Testing on the Cloud

A Sogeti Point of View on the potential of Software Testing using Cloud Computing

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Summary

The growth of cloud-based computing is outstripping even the most optimistic predictions. That growth is based on a compelling value proposition: speed to market, agility to bring forward or retire service, and the chance to move expenditure from capex into opex. For software testing, cloud also offers a range of opportunities for reduced cost testing. This paper looks at how testing can be revolutionized through the evolving Testing Cloud models, outlines the potential benefits and evaluates the challenges, the services being developed and provides an outlook for Cloud Testing.

The Rise and Rise of Cloud Computing

Cloud computing at it simplest is internet-based computing, with the use of shared resources and software provided on demand with reduced management effort. As a service it is still at an early stage, but the growth of cloud-based computing is outstripping even the most optimistic predictions.

That growth is based on a compelling value proposition: speed to market, agility to bring forward or retire service, and the chance to move expenditure from capex into opex. Although cloud computing is still in its infancy, it is increasingly clear that the cloud model will supplement, if not entirely replace, mainframe and client/server installations in the years to come.

What the Analysts Say

Gartner predicts that, as soon as 2012, one in five businesses will have no IT assets at all. They will simply leverage the capabilities of the cloud as computing becomes available to businesses in much the same way as a utility like electricity[1]. IDC expects the server revenues from the public and private cloud to increase by 29% and 62% respectively – a disparity explained by the heightened security considerations, lower appetite for risk, and lower responsiveness to financial drivers in the public sector[2].

In 2010 they forecast a growth in cloud service adoption, fuelled by the 'Pay-as-you-Go' model that means you pay only for what you use. Forrester goes further still, explicitly referring to cloud as not an adjunct, but a successor to traditional approaches; "Cloud computing is a sustainable, long-term IT paradigm, and the successor to previous mainframe, client/server, and network computing eras"[3].

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[1] Gartner Highlights Key Predictions for IT Organizations and Users in 2010 and Beyond, Christy Pettey and Holly Stevens, January 23, 2010

[2] IDC Cloud Services Forecast, Frank Gens, October 5, 2009

[3] The Evolution Of Cloud Computing Markets, Stefan Ried, Ph.D., Holger Kisker, Ph.D., Pascal Matzke, July 6, 2010

Four Deployment Models in the Cloud

For the sake of clarity, Sogeti identifies four cloud infrastructure deployment types within the cloud model:

- **Private Cloud –** operated solely for an organization. It may be managed by an organization or a third party, and may exist on or off premises;
- **Public Cloud –** made available to the general public or a large industry group, and is owned by an organization selling cloud services;
- **Hybrid Cloud –** composed of two or more clouds (private, community or public), which remain discrete from another but, offers data and application portability between each cloud using standardized or proprietary technology (eg cloud bursting for load-balancing between clouds);
- **Community Cloud –** composed of two or more public or hybrid clouds to form a community cloud for a group of organizations. This then runs the service for all the organizations within that community from an end-to-end perspective. It has the same deployment characteristics as a hybrid cloud.

Testing on the Cloud – rapid, cost effective and growing

As cloud computing evolves, and cloud service adoption becomes ever more wide-ranging, a new global infrastructure is being created; this infrastructure can easily be connected to traditional infrastructure (including legacy systems), as shown in Figure 1. But it is not just for business IT assets that cloud computing removes previous limitations. It does the same from a software or application testing perspective, removing the typical constraints presented by having to test on client-owned or internal resources. A cloud infrastructure creates significant new opportunities for software quality assurance and testing.

Among those possibilities, the emergence of entirely new 'greenfield' markets will be key, as organizations aggregate their needs. Rather than the old model of separate testing approaches for separate enterprise departments, organizations can now share public or hybrid clouds with each other, or create private clouds to be shared within the whole company.

