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ABSTRACT

Many cross-organizational business processes are implemented by hubs and integration platforms which support the electronic collaboration of multiple organizations. The available concepts and solutions based on service-oriented architectures focus on the automatization of long-term business relationships. However, they often do not provide intuitive ways to modify them according to situational needs. In particular, small and medium-sized enterprises characterized by limited know-how and resources are excluded in such electronic collaborations. This paper demonstrates how the user-driven development paradigm of enterprise mashups could be leveraged for implementing cross-organizational business processes. By means of a case study, we report about the experiences of a real-world scenario we have implemented in the frame of the EU-funded research project FAST. A business value analysis highlights the automational, informational and transformational effects. An organized laboratory experiment evaluates how the actual users create enterprise mashups for cross-organizational processes. We conclude with the benefits and limitations of the paradigm.

Keywords (Required)

Cross-Organizational Business Processes, Enterprise Mashups, Case Study, Gadgets.

INTRODUCTION

Motivation and Problem Scope

Since the beginning of the 1990s, companies have optimized their corporate IT by introducing transactions systems such as enterprise resource planning (ERP), customer relationship management (CRM) or supply chain management (SCM). By following a process-oriented approach (Hammer and Champy 1993) and by evolving towards service-oriented architectures, IT departments are enabled to adapt their automated IT systems according to their business needs. So-called hubs and integration platforms support the electronic collaboration of multiple organizations (Lheureux et al., 2007; Löwer, 2006). Currently available concepts and solutions focus on the automatization of long-term business relationships. They lack to provide users from the business intuitive ways to modify or to extend them according to their situational needs. The integration is done on a process or data level requiring dedicated knowledge (Goh, Lee, He, & Tan, 2008).

In the recent years, a new trend for software development, known as enterprise mashups, has gained momentum. At the core of the paradigm are two aspects: First, empowerment of end users to cover ad-hoc and long tails needs by reuse and combination of existing software artifacts. Second, broad involvement of users based on the peer production concept. According to Yochai Benkler, who coined the term peer production, *"it refers to production systems that depend on individual action that is self-selected and decentralized rather than hierarchically assigned"* (Benker 2006). Thereby, the creative energy of large number of people is used to react flexible on continuous dynamic changes of the business

environment. Instead of long-winded software development processes, existing and new applications are enhanced with interfaces (so-called Application Programming Interfaces, APIs) and are provided as user friendly building blocks.

The question is now how enterprise mashups can be leveraged to establish an electronic-based collaboration between two or more parties. The goal of this research paper is to fill this gap by introducing enterprise mashups in the domain of cross-organizational electronic collaborations. The general research questions guiding this research are to demonstrate the application of the paradigm and to analyze their benefits and limitations. The scenario of the case study deals with a cross-organizational promotion crew request in context of small and medium sized enterprises (SMEs). Due to their characteristics of a high flexibility for reacting on continuous changing business environments and of their limited IT know-how, SMEs are considered as one key target group for enterprise mashups.

Research Design: Design Science applied

All activities within a research project as well as its scope are defined by the research design. For answering the research questions motivated in the previous section and characterized by a practical nature, engaged research is needed in order to provide rigorous solutions. Design science research aims at solving practical and theoretical problems by creating and evaluating IT artifacts intended to solve identified organizational problems. Hence, it is considered as a problem-oriented approach (Hevner et al. 2004).

To come to rigorous and relevant research results, we draw upon on Peffers et al. (2008) to specify the relevant phase of the design science research process applied. Research projects often fail to adequately evaluate the designed artifact. Due to that reason the present article focuses on the evaluation activity in the design science research cycle (Hevner, 2007). In previous research works, we have already presented the designed artifact (Hoyer and Stanoevska-Slabeva, 2009; Janner et al., 2009).

- **Problem Identification and Motivation.** In section one, we specify the specific research problem, show the practical relevance and justify the value of a solution. Based on the problem scope, we derive the research questions guiding this paper.

- **Define the Objectives for a Solution.** In the second section, we infer the objectives of a solution from the problem definition and knowledge of the state of problems. A literature review (Webster and Watson, 2002) in section two elaborates on the underlying principles of the user-driven enterprise mashup paradigm.

- **Design.** In section three, we identify composition patterns for enterprise mashups. Based on the general architectural elements of enterprise mashups (Hoyer and Stanoevska-Slabeva, 2009), the patterns describe on which layer a composition can be done. Unlike the existing composition interpretation in context of service-oriented architectures, the patterns transfer composition to the presentation layer and regard users as part of a composition.

- **Demonstration and Evaluation.** Section four is related to the demonstration and evaluation by applying the case study research method as proposed by (Yin, 2009). The data collection of the single-case study is based on documents as well as on the experiences and results of the scenario implementation. In addition, an organized laboratory experiment (Creswell 2009, p. 179) evaluates the important user perspective.

