Cloud Computing: Fundamental Architecture & Future Applications

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Agenda

Virtualization: ESB & Grid
XaaS: IT as a Service
Dynamics: Provisioning as Basis
Impact: Outsourcing IT & Business Processes
Summary
Cloud Evolution

Focus: Optimized support of set of negotiated SLAs
A set of “IT resources” providing individual resources to the outside

Cluster → Grids → Clouds

Focus: Optimized utilization of IT environment

A set of “complete” connected computers (or clusters) providing their resources to the outside

Focus: Optimized support of individual application
A set of “complete” connected computers perceived as a single “computer” from the outside

The Net of SOA: Virtualization of Software

I want ...
But I don’t care about a particular provider: Chose the one who is at this point in time “the best” for me!

Virtualization

Virtual Service

Service Bus

Environmental Properties

Service Description
-Function
-QoS
-Data

Business Properties
The Grid: Virtualizing Resources

OGSA

Virtual clusters and storage

Service Bus!

The Combination: Computing On Demand

In 3 hours I need the following environment for 45 minutes: 253 machines, 1.7 TB storage, WebSphere, DB2, and the following SAP applications...
Reminder: Two Viewpoints

On Demand Computing  
Utility Computing

Service  
Customer  
Provider  
Service

Remember: The Bus

The Bus

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From WWW...  
...to BBB  
(Big Basic Bus)

Agenda

Virtualization: ESB & Grid

XaaS: IT as a Service

Dynamics: Provisioning as Basis

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Summary
What is SaaS?

≈≈ “Software deployed as a hosted service and accessed over the Internet”

- More precise definition needs to include
  - Scalability of the software
  - Availability of the software
  - Multi-tenant support of the software
  - Configurability/customizability of the software

⇔ ...problems to be solved

The First Major Step

Software as a Service (SaaS)
The Pioneer in SaaS

Business Processes as SaaS
BPM as SaaS

...And Do Not Forget...

- Zillions of Web Services already provided by
  - Amazon
  - eBay
  - Google
  - IBM
  - Microsoft
  - Nortel
  - Oracle
  - RightNow
  - SAP
  - Yahoo
  - ...
The Second Major Step

IT Infrastructure as a Service (IaaS)

Storage as a Service
Databases as a Service

Message Queuing as a Service
Virtual Images as a Service

Edge Server as a Service
The Third Major Step

Platform as a Service (PaaS)

An Operating System For the Cloud

Windows Azure

The Azure Services Platform provides a cloud-based infrastructure and operating system that enables businesses to create, deploy, and manage their applications and services on a global scale. It offers a comprehensive set of services and tools to help developers build, deploy, and manage applications in the cloud.

Try It now

Register now to try the Azure Services Platform.
Middleware For the Cloud

Workflows For the Cloud
Development Tools For the Cloud

Microsoft Unveils Vision and Road Map to Simplify SOA, Bridge Software Plus Services, and Take Composite Applications Mainstream.

Company announces multiyear investment in "Oslo," launches new SOA resources for IT professionals.

SEATTLE, Wash. — Oct. 30, 2007 — Attendees gathered at the fifth annual Microsoft SOA & Business Process Conference today, where the company shared its vision and road map to simplify the effort required to design, build, deploy and manage composite applications within and across organizations. Microsoft Corp. announced "Oslo," the code name for the set of technical investments that help customers realize this vision.

This multiyear, multi-product effort utilizes the company’s top engineering talent to build on the model-driven and service-enabled principles of Microsoft Dynamic IT.

The benefits of service-oriented architecture (SOA) extend beyond the "floor". This technology innovation further Microsoft software-plus-services efforts by providing extensions to the application platform to help developers bridge between on-premise and off-premise projects.

The plan is a structure that helps customers make the most of their investments to help organizations take advantage of "real-world SOA" today, including new SOA resources from Microsoft and a host of industry partners.

Public Versus Private Clouds

Cloud Computing

Gain access to your applications from anywhere, at any time.

