“The WOG EA program aims to establish a federated view of all government agencies' enterprise architectures to optimize government ICT assets for greater cost savings or avoidance” (IDA of Singapore).

“Singapore Government initiated its Enterprise Architecture (EA) program in 2002 with a focus on establishing a Technical Architecture. The Service Wide Technical Architecture (now renamed as Singapore Government – Technology (ICT) Architecture or SG-TRM) is a set of technology standards, product registers and best practices, which guides agencies in the construction of ICT systems, with the objective of enabling inter-agency systems interoperability” (IDA of Singapore).

“In 2007, a set of artifacts (collectively known as the Singapore Government Enterprise Architecture or SGEA) that broadly lists business functions across government agencies, supported by relevant data standards, common systems and services, and technologies was established to achieve enterprise goals” (IDA of Singapore).

“In addition, a methodology for agencies to develop their agency-wide EA called MAGENTA was established. This provides the government with a methodology that is relevant to its agencies when developing and using EA. An EA practitioner's certification program was also introduced in mid-2006” (IDA of Singapore).

The WOG EA program aims to achieve the following:

- “Identify opportunities for end-to-end service integration for a seamless government, leading to greater synergy and efficiency” (IDA of Singapore).
- “Identify shared systems that can be used by multiple government agencies to minimize duplicative efforts” (IDA of Singapore).
- “Improve clarity on application resilience requirements to achieve robust solution designs” (IDA of Singapore).
- “Improve impact analysis on technology adoption to attain better technology planning and policy development” (IDA of Singapore).
- “Improve transparency of Whole-of-Government (WOG) initiatives and government agencies' various ICT investments, as well as their policy alignment with business goals to reach better investment decisions” (IDA of Singapore).

4.4.3 Supply, Support and Maintenance of Service Wide Hosting Service (SHINE)

SHINE was an initiative by IDA to develop a central environment for government agencies to host their web sites and deploy their e-Services and applications. IDA awarded SHINE to NCS, a SingTel group

firm, in Oct 2005. As of 2009 over 100 government agencies were using SHINE (NCS Pte Ltd). The services provided, refer Figure 11, by SHINE include:

- Hosting on Demand
- Storage on Demand
- Services on Demand

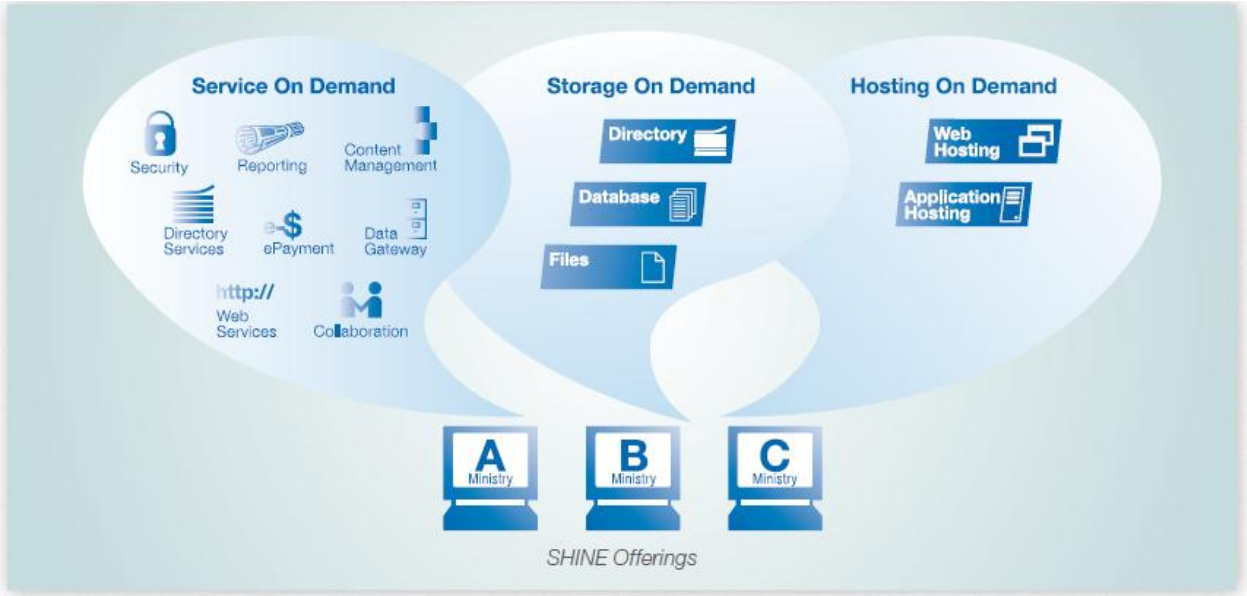

Figure 11: Singapore Government Shine Platform (NCS Pte Ltd)

Besides these, Singapore Government has developed new network through Next Generation Nationwide Broadband Network project, re-developed the eCitizen Portal to include new features such as the OneInbox, and implemented enhanced business intelligence capabilities to analyze information through the use of business analytics tools (IDA of Singapore).

4.4.4 G-Cloud Program

Singapore government has instituted a program to implement cloud based computing as part of eGov2015. It has adopted a multi-pronged approach to cloud computing, indicated in Figure 12, and intends to:

- "Leverage commercially-available public cloud offerings for appropriate needs" (IDA of Singapore).
- "Implement a private government cloud (G-Cloud) for whole-of-government use where security and governance requirements cannot be met by public clouds" (IDA of Singapore).
- "Enable interoperability between G-Cloud and agency Clouds through internal G-Cloud standards" (IDA of Singapore).

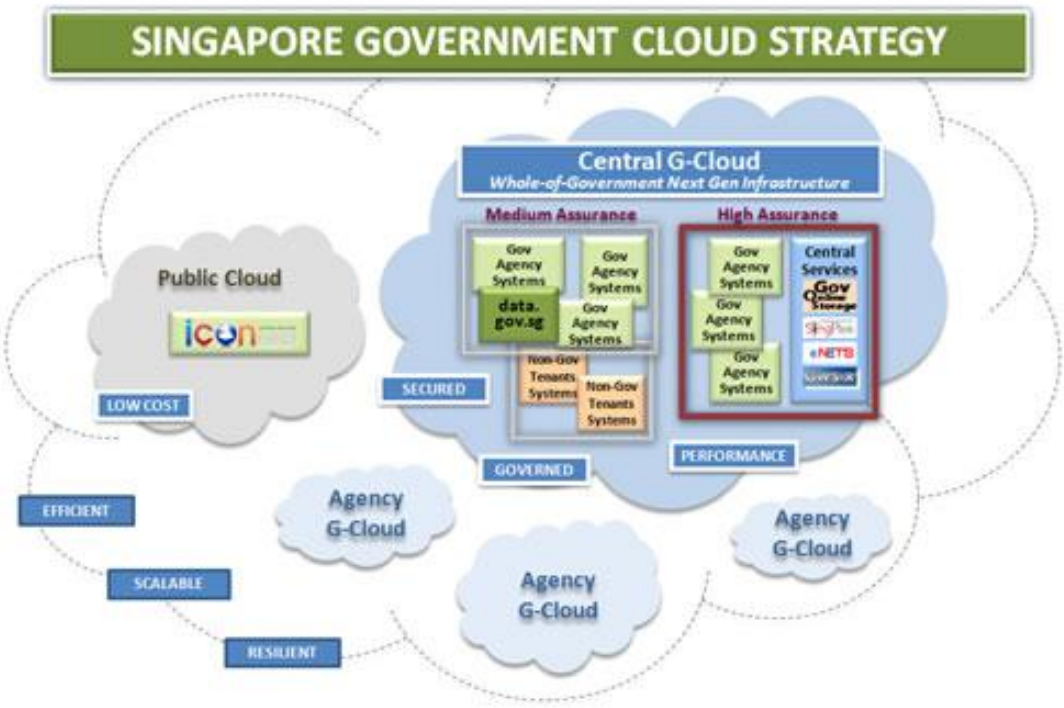

Figure 12: Singapore G Cloud Strategy (IDA of Singapore)

"To aggregate the whole-of-government demand to maximize cost savings to the government, Singapore Government plans to identify and provide common services, such as business analytics, customer relationship management and web content management, software-as-a-service and platform-as-a-service offerings on G-Cloud. New central services such as government web service exchange and gateways to authentication and payment services are planned to be added as the next phase of G-cloud" (IDA of Singapore).

"G-Cloud is expected to enable standardization, and sharing of computing resources and applications at the whole-of-government level, thereby generating cost savings to the government" (IDA of Singapore).

4.4.5 Cloud Implementation

Singapore Government called for a tender to provide Cloud Computing resources to the 'Whole-of-Government' and awarded the G-Cloud tender to SingTel in 2012 for a period of five years with the option to extend for another five years (IDA of Singapore). As indicated by IDA, the cloud infrastructure is in the process of getting deployed.

For easy procurement of public cloud services, IDA has also put in place a cloud services bulk tender. The many users include the Ministry of Health, National Environment Agency, National Library Board

and Urban Redevelopment Authority. Through this arrangement, public cloud service providers are qualified for use by ministries and Government agencies.

The challenges which Singapore Government sees in implementing the cloud program are:

- Services to be provided over public and private clouds
- Keeping services secure and ensuring privacy
- Use of public cloud, private cloud and hybrid cloud

4.5 CASE STUDY – US INTELLIGENCE COMMUNITY

The U.S. Intelligence Community is a coalition of 17 agencies and organizations, including the ODNI, within the Executive Branch that work both independently and collaboratively to gather and analyze the intelligence necessary to conduct foreign relations and national security activities. Among others US Intelligence Community (USIC) comprises CIA, DIA, NGA, NSA and FBI (Office of the Director of National Intelligence).

All agencies are unique in their IT. The agencies have their own infrastructure and distinctive application profile. All the agencies are on their own networks, use different applications such as for instant messaging, have different authentication mechanisms etc.

Budgets are aligned to business IT (finance, HR), enterprise IT (desktop, compute) and mission IT.

In 2012, the Director of National Intelligence (DNI) approved a strategy proposed by the IC CIO to change from the historically agency-centric IT approach to a new model - that of a common architecture and operations as an IC-wide enterprise. This strategy was developed in coordination with the CIOs of the big five intelligence agencies (Intelligence Community Information Technology Enterprise (IC ITE) Task Force)

4.5.1 US IC Transformation Objectives and IC ITE Strategy

The primary objective of the transformation is for USIC to benefit from improved agility, scalability, and security while realizing lower operating costs through the shared use of commercially developed IT and computing advances such as cloud technologies, virtualization, thin-client desktops, big data analytics, application stores, and improved security (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

This transformation is guided by the Intelligence Community Information Technology Enterprise (IC ITE).

4.5.2 Execution Model

"As per IC, each agency has particular strengths or core competencies that can be better leveraged by designating IC elements to act as Service Providers for specific capabilities for the entire Community. The DNI designates the IC Service Providers who are responsible for determining investment requirements and using their respective acquisition and contract authorities to execute their IC ITE responsibilities" (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

Currently identified common services and their respective providers include: the Desktop Environment (user desktop including applications for users across agencies), DIA and NGA; IC Cloud Services (integrated hosting including compute, storage), NSA and CIA; Applications Mall (platform for making available applications developed using Ozone Widget Framework), NSA; and Applications Stores, all agencies. The implications of this are:

- Big agencies become the providers and smaller agencies use their services. Helps to achieve economies of scale.
- RFP to the agencies on the services needed and they respond with their proposals.
- Decision making on part of the smaller agencies to use the services provided by bigger services.
- Governance involving deputies of five agencies and monthly tracking of progress.

Issues:

- Small agencies need to give up certain aspects of their IT.
- Complete view into data including where does the data reside, who is authorized to use it, who is modifying it at any given point in time.

