CloudWATCH
A European Cloud observatory supporting cloud policies, standards profiles & services

D2.1 Reference Model Framework Report

Revised Version

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This report provides a framework for the presentation of use cases for the purpose of the derivation of standardization requirements and the development of standard profiles for various areas from the cloud computing domain. It is intended to be of value for researchers and standardization experts that employ a use case driven approach.

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CloudWATCH Mission

The CloudWATCH mission is to accelerate the adoption of cloud computing across European private and public organisations. CloudWATCH offers independent, practical tips on why, when and how to move to the cloud, showcasing success stories that demonstrate real world benefits of cloud computing. CloudWATCH fosters interoperable services and solutions to broaden choice for consumers. CloudWATCH provides tips on legal and contractual issues. CloudWATCH offers insights on real issues like security, trust and data protection. CloudWATCH is driving focused work on common standards profiles with practical guidance on relevant standards and certification Schemes for trusted cloud services across the European Union.

The CloudWATCH partnership brings together experts on cloud computing; certification schemes; security; interoperability; standards implementation and roadmapping as well as legal professionals. The partners have a collective network spanning 24 European member states and 4 associate countries. This network includes: 80 corporate members representing 10,000 companies that employ 2 million citizens and generate 1 trillion in revenue; 100s of partnerships with SMEs and 60 global chapters pushing for standardisation, and a scientific user base of over 22,000.

Disclaimer

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The information, views and tips set out in this publication are those of the CloudWATCH Consortium and its pool of international experts and cannot be considered to reflect the views of the European Commission.

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Executive Summary

A major objective of the CloudWatch project it to develop a common standards profile for technical interoperability of cloud services, building on existing cloud federation and integration efforts in Europe and elsewhere, and leading to publication by a recognised standards groups operating in this area. A federated cloud profile can be applied across research, government and business communities enabling the sharing of resources for maximum benefit.

Hence, one of the main goals of the CloudWatch project is to identify standards profiles in the area of cloud computing (in particular in the area of "infrastructure as a service") and to support their development in cooperation with relevant Standardization Bodies. For this purpose, a use case driven approach is employed. This report provides a framework for the presentation of use cases as a first processing step towards this goal. It utilizes a cloud computing reference architecture that has been developed within the CloudWatch project (based on previous work in ISO/IEC and ETSI) to identify and classify elements that comprise a use case. From this reference architecture, templates for the formalized description of use cases have been defined. Moreover, selection criteria have been defined that will be used to identify use cases for further processing, i.e., the derivation of standardization requirements and finally standard profiles.

The work presented in this deliverable will be used as input for the CloudWatch Deliverable D2.2 (Use Case Report) that will comprise an actual list of use cases expressed by the approach described in this report.

The approach described in this report is based on previous work in the context of standardization in ISO/IEC, ITU-T and ETSI by Fraunhofer and CSA, and further refined and adapted for the use in the CloudWatch project by a collaborative effort of Fraunhofer and the University of Oxford.

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Table of Contents

Executive Summary 4
Table of Contents 5
Figures 7
1 Introduction 8
1.1 Additions in Revision 2 11
2 Cloud Use Case Reference Model 11
2.1 Cloud Computing Reference Model 11
2.1.1 Methodology 12
2.1.2 Roles and Activities 13
2.1.3 Functional Layers and Components 15
2.1.4 Cross-cutting Aspects 16
2.2 Usage Scenarios and Use Cases 17
3 Selection Criteria 19
4 Templates 20
4.1 Usage Scenario Template 21
4.2 Legal Use Case Template 22
4.3 Organizational Use Case 23
4.4 Technical Use Case Template 24
5 Conclusion and Next Steps 25
References 25
Annex 1 – Use Case Workshop Invitation (Excerpt) 27
Annex 2 – Simplified Use Case Template 30
Annex 3 - Can functional characteristics usefully define the cloud computing landscape? 32
Abstract 32
Introduction 32

Quantitative dimensions 33
Methodology 33
The Landscape of Cloud Computing 34
Next Steps 37
Annex 4 – Document Log 38

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Figures

Figure 1. Standard profile development approach 9

Figure 2. Relationship between actors, roles, activities, layers, and components/functions 13

Figure 3. Roles and sub-roles 14

Figure 4. Layers and multi-layer functions 16

Figure 5. Usage scenarios and use cases 18

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1 Introduction

A major objective of the CloudWatch project it to develop a common standards profile for technical interoperability of cloud services, building on existing cloud federation and integration efforts in Europe and elsewhere, and leading to publication by a recognised standards groups operating in this area. A federated cloud profile can be applied across research, government and business communities enabling the sharing of resources for maximum benefit.

This report defines a **cloud use case reference model framework**: The purpose of this framework is to provide a classification of use cases according to their:

- Application domain: **academic**, **industrial**, **public sector:** The selection of these domains will provide a comprehensive picture on the standardization requirements of various stakeholders. For instance, it is expected that in academia standards for cloud federation that allows the integration of various cloud platforms is very important. Industrial applications will additionally look into security and cloud management issues, to protect intellectual property rights and to ensure consistent management procedures over various cloud providers. Finally, the public sector will look into protection of personally identifiable data, avoidance of vendor lock-in, and availability issues, because or regulatory demands.
- Category: **legal**, **organisational**, **technical**. The majority of use cases considered in the CloudWatch project is expected to address technical issues such as cloud management, cloud service federation, etc. While these issues are most important for research and development projects, the practical application of cloud services within enterprises or public administration also requires the adjustment of organisational structures and procedures within these organisations. For instance, the application of organisational standards such as the ISO 20000 series on service management (which is based on the collection of best practices described in the Information Technology Infrastructure Library ITIL) is currently under discussion within the technical committees of ISO and IEC. Finally, there are requirements on service usage and provisioning that are neither technically nor

organisational but regulatory, for instance: protection of personally identifiable data or long term archiving.

- Stakeholders involved: the main **actors** that constitute the use case and their responsibilities, and the way they interact with the cloud system and with each other.
- **Functions/components**: The technical items within a cloud infrastructure or related to a cloud service that are exercised in the use case.