The results of each of the above activities are presented in the remaining part of the paper. Finally, the last section closes the paper with a brief summary, limitations of the conducted research and an outlook to further research.

ENTERPRISE MASHUPS

In literature, the definition of enterprise mashups is open to debate. In this work, we refer to the following definition: *"An enterprise mashup is a Web-based resource that combines existing resources, be it content, data or application functionality, from more than one resource by empowering end users to create individual information centric and situational applications"* (Hoyer and Stanoevska-Slabeva, 2009). By simplifying concepts of service-oriented architecture (SOA) and by enhancing them with the web 2.0 philosophy of peer production, enterprise mashups focus generally on software integration on the user interface level instead of traditional application or data integration approaches.
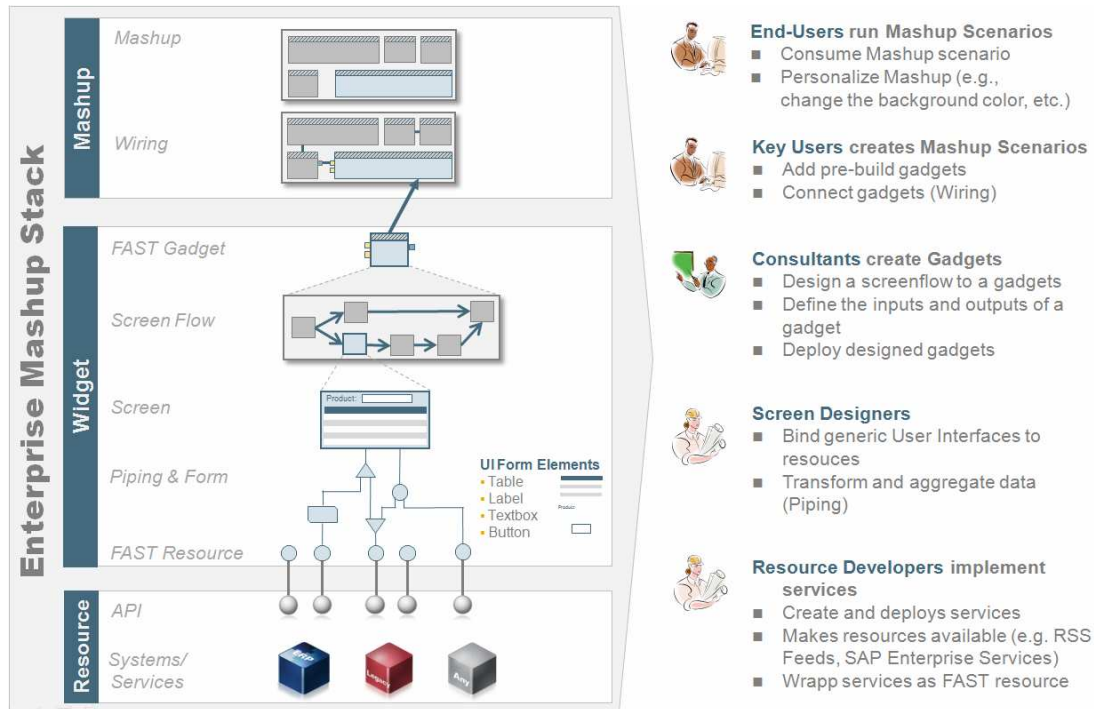
Figure 1. FAST Terminology – Enterprise Mashup Stack and Organizational User Roles (Hoyer and Stanoevska-Slabeva 2009)

The relevant architectural components of the enterprise mashup paradigm are resources, widgets, and mashups and can be structured in an enterprise mashup stack comprising three layers (see Figure 1):

- **Resources** represent actual contents, data or application functionality that are the core building blocks of mashups. They are encapsulated via well-defined public interfaces (*Application Programming Interfaces*; i.e., WSDL, RSS, Atom, etc.) allowing the loosely coupling of existing resources – a major quality of the SOA paradigm. These resources are provided by enterprise systems or by external Web providers and are created by traditional developers who are familiar with the technical development concepts.
- The layer above contains **widgets** or gadgets providing a simple user interaction mechanism abstracting from the complexity of the underlying resources. Thereby, the *piping* composition integrates heterogeneous resources by adapting, mixing, and manipulating them. A graphical user interface *form* is put on the composed resource. The combination of a form and the piping composition is called a *screen* which is created by the screen designer. This user role is characterized by basic programming skills in order to bind the resources to user interfaces. Screens are fully functional by themselves, and their pre- and post-conditions drive the transitions between them to tie them together, forming a *screen-flow*. A gadget consists of various screens and allows the handling of lots of information in several steps. In a similar way to the resource, input and output ports of a gadget can be defined by a consultant. The user playing the consultant role is able to deploy a gadget to different mashup platforms.
- Now, a key user who understands the business challenge is able to combine such visual gadgets in a mashup platform according to their individual business needs, thus creating a **mashup**. This visual composition by linking the in-/ outports of gadgets is called *wiring* and requires no programming skills. Finally, the end users consume and run the created mashup scenario. If necessary, they are able to configure the mashup to some extent, e.g. (de)activation of functionalities, moving gadgets, etc.

