Enriching Cooking Workflows with Multimedia Data from a High Security Cloud Storage

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Abstract: With increasing growth of cloud services and the ability to choose from different cloud providers we designed a new way to connect workflows with a high security cloud storage. We use Activiti for workflow design and JavaScript Object Notation (JSON) for structured data interchange with a sealed cloud storage. Our approach provides a new way to support cooking workflows with instructions from multimedia data (e.g. videos, pictures). This contributes towards current trends in Information-System research such as scalability and new pricing approaches. Furthermore, it connects Cloud Computing with Business Process Management.

1 Introduction

In growing world-wide globalization information technology has become a key-resource for business success or failure. IT is often used to manage business processes in companies and has become increasingly important., leading to a rise in new ways to organize business processes (Aalst, Benatallah et al. 2003). Cloud Computing changes the way how we can develop and organize our resources and also enables a flexible and individual allocation of resources (Schulte, Janiesch et al. 2015; Ciovică, Cristescu et al. 2014).

Business processes are modelled as a collection of activities and dependencies between activities and are technically supported by workflows (Aalst, Benatallah et al. 2003). Regarding actual research topics realizing business processes in a flexible and coast-efficient way is on a rise (Schulte, Janiesch et al. 2015). There are some studies focusing on an execution of workflows in the cloud, and researchers who investigate infrastructure challenges of elastic Business Process Management or security (Wang, Korambath et al. 2014; Schulte, Janiesch et al. 2015).

To develop our research proposition we concentrate our work on the implementation of workflows in the cooking domain with a special focus on multimedia data integration and data objects representing ingredients. For workflow adaptation and design we used the approach of Valmi Dufour-Lussier who introduced a new way for automatic text acquisition on recipes (Dufour-Lussier, Le Ber et al. 2014).

When a person starts preparing food, he or she is confronted with a lot of different ingredients and steps, which sometimes also happen in parallel. These different tasks can be supported by workflows and different multimedia data. To improve the user

experience we investigate the possibilities of using multimedia data from a high security cloud storage and of integrating this data into workflows. The user advantage is, that she no longer needs to store big multimedia files on her device and execute workflows in a web interface. Using a sealed cloud provider protects the data from unauthorized use and also enables to implement a pay-per-use strategy to charge the customer. With this new solution we address the open challenge of the Computer Cooking Contest.

The remainder of our Paper is structured as follows. At first we will provide an overview of our architecture and a sample workflow to ease comprehensibleness. Next we will present our implementation concept and workflows from the cooking domain which are based on cooking recipes of pasta. We conclude with a discussion of our research contributions and the new prospects for both companies and researchers.

2 Fundamentals

Sealed Cloud

A broad range of providers offer different models for services at different layers. But most of them don't guarantee security for the clients of a cloud provider or the privacy of the data (Santos, Gummadi et al. 2009). Especially in Germany, data protection and compliance requirements calls for new business models such as cloud technology (Rieken 2015). A sealed cloud offers the quality to encrypt contents and meta data so that the cloud provider itself has no semantic access. The monitoring of user behavior and the possible access of privacy contents by provider is a big issue as part of data privacy and anonymity at the internet. We implement a new architecture to integrate multimedia data from the cloud using Activiti as a workflow engine and the sealed cloud IDGARD.

Copyrighted Content

From user perspective the access of files over the internet by using i.e. mobile devices can be risky, because some information can be spied by unauthorized persons. If some potential attackers retrieve user information when data is send over the wire, they can gain full-access to the data storage. To prevent these attacks the usage of security tokens or passcodes (received via SMS) is necessary. IDGARD provides some of these additional security mechanisms.

From application, data or content provider perspective it is also difficult to secure data from unauthorized access and illegal sharing of copyrighted content. Providers want to ensure that only one user or a specific user-group can access data with the registered devices. By sending the unique keys to the registered devices, content provider can prevent the sharing of data (e.g. by using a sealed cloud). There are similar examples besides the cooking domain where images or videos are already protected, for instance mycoachnutrition.com (MyCoachNutrition 2015). In this way these services offer user individual content.

Definition Workflow

Work is often organized as a sequence of individual tasks in which the progress can be observed (Hammer and Champy 1994). These individual tasks are linked together and they underlie a business objective or a policy goal (Coalition 1998). The automation of these business processes is called workflow. According to the definition of the Workflow Management Coalition a workflow is: "The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules." (Coalition 1998). In the remainder of this paper we will use the term "workflow" as synonym for "business process". For our project we modelled different cooking instructions using Activiti as workflow engine. A simple workflow consists of a start event, a task with a data object and an end event (see figure 1). A task or an activity describes a piece of work that forms a logical step in a process. To support the process execution the workflow activity requires human and/or machine resources for process execution (Coalition 1998). We use different tasks and data-objects to describe a cooking control flow.

