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RABIC: A Reference Architecture for Business Intelligence in the Cloud

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Abstract: Classical Business Intelligence systems are based on common database management systems. The use of such classical, nonpolitical BI systems is not always the best solution. The incorporation of cloud computing technology offers great potential. Therefore, the combination of business intelligence and cloud computing is discussed more and more in science and industry with first products being already available on the market but so far no widespread use has been established. On the one hand, there are less scientifically based progress reports; on the other hand, there is an uncertainty and skepticism. Basic questions regarding the enterprise and software architecture are not yet clear. The absence of standards and transparency promotes skepticism and incomprehension. A lack of comparison and assessment models for BI cloud services and BI cloud systems fueled uncertainty. RABIC, the integrated reference architecture for business intelligence in the cloud, improves this situation by supporting the standardization, increase the transparency and abolish the skepticism. The measures to receive these objectives are to make BI cloud services in a uniform way describable and comparable and to make BI cloud systems assessable, comparable, describable and easier implementable. The vehicles as the integral constituents of the reference architecture are a taxonomy for BI cloud services and an architectural framework for BI cloud systems. This article presents an overview of the reference architecture.

Key words: Business intelligence in the cloud, BI as a service, reference architecture, standardization.

1. Introduction

In the area of corporate reporting so-called BI (business intelligence) systems have been developed with the aim to analyze data from various sources and to gain knowledge in order to support the management in the decision making process [1]. Thereby the ambition is to provide the relevant information at the right time at any place to the decision makers [2]. BI is in permanent change, which was particularly noticeable in recent years. BI is considered more important and this way, BI solutions became a part of the value of a company itself [1].

Traditional BI solutions are often rigid, complex and costly [3]. Moreover, a bottleneck is often seen in the context of the development and availability of BI in enterprises in particular due to budget and resources [4]. Predominantly enforced BI usage models, such as on premise or outsourcing models, offer less agility and adaptability [5].

Furthermore, strategic, inter-company and explorative missions of BI have become in focus of discussions. These go hand in hand with greater attention of poly-structured data sources, greater integration of more sophisticated analytical methods (Advanced, Visual and Predictive Analytics) and a stronger focus on agility aspects (inter alia via self-service BI and Agile BI). Regarding the further interaction with the parallel driven process integration and the extension to new internal and external user groups there is a need to revise established architectures [6]. Especially previously used BI systems are mostly inflexible and expensive [3], the combination of BI and CC (cloud computing) implies the chance to optimize flexibility, scalability and agility [7].

BI in the Cloud is an IT architecture paradigm with the purpose of providing analytical capacities as a

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service. Thus, BI systems and services can be deployed as a cloud service. The outcome is called BIaaS (BI as a service) or more common BI Cloud [6].

Due to the novelty of the development of BIaaS, there are not a lot of experience reports. The absence of standards and transparency promotes skepticism and incomprehension. The lack of comparison and assessment model for cloud-based BI systems also fuels uncertainty. That turns into a low acceptance of service offerings. Even though first products of different manufacturers exist on the market, a non-comprehensive utilization is imperceptible as the tools are mostly heterogeneous and in an early maturity and they cannot be combined in any way or integrate with existing systems. The main reasons are unanswered issues regarding the enterprise and software architecture. This emphasizes the potential of a standard [5, 6].

The aim of this envisaged standard is to increase transparency and to promote the standardization of BI in the cloud. Consequently, the objective is to design a conceptual model for the unique description, analysis, comparison and evaluation, as well as an implementation template for Business Intelligence Cloud systems and services. For this purpose, we have presented an integrated RABIC (reference architecture for BI in the cloud).

The main artifacts of the integrated reference architecture are:

(1) The taxonomy for describing and comparing BI Cloud services;

(2) The architecture model for realization, description, comparison and evaluation of BI Cloud systems.

RABIC as a communication tool increases the understanding and thus minimizes the skepticism and uncertainty. As analysis and evaluation tool RABIC allows the comparability of BI Cloud solutions and improves product selection decision. With the use of the architectural model as an implementation template, business and technical risks are minimized and the efficiency of the development process is improved.

The rest of this paper is structured as follows: In Section 2, we introduce the subject BI in the Cloud. Based on these foundations, we present in Section 3 an overview of our reference architecture. After that, we discuss the two integral components of the reference architecture: the taxonomy for BI cloud services (Section 4) and the system architecture (Section 5). We explicate one instantiation of the system architecture (prototype) in Section 6 and discuss the results in Section 7. Finally, in Section 8, we conclude with a short summary and remarks on future work.

2. BI in the Cloud

BI in the Cloud is not a fundamentally new technology. There are precursors and roots in both domains of BI and CC. On the side of the cloud technology (such as cluster computing, grid computing, virtualization and outsourcing), as well as on the side of BI technology (such as Core BI systems, mobile BI, Adaptive BI). Nevertheless, BI in the cloud is a new technology bundle for providing personalized and differentiated configurable, scalable and flexible analytical IT services [6].

These services fulfill recently increased requirements especially in flexibility, scaling and agility aspects due to continuous changes in the organizational, economic and technical environment [5]. In this context, BI in the Cloud is considered as a relevant field of research in science and industry and will still play a major role in future [1, 5, 8, 9]. Therefore, this standardized approach and proposal is an important research contribution.

Surveys and studies [5-10] show that there are already first approaches, products and works from science and industry, as well as of authorities and associations.

Table 1 shows an overview of the finding of the studies and surveys. As this table shows, the surveyed

Table 1 Results of Literature Analysis.

Reference	Level of abstraction			Formality		
	Meta model	aspect	instance	informal	In part formal	formal
BITKOM [11-13]	X			X		
Gartner [14]	X			X		
BARC [15, 16]	X			X		
SAP [17-19]			X	X		
Microsoft [20, 21]			X	X		
QlikTech [22]			X	X		
Oracle [23, 24]			X	X		
IBM [25, 26]			X	X		
MicroStrategy [27]			X	X		
TATA [28]			X	X		
Adabi [29]		X		X		
Ouf and Nasr [30]		X		X		
Chadha and Iyer [31]	X			X		
Tamer et al. [32]		X		X		
Grivas et al. [33]		X			X	
Demirkan and Delen [34]	X				X	
Baars and Kemper [3]	X				X	
Gurjar and Rathore [35]		X			X	
Gash et al. [36]		X		X		
Thompson and van der Walt [37]	X				X	
Haselmann and Vossel [38]		X		X		
Seufert and Bernhardt [8]		X			X	
Weinhardt et al. [39]	X				X	
Torkashvan and Haghighi [40, 41]		X				X
Leinmeister et al. [42]		X			X	
Schirm et al. [43]		X			X	
Chang [44]		X			X	
Ereth and Dahl [45]		X			X	

references differ in their level of abstraction and their type of formalization.

