Cloud Testbeds for Standards Development and Innovation

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Senior Scientist, High Performance Computing Center
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NIST SAJACC Working Group Co-Chair

Sep. 24, 2014
Organization of this talk

1. Past
2. Present
3. Future
Organization of this talk

In more detail:
1. Review of mission, plans and goals of SAJACC Phases I and II.
2. Discussion of the early role of the Cloud Plugfest series.
3. Evolution of the European Grid Initiative Federated Cloud from a testbed into full production status.
4. Discussion of several other standards testbed projects.
5. Update on current NSF projects in this area and ongoing work with NSF CAC partners on cloud standards definition, testing and cloud computing API and product benchmarking.

This is an update to talks given on this subject over the past several years, in which I will go into detail on motivations and accomplishments of some related and independent standards testing programs.
Organization of this talk

1. Past
2. Present
3. Future
A brief history of cloud computing

1970’s: Networking becomes commonplace. Distributed computing experiments via ARPAnet, etc. Ethernet developed.

1980’s: Experiments linking idle NeXT computers by Apple folks.


2000’s: Experiments lead to large-scale grids; cloud computing begins to emerge as a label but not yet as a widespread tool.

The pattern of trying things out on small scale and then scaling them up if successful is among the oldest approaches in computing. (In fact, it is clearly not limited to computing topics.)

In the grid and cloud context, which I regard as a continuum or at least connected, we have been doing this since the early days of distributed computing.
Generally speaking, when diagrams of collected resources were drawn that included groups of things reachable by the network, bubbles that were cloud-shaped were used to distinguish them from local resources. “Cloud computing” probably emerged from this pattern of drawing coupled with the idea of a nebulous, flexible set of resources.
Testbeds were used _EVERYWHERE_

The operative word in any initial project was a “testbed”. The Open Science Grid (now >760,000 cores) grew out of an early combination of three testbeds that merged into “Trillium”, then “Grid3” and then OSG — which led to other experiments that we will hear about later in this talk.
Open Science Grid currently consists of over 124 geographical sites, operating on a wide variety of computing systems.
Science VOs on the Open Science Grid

- Astrophysics
- Biochemistry
- Bioinformatics
- Earthquake Engineering
- Genetics
- Gravitational-wave physics
- Mathematics
- Nanotechnology
- Nuclear and particle physics

... and many others!
Example: Worldwide LHC Computing Grid

~450,000 cpu cores
~430 Pb storage
Typical data transfer rate: ~12 GByte/sec

Total worldwide grid capacity: ~2x WLCG across all grids and VOs
EGI international presence

<table>
<thead>
<tr>
<th>Storage</th>
<th>Value (yearly increase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk (PB)</td>
<td>235 PB (+69%)</td>
</tr>
<tr>
<td>Tape (PB)</td>
<td>176 PB (+32%)</td>
</tr>
</tbody>
</table>

Value (yearly increase)

| CPU cores | 361,300 across 53 countries (1.44 M job/day) |

Example of standards-based international collaboration
The Cloud Computing model offers the promise of massive cost savings combined with increased IT agility. It is considered critical that government and industry begin adoption of this technology in response to difficult economic constraints. However, cloud computing technology challenges many traditional approaches to datacenter and enterprise application design and management. Cloud computing is currently being used; however, security, interoperability, and portability are cited as major barriers to broader adoption.

The long term goal is to provide thought leadership and guidance around the cloud computing paradigm to catalyze its use within industry and government. NIST aims to shorten the adoption cycle, which will enable near-term cost savings and increased ability to quickly create and deploy enterprise applications. NIST aims to foster cloud computing systems and practices that support interoperability, portability, and security requirements that are appropriate and achievable for important usage scenarios.

Written comments on both volumes of the SP 500-293 may be sent to: Robert Bohn, National Institute of Standards
NIST SAJACC Public Process

Standards Acceleration to Jumpstart the Adoption of Cloud Computing

Description

The goal of the SAJACC initiative is to drive the formation of high-quality cloud computing standards by providing worked examples showing how key use cases can be supported on cloud systems that implement a set of documented and public cloud system specifications. The SAJACC initiative will develop and maintain a set of cloud system use cases through an open and ongoing process engaging industry, other Government agencies, and academia. Simultaneously, the SAJACC initiative will collect and generate cloud system specifications through a similarly open and ongoing process.