"Per IC CIO, agency leaders should provide full support for the extensive transition required of enterprise, business and mission systems, and cultures in order to implement the IT Enterprise as planned. Furthermore, change management must be driven from the top. The IC element heads have to actively drive the cultural, organizational, and policy changes required to implement the IC ITE. IC elements will be required to develop migration plans for transition of current operations and data to the IT Enterprise environment. A mutually agreed upon governance structure should enable the IC CIO to oversee Agency and capability integration into the ITE. Due to the complexity, scope, and aggressive timelines involved, the IC CIO intends to exercise an agile implementation approach, managing in three-month windows toward agreed-upon annual capability roadmaps and the five-year target architecture" (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

4.5.3 Execution Timeline

"The IC ITE will be delivered in increments with Increment 1 (Initial Operating Capability, or - IOC) in FY13 and achievement of Full Operating Capability (FOC) planned in FY18. Increments for the IC ITE will include all activities required to plan for and implement IC ITE services, including scaling services across the IC enterprise, transitioning relevant legacy data and applications, and retiring legacy capabilities as appropriate. The initial IC ITE services focus on delivery of a common IC desktop, common back office tools, broader and standardized access to analytic tools and applications, and data-centric computing using complementary government-developed and commercial cloud architectures. Development of Increment 1 began in 2012 and ultimately intends to deliver enterprise capabilities for the IC Cloud Environment, the IC Desktop Environment, and the IC Applications Mall services. In five years, the IC expects all agencies to be leveraging this shared services platform with each providing or paying for enterprise services" (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

4.5.4 Elements of Transformation

GOVERNANCE

"CIOs and technology leaders across the IC will need to restructure the coordination, synchronization, and governance model from one centered on control within stovepipes to one that fully leverages innovation across the enterprise with agility in order to manage changes in operations and the supporting cultural shift to enable sharing data across the IC" (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

"The IC CIO believes that decision-making and governance of the IT shared services needs to be centralized rather than divided among the intelligence agencies. However, execution of those services (implementation and operations) will be largely decentralized" (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

STANDARDS

Agencies follow their own standards in IT. Current IT standards, architectures, and approaches are not scalable in the current budget scenario. Standardization is expected to help scale operations in the face of tight budgets. Setting standards could also help mitigate the proliferation of Shadow IT organizations (groups within agencies setting up their own IT infrastructure or contracting independently with third party service providers).

SERVICE LEVEL AGREEMENTS

IC ITE Strategy envisages use of shared IT services across agencies. The agencies shall need agreement on standard levels of service to enable the community at large to operate in the new environment. IC ITE leaders will have to engage their stakeholders regarding the needed levels of service in order to help define baseline standards for these common IT services. Different committees shall determine the standards the community is going to use for data sharing, access control, identity and access

management. IC is likely to standardize service definitions for IT shared services, especially cloud shared services (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

BUSINESS PROCESS CHANGE

There is a growing consensus within USIC that although there may be some near-term degradation, common components and business processes are not only inevitable in a challenging budget environment, but the right thing to do to better integrate the IC (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

CULTURE

Moving to a shared architecture and IT shared services model will require significant cultural change in the IC, driven by the overarching need to share mission-related data.

Leaders across the board will have to constantly inform and reassure the workforce and other stakeholders about how the effort will enhance their ability to achieve the mission—and continually communicate the benefits and successes. As cultural barriers start to fall, standardization as part of shared services may raise concerns that individual initiative and creativity may be stifled. Balancing this dichotomy and creating a culture that understands and demonstrates these competing concepts where appropriate—a culture where people think and behave differently will require strong leaders (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

WORKFORCE RE-SKILLING

"The current IT workforce should be capable of implementing and supporting the early transition to a shared services solution for IT. However, a reinvestment of a portion of the savings will likely be needed to develop new skills as the implementation evolves. There will probably be less emphasis on system administrators and narrowly focused subject matter experts. To execute the plan for IC ITE, there will need to be more focus on a government IT workforce comprised of generalists who have a greater blend of skills to manage the increasingly complex systems and an agile contractor workforce that has the expertise to fully implement the program." (Intelligence Community Information Technology Enterprise (IC ITE) Task Force).

5 Cloud Computing Adoption Model for Governments and Large Enterprises

The case studies highlight salient aspects of cloud adoption. They point to key elements of readiness, discernible patterns, characteristics of organizations at different stages of adoption and also indicative timelines for a full scale move to cloud.

5.1 Readiness

Literature of recent vintage abounds in those extolling the virtues of cloud and its benefits but as survey of literature indicates not so much has been written on what is necessary for a successful move to the cloud. Answers partly lie in that cloud is still a few years away from mainstream adoption and is gradually moving beyond hype. Study of examples outlined earlier reveals common elements essential, highlighted in Figure 13, to a cloud adoption program. Some of these elements are true of any program but others are more cloud specific. These elements also lend themselves to be classified into the TOE framework.

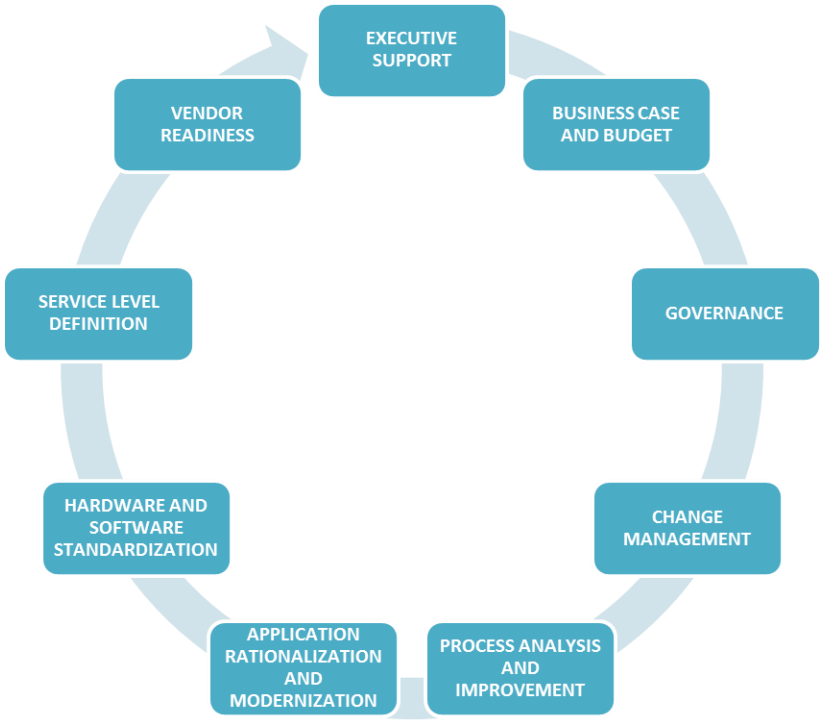

Figure 13: Cloud Readiness Dimensions

5.1.1 Organizational Context

Executive Support

Cloud adoption by its very nature is an enterprise wide initiative and as our examples indicate, needs large scale involvement of business functions, overhaul of existing technology landscape, and much

more and all this done over a period of several years. This necessitates Executive Support at the highest levels to articulate program objectives, keep up implementation momentum, catalyze solutions to issues and provide oversight. Executive Support is the Holy Grail for any program of such a scale and has been stressed umpteen times as organizations have become more adept at adopting business technology, but what makes it different in the context of the cloud is that Executive Support shall be needed for a number of years, continuously and at a sustained level.

Business Case and Budget

Cloud programs need a clear articulation of business objectives to be met, the desired future and the necessary investments. How is this any different from other programs? There is an abundance of cloud definitions, cloud means different things to different functions in any organization, adoption of a particular cloud mode could lead an organization into a very different direction as compared to other. Cloud needs a number of associated programs and steps, more sources of benefits are being discovered over time, and needs investment with uncertain benefits far out in the future.

Governance

Critical to any program implementation, governance is even more so in the case of cloud because of reasons outlined for 'Executive Support' and 'Business Case and Budget' dimensions. As part of this thesis, all the examples were mapped onto Weill's governance matrix (Weill and Ross, IT Governance: How Top Performers Manage IT Decision Rights for Superior Results), and the emerging pattern is that cloud programs need a combination of Business Monarchy and IT Monarchy or Federal and IT Monarchy for implementation and multi-dimensional success. Organizations might accordingly need to recast their governance organizations to set themselves up for a cloud implementation.

Change Management

Cloud entails changes in IT organization, how business groups transact with IT organization and get their requirements met, job descriptions of personnel, vendor outlook and use of IT resources among others. Depending upon how big the cloud program is, these changes could be sweeping in nature requiring frequent, multi-faceted and sustained change intervention. The example organizations in advanced stages of cloud adoption have faced challenges related to change and have instituted programs to manage change. These organizations also cited cultural change as a significant issue to be tackled.

Process Analysis and Improvement

Benefits of cloud are spread across infrastructure, platform and software horizontals. Benefits of the software horizontal are the most significant when accompanied by process analysis and improvement. Process analysis and improvement aligns business processes with the changes to the software applications and enables the business processes to best utilize the capabilities being offered by software applications. For the example organization which is working on the software horizontal of its cloud environment, business process modification and change is a key component of realizing cloud benefits.

5.1.2 Technological Context

Application Rationalization and Modernization

Move to cloud provides an opportunity for organizations to evaluate their application landscape, understand the usefulness of application set, and do some spring cleaning. As is evident in the case examples, application rationalization and modernization was an integral piece of move to cloud. This is especially critical as in a post cloud world it is highly likely that there shall be two environments, the cloud environment and the legacy environment. Maintaining these two environments is not going to be friendly to the wallet. Modernization follows as applications which are in the cloud or moving to cloud should ideally measure up to the standards which have been set. Aspects of modernization could be standard development language, central administration of security policies, and refactoring existing applications.

Hardware and Software Standardization

Cloud implicitly calls for converting vertical stacks into horizontals comprising infrastructure, platform and enterprise software. This horizontalization is possible if proper hardware and software standards are formulated. Each of the organizations studied as part of this thesis, but for one, developed standards over a period of time. Final push in the standardization drive was given by cloud initiatives. Standards were driven through dedicated architecture groups, which themselves underwent transformation through the cloud journey. Till the time standardization is not overdone, it drives flexibility and agility in an organization. Hardware and Software Standardization is critical driver for most of the cloud benefits and requires balancing act between today's priorities and future aspirations.

Service Level Definition

Cloud delivers organizational technology requirements in the form of services. Be it the internal IT organization which is delivering the service or an external entity, service levels define what is it that the end user organization desires from the service. For the internal IT organization, it also serves as performance measure. The example organizations have more or less defined their desired service levels and are using service levels such as Five Nines to drive their future programs.

5.1.3 Environmental Context

Vendor Readiness

Cloud has disrupted business of traditional hardware and software vendors and at the same time created opportunities for new vendors to step in. While the traditional vendors have struggled to get their cloud offerings off the ground, upstarts have taken a lead. This means that organizations looking to move to cloud need to consider vendors not necessarily part of their historical consideration set. Organizations also need to consider solutions which are open source based and thus challenge the standards that they have defined for themselves. Vendor readiness affects cloud adoption programs but for the purpose of this thesis vendor readiness is considered out of the study boundary as this factor is more often than not out of control of the adopting organizations.

5.2 ADOPTION STAGES

For organizations looking to adopt cloud or in the process of adopting cloud, the journey to cloud is marked with distinct milestones. All the example organizations have gone through one of these milestones in their journey. These milestones are progressive in nature, with one leading to another and the eventual state representing the acme of cloud adoption as it is defined today. These milestones will certainly vary with how organizations define their cloud programs. The milestones, depicted in Figure 14, also map onto TOE framework.

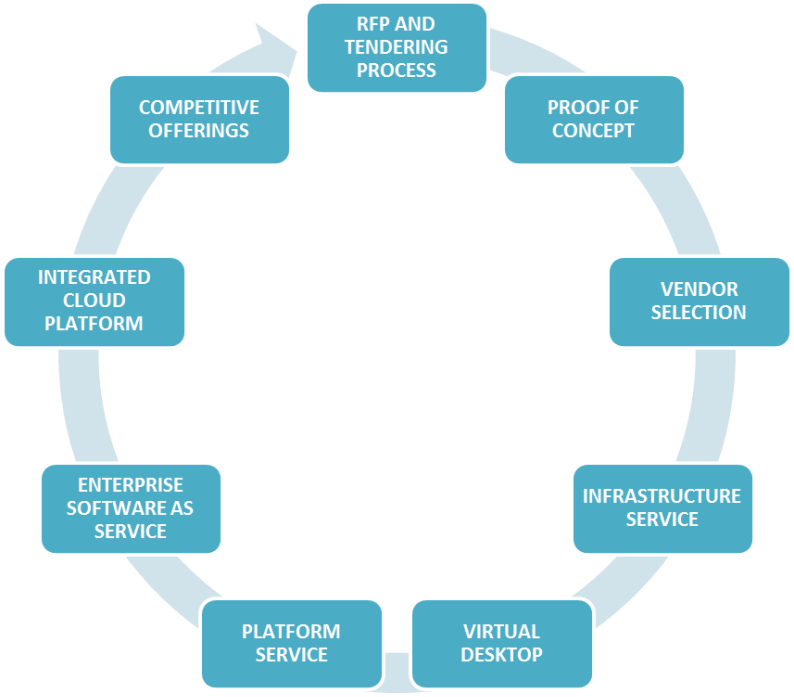

Figure 14: Cloud Adoption Milestones

5.2.1 Organizational Context

RFP AND TENDERING PROCESS

Large organizations go through RFP and tendering process to articulate organizational objectives and requirements for external partners, and identify candidates for providing consulting on cloud, implementing cloud programs, and sustenance on an ongoing basis. This will typically be a multi-step process with learning opportunities for both the contracting organization and potential partners. This stage assumes significance from the standpoint of Service Level Definition and overall expectations from cloud program.