The usage of the framework within the CloudWatch project is motivated as follows: For the development of cloud standard profiles the project employs a use case driven approach comprising five steps (compare Figure 1)

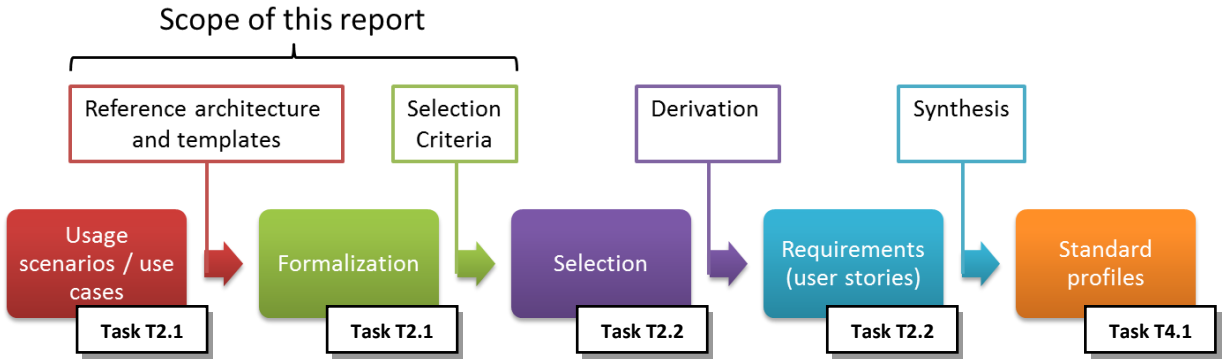

Figure 1. Standard profile development approach

- The development process starts with an initial input of use cases and usage scenarios for cloud computing originating from various sources. Due to the fact that a large number of organisations and activities have used a similar approach, there is no shortage on use cases (for instance, ISO/IEC JTC1 SC38 WG3 collected more than 40 use cases [ISO/IEC13b] ETSI Cloud Standards Coordination Task Group 2 came up with more than 100 use cases [CSC13]). These use cases vary in their level of abstraction, scope, and purpose.
- Therefore, to make the initial set of use cases useable for the CloudWatch project, a certain degree of formalization is required. We use an approach similar to the methodology developed in ISO/IEC JTC1 SC38 [ISO/IEC13a,b]: In order to classify the technical, organisational and legal elements that are mentioned in those use cases, a cloud computing reference architecture is defined that describes the term “cloud computing”. Moreover, templates are provided to express those use cases in a uniform way.

- The next step comprises the selection of an appropriate set of use cases for the original set for further processing (CloudWatch Deliverable D2.2). For this purpose, selection criteria have to be defined and applied.
- From the set of use cases selection in the previous steps, standardization requirements are derived (those requirements are sometimes analysed by means of so-called user stories[1] (CloudWatch Deliverable D2.3).
- Finally, standards profiles are synthetized; their implementation is performed in collaboration with relevant Standardization Bodies (CloudWatch Work Package 4).

(An additional CloudWatch Deliverable D2.4 addresses policy and compliance requirements identified in the use cases and that cannot currently be included in the profile due to the need for additional legislation or policy development.)

This report aims on preparing the first two transitions in the use case processing chain outlined above. It provided a use case reference model (Section 2) that comprises two main parts: Section 2.1 describes a cloud computing reference architecture that allows a classification of elements used in use case descriptions. The cloud computing reference architecture has been developed on the basis of several sources:

- The upcoming ISO/IEC standard "Information Technology — Cloud Computing — Reference Architecture" that is under development by a collaborative team comprising experts from ISO/IEC JTC 1/SC 38 WG3 and ITU-T SG 13 [Hib13, PSB13][2]. Fraunhofer is an active contributor to this work; CSA maintains a liaison to SC 38.
- The final report of the ETSI Cloud Standards Coordination Group [CSC13].

The second part of the use case reference model aims on providing a unified representation of use cases. In general, we distinguish between legal, organizational, and technical aspect. Various use cases can be grouped into so-called usage scenarios: Scenarios describe common elements of various use cases and thus provide a general usage context. Hence, scenarios can be used to relate a set of use cases to a certain application context, and thus are a first step for the identification of relevant

[1] The term user stories is borrowed from the area of agile software development, see http://www.agilemodeling.com/artifacts/userStory.htm for an example.
[2] Since the standard is not published yet, we have to refer to secondary material.

standards profiles and related Standardization Bodies. A detail description of these terms is provided by Section 2.2 (actual templates are given in Section 4).

To move from the "Formalization" to the "Selection" step in the use case processing chain, selection criteria are described in Section 3).

As mentioned above, Section 4 provides templates for use case formalization following the approach given in Section 2.2.

The final Section 5 comprises conclusions and a brief outlook on next steps.

1.1 Additions in Revision 2

The second revision of D2.1 contains in addition to the material presented in the first revision of the document a description of a quantitative methodology for use case analysis (and an overview of results) that will be used to derive standardization requirements (Deliverable D2.3) from the collection of use cases considered in the project (Deliverable D2.2). This material is presented in Annex 3.

2 Cloud Use Case Reference Model

The cloud use case reference model used in the CloudWatch project is based on

(a) a cloud reference architecture that provides us with a terminological framework to describe use cases and to compare them, and
(b) a structured representation format for use cases comprising a number of templates.

Its purpose is to provide a unified presentation of use cases that is mapped against the cloud computing reference architecture. Thus, it allows for comparing and grouping use cases and to prepare the derivation of requirements for standards profiles.

2.1 Cloud Computing Reference Model

Cloud computing systems are described using an architectural approach comprising four views:[3]

[3] This approach is compatible with the international standard ISO/IEC 10746-1 (Open Distributed Processing)

View	Description	In Scope
User view	Describes the system context; the actors, the roles, the sub-roles and the cloud computing activities	Yes
Functional View	Describes the functions necessary for the support of cloud computing activities an implementation neutral way	Yes
Implementation View	Implementation specific consideration of a cloud service within service parts and/or infrastructure parts: Specific technologies, supplementary services and platforms, are considered here.	No
Deployment View	how the functions of a cloud service are technically operated within already existing infrastructure elements or within new elements to be introduced in this infrastructure	No

While the user view and the functional view are important elements of use case descriptions related to standardization activities, the implementation and deployment view are related to the actual development of technical cloud systems and components and thus not in the scope of this report.

2.1.1 Methodology

These architectural views are utilized to build-up a terminology framework for the description of use cases and usage scenarios (see Section 2.1.4).

The **user view** is based on an actor model comprising the following elements:

- An **actor** is a person or organisation (or an automated system acting on behalf of a person or organisation) who uses a cloud system or components of a cloud system.
- Actors assume **roles**. Roles (and **sub-roles**) are defined by a set of activities that an actor assuming a certain role is supposed to perform. Another interpretation of a role is that of an organisational element.
- An **activity** described the usage of a number of cloud components with the purpose to achieve a certain goal or outcome. Using the organisational interpretation of roles, activities imply certain responsibilities of the organisational entities described by a role.

Use cases usually describe – on a given level of abstraction – an activity of a number of activities.

The **functional view** comprises of technical **components** that are supposed to provide certain functions. These components are structured into **layers**. Certain functions address more than one

layer, and components providing those functions are therefore referred to as **multi-layer components**.

Finally, certain aspects cannot be associated with the user or functional view but address both organisational and functional issues. We refer to those aspects to as **cross-cutting aspects**.

Figure 2 summarizes the model structure of the cloud computing reference model.

