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:

Thomas L. Friedman, “Hot, Flat, and Crowded”, 2008.

The Smarter Planet Vision

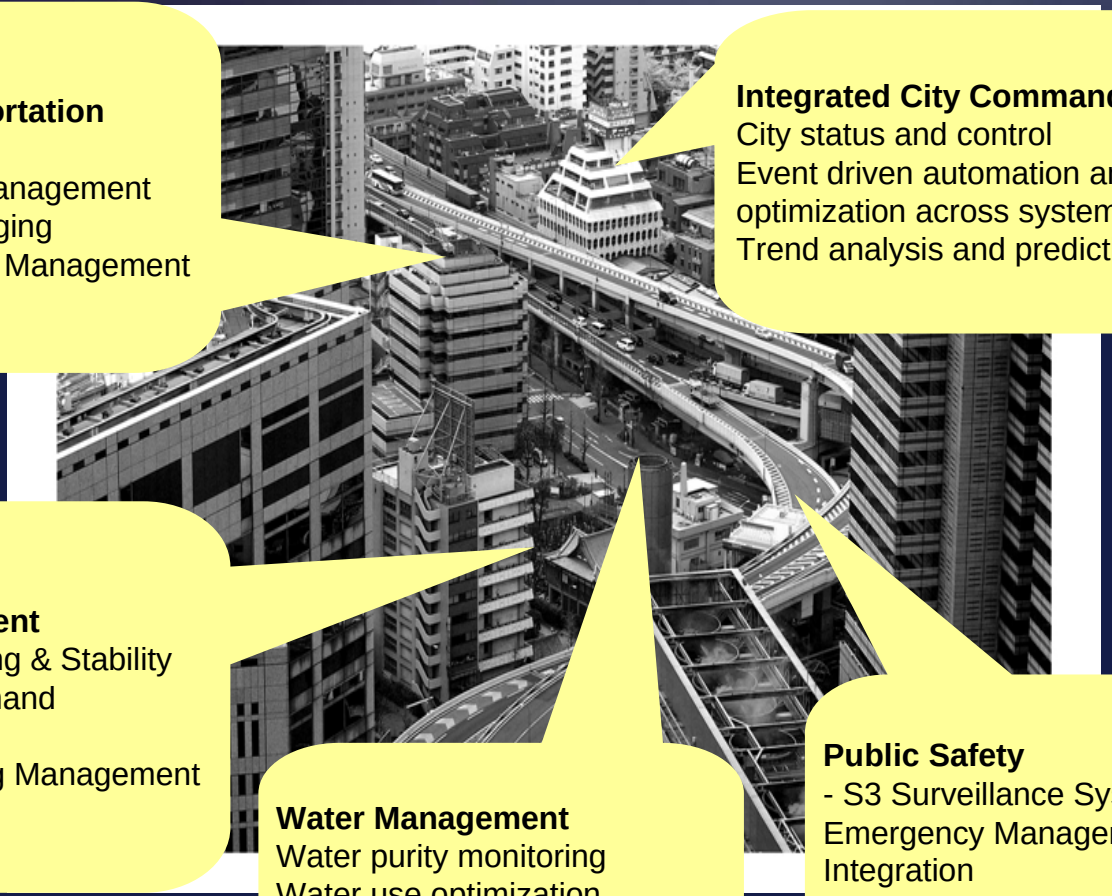
- First, our world is becoming instrumented. Sensors are being embedded across entire ecosystems, supply-chains, healthcare networks, power grid, cities and even natural systems like rivers.

- 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



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

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

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

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

Confusing Views and Debate

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

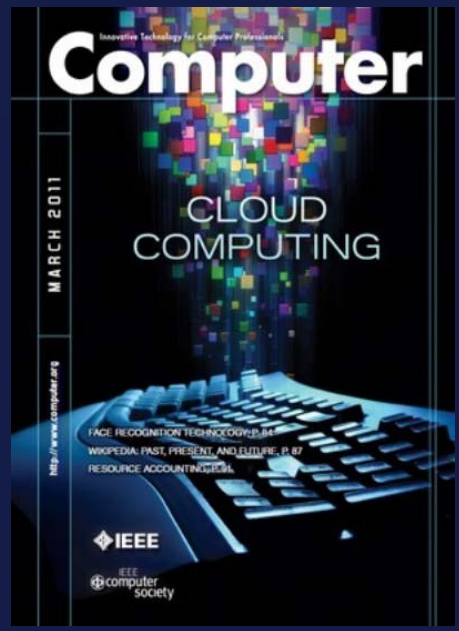
Background: ‘Invisible’ Grid Concepts

- Approach in the CoreGRID NoE (2004 – 2008):
  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.