In summary, the composition principle of the resource layer of traditional SOA environments is transferred to the user interface level where the end users are empowered to create an ad-hoc enterprise-class application. This architectural stack is supported by the FAST platform which is currently under development (Hoyer et al., 2009).

ENTERPRISE MASHUP COMPOSITION PATTERN

Lightweight composition is a central characteristic of enterprise mashups. But their application domain is different due to their composition power and due to the required IT user skills. That fact poses the questions what general composition

patterns exist in enterprise mashup environments? Patterns have been around a long time in the IT research community. Thereby, they can have a dramatic impact on flexibility and extensibility of an application (Gamma et al., 1995, p. 3).

Five identified composition patterns characterize the composition capabilities (Janner et al., 2009). These patterns establish a common understanding for discussing the composition of enterprise mashups in context of cross-organizational processes. Composition is not limited on the mashable components. Composition is driven by the agents and their roles (Minsk, Poh, Wei, & Siew, 2007). Two agents serve to describe the five patterns. An agent can be a user working at the company or at an external partner. Figure 2 depicts the first three patterns which are relevant in the case study.
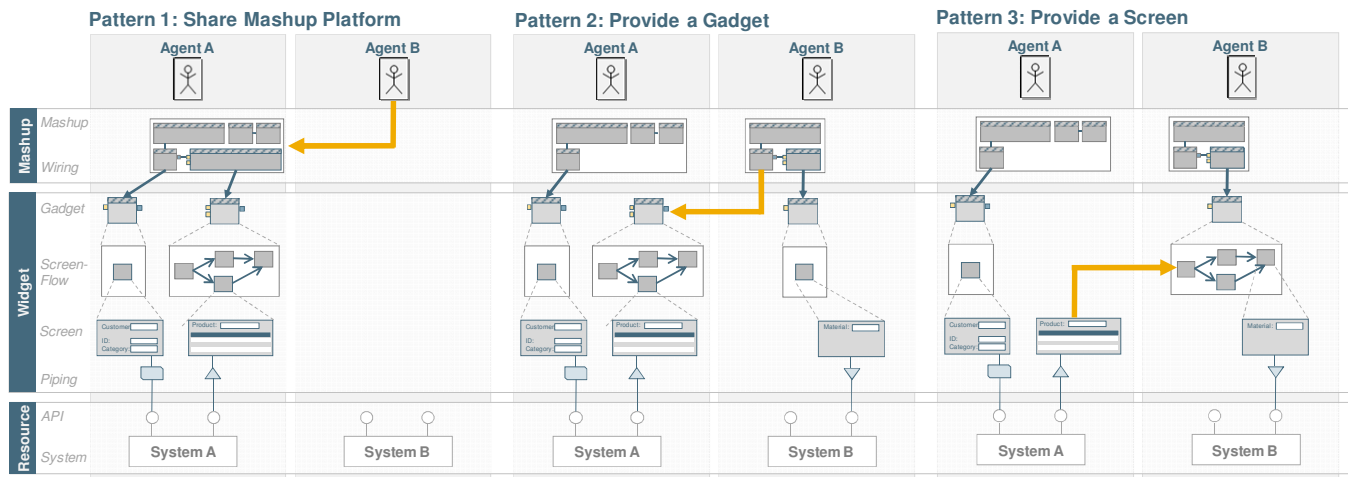
Figure 2. Enterprise Mashup Pattern (Share Mashup Platform, Provide a Gadget and Provide a Screen)

Pattern 1: Share Mashup Platform. Agent B provides access to his mashup platform to agent A. This composition pattern is quite easy to adapt as agent B only has to open agent A's mashup platform. The limitation of the first pattern is that there is no integration to the backend system of agent B. However, in some use cases the application of the composition pattern is suitable.

Pattern 2: Provide a Gadget. The second pattern goes one step down in the architectural stack. A key user of agent A is able to design a gadget which is published to the mashup platform of agent B. Now, agent B can add the gadget to an individual mashup and connects it with an internal gadget which encapsulates business logic from agent B's backend system. This solution has the advantage that data exchange between the two agents and systems is automated.

Pattern 3: Provide a Screen. Agent A provides a screen which can be embedded by agent B into a gadget screen-flow. To reach the full functionality as in the previous pattern, where a complete gadget is provided, agent B (consultant user role) has to compose additional screens into a resulting screen-flow. By applying the third composition pattern, agent B benefits of an intuitive gadget development platform that allows designing gadgets out of previously defined screens.

