The NLB Cloud Service Implementations - Balancing Security, Agility and Efficiency

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Abstract:

The National Library Board (NLB) of Singapore is an ardent user of infocomm technologies (IT). It leverages on established technologies to deliver innovative services to its patrons. A robust, agile and cost-effective IT infrastructure provides a strong foundation needed to enable the highly reliable and available 24x7 services library users are accustomed to, and get to expect from NLB.

Cloud computing is a critical part of the NLB IT infrastructure. To meet the tight security requirements required as a government agency, NLB invested significantly in the setting up of a private cloud. It is an early adopter of virtualisation, and achieved significant cost-savings and at the same time speed up the provisioning of new servers.

Within the safety and confines of the private cloud, NLB was able to explore and implement innovative initiatives such as unified communications for staff and patrons, a comprehensive service enablement architecture used by many NLB services (e.g., Singapore Memory Portal, Infopedia and Archives Online). An analytics-as-a-service platform for text analytics to associate related digital resources has been implemented.

NLB's implementation of cloud computing services goes beyond the private cloud. The public cloud is used for the crawling and indexing needs of the Web Archives Singapore project. A hybrid approach is used for the handling of enquiries across NLB via all channels. A software-as-a-service on the public cloud is used to handle the non-sensitive data and workflow and tracking of the enquiries, while the sensitive data are kept in the NLB private cloud.

1 INTRODUCTION

Cloud computing has been touted as one of the most critical technologies (alongside Mobility, Social and Big Data) that can disrupt and transform the business landscape. It has the potential to allow organization to start small and to realise values quickly, and yet is able to scale up when the needs arise. It promises to allow businesses to pay only what they use and without having to put in high up-front investments, just like water and electricity (i.e., IT as an utility).

Cloud computing has evolved very quickly over the last few years and we are now over the initial stage of over exuberance and hype, when cloud computing was portrayed as the solution for all problems. According to the Gartner Hype Cycle for Cloud Computing, cloud computing is clearly maturing[1].

Generally, cloud computing solutions can be divided into Infrastructure-as-a-service (IaaS), Software-as-a-service (SaaS) and Platform-as-a-Service (PaaS). While the initial focus was on the use of Public Cloud services, security and other considerations have resulted in the evolution of Private Cloud and Hybrid Cloud solutions.

The National Library Board of Singapore (NLB) oversees the National Library, the Public Libraries and the National Archives. The NLB's mission is to provide a trusted, accessible and globally-connected library and information service through the National Library, the National Archives and a comprehensive network of Public Libraries. Also under its management are 31 libraries belonging to government agencies, schools and institutions. Through its innovative use of technology and collaboration with strategic partners, NLB ensures that library and archives users have access to a rich array of information services and resources that are convenient, accessible and relevant.

NLB is a statutory board of the Singapore government and is required to comply with the stringent security requirements demanded on all Singapore government agencies.

As an ardent user of information technologies, NLB has been able to adopt and adapt the use of Cloud Computing into its Best Sourcing strategy while complying with all applicable policies and standards.

2 THE NLB CLOUD IMPLEMENTATIONS

NLB has been able to leverage on advances in cloud computing and apply the relevant technologies while complying with the stringent security requirements of the Singapore government. These implementations span the private, public and hybrid clouds while going

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[1] https://www.gartner.com/doc/2573318