The SAJACC initiative will develop tests that show the extent to which specific use cases can be supported by cloud systems that implement documented and public cloud system specifications, and will publish test results on the SAJACC web portal (this web site).

The SAJACC web portal will provide pointers to known cloud system implementations, use case documents, upcoming events, and will also provide a convenient means to provide feedback to the SAJACC team. These resources will serve to both accelerate the development of high-quality cloud computing standards and reduce technical uncertainty during the interim adoption period before many cloud computing standards are formalized.

Objectives

Mailing List and Meeting Information

Weekly SAJACC working group meetings will be held as teleconferences. Meeting discussion materials and meeting minutes are posted to this site as they become available.

The dial-in information for the bi-weekly meeting series is as follows:

- Phone: (Toll Free) +1 (855) 834-4888
- Conference ID: 73390239

The URL for the web conference tool for the meeting is: http://webconf.soaphub.org/conf/room/sajacc

Coordinators and contacts:

“Standards Acceleration to Jumpstart the Adoption of Cloud Computing” = SAJACC

One of several NIST Cloud Computing working groups that has been active since 2010 to pursue their mandate to produce guidance to the US government; other working groups for reference architecture, security, standards roadmap, accessibility and forensics

SAJACC Focused on use case definition and refinement to produce testable cloud computing scenarios

Demo code and presentations part of public record

New round recently started to refine test cases
SAJACC Use Cases
Standards Acceleration to Jumpstart Adoption of Cloud Computing

Breakout Sessions
Nov. 5, 2010
Overall Starting Points

- Want use cases that work across multiple clouds and in different environments
- Aim at specific use cases that can provide insight as to how clouds CAN work as well as demonstrations of how clouds work now
- Reference implementations to enable feasibility exercises
- Continuously growing, publicly accessible portal to showcase results
SAJACC Process

In a little more detail...
Inventory of Standards Relevant to Cloud Computing

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the entities, materials, or equipment are necessarily the best available for the purpose.

On this page, we gather the highest-level protocols, definitions and standards that are applicable widely to the cloud computing use cases identified elsewhere in this twiki. As the collection grows, our intention is to classify these according to the taxonomical hierarchy defined by the Reference Architecture and Taxonomy group and to supplement this categorization using tags to indicate other areas of applicability for a given standard.

Jump to General Standards - Internet And Web, Cloud And Web Services Standards, Standards Inventory Categorization, or Related Documents And Work In Progress.

Basic Definitions and Standards

This table gathers references and definitions for a set of underlying features that are common to Internet and generic web-based tools, including those that are not limited to cloud computing.

<table>
<thead>
<tr>
<th>Name</th>
<th>Developed By</th>
<th>Purposes</th>
<th>Document Info</th>
<th>Standard Status</th>
<th>Categorization</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Internet Protocol Suite (TCP/IP)</td>
<td>IETF</td>
<td>The Internet Protocol Suite is the set of communications protocols used for the Internet and other similar networks. It is commonly also known as TCP/IP, named from two of the most important protocols in it: the Transmission Control Protocol (TCP) and the Internet Protocol (IP), which</td>
<td>RFC 675, 12/1974, RFC 1180, 01/1991</td>
<td>Standard/RFC</td>
<td>Transport, Network</td>
<td></td>
</tr>
</tbody>
</table>
### High-Level Standards and Definitions for Cloud and Web Services

This table gathers information on standards and related definitions that are generically applicable to cloud computing across a range of usage scenarios and levels. We include standards useful for distributed computing in general and for web services where applicable. See also the links at the bottom of the page lists of specific standards and definitions for particular cloud sub-areas of interest.