Pattern 4: Provide an API. The interface between agent A and B is a formalized API and not a visual component. A screen accesses the information through an API. Agent B (screen designer user role) implements the screen which accesses an API provided by agent A. This pattern is even more flexible than the previous ones because agent B is able to decide how the screen shall look like and how it best fits in his own business process.

Pattern 5: Connect Resources. Although both agents use mashups to handle their business tasks, the composition doesn't have to be implemented by means of an enterprise mashup platform. The agents can connect their resources directly to integrate the backend systems. This pattern represents the traditional hubs or integration platforms.

CASE STUDY: CROSS-ORGANIZATONAL PROMOTION CREW REQUEST

By means of a case study, the mashup paradigm is introduced in the domain of cross-organization business processes. The structure of the case study is as follows: First, the report briefly presents the background of the scenario. The challenges and opportunities are discussed in the second sub section. Third, the case study introduces the new implemented enterprise

mashup solution. Fourth, the results of the laboratory experiment are presented. Finally, it concludes with the investigation of the business values.

Background and Scenario Description

Existing linear tightly coupled value chains characterized by a one-to-one relation among business partners and high adaptation effort will be replaced by adaptive business networks (n:m relation) to achieve seamless processes and real-time businesses across enterprises (Alt & Österle, 2004). Cross-organizational business processes are performed by multiple independent parties. On top of a SOA-based IT infrastructure, business process management concepts act as an intermediary between the IT infrastructure and strategy layer. In the first step, experts model the electronic interaction of the involved parties by means of business modeling language. In the second step, the IT backend systems are customized for supporting the processes.
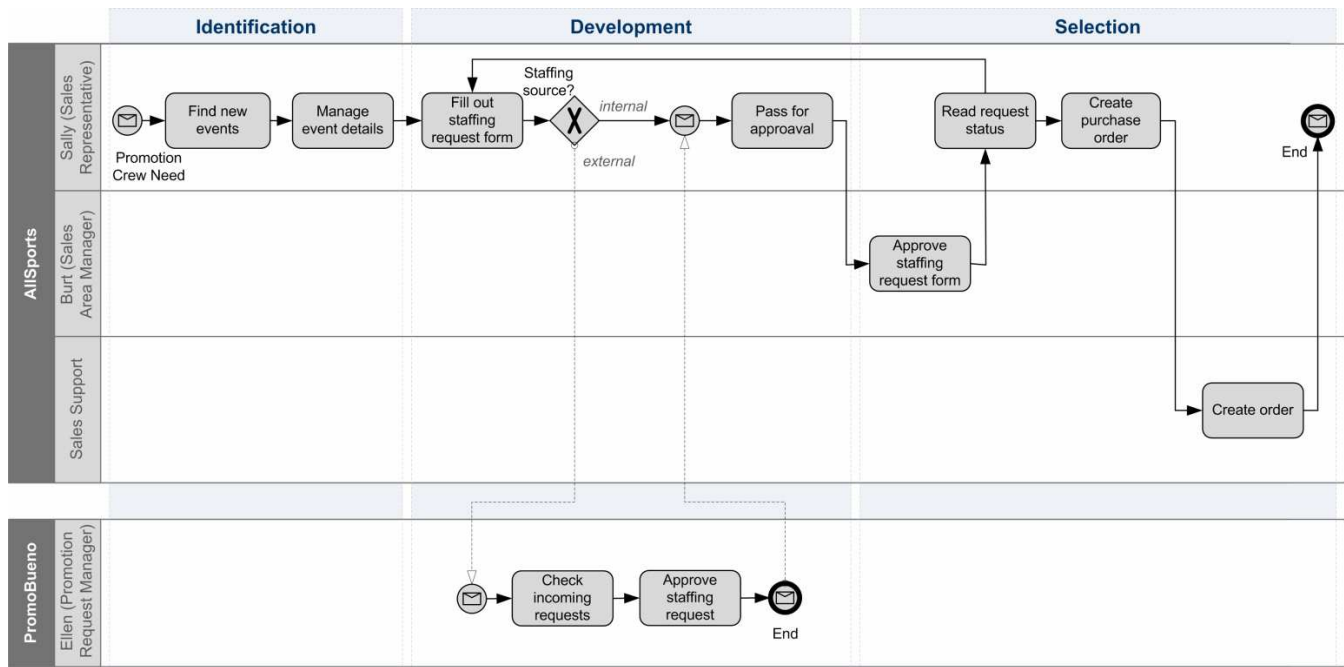
Figure 3. Business Process of Cross-Organizational Scenario

(Minsk et al., 2007) already describe a shift from static approaches to new, dynamic integration with mashups, which can adaptively react to unexpected disruptions and allow a rapid customization. In order to investigate the application of enterprise mashups for cross-organizational processes, the following scenario guides the evaluation.