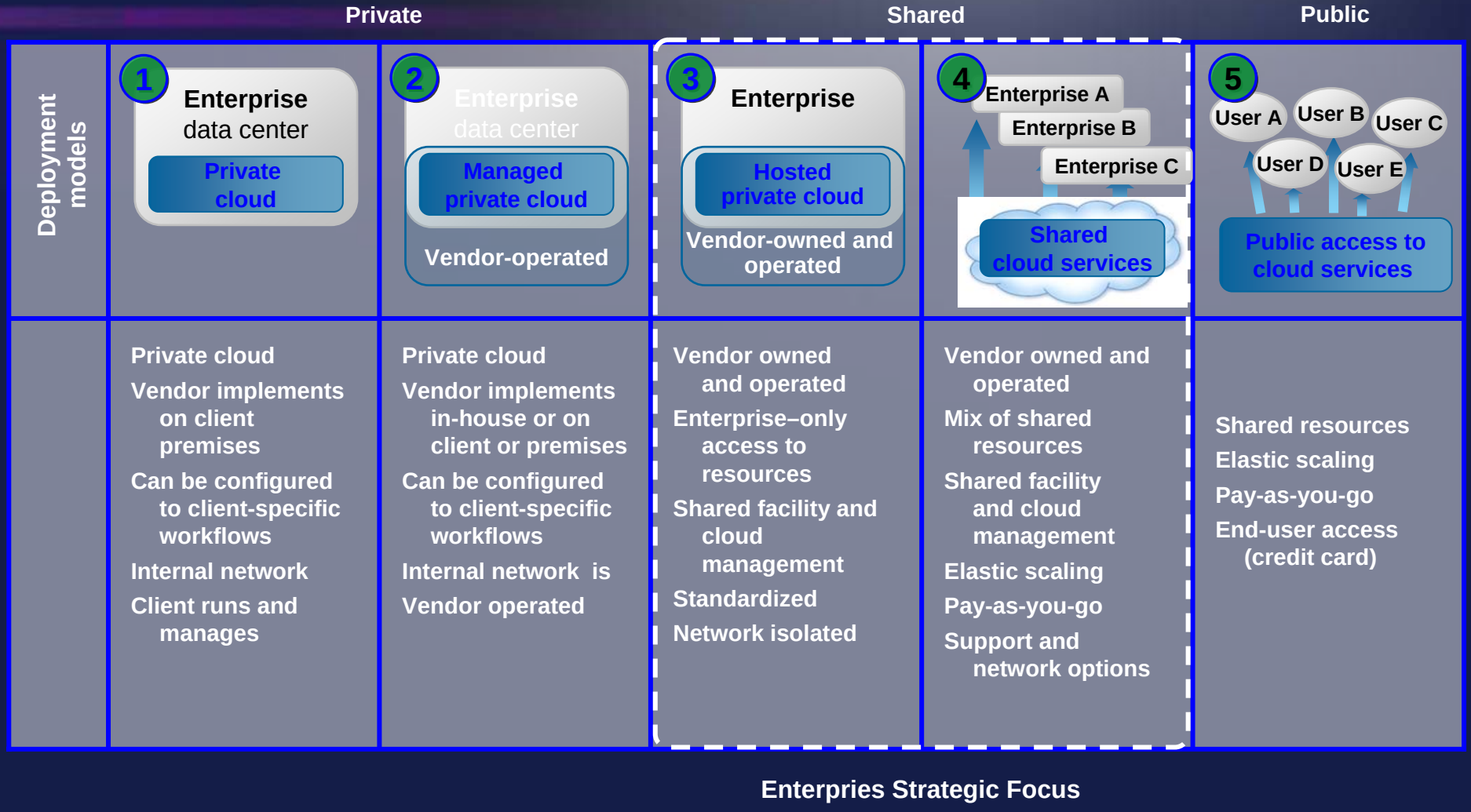
- More specifically:
  Wide range of heterogeneous devices/services →
  Need of dynamic properties and flexibility →
  Grid Component Model →
  Intelligent, autonomic frameworks →
  Component-based design methodology

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.



