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Service Oriented Application System Architetcture: Business Process Management Meets Workflow Management

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Service-oriented Application System Architecture: Business Process Management meets Workflow Management

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ABSTRACT

The research field "Services Science" deals with the opportunities and challenges of service sectors inside and outside organizations, aiming at the industrialization (global division of labor and automation) of these sectors. This goal can only be reached when the performance know-how an individual needs to execute a task can be language-critically reconstructed and managed with the aid of computers, like is the case with application software. By transforming the performance know-how into a linguistic schema that has been set up according to a human task, this "materialized know-how" –through the linguistic carrier– becomes available like a serviceable tool. Such materialization may take the form of a detailed process description through modeling languages. It can be managed –together with the IT supported processes– by business process management. The controlling of process execution can be conducted through workflow management systems. That way the process control logic is established on a technological basis.

Keywords

Business process management, workflow management, service-oriented architecture, process-centric approach, service-centric approach, human-based services, IT services, services science.

INTRODUCTION

The keyword "workflow management" (WfM), with all of its technologies included, often seems outdated and little connected with seminal approaches of the business world. En vogue catchphrases such as "service-oriented architectures" or "business process management" are often perceived as more up-to-date.

After an in-depth analysis it can be asserted, however, that nowadays scientific approaches of supposedly outdated disciplines once again stand in the focus of current and future developments. In this context, the upcoming discipline "Services Science" that is being developed all over the world represents a central field of application for workflow management systems (WfMS).

Although internal and external services can be found in every Organization (cf. Levitt, 1972), the service aspect has too often been neglected in the past. Among other reasons, this may be attributed to a predominant focus on the physical product. At the same time, in most economies the so-called "service industry" –with its primary characteristic of a growing (international) division of labor– is the industry with the highest growth rates. This is especially the case in the industrialized countries of Europe, in Japan and the USA. But also in the emerging economies of China or India industrialization in the service industry is rapidly advancing (cf. Bryson et al., 2005; Maglio et al., 2006).

In our sense services represent executable components, for instance human or IT system action. The ability to materialize performance know-how for human activity, like it's the case with software for IT system activity, can be used to build an enterprise service landscape. These services can be used to equip business processes for the objective of their execution. To bring this intention to a technological basis, WfMS can be used as already mentioned. On this, as the case may be, a transformation process (business process to workflow) will be necessary.

In this paper, after setting out a few basic ideas in the section entitled "Foundations" and before entering fully into the discussion of WfM, it is important to shed some light on the technology-neutral research field of "business process management" (BPM). Finally, the WfMS will be shown as a central element of a service-oriented application system architecture, thereby highlighting the prevailing relevance of this topic.

FOUNDATIONS

In this section, all essential definitions, differentiations and approaches shall be presented for the subsequent discussion.

Services

In the context of the current set of problems, the concept of a "service" is often used and shall also be used in this paper. It can be understood as follows: upon request of the service client, a service provider performs a certain task (also decentralized, as the case may be) with the aid of materialized services (e.g. software (computer system) or performance know-how (of an individual)). In this discussion, the term "service" in reference to its materialized representation is used in a managerial sense of a potential resource. In our considerations it can mean a HB service function (schematized performance know-how is used by an individual to perform a task) or an IT service function (an IT system uses a software to perform a data conversion). Other possible service classes are not considered in this paper.

Service-oriented application system architecture

In Allusion to Ortner, an "application system" is seen as a holistic approach (cf. Ortner, 2005). Contrary to the well-known service-oriented architecture (SOA) approach (cf. Josuttis, 2007), not just the technological aspect is covered; also organizational processes, human knowledge and all relevant people are considered. On this note the differentiation between HB and IT services is appropriate.

Business Process Management vs. Workflow Management

The title of this paper alludes to the connection between BPM and WfM. Analyzing the relevant literature it can be observed that there exists neither an unambiguous understanding of the terms nor a clear differentiation (cf. Heutschi, 2007; van der Aalst, 2003; Josuttis, 2007; Plesums, 2005). In order to obtain a consistent understanding with a view to the existing discussion on delimitation, the definitions of the respective core elements (business processes and workflows) shall now be looked at. To start with, it should be mentioned that a "business process" is in parts simply called a process. Both elements usually refer to its schema.

Based on the definitions of different researchers, it can be asserted that a *business process* is of a more general nature than a *workflow*. The former reflects a primarily functional view of a process, while the latter is additionally equipped with all necessary details of the underlying technology and is –with regard to its execution– fully specified (cf. Vogler, 1996, p. 345f; Josuttis, 2007, p. 82; Workflow Management Coalition, 1998, p. 8). A detailed conceptual and technical differentiation of the definitions will be presented below.

"Business process management aims at the systematic layout, control, supervision and further development of the business processes in a company." (Allweyer, 2005, p. 12). Conclusively this discipline can be understood as the functional process perspective, taking into account the necessary specifications of the organization.