<table>
<thead>
<tr>
<th>Name</th>
<th>Developed By</th>
<th>Purpose</th>
<th>Document Info</th>
<th>Standard Status</th>
<th>Categorization</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Virtualization Format (OVF)</td>
<td>Distributed Management Task Force (DMTF)</td>
<td>OVF is a packaging standard designed to address the portability and deployment of virtual appliances. OVF enables simplified and error-free deployment of virtual appliances across multiple virtualization platforms. OVF is a common packaging format for independent software vendors (ISVs) to package and securely distribute virtual appliances, enabling cross-platform portability. By packaging virtual appliances in OVF, ISVs can create a single, pre-packaged appliance that can run on customers’ virtualization platforms of choice.</td>
<td>OVF v1.1.0, 01/20/2010</td>
<td>DMTF Standard ANSI INCITS 469-2010</td>
<td>IaaS, Interoperability (Virtual machine management)</td>
<td></td>
</tr>
<tr>
<td>Open Cloud Computing Interface (OCCI)</td>
<td>Open Grid Forum</td>
<td>The Open Cloud Computing Interface is a RESTful boundary protocol and API that acts as a service front-end to a provider’s internal management framework. OCCI describes APIs that enable cloud providers to expose their services. It allows the deployment, monitoring and management of virtual workloads (like virtual machines), but is applicable to any interaction with a virtual cloud resource through defined http(s) header fields and extensions. OCCI endpoints can function either as service providers or service consumers, or both.</td>
<td>GFD.183: OCCI Core 1.1, 7 April 2011 (updated 21 June 2011)</td>
<td>OGF published standards (Proposed Recommendations)</td>
<td>IaaS, PaaS, SaaS, Manageability, Monitoring, Data transfer</td>
<td></td>
</tr>
<tr>
<td>Cloud Data Management Interface (CDMI)</td>
<td>Storage Networking Industry Association (SNIA)</td>
<td>CDMI defines the functional interface that applications will use to create, retrieve, update and delete data elements from the Cloud. As part of this interface the client will be able to discover the capabilities of the cloud storage offering and use this interface to manage containers and the data that is placed in them. In addition, metadata can be</td>
<td>Cloud Data Management Interface, v1.0, 04/2010</td>
<td>SNIA Technical Position</td>
<td>Storage, Interoperability</td>
<td></td>
</tr>
</tbody>
</table>
Cloud Computing Use Cases

Initial Cloud Computing Use Case TBD, 2010

A set of twenty five use cases that seek to express selected portability, interoperability and security concerns that cloud users may have.

1. Introduction
2. Important Actors for Public Clouds
3. Cloud Management Use Cases
   3.1 Open An Account
   3.2 Close An Account
   3.3 Terminate An Account
   3.4 Copy Data Objects Into a Cloud
   3.5 Copy Data Objects Out of a Cloud
   3.6 Erase Data Objects In a Cloud
   3.7 VM Control: Allocate VM Instance
   3.8 VM Control: Manage Virtual Machine Instance State
   3.9 Query Cloud-Provider Capabilities and Capacities
4. Cloud Interoperability Use Cases
   4.1 Copy Data Objects between Cloud-Providers
   4.2 Dynamic Operation Dispatch to IaaS Clouds
   4.3 Cloud Burst From Data Center to Cloud
   4.4 Migrate a Queuing-Based Application
   4.5 Migrate (fully-stopped) VMs from one cloud-provider to another
5. Cloud Security Use Cases
   5.1 Identity Management - User Account Provisioning
   5.2 Identity Management - User Authentication in the Cloud
   5.3 Identity Management - Data Access Authorization Policy Management in the Cloud
   5.4 Identity Management - User Credential Synchronizaton Between Enterprises and the Cloud
   5.5 eDiscovery
   5.6 Security Monitoring
   5.7 Sharing of Access to Data in a Cloud
6. Future Use case Candidates
   6.1 Cloud Management Broker
   6.2 Transfer of ownership of data within a cloud
   6.3 Fault-Tolerant Cloud Group

Appendix A
Appendix B
Appendix C
Appendix D

http://www.nist.gov/itl/cloud/use-cases.cfm
SAJACC Working Group Recommendations to NIST

National Institute of Standards and Technology

NIST Cloud Computing
Standards Acceleration to Jumpstart Adoption of Cloud Computing (SAJACC) Working Group
2011: Initiated “Cloud Plugfest” Series

(More about this later)

About Cloud Plugfests

The Cloud Interoperability Plugfest series (or "Cloud Plugfests" for short) is a co-operative community project designed to promote interoperability efforts on cloud-based software, frameworks, and standards among vendors, products, projects and implementations.

Next Cloud Plugfest: June 2012

The upcoming June 2012 event is the 5th in the series and is proudly co-sponsored by Cleversafe, Huawei, OGF and the SNIA Cloud Storage Initiative, with ETSI providing testing support.