IBM

Cloud computing services can be delivered to an organization as a single service or as an add-on to an existing infrastructure. A cloud computing service is typically provided as an on-demand service, allowing organizations to access software and infrastructure on a pay-as-you-go basis.

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Sigh: So, It’s Time to Classify Clouds

Public Clouds

Private Clouds

Hybrid Cloud

Off Premise

On Premise

Creating Clouds

SaaS

Cloud Computing

Virtualization

Our Strategy: Become Rainmaking

IBM

Rainmaking

SaaS

Cloud Computing

Virtualization

SaaS

Cloud Computing

Virtualization

Our Strategy: Become Rainmaking

IBM

Rainmaking

SaaS

Cloud Computing

Virtualization

SaaS

Cloud Computing

Virtualization
Collaboration in the Cloud

Features
Collaboration at its best

What is "Bluehouse"?
"Bluehouse" is a place where businesses come to get work done. Whether you need to plan for tomorrow's meeting, are ready to host a sales team of 100 in an office or want to collect feedback from yesterday's call - "Bluehouse" can help.

- Host your entire team on project meeting - everyone can see
- Build relationships with potential clients and business partners outside the firm
- Exchange files and share files with others
- Edit a group project
- Create documents
- Turn feedback into dynamic charts or graphs

Office in the Cloud

Google

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The Forth Major Step

Your Own Applications as a Service

Web Applications in the Cloud

Run your web applications on Google's infrastructure. Google App Engine enables you to build web applications on the same scalable systems that power Google applications.

- No assembly required.
- Google App Engine provides a fully-integrated application environment.
- It's easy to scale.
- Google App Engine makes it easy to build scalable applications that grow from one user to millions of users without infrastructure headaches.
- It's free to get started.
- Every Google App Engine application can use up to 500MB of persistent storage and enough bandwidth and CPU for 5 million monthly page views.

This is a PREVIEW RELEASE of Google App Engine. For now, account registrations are limited to the first 10,000 developers, and applications are restricted to the free account limits.
Rails in the Cloud

Spectrum of Clouds (Yes, This is a Bit Confusing 😊)

- Hardware
- Storage
- Machine
- Middleware
- Applications
- Services

- CPU
- Network
- ...?

- Raw Disk
- File
- BLOB
- Table
- Queue
- ...

- Images
- Appliances
- ...

- Security
- Bus
- Workflow
- ...

- Hosted RYO
- SaaS
- ...

- Best-of-Breed
- Compositions
- ...

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From BBB... 
...to CCC

(Cool Components Cloud)

Consequence: Today’s IT Resources...
... Will Disappears in the Cloud

Bringing a Bit Structure to the Cloud Spectrum

Increasing the level of abstraction

- IaaS
  - Hardware
    - CPU
  - Storage
    - Network
    - Raw Disk
    - File
    - BLOB
  - Machine
    - Table
    - Queue
  - Middleware
    - Image
    - Appliances
  - Applications
    - Security
    - Bus
    - Workflow
  - Services
    - Hosted RYO
    - SaaS

State of the art

Future

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Now, We Can Layer Clouds

(*) CaaS := Composite as a Service

Moving an Application to the Clouds

Sample Distribution

Sample Realization
Architecture of Composite Applications

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SOA Applications

Runtime of an SOA Application

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Application Structure (= Composite Application)

Refined View on a Composite Application
What Is Typically Customized

“Points-of-Variability: Application Logic”

“Points-of-Variability: Environment”
Customizing Application Logic

Application Logic Customization Tool

- Process Models
- Business Services
- GUls
- Schemas
- Environment Descriptions

Customizing Application Environment

Environment Customization Tool

I need an AppServer 7×24!

