STANDARDS ASSESSMENT IN DISRUPTIVE INNOVATION: A SOFTWARE PROTOTYPE FOR CLOUD COMPUTING

Prototype Paper

Bühler, Robin, Julius Maximilian University of Würzburg, Würzburg, Germany, robin.fischer2@uni-wuerzburg.de

Janiesch, Christian, Julius Maximilian University of Würzburg, Würzburg, Germany, christian.janiesch@uni-wuerzburg.de

Abstract

Standards impact interoperability, portability, and security of products or services. Standards contribute to open and flexible systems that, in turn, are a catalyst for the uptake of new technologies. The assessment of standards in disruptive innovation is, however, challenged by uncertainty over markets, technology evolution, and organizational change. The dynamics of technology progression, furthermore, contribute to high assessment efforts, leading to situations where up-to-date information on standards is effectively missing. In this paper, we build upon previous work on a model and method to support assessment of standards in disruptive innovation. We summarize the methods potentials for reducing standards assessment efforts and automation. Thereupon, we propose a conceptual software architecture for standards assessment platforms and instantiate the platform for the domain of cloud computing. Our discussion of the Cloud Standards Assessment Platform will present the user experience and reflect the realizability of automation potentials in standards assessment. We give an outlook on future work and platform adoption to conclude this paper.

Keywords: Standards Assessment, Cloud Computing, Platform, Prototype.

1 Introduction & Related Work

Disruptive innovation generates inefficiencies in managing emerging technology (Bower & Christensen, 1995). Technology providers and consumers, but also public authorities, demand for standards to create trust in the new technology, fasten its market uptake, and guide technology evolution (European Commission, 2012; Schubert et al., 2010). Continued standards assessment would improve capabilities to manage technology in the early phases of disruptive innovation, e.g., to analyze technology convergence trends (Gauch & Blind, 2015). Hence, suitable management approaches as well as supporting tools are paramount to make the right decisions at the time (Day and Schoemaker, 2000).

The assessment of standards, however, is not straightforward and depends on many factors such as the characteristics of the technology and their network effects (Liu et al., 2011), but also political and personal values (Jakobs, 2011; Nickerson & zur Mühlen, 2008). Also, knowledge of the environment, in which a standard should provide value, is key to successful standardization (Sherif, 2001) and, thus, is key to standards assessment itself. In disruptive innovation uncertainty characterizes the environment for standards. Market structures, technology concepts, and consumer requirements are only starting to develop (Phaal et al., 2010). In order to conduct sound evaluations rather than taking educated guesses on standardization alternatives, an assessment method and related tools are necessary. Since standards assessment must be flexible to incorporate changes to the environment, while keeping assessment efforts manageable, it is not trivial to design such a solution (Fischer and Janiesch, 2014).

Consequently, only few methodologies, frameworks, and tools exist today which help not only technology providers and consumers, but also standards developers and policy makers, to assess standards in disruptive innovation. Existing approaches are tailored for the assessment of a particular technology (e.g., Pautasso et al., 2008) or technology field (for interoperability cf. Mykkänen & Tuomainen, 2008), provide historical backgrounds on technology evolution (e.g., Chen, 2003, Motahari-Nezhad et al., 2006), or research extensions to a particular standard (e.g., Nitzsche et al., 2008). More generic approaches do not define sound conceptualization of underlying models and processes, but share hands-on experiences whose results can hardly be reproduced (de Vries & van der Zwan, 2008). While the approaches guide stakeholders in assessing standards, we are not aware that any of the methods or tools aims at reducing assessment efforts based on automation of standards assessment.

The potential of cloud computing (Schubert et al., 2010) as well as its perceived challenges against incumbent technologies (Toosi et al., 2014), render cloud computing as a current example of disruptive innovation (Kaltenecker et al., 2013; Marston et al, 2011). Significant efforts to assess cloud standards underpin the need for standards assessment in disruptive innovation: Regional and national governments (e.g., European Union (ETSI, 2013), U.S. (Hogan et al., 2011), Germany (Bernnat et al, 2012), and Japan (SCSG, 2010)), standards development organizations (e.g., IETF (Khasnabish & JunSheng, 2012), ITU (2010), and industry (e.g., NTT (Sakai, 2011), CSA (2009)) conducted or sponsored respective studies. The results provide a broad picture of cloud standards. Longevity of their conclusions, however, is questionable due to the dynamics of disruptive innovation, where development cycles are short (European Commission, 2011). The validity of standards assessments is, thus, challenged by the speed of technology progression and standards evolution. Thus, frequent and continuing updates of assessment information are required to provide ongoing guidance on standard selection in the disruptive innovation. The perpetuation of study results most of the time, however, is too costly for constant updates, due to high manual classification efforts. Standards assessment may thereby benefit from methods and tools to support the selection of cloud services. Sun et al. (2014) provide an overview that finds corresponding methods and tools to apply multi-criteria decision-making or optimization approaches. The choice of the particular technology, however, depends on the given use case and respective selection attributes. The aim of this research is to provide a method and a concept for a software platform which supports the automation of assessment approaches (e.g., as applied in cloud service selection). In doing so, we aim to lay the ground for a continuous standards assessment.