Locations:

- Asia: Shenzhen, CN (June 15 - 17)
- Europe: Amsterdam, NL (June 14 - 16)
- North America: Chicago, USA (June 14 - 16)

Subscribe to mailing lists for more information

Register to Attend  View Agenda  Submit a Presentation

NIST SEMINAR
WHICH FUTURE FOR US/EU TRUSTED CLOUD SERVICES?
Procurement, SLAs, standardisation on a global scale
Reality Check:

What it usually looks like when developers encounter standards committees.
What it ought to look like:

(Taken from an actual Cloud Plugfest.)
Cloud Interoperability Testbed

Abstract

The Cloud Interoperability Testbed will serve as a mechanism to host interoperability tests for different machine control, data transfer, resource reporting and usage agreement standards and implementations of other new standards efforts. The primary purpose will be to give developers an opportunity to try out implementations of code that implements either server or client functionality for the use of multiple standards from different standards development organizations. The initial effort for this project will be focused on implementations of the Open Cloud Computing Interface (OCCI) from the Open Grid Forum (OGF), Cloud Data Management Interface (CDMI) from the Storage Network Industry Association (SNIA), the Cloud Infrastructure Management Interface (CIMI) and the Open Virtualization Format (OVF) from the Distributed Management Task Force (DMTF). Other standards will be added as the project proceeds.

View Project Details

Intellectual Merit

A large amount of effort is being expended by multiple organizations to develop standards in the area of distributed computing, spanning many specific topics ranging from advanced networking to control to infrastructure management to data transfer and packaging protocols. In the absence of a common framework in which these can be tested, development activities for implementations of such standards are necessarily fragmented and limited to those chosen by a particular development team. The use of a virtualized space made available through FutureGrid provides a range of opportunities to streamline tests and coordinate activities to promote common use and interoperability of code written.

Project Number:
FG-176

Project Lead:
Alan Sill

Institution:
Texas Tech University

View Project Details

Project Members

Alexander Papaspyrou
Andy Edmonds
Anupam Tambe
Christian Karnath
Florian Feldhaus
Gary Mazzaferro
Ilja Livenson
Keyun Ruan
Michael Kretzschmar
Piotr Kasprzak
Rajendar K
Yugendra Guvala
Planning Grant: I/UCRC for Center for Cloud and Autonomic Computing site at Texas Tech University (CAC@TTU)

ABSTRACT

The proposed planning activity seeks to undertake planning of the establishment of a new Industry/University Cooperative Research Center (I/UCRC) site at Texas Tech University of the existing Center for Cloud and Autonomic Computing. The center currently involves Arizona, Florida, Mississippi State and Rutgers, and industry and government partners in the field. The Texas Tech site intends to provide a practical work arena for development and coordination of standards, standards-based software and reference implementations applicable to cloud and other forms of advanced distributed computing. The site will fill a need to organize, classify, develop reference implementations for and otherwise contribute to standards-based software in advanced distributed computing.

The planned site, in combination with the existing center plans to help build innovation capacity in cloud computing. The outcomes from the Texas Tech site has the potential to support effective, broad-based standards development for this emerging field. The site plans to have a significant impact on students via mechanisms including the TTU STEM Education and Outreach Project and the SURAgrid regional grid and cloud computing educational dissemination project.
Organization of this talk

1. Past
2. Present
3. Future
Example: (Big) Data

Present day real world:
Phones: 100+ Gigabytes
Science and Business: 100s to 1000s of Petabytes

Factor of 1000x bigger in less than a decade!
The Role of Standards for Risk Reduction and Inter-operation in XSEDE

XSEDE: The Next Generation of US National Supercomputing Infrastructure

Cloud and grid standards now power some of the largest academic supercomputing infrastructures in the world!
Over 13 million service units/day typically delivered as of 2014 across all XSEDE supercomputing sites (about 3 million core hours/day), totaling about 1.6 billion core hours per year.
About the Open Grid Forum:

Open Grid Forum (OGF) is a leading global standards development organization operating in the areas of cloud, grid and related forms of advanced distributed computing. The OGF community pursues these topics through an open process for development, creation and promotion of relevant specifications and use cases.

OGF actively engages partners and participants throughout the international arena through an open forum with open processes to champion architectural blueprints related to cloud and grid computing.