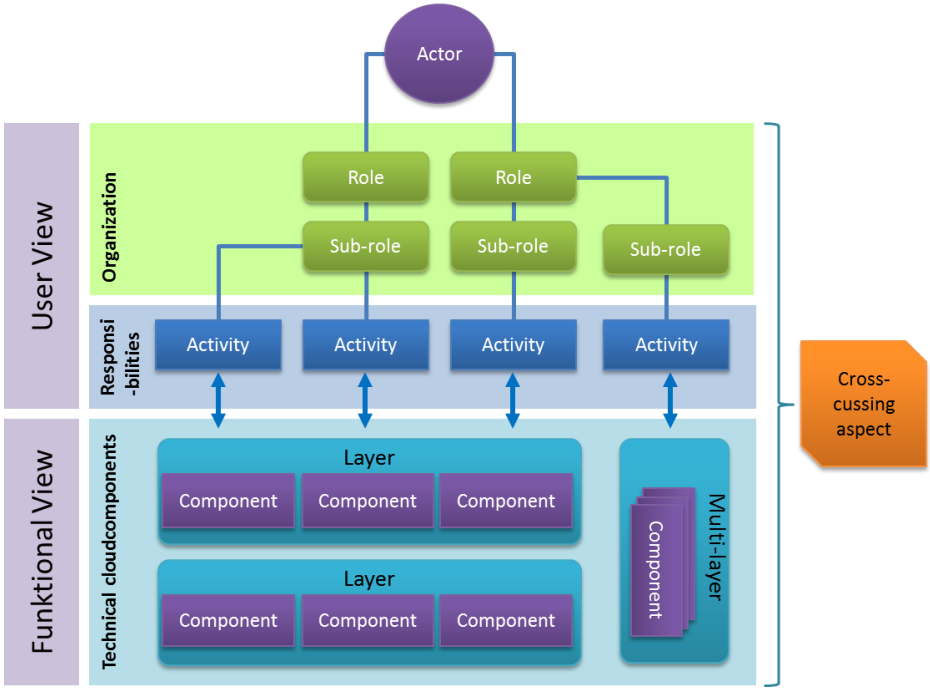

Figure 2. Relationship between actors, roles, activities, layers, and components/functions

2.1.2 Roles and Activities

Following [CSC13], we use three top-level roles, namely the cloud service customer, the cloud service provider, and the cloud service partner. Each of these roles has several sub-roles (cf. Figure 3).

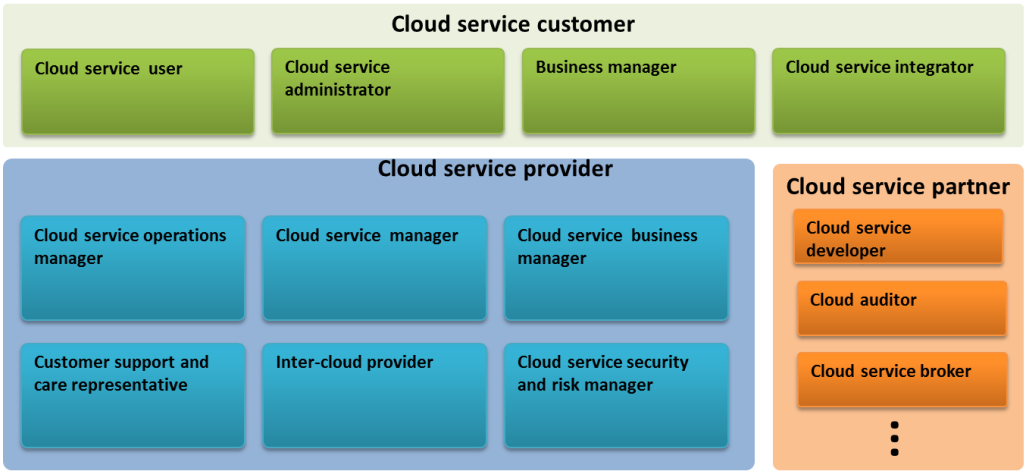

Figure 3. Roles and sub-roles

The **cloud service customer** comprises the following sub-roles:

- Cloud service user – The actual user of a cloud service.
- Cloud service administrator – Actor who administers cloud services on the customer side: Adds and removes users, manages access rights, performs service configuration, etc.
- Cloud service business manager – Actor who manages business aspects on the customer side, responsible for determining business incentives of employing a particular cloud service, contracting an appropriate provider, etc.
- Cloud service integrator – Actor who integrates a particular cloud services into the in-house IT of the customer, and with other cloud services.

The sub-roles of the **cloud service provider** are

- Cloud service operations manager – Actor who performs operational management activities (e.g., inventory management, capacity planning, problem management).
- Cloud service manager – Actor who performs service specific management activities (e.g., service level management, service deployment).
- Cloud service business manager – Actor responsible for financial and business aspects of a cloud service (e.g., management of business plans, customer relationship, supplier management)

- Customer support and care representative – Actor responsible for reacting to customer issues and queries (i.e., incident management).
- Inter-cloud provider – Actor responsible for technical aspects regarding federated or multiple cloud architectures (cloud burst scenarios and invocation of 3rd services).
- Cloud service security and risk manager – Actor responsible for the planning and implementation of security controls. This includes risk analysis.

As opposed to the previous roles, the **cloud service partner** role is open. The following list of sub-roles is meant to provide examples rather than a complete description.

- Cloud service developer – Developer of new cloud services. An actor assuming this role might be part of the provider's organisation or part of an external organisation. The developer makes use of development functions (see below).
- Cloud auditor – Actor performing conformance audits with regard to legal regulations, financial requirements, or quality/process standards (ISO/IEC 27000, ISO 9000, etc.).
- Cloud service broker – Actor responsible for negotiating relationships between customers and providers. Cloud service brokers do not necessarily offer inter-cloud capabilities, but if so, the broker assumes simultaneously the cloud service provider sub-role of an inter-cloud provider.

2.1.3 Functional Layers and Components

The cloud computing reference model comprises four layers (cf. Figure 4):

- User layer: User functions, administrator functions, and business functions that are available by the cloud service customer.
- Access layer: Access control functions and connection management.
- Service layer: Capabilities provided as services to the cloud service customer.
- Resource layer: Physical resources and resource abstraction mechanisms.

Additionally, a number of multi-layer functions are defined:

- Integration functions: Security, monitoring, service, and peer service integration functions
- Security: Authentication and identity management, authorization and service policy management, cryptographic functions and encryption management.

- Operational support systems: Service catalogue, service provisioning functions, monitoring and reporting, service policy management, service automation, service level management, incident and problem management, platform and virtualization management, peer service management.
- Business support systems: Produce catalogue, account management, subscription management, and billing.
- Development functions: Developer environments, build and test management, deployment management.