Based on our experiences with the assessment of cloud standards and prior work on the classification of standards (Fischer et al., 2013), we have developed a method to support the assessment of technology standards in disruptive innovation (ASSET). Our approach is agnostic of a particular assessment technology, but focuses on flexibility of the classification scheme and the coordination of classifications. In doing so, we seek to enable automation of standards assessment, e.g., by applying multi-criteria decision-making technologies as currently researched for cloud service selection. In the following, we describe the general assessment process and requirements for a software platform to automate the assessment process. As a contribution, we will present a conceptual architecture and go into details of our Cloud Standards Assessment Platform. The prototype was developed as an instantiation of our model and method (Hevner et al., 2004) as presented in Fischer and Janiesch (2014).

2 Assessing Standards of Emerging Technology

2.1 Information Model and Assessment Process

Technologies and business aspects can be defined through standards (de Vries, 2006). Standards may found a basis for legal and regulatory frameworks, constraining markets of a disruptive innovation (Brunsson et al, 2012). We apply the concept of a typology to structure the various dependencies of technology, business aspects, and standards (Smith, 2002). ASSET's conceptual model of a *technology typology*, describes the interplay of technology fields, technology and standards fields, summarizing the technology framework for a given domain of a disruptive innovation (Fischer and Janiesch, 2014). The technology typology, furthermore, comprises types of attributes and roles of stakeholder which are interested in standards. The combination of entities of the technology framework, assessment attributes, and stakeholder roles, thus, provide the schema which ASSET applies to classify standards. In mature innovations, technology typologies comprise a stabilized set of entities, providing conceptual order to the entire field of innovation and its stakeholders. In emerging technologies, however, discourse about constituting parts (e.g., enabling technology or implementations) and its categorization is still ongoing and stakeholders frequently change (Day and Schoemaker, 2000). As a result, any classification scheme against which objects are classified is in constant flux, demanding frequent re-evaluations of the technology typology and standard classifications.

ASSET's *procedural model*, depicted in Figure 1, defines an iterative sequence of assessment steps to ensure that changes of the standards' environment are constantly incorporated into the assessment. The goal of ASSET's assessment process, thus, is to provide up-to-date classification information (*Classification sub-process*) which stakeholders use to evaluate the value of standards for their purposes (*Evaluation sub-process*). We model the overall process of *standards classification* in emerging technologies to comprise two steps: *Create Domain Typology* and *Classify Standard*. Standard profiles are the results of ASSET's *Classification sub-process*, capturing organizationally independent classification information. The goal of ASSET's *Evaluation sub-process* is to guide stakeholders in the contextualization and prioritization of classification information. In terms of ASSET's concepts, stakeholders will identify their evaluation context creating a contextual typology, comprising the subset of entities of ASSET's technology typology which are relevant for the respective evaluation.

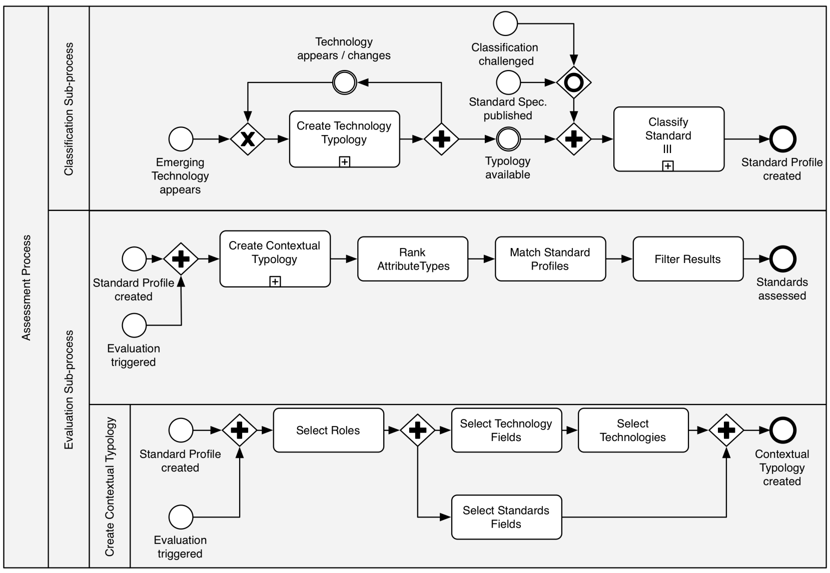


Figure 1. Standard Selection Process

Thus, the *Create Contextual Typology* sub-process is the first step when evaluating standards with ASSET. It comprises the following steps:

- *Select Roles:* Stakeholders have to describe their perspective of the standards assessment, selecting standard- or domain-specific roles from the domain typology. Implementations of ASSET may automatically filter assessment attributes, presented in subsequent steps, based on this selection.
- *Select Technology Fields* and *Select Technologies*: Stakeholders have to describe their product or service development project using ASSET's concepts to represent emerging technology. Firstly, stakeholders select technology fields that are relevant to their project. Choosing a technology may, subsequently, refine this selection. Stakeholders, thus, define their subject of standardization.

- *Select Standards Fields*: Stakeholders select the standards fields, matching the problem that should be addressed by their development project. They define relevant scopes of standardization.

In the *Rank Attribute Types* step, ASSET requires stakeholders to rank the relative importance of assessment attributes. In doing so, organizational capabilities, risks, and opportunities are incorporated into the standard selection process. Instantiations of ASSET may apply different techniques to ascertain weights and rank standards accordingly. ASSET's *Match Standard Profiles* step, however, leads to the creation of an ordered list of standard profiles by matching the contextual typology to standard profiles and applying automated decision support technologies. ASSET allows stakeholders to filter results in the final step of the Evaluation sub-process. In doing so, stakeholders may perform what-if-analyses to exploring the sensitivity of the results to their preferences of assessment attributes.

2.2 Potentials for Automation of Standards Assessment

The information model as well as ASSET's procedural model allows stakeholders to assess standards from different perspectives, valuing only attributes which a stakeholder is capable of assessing. Thus, aggregation of information and coordination of information updates are required to consolidate the different stakeholder perspectives. In this section, we discuss how ASSET provides potential for the automation of these assessment efforts. Moreover, we identify the potential to incorporate automation of elicitation of assessment information. Any implementation of ASSET should realize the following potentials to support assessment of standards in disruptive innovation:

Propagation of Information Updates: As motivated above, uncertainty and dynamics of disruptive innovation demand an iterative approach to assess standards. ASSET's procedural model, consequently, identifies sub-processes which can be executed iteratively. The events, which sub-processes share, build the basis for coordinating the iterations of ASSET's *Create Technology Typology*, *Classify Standards*, and *Evaluate Standards* sub-processes. Therefore, updates to the technology typology or standard profiles can be aligned automatically (e.g., be triggering re-classifications of standards).

Filtering and Aggregation of Assessment Information: Using ASSET, the amount and type of information, which a stakeholder is capable of assessing, is modeled through the varying roles which a stakeholder may enact. An implementation may, thus, filter assessment information which is presented accordingly. In consequence, the different stakeholders' classifications of a standard may be partial or even conflicting. A tool should, therefore, automate the process of aggregating the different assessment information. In the case of simple denominations of, e.g., constituents of the technology framework (i.e., technologies, technology fields, or standard fields), aggregation could be as simple as filtering the most frequently named instances. A corresponding tool should provide automation of such aggregations, e.g., by calculating thresholds or winners of majority votes. Aggregation of information may, however, be more complicated and require unforeseen logic (e.g., apply Delphi studies to consolidate assessments). An implementation should therefore provide the flexibility to customize application logic or to incorporate external aggregation functionality.

Valuation of Assessment Attributes: ASSET recognizes different types of standards assessment attributes: attributes summarize *descriptive* information (e.g., its status), the *applicability* of a standard (e.g., its service model), or *interpret* existing information (i.e., derive values from other attributes' values). While automation of the ascertainment of attribute values may require human reasoning (e.g., screening of a specification), ASSET provides potential to automate the valuation of attributes. The calculation of measures for network effects in standardization, for example, may be automated. Since ASSET's information model captures the amount and type of stakeholders, which support a standard, tools may automatically measure network effects. Similarly, the value of interpretive attributes could be automatically derived. An indicator of a standard's success could, e.g., be defined in function of a standard's status and the amount of stakeholders which provide implementations. ASSET's interpretative attribute type supports the modelling of dependencies among assessment attributes. Moreover, ASSET allows incorporating external logic to automate the calculation of attribute values.

3 A Platform for Standards Assessment

Our platform architecture aims to provide a blueprint for developing service-based Web applications to support standards assessment. Service-orientation is a guiding principle, providing and encapsulation of functionality. Our platform architecture identifies functional modules and different types of components to implement ASSET's functionality and automation potentials (cf. Figure 2). Moreover, the architecture applies three layers to separate data management from assessment logic and service front-end. We will now discuss each of the modules and the different types of components.