5.2.2 Technological Context

PROOF OF CONCEPT

Lynch pin of any cloud move, Proof of Concepts serve as a test bed for tools which are expected to be deployed, integration between different layers of cloud and provides input for selection of

technologies. Proof of Concepts are especially important in cloud as many of the tools used in cloud deployments are based on open source and the internal IT organizations might be using some of those tools for the first time. Proof of Concepts serve as an important milestone in cloud adoption.

VENDOR SELECTION

Inputs from RFP / Tendering and Proof of Concept go into identifying partners for cloud implementation. These vendors could be across the spectrum including cloud consulting, application maintenance and refactoring, infrastructure management, cloud tools and technologies, and change management. Vendor selection is a milestone as it means that the organization has firmed up its options of the technologies to deploy and which partners to align with for execution.

INFRASTRUCTURE SERVICE

In the journey towards cloud, offering compute infrastructure service can be seen as a low hanging fruit. Once the hardware standards have been developed and appropriate technologies and tools identified, organizations can take the first decisive step towards cloud. Large organizations can better reap the benefits of Infrastructure Service as they have the scale of current demand and need for future capacity.

VIRTUAL DESKTOP

Another of the low hanging fruits, virtual desktop brings cloud driven changes a step closer to the user. It offers numerous advantages such as central application of policies but also brings individual change into focus. Complementary to virtual desktop is Bring Your Own Device (BYOD) trend i.e., employees getting their personal devices such as laptops, tablets and smartphones to their offices and working on them rather than using devices provided by the organization. It provides extra justification to organizations to push for virtual desktop. Even in case of virtual desktop, parallel desktop environments will need to be maintained for people who travel frequently and need offline mode.

PLATFORM SERVICE

Software standards with underlying infrastructure enable the general availability of standardized development environment for an organization. Development platforms have become very common in public cloud (Amazon, Android, Salesforce.com) but only recently started to appear in private clouds. Standardized development platform shall need retraining and reskilling of personnel across the IT organization and business units which take up application development.

ENTERPRISE SOFTWARE AS SERVICE

Perhaps of the most importance to end user, this stage signifies an organization being able to offer its enterprise application set as service which can be metered and charged, and in their conceptual execution as close as possible to public cloud SaaS offerings. Besides change in how organizations use such applications, it also demands change in the IT organization from a pure cost center to a hybrid cost / profit center model. It simultaneously requires the user organizations to recognize the IT organization as such.

INTEGRATED CLOUD PLATFORM

Call it the Cloud El Dorado, this stage represents an organization which has been able to transform itself to a state where infrastructure, development environment, and enterprise software are all services that are metered, billed and eventually charged to user organizations. The services offer boundless scalability and response to even the minutest of changes.

5.2.3 Environmental Context

COMPETITIVE OFFERINGS

Cloud is likely to enable an organization to create new offerings especially Software as a Service. Such offerings can be additions to an existing solution suite or a new solution altogether. The Large Financial Institution has created Software as a Service offering that is being subscribed by customers. Cloud thus has the capability to enhance competitive position of an organization or enable the organization to offer better services to stakeholders. Since such competitive or service offerings are determined by a number of factors other than capability and readiness viz., environmental factors, it is being excluded from this analysis.

5.3 ASSESSING EXAMPLE ORGANIZATIONS ON CLOUD READINESS AND ADOPTION CRITERIA

The Readiness and Adoption framework can be tested by using the framework for mapping the organizations studied as part of this study. This exercise helps get further insights into the adoption pattern, visualize the differences between the organizations, and chart out an adoption path by analyzing the organizations at different stages of adoption. For the purpose of this mapping, all the organizations were evaluated on Readiness dimensions on a scale of 1-3 and given a score on a scale of 1-3 for reaching the milestones as laid out in Adoption spectrum. The assessment is given in the following sections.

5.3.1 Assessment of Organizations on Cloud Readiness and Adoption

LARGE AV MANUFACTURER

The Large AV Manufacturer has centralized IT that is responsible for technology decision making and program governance, undertakes a business assessment for each of its proposed programs, has defined standards, uses predominantly COTS applications, and enables change through training and continued support. All these make it score well on Readiness dimensions.

It does not follow an explicit cloud strategy but has embedded cloud based options in its decision making process. For each of the technology programs, it evaluates cloud alternative and decides to go ahead given positive economics and organizational impact. It creates proof of concepts, to validate the cloud option and uses that as a critical component in eventual decision to deploy or not. The firm has well laid out processes to evaluate cloud options but has not deployed infrastructure as service or virtual desktop. It has moved Office Suite to the cloud and intends to move a few other enterprise solutions to the cloud. Assessment scores for Large AV Manufacturer are given in Figure 15.

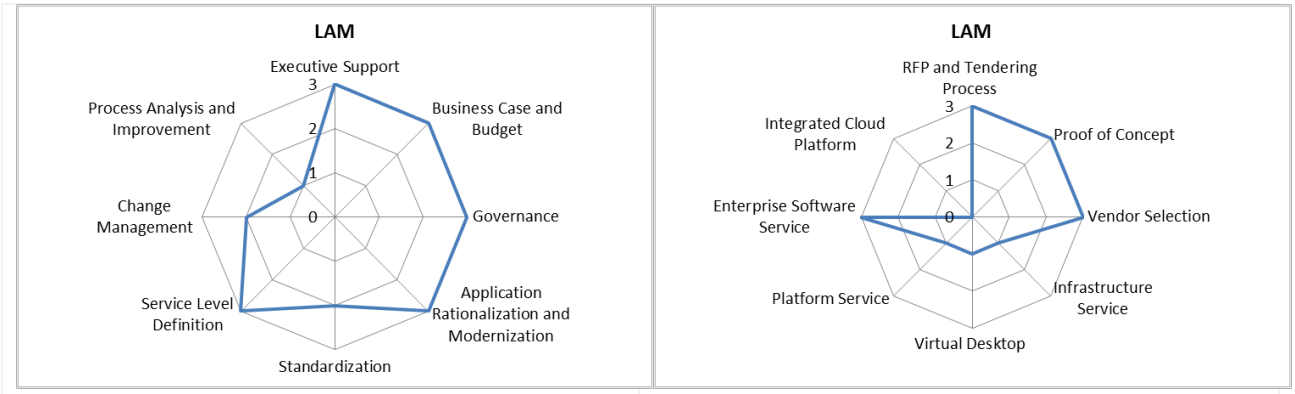

Figure 15: Large AV Manufacturer Readiness and Adoption Scores

GOVERNMENT OF INDIA

Government of India is in the very early stages of cloud adoption and has instituted a working group to look into various aspects of cloud. At present, each of the ministries and departments has its own technology strategy, contracts independently with vendors, and manages its own budget and technology landscape.

Cloud has caught attention of Federal and State Governments, but the efforts to adopt cloud are at best patchy. A few departments have tried to initiate independent cloud programs but they lack structure and organized thought. Otherwise no efforts have been made to adopt cloud solutions. Assessment scores for Government of India are given in Figure 16.

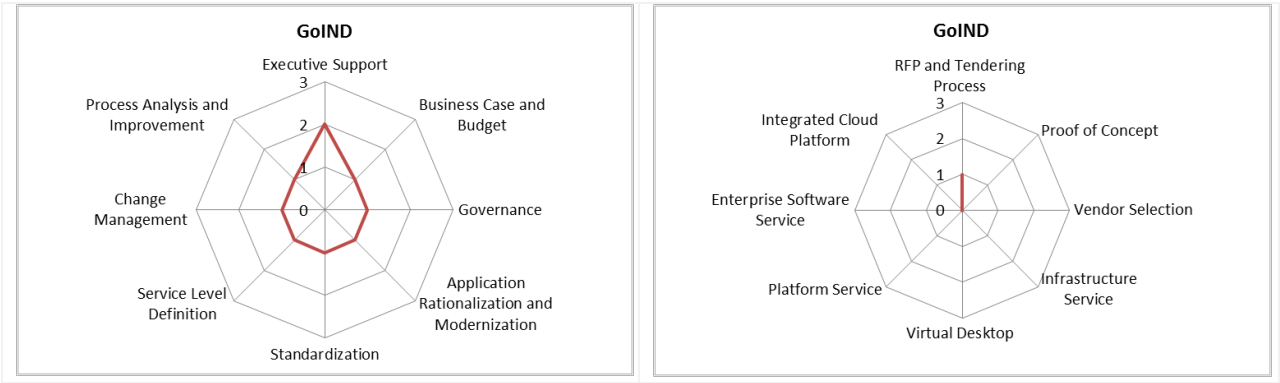

Figure 16: Government of India Readiness and Adoption Scores

LARGE FINANCIAL INSTITUTION

The Large Financial Institution is the most advanced on Readiness and Adoption among the organizations studied. It started its journey about a decade back by reorganizing its governance structure, centralized the budgeting and planning process, followed it up with definition of architectural standards, and used the events of 2008 to kick start its cloud program. It has undertaken exercises to rationalize its application landscape, defined appropriate service levels, and integrated change management and business process improvement into the cloud program.

This firm floated RFPs and through tendering process identified technology vendors. It conducted proof of concepts to validate technologies to be used and offers infrastructure as service. All new applications are hosted on the new infrastructure platform. It has also virtualized desktops and is now moving to create a development platform. 50 of its enterprise applications are being offered as a service and another 200 are in various stages of being converted to service form. At the same time, it continues to operate a number of legacy applications on legacy platforms. Assessment scores for Large Financial Institution are given in Figure 17.

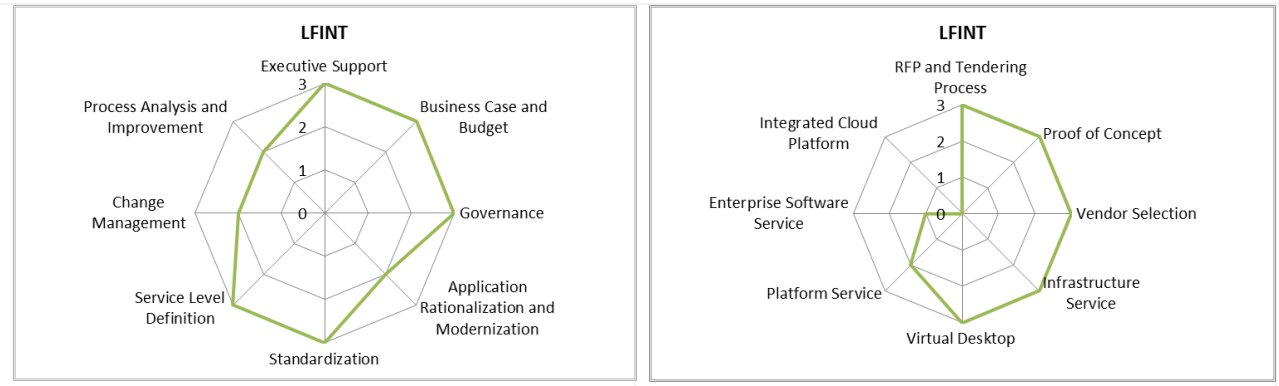

Figure 17: Large Financial Institution Readiness and Adoption Scores

SINGAPORE GOVERNMENT

Singapore Government has a central decision making and governance body (IDA) for technology programs. It follows structured business case approach for justifying investment in technology programs. Over the years it has standardized its architecture and through various programs also rationalized its infrastructure and set service levels to be adhered to. Though process improvement is not core yet, Singapore Government is well placed on Readiness dimensions.

Singapore Government initiated its cloud program in 2011, calling for responses to RFP from qualified bidders. It selected a consortium led by SingTel to execute on the cloud program. The consortium is in the early stages of deploying infrastructure as service. IDA is driving Singapore Government's cloud program. Assessment scores for Singapore Government are given in Figure 18.

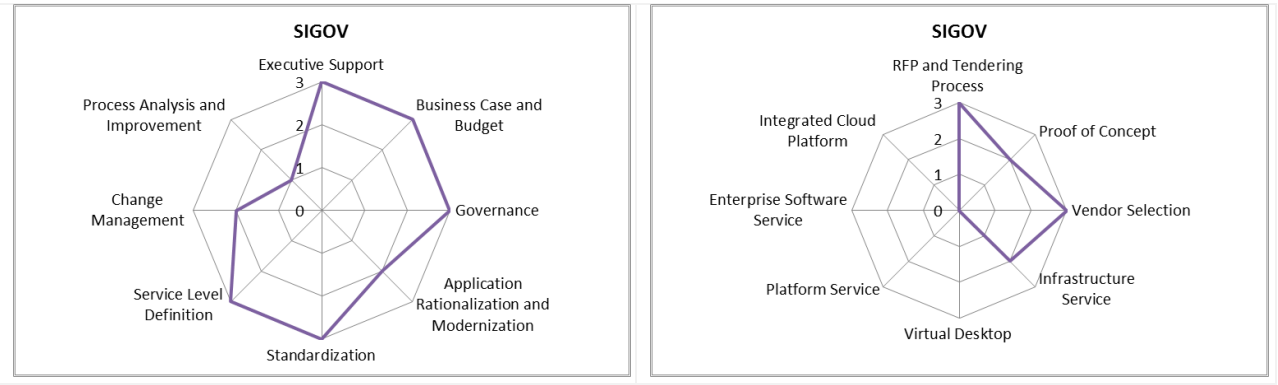

Figure 18: Singapore Government Readiness and Adoption Scores

US INTELLIGENCE COMMUNITY

US Intelligence Community has the stated objective of "shared use of commercially developed IT and computing advances such as cloud technologies, virtualization, thin-client desktops". To this end it is being guided by the Intelligence Community CIO, representing executive sponsorship and governance centralization but there is more effort needed to move beyond stovepipes. The agencies follow their own standards in IT, cultures across agencies are vastly different, there are no common business processes and agreement is needed on the service levels.