beyond the mainstream Infrastructure-as-a-Service and venturing into Software-as-a-Service and Platform-as-a-Service (Figure 1).
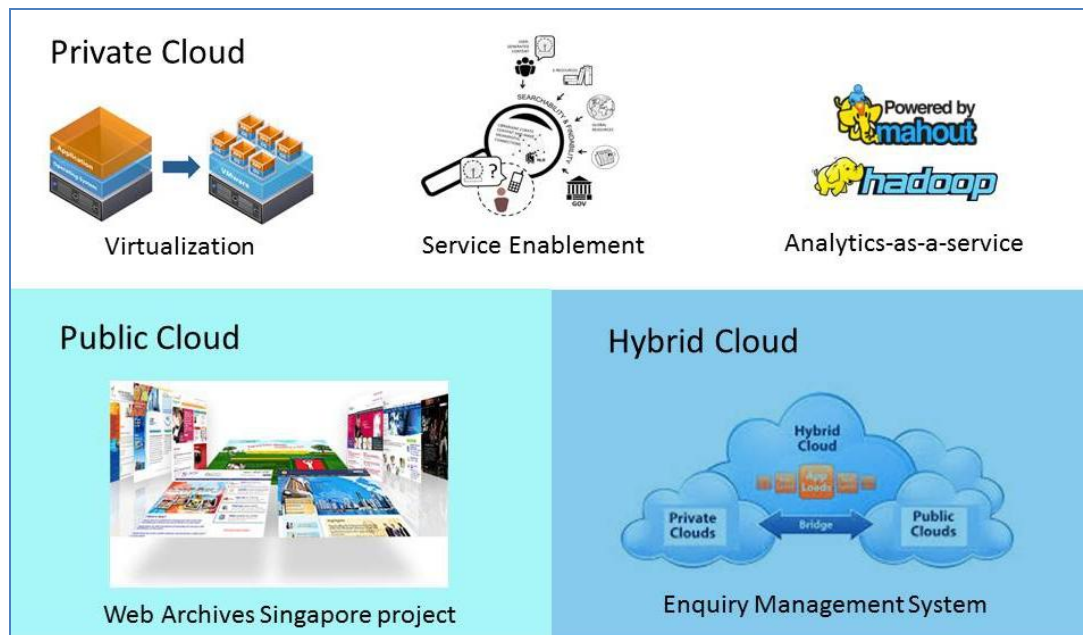

Figure 1: The portfolio of cloud implementations in NLB

3 THE NLB PRIVATE CLOUD

It is natural for NLB to focus on the implementation of its private cloud given the tight security regime it needs to work within. Moreover, it operates a large data centre with over 500 servers. Significant cost savings and quickly turnaround for the provisioning of servers can be achieved through the adoption of private cloud technologies.

3.1 Virtualisation

NLB is an early adopter of virtualisation. Starting in 2008 till to-date, NLB has consolidated 340 servers into 29 physical servers.

When NLB started its virtualisation journey in 2008, a cautious approach was taken to introduce virtualisation on the development servers first before progressing to implementing them on non-critical production servers. After attaining a good level of understanding of the technology and building core competence in managing virtualisation, NLB is now able to introduce virtualisation to the majority of its production servers and incorporating its preference for software systems which can operate on virtual servers in tender specifications.

Server virtualization offers cost savings in areas including the reduced capital expenditure arising from lesser number of physical servers, and lesser provisions for power, LAN and SAN connections. In the virtualized environment, hardware management and provisioning tasks can be managed more efficiently. In addition, tasks that used to be highly manual and time intensive, such as failover provisioning and load balancing, can now be completely automated. This typically has a dramatic effect in reducing the operational and maintenance

costs – even up to 50%. Overall, in the operational costs (excluding energy bills), NLB has achieved a saving of S$675,000 per year.

Reducing the number of physical servers through virtualization also cuts power and cooling costs and achieves better computer resource utilisation in less space. The virtualisation and data centre consolidation initiatives helped NLB to save 2,290,000 kWh of energy per year and the corresponding saving of S$572,500 per year (based on 25 cents per kWh)[2].

By adopting virtualisation, NLB is now able to drastically shorten the time taken to provision servers which could otherwise take weeks and months. Virtualisation is also a key factor that enables NLB to be the first government agency to achieve the SS564:2010 certification for Green Data Centre[3].

Through extensive virtualisation, we have transformed the IT infrastructure into one that is agile and more efficient in terms of resource provisioning and utilisation. This private cloud is critical in providing the level of security, reliability and high availability required of the 24x7 operations at NLB. It has also enabled NLB to innovate within the safety of the virtualised private cloud.

