

Business Processes as a Service (BPaaS): A Model-Based Approach to align Business with Cloud offerings

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Abstract: Cloud computing proved to offer flexible IT solutions. Although large enterprises may benefit from this technology by educating their IT departments, SMEs are dramatically falling behind in cloud usage and hence lose the ability to efficiently adapt their IT to their business needs. This paper introduces the project idea of the H2020 project CloudSocket, by elaborating the idea of Business Processes as a Service (BPaaS), where concept models and semantics are applied to align business processes with Cloud deployed workflows. The hybrid usage of conceptual and semantic models introduce smart knowledge processing mechanisms to bridge the semantic gap from business requests to deployable workflow bundle. Ideas, Concept and technical issues are highlighted and first prototypes introduced for download.

1. Introduction

Cloud computing proved to offer flexible IT solutions. Although big enterprises may benefit from this technology by educating their IT departments, SMEs are dramatically falling behind in cloud usage and hence lose the ability to efficiently adapt their IT to their business needs [1]. The reason for this is that they are concentrating on their core business and rarely have the possibility to deal with the complexity of business and IT alignment. This situation may evolve to a disadvantage in global competition.

This position paper introduces the new H2020 cloud project CloudSocket [2] that primarily targets SMEs that are currently excluded from using the cloud due a lack of competence and high entry barriers. These barriers come in the form of gap between pragmatic, legally influenced and well-defined business processes and a gigantic cloud market with numerous offerings that rarely consider the business episodes of an entrepreneur but focus on technical details.

Startups and SMEs typically focus on their core business. Hence, there are several business processes such as customer relationship and campaigning, administrative issues on registration, IT services as well as after sales support that are necessary for the business success, but can only be insufficiently supported by IT by those organizations.

Business Processes as a Service (BPaaS) enables brokers that may act as a public or private organisation to offer cloud-based execution of those business processes to support start-ups, founders and SMEs.

The use case Business Incubator focuses on supporting the “Coaching and Finance” effort for more than 300 Start-ups with designing, analyzing and simulating individual business plans, business processes, and also concerns a high degree of adaptability of Cloud Services for Start-ups, e.g. Customer Relationship Management, Order Management, Human Resources Management – both with respect to costs and functionality.

The Cluster Business Process Broker use case identifies typical business episodes. Within the ICT / Robotics cluster, there are more than 700 enterprises that deal with different application domains as eHealth, Manufacturing, Photonics, Government, Security, e-Commerce, Retail, etc. but share a common set of business processes.

CloudSocket targets brokers like the business incubator – operated by BWCON – and the Cluster Business Process Broker – operated by MATHEMA – by providing tools, framework and knowledge to setup smart business and cloud alignment in form of a service; the so-called Business Process as a Service.[3]

This paper introduces the concept of Business Process as a Service for enabling business and IT alignment using cloud offerings. Hence the objective of this position paper is:

1. Introducing Business Process as a Services (BPaaS) concept that uses business process management, case management and semantic technology to enable smart alignment algorithms for mapping business requirements with cloud offerings.
2. Discuss the meta modelling stack and the corresponding meta models and standards that have been used to realise a smart business process and IT-Cloud alignment model.
3. Introduce CloudSocket architecture that explains the major four building blocks, the functional capabilities, the conceptual requirements and stakeholder responsibilities to realise Business Processes as a Service.
4. Hence this paper introduces the idea of BPaaS, provides first insights into the modelling languages and the initial architecture for a semantic-driven business and IT alignment using cloud offerings.

1. Objectives

1.1 Terms and Related Work

Current marketplaces offer such processes in the cloud, but focus entirely on the combination of applications. Hence in our point of view, these are not business processes but these are workflows.

Therefore we define the following four layers [4]:

- Layer I - Business Processes: Domain specific business processes that describe the business activities of a worker, which are – in the way they are presented – not executable, neither by a workflow engine within or outside the cloud.
- Layer II - Workflows: Executable business processes are represented by workflows that orchestrate the interaction between software applications.
- Layer III - Cloud deployable BPaaS Bundles: Workflows that are packaged for cloud deployment consisting of all relevant deployment configurations – such as meta data, workflow, service description, service deployment description, SLA, semantic annotation of the bundle – so that it can be partly deployed on demand.
- Layer IV - BPaaS in production: BPaaS that is offered in the marketplace with a price and corresponding SLA similar to a SaaS that can be immediately run by the user. A model-based smart Wizard uses semantic inference to identify the most appropriate BPaaS in production for the marketplace user. It is important that this workflow is not a running instance, but a service that is offered. The concrete handling of instances in a multi-cloud environment is a typical cloud challenge, which is not the scope of this paper but described in D4.1 of CloudSocket [2].