The cloud program for US Intelligence Community was initiated in 2011. It expects to achieve first stage initial operational capability in 2013. As it continues on the program, it realizes the need to progress on readiness dimensions and continues to work on those. Assessment scores for US Intelligence Community are given in Figure 19.

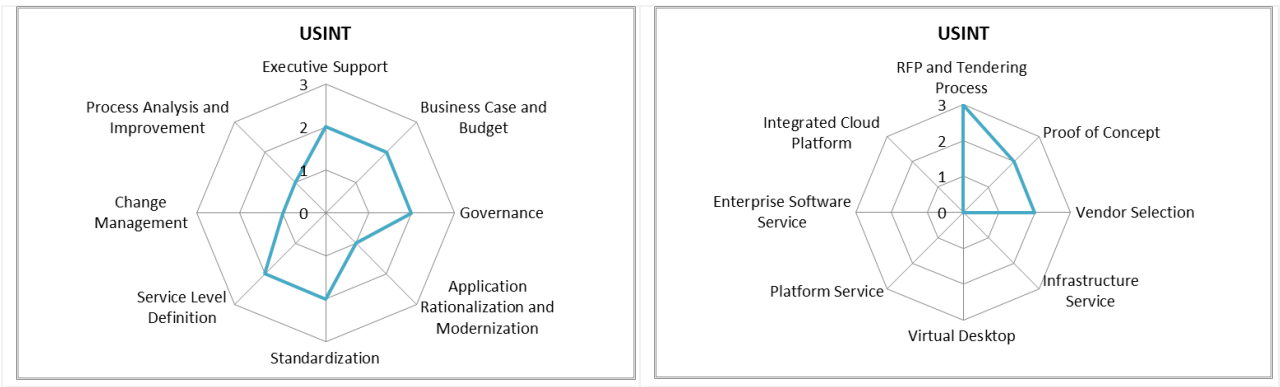

Figure 19: US Intelligence Community Readiness and Adoption Scores

The Readiness and Adoption scores presented in the graphs above (refer Appendix 9.3 for scores in tabular form) were consolidated to yield a Readiness – Adoption matrix and the relative placement of all the organizations under study. The results are presented in Figure 20 below:

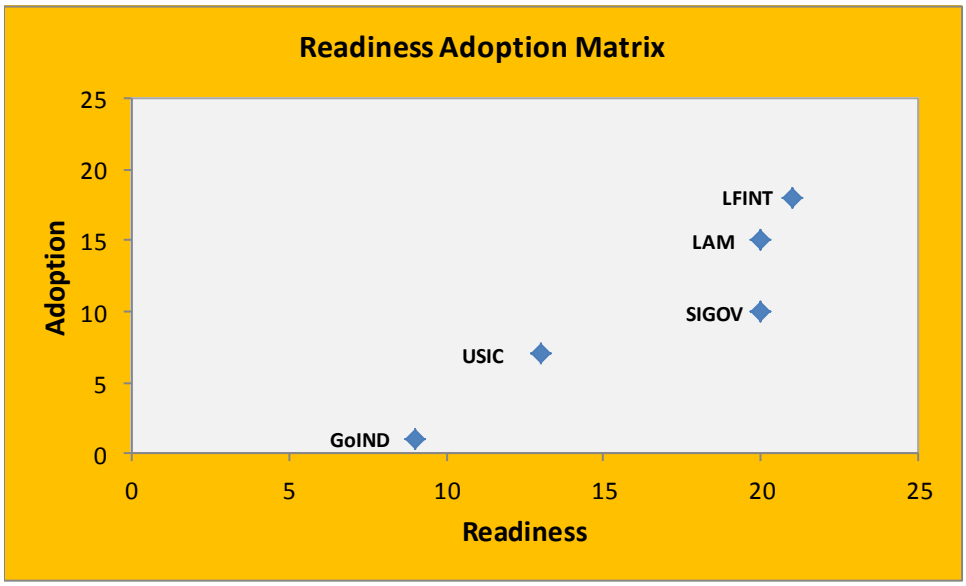

Figure 20: Relative Readiness Adoption Mapping

This assessment offers a number of insights:

- How ready an organization is on the dimensions outlined earlier, determines how far it can go in its cloud program. As a corollary, organizations should not look to initiate cloud programs unless they are ready or know how to plug the gaps which they have identified.
- Organizations need to address change management, process analysis and improvement, and application rationalization dimensions to make significant advances towards Enterprise Software as Service and Integrated Cloud Platform milestones.
- Infrastructure Service and Virtual Desktop milestones are low hanging fruits in cloud adoption. Development Platform falls in the middle ground between relatively easy to achieve and tougher to achieve such as Cloud only Platform.
- Governance and Executive Support are critical to cloud adoption as all the organizations high on adoption curve have good governance mechanism and solid executive support.
- Vendor Selection and Proof of Concept can be parallel processes where in depending upon the organizational procurement procedures, either one can come first. But for sound decision making Proof of Concept should come before vendor selection.

5.4 Governance Model Mapping

(Weill and Ross, IT Governance: How Top Performers Manage IT Decision Rights for Superior Results) provide a framework, given in Figure 21 below, for explaining different IT governance decisions that must be made and who should make them. The columns represent five related IT decisions and usually flow from left to right. The row headings depict people making the decisions and also decision making styles.

DECISION / ARCHE-TYPE	IT Principles	IT Architecture	IT Infrastructure Strategies	Business Application Needs	IT Investment
Business Monarchy					
IT Monarchy					
Feudal					
Federal					
Duopoly					
Anarchy					
Don't Know					

Figure 21: Governance Arrangement Matrix (Weill and Ross)

The example organizations were mapped on to the framework to gain insight into governance mechanism which could best drive cloud program. The mapping is given in Figure 22 below.

	IT Principles	IT Architecture	IT Infrastructure Strategies	Business Application Needs	IT Investment
Business Monarchy			LFINT	LFINT, LAM	LFINT
IT Monarchy	LFINT, SIGOV, GOIND, LAM	LFINT, SIGOV, GOIND, LAM	LAM		LAM
Feudal			GOIND, USIC	GOIND, USIC	GOIND, USIC
Federal	USIC	USIC	SIGOV	SIGOV	SIGOV
Duopoly					
Anarchy					
Don't Know					

Figure 22: Governance Structure Mapping

It can be seen that LAM and LFINT have a combination of IT Monarchy and Business Monarchy guiding their efforts, though LAM is predominantly driven by IT Monarchy. GOIND is the least evolved on the path of adoption and is accompanied by a diffused governance structure (Feudal). USIC is starting out on its journey with some accomplishments to talk about and its governance structure is a mix of Federal and Feudal. SIGOV is deep into the process of adopting cloud and uses both IT Monarchy and Federal mechanisms. The pattern which can be seen here is that large private organizations use a combination of IT Monarchy and Business Monarchy, whereas governments down the path of cloud adoption employ IT Monarchy and Federal structure.

5.5 Multi Year Effort

Organizations in advanced stage of adoption started on their cloud journey years back. Even those organizations which are in early stages of adoption or thinking about it, started the process at least two to three years ago. The adoption timelines are given in Figure 23.

The Large Financial Institution credits the success of its cloud program to the governance model recast which took place in 2002 and experience with cloud enabling technologies such as virtualization which began in 2006. It formally began its cloud journey in 2008 and expects to achieve its objectives by 2014.

Singapore Government initiated its enterprise architecture program in 2002 and devised a program to provide central environment for eServices and applications in 2005. It initiated another program in 2008 to standardize ICT operating environment. It formally launched the program in 2011 with call for tenders and is now in the process of deployment.

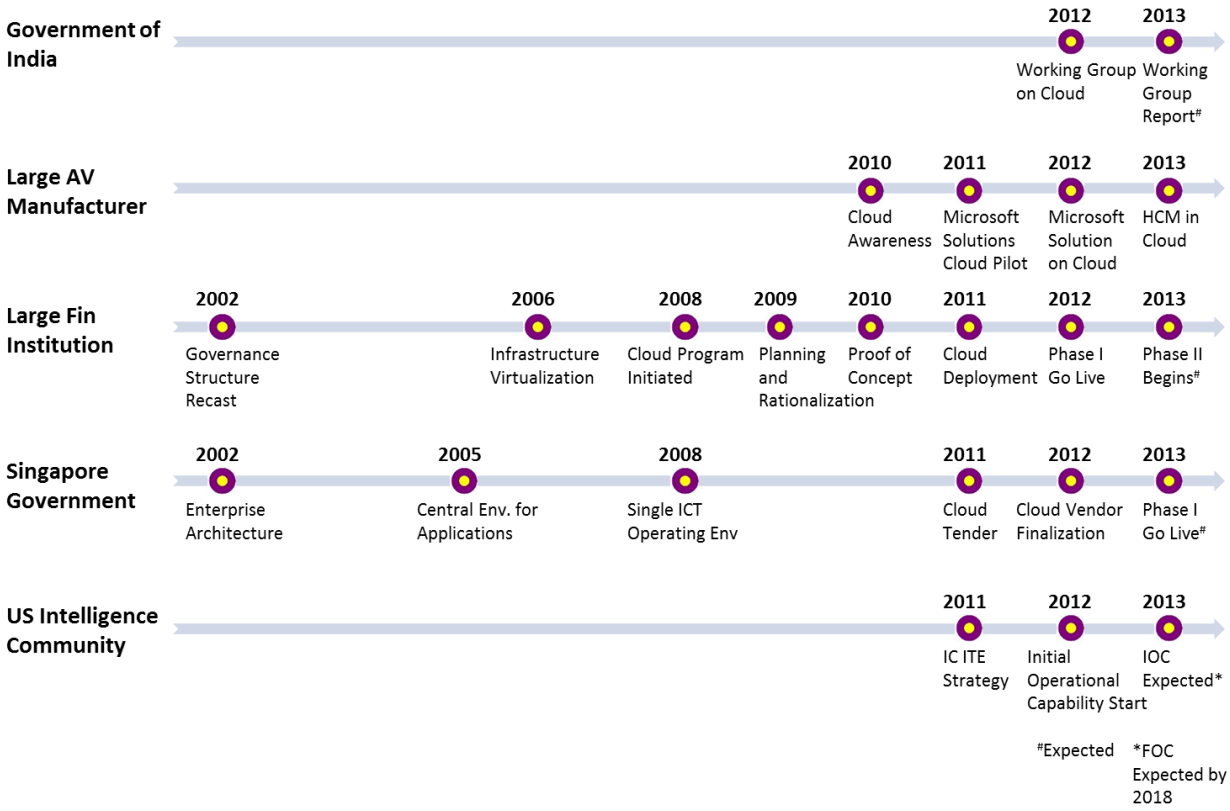

Figure 23: Evolution of Cloud Programs

Large AV Manufacturer has been aware of different aspects of cloud before cloud became a buzzword but a wider organizational awareness came about in 2010. In 2011 they initiated the program to move all Microsoft solutions on to Microsoft hosted cloud and completed the move by 2012. They are initiating another program to move their Human Capital Management solution to cloud.

US Intelligence Community initiated its program in 2011. It expects to achieve Stage I of Initial Operational Capability in 2013 and get to the later stages of the program not before 2018.

Government of India has started with its cloud initiative in 2012 by setting up a Working Group on cloud adoption. It is supposed to come up with recommendations on cloud adoption in 2013.

These timelines indicate that capabilities and experience necessary for successful cloud adoption are built over years. Cloud programs themselves being of wide scale and impact in any organization require intense planning, proof of concepts, application rationalization, and deployment in stages and are thus executed over several years. Cloud programs also benefit from capabilities developed as part of execution of other programs. It can also be said that cloud programs bring intense focus on IT organizations and in fact provide it sustenance through a program which might continue for even multiple five year blocks.