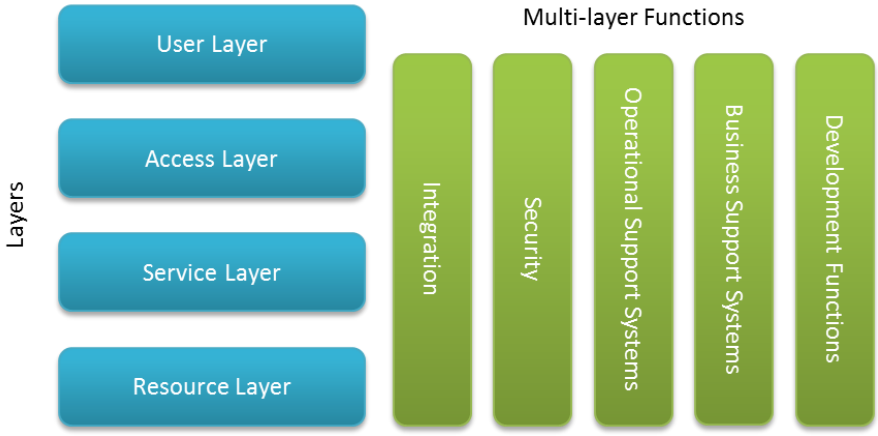

Figure 4. Layers and multi-layer functions

2.1.4 Cross-cutting Aspects

Cross cutting aspects include both architectural and operational considerations, which may apply to multiple elements of a Cloud. Such cross-cutting aspects may impact multiple roles, activities, and components, and may not be clearly assigned to individual roles or components.

Cross-cutting aspects are:

- **Interoperability**: Ability of a cloud service customer to interact with a cloud service and exchange information according to a prescribed method and obtain predictable results. The term also includes the ability for one cloud service to work with other cloud services
- **Portability**: Ability to move cloud service customer data or their applications between multiple cloud service providers at low cost and with minimal disruption.

- **Reversibility**: Ability of the cloud service customers to retrieve their cloud service customer data and application artefacts and for the cloud service provider to delete all cloud service customer data as well as contractually specified cloud service derived data after an agreed or regulatory defined period.
- **Security**: Security capabilities for cloud services include: access control, confidentiality, integrity and availability.
- **Privacy**: Protection of the assured, proper, and consistent collection, processing, communication, use and disposition of personally identifiable information in the relation to cloud services.
- **Resiliency**: Ability of a system to provide and maintain an acceptable level of service in the face of faults (unintentional, intentional, or naturally caused) affecting normal operation.
- **Performance**: A set of non-functional facets relating to the operation of a cloud service such as availability of the service; response time to complete service requests, transaction rate at which service requests are executed, etc.
- **Auditability**: Availability of means to ensure that services are provided and used consistent with the associated service agreements between the cloud service customers, cloud service providers and cloud service partners.
- **Maintenance and versioning**: Preservation and improvement of the function of services and underlying resources. Versioning ensures changes become traceable and roll-backs can be performed.
- **Service levels and service level agreement**: A cloud computing service level agreement (SLA) is a service level agreement between a cloud service provider and a cloud service customer based on a taxonomy of cloud computing specific terms to set the quality of the cloud services delivered.

2.2 Usage Scenarios and Use Cases

The cloud computing reference architecture outlined in the previous section provides us with the terminology and background to describe the use cases for the CloudWatch project.

Use cases are usually employed as tool for software or system engineering. This document proposes the employment of usage scenarios and use cases as an analysis tool to identify specific characteristics and requirements of cloud computing service various purposes, such as:

- Interoperability requirements to analyse standardization requirements (gaps, overlaps)
- Analysis of compliance with regard to European regulations
- Software and system definition in the sense of a preliminary identification of system components

By a **usage scenario** we mean a concrete (real life, or fictitious but realistic) usage context of a cloud based system or service: a business case or the usage of a set of cloud services for a particular purpose. In the context of the CloudWatch project, scenarios will be utilized to group a set of use cases with regard to a specific application area or technological context that implies a set of interrelated standards (i.e., a standards profile).

A **use case** describes the activities of a number of the actors while using such a system or service in a particular way. A usage scenario usually comprises of a number of use cases. A usage scenario therefore serves as a concrete "cover story" with the purpose to demonstrate a certain concept or idea.

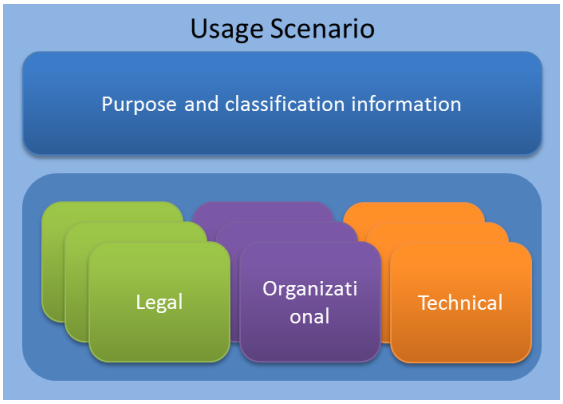

Figure 5. Usage scenarios and use cases

We moreover distinguish between three categories of use cases:

- **Legal use cases** describe certain activities in the context of a law or regulation to understand whether this activity is compliant to a given regulatory framework. For instance, data

security mechanisms of a certain cloud system can be analysed with regard to data protection regulations within the European Union.

- **Organisational use cases** aim on the analysis of organisational structures and processes. For instance, change management is one of the major driving management processes of IT service provisioning. Since cloud computing automates various aspects of IT service management, organisational use cases can illustrate how classical service management disciplines are performed within a cloud-based data centre.
- **Technical use cases** describe technical aspects of cloud systems and components. Examples are usage of protocols and interfaces, document and data exchange mechanism, or security and privacy mechanisms.

It is not imply that each use case can be uniquely identified with one of these categories. If a use case is related to more than one category, two separate descriptions will be used that reference each other (the usage scenario description templates introduced in Section 4.1 contain a specific field labelled “Related use cases” for this purpose).

3 Selection Criteria

The CloudWATCH project performs two distinct tasks in reference to use cases:[4]

- Identify international use cases and open collaborative models
- Collate use case requirements, providing input criteria for interoperability profile

In particular, an activity is “*to develop a framework for use case selection to identify and collect a portfolio of international cloud use cases*” as an outcome of the first task and pre-requisite of the second one (refer also to diagram shown in Figure 1).

The selection criteria for use cases are guided by the requirements of the analysis of use cases; we will dissect each of the use cases in turn for their requirements around interoperability. Final output

[4] These tasks are described in the CloudWatch Description of Work (DOW) as Task 2.1 and Task 2.2, respectively.

from these tasks will be a single report giving the user stories, and their derived technical interoperability requirements.

