## A New Paradigm in Cloud Computing

The Infocomm Development Authority of Singapore (IDA) notes that there is a paradigm shift in computing, where businesses and end-users will be accessing applications such as word processing, storage, and even compute power, through the Web. In short, the interwoven nature of Internet applications will be akin to a "cloud" of services that everyone can eventually access easily through a broadband connection. These services are also typically offered via a "pay-as-you-use" model. Cloud computing enables consumers and business users to consume infocomm services without the need for an IT support team.

With this paradigm shift, it is important for Singapore to remain competitive through the adoption of cloud computing and enhance the vibrancy and growth of the Singapore infocomm sector through the development of a cloud computing ecosystem. With the Next Generation Nationwide Broadband Network (Next Gen NBN) coming into place, Singaporeans will have even faster access, with cloud computing offerings being part of the exciting range of next generation services to come.

Six Key Thrusts

IDA has taken a strategic approach to leverage this paradigm shift to sharpen the overall economic competitiveness of businesses in Singapore. The six key thrusts are detailed in the paragraphs below, and the related framework in Figure 1:
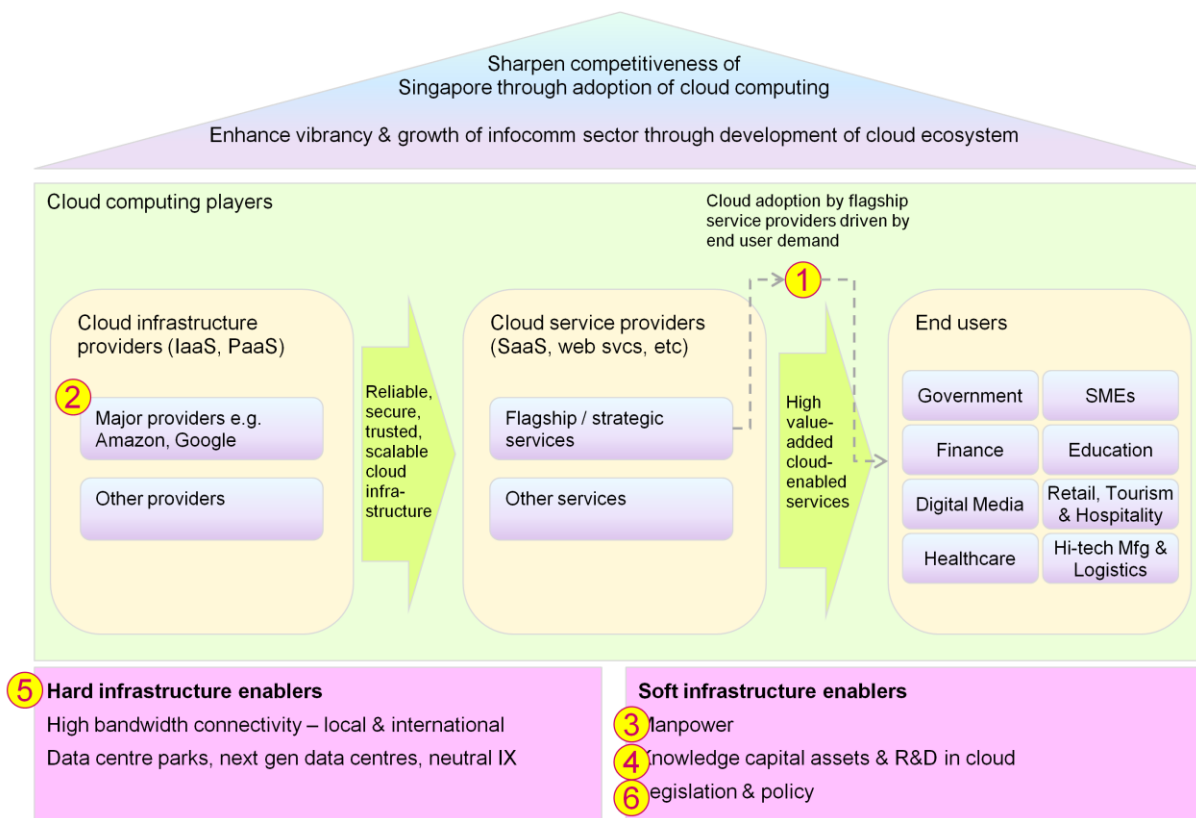
Thrust 1 – Support Flagship Users of Cloud Services

The attraction of flagship cloud users into Singapore would lend global credibility of Singapore's capability in this space.

Thrust 2 - Attract Cloud Players

Clouds require significant investment in the underlying infrastructure, such as data centres, broadband connectivity and servers, as well as in manpower resources for research and operations. Such investments are long-term and well considered business decisions.