3.2 Service Enablement

With the private cloud as the foundation, NLB established a robust service architecture comprising a comprehensive suite of re-usable components, as illustrated in Figure 2.
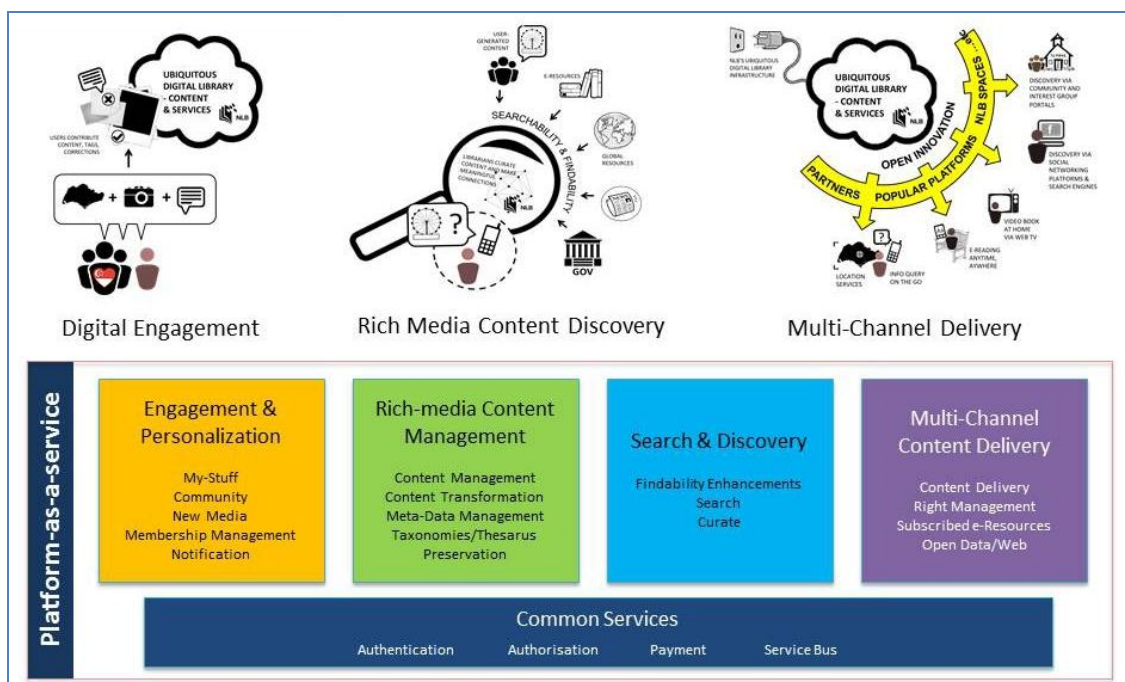

Figure 2: Service Enablement Architecture

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[2] http://www.ema.gov.sg/Electricity/new/
[3] http://www.ida.gov.sg/Collaboration-and-Initiatives/Initiatives/Store/Green-Data-Centre-Standard

These components work in tandem to provide an engaging experience for NLB patrons to find, discover and enjoy the rich and valuable content that NLB painstaking collected, anytime, anywhere, on any device. Through standardisation and re-use, innovative and robust services can be implemented quickly and in a cost-effective manner. One of the components is Content Management (Kia & Wang, 2013).

The Service Enablement Architecture is the bedrock of many innovative services in NLB. It provides established standards within NLB for the handling of common requirements, such as content management and content delivery for media-rich content (e.g., audio-video streaming, online viewing, authentication). The re-use of standard components lowers the overall total cost of ownership (TCO) of developing and operating the services. As importantly, the time required to deliver new services is reduced since not everything needs to be built from scratch.

3.3 Analytics-as-a-Service

Over the years, NLB has built up a huge collection of content to meet the diverse needs of its patrons. The collection was further expanded when the National Archives of Singapore (NAS) came under the NLB family in Nov 2012.

A key focus of the access strategy has been to leverage on the popular search engines as they are the first port of call when we look for information. Search engine optimisation and the user friendly content sites resulted in a wider reach and higher usage of these valuable digital resources (Chellapandi, Chow & Tay, 2010)

Together with these search strategies, we see huge values and convenience for our users for us to recommend to them related content in our collection, across the various institutions within NLB, regardless of the format of the content. We term this *contextual discovery*, where we proactively '*push*' relevant content to our users.

Figure 3 shows a subset of the related content within NLB's collections on the Cenotaph monument[4].

