Cloud Computing as a Source of Innovation for Global Software Engineering

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Background Brief

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Work History:
Associate Professor ITU, CPH: Dec. 2009 …
  NICTA, Australia: 2003 - 2007
  JRCASE, Macquarie University: 2001 – 2003
  Various industrial roles in IT: Prior to 2001

Research in software architecture,
Service Orientation, Cloud Computing, and
Software Development Paradigm

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Talk’s Goals

• Getting familiar with emerging technological and development paradigms

• Reflect about the areas of software engineering research motivated by cloud computing.

• Learn about some of the key challenges of developing software with distributed teams.

• Understand how cloud computing can be leveraged for global software engineering.
Overview

- Cloud computing & research issues.
- Global software engineering & challenges.
- Leveraging cloud computing for GSE.
- Tool as a Service (TaaS) for GSE.
What is 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 service provider interaction.” (A definition by the US National institute of standards and technology (NIST))

• Some of the characteristics
  – Distributed computing at a massive scale.
  – On demand elasticity.
  – Exploiting existing technologies (Grid, Utility, Virtualization).
  – Pay per use model.
  – Driven by economies of scale.
Market Forecast

Market study on worldwide public IT cloud services by category

Market study on worldwide IT spending by consumption model
Some Examples

- The New York Times made its archives 1851–1980 free by providing 11 million articles as PDF – the job was done under 24 hours at a cost of US$240 using Hadoop on Amazon Web Service.
- Danish Rail – cancellation information services used Microsoft Azhure for less than US$25.
- Animoto handled flood of nearly 750,000 new sign ups in three days using Amazon’s cloud, which cost them about 10 cents a server per hour - the required scalability fluctuated from 50 servers to over 3500.
Economic Aspects

• Cost reduction – Reducing the cost for infrastructure acquisition and maintenance
• Improved time to market – Imperative for SMEs. Larger enterprises can publish new capabilities with little overhead to remain competitive.
• Return on investment – Essential but not guaranteed
• Turning CAPEX into OPEX – from capital cost to operation cost model
• Going Green – Reducing the energy consumption of unused resources
Potential Advantages

- Faster time to market and improved productivity
- Lower cost in terms of licensing fee
- No installation and maintenance
- Fast upgrades of new features and patches
- Application developed using mature processes
- Innovation without supportive applications
Potential Disadvantages

- Maturity in designing multi-tenant applications
- Cultural change in software development companies
- From licensing model to subscription business model
- Not for all applications, e.g., online share trading
- Vendor dependency is quite common
- Migration can be quite problematic
Some of the Challenges!!!(

- **Security**
  - Would my data be more secure with Cloud provider?

- **Interoperability**
  - Significant risk of vendor lock-in – standardized interfaces not available, incompatible programming models

- **Reliability**
  - Use of commodity hardware, prone to failure ...Cloud 2.0

- **Laws and regulations**
  - Privacy, security, and location of data storage

- **Organizational changes**
  - Changing authorities of IT departments, compliance policies

- **Cost**
  - Purchase vs. lease, migration cost, models to design capital and operational budgets, cost of cloud providers
Is Cloud Computing for Me?

• For end users
  – Cost reduction: From capital investment to operational expense (pay per use)
  – Ease of use via standardized mechanisms, e.g. Browser
  – Flexibility and short time-to-result

• Services providers
  – Reduction of the entrance barrier
  – Reduction of time to market

• Private Cloud
  – Maximize the utilisation of computing resources
  – Minimize operational costs and the organisation keeps full control of its data centres
Storage as a Service

- A third party rents space on their storage infrastructure
- Specialized cloud storage providers
  - Google Docs are stored on Google’s data server
  - Web mail provider – Gmail, Hotmail, Yahoo!
  - Flicker and Picasa
  - YouTube, Facebook, MySpace
- Reliability
  - Unreliability can become a liability
- Security
  - Encryption
  - Authentication processes
  - Authorization practices
Some Common Cloud Based Tools
Google Docs!!