The scenario is about the sports equipment and nutrition producer AllSports, a SME located in Hamburg, Germany. Recently, AllSports created a new, organically produced product, the BioPower protein bar for high endurance athletes. The sales and marketing departments arrange and organize so-called point-of-sale promotion. It includes the monitoring of current point-of-sale activities, creation of new requests and guidance through all required steps, handling the required approvals of the sales manager, etc. AllSports wants now to organize a booth at a sports fair along with the Madrid marathon to promote their new organically produced protein bar BioPower. As it is their first time of organizing a booth at a fair in Spain, they need help of a local promotion agency, in this case PromoBueno. The company is a midsize company located in Madrid, Spain. PromoBueno offers different services to its customers, i.e. the organization of promotion activities at fairs and events, brand promotion as well as marketing campaigns.

In order to structure the underlying process, we apply the phase model of unstructured decision processes proposed by (Mintzberg et al., 1976). Figure 3 depicts the resulting business process following the Business Process Modeling Notation (BPMN). The swimlanes represent the involved user roles of the two companies.

- **Identification Phase.** The first phase comprises the decision recognition of opportunities or alerts and the evocation of decisional activity. Sally Richards, the sales representative at AllSports, searches for a list displaying the current events where a promotion of AllSports products would be possible. Subsequently, she selects an event (i.e., the Madrid marathon) and receives details of the event.
- **Development Phase.** The heart of the decision-making process is the set of activities that leads to the development of one or more decision alternatives. In the scenario, Sally checks the availability of the internal staffing situation at AllSports. Due to the reason that AllSports has no branch office in Madrid and therewith no local employee, Sally checks the staffing situation at PromoBueno. Thus, Sally fills out the staffing request form and sends it to PromoBueno. Ellen Fernandez, the promotion request manager at PromoBueno approves the staffing request which allows Sally to pass for internal approval.
- **Selection Phase.** Selection represents the last step in the decision process. In general, the development phase frequently involves factoring one decision into a series of sub-decisions. Each one requires at least one selection step. In the scenario, the sales area manager (Burt Synder) at AllSports approves the staffing request. Then, Sally creates a purchase order which is processed by the sales support of AllSports.

Challenges and Opportunities

Current cross-organizational integration is handled on three levels: Data, application and processes (Linthicum, 2001). With the introduction of enterprise mashups, users evolve into an additional level of cross-organizational integration (Minsk et al., 2007, p. 318). A conducted literature review points out the following challenges and opportunities:

- **More participants.** Cross-organizational collaborations tend to involve more and more participants, while the growing number of participants also draws a huge amount of differing requirements (Ward-Dutton, 2006).
- **Unstructured processes.** Cross-organizational business processes are only sparsely structured and formularized. They are rather loosely coupled and based on ad-hoc collaboration (Larsen & Klischewski, 2004, p. 1).
- **Integration complexity.** The complexity is often linked with heterogeneous systems and platforms. The tedious integration processes is a major hindrance to today's dynamic cross-organizational integration, especially for the SMEs (Minsk et al., 2007, p. 319).
- **Harness the knowledge of users.** Business transactions are executed by users who know the requirements and processes. However, they are currently left out in the discussions (Minsk et al., 2007, p. 318). Users are constantly aware of the changing environment to make decisions. The implementation on SOA-based architectures is not designed for these use cases. It still requires developers who are expensive and have been sourced externally by SMEs.