5.6 MULTIPLE SOURCES OF BENEFITS

Cloud literature talks about numerous benefits of cloud. These typically are cost reduction, high response scalability, organizational agility and so on. Example organizations of this thesis indicate other sources that can bring significant benefits to implementing organizations. Some of these are:

- Business process analysis and improvement (efficient processes)
- Modern architecture (enhanced security)
- Hardware standardization (utilization)
- Development standardization (reduced development time, cost)
- Application rationalization (simplified landscape, reduced cost)
- Legacy modernization (enhanced features, functionality)
- Central administration of policies (uniform policies)

Figure 24 below maps the objectives of the cloud programs of organizations studied to the benefits outlined above. This mapping indicates that the organizations further down the road on cloud adoption are reaping benefits beyond their stated objectives. This is consistent with the assertion that cloud programs have benefits, on top of the most obvious and most often sought after.

	Large AV Manufacturer	Large Financial Institution	Singapore Government	US Intelligence Community	Government of India
Objectives of Cloud Programs / Benefits	**Increased organizational agility and reduced costs**	**Reduced time to market and costs, enhanced security, and**	**Reduced costs and organizational transformation**	**Improved agility, scalability, security and reduced costs**	**Not Stated**
Business process analysis and improvement (efficient processes)	✗	!	✗	✗	
Modern architecture (enhanced security)	!	!	✗	✗	
Hardware standardization (utilization)	✗	✓	✗	✗	
Development standardization (reduced development time, cost)	✗	!	✗	✗	
Application rationalization (simplified landscape, reduced cost)	!	!	✗	✗	
Legacy modernization (enhanced features, functionality)	✗	!	✗	✗	
Central administration of policies (uniform policies)	✓	✓	✗	✗	

Figure 24: Cloud Program Objectives and Benefits Mapping

5.7 CLOUD ADOPTION MODEL

The last few sections dealt with organizational readiness to adopt cloud and its key elements, the milestones to be achieved, different governance models of organizations moving to cloud and the time that organizations are taking to deploy cloud. These discussions set the stage for discussing about Cloud Adoption Model.

Readiness, Milestones, and Time duration involved, when combined together yield a Cloud Adoption Model. The example organizations can be mapped onto this model and their progress on cloud adoption determined. The model also serves to indicate characteristics of organizations at different stages of cloud adoption.

The adoption model, given in Figure 25, comprises four stages: Thinking, Initiating, Creating and Riding. Each of these is explained below.

5.7.1 Thinking (about cloud)

Organizations in this stage are characterized by IT as we have known for the last two decades or so.

- Decentralized IT and Budgeting: IT function is more often than not diffused across business units and central IT, and they pursue their own budgetary goals. Moreover IT function is seen as a cost center.
- Inconsistent Governance and Enforcement of Standards: Diffused IT function leads to inconsistent governance of programs and lack of enforcement of standards, if standards exist.
- Lack of Standards and Policies: Organizations have central IT but since business units also have large scale IT functions, finding common ground on Standards and Policies becomes challenging.
- Heterogeneous IT Landscape: Business units use their empowerment to procure or develop a range of applications leading to an IT portfolio with a spectrum of solutions.

Besides, the organizations typically have on premise enterprise applications, data centers with shared or dedicated machines, and long cycles for provisioning capacity.

For organizations in this stage, the first accomplishment lies in the executives and the organization (if possible) developing an appreciation of cloud including its benefits, challenges, and applicability in specific context. In today's environment, almost everyone at the executive level should have heard of cloud. Assuming so, executives should be able to develop deeper appreciation and be ready to take the next step in less than a year. Among the organizations studied, Government of India is 'Thinking' about cloud.

5.7.2 Initiating (reach for cloud)

This stage forms the bedrock of success of any cloud program and builds on the Executive and Organizational Awareness achieved in the previous stage.

- Executive Support: Organizations need to develop wide executive support for initiating cloud programs as such programs are broad in scope, impact and resource needs.
- Business Case and Budget: Cloud comprises a broad spectrum of service and deployment models. Organizations should clearly define their objectives for cloud program and make required budgetary allocation.
- Adoption Roadmap: Cloud programs, as evidenced by case studies, last many years. Hence creating a roadmap that identifies milestones to be achieved shall ensure that organizations stay on course. Adoption Roadmap is more often than not part of Business Case.
- Rethought IT Governance: Analysis of governance mechanism of organizations studied indicates that an IT Monarchy along with Business Monarchy or Federal structure is well suited to cloud programs. Depending upon the governance model that an organization follows for managing its programs, the organization could either decide to continue with its existing model or adopt a new one.
- Hardware and Software Standardization: Organizations in this stage also make significant progress in defining hardware and software standards. They might have done this in bits and pieces earlier but such efforts need to be taken to decisive end.
- Legacy Mapping: Organizations should also start with legacy mapping in preparation for application rationalization and modernization to follow later. Legacy mapping falls within the boundary of Application Rationalization and Modernization.

To set the stage for implementation and deployment later, the key milestones to be achieved in this stage are formulating a Governance Structure, setting Hardware and Software Standards, executing on RFPs and Tendering Process, and conducting Proof of Concepts. These milestones could take anywhere between 1 to 3 years to reach. US Intelligence community is still tethered to this stage of cloud adoption spectrum.

5.7.3 Creating (organizational cloud)

Organizations in this stage are knee deep in the weeds of executing the cloud program and draw on the milestones achieved in the previous stage.

- Service Level Agreements: Cloud calls for providing technology solutions in the form of services. To ensure that the services meet needs of organizations and performance is at acceptable levels, organizations should define service standards.

- Application Rationalization and Modernization: Organizations should assess their IT landscape to retire, re-factor, recreate or retain existing applications. It sets the context for move to cloud including maintaining a parallel legacy infrastructure for supporting legacy applications.
- Change Management: Organizations studied in this research indicate that cloud programs have extremely broad scope and degree of impact. It has implications for people, structure and processes alike, and thus change management is of paramount importance. Key elements of addressing the change should be communication, incentives, training, resistance management, and reinforcement.
- Process Analysis and Improvement Initiatives: Cloud programs can affect changes at enterprise software level. For such changes to be impactful and fruitful, organizations can supplement their cloud programs with process change initiatives and take the opportunity to improve their processes.
- Vendor Retraining: Our study organizations indicate that cloud is accompanied by application refactoring and also change in technologies. Such change might necessitate vendor retraining if the implementing organization is using vendors who are new to the technologies identified for cloud programs and the refactoring standards being used. Vendor Retraining maps to Vendor Readiness.

Based on the readiness attained in this stage and the previous stages, organizations by this stage Rationalize and Modernize IT Landscape (within defined constraints), Identify Technologies and Select Vendors for supplying technologies (internal capability development), deploy Infrastructure as Service (with likely contracts with third parties for managing the infrastructure) and pluck the low hanging fruit of Virtual Desktop. This stage is much more intense than the previous stage and could take 2 to 3 years for execution. Singapore Government is in this stage of cloud adoption. Large AV Manufacturer, though ahead of Singapore Government, shall still fall in this stage of moving to the cloud.

5.7.4 Riding (the cloud)

This stage represents the El Dorado of cloud adoption.

- Cloud Champions: Organizations in this stage stimulate the adoption of cloud model through cloud champions who act as ambassadors for the program and stimulate adoption. Cloud Champions play an especially critical role in the development communities. Cloud champions are a critical tool for Change Management.
- Change Management: During the process of deploying cloud platforms, Change Management program helps navigate employees through the process of change by making clear the need for change, benefits of change, and implementing reskilling and retraining plans.
- Centers of Excellence: Organizations can also set up Centers of Excellence to institutionalize the broader business process improvement initiatives and align them with higher cloud adoption milestones to be achieved.

This stage is also marked by co-existence of legacy and cloud environments. Organizations can look to ride the cloud wave by offering Enterprise Software as Service and providing for a Development Platform as Service. This stage could take 2 to 3 years for execution. From the example organizations, the Large Financial Institution is in this stage of cloud adoption.

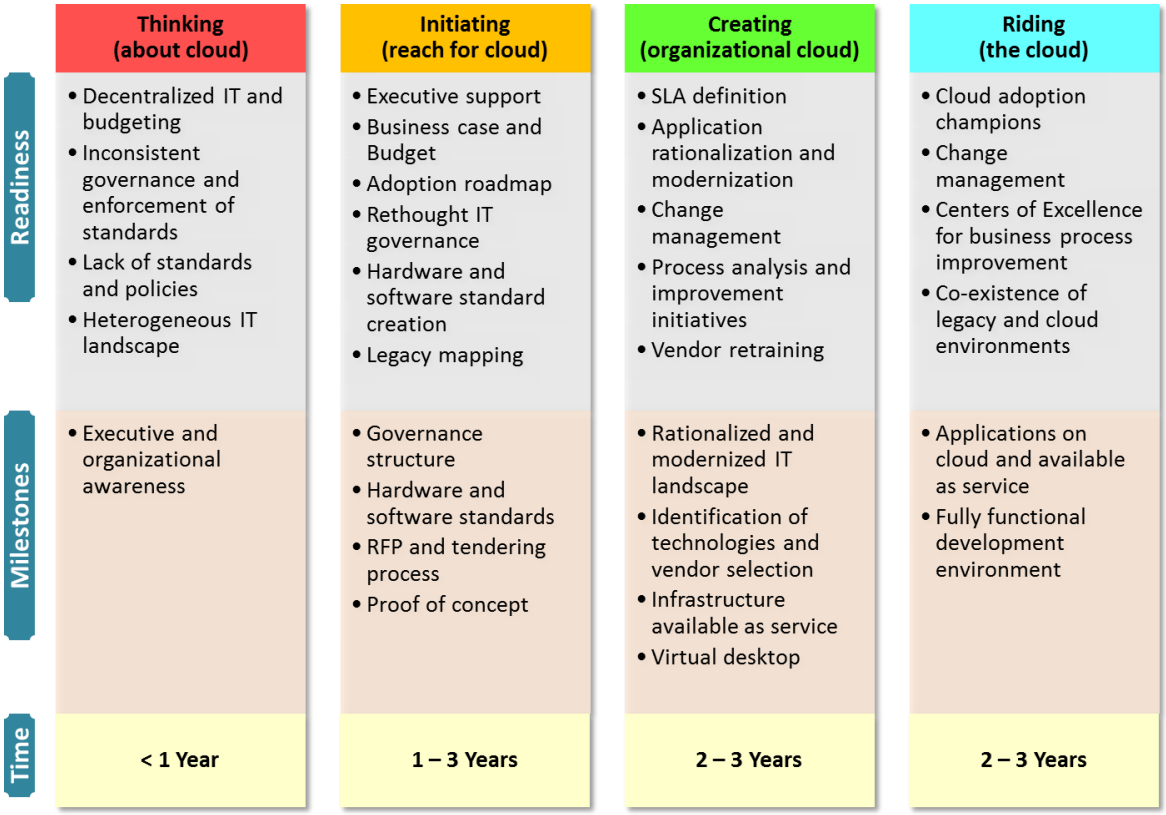

Figure 25: Cloud Adoption Model

6 SYSTEMS MODELING

Organizations today are very complex and so are the IT program implementations in them. Successful IT program implementations among other things need holistic perspective, understanding of dynamic forces at play, ability to project future consequences of actions taken today and managing the right levers to get the desired results.

6.1.1 Systems Dynamics

Systems dynamics is a method to gain insight into situations of dynamic complexity and policy resistance. It can help in designing more successful policies in companies and public policy settings (Sterman).

The dynamics of systems arise from feedback processes, either positive (reinforcing) or negative (balancing). Figure 26 given below represents a reinforcing process. More population leads to more births and adds to the population. Increased population leads to more births and so on. +ve sign indicates positive effect on the following variable. Since it is a reinforcing loop, it is indicated by R.

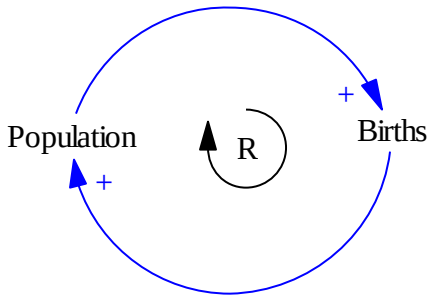

Figure 26: Reinforcing Loop

But population, like all other real quantities cannot continue to grow forever. There are limits to its growth. One such balancing process is given in Figure 27. More population leads to more deaths which in turn reduces the population. Since deaths decrease population there is a –ve sign from deaths to population. Since it is a balancing loop, it is indicated by B at the center.

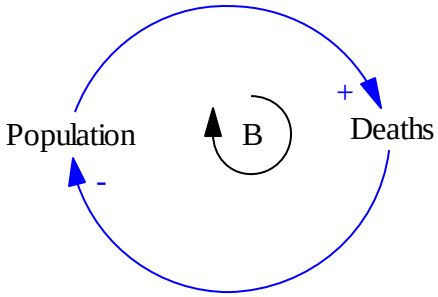

Figure 27: Balancing Loop

Do feedback processes make up for everything? No they do not. There are stocks and flows, and they along with feedback are the key concepts in systems dynamics. Stocks are accumulations and flows are rates at which stocks increase or decrease. Figure 28 represents a stock and flow diagram.