1.2 Concept Models for Information Processing

A well-known approach in knowledge externalization is the use of conceptual modelling. Meta modelling [5] is introduced as a realisation approach to develop domain-specific modelling tools and hence enable IT-supported concept modelling. Based on Strahinger [6], Karagiannis and Kühn [7] a layered approach for conceptual modelling is used.

Meta models can be specified with a meta modelling language that is derived from an meta meta model. In the following the most prominent meta meta models based on Kern [8] are mentioned: (a) Ecore from the Eclipse platform [9], (b) GOPRR from MetaEdit+ Platform [10] and (c) MS DSL Tools and MS Visio [11]. Additionally the following meta meta models are introduced: (d) MOF [12], which is realised on different UML Profile platforms (e) ADOxx based on the equally named platform ADOxx [13], (f) Obeo Designer on Eclipse [14] and (g) Generic Model Environment GME [15].

This project uses the open development community ADOxx.org [16], which is a world-wide acting meta modelling community with more than 600 software developers and more than 1.800 interested stackholder.

The Enterprise modelling frameworks from Zachmann [17] is used as the basic skeleton for business and IT alignment as it identifies not only the different layers from business down to IT but also different aspects from process to human worker. In the plugIT project [18] the Business and IT alignment modelling language WIKI [24] has been developed based on extended aspects of the Zachmann framework in the form of data, knowledge, processes, people, organisation, application, products and motivation. Strategy, business, system and technology are the perspectives that span a matrix of modelling languages, each with a list of different modelling languages.

Modelling for Cloud-based applications is a rather new research topic. Preliminary ideas are proposed in REMICS [19], as well in MODACloud [20] and PaaSage [21].

BPMN is a semi-formal language, where formal semantics can be introduced via semantic lifting and operational semantics can be introduced via inheriting directed graph semantic. Furthermore the language is intuitive for a human user. The executable part of BPMN [22] is used to define the deployable and executable workflows, hence the same notation is used to define different aspects of a business process.

The requirement is hence to (a) realise a hybrid modelling tool that can model both aspects – the domain specific business process as well as the cloud specific technical workflow and (b) enable semantic lifting of business processes and workflows to enable smart business and IT alignment and finally.

1.3 Model Based Methodology for Business Process and IT-Cloud Alignment

1.3.1 The Domain Knowledge Externalization:

A business user and a Cloud solution provider represent the features of the cloud services in a way that is both adequate for humans to interact with and that allows for machine assistance for the identification of appropriate services

We use a model-based approach for knowledge externalization. Models are a means for communication between people, in our case the users and providers of cloud services. Moreover, if models have a clear semantics and are represented in a formal language, they provide the basis for, automated analysis, adaptation and evaluation. This is a step towards the vision of The Open Models Initiative, namely: “Models are knowledge that can be operationalized”.

We use and enhance standard modeling languages for enterprise architecture, whereas each business process – reflecting the selected SLAs – is listed with a certain price. The user can select the business process and create the process into the workspace.

1.3.2 The BPaaS Design

Smart Business-IT alignment maps the business process to cloud services which serve as building blocks to realize the business process as a service. Typically, several components cover the processes, but in some cases there might be a single service that maps the whole process. In our scenario the user specifies the requested services by modelling three dimensions:

Business Episode: Each business process represents a concrete business episode that characterizes the tasks that have to be performed. It covers the whole spectrum from structured routine processes to dynamic case management. The description is mapped to the workflow.

Business Compliance: Legal issues such as dealing with personal data or country-specific aspects about data storage are considered in this dimension. In addition properties as confidentiality, privacy or integrity are also parameters such as accepted failure rate or cycle times. This dimension defines SLAs.

Quality/Costs: The usage of Cloud must be aligned with the strategy and the goals in the organization like cost savings or increased speed of innovation. However, the “right” services with the “right” pricing model need to be found. This dimension considers the findings of Service monitoring.

