



\* 4<sup>th</sup> Generation Datacenter  
IEEE Spectrum, Feb. 2009

- *Cloud Computing Introduction*
- *Cloud Computing Architecture*
- *Software Architecture for Cloud*
- *Outlook*

Corporate Research and  
Technologies ,  
Munich, Germany

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20<sup>th</sup> May 2010

**SATURN 2010**

## Motivation and Goals

- Cope with Cloud Computing paradigm in complex enterprise and industrial environments in the roles as customer, provider, and ISV
- Design guidelines for native cloud applications for industrial domains
  - Embedded systems integrated with cloud services
  - ISVs prepare their software for cloud operation
- Support for re-engineering existing on-premise applications for the Cloud Computing paradigm
- Coping with required break to existing IT and software architecture (data (storage, distribution), processing, transactions, caching, workflows, access control, etc.).

## Reminder: Cloud Computing

...focus on automation, resource sharing and business

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**Novelty comes from the composition of existing technologies combined with new business models for software and service selling.**

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  
(Source: NIST Cloud Computing Project\*)

\* <http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v14.doc>

Page 3

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## Cloud Computing Business Challenge

Which applications profit from Cloud Computing?

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### Applications with these requirements are candidates:

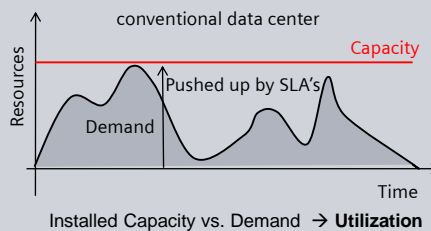
- massive scale (computation, storage, ...)
- high reliability and availability
- heavy load variations
- world-wide distribution
- non- deterministic life-time (start-up's)
- collaboration across company boundaries
- application do not fit to company core business

### Benefiting from:

- reduced administration effort
- contract flexibility (pay as you go)
- availability and elasticity

### Business Driver - TCO

- Utilization Rate
- CAPEX → OPEX



### Business Driver - Flexibility

- pay as you go instead of long-term contracts

Page 4

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## Cloud Computing Architecture

Our first definition

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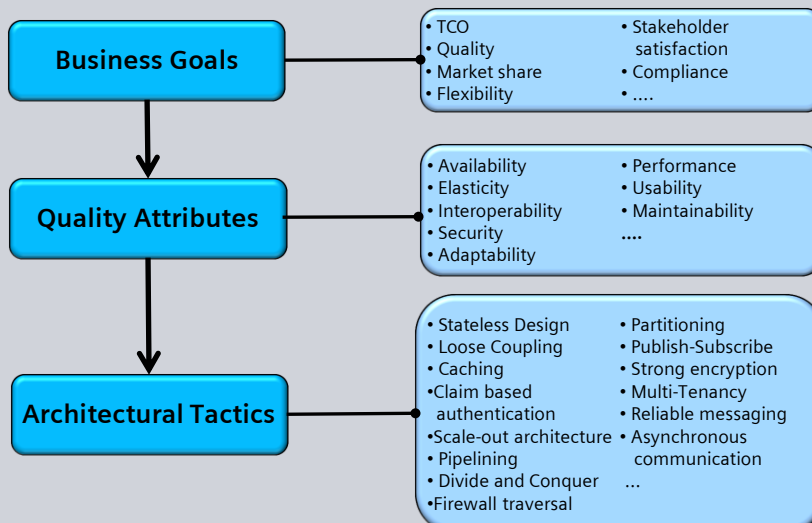
The **Cloud Computing Architecture** of a cloud solution is the structure of the system, which comprise on-premise and cloud resources, services, middleware, and software components, geo-location, the externally visible properties of those, and the relationships between them.

The term also refers to documentation of a system's cloud computing architecture. Documenting facilitates communication between stakeholders, documents early decisions about high-level design, and allows reuse of design components and patterns between projects.