Level of abstraction: Does the respective reference describe one or more concrete BI service offerings (instance), does it provide a generic description of BI Cloud (meta model), or does it discuss certain aspects (aspects)?

Type of formalization: How is the respective framework described? Typically examples are taxonomies, block diagrams, ontologies, lists and plain text.

As Table 1 illustrates, existing contributions differ in their formalization and in their level of abstraction. Most posts are described only informally. This prevents a comparison and leaves room for unintended interpretations. The surveyed articles and approaches consider merely different aspects and sections and follow different methods and objectives. Comprehensive models are imperceptible. The sighted contributions cannot serve as implementation, comparison or evaluation tool. This fact motivates the integrated reference architecture described in this article.

3. Reference Architecture

Regarding BI in the Cloud, there are not a lot of experience reports. The absence of standards and transparency promotes skepticism and incomprehension. Against this background, the paper aims to promote the standardization and to increase the transparency and understanding. To achieve this, the systems and services in the BI Cloud environment must become uniformly and structured describable, comparable and assessable.

As a vehicle for this, the paper presents an integrated reference architecture consisting of two artefacts:

(1) A consolidated taxonomy for BI Cloud services and;

(2) A standardized IT architecture for BI Cloud systems.

The taxonomy enables a uniform description and a structured comparison of BI Cloud services. Thus, providers can describe their BI Cloud product as well as customers can describe their demand uniformly. With the taxonomy as a comparison tool, the selection of a suitable service becomes easier. Thus, BI consultants and BI managers are supported by describing their requirements and by finding the best matching service.

The IT architecture serves as evaluation and comparison model for existing as well as design patterns for new BI Cloud systems. Thus, BI project managers, BI architects and BI developers are supported in their work, especially by comparison, selection, evaluation and development of BI Cloud systems. Fig. 1 illustrates the relationship between the artifacts and the use of options.

The classification of the integrated reference architecture is described following the approach from Ref. [46] where after a model is to be classified based on a “From which—Why—For what—For whom” construct.

From which? The architecture is a model of BI systems and BI services that are based on the cloud technology.

Why? The architecture serves to increase transparency and to promote standardization in order to favor acceptance and use of BI in the Cloud and to avoid the uncertainty and lack of experience.

For what? The integrated reference architecture can be used for description, comparison and evaluation of existing BI cloud solutions. Besides supporting the IT architecture as an implementation template supports the operational development and use of BI in the Cloud. As a communication model it can be used to pass requests and expectations and enables discussions.

For whom? Target user group of the reference architecture are BI architects and BI developers. These can use the model to compare existing product and to assess and set their own designs. Here, the IT architecture model supports especially to minimizing risks, to identify pitfalls and increases the efficiency of development and selection process.

The integrated nature of the reference architecture consists in its composition and the interaction of the components. RABIC takes the service and the system level into account.

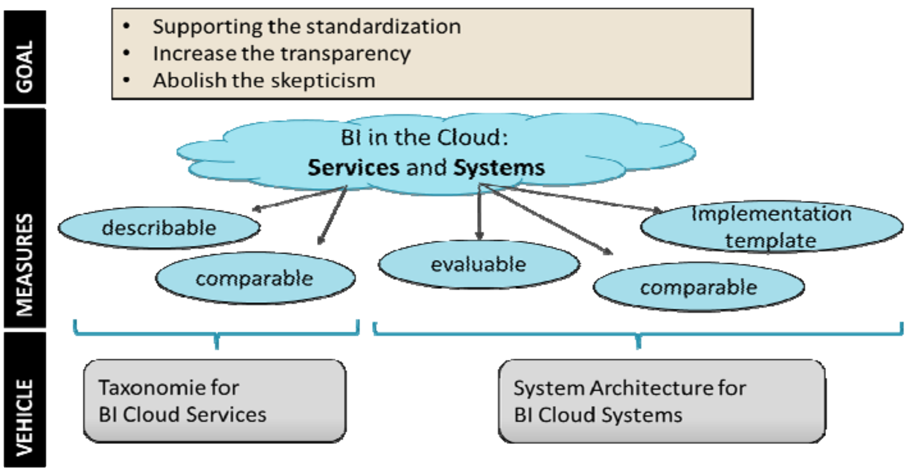

Fig. 1 Target range.

The service layer contains the taxonomy for describing and comparing BI Cloud services. Thus, providers can describe their service properties and buyers their service requirements, both uniformly and completely. This creates a better understanding of the services and a better result in the selection process.

The system layer embodies the system model with a component and class architecture, data exchange formats and deployment diagrams. Therein different scaling algorithms and billing models are discussed. In addition, there is a concept for a distributed data warehouse system. An abstraction mechanism allows any cloud and other storages as data warehouses. A rule-based algorithm selects the best storage service by optimizing the cost, performance and safety. This reusable system architecture makes recommendations for implementing a BI Cloud system. Furthermore, the system layer models are suitable for comparison and evaluation of existing instances.

The interaction between the taxonomy and the architecture is an important characteristic of the integrated reference architecture: As Fig. 2 illustrates, there is a clear and unambiguous link between the components and methods of the architecture and characteristics of services from the taxonomy. The individual components of RABIC are discussed later on; the system architecture in Fig. 2 on the left side is the subject of Section 5 and the taxonomy in Fig. 2 on the right side is subject of Section 4.

If the taxonomy is filled out for existing needs to a service, the corresponding components of the architecture can be used in order to satisfy the requirements. If there are existing services or existing systems, they can be described with the taxonomy and the architecture and evaluated and compared with other approaches.

So, with the integrated reference architecture, a holistic proposal for the standardization of the field BI in the Cloud is available. In the Sections 4 and 5 the taxonomy and the architecture are examined more closely.

4. Taxonomy for BI Cloud Services

In order to systematically and uniformly describe and compare BI Cloud services, it requires a standardized description model. For this purpose, the taxonomy can be used. It enables providers to describe their service offering and customers to formulate their needs. Thus, the taxonomy supports by choosing the appropriate service, enables a comparison and an assessment of different BI Cloud services.