In our view, cloud computing is a model or platform on which testing must be carried out just like any other service. It enables convenient, on-demand network access to a shared pool of configurable computing resources. Those resources, from networks, servers, storage, applications and services, can be rapidly provisioned and released – thereby drastically reducing management effort and service provider interaction.
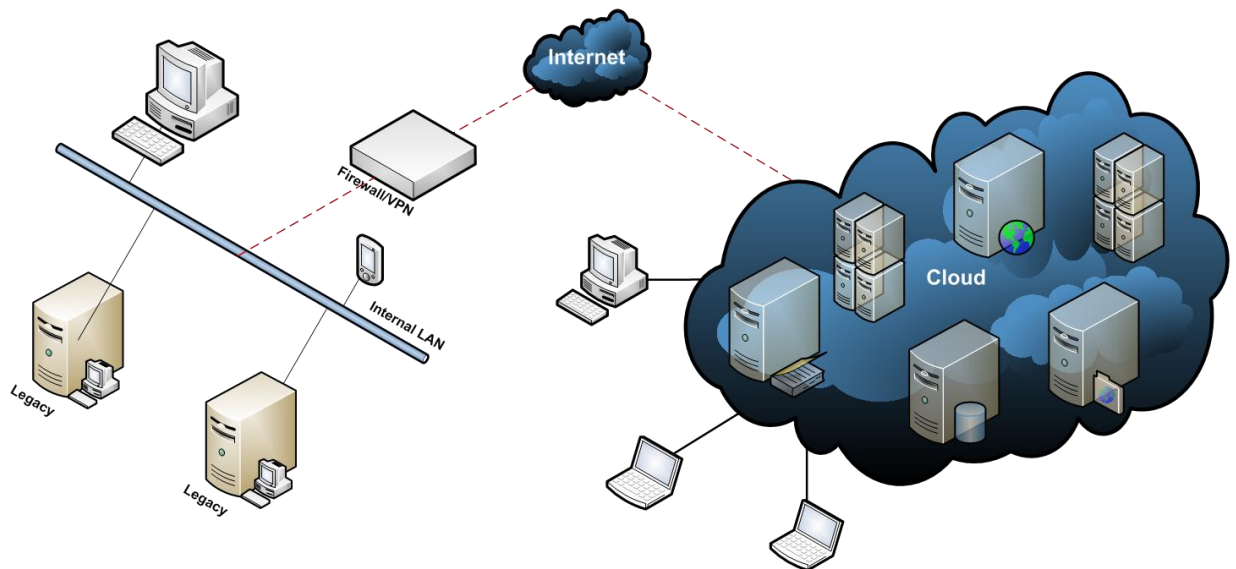
Figure 1 - Connecting cloud environments with traditional environments

Naturally, there is an understandable nervousness about this new approach and questions are being asked around integration, security and implementation. But, in our view, these challenges are outweighed by the advantages, as cloud breaks down limitations caused by testing on internal resources, and gives test teams the opportunity to free themselves from issues relating to the internal availability of hardware, applications and services, and enable a more effective way to collaborate.

We now explore the Testing Cloud models that are evolving, outline the potential benefits, evaluate the challenges, and provide a view on the new services being developed and the way forward for cloud testing.

Delivering Testing on the Cloud

Sogeti has identified a number of test cloud models, simply based on cloud vendor solutions, see Figure 2. These are:

- **Private Cloud –** A cloud owned by the client on which a private cloud is implemented
- **Hybrid Cloud –** A cloud on which Sogeti operates a hybrid cloud (or multiple hybrid clouds in a community cloud)
- **Public Cloud –** A public cloud that is available to the client on demand.
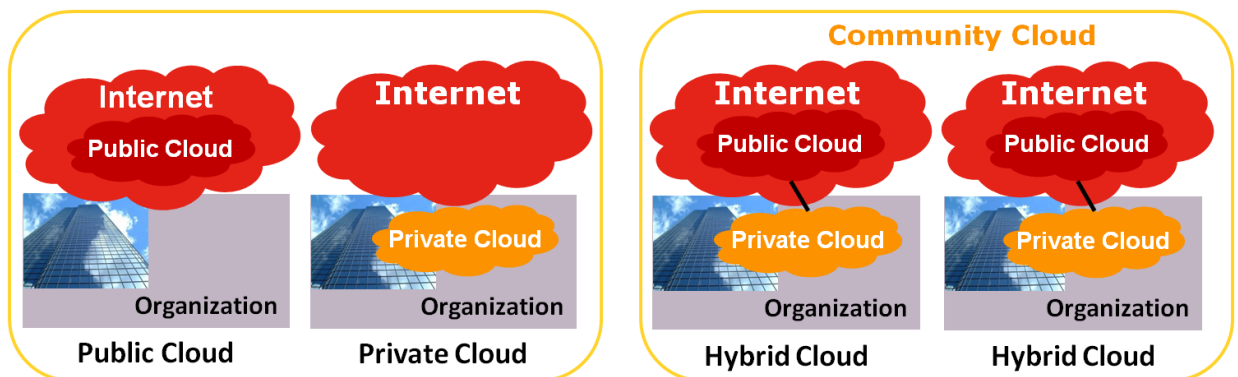
Figure 2 - The 3 basic Test Cloud models: public, private and hybrid (including hybrids on a community cloud)