Figure 28: Population Stock and Flows

Population is the stock and the birth and death rates are flows. Such stock and flow diagrams have precise mathematical meaning, and they also need to be dimensionally consistent. Figure 29 gives stock and flow diagram along with units.

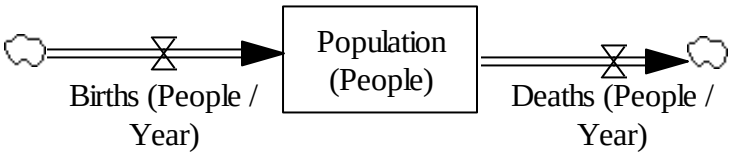

Figure 29: Population Stock and Flows with Units

Stocks can change only through rates of flow. There can be no causal link directly into a stock (Sterman). But variables, known as auxiliary variables can be added to explain a model. A simple model with auxiliary variables is given in Figure 30.

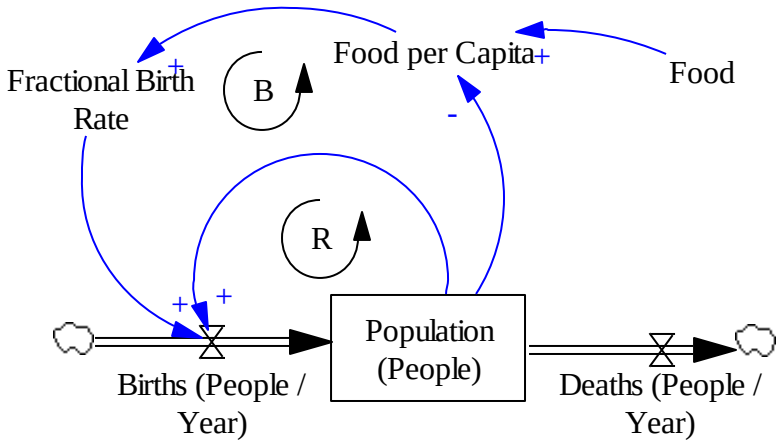

Figure 30: Population Stock and Flows with Units and Auxiliary Variables (Sterman)

Since the model presented above also has a mathematical foundation, the behavior of stocks and flows can be observed by simulating for various time periods using different values of stocks and flows.

To investigate deeper into the cloud adoption pattern, understand finer dynamics, identify interplay of systems, and simulate key scenarios, systems models are presented for Infrastructure Service, Platform Service and Enterprise Software as Service.

6.1.2 Infrastructure Service

Systems model for Infrastructure Service, given in Figure 31, shows us the different forces at play and throws up a number of possibilities including:

Infrastructure Service can lead to reduction in costs and consequent investment in such a program. It shall drive resources towards service management tools, standardization, and virtualization. All these have positive influence on conversion of infrastructure into service. This is a reinforcing loop represented by R1.

Common standards though an enabler of Infrastructure Service can lead to certain Mission Specific Systems not being available and thus Unmet Mission Needs. Such a situation could arise with a delay. It can lead to Infrastructure Service erosion because of systems being created to meet the mission needs. This is a balancing loop represented by B1.

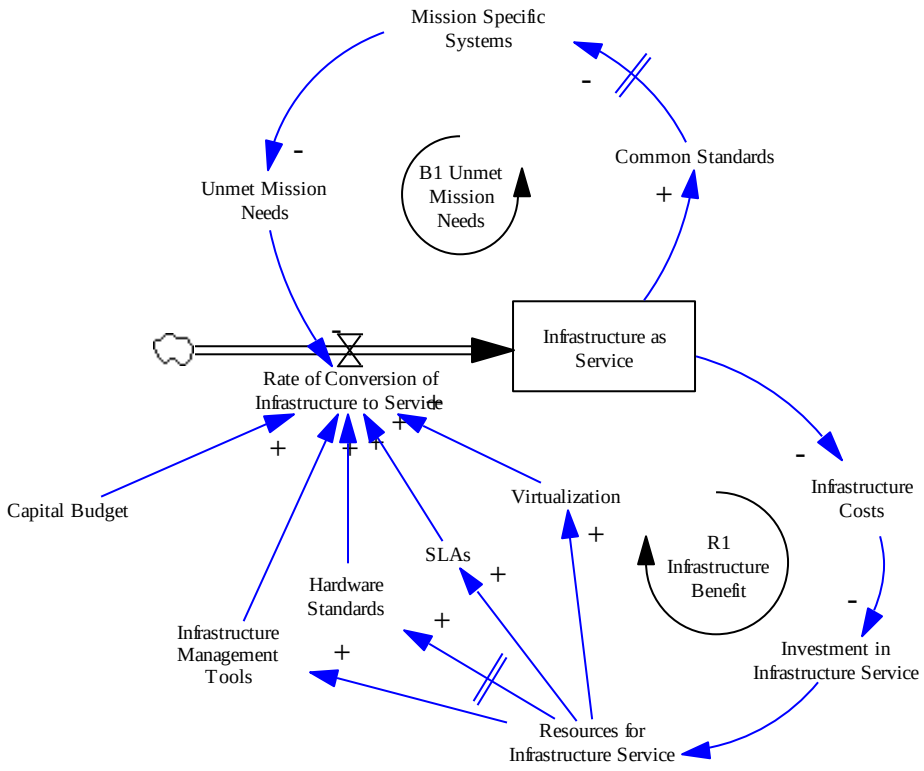

Figure 31: Infrastructure Service Stock Flow Model

6.1.3 Development Platform Service

Development Platform Service is expected to confer the benefits of reduced Development Time and Development Staff, translating into reduced Development Costs. Such a situation shall spur further investment in Platform Consolidation through Software Standards, Reusable Components, and Prototyping. All this will positively impact the Rate of Consolidation of Platforms. This reinforcing loop is represented by R2 in Figure 32.

The above scenario of platform induced benefits is dependent upon change management over a period of time including training and reskilling of current staff. Scale of Platform Consolidation can mean significant requirement for change management, thus slowing the rate of Platform Consolidation. This balancing loop is indicated by B2 in Figure 32.

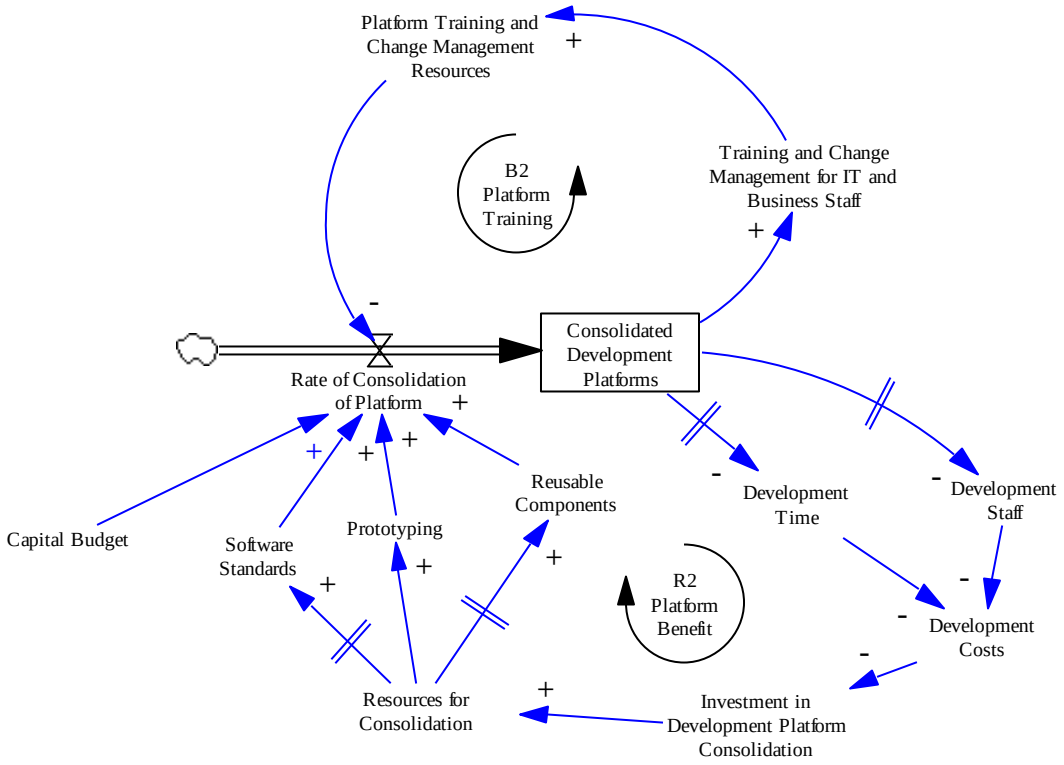

Figure 32: Platform Service Stock Flow Model

6.1.4 Enterprise Software as Service

Enterprise Software as Service among others promises upfront cost advantages but it essentially converts capital costs into operational costs. Jury is out on whether Enterprise Software as Service indeed confers cost advantages. None the less, Enterprise Software as Service offers Ease of Maintenance including upgrades, application of fixes, and continued sustenance. In advanced

scenarios, organizations can also benefit from Services for Clients enabled by their Enterprise Software as Service platform. In both the scenarios there is incentive for Investment in Enterprise Software as Service. It helps with Application Rationalization and Modernization, and consequently Rate of Conversion of Software into Service. This reinforcing loop is indicated by R3 in Figure 33.

As in the cases of Infrastructure Service and Platform Service, change management including training will be a key issue. This balancing loop is indicated by B3 in Figure 33.

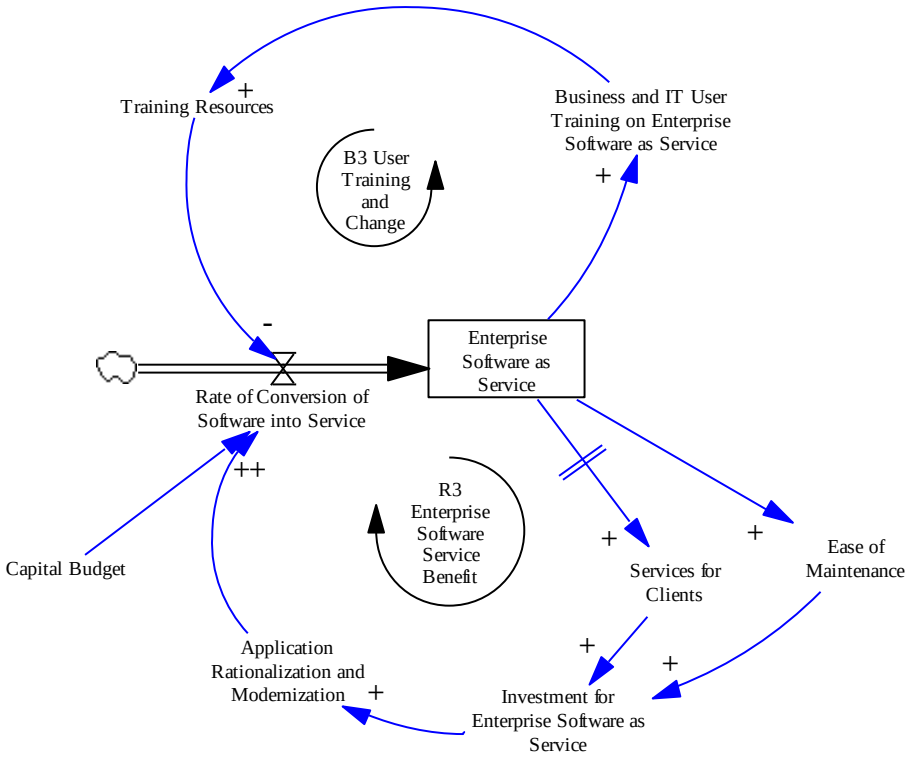

Figure 33: Enterprise Software as Service Stock Flow Model

6.2 SIMULATION MODEL

Stock Flow diagrams discussed earlier give us an indication of the key drivers of Infrastructure Service, Platform Service and Enterprise Software as Service. The Enterprise Software as Service stock and flow has been developed into a simulation model, given in Figure 34, to better understand:

- Factors that drive conversion of non-cloud applications into Enterprise Software as Service
- Impact of routing benefits from cloud programs into cloud budget
- Time line for an organization to move to Enterprise Software as Service

The simulation model has Total Non-Cloud Applications, Modernized and Rationalized Applications, and Enterprise Software as Service as stocks. The flows are Rationalization and Modernization Rate and Conversion. The stocks were chosen under the hypothesis that a typical organization in the initial state shall have only Non-Cloud Applications, Modernize and Rationalize the applications as an intermediate step and eventually convert them to Enterprise Software as Service.