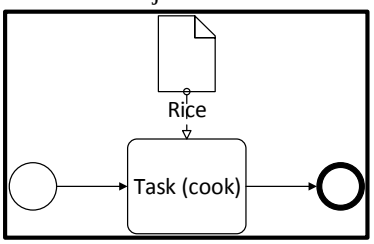

Figure 1: Sample workflow

3 Architecture

General overview

As one can derive from figure 2, the introduced architecture consists of three layers:

From the perspective of the user, the first layer or subcomponent is based on the so called Ninja Web-Framework, which is required in order to handle the graphical interaction with the user by initiating a workflow instance.

Below the Web-Framework, the Business Process Management (BPM) platform Activiti initially receives the user commands and controls the processing of the corresponding instance. In doing so, this engine requests relevant information from the data source (IDGARD) and hands them over to the user.

IDGARD, as the third or bottom layer of the architecture, is not just any external database but a sealed cloud solution. Therefore it not just primitively holds the data, but moreover specifies API functions that affirm secure retrievals.

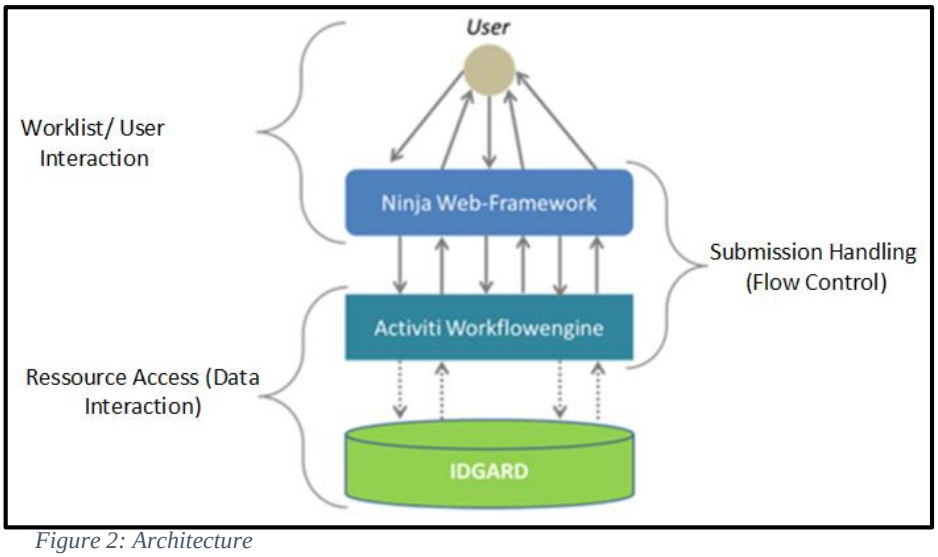

Figure 2: Architecture

Reasons for Usage of a 3-Layer-Architecure and its Components

When the goal is to develop and execute (cooking) workflows, it is required to use Business Process Management and a solution to save the corresponding multimedia data. As a result, it is predetermined to stage a 2-Layer-Architecure at minimum. Since it is typically demanded that users have not just locally access to the workflows, a browser-based solution is reasonable. This kind of functionality is not offered by the already mentioned layers and therefore asks for an additional one.

Starting from the bottom layer, there is the complex question of how to save an application's data or where to put it. As Cloud Computing nowadays has already overcome just being a trend, it is appropriate and scientifically valuable to embed this idea in various contexts.

IDGARD´s sealed cloud is specifically designed to enhance security. Because protecting own content like graphically supported cooking steps or even whole recipes can be important, such a cloud service might be beneficial. This especially applies to companies that want to distribute such services via Internet and protect themselves against copyright infringements.

Concerning the choice of a workflow engine, there is a huge range of open source technologies available. In terms of basic functionality (e.g. integration in an IDE or graphically establishing workflows) they usually show similarities. To address our requirements properly we decided to use two different GUI's for our project. Activiti as the modelling GUI and the Ninja Web-Framework for the user worklist. However, Activiti convinces with a distinct manual, a large community and a clear, browser based testing environment.

To provide the worklist, the Ninja Web-Framework is useful because as an integrated software stack it already comprises many important libraries. That means one do not have to set up much by yourself in your IDE to start working.

