Cloud computing is now a popular distributed computing model embraced by many developers. However, while adoption of cloud has been widespread amongst the small business, startups and the vibrant long-tail communities, enterprise use of cloud for mission critical system deployment is still nascent. This keynote examines some of these tough technical challenges as seen by these large enterprises, including security and privacy, performance and SLA issues, migration challenges, interoperability and integration and business continuity requirements. I will also share with the audience the various proof of concept and cloud application migration experiences that researchers at NICTA have derived from various industry collaboration projects. Finally, this keynote presents some software engineering and software architecture research challenges surrounding the cloud computing paradigm that lie ahead.

Keywords - cloud computing; enterprise software systems; software engineering research;

I. INTRODUCTION

Cloud Computing is a popular distributed computing model embraced by many developers. The benefits of 'low infrastructure setup cost', 'pay per use', 'elasticity' are particularly appealing to internet startups. However, for the large enterprise organisation, with mission critical business applications and stringent enterprise level SLA requirements, the adoption of cloud computing is still nascent. Despite the attractive IT cost reduction proposition and innovation opportunities, many enterprise organisations still see cloud computing to be high risk. These perceived risks include: security and privacy concerns; performance and lack of SLA assurance; unclear and unproven migration approaches; interoperability and integration challenges, business continuity and disaster recovery. In this keynote, I will take the often unchartered territory of looking at Cloud Computing from the Enterprise Perspective, in particularly, evaluating cloud computing for deploying mission critical business applications. I will present some of the experience at National ICT Australia (NICTA) - Australia's peak research body in the Information and Communication Technologies industry, in conducting cloud platform evaluations (Amazon WS, Microsoft Azure, Google AppEngine) and proof of concepts of migrating mission critical business applications to the cloud in collaboration with various enterprise organisations. Finally, we provide a view into the key software engineering research challenges surrounding the Cloud paradigm that still lies ahead.

II. ENTERPRISE CONCERNS IN ADOPTING CLOUD COMPUTING

Large scale software systems typically found in enterprise organizations are complex and expensive to engineer, maintain and evolve to changing business requirements over time. Yet, in many industries such as finance, retail, telecommunication and many other customer facing services industries, the capabilities of the software systems are also often the key differentiation from competitor offerings. Particularly in the services domain, speed to market a new service, pervasive reach to customers across the world, advanced customer data analytics, all implemented with reduced IT cost and complexity is top of mind of many CIOs around the world.

The cloud computing paradigm has the potential to deliver on many of the above CIO wish-list items. Through its rapid and dynamic computing service provisioning and de-provisioning capabilities, pay per use charging model, coupled with the generally pervasive reach of the internet and smart devices, we are already seeing some innovative web solutions online transforming the way we work and socialize.

Whilst we are seeing wide-spread cloud computing adoption in the consumer, small business, startup communities, large enterprises are struggling with making serious adoptions of cloud computing. Some of these technical challenges include:

A. Security and Privacy

By using 3rd party provided cloud platform, the enterprise organization is losing a large degree of operational control over its IT assets, compared to the traditionally owned computing infrastructure. The organization has to now move to the model of ‘trusting’ the cloud service or platform provider with its security offerings, and for them to respect the privacy aspects of handling and managing its customer and organization data. This not only requires taking a ‘leap of faith’, but may in fact be impossible to achieve, as regulation and compliance issues prevent the enterprise to adopt cloud computing.
B. Performance and Lack of SLA Assurance

Similar to the use of COTS software, many cloud services or platform components still have unknown and unproven performance characteristics. The latency inherent in a wide area network environment such as those typically found across geographically distributed cloud data centers and its end consumers means that latency may be an issue for many mission critical applications that are not latency tolerant. To compound this problem, cloud platform vendors often have SLA terms and conditions that are not satisfactory for the typical enterprise requirement. Getting a discount on the next month’s cloud utilization bill is often not sufficient a compensation nor provides adequate operational visibility for lost high value customer transactions in a previous month.

C. Unclear and Unproven Migration Approaches

Rarely do enterprise organizations have the opportunity to create ‘green field’ development projects. In many instances, existing line of business applications embody many years of business analysis and software engineering efforts, and these are often also the applications that need to continually evolve in order to adapt to changing business requirements over time. With the potential to reduce IT operating cost through the use of cloud computing, is there a true benefit to migrate a line of business application over to the cloud? What is the technical migration efforts one need to be aware of? How does one go about carrying out a migration effort to the cloud? Is there radically different programming, deployment and operational models between the traditional way and the new cloud paradigm? How does one perform cost benefit analysis on potential cloud migration project [1]?

D. Interoperability and Integration Challenges

Not all enterprise applications are suitable workloads for the cloud. Enterprise will need to manage enterprise applications running both in local servers and in the cloud. How does one enable straight through processing across applications running in cloud and local servers? How does one ensure identity management/single sign on works well across the firewall into and out of the cloud? Interoperability across different cloud is also at present non-trivial to set up. How does one run monitoring and management across multiple clouds and hybrid cloud? How does one create an enterprise architecture that supports integration of monitoring and management processes with traditional processes and tools?

E. Business Continuity and Disaster Recovery

For many enterprises, business continuity is a top priority that their software systems must fulfill. With unclear SLA assurance, and unpredictable unavailability characteristic that cloud platforms currently display [2], enterprises are struggling to commit to deploying mission critical applications to the cloud. However, at the same time, the distributed and highly replicated architecture of the cloud platform can be a great solution to disaster recovery. Through the cloud, there is now a cheap and easy way to rapidly create replicated application and data instances residing in different cloud data centers across different corners of the world. With some careful architecture design and engineering, the cloud holds some promise to provide a great disaster recovery solution option [3].

III. SOME MIGRATION PROJECT AND PROOF OF CONCEPT EXPERIENCES

A. The NICTA Experience

Over the last 2 years, researchers at NICTA have conducted a number of cloud computing platform evaluation studies, producing benchmarking tools [4] and evaluation methods [5]. NICTA researchers have also worked in close collaboration with various enterprise organizations in conducting cloud computing proof of concepts and application migration exercises. At the FoSEC workshop, I will describe some of these projects, and share with the audience some of our lessons learnt.

IV. KEY SOFTWARE ENGINEERING AND SOFTWARE ARCHITECTURE RESEARCH CHALLENGES AHEAD

The cloud computing paradigm offers a radically different model of provisioning and de-provisioning computing infrastructures, employs a different charging model, and embodies some innovative distributed systems replication, fault tolerance, load balancing mechanisms in the internal building of the cloud. The distributed systems and database communities are already engaging in vibrant and active research programs in advancing the state of art research in cloud computing platform development. From the cloud platform provider perspective, creating the most efficient and high performing cloud data store is already a hotly researched systems issue. For the software engineering and software architecture research community, we must look to help the enterprise consumers of the cloud, in bridging the gap between what is provided by the cloud platform, and what is required to truly realise the vision of reduced IT cost and complexity through effective use of cloud. Future methods around software development lifecycle methods for cloud, cost effort estimation to migrate to cloud, integrated SLA monitoring and management solution patterns, architecture styles for achieving high performance enterprise cloud applications are some concrete example promising research topics. Continually supporting the enterprise to manage large scale software projects that include cloud as part of the enterprise architecture portfolio is the only perspective to take that will lead us to identifying the right software engineering research questions in cloud computing, and delivering impact and results for our practitioners at the same time.

I welcome you all to join me on that journey.

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REFERENCES