In addition, we developed the BI-CSN (BI cloud

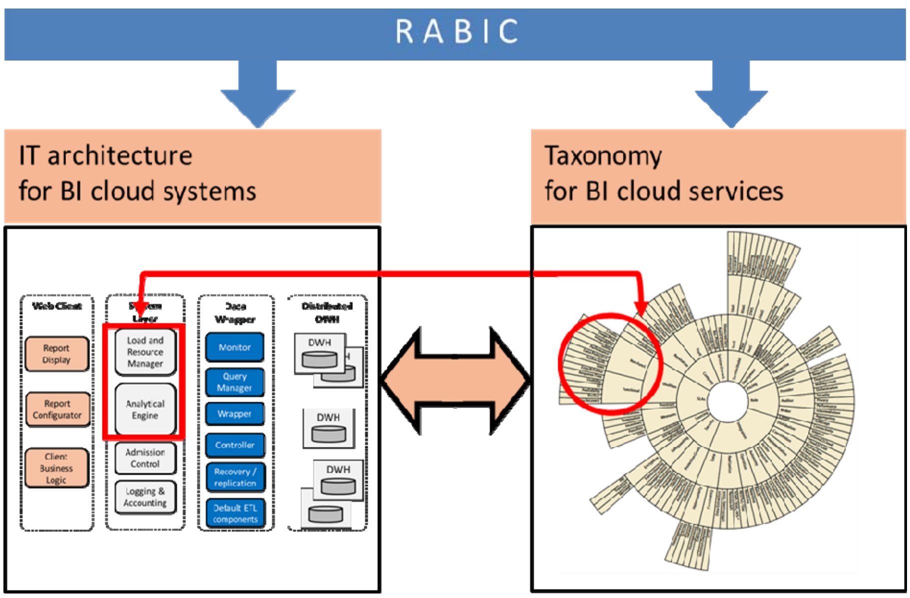

Fig. 2 Integrated reference architecture for BI in the cloud.

service navigator) as a visualization for BI cloud service description. BI-CSN are based on radial, space-filling Sunburst diagrams. The goal of this visualization is to support the fast perception of service descriptions, a feature Sunburst diagrams are well-known for Ref. [47].

The taxonomy was created in a three-step process [9]: (1) Existing approaches, results and projects from industry, academia and other organizations were sought worldwide, containing a contribution to a description language. (2) All existing approaches have been analyzed and formally described with feature models. (3) The elements of all approaches were consolidated by developing the taxonomy.

In addition to general elements such as name and description, a unique identification and the version of the service, the taxonomy considered the following 10 service aspects [9]: (1) service type, (2) deployment model, (3) pricing model, (4) roles and activities, (5) integration, (6) security, (7) sourcing, (8) service level agreement (SLA), (9) organizational and (10) cloud service characteristics.

(1) Service Type: The taxonomy distinguishes between the types of services SaaS (software as a service), PaaS (platform as a service), IaaS (infrastructure as a service) and mashup as a service. The SaaS subtype VaaS (visualization as a servie) includes for example dashboards, scorecards and reports. Besides VaaS, MaaS (model as a service) is understood as software services, including OLAP functions, data mining and self-service features. PaaS means data warehouse system functions such as development and configuration. IaaS includes subtype DaaS (data as a service) what is the staging area, the repositories, data marts and the data warehouse. In addition, the pre-execution of analytical operations is located at the IaaS. Mashup as a service specifies any kind of applications and services combined to a BPaaS (business process as a service).

Fig. 3 shows the described features of service types of clouds as a feature model. The same features are in Fig. 4 visualized as a part of the BI-CSN.

(2) Deployment Model: Regarding service deployment, the taxonomy considers the deployment types: Public, Private, Hybrid and Community Cloud. Virtual Private Cloud is a specialization of Public Cloud to take into account Cloud environments that provide similar service guarantees as Private Cloud environments but are realized with Public Clouds.

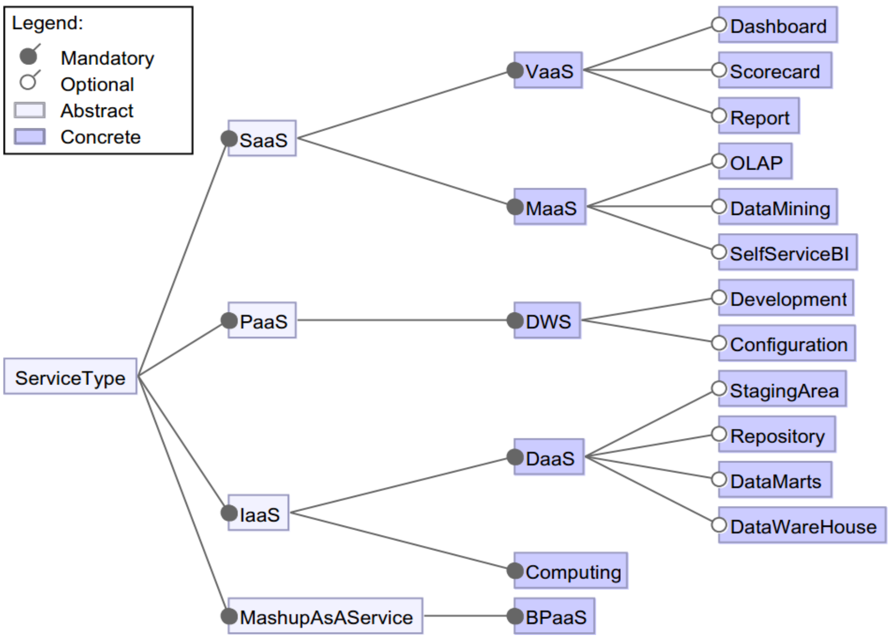

Fig. 3 Service types of clouds as feature model.

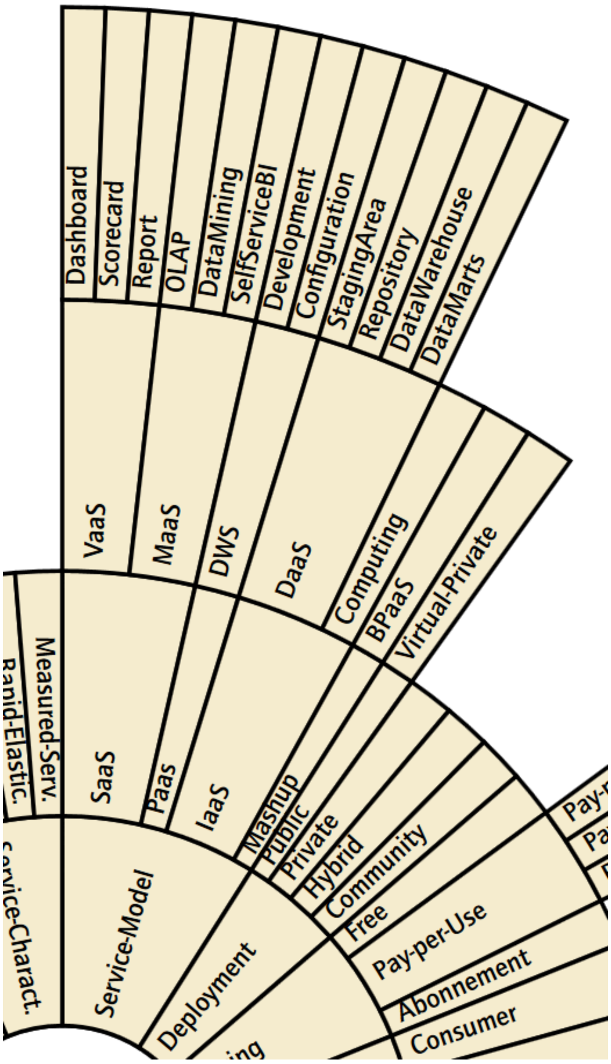

Fig. 4 Service types of clouds in BI-CSN.

