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 propose a new way to connect cooking 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. This approach supports cooking workflows with instructions from multimedia data (e.g. videos, pictures) for special interest groups of the cooking domain like private communities or even chronically ill patients. The paper makes a contribution to current trends in information-systems related research such as scalability and experience reuse. Further, it connects Cloud Computing with Business Process Management.

1 Introduction

With growing 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 we can develop and organize our resources and also enables a flexible and individual allocation of resources (Ciovică, Cristescu et al. 2014, Schulte, Janiesch et al. 2015).

Business processes are modelled as a collection of activities, 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 cost-efficient way is on a rise (Schulte, Janiesch et al. 2015). There are some studies focusing on workflow execution in the cloud investigating infrastructural challenges of elastic Business Process Management or security issues (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 applying secure cloud technology for multimedia data integration and data objects representing ingredients.

To improve the user experience, we investigate the feasibility 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 can execute workflows in a web interface. Secure cloud technology provides rapid

scalability as well as data protection. Both are beneficial properties for using multimedia data in the cooking domain. With our proposed solution, the user is able to easily create cooking recipes on a platform and store multimedia data. Having started the workflow, the user is provided with cooking instructions including pictures or videos. Using secure cloud technology addresses private communities which e.g. do not want to publish content or appear in any videos accessible to the public, for instance chronically ill persons or allergy sufferers who do not want to share their special recipes or videos because their identity might be linked to serious diseases. For many people it is not an option to simply store the content on scalable platforms like YouTube because their children might be visible or because their employer might get knowledge about their special concerns. Our solution combines scalability with additional security and ensures that content is protected from persons who are not supposed to have access to the recipes. The technical solution is based on IDGARD which allows to separate data in different, sealed containers and to keep own videos or pictures confidential.

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 of a workflow to ease comprehensibility. After that 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 contribution 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 do not 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 issues require new technologies such as sealed cloud technology (Rieken 2015). A sealed cloud offers the technology to encrypt contents and meta data so that the cloud provider itself is not able to access data contents. The monitoring of user behavior and the possible access to protected content by providers is a big issue as part of data privacy and anonymity in 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 a user perspective, the access to files via the internet, for instance, by using mobile devices can be risky, because some information can be spied out by unauthorized persons. If some potential attackers retrieve user information while data is sent over the wire they may 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 the provider perspective it is also difficult to secure data and protect it from unauthorized access or illegal sharing. Providers want to ensure that only one user or a specific user group is able to access data with the registered devices. By sending the unique keys to the registered devices, content providers can prevent the unauthorized sharing of data (e.g. by using a sealed cloud). There are similar examples in the nutrition domain where images or videos are already protected, for instance mycoachnutrition.com (MyCoachNutrition 2015). Like our approach, these services offer user individual content. In contrast to our work, they do not provide rapid scalability.

Definition of Workflows

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 to each other and they underlie a business objective or a policy goal (Workflow Management Coalition 1998). The automation of 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." (Workflow Management Coalition 1998). In the remainder of this paper, we will use the term "workflow" as synonym for "business process". For our project, we model different cooking instructions using Activiti as a 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 (Workflow Management Coalition 1998). We use different tasks and data objects to describe a cooking control flow.

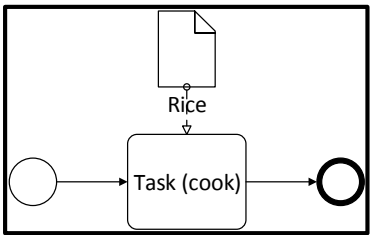

Figure 1: Sample workflow (own representation)

3 Architecture

General overview

As illustrated in Figure 2, the introduced architecture consists of three layers:

From the perspective of the user, the first layer or sub-component 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. The Activity 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 an external database but a sealed cloud solution. Therefore, it does not only store the data but provides API functions that ensure secure retrieval.

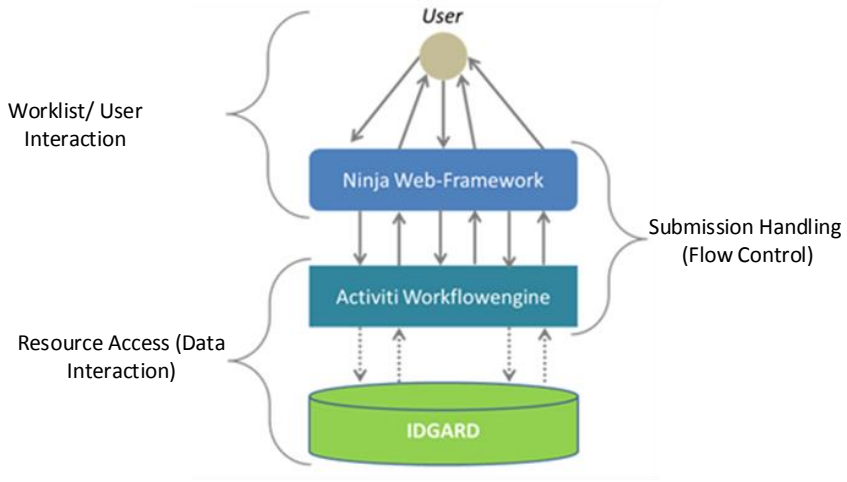

Figure 2: Architecture (own representation)

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

Since 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 pre-determined to stage a 2-Layer-Architecure at minimum. Since it is a typical demand that users have not just local 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 into 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.