4 Implementation Concept

As above section describes, the main technic of the project can be divided into three levels (see figure 2). In the following, every individual level will be interpreted in detail:

The quite closer IDGARD cloud layer is a java project that represents interactive communications between the cloud server and the workflow data stream. IDGARD cloud server utilizes one common type named JSON, which is a language-independent data interchange format and a subset of JavaScript (Crockford 2006). JSON has two basic structures: object and arrays. An object can represent a collection of pairs, which consist of one-to-one name and value. An array is identical as in other types, i.e. is an ordered list of values (Crockford 2006).

Our java program provides the most basic functions to external applications through API communication: managing files (e.g. delete, upload, download, or sort them), creating own boxes and folders in cloud, request contents, details of boxes and folders.

An abstract class defines the fundamental mode of functions, i.e. basic java member and abstract methods that deal with the communicating information between java and JSON, and the log file for further checks and troubleshooting. Still each function has its own unique request and another response representation including corresponding JSON format. We take the "retrieving box information" function as example to present a closer interpretation. For request the JSON is as `{clientToken: String client token, serverToken: String server token}` and response JSON is formatted as an array of object: `{boxes: array of boxes}`. Our request class utilizes java strings as input and converts them into JSON that is available in the cloud server. The response works the other way round. It converts the information in JSON returned from server into java object. In order to successfully connect request- and response-class, some middleware classes are required. For cloud access we have to send

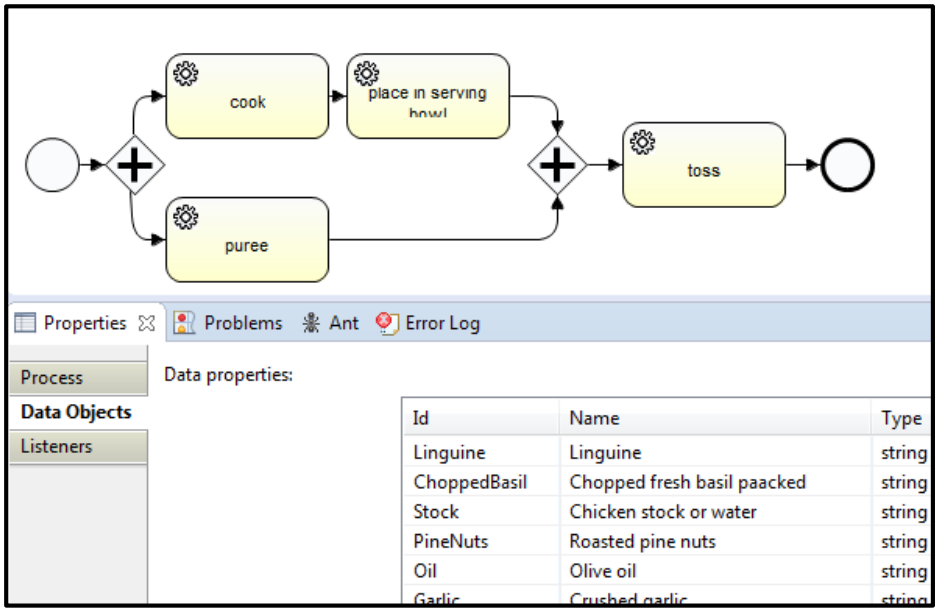

Figure 3: Activiti Process Model and modelling GUI

login-data and a random clientToken in JSON-format. Afterwards we receive a unique serverToken that we use with the clientToken together for identification during each data transaction. Factory method pattern is utilized for central invoking of individual requests and its corresponding response classes. In the meanwhile cookie and threats are also be recorded in the middleware. Especially for some request functions cookie-data is additionally needed for authentication. The classes from the java project that realize the communication with the cloud server are directly implemented in the work-flows, which we use for cooking instructions.

Workflow engines for Business Process Management are abound. Examples for these are JBoss jBPM or Activiti. For our workflow development, we use Activiti as an open-source workflow engine. Activiti uses BPMN 2.0 as processing language and can be easily used in Java environments and therefore it is well suited for our Architecture (Alfresco 2015). We used seven already created pasta cooking workflows from the work of Mirjam Minor et al. and convert them into an Activiti-Workflow (see figure 3; Minor, Bergmann et al. 2010). Each cooking task is modelled by a service task. This kind of task enables us to invoke a Java class for API cloud access. We also deposit the ingredients as data objects directly in the activity workflow. Other content like pictures or movies for cooking instructions are stored in the cloud.