Using a combination of these models, there are many opportunities for software testing notably in three distinct areas: Infrastructure, Platform and finally Software, see Figure 3.

Infrastructure as a Service (IaaS)

This is the foundation of cloud computing as we now understand it - the remote provision of process capacity, storage, networking and other basic computing resources. An organization simply contracts for the necessary amount of virtual infrastructure and installs its operating system, applications and data. Depending on the cloud provider and commercial model, these resources can be highly flexible and scalable, responding and billing the client, according to demand and load. On one hand, this approach gives the client an extraordinary amount of freedom, but on the other hand, the client needs to exercise close management. Availability and reliability of the rented infrastructure, including 'fall over' and data protection, is the responsibility of the cloud provider.

Platform as a Service (PaaS)

For this service, the cloud provider offers a programming platform and tools for the client to develop its own applications. This development platform is mostly based on .NET or Java, extended with cloud-specific services. As such, it has great appeal for organizations who want to build their own software, without the need or costs of building and running their own data centers. In addition, they benefit from effectively outsourcing the management and maintenance of the underlying cloud infrastructure (network, servers, operating systems and storage).

Software as a Service (SaaS)

Here the cloud provider offers complete applications for end users, created on PaaS. Only the service is paid for, normally on a unit cost basis. The software does not run locally on a machine but in the cloud and is delivered via a browser. The most well known example of this would be Google Appz. The client only needs to very lightly configure the application before its immediate use.

The downside of this simplicity is that the client has very little influence on how the application works or on its future development life cycle. The amount of control on the development life cycle is governed by the SaaS provider, acting on behalf of a massive client base, passing on to those clients the economies of scale and investment efficiencies, as shown in Figure 3. Here, as elsewhere, clients benefit from moving spend out of capex and into opex, while retaining an ability to move as fast as the marketplace in which the SaaS sits.
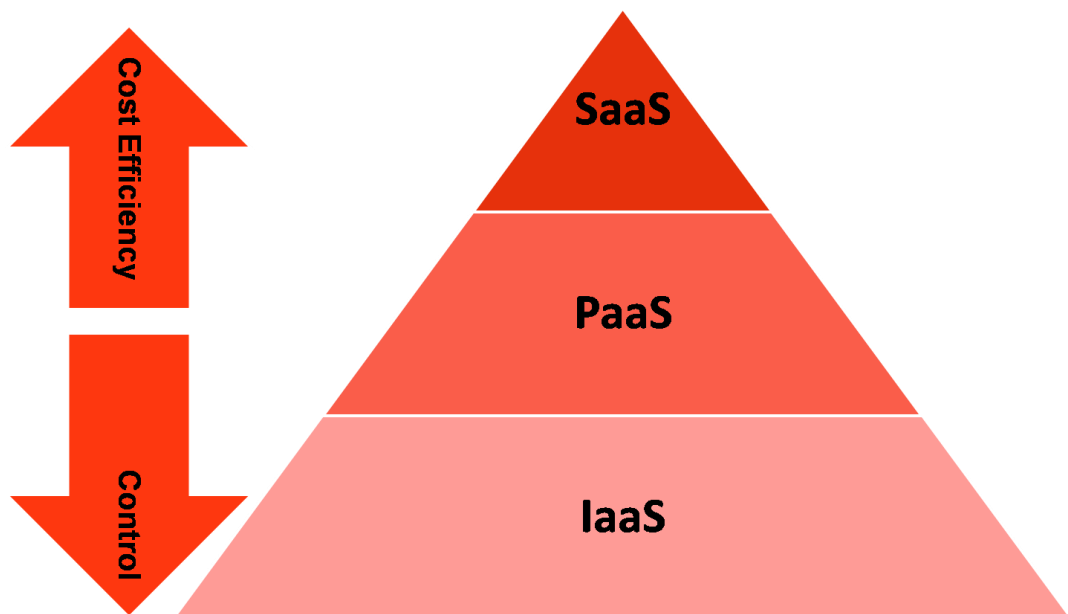