The challenge is to map business language to technical solutions. Hybrid modelling, semantic lifting, rule-based inferences and collaborative modelling are used to support smart business and IT alignment and to map a selected business episode – described in more detail as a business process – with a workflow in the Cloud.

1.3.3 The BPaaS Allocation

Each workflow in the Cloud can be seen as a service. Hence, the approach of CloudSocket is to create workflows as deployable services. As the aforementioned BPaaS design environment already provides concept models, a model-driven approach for the creation of workflows as a service is used. Thus, the concept of the PaaSage deployment files is used as a starting point to act as a configuration file to be deployed in the Cloud for a SaaS and extended it with workflow functionalities to enable the deployment of a Cloud orchestrator, combining different Cloud services or Cloud application components.

Hence, workflows orchestrate different services, systems or components from market like docker [23], Cloudify [24] or one of the Amazon components [25], or “develop” a specific cloud application for the user in order to fulfil the functional and non-functional requirements of the workflow specification.

1.3.4 The BPaaS Execution

Cloud orchestration by introducing a higher abstraction layer between Cloud services is introduced and deployed in the form of BPaaS. Knowledge-based execution is introduced by adding deployment rules to allow adaptation of the workflow like (a) substituting SaaS components, (b) obtaining additional cloud resources, (c) exploiting different cloud resources-services (migration), (d) SaaS re-composition or data flow modification.

Based on the results of the SeaClouds project a messaging platform is provided in the Cloud to enable (i) synchronous operation of component elements, (ii) multiple data formats, (iii) context awareness applications, (iv) non-standard application interface protocols.

As this paper focuses on the modelling part, the execution environment is here only mentioned for completeness reasons. In case more details are required, this paper refers to the architecture description.

1.3.5 The BPaaS Evaluation

SME's and in particular startups have to be agile and react flexibly on changing market requirements and business development. This means that also the realization of their business processes is also subject to changes.

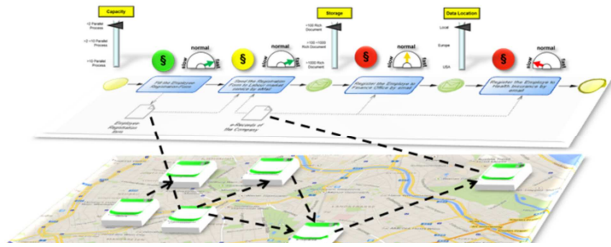


Figure 1 Sample of Conceptual Analytics of BPaaS

The last phase collects all information from the BPaaS deployment in a multi-cloud environment and abstracts it with conceptual analytics technology to the business level enabling all stakeholders - business client, BPaaS Broker, I/P/SaaS and component provider - to collaboratively optimize their billing models. Conceptual analytics is

introduced as a combination of process mining and conceptual modeling with particular focus on graphical representation and so-called “assimilations” of process mining results.

The idea is to semantically lift process log data and integrate them into concept models like business processes and hence enable a graphical representation of the Monitoring results. Figure 1 introduces a sample, where the used data storage locations are assimilated with a geographical map, so business client can easily follow where the data had been stored during the execution of the business process. Furthermore the business process on top is enriched with monitoring symbols, such as a green, yellow and red indication with respect to legal compliance, a tachometer indicating to what extent the SLA has been fulfilled or additional bars representing key performance indicators of the business process.

2. Research Methodology

The overall idea of the project CloudSocket can be formulated as “The Smart Cloud Business Process Broker”, comprising of discovery, orchestration, deployment and execution of services in the cloud.

During these phases the level of integration is lifted from the technical to the business level. CloudSocket applies a model-based approach to affect this lifting and integration. A detailed analysis of the business requirements based on the phases - plan, model, manage and measure - is common in business and IT-alignment. On business level we have models such as business processes, rules or cases, which need alignment with models on IT level such as workflows, SLA and architectures.

First a common understanding is established by a terminology WIKI, referencing to existing approaches, literature and common agreements. This is published as a terminology. Then, end end user specific workshops and business process modelling sessions enable a first insights into real SME demands for cloud offering.

Following the “conceptualisation of modelling methods” approach from OMiLAB [26], a modelling method is developed that enables to bridge from business process requirements to cloud offerings.