The resulting specifications and standards enable pervasive adoption of advanced distributed computing techniques for business and research worldwide.
History and Background

- OGF began in 2001 as an organization to promote the advancement of distributed computing worldwide.
- Mandate is to take on all forms of distributed computing and to work to promote cooperation, information exchange, best practices in use and standardization.
- OGF best known for a series of important computing, security and network standards that form the basis for major science and business-based distributed computing (BES, GridFTP, DRMAA, JSDL, RNS, GLUE, UR, etc.).
- Have also been working on cloud and Big Data standards (OCCI, WS-Agreement, DFDL, etc.) for several years.
- Cooperative work agreements with other SDOs in place.
# Starting Point: OGF Documents

[http://ogf.org/documents](http://ogf.org/documents)

## OGF Published Documents

OGF documents are developed according to an open public process as described at this link.

<table>
<thead>
<tr>
<th>GFD</th>
<th>Type</th>
<th>Area</th>
<th>Group</th>
<th>Publication</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFD.203</td>
<td>REC</td>
<td>Compute</td>
<td>JSDL-WG</td>
<td>2013-09-16</td>
<td>Activity Instance Description Specification, Version 1.0</td>
<td>P. Wieder, A. Papaspyrou, A. Savva, D. Felcows, S. Memon</td>
</tr>
<tr>
<td>GFD.200</td>
<td>REC</td>
<td>Data</td>
<td>DAIS-WG</td>
<td>2013-01-10</td>
<td>Web Services Data Access and Integration - The RDF(S) Realization (WS-DAIRDFS) RDF(S) Querying Specification, Version 1.0</td>
<td>I. Kojima, S. M. Pahlevi, S. Lynden</td>
</tr>
</tbody>
</table>
XSEDE Services Layer: Simple services combined in many ways

- Resource Namespace Service 1.1
- OGSA Basic Execution Service
- OGSA WSRF BP – metadata and notification
- OGSA-ByteIO
- GridFTP
- JSDL, BES, BES HPC Profile
- WS Trust Secure Token Services
- WSI BSP for transport of credentials
- ... (more than we have room to cover here)

Basic message: XSEDE represents best-of-breed engagement of open computing standards with the US cyberinfrastructure.
Open to new members:
Join as user, or as an IaaS/PaaS/SaaS service provider:
http://go.egi.eu/cloud
EGI Federated Cloud: A successful standards-based international federated cloud infrastructure

Members
- 70 individuals
- 40 institutions
- 13 countries

Stakeholders
- 23 Resource Providers
- 10 Technology Providers
- 7 User Communities
- 4 Liaisons

Technologies
- OpenStack
- OpenNebula
- StratusLab
- CloudStack (in evaluation)
- Synnefo
- WNoDeS

Standards
- OCCI (control)
- OVF (images)
- X.509 (authN)
- CDMI (storage - under development)

Credit: David Wallom
Chair EGI Federated Cloud Task Force

(Last updated July 2014)
Of course, in the intervening time - mostly within the past few years - we’ve seen the explosive growth of the use of cloud computing in industry, and consequent development of thousands of variations on the above theme.

As virtualization was added to the mix, and new ways of separating, distributing and designing tasks that can be carried out on distributed infrastructures has grown - and especially as the commoditization of computing has driven costs down, cloud computing is no longer a way of doing computing in general — it is THE way!

Nonetheless we have to ask ourselves at this point:

Are we learning anything new from this process? *(Answer: Yes)*

And if so, how? *(Answer: Open Source, DevOps and best practices)*
Cloud Interoperability Week

Sep. 16-20, 2013
Santa Clara, CA and Madrid, Spain

Workshop to highlight applications, frameworks and user communities
Cloud Plugfest Developer Series:

Continuing series...

Oriented towards REAL DEVELOPMENT

Past and current events co-sponsored by many open source and standards-related organizations including OGF, DMTF, SNIA, OASIS, ETSI, OCEAN, CloudWATCH and OW2

Cloud Plugfest 12 just completed!

More events in planning pipeline.

Easy to get involved and join in events as open source or commercial developers or project researchers!

http://cloudplugfest.org

Continues!
SAJACC Working Group
Recommendations to NIST

National Institute of Standards and Technology

NIST Cloud Computing
Standards Acceleration to Jumpstart Adoption of Cloud Computing (SAJACC) Working Group
Basic Goals of SAJACC Phase II

• Drastically increase the level of detail and modularity of the use cases for portability, interoperability, security and for other NIST goals added, such as mobility and accessibility.