Thrust 3 – Develop Competency for Industry & Manpower

A pre-requisite to a vibrant cloud computing ecosystem is the capability of the local infocomm companies and workers exploit the new paradigm shift in order to develop innovative cloud-based services. There is a role for IDA to put in place the necessary framework and incentives for companies and workers to upgrade their competencies in this new space.

Thrust 4 – Forge R&D Relationships and Build Knowledge Capital Assets

Singapore seeks to harness its existing knowledge capital resources in IHLs and RIs to attract major corporate cloud R&D to set up in Singapore. Investing in cloud R&D is not enough where there is a need to bridge the gap and provide a conducive environment for the translation of R&D results into industry practice and product/services deployment.

Thrust 5 – Provide Enabling Infrastructure

For Singapore to be a cloud computing hub to the rest of the world and region, there would be a need for world-class high speed and seamless broadband connectivity within Singapore, as well as connecting Singapore with other major cities. Development of major infocomm infrastructures such as Next Gen NBN, Singapore Internet Exchange and Data Centre Park, provide a competitive environment in nurturing a vibrant cloud computing ecosystem.

Thrust 6 – Build a Trusted Environment through Policy and Legislations

Cloud computing investments would gravitate towards jurisdictions with stable, trusted business environment, especially when larger enterprises with mission-critical or data sensitive requirements move into the cloud.

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Support Flagship Users of Cloud Services

1. **Calls for Cloud Computing Proposals**
   IDA has launched six Calls for Cloud Computing Proposals since 2010, as part of its efforts to promote the adoption of cloud computing. Depending on the impact and scope of the project, selected projects (from industry, Government and R&D) receive support in terms of compute and storage resources based on the approved duration (of up to 6 months) and quantum of cloud services (compute core-hours and storage GB-months) from one of the participating CSPs which sponsor cloud resources. To-date, these Calls have awarded a total of 75 projects with cloud resources worth nearly $5 million to undertake test-bedding, proofs-of-concept and research.

2. **Bulk Tender for Cloud Services**
   Three local consortia, led by SingTel, PTC System (S) Pte Ltd, and New Media Express Pte Ltd have been offering commercial services to the industry on a pay-per-use mode since November 2008. Businesses can enjoy these services as a utility, without upfront investment in hardware and software on their part. For Government users, such services can be procured under the Bulk Tender for Cloud Services. The Bulk Tender is aligned with Government's objective of achieving greater efficiency at the Whole-of-Government level to achieve fiscal prudence and greater efficiency by aggregating end users' demand and provide shared facilities to achieve economies of scale. In December 2011, another bulk tender was called to tap on the offerings of new public CSPs. Six public CSPs have been awarded the bulk tender for a period of two years with the option to extend for another year. They are aZaaS (with Microsoft Azure), CrimsonLogic (with ClearManage), NewMedia Express, PTC, SingTel and StarHub

3. **EnVision**
   This period bulk tender was called by IDA for the supply of cloud-based video hosting and streaming services using the utility pricing model to Government ministries/departments, statutory boards, organs of state, and participating entities. Government agencies have been using EnVision for hosting and streaming videos for corporate events, public education and information.

   As at 1 April 2013, a total of 29 agencies have put up more than 1,100 videos using EnVision. There are also 14 schools that have used EnVision to put up about 560 videos. These schools range from primary schools to institutes of higher learning. To encourage greater adoption by schools, IDA and the EnVision providers render a support scheme for schools to develop their own video sites. Under this arrangement, each school can enjoy up to six-month worth of cloud resources, capped at $1,300, while they need to pay for only 50 per cent of the network bandwidth consumed. To further promote such use among schools, IDA has organised a video site competition in January 2013.

4. **SaaS Enablement Programme**

IDA has established a Software-as-a-Service (SaaS) Enablement Programme in October 2011. IDA supports efforts to convert existing software operating on the traditional upfront software licensing model to one that is cloud-based on a utility pricing model. Under this programme, funding support will be provided for manpower, professional services and training expenses in relation to SaaS enablement efforts. As of July 2012, for the construction sector, IDA has provided grants to two independent software vendors or ISVs to SaaS-enable their construction software. For the engineering sector, IDA has also provided grants to four ISVs to SaaS-enable their Precision Engineering software.

5. **Inclusion of Cloud Computing under PIC**

Cloud computing, specifically SaaS, Platform-as-a-Service and Infrastructure-as-a-Service, is now allowed under the Productivity and Innovation Credit (PIC) Scheme. The first $400,000 in costs incurred to acquire cloud computing resources would qualify for a 400 per cent tax deduction. Businesses are strongly encouraged to make full use of the PIC Scheme to invest in productivity and innovation. To take advantage of this, no application is required; businesses can claim the tax benefits as part of their tax filing.