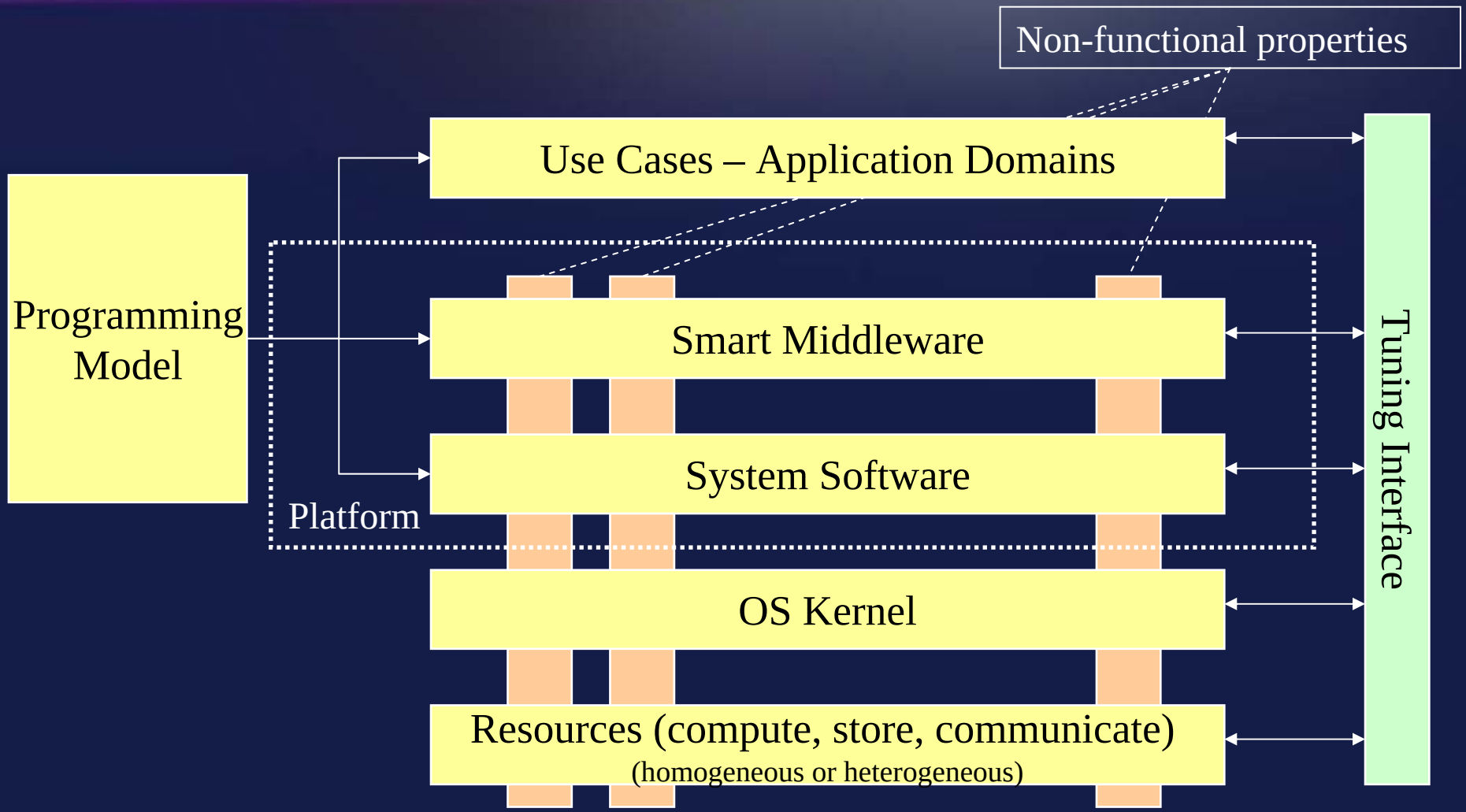
Enterprise Cloud Computing Models



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.