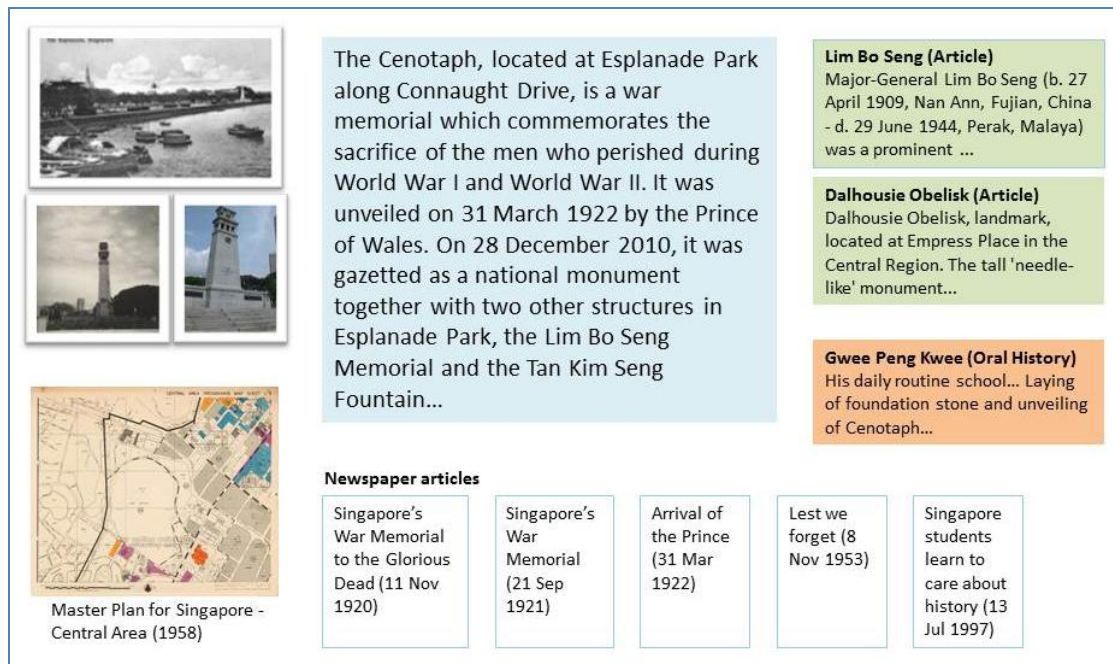[4] http://eresources.nlb.gov.sg/infopedia/articles/SIP_10_2004-12-17.html

Figure 3: Contextual discovery through the recommendations of related content

With a total collection size that goes into tens of millions, it would not be cost-effective to identify the recommendations manually. Text analytics technologies have been identified to be suitable and scalable to perform this task (Lim & Chinnasamy, 2013).

A Hadoop[5] cluster of 13 servers has been implemented in the NLB private cloud to perform the text analytics tasks (Figure 4).
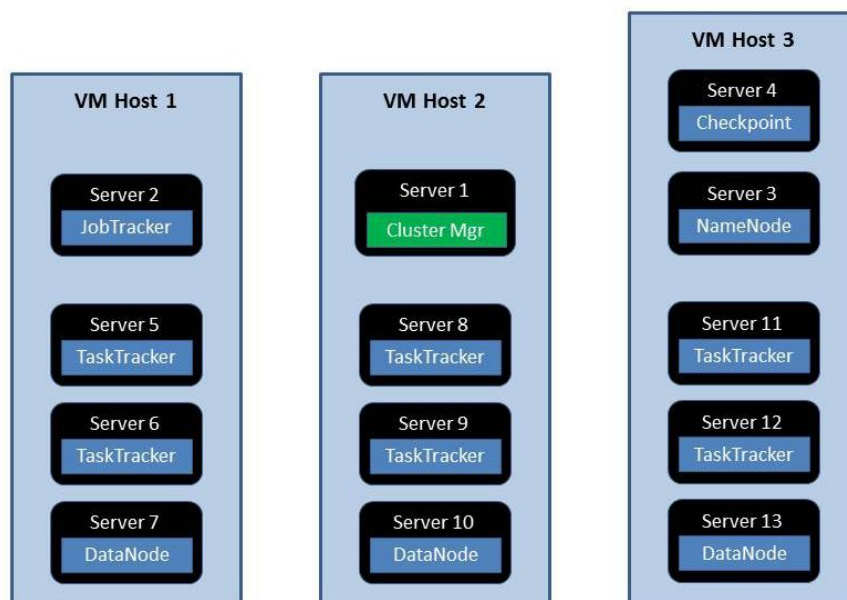

Figure 4: NLB Hadoop cluster

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[5] http://hadoop.apache.org

The Hadoop cluster has been implemented on virtual servers. This allows NLB to scale and re-configure the cluster quickly depending on the resource requirement of the analytics to be performed. Analytics algorithms can be very resource intensive at times.