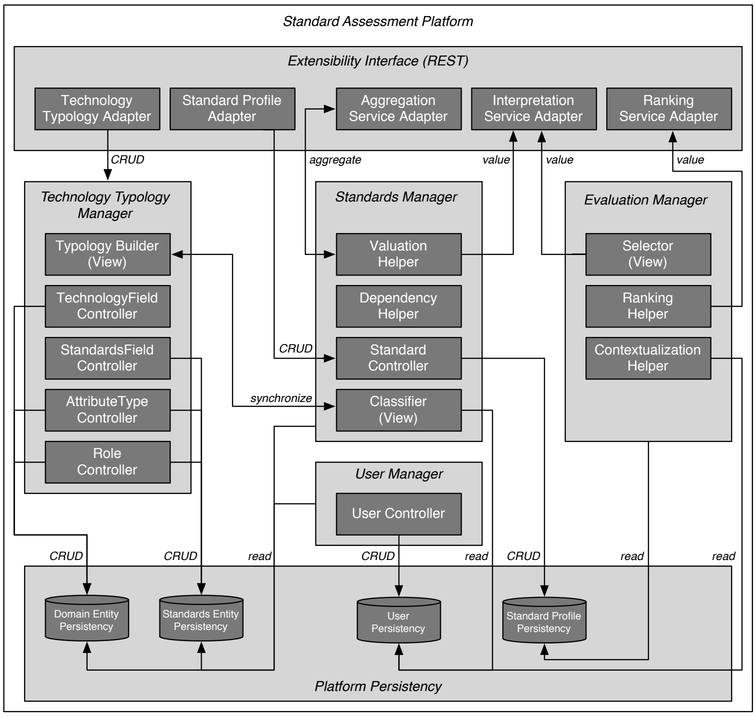


Figure 2. Standards Platform Architecture

The platform architecture proposes six functional modules: *Platform Persistency*, *Technology Typology Manager*, *Standards Manager*, *Evaluation Manager*, *User Manager*, and *Extensibility Interface*. While the components of the *Platform Persistency* provide the foundation of the assessment platform, components of the *Extensibility Interface* make these entities available to the outside world and provide means to incorporate external functionality into an implementation of the platform. The manager modules implement ASSET's assessment steps, provide the functionalities to maintain ASSET's entities, and provide the toeholds for the aspired automation. The *Technology Typology Manager*, thus, implements ASSET's Create Technology Typology sub-process. Therefore, it defines a view component (*Typology Builder*) to support users in creating the technology typology for the given domain of disruptive innovation (e.g., cloud computing). Corresponding controller components take care of maintaining the respective entities, e.g., update references between entities. The *Standards Manager*, in turn, provides the features to maintain and update standard profiles. A graphical component (*Classifier*) is defined to implement ASSET's classification sub-process. Respective helper components encapsulate functionality to automatically valuate attributes or discovery dependencies between standards. The scope of the *Evaluation Manager* is to support ASSET's steps to perform standard evaluations. The graphical *Selector* component implements ASSET's evaluation sub-process, guiding users in finding and ranking standards. Again, helper components encapsulate reusable logic for building the queries against the database of standards (*Contextualization Helper*) or order the matching set of standards to the user's preferences. Finally, the *User Manager* takes care of maintaining user information which is used to automate the filtering of information.

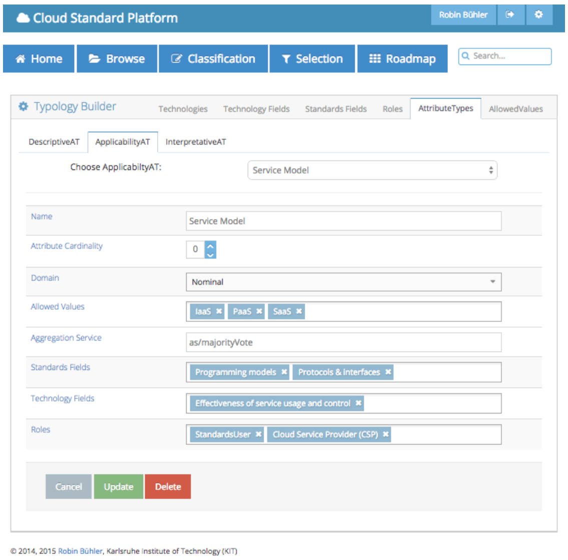
In summary, we propose five types of components: *Controller components* provide basic create, read, update, and delete (CRUD) functionality of respective entities. The *Technology Field Controller*, for example, provides CRUD functionality to manage the technology field entities. Similarly, *adapter components* define interfaces to either proxy CRUD functionality to extern services, i.e., provide access to the assessment entities, or extend the functionality of the assessment platform using external services. The *Technology Typology Adapter*, for example, proxies CRUD functionality to access and manage all entities of the technology typology. In contrast, the *Aggregation Service Adapter* provides an interface to trigger aggregation of standard profiles or to invoke calls to external aggregation services. Next, *persistency components* provide the storage capabilities for the different assessment entities. The *Standard Profile Persistency*, for example, stores information on the assessment of standards such assessment attributes. The purpose of *helper components* is twofold: They provide reusable assessment logic such as required for the aggregation of standard profiles, supporting our concept of providing updated data that can be used in a variety of different methods. They may apply external logic by invoking services through adapter components interactions. For example, the *Ranking Helper* may call services to integrate group decision-making functionality. The *Valuation Helper* comprises simple logic to aggregate values of attributes, but may also use remote aggregation or interpretation services. In addition, the *Valuation Helper* provides the endpoint implementation that allows external applications to trigger the execution of the aggregation logic from remote services. The *Contextualization Helper* component provides functionality to filter assessment information. Likewise, the *Dependency Helper* supports the identification of the similarity of any pair standards.