Enterprise Mashup Solution

Now, this section introduces one possible enterprise mashup solution for the cross-organizational scenario. Both enterprises AllSports and PromoBueno use enterprise mashup environments and leverage the FAST platform in order to design the relevant gadgets. However, the composition can be done on the different architectural layer. This fact leads to the question how to design enterprise mashups for this concrete scenario? Shall the business logic put in one gadget consisting of different screens or shall it distribute on several gadgets which communicate with each other?
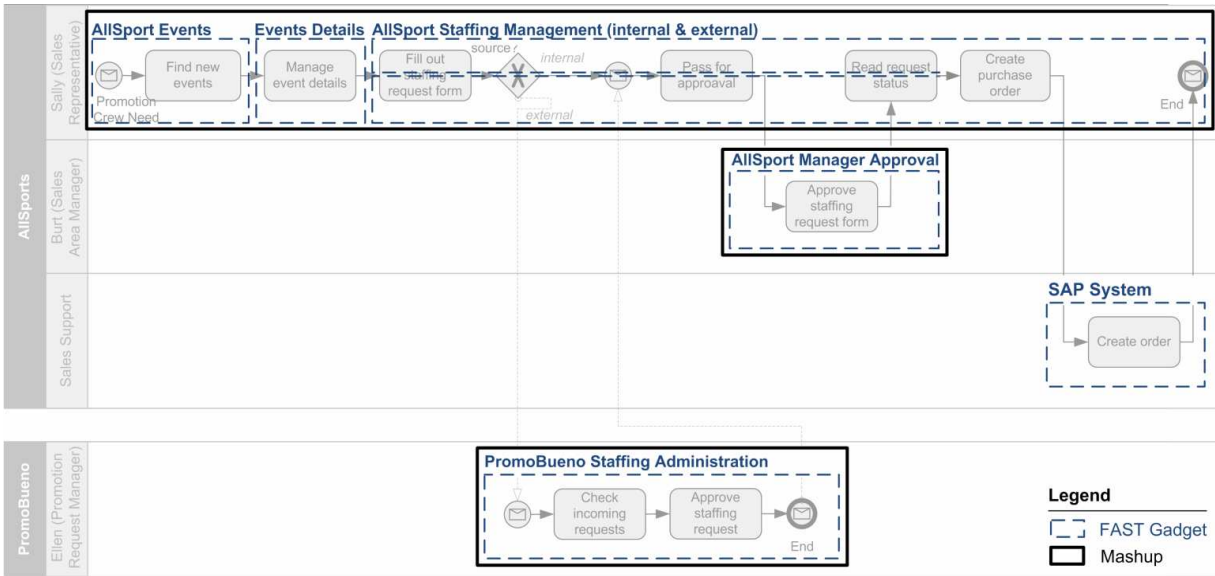
Figure 4. Master Solution – Enterprise Mashup Design

First of all, each user role of the scenario requires at least one enterprise mashup in order to handle their operational tasks. Apart from Sally's user role, the tasks in the scenario are characterized by a limited scope. For example, the process step of the sales manager of AllSports just deals with the approval of a request. Due to that fact, these enterprise mashups consist of one gadget each. If required, the business logic is distributed on two or more screens within a gadget. In case of Sally's enterprise mashup, four gadgets cover the necessary process steps. Figure 4 depicts the resulting master solution. The relevant backend systems handle the communication and data exchange between the enterprise mashups. The dashed blue frames indicate which process step are covered within one FAST gadget. The black frames show the enterprise mashups.
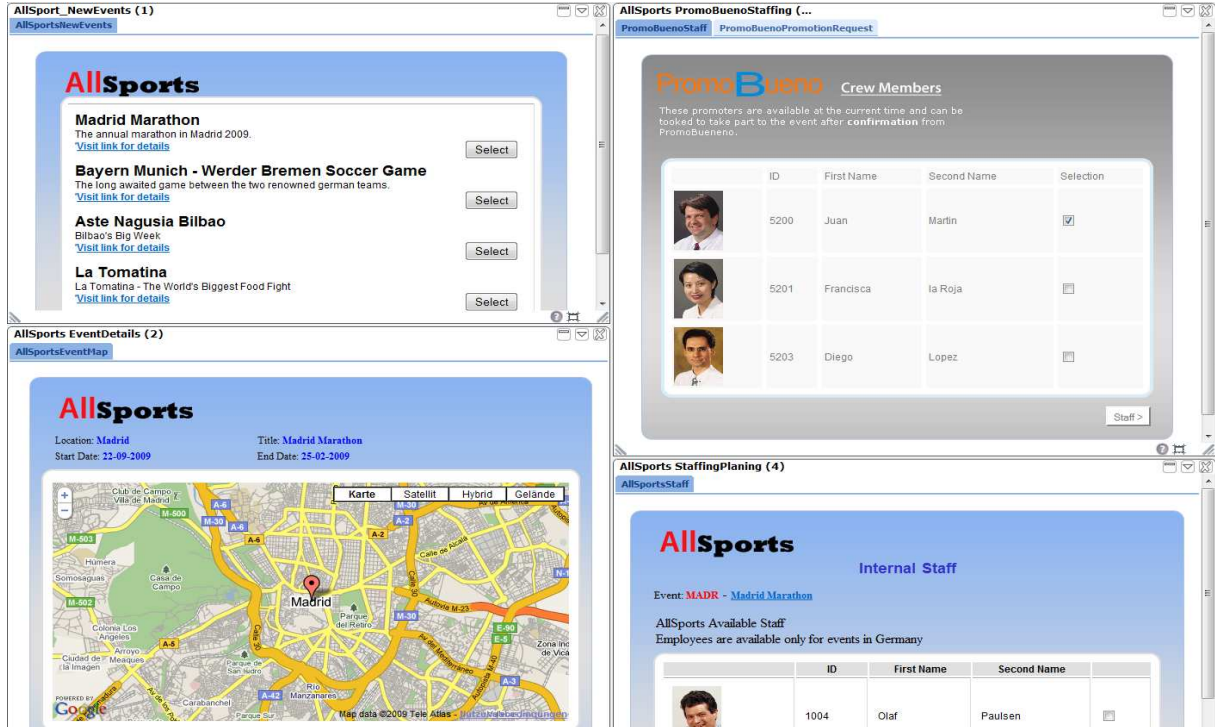