The Hadoop cluster has since been extensively used to perform text analytics processing via the Mahout[6] software on NLB collections ranging from Infopedia[7] (approximately 1,800 articles), Archives Online[8] collections (around 1 million records) to the English, Chinese and Malay newspaper collection in NewspaperSG[9] (of over 9.5 million newspaper articles).

4 PUBLIC CLOUD FOR THE WEB ARCHIVE SINGAPORE PROJECT

NLB has embarked on an extensive project to archive Singapore-websites (.sg) of national and historical significance. NLB's objective of archiving Singapore-related websites is to create a collection of websites reflecting various aspects of Singapore's life and heritage. Through the use of the web as a tool for social communication and interaction, it could encourage a sense of community, national identity and rootedness among Singaporeans.

The Web Archive Singapore (http://eresources.nlb.gov.sg/webarchives/) project would be very resource-intensive, involving the heavy use of compute, storage and bandwidth resources to crawl and index the huge number of websites involved. As such, NLB decided to leverage on the public cloud resources to meet the project resource requirements. The first production crawl, which involved 50,000 .sg websites, was completed in about six months using grid resources. In comparison, this would have taken about eight times as long using NLB's existing resources.

5 HYBRID CLOUD FOR ENTERPRISE ENQUIRY MANAGEMENT

Another cloud computing project that the NLB has embarked is the Enquiry Management System (EMS). NLB receives regular enquiries at the Contact Centre, Reference Desks and Public Libraries via various channels (e.g., face-to-face, phone-in, websites, e-mails, SMS). EMS provides a centralised platform and streamlined workflow to manage these enquiries.

The EMS is based on the hybrid cloud model where sensitive data is processed in-house while the non-sensitive data resides in the cloud. The system facilitates the ease of logging, tracking, auditing and improving the enquiry handling and management process, and can also be used to track and manage customer interactions such as complaints and feedback.

Encryption was implemented for fields deemed sensitive in the Software-as-a-Service (SaaS) residing on a public cloud for added security.

The adoption of the public cloud model resulted in the system being implemented within 3 months versus the estimated 6 to 9 months if it is based on a commercial off the shelf (COTS) model hosted internally or development from scratch. The SaaS software comes with

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[6] http://mahout.apache.org
[7] http://eresources.nlb.gov.sg/infopedia
[8] http://www.nas.gov.sg/archivesonline
[9] http://eresources.nlb.gov.sg/newspapers

established features, workflows and integration points that we directly adopted and leveraged on to shorten the implementation timeframe.

6 NEXT STEPS

NLB will continue to use the existing systems and identify areas where it can leverage on the strength of cloud computing. There are tremendous benefits to be achieved although the biggest concern is still in the area of security. As such, NLB will tread carefully in continuing with this journey. There are several areas that NLB is still learning to manage cloud computing especially in situations where the cloud service provider is unable to discharge its service level obligations and how to migrate from one cloud service provider to another provider.

NLB has also recently implemented a unified communications solution (UCS) that leverages its private cloud. For over 1,000 NLB staff located all over Singapore, the UCS will improve their productivity through enhanced conferencing tools in and out of office. They are able to set up conferencing with external partners and vendors easily. The UCS is also integrated with the NLB Call Centre, and will be made available to patrons at Digital Concierge kiosks at library branches.

The Government of Singapore has embarked on an initiative to establish a Government Cloud (G-Cloud) for the use by various government agencies. This will help to address the security concerns when using the public cloud services, and hence allows the government agencies to make use of more cloud services to achieve the efficiency gains, without compromising on the security. NLB will monitor the progress of the G-Cloud implementation and explore its potential usage.

7 CONCLUSION

While complying with the strict Singapore Government security requirements, NLB has been able to leverage on established cloud technologies and implemented cloud solutions that are critical to NLB. Its private cloud enables speedy provisioning and cost effective utilisation of infrastructural resources. It provides a safe environment for innovations, supporting the service enablement architecture, the text analytics and the unified communication platforms.

NLB has been able to strike a balance between security, agility and efficiency in its cloud implementations.

Recognising its innovative use of Cloud Computing services, NLB won the FutureGov Awards 2012 for the category of Government Cloud[10].

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[10] http://www.futuregov.asia/events/futuregov-awards-2013/past-winners/

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