- AppServer Vendor1
- AppServer Vendor2

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Specifying the Ability to Customize an Application

- Concept of **variability descriptors** motivated by product line engineering
- Variability descriptors describe dependencies between variability points
- Variability descriptors point into artifacts of the application
  - describe alternative values

```
<table>
<thead>
<tr>
<th>Application Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>.bpel file</td>
</tr>
<tr>
<td>.html file</td>
</tr>
<tr>
<td>.wsdl file</td>
</tr>
</tbody>
</table>
```

How Can a Mere Mortal Customize Applications?

- **Customization flows** guide tenants through the customization of the SaaS application
  - Are generated from variability descriptors (dependencies between variability points are taken into account)
  - Guarantee that tenants only perform valid customizations
  - Are specified in BPEL (with BPEL4People extension)
  - Are run in a BPEL engine at the SaaS hoster

```
Example Customization Flow

SaaS app

- Specify WSDL of payment service
- Specify Port type
- Specify currency ($ or €)
- Specify Operation
  - Invoke payment service from SaaS application or own service
```

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Result of Customization

Application Logic Customization Tool

Process Models
Business Services

Template

Environment Customization Tool
(SLAs, Deployment Descriptors, ...)

Tenant Solution

Process Models
Business Services
GUIs
Schemas
Environment Descriptions

Provisioning: Getting Ready for Execution

Tenant Solution

Process Models
Business Services
GUIs
Schemas
Environment Descriptions

Customer Environment

GUI
Application
Middleware
Hardware
Application Database

“Script”

Derive
Run
Putting Things Together

SaaS Provider

- Template Portal
- BPEL Engine
- Customization Flows
- Provisioning Flows / Resource Processes

- Application Template Library
- Solution Library (configured templates)

- Provisioning Bus
- Provisioning Engines
- Hardware Resources

Tenants

Application Vendors

 Provisioning Infrastructure

End user

- Template/Solution Portal
- Provisioning/Management Layer
  - B & M Plans
  - Application Provisioning Flow
  - Instantiation Requests (= requirements)

Matching / Discovery & Resource Layer
  - Cloud / Provisioning Service Descriptions (= capabilities)
  - WS-RF based unified API

Unification Layer
  - Provisioning engine specific APIs

- Cloud Service Catalog
- AMI Catalog
- EC2
- TSAM Service Catalog

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Prototypical Implementation

- Resource Bus based on Service Mix
- Variability Descriptor Editor based on Eclipse
- Variability Descriptor to CustomizationFlow translator
- Resource Processes for sample Infrastructure (Tomcat w/ Sun N1 provisioning Engine)
- Sample Application to test concepts
  - Built on Google AppEngine (for GUI) + ActiveBPEL engine (run locally or on EC2)

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Geographic Distribution of Application

A Pessimistic Scenario

Your and your application

Your headquarter
“Your” compute center (business processes)
“Your” compute center (application functions)
“Your” programmers
But There Is Hope: Shift of Skills

A Business Process Involving Multiple Departments
Step 1: Projecting Onto Departments

Step 2: Wiring the Projections ⇒ Choreography
Single Site Company

Geographically Distributed Company
Conclusion

- SOA & Web Service/Grid middleware is technology for virtualization:
  IT becomes subject to dynamic out-/insourcing
- Virtualization and provisioning technology enable the Utility model
- Utility model enables “All of IT” as a Service which enables the On Demand model
- Result is agile IT Infrastructure enabling companies to react fast on changing environment by out/in-sourcing
- Not only IT can be outsourced but any part of business processes (i.e. focus on core competencies)

The future will be cloudy 😊
...But There is a Lot Research to do...

Vision

- Customizable, multi-tenant aware and continuously adaptable applications on demand in the cloud based on a pay-as-you-go cost model

(*) CaaS := Composite as a Service
Most Critical Research Areas

- Composability within spectrum of clouds
- Interoperability of clouds
- Layered structure of clouds
- Applications for the cloud
- Humans in the cloud
- Data in the cloud
- Compliance in the cloud
- Security
- Multi-tenancy
- SLAs
- Service Network support by clouds
- Scheduling/brokering within Clouds

The End!

Thanks

For Your Attention...