Figure 5. Enterprise Mashup of the Sales Representative at AllSports

Drawing on the example of the relative complex enterprise mashup of Sally, this paragraph explains the considerations during the design. As depicted in Figure 5, the enterprise mashup is organized as follows: On the top left, the "AllSports New Event" gadget displays a RSS-Feed about upcoming sports events. After selecting one event (here the Madrid marathon), the details of the event are depicted in the gadget "AllSports Event Details" located in the bottom left. Apart from the start and end date of the event, the gadget shows the event location on Google Maps. The communication between the two elements is handled through a configured wiring composition (see also Figure 6 concerning the underlying composition model). Now, Sally is checking which resources (employees) are available for organizing the marathon event in Madrid. The "AllSports Internal Staffing" gadget located on the bottom right indicates that AllSports employees are only available in Germany. This information is sourced from the SAP backend system of AllSports through SOAP/ WSDL-based SAP enterprise service entitled "Employee". That's why Sally is switching to the fourth gadget "AllSports PromoBueno Staffing". It allows checking online the resource situation at the business partner PromoBueno. Thereby, the staffing screen and the promotion request screen are provided by PromoBueno. Sally is selecting Juan Martin and is filling out the promotion request which sends it to the backend system of PromoBueno.
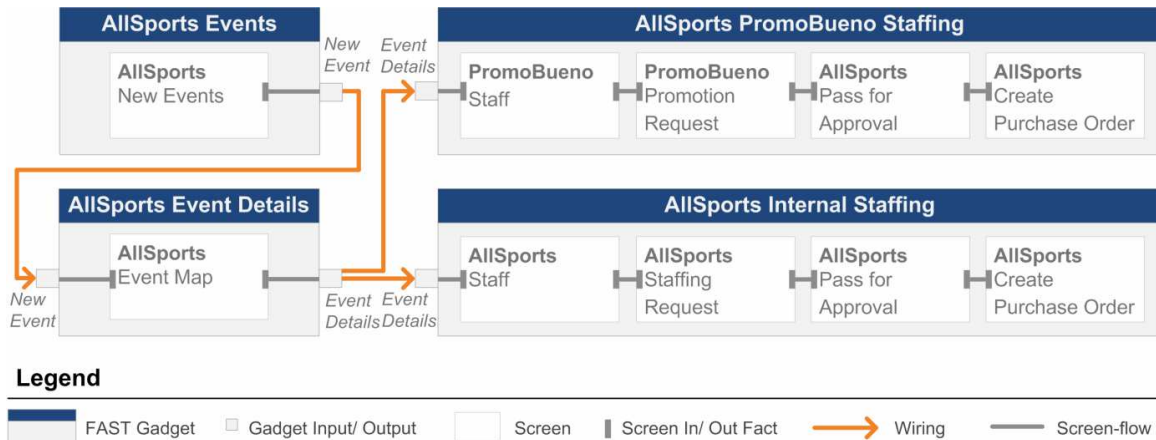

Figure 6. Composition Design Model of the Master Solution

The composition design model in Figure 6 summarizes the applied composition styles. Theoretically, it is possible to put all screens within one single gadget. The problem is then the usability meaning Sally has to switch between different screens for performing her process steps. The master solution is characterized by a balance of the composition pattern 2 (provide a gadget) and 3 (provide a screen). In particular, the display resolution significantly influences the composition design. In case of a higher resolution, the screens relevant for the identification and development phase are distributed on more gadgets. It supports the user to create a common picture and opportunities.

Laboratory Experiment

In total, 41 participants joined the laboratory experiment and designed parts of the cross-organization scenario as described in the previous section[1]. Without a dedicated training session, the participants had to design the enterprise mashup for the AllSports sales representatives Sally.

The created solutions of the test persons are analyzed by comparing them with the master solution. One central characteristic of the enterprise mashups paradigm is its flexibility. In this sense, 93% of the created enterprise mashups from the participants are not similar to the master solution. Instead of one possible solution, there exist several possibilities how to implement the underlying cross-organizational scenario. The user decides which fits best according to his requirements and personal working philosophy.

Both the technical (students with computer science background) and business (students with business administration background) people in the laboratory experiment started with the integration of all screens into one gadget. After publishing and executing the gadget, they recognize that it would make sense to distribute the logic on several gadgets. Thanks to the

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[1] http://sites.google.com/site/oneonlinecontest/, last checked 2010-04-26

flexible concept of enterprise mashups, they are able to adapt the gadget and to create new gadgets without starting from scratch. After deleting screens from the first gadget and by adding the inputs and outputs, the adaptation effort is low (high learning curve).