Figure 3 - The relationship between the 3 main testing services on the cloud and impact on control and cost efficiency

Development, Test, Acceptance and Production Environments

Looking at Test Infrastructure in more detail, an appropriate environment is a *sine qua non* of dynamic testing. To achieve a robust level of quality in preparation for production, it is a best practice to use separate environments for development, test, acceptance and production - the DTAP model.

As IaaS and PaaS solutions, cloud test environments need to be virtualized parts of that environment. This both makes implementation easier and facilitates the execution of the different instances in the cloud. These virtualized testing environments can be added or removed from the cloud at will, thereby providing a flexible option to create test environments (including necessary configuration), whenever needed.

Development environment: Cloud solutions are uniquely well suited to creating development environments, because they are often relatively small in size (IaaS and/or PaaS).

Test environment: The use of cloud solutions for test environments is highly dependent upon the nature of the applications, information systems (whether administrative or technical), test levels and test types. The applicability of a cloud test environment also depends on criteria like test data, dependencies and interfaces.

Acceptance environment: A Public Cloud solution is less suited than a traditional environment one for acceptance testing. It is often necessary to use (production) test data and therefore private and hybrid cloud solutions seem the most appropriate for acceptance environments, or parts thereof. However, when using Agile development methods, acceptance testing on the cloud can be achieved iteratively in every environment, step by step. Whenever the infrastructure needs to be upgraded to a 'production-like' infrastructure, the environment can be stepped up, and after the tests have been carried out, it can be stepped back down.

Production environment: These can also be created, providing 'cloud-ready' applications.

Test Tooling from the Cloud

SaaS offers great value in using test tools from a cloud environment, recognizing the dilemma of cost and license commitment that many organizations face when wanting to use test tools. Test tools can be offered from a service perspective, using these tools on a short term, on-demand basis. Whenever a new project needs to employ test tools for a short to medium amount of time, cloud-based test tools can be used.

In addition to the benefits of greater flexibility in tool usage, there is also a reduction in license fees and the elimination of tools maintenance will further increase cost savings.

Key Benefits of Testing on the Cloud

All levels of testing can be carried out in cloud environments, and indeed, some types of testing benefit greatly from a test environment in the cloud. In an early pilot with a European Financial Services client, and in subsequent assignments with clients in the public and private sectors, we have identified a number of distinct differences and corresponding benefits to testing on the cloud.

Flexibility
- Different levels or grades of tests can be executed on separate environments at an organization's convenience;
- Testers no longer need to wait until the end of the testing phase to move to a 'production-like' environment for their performance, load and stress tests. Instead a production-like environment can be brought into action at will.

Simplicity

- End-to-end testing can be set-up in the cloud relatively simply, provided the necessary servers and images can be accessed to create an end-to-end environment;
- The cloud also offers a new level of simplicity in terms of training or bug-fixing environments, which can be launched as quickly as the images and configuration can be put in place.

Comprehensive and indicative testing

- Even end-to-end tests for more generic business processes can be carried out in the cloud. All the necessary components can be published in the cloud to create the whole chain of systems. In this way, the whole business processes can also be tested;
- In the cloud, a more 'realistic' load can be generated than the virtual load generated by other tools. Cloud-enabled performance test tools generate the needed load and stress to test an application more accurately.