• Bring organization and definition of use cases into line with NIST Cloud Computing Reference Architecture and other NIST working group output.

• Add sections necessary for USG agency and organization adoption.

• Improve technical guidelines and content for possible automation, and to provide the basis for more formal testing.

• Write enhanced use cases and leave a legacy for future reuse by defining the process for writing testable use cases.
Example Work In Progress:

NIST Cloud Computing Test Scenario Use Cases - Version 2

Introduction to SAJACC Version 2 Use Cases

Important Actors for Public Clouds (Version 2)

Cloud Management Use Cases (CM)

- CM - Allocate IaaS Instance IaaS Virtual Machine Control: Allocate VM Instance
- CM - Manage IaaS Instance State IaaS Virtual Machine Control: Manage VM Instance State
- CM - Query Cloud-Provider Capabilities and Capacities Query Cloud-Provider Capabilities and Capacities
- CM - Broker Cloud Management Broker
- CM - Fault-Tolerant Cloud Group Fault-Tolerant Cloud Group or Multi-Cloud with defined failover

Data Management Use Cases (DM)

- DM - Copy Data Into Cloud Copy Data Objects Into a Cloud
- DM - Copy Data Out of Cloud Copy Data Objects Out of a Cloud
- DM - Erase Data In Cloud Erase Data Objects In a Cloud
- DM - Transfer Data Ownership Transfer of ownership of data within a cloud

Cloud Interoperability Use Cases

- CI - Copy Data Between Providers Copy Data Objects Between Cloud-Providers
- CI - Dynamic Dispatch to IaaS Dynamic Operation Dispatch to IaaS Clouds
- CI - Cloud Burst From Data Center Cloud Burst From Data Center to Cloud
- CI - Migrate Queueing-Based App Migrate a Queueing-Based Application
- CI - Migrate Fully-Stopped VMs Migrate (fully-stopped) VMs from one cloud-provider to another

Identity Management Use Cases

- IM - Open Account Open An Account
- IM - Close Account Close An Account
- IM - Terminate Account Terminate An Account
- IM - Provision Account Identity Management - User Account Provisioning based on external ID
- IM - User Authentication User Authentication in the Cloud
- IM - Data Access Authorization Identity Management - Data Access Authorization Policy Management in the Cloud
- IM - User Credential Synchronization Identity Management - User Credential Synchronization Between Enterprises and the Cloud

Reorganize and rewrite previous SAJACC Use Cases
Example Work In Progress:

Design document for technical workflow modeling of SAJACC use cases

The purpose of this document is to perform technical workflow modeling of SAJACC use cases. As described in the SAJACC working group report [2], about twenty-four use cases are defined. Although the use cases are a well-known tool for expressing requirements to be used at cloud system, the provided use cases has a limitation for users to understand them. Therefore, it is important to have alternatives and differences in interpretation of use cases especially following technical work flows. Specifically, Unified Modeling Language (UML) is utilized.

1. Important Considerations

In designing alternative use cases by following technical workflows, there are six items need to be addressed.

1. How do we partition the use case into units of activities? Too many small atomic units are not a good thing, makes execution more difficult and tedious to track and control. Working on a few use cases will help figure out some best practice rules for this (e.g. should failure handling tasks be separate or part of related activity, etc.)
2. Which party or role (as defined in ref architecture) is driving or responsible for each activity unit?
3. How do we express time limits (maximum duration) for activities? And how do we model the related failure (timeouts).
4. If an activity unit fails, in some cases that means failure of the entire use case to proceed further but in other cases the failure is one that is planned as possible and just one path among several in the use case workflow. What failures are fatal and which ones are not?
5. Some use cases seem to rely on other use cases as subpart or as precondition. Should we use such references to avoid repeating some activities or sequences of, from one use case to the other?

Add technical components for workflow modeling and improved use case internal detail.
Example Work In Progress:

Incorporate input from other ongoing NIST cloud computing working groups
Example Work In Progress:

1. **Use Case Identification**
   - **Use Case Name:** PI
   - **Agency:** W
   - **Model Matrix:** X, X
   - **Version:** 1.0
   - **Date Updated:** 8/30/2013

2. **Background**
   - Give more details for the background.