During the discussion in the focus group, the participants mentioned that it is easier to put all screens into one gadget because the logic is modeled within one view. However, the users recognized that the composition of building blocks could be done on several levels as described by means of the enterprise mashup integration pattern. In this context, an interesting comment popped up in the focus group discussion: One participant would define generic gadgets, which implicate more creation effort, if he can reuse it in other contexts. Regarding a business perspective, incentives for creating building blocks for the community have to be considered.

Business Values

The business value investigation focuses on the process level. In order to develop an understanding of adequate value metrics, the process-oriented framework for assessing the business value of IT developed by (Mooney, Gurbaxani, & Kraemer, 1996) is applied. According to the framework, IT and therewith enterprise mashups can have three separate but complementary effects on business processes: Automational, informational and transformational effects. The implemented scenario serves as foundation to quantify the business values. Table 1 summarizes the findings for the effect types.

Effect Type	Identification	Development	Selection
Automational			
Processing Time	3 → 1 min (-67%)	11 → 5 min (-55%)	6 → 2 min (-67%)
Aggregation of various sources	++	+++	+
Informational			
Process breaks	1 → 0	5 → 0	2 → 0
Decision quality	++	+++	+
Transformational			
Competiveness	++	+++	+

Table 1. Business Values (Operational Perspective)

First, the **automational effects** refer to the operational efficiency. The processing time of the three decision phases can be reduced significantly. To measure these time savings, own experimentations are made by executing all phases separately from the perspective of the sales representative of AllSports. First, the traditional solution of switching between the different systems is executed. Subsequently, the processing time for conducting the scenario by means of the created enterprise mashup is measured. The time used for going through the identification phase decreases from three minutes to one minute (-67%). In the development phase, the process can now be executed within five minutes instead of eleven minutes (- 55%) The selection phase can be decreased by 67% from six to two minutes in total. In addition, the automation is achieved by the aggregation of various resources across the company boundaries. Unlike large enterprises, SMEs have often no dedicated IT departments which take care of integrating their heterogeneous IT landscape.

On top of the automation effects, the **informational effects** are related to the reduced process breaks and the resulting improved decision quality. The implemented enterprise mashup solution demonstrates how the information exchange between the two involved parties can be implemented by means of enterprise mashups. The combination of composition pattern 2 (wiring) and pattern 3 (screen-flow composition) results in the elimination of process breaks. The seamless process flow fosters the development decision phase. In the scenario, Sally, the sales representative of AllSports, is able to check the resource current situation at AllSports as well as at PromoBueno. By finding the available employees, the development of a decision alternative for reacting on the triggered event is no problem for Sally.

Finally, the **transformational effects** refer to the value facilitating and supporting process innovations and transformation. By today, electronic collaborations between heterogeneous backend systems are often limited on large enterprises. By means of the new composition capabilities of enterprise mashups, SMEs are empowered to seamlessly collaborate in business

networks which represent a competitive advantage. Instead of using traditional portal solutions (pattern 1) or hubs/ integration platforms (pattern 5), enterprise mashups provide a new concept to establish ad-hoc business networks for SMEs. Even if the composition power is limited, the scenario proves the worthwhile application of the user-driven composition pattern.

CONCLUSION AND OUTLOOK

The aim of this paper is the introduction of enterprise mashups into the domain of cross-organizational business processes. In order to achieve this, we follow the design science methodology. After defining the main terms related to enterprise mashups, we presented composition pattern of enterprise mashups. By means of a case study and a laboratory experiment, we demonstrated and evaluated the applicability of enterprise mashups.

The result is that enterprise mashups have the potential to enable ad-hoc electronic collaborations. Enterprise mashups are more than hype. The scenario demonstrates the related automational and information effects. Apart from the increased processing time, the improved decision quality is a central benefit. The laboratory experiment also proves that business people are really surprised how easy they can create their individual application. However, the support of a complete end-to-end business process cannot be handled by enterprise mashups. Additionally, the exchange of screens and gadgets requires a common user interface style. Screens within one gadget must follow a common size, color, font style etc. Otherwise, the user is facing with a completely different look and feel. The case study also lacks on the consideration of relevant security issues.

There also exist some limitations of our conducted research. Due to the immediate development stage of FAST platform, the evaluation is limited on the three top level of the enterprise mashup stack. By following the iterative design cycle ("Design as a search process"), further research will deal with covering the lower level architectural elements (screen design, piping and resources) and the related composition pattern. In this sense, the next evaluation cycle will take into account all composition patterns.

ACKNOWLEDGMENTS

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