Cost Reduction

- There is a reduced need for expensive environments, which need to be used only when tests have to be executed;
- Historically, internal testing and acceptance environments have been permanently available for testing projects within a company, creating a permanent pressure on development budgets and infrastructure resources. Cloud environments however can be enabled and disabled at will, reducing the cost of environment management.

Cleaner, Greener Testing

- It is intuitively true that the efficiencies cloud computing provides make it significantly 'greener' than traditional, hosted models. That is true for testing, too. By sharing cloud resources for their test infrastructure, businesses will use IT resources 'on demand' and eliminate waste. In addition, clients using cloud data centers can minimize energy use and deliver environmental savings in CO_2 up to 55%[4].

Geographic Transparency and Traceability

- Test data is frequently sensitive and its location is therefore important, since data entering or exiting national borders can contravene national and international regulations, such as the EU Data Protection Directive. To address this, the Test Cloud solution is transparent about the geographic location where data and services are stored, and allows clients to keep data on their own servers, using a VPN connection.

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[4] IDC Energy Report - Potential Server and Datacenter CO2 Savings in Denmark, Anders Elbak and Per Andersen, October, 2009

Driving Standardization

- In one sense, creating test environments in the cloud is merely a temporary first step on a much longer journey. Cloud computing will give a huge impetus for the standardization of organizations' infrastructure. That key shift will inevitably catalyze IT modernization and improve internal IT services maturity, impact upon application consolidation and portfolio rationalization, and change the way enterprises look at resourcing IT services internally.

Operational Challenges

Despite the clear benefits, there are still some areas where testing on the cloud will have some limitations, of which organizations need to be aware.

Infrastructure requirements: It is vital that Infrastructure requirements are rigorously set, because the very flexibility that the cloud offers for testing environments can itself be a risk if the requirements for those environments are inappropriate. Results will then be poor and negative perceptions of the cloud as a test environment will result from what was really an inattention to requirements around the infrastructure. Using a simple checklist will help reduce this risk to a minimum.

Legacy Systems: Most types of services and systems can be virtualized, including legacy systems, but 5-10% of all systems cannot. However, by using robust interfaces with these legacy systems, the risk posed by that disjunction can be reduced. An example might be using a VPN connection between the cloud and the client's own servers to create a connection between legacy and cloud systems.

Security Issues: The well-publicized nervousness around security in the cloud is an issue that all service providers are working hard to answer. Fundamentally the nature of cloud computing means the data of one consumer is often stored alongside the data of another. To some extent that challenge is being met through encryption, which is often used to segregate data-at-rest, but this is not a cure-all and a thorough evaluation of the encryption systems used should always be undertaken. Figure 4 shows a cube model to help architecture cloud security in the various cloud deployment models.
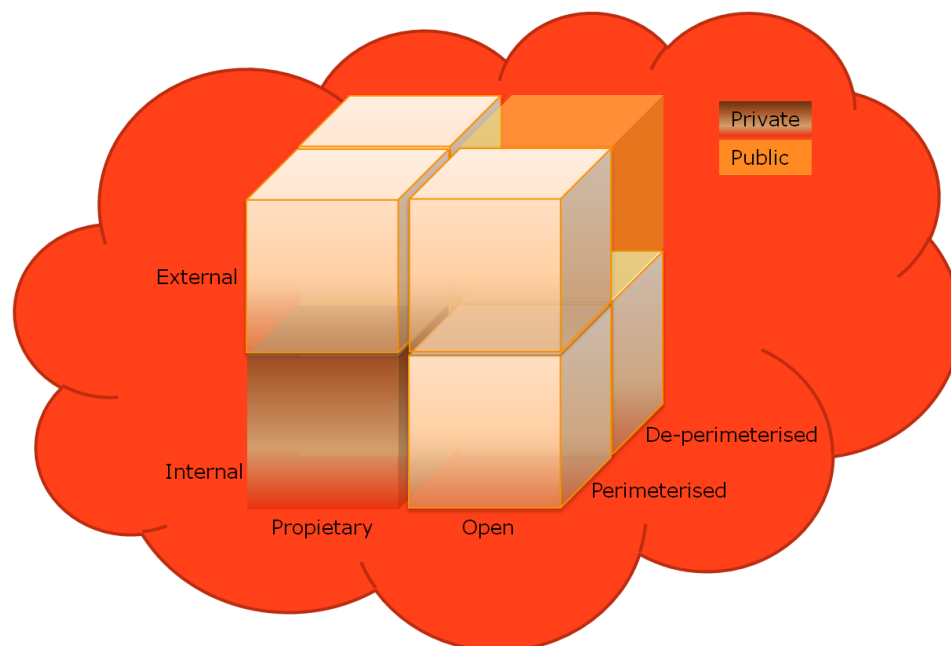
Figure 4 - Cloud security cube[5]

