Smart Cloud Computing: Autonomy, Intelligence and Adaptation

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Overview

- Main challenges for our planet
- Cloud computing – background
- Core concepts
- Confusing views and debate
- Smart cloud infrastructure
- Reference platform architecture
- Future research topics and summary
Main Challenges for our Planet

A series of “wake-up calls”, with a single subject of focus, the reality of global integration:

• Climate change – global warming
• Frozen credit markets and limited access to capital
• Energy shortfalls and erratic commodity prices
• Increasingly complex supply chains and empowered consumers
• Population growth and health problems reminding us how globally interconnected we are

Reference:
The Smarter Planet Vision

• First, our world is becoming instrumented. Sensors are being embedded across entire ecosystems, supply-chains, healthcare networks, power grid, cities and even natural systems like rivers.

• Second, our world is becoming interconnected. Systems and objects can now “speak” to one another. Soon there will be a trillion connected and intelligent things – cars, appliances, cameras, roadways, pipelines, pharmaceuticals, and even livestock. The amount of information produced by the interaction of all those things will be unprecedented.

• Third, all things are becoming intelligent. Advanced analytics can turn the mountains of data from these systems and objects into decisions and actions that make the world smarter.
Example: Smart Cities

Intelligent Transportation Systems
- Integrated Fare Management
- Road Usage Charging
- Traffic Information Management

Energy Management
- Network Monitoring & Stability
- Smart Grid – Demand Management
- Intelligent Building Management

Water Management
- Water purity monitoring
- Water use optimization
- Waste water treatment optimization

Integrated City Command
City status and control
- Event driven automation and optimization across systems
- Trend analysis and prediction

Public Safety
- S3 Surveillance System
- Emergency Management Integration
- Deep Thunder Micro-Weather Forecasting
Cloud Computing - Background

- Modern distributed computing infrastructures
- Introduction of ‘invisible’ grid concepts
- The telecom industry was perhaps the first to conceptualize the term “cloud” - early 1990s
- The introduction of computing clouds didn’t happen until 2006, when Google announced the software-as-a-service (SaaS) approach
- The term “cloud computing” became mainstream rapidly after Amazon launched its elastic compute cloud (EC2)
Core Concepts

- Virtualization
- Service-oriented architectures
- Utility computing
- On-demand computing resources
- Elastic scaling
- Elimination of up-front and operational expenses
- A pay-as-you-go business model
Utility computing is not a new concept — introduced by John McCarthy, MIT in 1961.

Larry Ellison, CEO of Oracle said that cloud computing is "everything that we already do", claiming that the company could simply "change the wording on some of our ads" to deploy their cloud-based services.
Confusing Views and Debate

Free WIFI
For all of our guests
provided by The Cloud
Background: ‘Invisible’ Grid Concepts

  To develop the design methodology of a generic component-based Grid platform for both applications and tools/systems/PSEs to operate in a single, seamless, “invisible” Grid infrastructure supporting the Services Computing paradigm.

- More specifically:
  Wide range of heterogeneous devices/services → Need of dynamic properties and flexibility → Grid Component Model → Intelligent, autonomic frameworks → Component-based design methodology
Current Challenges – Cloud Computing

- Scalability: where ‘just more of the same’ does not work!
- Security: Service Provider responsible for SLAs
- Autonomy
- Intelligence
- Adaptation
- Complexity is qualitatively harder and multidimensional.
# Enterprise Cloud Computing Models

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<td>Private cloud</td>
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<td>3. <strong>Enterprise</strong></td>
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<td>4. <strong>Enterprise A</strong></td>
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<td>5. <strong>Enterprise</strong></td>
<td><strong>Public access to cloud services</strong></td>
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**Enterprises Strategic Focus**

- **Private cloud** Vendor implements on client premises
- Can be configured to client-specific workflows
- Internal network
- Client runs and manages

- **Managed private cloud** Vendor implements in-house or on client or premises
- Can be configured to client-specific workflows
- Internal network
- Vendor operated

- **Hosted private cloud** Vendor owned and operated
- Enterprise—only access to resources
- Shared facility and cloud management
- Standardized
- Network isolated

- **Vendor-owned and operated** Vendor owned and operated
- Mix of shared resources
- Shared facility and cloud management
- Elastic scaling
- Pay-as-you-go
- Support and network options

- **Shared resources** Elastic scaling
- Pay-as-you-go
- End-user access (credit card)
Smart Cloud Infrastructure and Reference Platform Architecture

- Natural environment (sensors);
- Electrical power grid and other industrial establishments (sensors);
- Smart computer communication networks;
- Sustainable services;
- Information resources, infrastructures, and repositories;
- Smart programming models, tools, and environments;
- e-Science simulations for new discoveries;
- Use cases in strategic application domains.
Component-Centric Problem-to-Solution Pipeline

Main issues: composition and dynamic properties – deployment, monitoring and steering
Component-based design methodology

- Integrated Development Environment
- Applications (Algorithms)
- Programming Model - GCM
- Composition
- Scheduling & Deployment
- Monitor & Steer
- Metadata Description incl. ADL, etc.

Obtaining the Solution
Conclusions and Some Relevant Research Topics

• Generic smart platform architecture and design methodology
• Dynamic service composition and aggregation
• Relevant programming model for software services development/execution – evolution of SCA and GCM - ?
• Metadata-based intelligent decision-making support
• Integrated development and execution framework
• Automation of application deployment – skeletons/patterns
• Use Cases – rapid development of complex applications: Cloud-aware or Cloud-unaware - ?