The key auxiliary variables are Application Modernization Factor (% of total applications modernized), Overall Budget, Benefit Routing Fraction (% of cloud benefits that goes to Overall Budget), Cost to Maintain Modernized Applications, Cost to Maintain Enterprise Software as Service and Cost of Conversion.

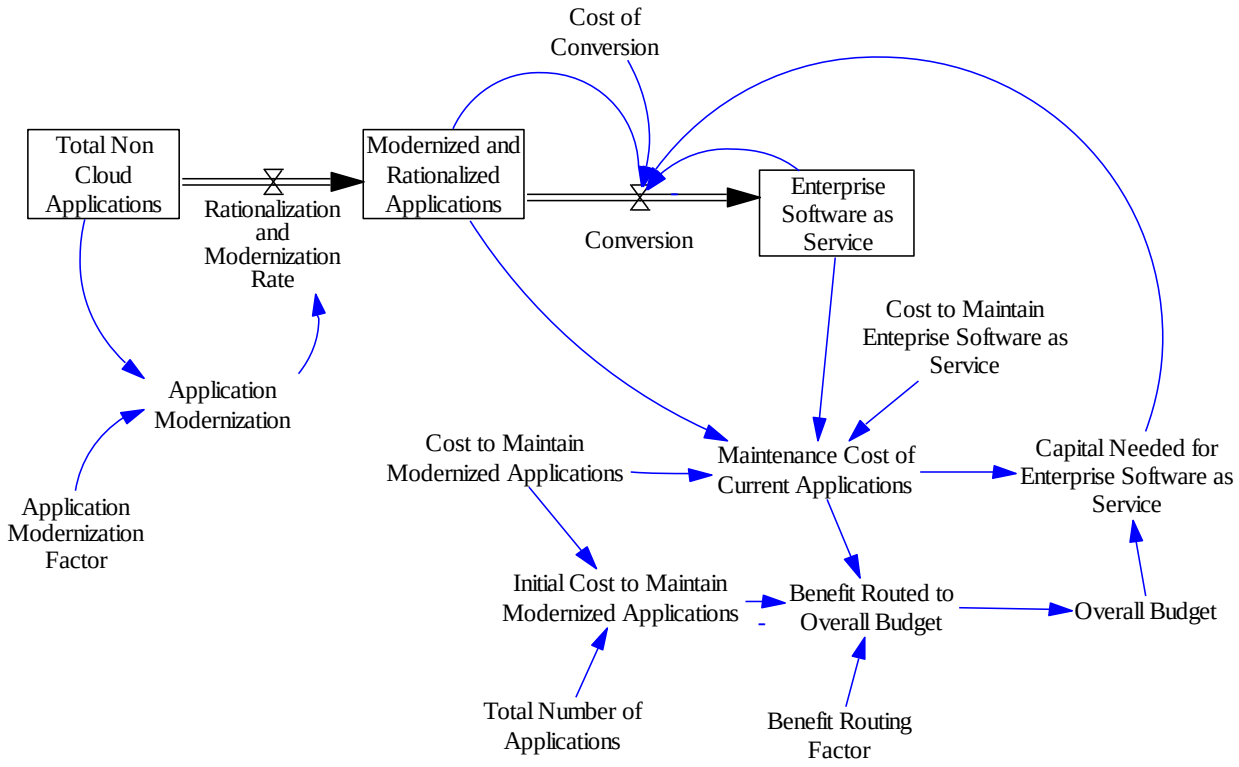

Figure 34: Simulation Model

The cloud related benefits in this model are captured by the difference in Cost to Maintain Modernized Applications and Cost to Maintain Enterprise Software as Service.

For purpose of simulation, the initial levels of Total Non-Cloud Applications, Modernized and Rationalized Applications, and Enterprise Software as Service were set at 1000, 0, and 0 respectively. The assumptions associated with the auxiliary variables for the simulation runs are given in Figure 35.

	Base	Run 1
Total Number of Non Cloud Applications	1000	1000
Application Modernization Factor (Percent of Total Non Cloud Applications)	0.2	0.2
Overall Budget (USD MN / Quarter)	50	50
Benefit Routing Fraction (Percent of Total Maintenance Savings)	0.1	0.2
Cost to Maintain Modernized Applications (USD/Quarter/Application)	25000	17500
Cost to Maintain Enterprise Software as Service (USD/Quarter/Application)	20000	10000
Cost of Conversion to Enterprise Software as Service (USD/Application)	500K - 10MN	500K - 5MN

Figure 35: Simulation Run Parameters

For the purpose of simplicity, the simulation model considers only reduced maintenance cost as benefit of cloud computing and does not take into consideration the impact of user training and change as indicated in section 6.1.4.

6.2.1 Key Observations

Simulation runs indicate that it could take an organization with 1000 applications up to 50 quarters (or 12 years) to reach Enterprise Software as Service steady state, if it were to move all its applications to cloud. Figure 36 charts the behavior of Total Non-Cloud Applications, Modernized and Rationalized Applications, and Enterprise Software as Service over a period of time for parameters of Run 1 as given in Figure 35 above.

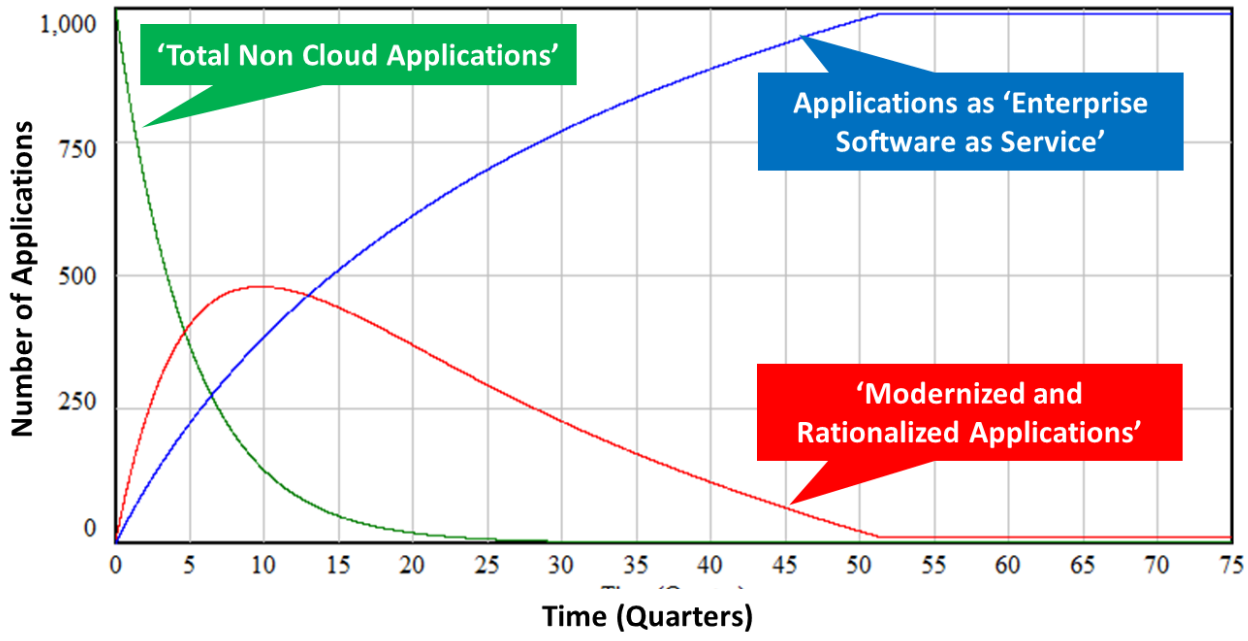

Figure 36: Total Non-Cloud, Modernized and Enterprise Software as Service Applications over Time

Total Non-Cloud Applications curve in Figure 36 indicates the amount of time it shall take for the applications to reach the intermediate Modernized and Rationalized Applications state.

The Modernized and Rationalized Applications curve in Figure 36 initially shows an increase as more number of Non-Cloud Applications are modernized and rationalized. Over time the curve shows a decreasing trend as the Modernized and Rationalized Applications start getting converted into Enterprise Software as Service.

Enterprise Software as Service curve in Figure 36 gradually increases and reaches a plateau as the Modernized and Rationalized applications get converted into Enterprise Software as Service.

Conversion of Total Non-Cloud Applications into Enterprise Software as Service is driven by Capital Needed for Enterprise Software as Service (and made available), indicated in Figure 37, and Cost of Conversion (per application) that are treated as proxy for resource availability.

Capital Needed for Enterprise Software as Service, refer Figure 37, starts at a high level initially as number of applications to be converted to Enterprise Software as Service is high. The need for capital decreases over time as benefits from Enterprise Software as Service are realized and routed to cloud program. The need for capital increases subsequently as the cost of Conversion to Enterprise Software as Service increases over time.

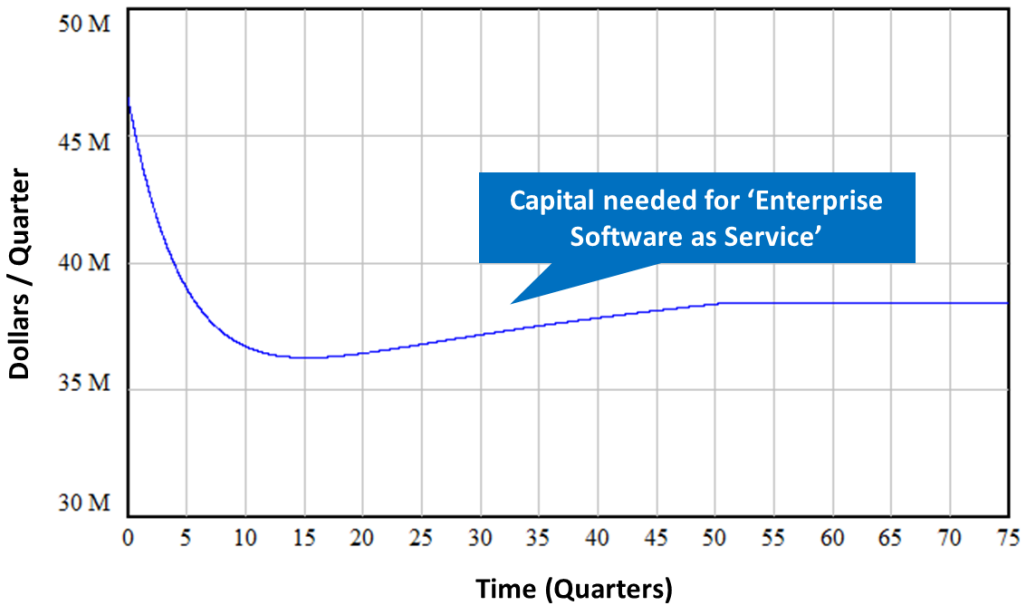

Figure 37: Capital Needed for Conversion of Applications to Enterprise Software as Service

This timeline and the associated cost in turn imply that organizations should decide upfront whether they want to convert all their applications to Enterprise Software as Service. If they decide to do so they need to have strong governance to manage a program of this length and clear idea of the extent to which they would convert applications to Enterprise Software as Service.

7 CONCLUSION

Cloud is known as different things to different audiences (proverbial elephant in the dark room) but agencies such as NIST have cleared the mist to some degree. As organizations across public sector and private sectors understand what cloud means for them, they are looking to act and deploy cloud solutions.

Some organizations, studied as part of this thesis, have made significant progress in their journey to cloud and others are just about starting. These organizations offer tenable insights into what makes for a successful cloud program and the required competencies. Certain themes such as application rationalization and modernization, standardization, centralized governance (IT Monarchy / Business Monarchy or IT Monarchy / Federal combinations), and change management have revealed themselves as common threads.

The journeys specifically have been marked by proof of concepts, technology selection, infrastructure service, and platform service as milestones. The organizations at different stages of cloud adoption exhibit different characteristics and possess distinct competencies, and organizations should not bite more than they can chew, lest their programs fall flat. Furthermore, what might constitute a success for one organization might turn out to be a not so successful initiative for another organization as evidenced by Virtual Desktop.

Last but not the least, cloud programs require competencies that organizations have tried to master for many decades now but what makes them different in the context of cloud are the scale i.e., cloud programs touch every piece of hardware, development platform, and enterprise software application in an organization and will potentially run for at least a decade for a large organization.

8 AREAS OF FURTHER STUDY

The thesis has attempted to explore in detail cloud adoption examples from a wide cross section of organizations, raise questions and answer them. But many key questions still remain and these can be further areas of study.

The Cloud Adoption Model discussed in this study is based on private cloud deployments. Increasingly organizations are looking at hybrid deployment models comprising private and public clouds. Further study can be done to understand cloud adoption in a hybrid scenario.

The model equates the context of governments and large enterprises. The generalization has enabled the formulation of a model but ignored any specific procurement and adoption patterns. The model can be studied further to identify differences between adoption for governments and large enterprises.