In this example we have four individual instructions for the user. First, cook and place in serving bowl as well as puree should be conducted in parallel. Parallelization can be modelled using XOR-, AND- (symbolized by the plus), or LOOP-blocks (Schumacher, Minor et al. 2013) When both branches are finished the last task is toss. In each task, users get instructions with support of multimedia data from the cloud. To execute our designed workflows we use Ninja Web-Framework which is the uppermost part of our 3-Layer Architecture and also closest to the user.

The Web-Framework (worklist) is a resource which performs the work presented by a workflow activitiy instance and therefore directly interacts with the user and supports

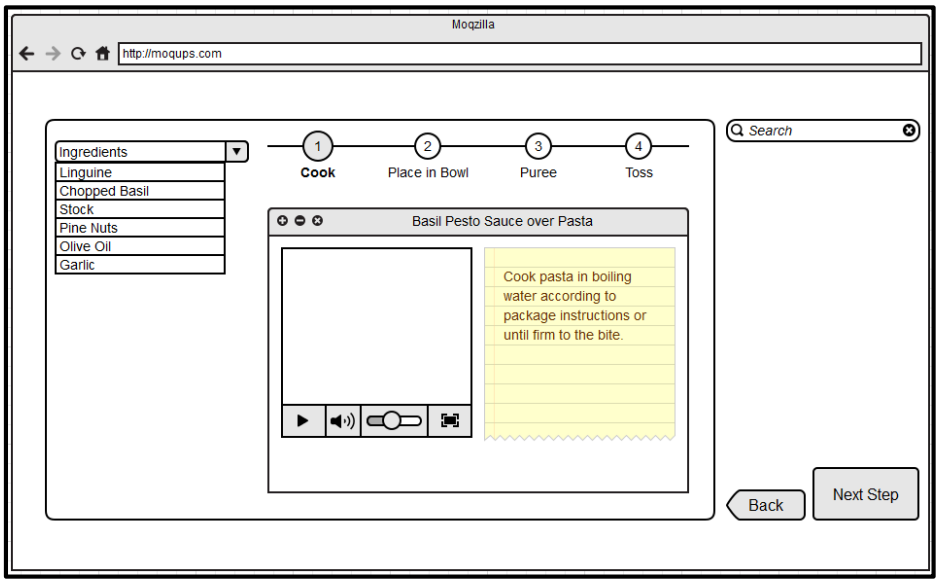

Figure 4: Mockup of the worklist

him by executing her tasks (Coalition 1998). After successfully login a user can choose to design her own recipe and upload new elements, or choose ingredients to process. In figure 4 we designed a Mockup user interface (SRL 2015). When the user starts to cook she immediately sees which ingredients she needs, next steps and a video or picture to support her task. Thereby we provide a worklist with different instructions for a kitchen chef. The multimedia contend is directly stored in the cloud and not on the users device. If the user finishes an instruction she can jump to the next step.

5 Discussion and Conclusion

In our paper we present a novel approach to integrate a high security cloud storage (sealed cloud) in Business Process Management. The prototypical implementation is still ongoing work. We implement a new model for using a sealed cloud multimedia data storage for our copyrighted workflow contents. As a first step we implement a pasta-cooking workflow, which can be processed by the user in a web form. The content is stored in the sealed cloud of the Uniscon GmbH who provides the cloud infrastructure. The content and meta data is encrypted and protected from unauthorized provider or third-party access. By using cloud storage for our workflows we examine three main benefits: data protection, new billing possibilities and scalability.

Our work provides potential to address privacy and security concerns and to protect our copyrighted multimedia data, which we use in our workflows. With this solution third parties are not able to copy or even access our data without paying for the service.

Pricing of physical computers and software is often based on yearly license fees. Cloud Computing has the opportunity to implement pay-as-you-go strategies and use these for our cooking instructions (Armbrust, Fox et al. 2009). This is supported due to the fact that our multimedia data is encrypted in the cloud and can only be accessed when paying for our service.

The third benefit is the scalability. Scalable storage provides the advantage of adapting storage up and down on-demand without using rare data space on physical disks of computers or other devices (Armbrust, Fox et al. 2009). By using IDGARD we are able to scale our storage capacity in a flexible way in response to service usage.

To sum up, our approach of using cloud storage for workflows in the cooking domain benefits from flexible scalability, higher privacy and data protection leading to a higher user experience. The user no longer needs to use her limited, physical storage. She can store multimedia data with cooking instructions directly in the cloud. Our work also contribute to other future trends besides the cooking domain. Sealed cloud technology offers opportunities to use cloud storage without harming privacy or security regulations. This can be very important for audit companies who want to store audit-documents or other critical contents in the cloud.

6 Acknowledgment

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