Technically the ADOxx.org meta modelling platform has been used for the implementation. Free proof of concept research prototypes are developed within the development spaces of the ADOxx.org portal to enable an interactive and iterative prototype development of the aforementioned design environment.

When stable research prototypes have been achieved, there will be a technology shift to the commercial version of the meta model platform.

3. Technology Description

The model based approach is realised using the meta model form ADOxx.org. Hence, this section introduces first the meta model stack to introduce relevant modelling layers that enable the business and IT-cloud alignment.

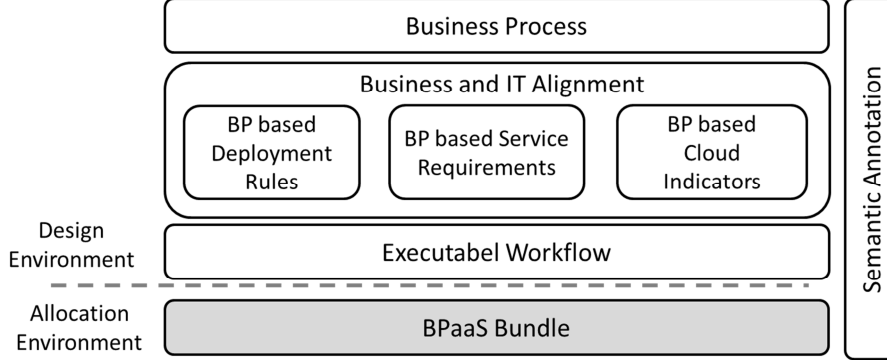


Figure 2 The CloudSocket Modelling Stack

Figure 2 introduces the CloudSocket modelling stack that in principles follows the distinction between domain-oriented business process and IT-oriented workflows. In order to fill the gap from business processes to workflows, a so-called business and IT alignment layer has been introduced, consisting of (a) business process based deployment rules, (b) business process based Service requirement descriptions, as well as (c) business process based cloud indicators. A semantic notation enables the semantic lifting of all three layers, the business process layer, the workflow layer and the BPaaS Bundle layer.

For completeness reasons it is mentioned that the BPaaS Bundle is expected to be designed in an external allocation environment, whereas the business and workflow models are expected to be designed in the design environment.

This paper introduces the weaving between BPMN for business process and the executeable workflow models, DMN [27] for deployment rules, self-defined BP described service requirements (BPDS), self-defined business process indicators and RDFS for the semantic annotation.

We focus on the integration of (a) deployment rules, (b) service description and (c) cloud indicator with the business process.

3.1 The Hybrid BPMN Meta Model Overview

A meta-model is a tuple $\mathbf{MM} = \langle \mathbf{MT}, \leq, \text{domain}, \text{range}, \text{card} \rangle$ where

\mathbf{MT} is the set of the defined model types, i.e. for $i=1, \dots, m$ we have

$$\mathbf{MT} = \{MT_1, MT_2, \dots, MT_m\}.$$

The MT_i 's ($i=1, \dots, m$) are itself a tuple $MT_i = \langle O_i^T, D_i^T, A_i \rangle$, where

O_i^T is the set of object types or classes, D_i^T is the set of data types, and A_i is the set of the attributes.

In CloudSocket we have additionally to the business process model types (a) MT_1 Business Process Model Notation (BPMN), (b) See BPMN Specification, (c) MT_2 Company Map, (d) MT_3 Document Model and (e) MT_4 Working Environment Model

the following 4 model types: (f) MT_5 Decision Model Notation (DMN), (g) MT_6 Business, (h) Process Described Services (BPDS), (i) MT_7 Key Performance Indicators (Cockpit), (j) MT_8 Business Process Indicators (BPI)

Therefore $\mathbf{MT} = \{\text{BPMN}, \text{Company Map}, \text{Document Model}, \text{Working Environment Model}, \text{DMN}, \text{BPDS}, \text{Cockpit}, \text{BPI}\}$.

\leq defines an ordering on O^T . I.e.,

Let $o_1^t, o_2^t \in O^T$ we say o_1^t is **subclass** of o_2^t , if $o_1^t \leq o_2^t$

The **domain** is a function with domain: $A \rightarrow P(O^T)$
The **range** is a function that maps an attribute to the power set of all pairs of classes and model types, all data types, and all model types.
range: $A \rightarrow P(\bigcup_j (O_j^T \times \{MT_j\}) \cup D^T \cup MT)$

The card function

$$\text{card} : O^T \times A \rightarrow P(\mathbb{N}_0^+ \times (\mathbb{N}_0^+ \cup \{\infty\}))$$

For details on the modelling language, please refer to the CloudSocket development space on ADOxx.org [28].