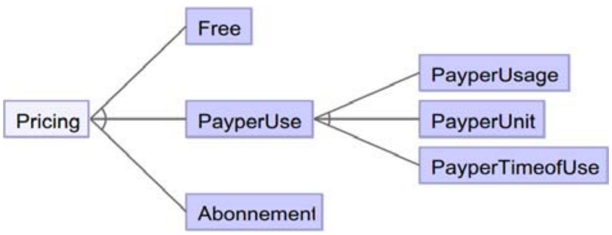

Fig. 5 Models for pricing.

(3) Pricing models: A distinction is made between free, usage-dependent payment and subscriptions (abonnement) (see Fig. 5). The usage-based variants are pay-per-usage, per-per-unit and pay-per-time-of-use. Within pay-per-time-of-use is a payment for a certain period of use mentioned. Pay-per-usage covers the payment for the number of consideration respective views of a report; a concrete instance is pay-per-report. A resource-based billing, e.g., payment for calculation power units or storage, used hardware resources is summarized with pay-per-unit.

(4) Roles and Activities: The taxonomy takes into account the roles consumer, provider, auditor, broker and carrier. The customer consumes the services provided by a provider. A broker acts as an intermediary and is responsible for service aggregation and arbitrage. The auditor provides security, performance and other audits. The carrier is responsible for network connectivity.

(5) Service Integration: Here the taxonomy takes into account the aspects of technical integration, implementation, and access, level of abstraction, autonomy, consistency, latency and data integrity.

(6) Security: As Fig. 6 shows, the taxonomy considers the security aspects divided in protection goals, and methods and techniques to gain these goals. Protection goals are for instance authenticity, authorization, integrity and confidentiality. Methods to accomplish these goals could be message or transport encryption.

(7) Sourcing Options: regarding the fact, how the cloud environments and services are hosted and managed, it is differentiated between complete self-management, hosting or management by third parties.

(8) SLA: In terms of quality of service for instance non-functional and functional aspects are considered. In addition, aspects of the change process and governance are relevant.

(9) Organization specific aspects: To establish trust, offering organizations must demonstrate their reputation and skills. This branch of the taxonomy finds such aspects into account.

(10) Service characteristics: There are five key features a cloud service must have: on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. These are included

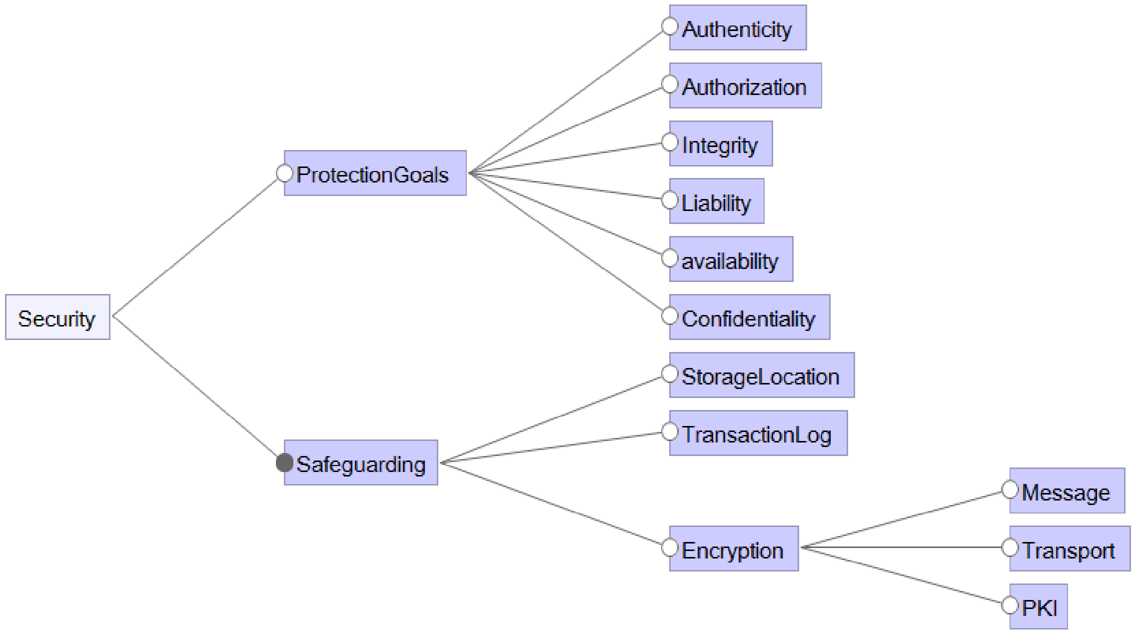

Fig. 6 Security in the taxonomy.

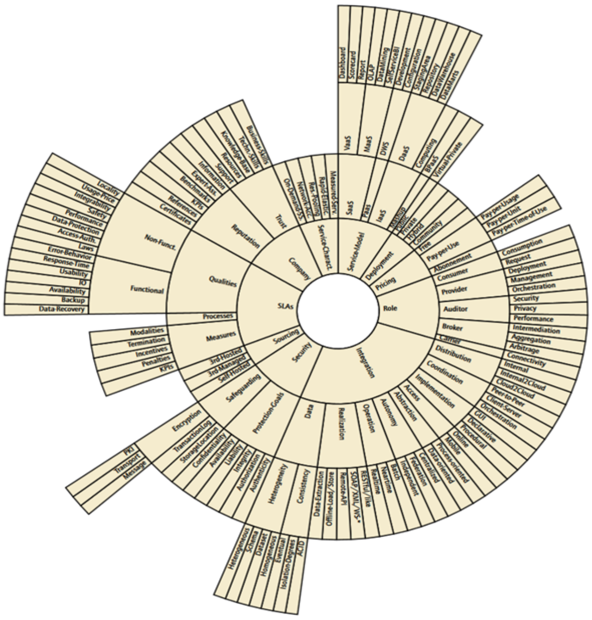

Fig. 7 Complete BI-CSN.

in the taxonomy to identify cloud washing offers.

Since the formal notation with feature models provides too much complexity for fast visual understanding, the BI-CSN was created as a suitable visualization technology for graphical description of BI Cloud services. The complete BI-CSN is shown in Fig. 7. Within that visualization, the absence or presence of characteristics of the taxonomy for a specific service can be realized by coloring the specific features in the BI-CSN.