As demonstrated, individual components may used functionality of other components. CRUD operations on persistency are, however, restricted to controller components. The *Technology Typology Adapter* and the *Standard Profile Adapter* component are proxies for CRUD functionality of the *Extensibility Interface*. However, adapters are not allowed to directly access persistency components. With the exception of the *synchronize* interaction, there are no interactions of components of manager modules. In doing so, manager modules are self-contained reducing complexity and increasing component reuse. The synchronize interaction of the *Typology Builder* and the *Classifier*, however, is required to update standard classifications, if the technology typology changes. The same applies, if a standard classification requires an update of the technology typology. Consequently, the synchronize interaction is defined as bi-directional. Non-controller components may call adapters, incorporating external assessment logic. The *Valuation Helper* may retrieve the value of a standard's assessment attribute, using the value interaction. Only the *Aggregation Service Adapter* may invoke the *Valuate Helper* component using the bi-directional aggregate interaction. The architecture, thus, supports the initiation of attribute aggregation by external triggers.

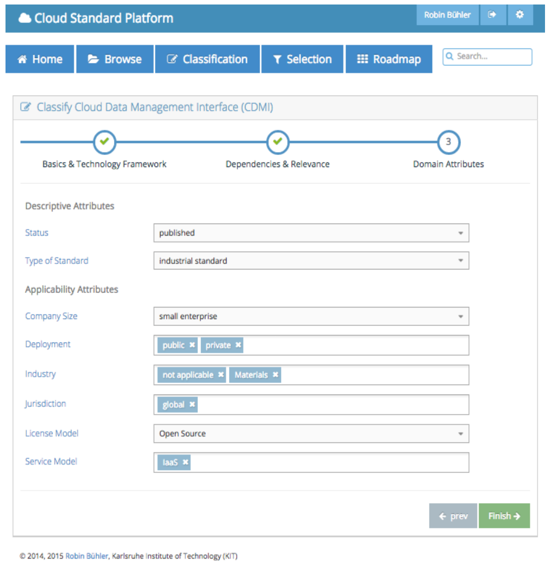
4 Cloud Standards Assessment Platform

Our proof-of-concept is implemented in Java using the Play framework for Web application development (cf. http://playframework.com/). Play is based on the Model-View-Controller (MVC) architectural-paradigm and provides support for RESTful service implementations. Therefore, we implemented all persistency components as model classes. We implemented controller, adapters, and helper components using controller classes. *Typology Builder*, *Classifier*, and *Selector* functionality was realized using view classes. More specifically, these components make use of form-based wizard to implement the guidance on classifying and selecting standards as defined by ASSET's procedural model. We applied the ace template for bootstrap providing customizations of HTML, CSS, and JavaScript files (cf. http://getbootstrap.com/).