3.2 BPMN and DMN Weaving

Weaving is a modelling technique where different model types are connected. Additionally to the already defined **MM** of BPMN in [FDMM] [26] and BPMN Specification [22], we have to add some extensions of some Relations to the

$$\mathbf{MM}_{BP_{spec}} = \{\mathbf{MT}_{BP_{spec}}, \mathbf{O}_{BP_{spec}}^T, \ll, \text{domain}, \text{card}\},$$

$$\mathbf{O}_{BP}^T = \mathbf{O}_{BP_{spec}}^T$$

$$\mathbf{A}_{BP} = \{\mathbf{A}_{BP_{spec}}, \text{Referenced Decisions-from}, \text{Referenced Decisions-to}, \text{Referenced Service Description-from}, \text{Referenced Service Description-to}\}$$

3.3 Business Process Described Services (BPDS) Definition

This model type should improve the communication between the Business Process designer and a workflow engineer. The Class ‘Service Description’ contains several attributes which should describe the business process services from the (a) technical, (b) domain, and (c) business point of view. Those attributes are in text format to enable semi-formal text. The formal definition of this model type is as follows:

$$\begin{aligned} \mathbf{O}_{BPDS}^T &= \{\text{Service Description}\} \\ \mathbf{D}_{BPDS}^T &= \{\text{String}\} \\ \mathbf{TechnicalAttrs} &= \{\text{Description}, \text{Input}, \text{Output}, \text{Functional Details}\}, \\ \mathbf{DomainAttr} &= \\ &\{\text{Privacy}, \text{Data Compliance}, \text{Domain Country}, \text{Domain Description}\}, \text{ and} \\ \mathbf{BusinessAttrs} &= \{\text{Vendor Issues}, \text{Payment}, \text{Trust}, \text{Securities}\} \\ \text{Then } \mathbf{A}_{BPDS} &= \{\text{Name}, \mathbf{TechnicalAttrs}, \mathbf{DomainAttrs}, \mathbf{BusinessAttrs}\} \\ \mathbf{Attribute attachments:} \\ \forall attr \in \{\mathbf{A}_{BPDS}\}: \text{domain}(attr) &= \{\text{Service Description}\} \\ \forall attr \in \{\mathbf{A}_{BPDS}\}: \text{range}(attr) &= \{\text{String}\} \\ \text{card}(\text{Service Description}, \text{Name}) &= \langle 1, 1 \rangle \end{aligned}$$

3.4 Business Process Indicator Assimilation

Model assimilation is a technique where data sets are “assimilated” into conceptual model. In CloudSocket the assimilation is applied, when log data are mapped into business process models as indicated in Figure 1. The meta model is described as:

$$\begin{aligned} \mathbf{O}_{BPI}^T &= \mathbf{O}_{BP}^T \\ \mathbf{D}_{BPDS}^T &= \{\mathbf{D}_{BP}^T, \mathbf{Enum}_{SLAtype}, \mathbf{Enum}_{DataLocation}, \mathbf{Enum}_{Storage}, \mathbf{Enum}_{Capacity}, \mathbf{Enum}_{Legacy}\} \\ \mathbf{Enum}_{SLAtype} &= \{\text{gold}, \text{silver}, \text{bronze}\} \\ \mathbf{Enum}_{DataLocation} &= \{\text{Vienna}, \text{Austria}, \text{Europe}, \text{USA}, \dots\} \\ \mathbf{Enum}_{Storage} &= \{\text{storage } x, \text{ storage } y, \dots\} \\ \mathbf{Enum}_{Capacity} &= \{\text{capacity } x, \text{ capacity } y, \dots\} \end{aligned}$$

$$\text{Enum}_{Legacy} = \{Green, Yellow, Red\}$$

$$A_{BPI} = \{A_{BP}, Capacity\ KPI, Storage\ KPI, Data\ Location\ KPI, Legacy\ KPI, SLA\ type\ KPI\}$$

Attribute attachments:

$$\text{domain}(Capacity\ KPI) = \{Task\}, \text{range}(Capacity\ KPI) = \{\text{Enum}_{Capacity}\},$$

$$\text{card}(Capacity\ KPI) = \langle 1, 1 \rangle$$

The attribute attachments for Legacy KPI, Storage KPI, Data Location, SLA type can be defined as the Capacity KPI. Due to the complexity of the whole meta model and the page limitation, we introduced only selected parts of the modelling stack, where the weaving, assimilation and the use of the new service description is described.