By using a MongoDB database, we save standardized keywords for each possible instruction and ingredient on the one hand, as well as the recipes with already assigned processing times, instructions and information on the other hand. We are planning to use time information for the retrieval of a process in our future work.

4 Implementation Concept

An abstract class in Java defines the fundamental set of functions, i.e. basic java members and abstract methods that deal with communicating information between java and JSON, and the log file for further checks and troubleshooting. Each function has still its own unique representation for requests and responses including the corresponding JSON formats. In order to successfully connect request- and response functionality for data interchange, some middleware classes are required. For providing cloud access, we have to send login-data and a random token of the client for identification purposes. The factory pattern is used to invoke requests and their corresponding response classes. The Java classes that realize the communication with the cloud server are directly implemented in the workflows, which we use for cooking instructions.

Workflow engines for Business Process Management are abounding. 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 a modelling language and can be easily integrated with Java environments (Alfresco 2015). We used seven already created pasta cooking workflows from the work of Minor et al. and converted them into an Activiti workflow (see Figure 3 following 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 the 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 the Ninja Web framework. The Web framework (worklist) is a resource which performs the work presented by a workflow activity instance and

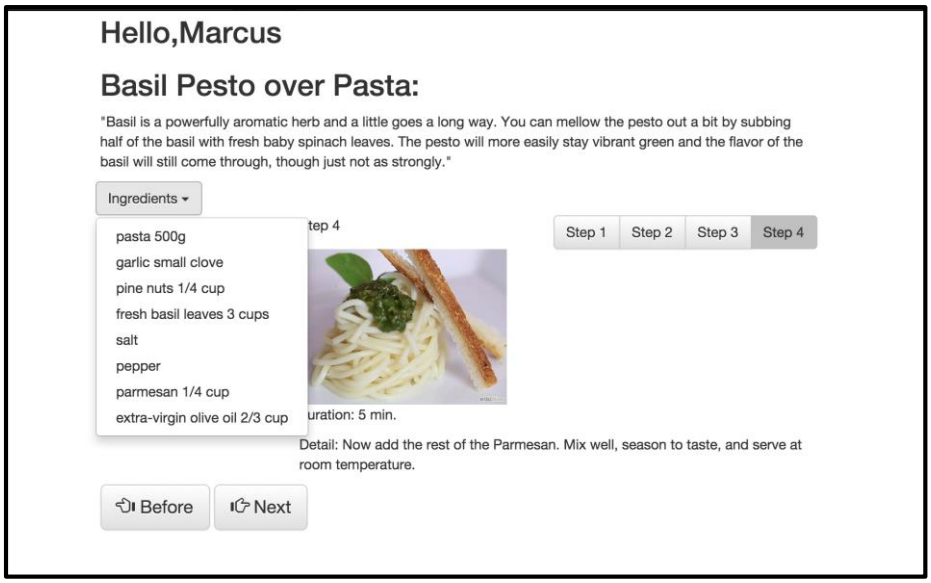

Figure 4: Current worklist (own representation)

therefore directly interacts with the user and supports her in executing her tasks (Workflow Management Coalition 1998). After successfully logging in, a user can choose to design her own recipe and upload new elements or choose ingredients to process. When searching for new processes for recipes in the database it is difficult to find a workflow or recipe which is well suited for the desired ingredients. To implement a search, case-based retrieval can be used. However, because of the small size of the recipe base in our solution this is not implemented yet.

Each recipe consists of several steps that are described by its linked ingredients, related instructions and actions that are supposed to be undertaken. In Figure 4, the prototypical implementation of our worklist is depicted. The sample picture is directly imported from the cloud. The non-multimedia information around the task is saved in a MongoDB database. When the user starts to cook she immediately sees which ingredients she needs, processing time, next steps and a video or picture to support her task. In the left top corner of Figure 4, one can see the ingredients to be used for the particular task. In the center is a management board with the instructions supported by a video or

a picture of the specific task. The workflow running in the background is modelled in BPMN 2.0. By pressing next step the user is guided to the next task of the related recipe as specified in the BPMN workflow. Thereby, we provide a worklist with different instructions for a kitchen chef.

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. We implement a new model for using a sealed cloud multimedia data storage for our workflow contents. The implementation of a case-based retrieval is not implemented yet. As a first step, we demonstrate a pasta-cooking workflow, which can be processed or uploaded by the user in a web form. The content is stored in the sealed cloud IDGARD 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 two main benefits: data protection and scalability. With the IDGARD solution third parties are not able to copy or even access the data.

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 and new customer demands. Since it is very difficult to estimate, what recipes and data with instructions will be added, scalability is very important. Apart from that, the evolution in terms of video quality has significantly risen in the past years (and probably keeps rising in the future) which contributes to the fact that scalability is an important factor because customers also tend to pressure companies to provide state-of-the-art content. The amount of data that goes along with this development is significant. It is also possible to migrate our workflow engine into a cloud solution in future. As a result, the whole platform can be scaled 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 especially for special interest groups of the cooking domain. 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 contributes 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.

7 Acknowledgment

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