## Context: High-level Architectural Approach

... aligned with common architectural approaches

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## Cloud Computing Architecture

Major building blocks

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### Reference Architecture

- Basis for documentation, project communication
- Stakeholder and team communication
- Payment, contract, and cost models

### Technical Architecture

- Structuring according to XaaS Stack
- Adopting Cloud Platform paradigms
- Structuring cloud services and cloud components
- Showing relationships and external endpoints
- Middleware and communication
- Management and security

### Deployment Operation Architecture

- Geo-location check (Legal issues, export control)
- Operation and monitoring

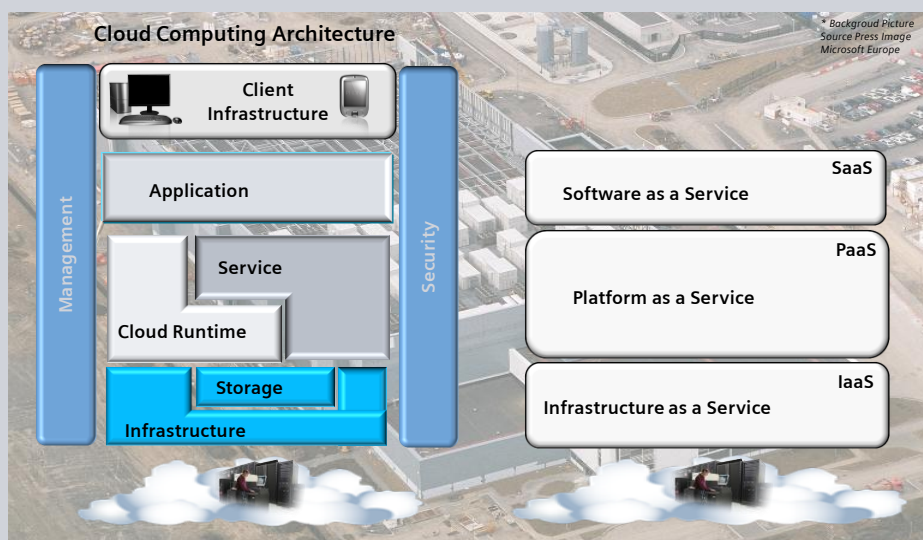
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## Cloud Computing Architecture vs. "XaaS"

... allows comparisons, maps to common dictionary

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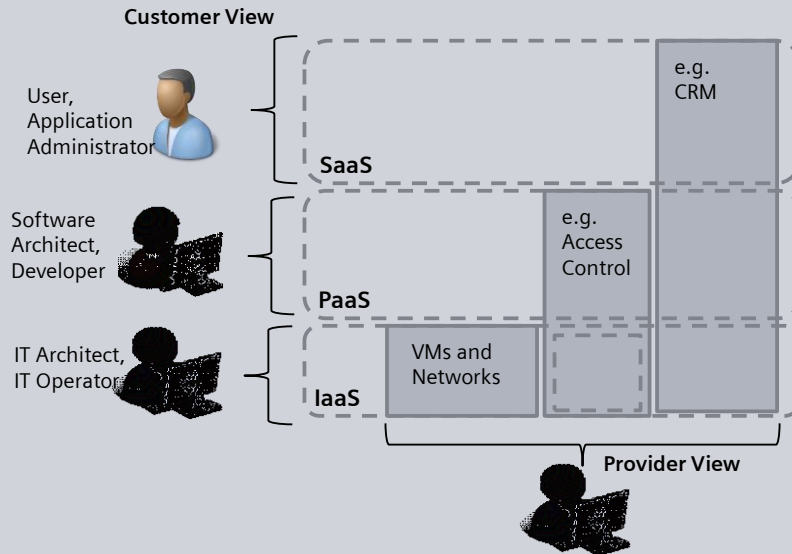


Page 8

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## “XaaS” Stack Views Customer View vs. Provider View

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Page 9

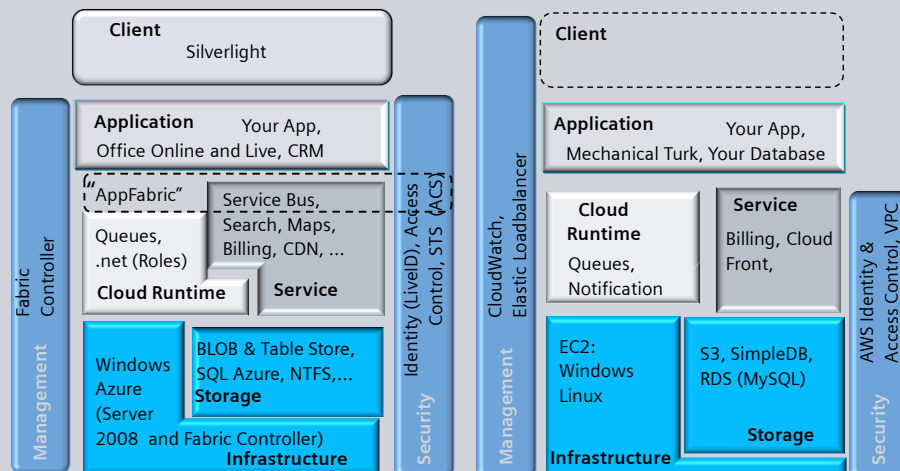
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## Cloud Reference Architectures Allow comparison of vendors and technologies