- Provides documents, spreadsheets and presentations
- Support sharing and real time collaboration
- Provide access from anywhere over the Internet
- Export to formats like DOC, XLS, CSV, ODS, ODT, PDF, RTF, and HTML.
Office 365

- Microsoft office collaboration and productivity tools
- Support access through multiple devices via browser
- Global-redundancy for scalability & availability.
- Per-user per-month subscription plan with predictable annual cost.
- Through administrative user interface, IT staff can set up new user accounts, control access to features and see the status of all office 365 services and tools

Source: www.office365.com
Office Web Applications

- View, edit and share contents in the Word, Excel, PowerPoint and OneNote.
- Common set of online viewing and editing tools.
- Support to access online documents with respective desktop application for rich editing.
- Simultaneous editing of shared Excel spreadsheets

Source: www.office365.com
Github Social Coding

- Distributed version control system for collaboration

- Collaboration
  - Manages teams within organizations and shared administration.

- Git powered Wikis

- Integrated issue tracking

- Code reviews

Source: https://github.com/
A Snapshot of Potential Areas of Interest

Reproduced from Figure 1 of The Future of Cloud Computing: Opportunities for European Cloud Computing beyond 2010.
Service and Deployment Models

- **Infrastructure as a Service (IaaS)**
  - Amazon EC2
  - Eucalyptus
  - IBM – Computing On Demand (DoC)
  - VMWare vSphere

- **Platform as a Service (PaaS)**
  - Google App Engine
  - Microsoft Azure
  - Force.com
  - Yahoo Open Strategy

- **Software as a Service (SaaS)**
  - Google Apps
  - Zoho
  - Salesforce CRM
  - Microsoft Cloud Services

Deployment Models:
- Public Clouds
- Private Clouds
- Community Clouds
- Virtual Private Clouds
- Hybrid Clouds
**Stakeholders Involved & their Perspectives**

Use **APIs** offered by Cloud providers to exploit their resources and **deliver high-value services** for end-users.

The Cloud extends the general internet-based service provisioning model with aspects of **high availability, reduced cost** (through improved resource usage) and **ease-of-use**.

**Dynamic management** of **hosted services** (*aaS*) to guarantee availability, reliability and related quality aspects through automation in order to **optimise the overall resource utilisation**.

Source: EASI-Cloud Review Presentation
Global Software Engineering
Many Meanings & Forms of GSE

- Open Source Software Development
- Inner Source Software Development
- Offshore Outsourcing
- Near-Shore Outsourcing
- Offshore Development Centers
- Global Software Development
- Distributed Software Development
Types of GSE Arrangements

One Client

One Vendor

Simple

Many Vendors

Multi-Vendors

Many Clients

Co-Sourcing

Complex

Source: Gallivan and Oh, 1999
Scenarios of Tool Support Challenges
Tools for Distributed Architecting Process

Main activities of software architecture process

Types of tools required


- Architectural knowledge repositories
- Decision support systems
- Architecture modeling tools
- Web 3.0 technologies
Tool Support for GSE

Integration provided at the application level
Leveraging Cloud Computing for GSE
Why Cloud Computing Matters for GSE?

- Software testing
  - Stress testing with cloud-based infrastructure.
  - Enabling testing of application for sensitive data by offshore testers.

- Collaborative environments in Clouds
  - Just-in-Time (JIT) tool composition.
  - Processes, tools, & context aligned.

Source: http://aws.amazon.com/solutions/case-studies/8kmiles/
NexGen Infrastructure for GSE

• **Context**
  – Providing supportive technologies to GSE teams.

• **Challenges**
  – Dozens of different tools required.
  – Some commercial tools (IBM SameTime and MS Communicator) available but across vendor integration is problematic and the tools are expensive.
  – No Just In Time (JIT) composition and use of services.
  – Misalignment between tools, processes, and culture.

• **Proposed solution**
  – Cloud-based infrastructure for supporting GSE through Tool as a Service (TaaS).
Advantages of TaaS for GSE

• On demand tools acquisition & access to a wide range of tools.