3. **Definitions**
   - Define components of the use case.

4. **Concept of Operation**
   - **Current System**
     - How the use case is currently implemented.
   - **Desired Cloud Implementation**
     - How the use case should be implemented in the cloud.

5. **Primary Actors**
   - Describe the primary actors involved.

6. **Business Goal**
   - What is the business goal?

7. **Service Model**
   - Is it SaaS, PaaS, IaaS?

8. **Deployment Model**
   - Is this a Private, Public, Hybrid, or Community Cloud? What are the benefits to a specific deployment?

9. **Necessary Conditions**
   - **Security**
     - Describe security requirements.
   - **Interoperability**
     - Describe interoperability requirements.
   - **Portability**
     - Describe portability requirements.
   - **Other**
     - Describe any other requirements.

10. **Priorities and Risks**
    - Describe the priority of this use case within the agency. What are some of the risks? See risk register on point 16.

11. **Essential Characteristics**
    - How does it meet the essential characteristics of a cloud computing environment?

12. **Success Outcome**
    - List the possible user outcomes.

13. **Error Outcomes**
    - List any possible error outcomes.

14. **Detailed Technical**
    - Data here

15. **Frequency of Use**
    - Estimate the frequency.

16. **Applicable Federal Regulation Requirements**
    - Applicable federal regulation requirements.

17. **Special Requirements**
    - List any special requirements to support this use case.

18. **Notes and Issues**
    - List additional comments here.

19. **General Security Considerations**
    - List additional comments here.

20. **Risk Register**
    - Data here

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Likelihood</th>
<th>Severity</th>
<th>Countermeasures</th>
<th>Status</th>
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<td>Medium (31-70%)</td>
<td>High (&gt;70%)</td>
<td>Later.</td>
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<tr>
<td>8/24/2012</td>
<td>Later</td>
<td>Low (&lt;30%)</td>
<td>Low (&lt;30%)</td>
<td>Later.</td>
<td>Current</td>
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</tbody>
</table>
Example Work In Progress:

5.2.1. Technical Workflow

Include diagrams where appropriate to improve clarity of the logic sequence and workflow of a complex operation, step or procedure.
Organization of this talk

1. Past
2. Present
3. Future
A New Research Effort

NIST SEMINAR
WHICH FUTURE FOR US/EU TRUSTED CLOUD SERVICES?
Procurement, SLAs, standardisation on a global scale
We have now assembled a *multidisciplinary team* of talented researchers active in *practical application topics* to guide and inform cloud standards research for the NSF through the CAC.
NSF CAC Cloud Standards Vision

- The CAC@TTU intends to provide a practical work arena for development and coordination of standards, standards-based software and reference implementations applicable to cloud and other forms of advanced distributed computing.

- The site will fill a need to organize, classify, develop reference implementations for and otherwise contribute to standards-based software in advanced distributed computing.

- The vision that underlies these goals is one of harmonious, coordinated development of software that interoperates across many boundaries of deployment and implementation, and that can be repurposed, rescaled and redeployed as needed to solve a wide variety of user, vendor and supplier problems. In other words: fulfill the dreams of cloud computing!
CAC will use its testbed efforts to work with all relevant SDOs and standards-related customer and trade organizations.

- It is often said that there are “too many standards organizations”. This is a lot like saying there is “too much software”.
- Each has its own area of specialty, its own contributor base, and its own method of funding to develop its work products.
- CAC will study products and effectiveness of each of these organizations and work with them using a DevOps approach.
Core Technology Efforts

Primary CAC@TTU project areas:

- *Cloud Standards Testbed*
- *Cloud Performance Testbed*
- *Cloud Interoperability Testbed*
- *Cloud Tester Benchmark Suite*

* (In cooperation with The Aerospace Corporation and other CAC partners)

Of these, we expect the Cloud Standards and Cloud Interoperability projects to be of principal interest for the future. **CAC will therefore join the Federated Cloud.**
Initial CAC@TTU Project Areas

1. Product and Standards Testing
   • Cloud Performance Testbed
   • Cloud Standards Testbed
   • Cloud Interoperability Testbed
   • Cloud Security Testbed <— (Future)

2. Design Labs
   • Storage Design and Testing Lab
   • Network Design and Testing Lab

3. Developer Events
   • Cloud Plugfest Series
   • Participation in technical partner events
   • Organization of and participation in conferences

CAC@TTU is new!
- More coming…
Other New and Related Efforts

- IEEE P2301 and P2302:
  - P2301 developing “Guide for Cloud Portability and Interoperability Profiles” (CPIP), chaired by John Messina (NIST).
  - P2302 working on “Standard for Intercloud Interoperability and Federation (SIIF)” and working toward assembling an “intercloud testbed” (www.intercloudtestbed.org) with multiple participants.
  - Both open to public participation and additional partners.
  - Related Intercloud Testbed effort (see next slide) updated & reconfigured.