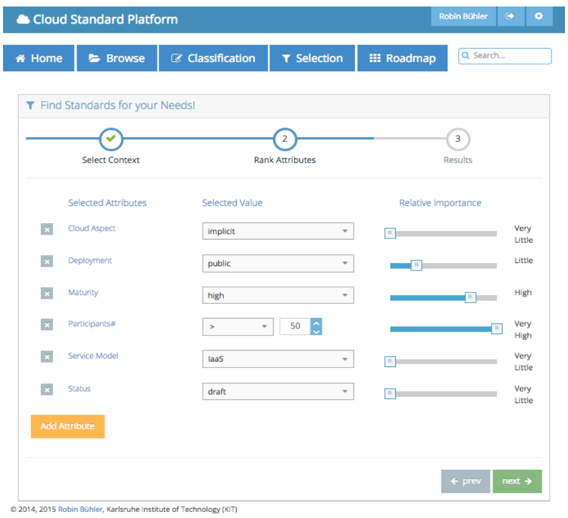
Figure 3 shows four screenshots (a-d), illustrating the user experience of ASSET's main functionality. In 3a) a user performs an adaptation of the technology typology, e.g., changing the assignment of the Service Model attribute to a technology or a standards field or changing its possible values. In 3b) a user is classifying a cloud standard. In the third step of the *Classifier*, the user provides values for the selection of descriptive and applicability assessment attributes. The selection of attributes depends on his roles as well as the technology or standards fields which the attribute is assigned to. The standard's technology and standards field have been assigned in a previous of the wizard (cf. checkmarks in 3b). Figure 3c) and 3d) depict our implementation of the *Selector* component. In Figure 3c) a user is asked to provide his preference for assessment attributes by selection and ranking attribute values. The amount of shown values, depends on the roles that use has selected in the previous step. Finally, Figure 3d) presents the results of a standard selection process. Here, the platform found one standard which matches the context of user as characterized using the contextual typology. As can be seen, the horizontal bar allows the user to change the scoring filter (e.g., reduce the threshold score).



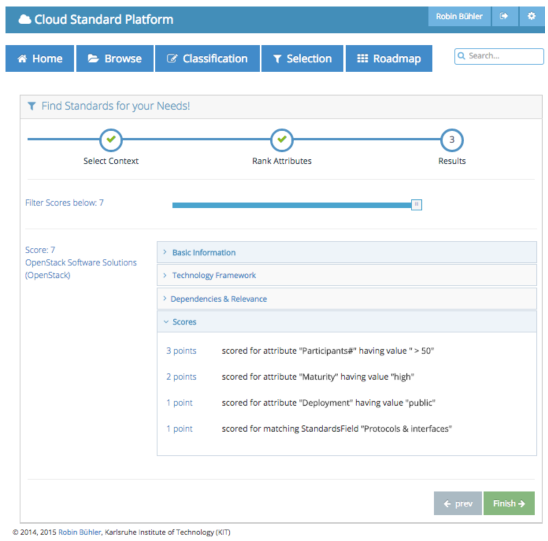
a) Typology Builder (Define AttributeTypes)



b) Classifier (Domain Attributes)



c) Selector (Rank Attributes)



d) Selector (Filter Results)

Figure 3. Cloud Standards Platform (cf. http://cloudstandards.de/)

In particular, we would like to highlight the following capabilities of the instantiation:

Propagation of Information Updates: Implementing the platform architecture, the *Typology Builder* and *Classifier* components are capable of informing one another, if changes to the technology typology require updates of standard profiles and vice versa. Due to design of the information model and shared access to persistency in the architecture, updates and deletions of instances of technology and standards fields as well as attribute types will be instantly reflected in standard profiles. If more instances of these entities were, however, added to the technology typology, changes will require the re-assessment of standards. Our implementation will automatically incorporate such attributes new classifications of any affected standards. Over time, values of the attribute will, therefore, propagated into the standard profile.

Filtering and Aggregation of Assessment Information: Our cloud standards assessment platform makes heavy use of ASSET's information filtering and aggregation potential. While providing classifications of standards, for example, users will only be asked to value attributes that fit their role and the technology framework of the standard (cf. Figure 3b). The same logic is applied to build the contextual typology when users perform the process of selecting standards. Based on ASSET's information model, our prototype stores standard classifications of different users individually. Automated aggregation capabilities are executed in the background using the *Valuation Helper* component whenever a user submits a classification of a standard. We implemented services for majority vote and threshold-based value aggregation. The aggregation logic, which is applied for aggregating standard's attribute, can be customized (cf. *Aggregation Service* property in Figure 3a).

Valuation in Assessments: Similar to concept of using services to aggregate assessment attributes, we implemented two services to demonstrate ASSET's potential of performing automated valuations in assessments. The first service is used to count the amount of stakeholders which currently supports a standard. We configured our prototype to include an interpretative attribute Participants# that is linked to the external service. Moreover, we implemented a more complex service which predicts a standard's market potential. The service calculates a standards market potential in function the Participants# attribute and the standards current maturity level value (cf. e.g., Figure 3d)).

5 Discussion and Outlook

In this paper, we presented a conceptual architecture and a prototypical implementation of a platform to reduce efforts of standards assessment in disruptive innovation. ASSET, our approach for standards assessment in disruptive innovation, defines required concepts and the procedural model which guided the development of our proof-of-concept implementation for the domain of cloud computing.