The taxonomy was applied in several scenarios and projects to describe various service offers [9]. The taxonomy cannot only be used as a described tool, but also as a tool for comparison. As Fig. 8 shows, two different BI cloud service offers, on the left side Microsoft Power BI (existing features are marked blue) and on the right side SAP HANA Cloud platform (existing features are marked in orange). In the middle of Fig. 7 the easily understood visual comparison is shown. This shows, which features are met by both services (marked in green) and what the differences are. Here the taxonomy serves as a reference framework against which services can be validated.

In addition to the models of the taxonomy, there is a software component that supports the comparison systemically. With this software, business and technical requirements of a potential customer to a service can be managed as well as service characteristics of existing services of a provider —and then the best matching service for a scenario can be found.

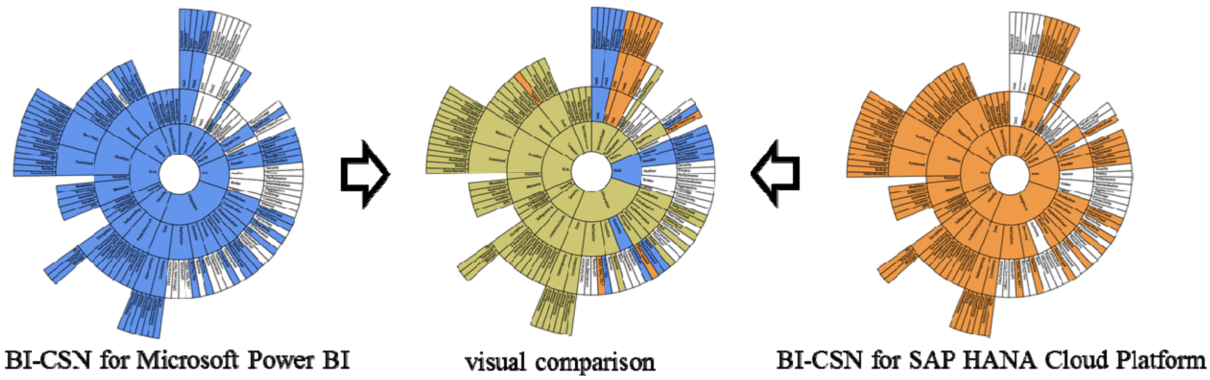

Fig. 8 Visual comparison using BI-CSN.

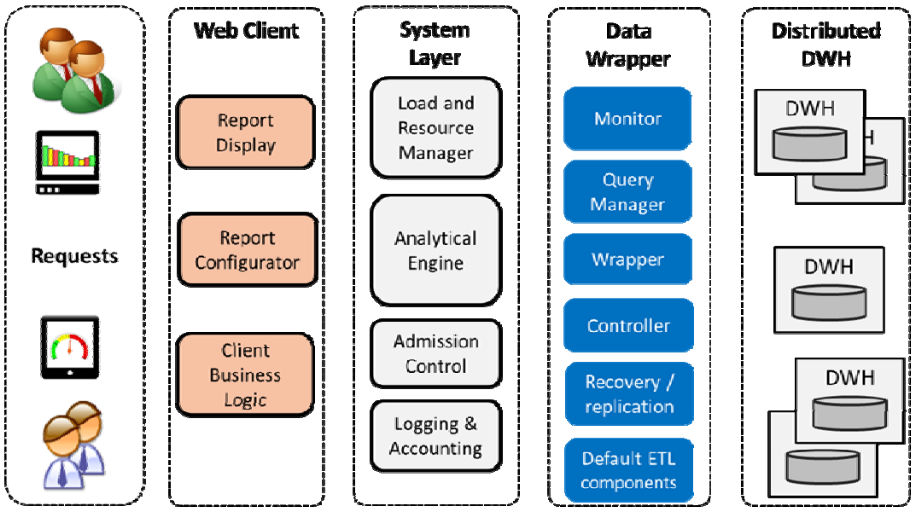

Fig. 9 Architecture overview.

By testing and evaluating the taxonomy through applying on existing services and interviewing experts it was showed that the taxonomy is an adequate for fully describing and suitable comparing BI Cloud services.

5. Architecture for BI Cloud Systems

The system architecture describes components, relations and constrains to design and implement a cloud-based BI system. The main features of this architecture are the agility and flexibility as well as the scalability and availability. Each component can be omitted depending on the deployment scenario.

This way a lean and agile architecture can be reached. In addition, each component and class can be initiated several times. So computing tasks can be distributed, also beyond data centers, to achieve a low response time.

Due to the flexible expandability and the quick reaction to requirements, coupled with the shared use of resources a scalable architecture becomes possible [6].

As an overview, the architecture is based on a tree layer concept. In Fig. 9, from left to right, the user can get access to the system with any devices (e.g., tablets, smartphone or desktop pc's). These devices communicate with the web client (layer 1) which takes care of visualization of KPIs and provision of analytical functions, additivity and self-service functions. The system layer (layer 2) is responsible for the access management and monitoring. This layer manages the hardware capabilities as base for all analytical functions and thus guarantees a high availability and a low response time. The data wrapper (layer 3) abstracts of all different data sources, types and locations, thus enables the connection of any data source and of any data storage as distributed data warehouse. Furthermore, the data wrapper takes care of the data integration and cares about data quality.

In a more formal view, Fig. 10 shows the components of the architecture in a UML component diagram [6].

(1) Web Client: The WC (web client) acts as a single point of contact. The user accesses with his devices only by using the web client. This can be implemented as browser access or native app. The WC ensures flexibility in visualization and encapsulates all functions from the back end.

Fig. 11 gives a view inside the web client (left side). The tree components within the web client operate based