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e.g. Microsoft Windows Azure Platform

e.g. Amazon Cloud Platform



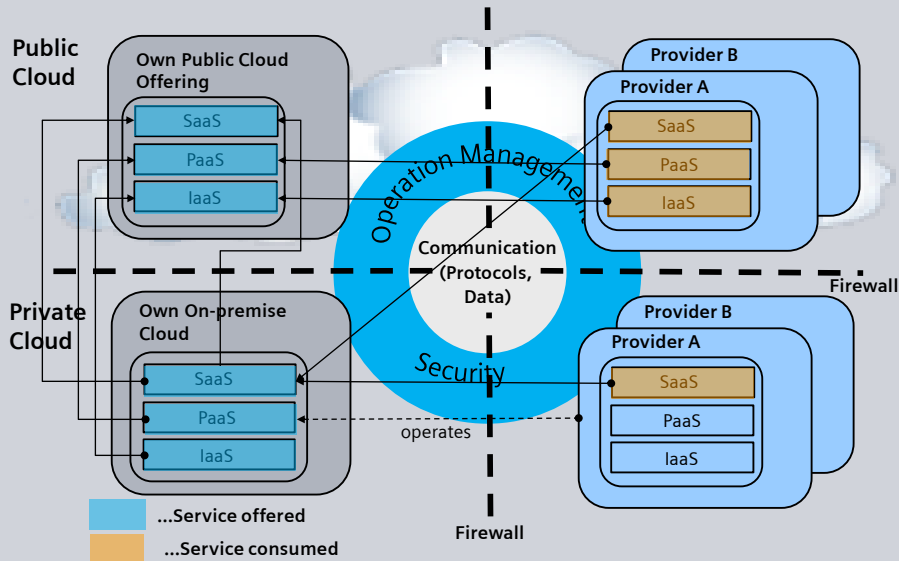
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## Hybrid Cloud Architecture Model

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... XaaS Stack extended by the location, provider dimensions



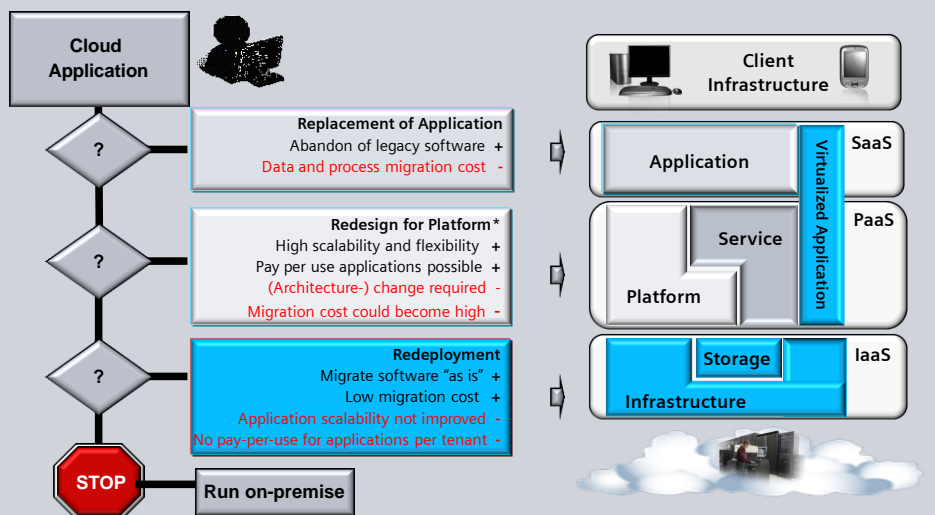
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## Cloud Migration Strategy

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...which layer fits the demand?