As demonstrated by in the previous chapter, our proof-of-concept demonstrates realizability of automation potentials using ASSET's constructs and procedures and the concept of our platform architecture. The concept of service-orientation, furthermore, enables flexible incorporation of different assessment methods and tools to, e.g., aggregate assessment information. In doing so, the platform provides capabilities to reduce the efforts of standards assessment in disruptive innovation. Moreover, it provides the possibilities to incorporate more advanced assessment capabilities from the domain technology and innovation management. For example, we envision the support of Delphi-based consensus building methods to consolidate standard profiles instead of simple aggregation logic as demonstrated in this paper. The combination of ASSET's information and procedural model and the accessibility of information over our prototype's *Extensibility Interface*, thereby, provide the basis for the automated creation of required questionnaires. Moreover, we will need to incorporate more elaborated aggregation, interpretation, and ranking services to verify the general applicability of ASSET's concepts in a wide range of standards assessment methods in the future. In particular, we will test the feasibility of our technology typology concept to derive hierarchical inputs as required by multi-criteria decision-making approaches such as discussed in the context of cloud service selection (cf. Sun et al., 2014).

The overall practicality of our approach and prototype, however, will only demonstrate, if a community of standardization stakeholders starts using approach. The data that is currently maintained by our prototype reflect results from our study of standardization in cloud computing from 2012 (Bernnat et al., 2012). As such, it provides starting point for building a community that is willing to assess cloud standards. A lively community would build the substantial database of standards which is required to, e.g., perform tests of the quality of ASSET's standards assessment process or quantify the efficiency gains in assessing standards of in disruptive innovation.

References

Bernnat, R., Zink, W., Bieber, N., Strach, J., Tai, S., & Fischer, R. (2012). Das Normungs- und Standardisierungsumfeld von Cloud Computing. Downloaded from http://www.trusted-cloud.de/documents/20111222_BMWi_Cloud_Standards_Studie_Abschlussbericht_%28FINAL%29.pdf on 2015-03-26.

Bower, J. L. and Christensen, C. M. (1995): Disruptive Technologies: Catching the Wave. Harvard Business Review, 73 (1), pp. 43-53.

Brunsson, N., Rasche, A., & Seidl, D. (2012). The Dynamics of Standardization: Three Perspectives on Standards in Organization Studies. Organization Studies, 33 (5-6), pp. 613-632.

Chen, M. (2003). Factors Affecting the Adoption and Diffusion of XML and Web Services Standards for E-business Systems. International Journal of Human-Computer Studies, 58 (3), pp. 259-279.

CSA (2009). Security Guidance for Critical Areas of Focus in Cloud Computing (V2.1). Cloud Security Alliance. Downloaded from https://cloudsecurityalliance.org/csaguide.pdf on 2015-03-26.

Day, G. S. and Schoemaker, P. J. H. (2000). A Different Game. In Wharton on Managing Emerging Technologies (Day, G. S., Schoemaker, P. J. H. and Gunther, C. W. Eds.), pp. 1-23, Wiley, Hoboken, NJ.

de Vries, H. J. and van der Zwan, J. (2008). What Standards Do I Need for My Product or Service? Downloaded from http://repub.eur.nl/res/pub/31689/standards.pdf on 2015-03-26.

de Vries, H. J. (2006). IT Standards Typology. In Advanced Topics in Information Technology Standards and Standardization Research (K. Jakobs), Volume 1 (pp. 1-26), IGI Global, Hershey.

ETSI (2013). Cloud Standards Coordination - Final Report, European Telecommunications Standards Institute. Downloaded from http://www.etsi.org/images/files/Events/2013/2013_CSC_Delivery_WS/CSC-Final_report-013-CSC_Final_report_v1_0_PDF_format-.PDF on 2015-03-26.

European Commission (2011). COM(2011) 311, A Strategic Vision for European Standards: Moving Forward to Enhance and Accelerate the Sustainable Growth of the European Economy by 2020. Downloaded from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0311:FIN:EN:PDF on 2015-03-26.

European Commission (2012). COM(2012) 529, Unleashing the Potential of Cloud Computing in Europe. Downloaded from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=yCOM:2012:0529:FIN:EN:PDF on 2015-03-26.

Fischer, R., Janiesch, C., Strach, J., Bieber, N., Zink, W., & Tai, S. (2013). Eine Bestandsaufnahme von Standardisierungspotentialen und -lücken im Cloud Computing. In Proceedings of the 11. Internationale Tagung Wirtschaftsinformatik (WI), pp. 1359-1373. Leipzig.

Fischer, R., and Janiesch, C. (2014). A Method for the Classification of Emerging Technology Standards: The Case of Cloud Computing. In Proceedings of the 22nd European Conference on Information Systems (ECIS), pp. 1-10, Tel Aviv.