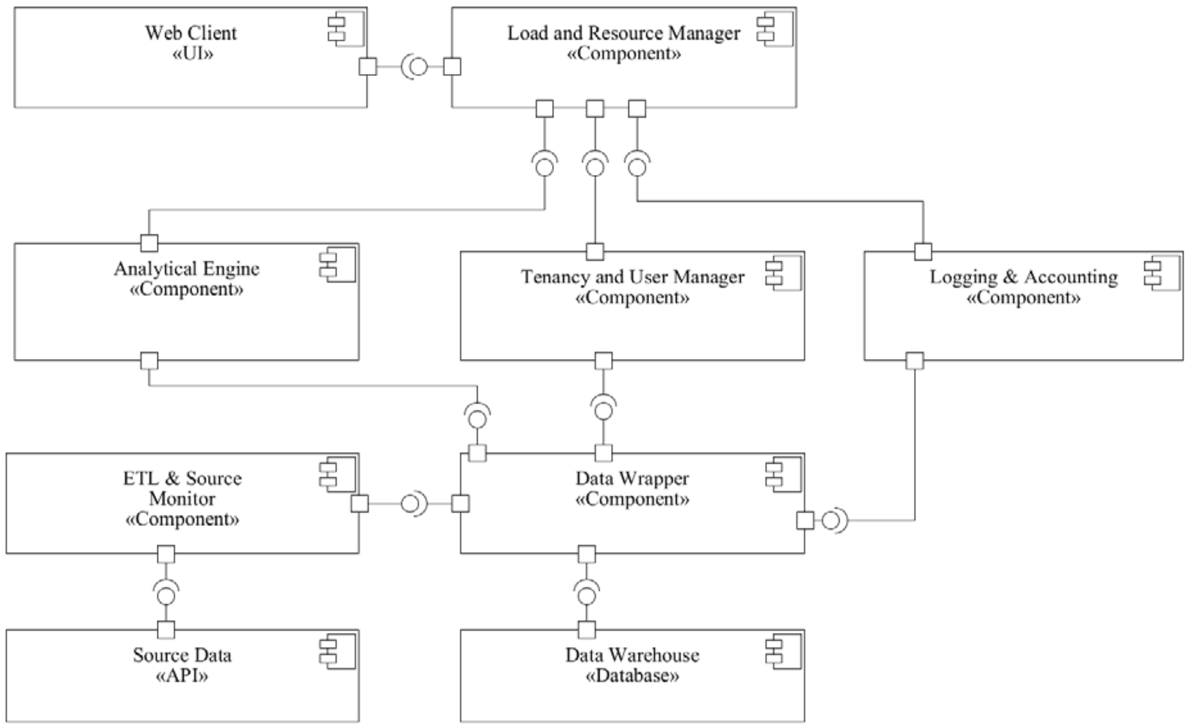

Fig. 10 Component architecture.

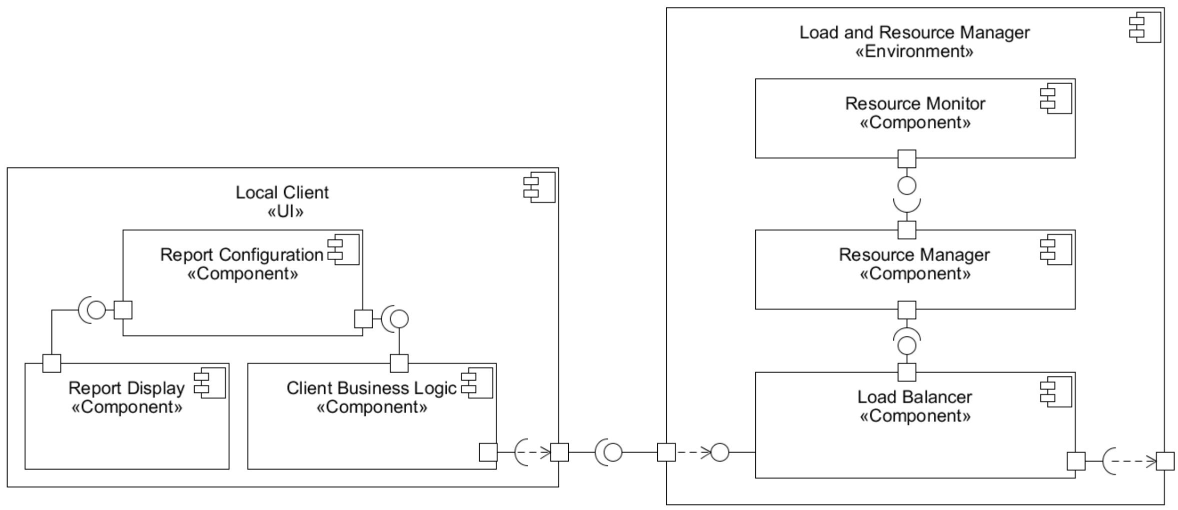

Fig. 11 Architecture part 1: web client, load and resource manager.

on a model-view-control paradigm. The report display is a visualization-as-a-service. The report type and the chart type can be chosen freely, this component takes over the visual representation. The report configurator provides analytical functions and adaptively. By this component, the user can apply OLAP functions, analyze indicators or define new KPIs. By this, the report configurator is a model-as-a-service. The flow control and monitoring is taken by the client business logic.

(2) System Layer: The system layer (see Fig. 12) manages the access control and the hardware capabilities, guarantees a high availability and low response times by load balancing and performance-based resource management.

Hereby an important role is taken by the load and resource manager, the component on the right side in Fig. 11. The load balancer receives the incoming requests and forwards them depending on a) their types and b) the utilization of the corresponding target components. The resource monitor overserves the respective hardware capabilities (server, virtual machines). The resource manager gets this monitoring and utilization data and provides accurate hardware capacity by starting up or shutting down components.

As a part of its forwarding task, the load balancer acts like a dispatcher and checks what kind of request it is: analytic requests will be forwarded to an analytical engine; admission requests to the multi-tenancy and user manager and logging and accounting requests to the logging and accounting component.

The analytical engine acts within the backend as a provider of analytical capacity. The engine encapsulates the calculation power. Depending on the workload, it can be instantiated as often as needed. The analytical engine allows MOLAP, HOLAP, ROLAP, offers all OLAP functions (e.g., slice, dice, drill down) as well as data mining and forecast methods.

Within the multi-tenancy and user management and its sub components the safeguarding is done. Here is checked, if the user is who he claimed to be and if the authorized user is allowed to run the specific function and to access the requested data.