\*... "Requires change of applications (own or partner application) or development of adapter layer"

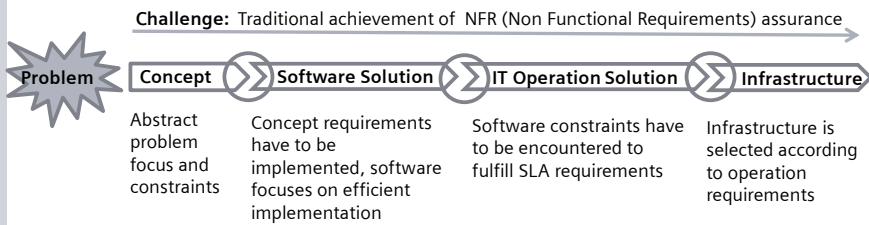
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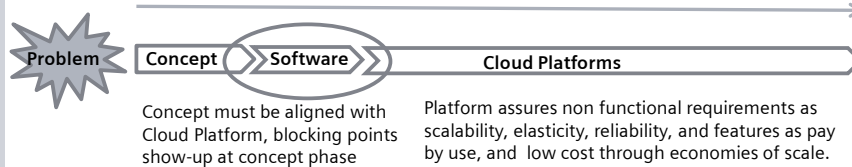
## Cloud Platforms - Simpler NFR Engineering

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Software architecture becomes deployment architecture



**Advantage:** Match of NFRs are verified at higher level (platforms plus SAL), miss-match adaptation is possible through **change of concept or change of cloud platform**.



Page 13

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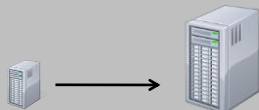
## Architecture for Elasticity

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...elasticity and cost requirements impact architecture

### Vertical Scale Up

- Add more resources to a single computation unit i.e. Buy a bigger box
- Move a workload to a computation unit with more resources



For small scenarios scale up is probably cheaper - code "just works"

### Horizontal Scale Out

- Adding additional computation units and having them act in concert
- Splitting workload across multiple computation units
- Database partitioning



For larger scenarios scale out is the only solution  
1x64 Way Server much more expensive than  
64x1 Way Servers

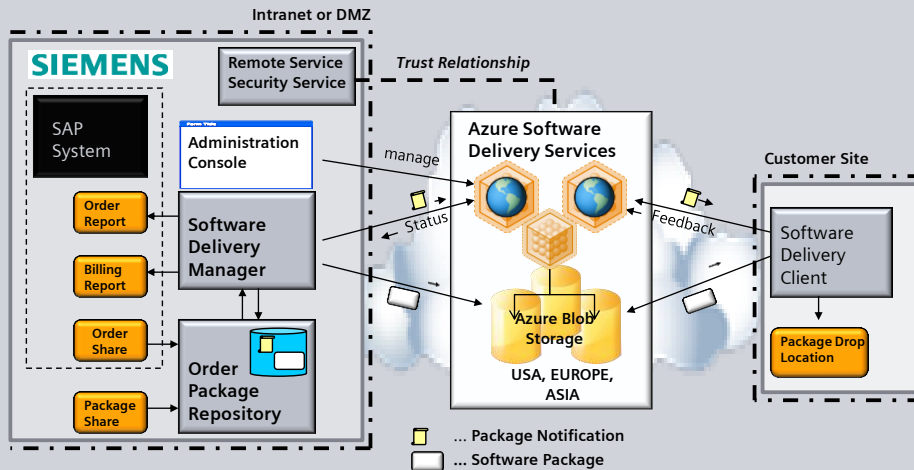
Page 14

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## Siemens Cloud-based Software Distribution Some experiences ...

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Siemens Cloud Software Delivery Service provides saleable software distribution based on Windows Azure across enterprise boundaries (firewall friendly).



Page 15

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## Outlook

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- Cloud Computing approaches will spread because of lower TCO and higher flexibility (business, technical)
- Cloud Computing will massively change the future IT business in a way that many standard IT services will be offered by big IT providers
- Cloud Computing platforms commoditize native Internet scale application development and operation
- Cloud Computing Architecture aspects will be integrated in Cloud **platforms** as framework, process, templates, guidance to lower the business, legal, and technical **burden** for application developers



Page 16

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Thank You for your Attention!

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*Within Corporate Technology the Global Technology Field System Architecture and Platforms focuses on software architectures for a wide range of software-types. This includes embedded systems, distributed applications, and enterprise software.*

*In the recent field of cloud computing the focus is cloud computing architecture for cloud platform stacks and applications. Cloud computing architecture is key for scalability, cost efficiency, and meeting of legal and business requirements. These activities are completed by the industry focused evaluation of strategic cloud computing platforms in order to support customers on their way to cloud computing.*

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