Gauch, S., and Blind, K. (2015). Technological Convergence and the Absorptive Capacity of Standardisation. Technological Forecasting and Social Change, 91, pp. 236-249.

Hevner, A. R., March, S. T., Park, J. and Ram, S. (2004). Design Science in Information Systems Research. MIS Quarterly, 28 (1), pp. 75-105.

Hogan, M. D., Liu, F., Sokol, A. W., & Jin, T. (2011). NIST-SP 500-291, NIST Cloud Computing Standards Roadmap. Downloaded from http://www.nist.gov/itl/cloud/upload/NIST_SP-500-291_Jul5A.pdf on 2015-03-26.

ITU (2010). Activities in Cloud Computing Standardization. ITU Telecommunication Standardization Bureau. Downloaded from http://www.itu.int/dms_pub/itu-t/oth/49/01/T49010000020002PDFE.pdf on 2015-03-26.

Jakobs, K. (2011). How People and Stakeholders Shape Standards: The Case of IEEE 802.11. In Proceedings of the 6th International Conference on Web Information Systems and Technologies (WEBIST2010), LNBIP 75, pp. 1-13.

Khasnabish, B. and JunSheng, C (2012). Cloud SDO Activities Survey and Analysis. Internet Engineering Task Force. Downloaded from https://rsync.tools.ietf.org/html/draft-khasnabish-cloud-sdo-survey-04 on 2015-03-26.

Kaltencker, N., Huesig, S., Hess, T., & Dowling, M. (2013). The Disruptive Potential of Software as a Service: Validation and Application of an Ex-ante Methodology. In Proceedings of the 24th International Conference on Information Systems (ICIS), pp. 3808-3826. Milan.

Liu, C. Z., Gal-Or, E., Kemerer, C. F., & Smith, M. D. (2011). Compatibility and Proprietary Standards: The Impact of Conversion Technologies in IT Markets with Network Effects. Information Systems Research, 22 (1), pp. 188-207.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud Computing: The Business Perspective. Decision Support Systems, 51 (1), pp. 176-189.

Motahari-Nezhad, H. R., Benatallah, B., Casati, F. and Toumani, F. (2006). Web Services Interoperability Specifications. Computer, 39 (5), pp. 24-32.

Mykkänen, J. A. and Tuomainen, M. P. (2008). An Evaluation and Selection Framework for Interoperability Standards. Information and Software Technology, 50 (3), pp. 176-197.

Nickerson, J. V. and zur Muehlen, M. (2007). The Ecology of Standards Processes: Insights from Internet Standard Making. MIS Quarterly, 30 (Special Issue/August 2006), pp. 467-488.

Nitzsche, J., van Lessen, T. and Leymann, F. (2008). Extending BPELlight for Expressing Multi-Partner Message Exchange Patterns. In Proceedings of the 12th International IEEE Enterprise Distributed Object Computing Conference (EDOC), pp. 245-254, München.

Pautasso, C., Zimmermann, O. and Leymann, F. (2008). Restful Web Services vs. "Big" Web Services: Making the Right Architectural Decision. In Proceedings of the 17th International Conference on World Wide Web (WWW), pp. 805-814, Beijing.

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2010). Roadmapping for Strategy and Innovation: Aligning Technology and Markets in a Dynamic World. Cambridge, UK: University of Cambridge, Institute for Manufacturing.

Sakai, H. (2011). Standardization Activities for Cloud Computing. NTT Technical Review. Downloaded from https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201106gls.pdf&mode=show_pdf on 2015-03-26.

Sherif, M. H. (2001). A Framework for Standardization in Telecommunications and Information Technology. IEEE Communications Magazine, 39 (4), pp. 94-100.

Schubert, L., Jeffery, K. and Neidecker-Lutz, B. (2010). The Future of Cloud Computing: Opportunities For European Cloud Computing Beyond 2010. Downloaded from http://cordis.europa.eu/fp7/ict/ssai/docs/cloud-report-final.pdf on 2015-03-26.

SCSG (2010). Smart Cloud Strategy. Smart Cloud Study Group. Downloaded from http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/councilreport/pdf/100517_1.pdf on 2015-03-26.

Smith, K. B. (2002). Typologies, Taxonomies, and the Benefits of Policy Classification. Policy Studies Journal, 30 (3), pp. 379-395.

Sun, L., Dong, H., Hussain, F. K., Hussain, O. K., & Chang, E. (2014). Cloud Service Selection: State-of-the-Art and Future Research Directions. Journal of Network and Computer Applications, 45, pp. 134-150.

Toosi, A. N., Calheiros, R. N., & Buyya, R. (2014). Interconnected Cloud Computing Environments: Challenges, Taxonomy, and Survey. ACM Computing Surveys (CSUR), 47 (1), pp. 7:1-7:47.