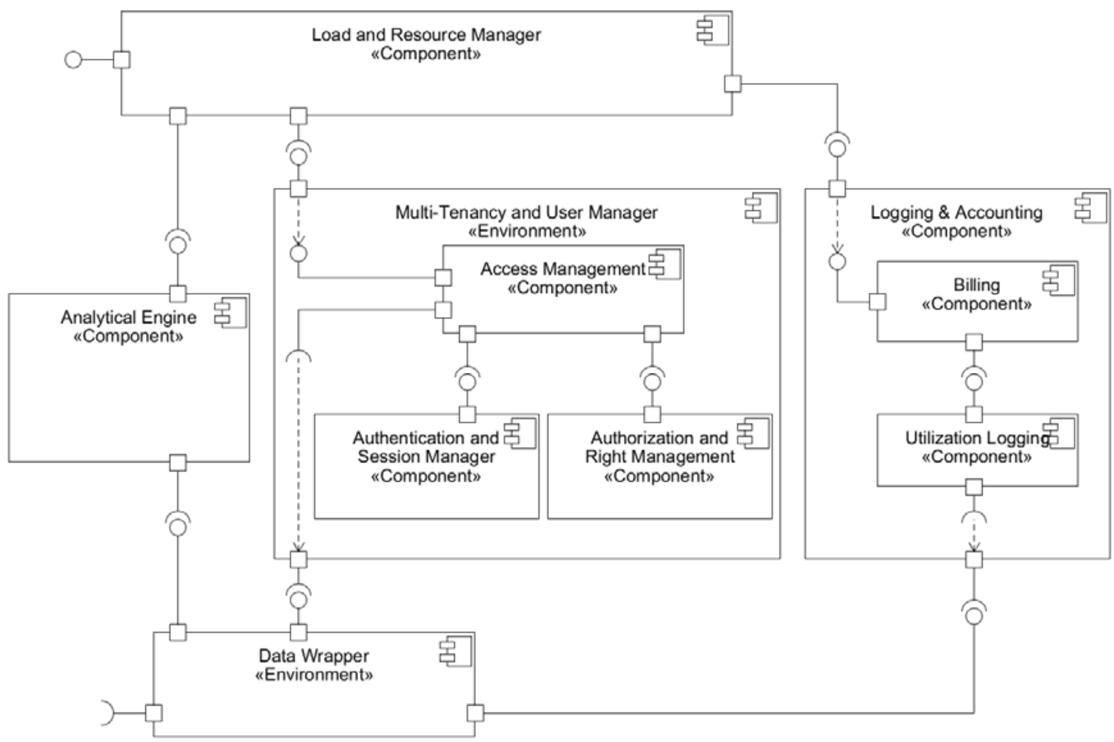

Fig. 12 Architecture part 2: Analytical engine, user management, logging and accounting.

The logging and accounting component enables the pay-per-use payment model. The utilization logging component records the whole access data (who has when how long and how accessed which data?) and hands over this data to the billing component. Here the usage-based pricing is based. Several models (e.g., pay per usage time, pay per calculation time, pay per report view or pay per MB storage) are possible and can be combined.

(3) Data Wrapper: The data wrapper is responsible for all data access requests and for the management of all data sources and data storages. It works with an abstraction layer over all different data sources and locations. The data wrapper enables a distributed data warehouse by providing a unique interface to all affiliated cloud storage services through the abstraction layer. It so encapsulates the different characteristics of the storage services and provides a simple way of access. This concerns both the data warehouse environment as well as the source data within the ETL process.

Fig. 13 shows the architectural design of the data wrapper and other related components.

The storage manager takes care of the different storage services and provides access to them. Internal (e.g., enterprise data center) or external data storage services can be used as a data warehouse. The data manger gets the access data from the storage manager and optimizes the specific data query together with the query optimizer. For example in terms of languages or execution plan. To increase data security, the recovery and replication component enables different scenarios of a Cloud-RAID and the Monitor controls all activities. The data wrapper as whole environment represents the abstraction layer and provides a rule-based data sharing, storing and sourcing at different

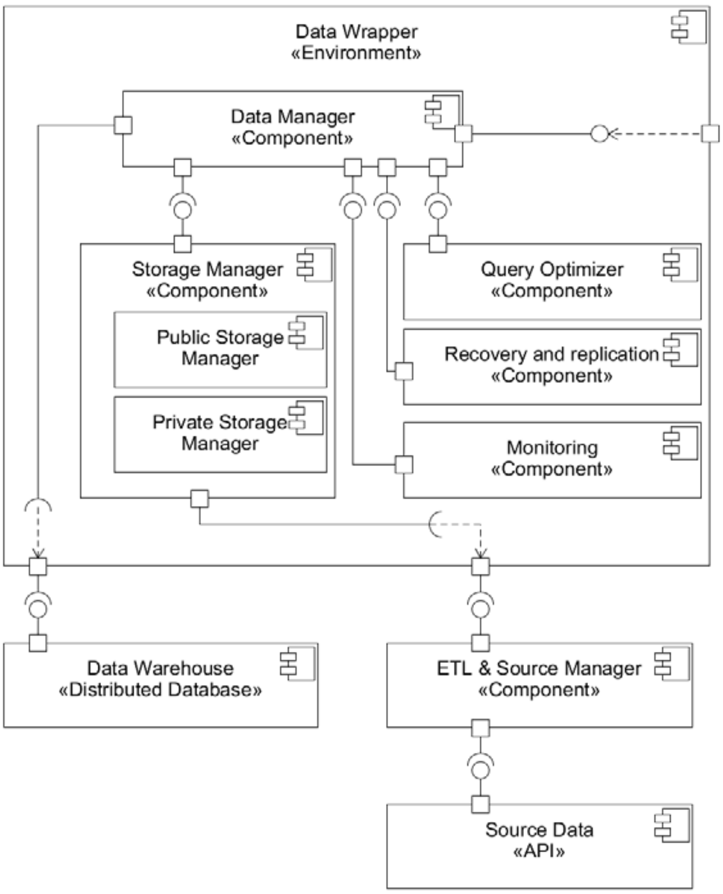

Fig. 13 Architecture part 3: data wrapper.

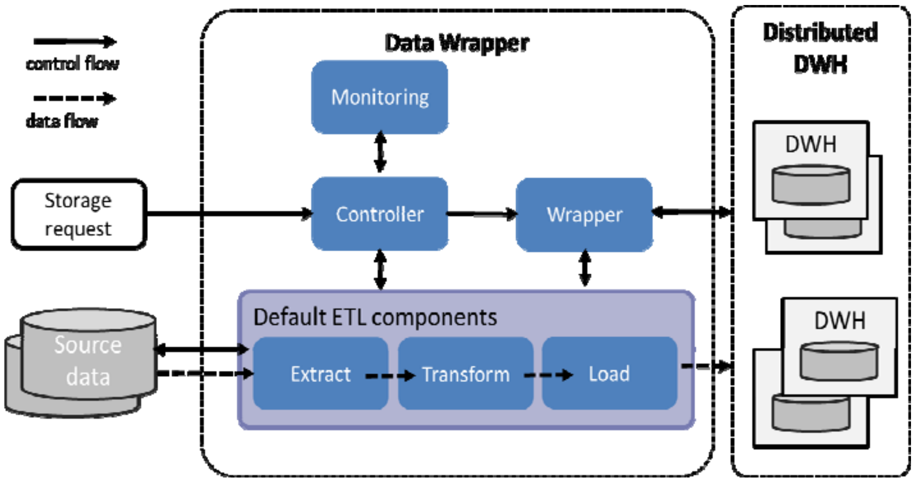

Fig. 14 ETL architecture.

storages. This is done on the base of three pillars: security, costs and performance.

If a data set from a data source is to be loaded into the data warehouse system by using an ETL process, the data wrapper selects the best suitable storage service based on the characteristics of the data set (e.g. security requirements) and the configuration (e.g. payment limitations) with the help of rules or reasoning (depends on configuration). Fig. 14 shows schematically the architecture of the ETL process. Depending on the data characteristic, like kind of data (structured, semi-structured, non structured) and amount of data, the sensibility, the security and availability requirements the data wrapper selects the adequate storage service by comparison with the characteristic of the service, like costs, security parameters, response time, location, reputation.