Therefore, candidate use cases and scenarios will be assessed against the depth and completeness of information given on each of the following:

- The use cases focus on (legal, organisational, or technical) requirements around interoperability.
- The scenario describes a set of co-ordinating services that in turn imply requirements regarding a set of standards.
- Is there any provider or community that offer or use the described set of services? If so, does the CloudWatch project maintain a direct personal contact?
- Cataloguing of necessary or provided external interfaces.
- Overall functional requirements are explained sufficiently clear to derive standardization requirements.
- User stories are available.
- The 'who', 'what' and 'why' of the requirement.

Each use case will have a ‘champion’ who completes the template document and each champion will have the opportunity for self-evaluation of the use case against the above criteria. These templates and evaluations will be live, public and iterative, and will form the basis of the derivation of standards profiles.

4 Templates

In the following sections, we introduce templates for usage scenarios and use cases. Fields are either mandatory or optional; in addition, we allow the definition of additional fields if this is appropriate for a particular purpose. As indicated above, we summarize a number of use cases under the umbrella of a common usage scenario.

Both scenario and use case template contain entries defining the user view and the functional view as described in Section Cloud Computing Reference Model2.1. The field describing the user view, “**Actors, roles, and activities**“, is further divided into several sub-entries:

- The name of an actor that assumes one or several roles
- The roles the actor assumes, and
- For each role a description of the activities in question.

The functional view is described by the field "**Components"**. This field is also sub-divided in a list of layers or multi-layer function groups, and a description of the components of these layers/multi-layers that play a role in the use case or scenario.

Finally, the field "**Cross-cutting aspects**" comprises a list of cross-cutting aspects addressed in the scenario or use case.

The usage scenario should take into account the main architectural components (i.e., actors, roles/sub-roles, activities, layers/multi-layers, components, cross-cutting aspects) addressed in the associated set of use cases.

4.1 Usage Scenario Template

Usage scenario		
ID (mandatory)	**Title** (mandatory)	
Description (mandatory)	Main "storyline" for the use cases	
Categories (mandatory)	Technical, organizational, legal, …	
Domain (optional)	E.g., public sector services	
Goals and purpose (mandatory)	What is demonstrated by the scenario?	
Actors, roles, and activities (optional, use case descriptions should address)	Actor name	
	Role name	Description of activity 1
		Description of activity 2
	(Add rows as appropriate to describe other actors and roles)	
Service layers (optional)	IaaS/VM layer, PaaS layer, etc.	
Deployment model (optional)	Private, public, community, hybrid, …	
Components (optional, use case descriptions should address)	Layer / multi-layer name	Description of component/function 1
		Description of component/function 2
	(Add rows as appropriate to describe other components)	

Cross-cutting aspects (optional, mandatory in the use case descriptions)	List cross-cussing aspects addressed in the usage scenario
Related use cases (mandatory)	List of use cases related to this scenario (use identifiers as given in the use case templates)
Additional field (optional)	Add fields as appropriate

4.2 Legal Use Case Template

Legal use case		
ID (mandatory)	**Title** (mandatory)	
Description (mandatory)	Short summary of the use case	
Actors, roles, and activities (mandatory)	Actor name	
	Role name	Description of activity 1
		Description of activity 2
	(Add rows as appropriate to describe other actors and roles)	
Goals and aspirations for the use case (mandatory)	Background and main message of the use case	
Legal domain (mandatory)	Data privacy regulations, licensing, contracting, etc.	
Area (mandatory)	E.g., Europa, US, . . .	
Components (optional)	Layer / multi-layer name	Description of component/function 1
		Description of component/function 2
	(Add rows as appropriate to describe other components)	
Cross-cutting aspects (mandatory)	List cross-cussing concerns aspects in the use case	
Legal frameworks, laws, etc., to be taken into account (mandatory)	Laws, policies, etc. which are of relevance	
Required preconditions (optional)	Any preconditions necessary to understand the use case	
Compliance criteria (mandatory)	Explanation why the use case is an illustration on how legal requirement can be implemented	
Description of procedures to ensure legal compliance (optional)	Explanation how the use case shows the implementation of legal requirements	
Existing specifications to rely on	Specifications and standards already dealing with aspects related to the use case	

(optional)	
Additional field (optional)	Add fields as appropriate

4.3 Organizational Use Case

Organizational use case		
ID (mandatory)	**Title** (mandatory)	
Description (mandatory)	Short summary of the use case	
Actors, roles, and activities (mandatory)	Actor name	
	Role name	Description of activity 1
		Description of activity 2
	(Add rows as appropriate to describe other actors and roles)	
Goals and aspirations for the UC (optional)	Background and main message of the use case	
Organization domain (mandatory)	E.g., security procedures, data privacy procedures, etc.	
Regulations and policies to be taken into account (optional)	Policies, standards, best practices to be taken into account	
Description of organization procedures (mandatory)	The "workflow" (or procedures) on organizational level used to achieve the goal of the use case	
Components (optional)	Layer / multi-layer name	Description of component/function 1
		Description of component/function 2
	(Add rows as appropriate to describe other components)	
Cross-cutting aspects (mandatory)	List cross-cussing aspects addressed in the use case	
Required preconditions (optional)	Any preconditions necessary to understand/implement the use case	
Criteria for success (optional)	The expected output and the side effects	
Failure conditions (optional)	What can go wrong	
Failure handling (optional)	what to do about it	
Related UCs and those that are pre-requisite (optional)	May refer to technical UC describing the technical means to implement this UC.	
Existing specifications to rely on	Specifications and standards already dealing with aspects related to the use case	

(optional)	
Additional field (optional)	Add fields as appropriate

4.4 Technical Use Case Template

Technical use case		
ID (mandatory)	**Title** (mandatory)	
Description (mandatory)	Short summary of the use case	
Actors, roles, and activities (mandatory)	Actor name	
	Role name	Description of activity 1
		Description of activity 2
	(Add rows as appropriate to describe other actors and roles)	
Primary Actor (optional)	The actor who initiates the technical use case	
Goals and aspirations for the UC (optional)	Background and main message of the use case	
Components (mandatory)	Layer / multi-layer name	Description of component/function 1
		Description of component/function 2
	(Add rows as appropriate to describe other components)	
Cross-cutting aspects (mandatory)	Lists cross-cussing aspects addressed in the use case	
Preconditions (optional)	Assumptions made prior to the execution of the use case	
Input parameters needed for initialization (optional)	Initial input values for the execution of the use case	
Criteria for success (optional)	Expected process, outcome, side effects. Described by sequence charts, etc.	
Failure conditions (optional)	what can go wrong	
Failure handling (optional)	what to do about it	
Related use cases and those that are pre-requisite (optional)	Relevant use cases for the associated usage scenario.	
Existing specifications to rely on (optional)	Specifications and standards already dealing with aspects related to the use case	
Additional field (optional)	Add fields as appropriate	

5 Conclusion and Next Steps

In this report, we have provided an approach for the formalization of use cases and usage scenarios basing on the employment of a cloud computing reference architecture as a means of classification of the various elements that comprises a use case. Moreover, templates have been provided to express use cases in a uniform and comparable way, addressing legal, organisational, and technical aspects. Use cases are furthermore grouped into usage scenarios that describe an application area or technological context of these use cases and therefore help to identify an associated standards profile.