Evolving fast to meet a growing need

Given these benefits and challenges, there is a clear role for experienced service providers with testing expertise, such as Sogeti, to help clients adopt the most appropriate and relevant Cloud Testing route map. Sogeti for example is already developing a number of services that will enable client organizations to leverage the advantages of Testing on the Cloud and avoid the pitfalls.

Services will include the provision of a suitable owned or shared test infrastructure for a range of test environments and test levels, like performance testing as indicated above. In addition, at Sogeti, we are developing a SaaS or STaaS service with 'pay as you go' test tools. For many enterprises, there is a significant cost and license commitment in using test management tools. However on the cloud, if a new project needs to use test tools for a short to medium term, these can be used (and paid for) when required and only then! By utilizing Software in the Cloud, organizations can enjoy significant pricing benefits, not least because it becomes possible to more precisely judge the actual usage, and pay according to use, rather than annual fees.

Beyond the standard services currently provided, Sogeti is also developing services for the testing of package applications, OS, servers and databases- for example Oracle, Microsoft and SAP modules. We anticipate that clients will need new specialist types of services that create real added-value combined with pay-as-you-go pricing models. Ultimately an Enterprise Ready Standardized Infrastructure (ERSI) might be created to be used for testing and eventually to take into production.

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[5] The Jericho Forum: https://www.opengroup.org/jericho/index.htm

Looking Forward

Money talks and the chance to cut costs and move them from capex into opex means cloud service adoption will continue to rise and rise. To that extent serious engagement is not optional; it is imperative as the opportunity is enormous. Looking forward, we anticipate an incremental take up of testing on the cloud, explained below.

Short Term: High profile cloud Solutions, such as the UK's Royal Mail announcement of a cloud-based enterprise architecture are inevitably going to boost credibility and drive adoption. That said, imperfect understanding of the cloud means that organizations will look to service providers for advice rather than exploratory projects, with a gradual adoption of Software as a Service offerings.

Medium term: Cloud solutions, and consequently testing, will gather momentum and offerings will gain maturity. Organizations will increasingly implement their development and test environments in the cloud, and performance testing in the cloud will become more routine through a managed test line model. Increasingly activity will focus on building private, hybrid and public (test) clouds and testing cloud-based applications for a growing number of adopters. That will create a need for more services based on assessment, implementation and strategy. Cloud-ready applications and cloud-based applications will come on-stream at speed.

Long Term: Cloud will become a full model for computing, but as an **additional** platform rather than a replacement for mainframe and client/server. Service providers will develop a broader base of offerings from the test cloud business models, such as creating cloud-based test environments, testing on cloud-based environments, testing cloud-based applications, using SaaS for testing tools and becoming a broker for test cloud services. There will be a corresponding decline in demand for infrastructure/data center services.

Key Conclusions

The IT industry faces significant changes that will impact on most areas of the traditional IT department, including the software delivery lifecycle. In years to come, more and more organizations will implement their development and test environments in a cloud environment, and agile performance testing will become mainstream.

The real opportunity to cut costs of test environments in private, hybrid, public or community clouds lies in both their management and maintenance. When cloud resources are not needed, they can be turned 'off' cheaply and efficiently, and then 'on' again as necessary, without implementing the environment again.

As the market develops, organizations will need more mature, less-standardized cloud services that focus on specific or packaged applications, OS, servers or databases. Service providers such as Sogeti have a role to play in providing customized cloud strategy and support in delivering efficient and transparent test execution on the public, private or hybrid cloud.