4. Developments

CloudSocket comprises four phases, each phase supported by a corresponding building block: (a) the design environment to describe business processes, business requirements and workflows as elaborated in the previous section, (b) the allocation environment linking executable workflows with additional SLA information to a set of deployable bundles, (c) the execution environment that executes and monitors the workflow as well as (d) the evaluation environment that lifts key performance indicators back to the business level.

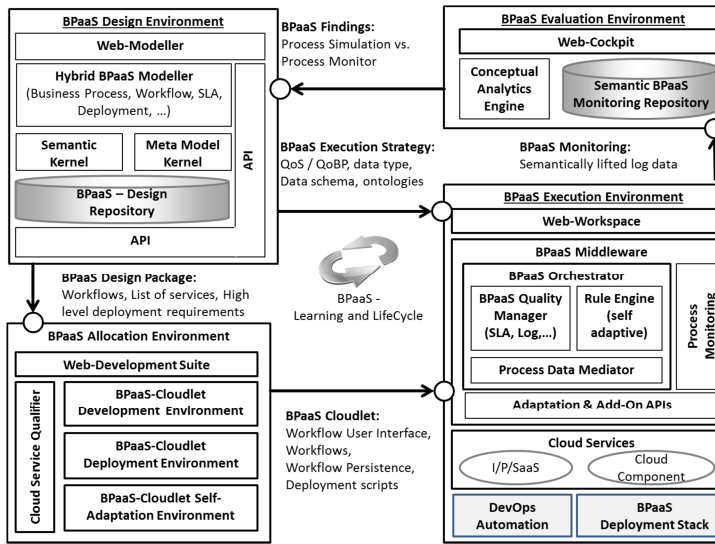


Figure 3 CloudSocket High Level Architecture

Figure 3 introduces the four major building blocks, whereas each of the four building blocks supports one phase of the BPMS paradigm when applied for business process management in the cloud. The BPMS is a well-established business process management system paradigm that can be applied also on business process management in the cloud. Based on the major building blocks – each supporting one phase of the BPMS methodology – the current status of the architecture is stated in D4.1. [2]

5. Results

The first prototype implements the BPMN and DMN coupling. The second prototype implements the BPMN for business processes and workflows as well as enriches those models with KPIs and so-called “BP described Service requirements”. The third prototype implements the visualisation of KPIs and their assimilation into the BPMN. All three prototypes can be downloaded from the CloudSocket development space from ADOxx.org. Semantic lifting of business processes enables a hybrid design environment that combines all aspects [28].

6. Business Benefits

Our primary targets are SMEs that are currently excluded from using the cloud due to a lack of competence and high entry barriers. These barriers come in the form of a gap between pragmatic, legally influenced and well-defined business processes and a gigantic cloud market with numerous offerings that rarely consider the business episodes of an

entrepreneur but focus on technical details. Startups and SMEs typically focus on their core business. Hence, there are several business processes such as customer relations and advertising, administrative issues on registration, IT services as well as after sales support that are necessary for business success, but can only be insufficiently supported by the IT resources of those organizations. A complete analysis of the use cases can be seen in [3].

7. Conclusions

Cloud offerings have a high potential to massively impact European economy, but the use of Cloud offerings, especially for the needs of SMEs needs improvement. Business Process and IT-Cloud Offering alignment using smart knowledge processing, has the potential to bring Cloud offerings closer to the business requirements and to the business user.

Initial implementations are promising that the use of hybrid knowledge processing – the machine interpretation of conceptual models as well as the human interpretation – enables a smart bridge from high level business processes to Cloud offering.

Those smart mechanisms are used to (1) guide the implementation of Cloud offerings – the BPaaS Bundles, (2) assist the user when selecting the appropriate Cloud offering from the marketplace using a Wizard as well as (3) align log data to intentions, requirements and Business Process indicators.

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