• Processes and tools alignment – acquiring tools for process requirements of each project.
Advantages of TaaS for GSE

- Artifacts’ traceability across multiple sites.
- Implicit support for real-time awareness and collaboration.
Advantages of TaaS for GSE

- Access to sensitive and massive amount of data without data movement.
- Easy access to expensive and sensitive technologies.
A Coherent Picture of TaaS Benefits
An Asian organization X is working on two GSD projects for French clients. Project A will be developed using open source technologies and requires access to private data and other services during unit and integration testing in different releases.

This project requires access to security and privacy sensitive data and services. French data security and privacy laws restrict the transfer of such data outside of France.

If the data and services cannot be made available to organization X, complete development cannot be carried out on their premises in Asia and requires development of artefacts dealing with sensitive data and services inside France.
Consider Some Scenarios

Project B needs access to the real-time data about the traffic flows on French roads and expensive and proprietary platforms for simulation of the traffic flow patterns on road networks.

The organization may also need to shuffle developers within projects depending on the workload and criticality of the release. Configuration of development environments requires significant effort during resource shuffling.
How Would a Potential Solution Look Like?

- **Application Servers**
  - Oracle
  - MS SQL

- **Project Management Tools**
  - HP Project Planner Suite
  - MS Project
  - MS Team Foundation Server

- **Design Tools**
  - Enterprise Architect
  - IBM Rational Suite
  - Visio
  - Visual Paradigm
  - Eclipse-based Design Tools

- **Source Code Repositories**
  - GIT
  - GIT Hub
  - SVN
  - CVS
  - Visual Source Safe (VSS)

- **Persistence Handling Services**
- **SLA Compliance & Brokerage Services**
- **Multi-tenancy Management**
- **Versioning Management**
- **Virtual Nodes Manager**
- **Response Transformation for Mobile Devices**
- **Data Management Services**
- **Services Management Engine**
- **Services Composition Modules**
- **APIs For Integration With External Tools**
- **Monitoring Services**
- **SLA Modeling & Specification Services**

- **Middleware Infrastructure**

- **Expensive/Sensitive Hardware**

- **Private Cloud Hosting Sensitive Data**

- **Host Type 3**: MS Project
  - IBM Rational Suite

- **Project Managers’ Tablets**

- **Developers’ Terminals**
### Some of the Commercial Tools for GSE

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
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<tbody>
<tr>
<td>AgileZen</td>
<td>Collaborative project management.</td>
</tr>
<tr>
<td>LucidChart</td>
<td>Tool to create flowcharts, organizational charts, UML designs, mind maps etc.</td>
</tr>
<tr>
<td>MeetingSphere</td>
<td>Group meeting and decision support system.</td>
</tr>
<tr>
<td>Microsoft Live Meeting</td>
<td>Web conference service.</td>
</tr>
<tr>
<td>Microsoft Project</td>
<td>Project management solution.</td>
</tr>
<tr>
<td>Microsoft Team Foundation Server</td>
<td>Source control, data collection/reporting and project tracking</td>
</tr>
<tr>
<td>Pidoco</td>
<td>Software to design GUIs for web and mobile apps and make it live to share with other users.</td>
</tr>
<tr>
<td>IBM Rational Suite</td>
<td>Suite of tools for different phases of software development life cycle.</td>
</tr>
<tr>
<td>Cloud9 IDE</td>
<td>Cloud-enabled Online IDE.</td>
</tr>
<tr>
<td>Eclipse Orion</td>
<td>Cloud-enabled IDE that can be hosted on private/public clouds.</td>
</tr>
<tr>
<td>eXo Platform</td>
<td>Collaboration Platform and IDE.</td>
</tr>
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Summary Remarks!!

• Cloud Computing matters – need to quickly learn how to exploit the promised benefits and address the challenges

• Cloud computing stimulates new research directions for new and novel ways of developing software & services

• GSE is increasingly becoming popular for many good reasons – technological and socio-technical innovation are required

• Cloud computing presents huge potential for ICT innovation including GSE paradigm
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- Socio-technical challenges and solution strategies work has been performed with Mansooreh Zahedi for her PhD research.

• I. Brandic, et al., Service mediation and negotiation bootstrapping as first achievements towards self-adaptable grid and cloud services, Proceedings of the 6th international conference industry session on Grids meets autonomic computing (GMAC '09), 2009.

Thank You!

Questions

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