All of the organizations studied are in the process of adopting cloud. It shall be worthwhile to investigate those organizations where cloud program was executed but the results were not as per expectations. This shall test the tenets of the proposed adoption model and also suggest modifications.

Cloud by its nature converts ostensible vertical silos into horizontal discs expected to perform different functions. Will such a horizontalization, based on common standards, of verticals enable flexibility or impede it in the future when businesses change?

As organizations leap into the future by executing cloud programs, they are also rooted to the past through a landscape of legacy applications, many of them business critical. Cloud programs offer the opportunity to rationalize and modernize those applications but to what extent should organizations refactor legacy applications? How can organizations optimally manage their legacy and cloud platforms?

Last but not the least; is it likely in any scenario for an organization to move back from cloud platform to a non-cloud platform? What could be the reasons behind such a move and how will it impact the platform strategy of future?

9 APPENDIX

9.1 INTERVIEW QUESTIONNAIRE

PRE CLOUD SUMMARY DISCUSSION QUESTIONS

1. What has happened so far in the cloud program and what are the expectations at the highest level? What are the likely next steps?
2. What benefits can cloud provide to XXXX? Reduced costs, application platform to let departments develop own applications, common infrastructure including networking computing.
3. What is the typical life cycle of a project similar in size to what cloud project is likely to be? What are the stages, how much time it takes etc.?
4. What is existing budgeting, planning, procurement and execution process for large technology projects? It is centralized, managed by YYYY or decentralized.
5. Are there any projects which have multiple departments or ministries involved? How are those projects managed? Do they have a governance model with representation from all the concerned departments?
6. Is YYYY the only agency which provides technology services to the ministries or do ministries and departments also do some things on their own?
7. What is the scope of existing data centers? Can they provide cloud based services? Is it accessible to all departments and ministries? Does it use technologies such as virtualization?
8. Do departments and ministries work on the same network? Different networks, if so, then how many?
9. How is culture change handled at present? Is there an organized program to manage change?

FIRST LEVEL SUMMARY CLOUD COMPUTING DISCUSSION QUESTIONS

Business Goals and Strategy

1. What does XXXX hope to achieve and plan to establish from cloud?
2. What is XXXX's cloud adoption roadmap? Key elements of roadmaps are time, functions, businesses, business applications, resources.

Execution and Program Management

1. What approach to cloud computing is XXXX taking (Public cloud, single vendor stack, best of breed, private cloud, hybrid cloud) and what resources is XXXX utilizing to realize program goals?
2. How is XXXX governing its move to cloud? Elements of governance are structure, personnel, processes, tools.

Benefit Realization and Measurement of Success

1. Has XXXX quantified benefits of moving to cloud? If yes, what are those benefits?
2. How is XXXX measuring success of its cloud program and what are some of those measures?

Organizational Readiness and Risk Mitigation

1. What changes did XXXX make to its organization structure, processes and culture to support move to cloud?
2. What risks has XXXX identified in moving to the cloud and how does XXXX plan to mitigate those risks?

FIRST LEVEL DETAILED CLOUD COMPUTING DISCUSSION QUESTIONS

1. What was XXXX's motivation to move to the cloud?
2. What does XXXX hope to achieve, and plan to establish from cloud?
3. What would be the "Ideal Scene" for XXXX?
4. Who championed moving to cloud idea in XXXX?
    a. Did the idea come from the top management? If not, who suggested it?
5. What was the reaction to the idea?
    a. Did any of the stakeholders display resistance and what were their reasons/justifications?
    b. How did XXXX manage resistance?
6. How have XXXX's customers, partners and employees reacted to XXXX move to cloud? Did customers bring out concerns related to security? Are XXXX's partners able to help XXXX realize its vision? Are employees exhibiting a different behavior?
7. What is XXXX's cloud adoption roadmap? Key elements of roadmaps are time, functions, businesses, business applications.
8. What approach to cloud computing is XXXX taking? Public cloud, single vendor stack, best of breed, private cloud, hybrid cloud.
9. Where is XXXX today in cloud adoption? Completely new to Cloud, Data Center, Data Center with Virtualization, Cloud – fully versed.
10. What investments has XXXX made to establish cloud? Business planning, business case, vendor selection, services budget, staff acquisition / training, internal buy in.
11. How did XXXX identify candidate applications for cloud and what are those? The best candidate applications for the enterprise cloud computing model are those with a dynamic aspect to them: Applications with highly variable load characteristics (e.g. Web apps, virtual desktops)
12. Did XXXX rationalize its portfolio of applications as it embarked on cloud initiative?
13. How is XXXX governing its move to cloud? Elements of governance are structure, personnel, processes, tools.
14. Cloud solutions are complex and involve the use of many different applications, tools and services, all of which may have differing licensing models and processes. Does XXXX have an understanding of that complexity?
15. Has XXXX involved external partners in its cloud program? Who are these partners and what are their roles?
16. Who in XXXX is responsible for overall management of all finance and procurement activity for cloud, business relationships with vendors and partners?

17. Cloud solutions are complex and often require many layers of legal agreements to be in place. Does XXXX understand all the legal layers and is able to create and manage all legal contracts accordingly?
18. What changes did XXXX make to its organization structure, processes and culture to support move to cloud?
19. What advantages and performance improvements does XXXX want to achieve by moving to the cloud? Has XXXX quantified benefits of moving to cloud? If yes, what are those benefits?
20. How is XXXX measuring success of its cloud program and what are some of those measures?
21. Is XXXX also moving to a shared services concept? If yes, how are the services charged?
22. What risks has XXXX identified in moving to the cloud? Security, Availability, Lack of Transparency.
23. How does XXXX plan to mitigate risks?
    a. Incentive structures
    b. Service level agreements
    c. Other governance mechanisms
24. What best practices has XXXX identified as part of the cloud program?
25. What factors, from XXXX's perspective, are key to cloud adoption? Control, Service Level Management, Compliance, Security.

SECOND LEVEL DETAILED CLOUD COMPUTING DISCUSSION QUESTIONS

Organizational Dynamics

1. How is XXXX organized (along functions, countries, markets, centralized functions) and what is its organization structure like?
2. Has technology procurement process changed for business units and IT organization?
3. Which organization in XXXX controlled the deployment of applications, infrastructure before the move to cloud and which organization controls it now? What was the transition like?
4. Did XXXX modify its program governance model to address the uniqueness of cloud program (scale, scope, duration, and cost)? If it did so what were those changes? Does XXXX have external consultants in its governance structure?
5. Do XXXX business units still procure applications on their own? Does the move to cloud restrict their independence in any form?
6. What is the organizational distance between IT and business decisions?
7. Has the move to cloud led to greater innovation and higher need for change management?

Human Dynamics

1. How do users, on virtual desktop, work on their desktops / laptops if they are travelling? How do virtual desktop users personalize their experience?
2. Has move to virtual desktop involved change in the way employees work?
3. Were employees given any form of training or prior communication on virtual desktop?
4. Have employee work pattern changed with the move to cloud? Does XXXX see any changes happening in employee work pattern in future?

Costs and Benefits

1. Did XXXX see a surge in costs during its move to cloud?
2. Did applications which moved to cloud show immediate benefits too?
3. What is the cost saving distribution across compute and other environments?

Cloud Adoption

1. Where is XXXX in its cloud adoption program? What milestones has the program achieved so far and what milestones are yet to be achieved? Did XXXX see any slippage in achieving any of the milestones? What are the success criteria?
2. Did XXXX consider different forms of cloud viz., private, public and hybrid cloud and why did XXXX choose its current cloud?
3. Who runs the private cloud for XXXX? The IT organization?
4. Were special capabilities (in XXXX and amongst Vendors) required to move to cloud? If those capabilities were not present, how were they developed?
5. Does XXXX provide access to software in Software as a Service mode? Have business units moved to paying for using software? What is the payment model used?
6. Why didn't XXXX start with low volume transactions? What is the top management's view on it?
7. Was an inventory of applications, servers, networks made and which team in XXXX made it?
8. Were policies adopted to standardize the compute environment to enable faster virtualization e.g., standardizing on windows instead of MACs?
9. What was the surge in resources required to execute on cloud? What happened if the resources required got pulled into something else such as a crisis?
10. How does XXXX comply with regulations as it moves to cloud?

Existing Cloud Set Up

1. How is the Program Management Office organized? Does it have a Steering Committee, Program Team, Project Team etc?
2. Does XXXX have only private cloud set up?
3. Do all legacy and core applications run on cloud compute platform / virtual machines? If not, what is the plan to migrate them to cloud? Have new applications replaced legacy applications?
4. Are users able to exploit the unique features of databases i.e., do users interchange between different application types / databases and use only the common features to enable such a use?
5. How do applications get upgraded in cloud? E.g., how is Siebel upgraded and how do vendors handle the change?
6. Does the IT organization have a view of the complete application landscape?

Future View

1. How does XXXX plan to address specific business needs such as a very specific application which might require change to the underlying common standards viz., compute, security?
2. Is XXXX cloud platform flexible enough for applications and platforms which will come in future?
3. How does XXXX plan to address likely business events such as acquisition, financial crisis aka 2008 with respect to the cloud platform?

9.2 TOE Framework Components

Reference and innovation	Technological context factors	Organizational context factors	Environmental context factors
Chau and Tam (1997)	Perceived barriers*	Satisfaction with existing systems*	*Environmental uncertainty*
	Perceived benefits	*Complexity of IT infrastructure*	
Open systems	*Perceived importance of compliance to standards, interoperability, and interconnectivity*	*Formalization on system development and management*	
Grover (1993)	Compatibility*	Size*	Role of IT*
	Complexity*	Strategic planning*	Management risk position*
Customer-based IOS	*Relative advantage*	Infrastructure*	Adaptable innovations*
		Top management support*	Technology policy
		Championship*	Customer interaction
		Centralization	Competitor scanning
		Formalization	Competition intensity
		Integration	Information intensity
		Implementation planning	Power
			Generic strategy
			Maturity
			Vertical coordination
Kuan and Chau (2001)	Perceived direct benefits*	Perceived financial cost*	Perceived industry pressure*
EDI	*Perceived indirect benefits*	Perceived technical competence*	Perceived government pressure*
Lee and Shim (2007)	Perceived benefits*	Presence of champions*	Performance gap*
RFID	Vendor pressure		Market uncertainty*
Mishra et al. (2007)	Procurement process digitization*	Diversity of organizational procurement knowledge	Suppliers' sales-process digitization*
Internet in procurement		Organizational perceptions of technological uncertainty	
Ramdani et al. (2009)	Relative advantage*	Top management support*	*Industry*
	Compatibility		*Market scope*
	Complexity	Organizational readiness*	*Competitive pressure*
Enterprise systems	Trialability*		*External IS support*
	Observability	*IS experience*	
		Size*	
Thong (1999)	Relative advantage of IS	Business size*	*Competition*
	Compatibility of IS	Employees' IS knowledge*	
IS	Complexity of IS	Information intensity	
		CEO's innovativeness	
		CEO's IS knowledge	
Zhu et al. (2003)	Technology competence (second-order construct composed of IT infrastructure, Internet skills, e-business know-how)*	Firm size*	Competitive Pressure*
E-business		Firm scope*	Consumer readiness (interactive construct composed of consumer willingness, Internet penetration)
			Lack of trading partner readiness
Zhu et al. (2004)	Technology readiness*	Firm size*	Regulatory environment*
		Global scope*	*Competition intensity*
e-business		Financial resources*	
Zhu and Kraemer (2005)	Technology competence*	Size*	Regulatory support*
e-business		Financial commitment*	Competitive pressure
		International scope	
(Zhu et al. 2006b)	Technology integration*	Firm size	Competition intensity
e-business	Technology readiness	Global scope	Regulatory environment
		Managerial obstacles	

9.3 Readiness – Adoption Assessment Scores

Readiness Scores

Organization	LAM	GoIND	LFINT	SIGOV	USINT
Readiness Metric					
Executive Support	3	2	3	3	2
Business Case and Budget	3	1	3	3	2
Governance	3	1	3	3	2
Application Rationalization and Modernization	3	1	2	2	1
Standardization	2	1	3	3	2
Service Level Definition	3	1	3	3	2
Change Management	2	1	2	2	1
Process Analysis and Improvement	1	1	2	1	1
Total	**20**	**9**	**21**	**20**	**13**

Adoption Scores

Organization	LAM	GoIND	LFINT	SIGOV	USINT
Adoption Metric					
RFP and Tendering Process	3	1	3	3	3
Proof of Concept	3		3	2	2
Vendor Selection	3		3	3	2
Infrastructure as a Service	1		3	2	
Virtual Desktop	1		3		
Development Platform	1		2		
Software as a Service	3		1		
Integrated Cloud Platform					
Total	**15**	**1**	**18**	**10**	**7**

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