The purpose of this work is to provide formalized methodology for the presentation and processing of use cases towards the definition of standards profiles and the supporting their development.

An obvious open issue is how to implement the derivation of standardization requirements from a use case selection. To resolve this issue, a work shop will be organized during the CloudWatch Concertation Meeting (12-13 March 2014, Brussels, Belgium). During this workshop, this issue will be addressed from various perspectives (academic, industrial, and public sector). In addition, the audience (representatives from various projects funded by the European Commission and related initiatives) will be asked to provide an answer to this question from their own perspectives using an online survey.

An excerpt of the invitation of the work shop (stripped by organisational details) has been added as Annex 1. Annex 2 consist a simplified version of the templates given in Section 4 of this report that will be used to approach an external audience.

References

[ISO/IEC13a] ISO/IEC JTC 1/SC 38/WG 3 Standing Document 1, Methodology and Guidelines for Cloud Computing Usage Scenario and Use Case Analysis, 9 April 2013, avail. at http://isotc.iso.org/livelink/livelink?func=ll&objId=8919753&objAction=browse&viewType=1

[ISO/IEC13b] ISO/IEC JTC 1/SC 38/WG 3 Standing Document 2, Compendium of Cloud Computing Usage Scenarios and Use Cases, 7 March 2013, avail. at

http://isotc.iso.org/livelink/livelink?func=ll&objId=8919753&objAction=browse&viewType=1

[CSC13] ETSI Cloud Standards Coordination, Final Report, November 2013, avail. at http://csc.etsi.org/Application/documentApp/documentinfo/?documentId=204&fromList=Y

[Hib13] E. A. Hibbard, Latest in Cloud Computing Standards, CSA Congress 2013, Orlando, FL, December 4, 2013, avail. at https://community.hds.com/docs/DOC-1001302.

[PSB13] B. Piprani, D. Sheppard, and A. Barbir, Comparative Analysis of SOA and Cloud Computing Architectures using Fact Based Modeling, OTM Workshops 2013: 524 - 533, avail. http://www.slideshare.net/abarbir/presentation1-v5-20130911

Annex 1 – Use Case Workshop Invitation (Excerpt)

Background & Purpose

CloudWATCH has produced a *Reference Model Framework Report (D2.1)* to guide the selection, capture and analysis of Use Cases from three different classes of user community: Enterprise, Government and Academic. The purpose of the workshop is to bring together representatives from those user communities to utilise the framework in the capture of use cases pivotal in the future development of those communities. Interoperability is a key feature in many of the RTD projects, so it represents an effective time and cost saving to engage with these at the Concertation Meeting.

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Value Proposition (standards profiles)

Although it takes time, effort and commitment, the capture and documentation of use cases is relatively easy and straightforward: this is just one of the aims of the workshop. We provide templates derived from the *Reference Model Framework Report* and invite participants to fill in the forms (preferably in advance of the workshop). We then capture and collate the information in preparation for analysis.

However, the true value lies in being able to extract from the captured collection of use cases relevant and meaningful standards profiles for each of the participating user communities: this process is hard. The primary goal of the workshop is to engage with community representatives in the formulation of just such an extraction process that will result in standards profiles that are widely accepted, and widely regarded as representative and meaningful.

Use Case Selection Criteria

The *Reference Model Framework Report* sets out criteria for the selection of use cases for further analysis. Candidate use cases are to be assessed against the depth and completeness of information given on each of the following:

- Technical requirements around interoperability.
- Set of co-ordinating services.
- Meta-services and their access.
- Any current community utilized solutions.
- Cataloguing of necessary external interfaces.
- Overall functional requirements.
- User stories.
- The 'who', 'what' and 'why' of the requirement.

Each use case will have a ‘champion’ who completes the template document and each champion will have the opportunity for self-evaluation of the use case against the above criteria.

Use Case Capture

The *Reference Model Framework Report* presents four templates for the capture of use cases and usage scenarios: we are in the process of turning these into an online capture survey for use prior to, during, and after the workshop, in an iterative process of information capture and refinement.

The final survey will be live, public and persistent, encouraging complete, detailed and in-depth submissions with opportunities for capturing commentary from the community and iterative revision by the author.

Self-Evaluation of Use Cases

Included in the use case capture survey will be a series of questions designed for self-evaluation against the depth and completeness of the information provided as related to the selection criteria. Responses will be in the form of a rating [1-5], giving an estimate of how successfully the use case might contribute to the overall extraction of standards profiles. These ratings will be gathered and collated on a live updating summary page, possibly for display on a public screen at the workshop.

Structure of the Workshop

The workshop will encourage active participation in the use case capture process, and in the formulation of a process for building standards profiles. Presentations by representatives of each of the community sectors will analyse the capture process and give a critique of the profiling process as participants continue with the iterative revision and self-evaluation of their submissions.

Follow-up

The analysis of submitted use cases and the extraction and compilation of standards profiles for the three community sectors will continue for some months after the workshop. CloudWATCH will engage with its network of SDO contacts from among the BIGI representatives, including members from OASIS, OGF, SNIA, IEEE and DMTF, for eventual convergence and consensus of the standards profiles. All workshop participants will be invited to continue to contribute in an iterative process of evaluation until the final output document is produced, which will serve as content for the final user stories for a deliverable in month 18 of CloudWATCH. All participants and affiliations will be acknowledged.

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Annex 2 – Simplified Use Case Template

Use Case		
Title		
Description		Short summary of the use case
Goals and aspirations for the use case		Background and main message of the use case; context of the use case
Legal aspects	Legal domain	Data privacy regulations, licensing, contracting, etc.
	Legal frameworks, laws, etc., to be taken into account	Laws, policies, etc. which are of relevance
	Compliance criteria	Explanation why the use case is an illustration on how legal requirement can be implemented
Organizational aspects	Organization domain	E.g., security procedures, data privacy procedures, etc.
	Regulations and policies to be taken into account	Policies, standards, best practices to be taken into account
	Description of organization procedures	The "workflow" (or procedures) on organizational level used to achieve the goal of the use case
	Compliance criteria	Explanation why the use case is an illustration on how organisational requirement can be implemented
Technical aspects	Preconditions	Assumptions made prior to the execution of the use case
	Criteria for success	Expected process, outcome, side effects. Described by sequence charts, etc.
	Failure conditions and responses	Description of what can go wrong, and what to do about it.
Existing specifications to rely on		Specifications and standards already dealing with aspects related to the use case
New specifications required		Specifications and standards needed to establish the goals of the use case
Additional comments		Add comments, remarks, suggestions, as you see fit

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Annex 3 - Can functional characteristics usefully define the cloud computing landscape?