Attracting Cloud Players

1. Cloud requires significant investment in underlying infrastructure such as data centres, broadband connectivity and servers, as well as manpower resources for research and operations. IDA works closely with other Government agencies to attract cloud players into Singapore. Global CSPs that have established their cloud data centres in Singapore for local and Asia Pacific market include Amazon Web Services, Atos, Chunghwa Telecom, Fujitsu, IBM, Iconz-Webvisions, Microsoft Azure, NTT, Savvis, Softlayer and Tata Communications.

Facilitating Competency Development for Industry & Manpower

1. **Developing Cloud Competency Standards**

An important first step in professional training is to develop the competency standards governing job roles with focus on cloud computing. In 2010, IDA in collaboration with the Workforce Development Agency (WDA) established a technical committee comprising representatives from leading cloud computing industry companies under the National Infocomm Competency Framework (NICF). The cloud computing technical committee developed a total of 22 new competency standards for 14 cloud computing job roles across four job families, namely cloud architecture, cloud engineering, cloud operations and cloud services. The new cloud computing competency standards were released to the industry for adoption in July 2011 at the Infocomm Professional Development Forum.

2. **Enabling Professional Conversion**
   Under this initiative, IDA will enable IT professionals who are not familiar with cloud computing technologies to acquire essential skills and knowledge through various platforms such as workshops and practical, on-the-job training.

   IDA had conducted two workshops for IT professionals in July 2012 as part of the programme for Infocomm Professional Development Forum (IPDF) 2012. These workshops were delivered by industry leaders EMC and Microsoft to provide in-depth knowledge on various cloud computing topics, including data centre transformation and big data storage processing.

   IDA also encourages leading companies to provide on-the-job training opportunities for IT professionals to acquire cloud computing skills through hands-on, practical projects. The Company Led Training programme is led by IDA and supports on-the-job training for fresh graduates and young professionals. In 2012, IDA partnered with Dimension Data and IBM to create on the job training opportunities in cloud computing for fresh graduates.

   IDA launched two Centres of Attachments (COAs) with EMC and Microsoft in 2012. These COAs will enable infocomm professionals to acquire in-depth cloud computing skills with the use of leading-edge EMC and Microsoft products. In addition, IDA also partnered companies embarking on cloud computing projects to provide on-the-job training for professionals under the Infocomm Leadership Development Programme (iLEAD). To-date, IDA has partnered with companies such as NCS, SingTel, GigaSpaces Technologies, JustLogin, and Inspire-Tech to enable professionals to acquire skills at an expert or management level.

3. **Creating and Delivering Training Capacities**
   Under this initiative, IDA has collaborated with training providers to provide short courses to equip IT professionals with cloud computing skills

   To support professionals in taking up these courses, IDA expanded its Critical Infocomm Technology Resource Programme (CITREP) to cover training in new and emerging areas such as cloud computing. The expanded CITREP programme provides funding support for training courses and certifications with competency units aligned with cloud computing competency standards. Details of such courses can be found at nicf portal at https://www.nicf.sg

4. **Building Talent Pipeline**
   IDA also collaborates with IT schools for diploma and undergraduate students to acquire cloud computing skills.

   In 2011, Microsoft Singapore and Nanyang Polytechnic (NYP) signed a memorandum of understanding to deploy cloud curriculum on a large scale. The Polytechnic also became the first cloud-ready institution in Singapore where students will be trained commencing first year of enrolment. The program will train

4,000 students and 100 faculty members over three years. Building on this momentum, IDA facilitated for NYP and Temasek Polytechnic to design and launch the Specialist Diploma in Cloud Computing for professionals. Both Specialist Diplomas will be available for enrolment from April 2013.

5. **Public Talks on Cloud Computing**

Building upon the success of public talk series conducted by IDA and National Library Board from 2011 to 2012, IDA will launch a new public talk and industry sharing series in 2013. The aim is to further increase the awareness of cloud computing for the public and across industry verticals. These talks will commence in July 2013 at IDA's Infocomm Experience Centre, or iExperience, located at the Esplanade Xchange.

Forging R&D Relationships & Building Knowledge Capital Assets

1. **IBM Cloud Lab**

This collaboration between IDA and IBM seeks to promote and accelerate the adoption of cloud computing and associated business models through conducting applied R&D to tackle challenges and issues identified by users from Government and industry. The collaboration resulted in the launch of IBM Cloud Lab on 4 May 2010 and is hosted at IBM Changi Business Park Building with required hardware, software and resources. It aims to provide an integrative capability that creates prototypes of innovative solutions required by the industry, facilitating the harnessing of research results and deployment, and shortening the timeframe to adoption.