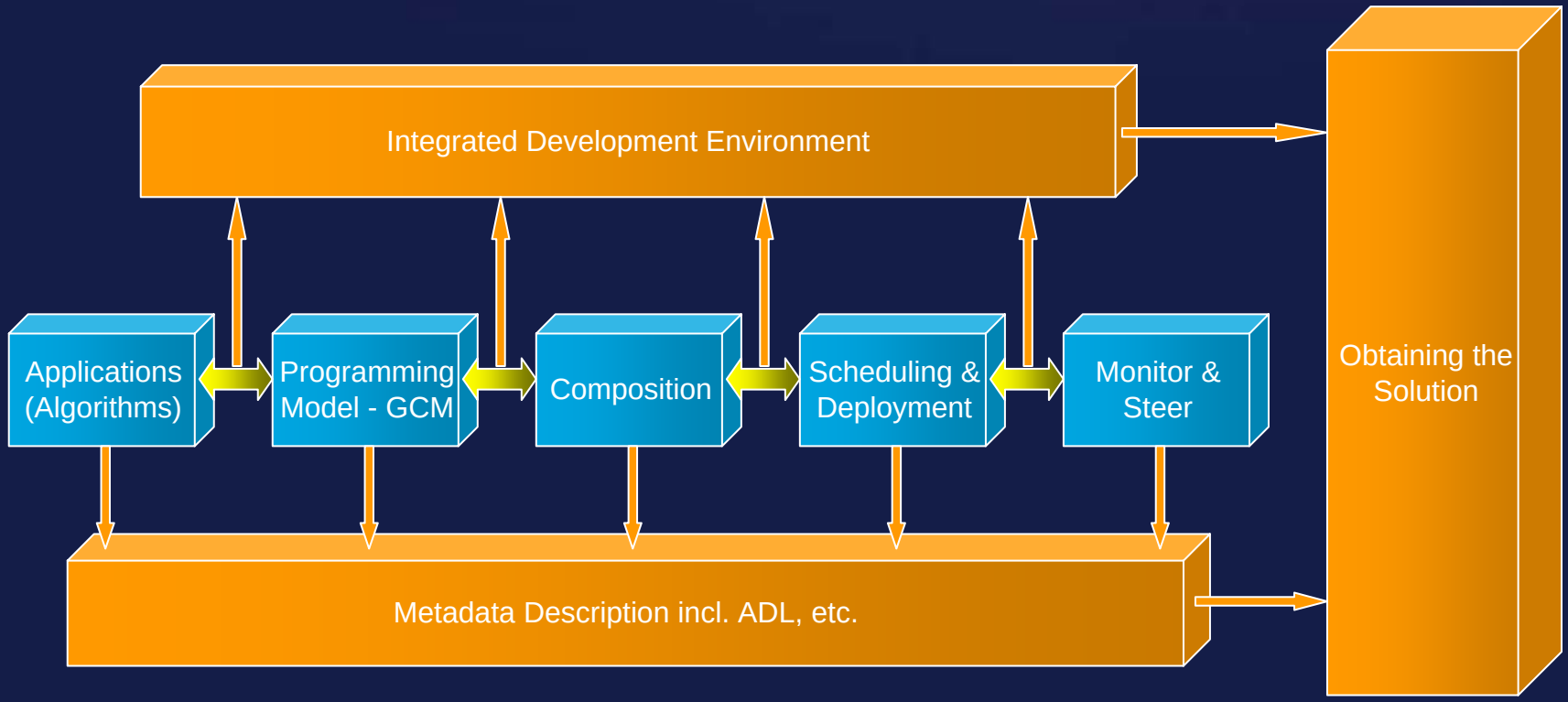
Generic Platform Architecture



Component-Centric Problem-to-Solution Pipeline

Main issues: composition and dynamic properties – deployment, monitoring and steering

Component-based design methodology



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 - ?