With the rule-based automatic distribution of ETL-storage-request to various cloud storage services an optimization of the costs, performance and security parameters is reached by the abstraction layer by which any data storages can be integrated. As a result, data warehouses can be set up quickly and flexibly in favor for specific needs and requirements.

It can be stated, that scalability and flexibility are the most important requirements regarding the architecture. Consequently, these requirements are the high-prioritized attributes of the architecture. These properties are achieved by the following facts [6]:

(1) Modular design of the components,

(2) Distribution of incoming request based on the utilization pf physical and virtual components,

(3) Flexible starting and terminating of components and virtual machines, based on the utilization,

(4) Lean and demands exact complexity: sleek architecture by small agile requirements, powerful architecture for complex requirements,

(5) Location of the parts of the control logic in the local client,

(6) Usage of various types of storage systems (distributed data warehouse concept).

6. Prototype

On the base of this architecture specification, a prototype has been implemented [48]. Thus, the possibility of using this architecture specification as a reference implementation has been shown. In addition, the specification has been used as communication framework during the whole project. Furthermore, the prototype was applied in a case study in which a scenario-based architecture evaluation was performed.

The prototype was developed by using state-of-the-art technologies, which was possible through the cooperation with the German HPI (Hasso-Plattner-Institute) [49]. For the local client we used the SAP UI 5 as frontend development tools. The virtual machines were running on the base of a HP Converged Cloud. In addition, OpenStack has been used

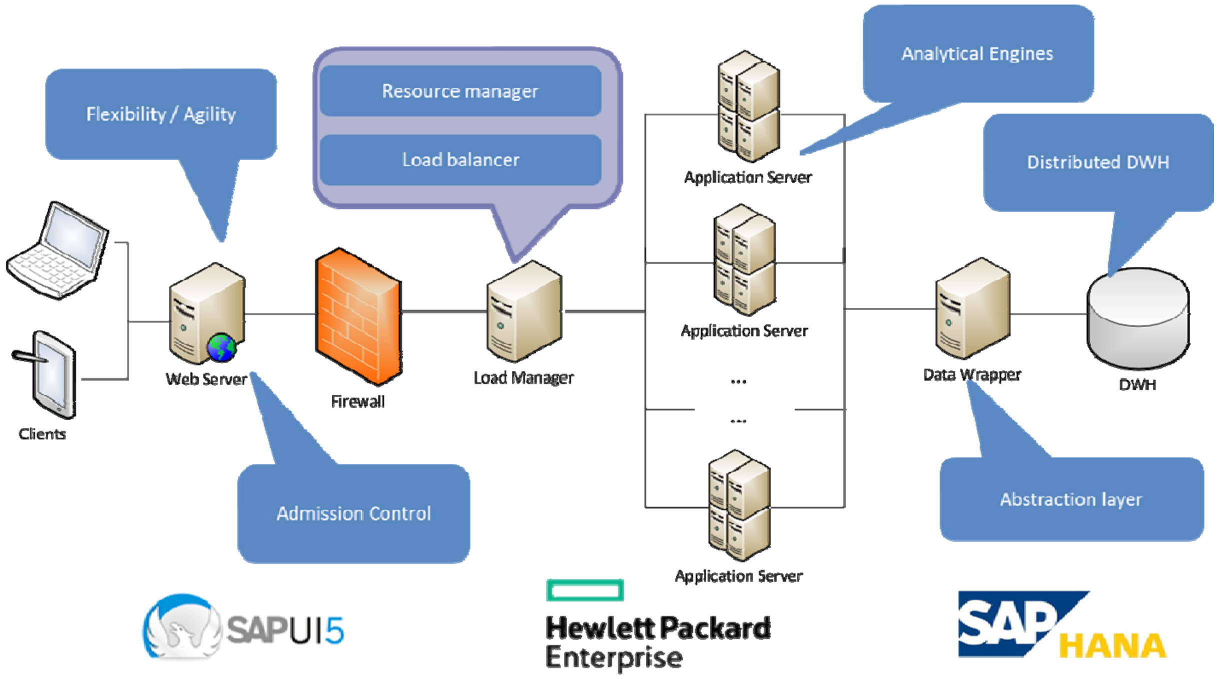

Fig. 15 Prototype of a cloud BI system.

to solve the scalability challenges. As a database an SAP HANA Cloud Platform was used. The architectural design of the prototype is shown in Fig. 15.

The prototype was used in a case study by applying a scenario-based architecture evaluation. The case study came from the German energy sector and consisted of several different scenarios. One of them was the contribution margin control for a major customer of a big energy supplier. From different viewpoints and on different level the architecture evaluation was performed.

By using checklists and quality metrics, we demonstrated that the architecture specification instantiated in the form of the prototype meets the functional and quality requirements by corresponding components of the architecture. This shows that the architecture specification serves as a reference implementation and description framework, as well as communication tool. Especially by inclusion of the taxonomy a holistic view on BI Cloud system is possible, and this both in the description, analysis, implementation and requirements analysis.

7. Discussion

To obtain an established status of a reference architecture, the integrated reference architecture has to be accepted beyond and across subjective and project-specific concerns. In consideration of several channels, the dissemination of the RABIC is targeted.

On the one hand, the development of RABIC is in continuation of the project FBC (future business clouds). FBC was realized by the University of Oldenburg, OFFIS (associated institute of the University Oldenburg) and acatech (German nation Academy of science and engineering) and founded by the German federal ministry for economic affairs and energy. In this project, preliminary and basic work was realized and noted the continued need for work on BI cloud [50, 51]. The University of Oldenburg and OFFIS are drivers of RABIC.

On the other hand, industry working groups, associations and industrial facilities are addressed as a multiplier. For example, within the BITKOM (Germany's digital association) the working groups Cloud Computing and Outsourcing as well as Big Data are used as multiplier and entrance to the industry.

In addition, other international publications are planned to increase awareness and to engage in dialogue with experts internationally. Examples are the publication at Economie of Grids, Clouds, Systems and Services (9th International Conference, GECON 2015) [6] or Semantic Web Business and Innovation (International Conference, 2015) [9]. In addition, this article also serves for dissemination.

8. Conclusions

To help overcoming the prevalent skepticism of enterprise regarding BI in the Cloud, to promote the standardization and to increase the transparency, we developed an integrated reference architecture. This integrated reference architecture can be used a) to implement new BI cloud systems, to describe and evaluate existing BI cloud systems as well as b) to describe, to check and to compare BI cloud services.

Therefore the reference architecture consists of two layers: a) the system layer and b) the service layer. These items of the reference architecture, the application and evaluation were explained and discussed in this contribution, according to the limited number of pages.

In overall, with RABIC an integrated reference architecture now exists which can be used as a description and comparison model, as an implementation template as well as an evaluation tool. As a part of the dissemination, RABIC needs further international distribution.

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