Abstract

Understanding the diversity of cloud computing activities becomes important when trying to derive consistent and useful standards recommendations for cloud adoption and interoperability. In this paper we present a methodology for representing the landscape of cloud computing from the view-point of functional characteristics. We then use this representation to group cloud projects and interpret their commonalities in terms of the dimensions of their functional properties.

Introduction

The Reference Model Framework Report (D2.1) of CloudWatch includes a use case template defining the terms of reference for documenting use cases for representative projects. This template covers various legal, organisational and technical aspects, but in retrospect this has served mainly to document the extreme diversity of projects in the cloud ecosystem. This diversity makes the original plan within CloudWatch to produce a single standards profile for all cloud computing adoption far less supportable and has prompted us to devise a methodology for clustering projects in such a way that makes several targeted standards profiles more specifically applicable.

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Quantitative dimensions

The National Institute of Standards and Technology of the U.S. Department of Commerce (NIST) has produced a Definition of Cloud Computing[5] that includes a list of five *essential characteristics*:

1. On Demand Self-Service
2. High Performance Network Access
3. Resource Pooling
4. Rapid Elasticity
5. Measured Service

An earlier draft of this publication included eight additional *common characteristics*:

6. Massive Scale
7. Homogeneity
8. Virtualization
9. Low Cost Software
10. Resilient Computing
11. Geographic Distribution
12. Service Orientation
13. Advanced Security

These 13 features lend themselves to the assignment of a numerical score which then allows a rich quantitative analysis of the landscape of cloud computing. The aim of this work is to explore if this quantitative analysis will prove to be consistent, robust, and above all, useful.

Methodology

We subjectively scored selected cloud projects on an integer scale [0 - 10] based on insights into the projects gained from the documented use cases and through interviews with project representatives. (These assignments will be validated by the projects themselves and any changes in the analysis or results will be reflected here in future iterations. The number of included projects will also be expanded in future iterations, but in this first version we present the authors' scoring of the initial 15 selected projects.)

[5] http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf

Table 1. Numerical score for selected projects on NIST functional characteristics.

		On Demand Self-Service	High Perf Network Access	Resource Pooling	Rapid Elasticity	Measured Service	Massive Scale	Homogeneity	Virtualization	Low Cost Software	Resilient Computing	Geographic Distribution	Service Orientation	Advanced Security
1	WeNMR	9	8	8	9	5	7	9	8	7	3	9	6	3
2	OpenModeller	9	7	8	7	3	7	8	8	9	4	7	8	5
3	Catania Science Gateway	8	6	6	7	5	6	6	8	7	5	6	5	5
4	BNCweb	7	4	4	3	2	4	5	3	5	2	1	7	2
5	Embassy Cloud	7	7	2	1	6	3	6	8	3	8	1	7	9
6	ARTIST	1	1	1	6	6	3	3	4	2	5	6	7	7
7	U-QASAR	5	7	6	7	7	2	2	5	4	4	4	7	6
8	CloudWave	8	8	8	8	9	4	3	7	8	7	3	9	5
9	CloudCatalyst	6	6	6	4	1	1	1	6	8	4	4	6	5
10	PANACEA	8	9	8	8	6	6	5	7	5	8	7	9	8
11	Texel	5	8	7	7	8	4	4	4	4	8	3	8	7
12	Umea	5	3	3	2	2	2	4	6	4	3	3	7	7
13	GEMMA	8	7	8	8	7	3	3	4	3	8	5	8	9
14	Varberg	8	7	8	5	4	3	4	5	3	6	3	8	8
15	Leicester	6	6	5	5	3	2	7	3	4	5	2	6	8

The Landscape of Cloud Computing

Dimension reduction is one of the primary achievements of classic multivariate statistics – the meaningful reduction of data observed in many dimensions into just a few synthetic dimensions that can be rendered in two or three dimensional plots.

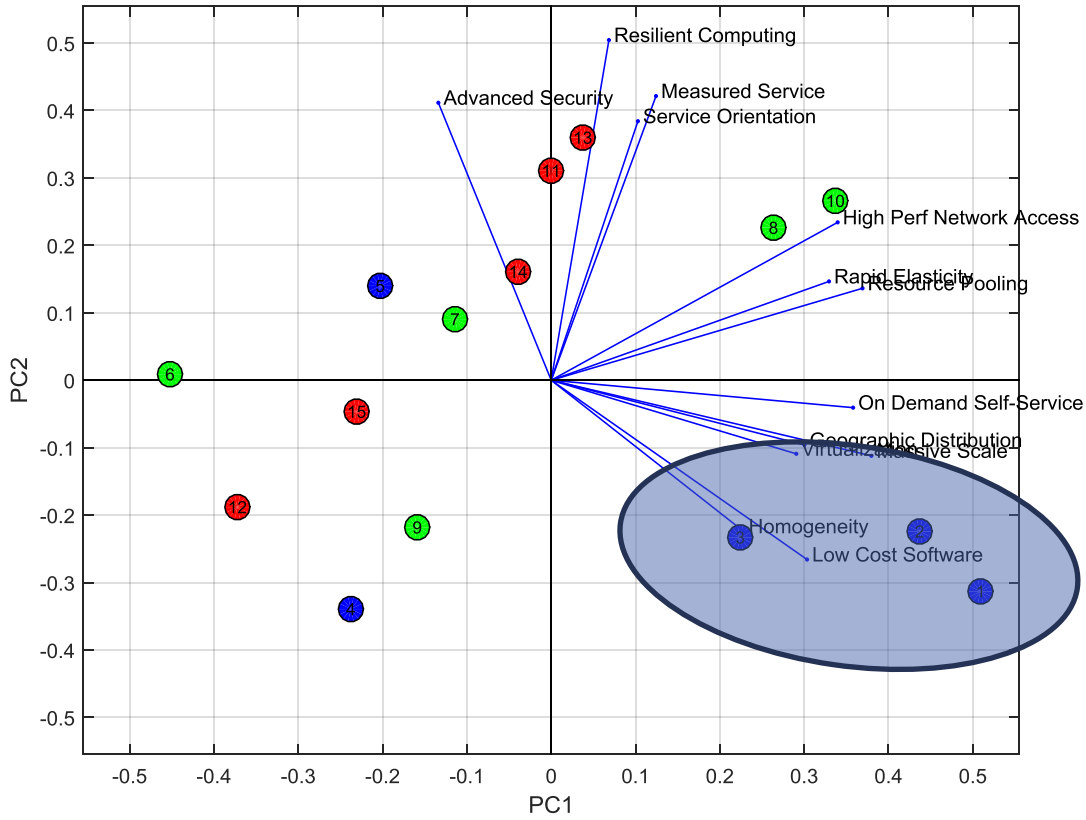

Figure 6. Biplot showing the first two Principal Component axes with vectors of component loadings indicating relationships to the original variables.

of the landscape of cloud computing in the context of the originally observed variables.