The first result of the IBM Cloud Lab is the High Performance Computing (or HPC) cloud platform at the Nanyang Technological University (NTU) – a first-of-its-kind in the world – which offers a combination of the best of high performance computing from HPC infrastructure, and the flexibility, self-services, scalability and virtualisation from cloud computing. This is currently being developed as a production pilot for use by NTU researchers. One of the first set of users to benefit is from NTU's School of Art, Design and Media which will use the new HPC cloud platform for rendering digital animation media to create rich content for their media and entertainment projects. After the initial cases have been validated, this HPC cloud environment will be opened up to the wider pool of researchers and students at NTU, and potentially to commercial users as well. The three-year collaboration with IBM has ended, with a total of four projects undertaken with user organisations

2 **Technology Evaluation Programme (TEP)**

Since August 2011, IDA has partnered with the Agency for Science, Technology and Research (A*STAR) on a technology evaluation programme, or TEP, where ICT companies can develop cloud computing solutions based on technologies made available by the Institute for Infocomm Research (I^2R) and Exploit Technologies Pte Ltd through a short-term no-fee evaluation licence grant that also gives these companies an option to take on a commercial licence if their trial

deployment proves to be successful and of value. IDA also signed MOUs on the TEP with the National University of Singapore and NTU in October 2012 and with the Institute of High Performance Computing in March 2013

Arising from the collaboration, IDA and its TEP partners jointly identify end-user challenges and requirements from industry and Government sectors. To date, six local companies have benefitted from the partnership through eight technology agreements.

Provide Enabling Infrastructure

1. **Grid Services Provisioning Call-for-Collaboration**
   In November 2007, IDA launched a Grid Services Provisioning CFC with the purpose of seeding development of necessary infrastructure towards providing infocomm resources on a pay-per-use basis. This enables more firms to leverage on cloud services to develop new, innovative business models and infocomm services. In November 2008, three cloud providers, mainly Alatum, nGrid and PTC, started offering commercial cloud services. The CFC has since ended in November 2012, with cloud providers exceeding the agreed KPIs. More than 3,500 SMEs have adopted SaaS, as well as 89 enterprises using Infrastructure-as-a-Service and 87 SaaS ISVs with at least 10 paying customers each. Following that, more public CSPs have started to offer cloud services in Singapore.

2. **Data-as-a-Service**
   The Data-as-a-Service (DaaS) programme will be launched in second half of 2013 to catalyse the development of a nationwide platform that allows the efficient delivery of data, on demand, to interested data buyers to develop applications for in-house or business consumption. The launch complements Government's efforts in making public sector data available to the public by focusing on the datasets from the private and people sectors. In conjunction with the DaaS programme, IDA has jointly worked with the Singapore's Information Technology Standards Committee (ITSC) to produce a Technical Reference on DaaS API, which was published in April 2013.

3. **Central Government Cloud**
   The Government adopts a multi-prong approach to cloud computing by leveraging on commercially available public clouds and implementing a private Government cloud, the G-Cloud, for Whole-of-Government use. Through G-Cloud, Government agencies can also procure cloud services easily to deliver Government services securely and quickly on demand. With the option to scale up and down rapidly, G-Cloud is able to meet the demands of changing workloads, resulting in increased agility. In addition, G-Cloud is an ideal platform for agencies to leverage as a test-bed to pilot new and innovative applications for a small group of users without up-front costs or asset ownership.

The G-Cloud Tender was awarded to SingTel in May 2012 for a period of five years with the option to extend for another five years. G-Cloud is ready for deployment and has already been subscribed to by a few agencies, such as the Personal Data Protection Commission website, and IRAS's Virtual Assistant launched in February 2013.

4. Infocomm Infrastructure

The development of major infocomm infrastructures, such as Next Gen NBN, Singapore Internet Exchange and Data Centre Park, provide a competitive environment in nurturing a vibrant cloud computing ecosystem.

Building a Trusted Environment

1. ITSC Cloud Computing Task Force

IDA worked with ITSC to set up a cloud computing standards coordinating task force in February 2011. The task force, which comprises representatives from IDA, ITSC, Singapore Computer Society, Singapore Infocomm Technology Federation, Information Technology Management Association, as well as industry verticals (e.g. healthcare), works on guidelines for issues with inputs from the industry. The deliverables include the completion of the Technical Reference documents on guidelines, best practices for virtualisation, cloud security and service level for public cloud services' users have been developed and available to the public since 2012.

2. Cloud Security Standards and Guidelines

IDA also embarked on the development of cloud security standards and guidelines for certification and cloud service providers. This multi-tier approach aims to provide transparency on their security provisions and a level of visibility of provisioning to cloud users. These Standards and Guidelines will highlight the key security areas and associated controls to be addressed arising from a cloud computing environment. The draft standard has just completed a two-month public comment phase and is scheduled to be available as a Singapore Standard in August 2013.

3. Data Protection Policy

The Personal Data Protection Act came into effect in January 2013. With this legislation, cloud service providers will definitely welcome the removal of ambiguity when servicing cloud users from and outside Singapore.

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