- NSF Cloud:
  - Two awards recently made by the National Science Foundation for two new cloud testbeds, “Chameleon” and “CloudLab”.
  - *Replaces FutureGrid project previously used for interoperability testing.*
  - Further details emerging soon!
Intercloud Testbed

An Open, Global, Cloud Interoperability Project
CloudLab is flexible, scientific infrastructure for research on the future of cloud computing. Researchers come to CloudLab to build their own clouds, experimenting with new architectures that will form the basis for the next generation of the world's computing platforms.

Build Your Own Cloud ...

CloudLab provides researchers with control and visibility all the way down to the bare metal. Provisioning an entire cloud inside of CloudLab takes only minutes. Most CloudLab resources provide hard isolation from other users, so it can support hundreds of simultaneous "slices", with each getting an artifact-free environment suitable for

... On Our Hardware

The first CloudLab clusters will have 15,000 cores distributed across three sites around the United States: Utah, Wisconsin, and South Carolina. Each cluster has a different focus: storage and networking (using hardware from Cisco), high-memory computing (Dell), and energy-efficient computing (HP). CloudLab is interconnected with nationwide...
Chameleon is a large-scale, reconfigurable experimental environment for next generation cloud research.

NSF ANNOUNCES NEW CLOUD TESTBED - 2014-08-20

The National Science Foundation announces an award for the Chameleon cloud testbed.

CHAMELEON WILL BE LAUNCHING SOON - 2014-08-20

The Chameleon Cloud will be available to users soon!
What Can You Do?

• Several ways exist to get involved in the organizations and cloud projects just described that are working towards interoperability and standards. (Almost all are!)
• Your institution, organization, company or client can ask for standards compliance as a condition of purchasing or implementing cloud products and services.
• Join a Cloud Plugfest, or sponsor one, or start an activity with a similar DevOps orientation to development and continuous testing of cloud standards.
• Join a Cloud Interoperability testbed.
• Lobby for standards to be a required item in software development, and vice versa, in all projects and products.
I’ve left a lot out!

- This talk has a theme, though, that should now be clear: I have focused primarily on hands-on, real-world projects and related efforts for immediate feedback between standards and software developers.
  - Definition of the testing environment is definitely in scope.
  - Focus on topics that can produce real-world tests that produce feedback.
  - Take a “DevOps” approach and don’t wait for the documents to be completely finished or perfect.
  - Anyone can do this. You can, too!
  - Other projects of this nature should not feel slighted. I endorse them!!

- The main theme - and my long-term primary theme for some time now - is this:

  Both standards and software require different types of development. The trick to success is keeping them in sync!
Conclusions

• We will leverage public processes such as NIST SAJACC to pursue a broader range of testing tools needed to do conformance/compliance testing for cloud products and standards. DISA has joined the CAC to pursue these efforts.

• CAC@TTU projects are being defined to add standards and interoperability testing tools and to expand the range of acceptance tools available to conduct such evaluations.

• These will be tested first within the CAC center, and results could be offered for use by other organizations.

• Outputs from this project will improve understanding of capabilities of cloud APIs, products and standards and improve feedback to public software development and standards development processes such as SAJACC.
Links For Further Information and To Help:

- NSF Cloud and Autonomic Computing Center main site: [http://nsfcac.org](http://nsfcac.org)
- CAC@TTU information and membership materials: [http://cac.ttu.edu](http://cac.ttu.edu)
- Cloud Plugfest developer series: [http://cloudplugfest.org](http://cloudplugfest.org)
- Cloud standards organization compilation: [http://cloud-standards.org](http://cloud-standards.org)
- NSF CAC@TTU contact email: cac.info@ttu.edu