The labelled vectors already reveal useful information about the relationships between the functional features of cloud computing. For example, *Homogeneity* and *Low Cost Software* are usually considered together, and when these are valued as important, then *Advanced Security* is considered unimportant, and vice versa. In contrast, *High Performance Network Access*, *Rapid Elasticity*, and *Resource Pooling*, are also usually considered together, and

[6] Pearson, K. (1901). On Lines and Planes of Closest Fit to Systems of Points in Space. *Philosophical Magazine,* 2(11): 559–572. doi:10.1080/14786440109462720.

[7] Jolliffe I.T. (2002). *Principal Component Analysis*. Springer Series in Statistics, 2nd ed., Springer, NY. ISBN 978-0-387-95442-4.

[8] Greenacre, M. (2010). *Biplots in Practice*. BBVA Foundation, Madrid, Spain. ISBN 978-84-923846-8-6.

whatever value is attached to these, they are essentially unrelated to the orthogonal features mentioned previously.

Next, local clusters of points are readily identifiable. For example, in the lower right quadrant there are three projects (*WeNMR*, *OpenModeller*, and *Catania Science Gateway*). These share a common 'locality' in the total landscape of the cloud computing ecosystem, distinct from other such clusters. They are characterised by valuing *Homogeneity*, *Low Cost Software, Virtualization, Massive Scale, Geographic Distribution*, and *On Demand Self-Service.* They attach little or no importance to *Advanced Security* (they may even see this as an unwanted feature), and are quite neutral with regard to the remaining characteristics like *High Performance Network Access.*

There is a cluster of two projects in the upper right quadrant (*CloudWave* and *PANACEA*). These share the common 'locality' that is aligned with *High Performance Network Access*, *Rapid Elasticity*, and *Resource Pooling*. They are partially aligned with *On Demand Self-Service,* and more-or-less indifferent to most of the other functional features in the analysis. Continuing with this kind of interpretation we can see a cluster of five projects in the lower left quadrant, and a cluster of the remaining five mostly in the upper left. The same kind of reasoning regarding the vectors of feature loadings applies.

Overall we can see four rational clusters of projects. We suggest that this interpreted partitioning of the projects will further facilitate the development of credible standards profiles targeted for different localities in the overall landscape.

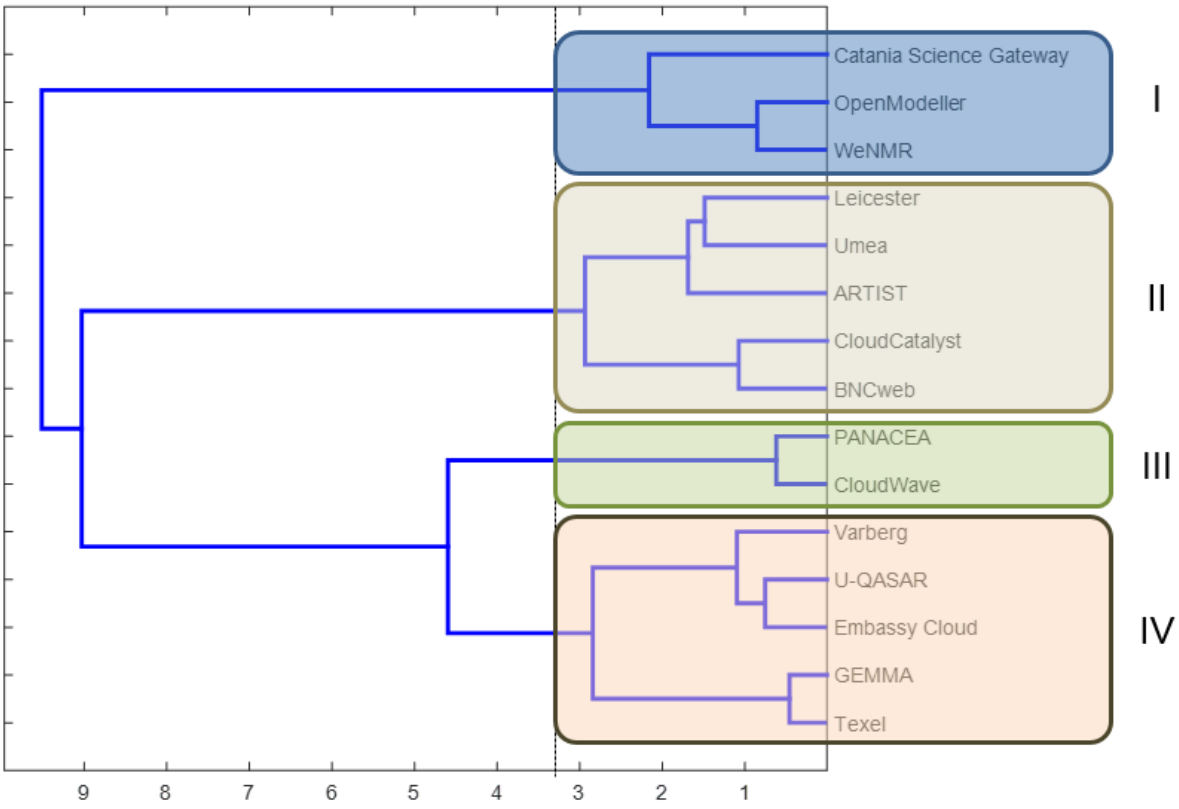

Figure 7. Functional clustering showing the partitioning of projects into four rational clusters.

Next Steps

First, we need to validate our own scoring of projects be asking each of the projects to engage in a self-scoring exercise. Second, how robust are the clusters to variations in scores? Third, we will expand the representation of projects to a much wider set of projects. Fourth, we will collaborate with WP4 in the interpretation of the landscape to inform the process of deriving appropriate standards. (This annex will be revised as appropriate to reflect the ongoing development.)

Annex 4 – Document Log

DOCUMENT ITERATIONS		
V1.O	Initial Version: TOC and indication of contents	Peter H. Deussen (Fraunhofer)
V1.1	CloudWatch deliverable template applied; initial contents for Sections 2 and 4	Peter H. Deussen (Fraunhofer)
V1.2	Contents for Section 3	Neil Caithness (UOXF)
V1.3	Contents for Annex 1 and 2	Neil Caithness (UOXF)
V1.4	Introduction and Conclusions added	Peter H. Deussen (Fraunhofer)
V1.5	Executive summary added	Peter H. Deussen (Fraunhofer)
	Internal review	Daniele Catteddu (CSA) Neil Caithness (UOXF)
V1.6	Reviewer's remarks received and integrated	Peter H. Deussen (Fraunhofer)
V2.0	Final quality control and delivery	Peter H. Deussen (Fraunhofer)
Additions in revision 2		
V2.1	New appendix on functional characteristics	Neil Caithness, David Wallom (UOXF)
	Additions to the introduction	Peter H. Deussen (Fraunhofer)