According to Vogler, WfM primarily covers the detailed description and specification of business procedures, the control of workflow entities, the recording of all activities in the context of the workflow runtime and the integration of all elements into a system as a whole (cf. Vogler, 1996, p. 346). In the context of this paper, WfM describes a technology-oriented process perspective regarding the process execution.

A 2-level model is an appropriate method of differentiation in the context of this paper, delivering a professional or management-oriented (BPM) as well as a technology-oriented level (WfM).

Workflow management systems

WfMS's can be viewed as basis systems in the sense of application systems. This means that –on the basis of WfMS's with a specification through metadata– a process-oriented application can be constructed.

Historic development of WfMS's

WfMS's originate from office automation systems. According to Gadatsch (2008), the development can be divided into five generations. The present status-quo of WfMS can be seen as the fifth generation. The move of a client/server architecture towards a SOA with distributed data management provides maximum flexibility for process control. Products and services of different suppliers can be combined and integrated in automated or partially automated business procedures, controlled through WfMS's together with HB services (Gadatsch, 2008, p. 268).

The workflow management paradigm

Regarding the increasingly strive for organizational flexibility to be able to meet new challenges, this development towards greater flexibility, the WfM paradigm is justified inasmuch as it allows for a division of the WfMS into a control level and an execution level. In this approach, controlling is conducted by the WfMS, "while the execution of the process stages is left to the participants (individuals, machines, application software)" (Lehmann and Ortner, 1998, p. 7).

The control element entails taking a step towards the execution element when this step was decided over on the basis of the given workflow schema (controlling schema) and, as the case may be, on the basis of the relevant monitoring information. Thus, the WfMS does not regulate the details of the execution level but primarily operates the controlling flow and the inherent dependencies (Lehmann and Ortner, 1998, p. 7). Execution schemas could be the program code of IT services or a work manual for HB services.

ESTABLISHING BUSINESS PROCESS MANAGEMENT

BPM deals with all challenges that surround business procedures responsible for value creation and economic success of an organization. Therefore, BPM can be described as the backbone of each company. In an age of, for instance, ever-decreasing time-to-market periods and frequently changing production sites every organization that can rapidly adjust to the given conditions has a competitive edge. Benner and Tushman (2003) argue that a business organization should no longer be viewed from a means-oriented but from a purpose-oriented perspective.

„The process revolution has been marked by a shift from the view of organizations as a collection of departments with separate functions and outputs to a view of them as systems of interlinked processes that cross functions and link ... activities." (Benner and Tushman, 2003, p. 240). Against the background of this citation and its inherent perspective, Figure 1 will be analyzed.

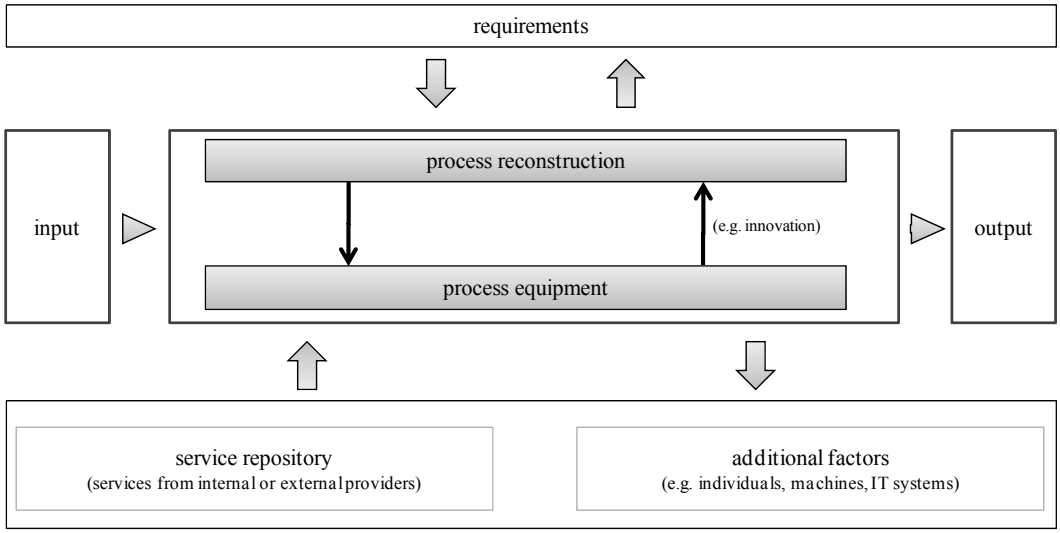

Figure 1: Process equipment with services and additional factors

Process reconstruction and process equipment stand at the center of this figure. Process reconstruction (recording and modeling, possibly also optimization) through the BPM takes place when a new process needs to be established or diverse requirements make a process adaption or improvement necessary.

Among these influencing requirements we find

- the market situation (product adjustments because of customer demand or competitive pressure),
- external parameters (e.g. changes in the legal background) or
- the realignment of the corporate objectives.

When a process has seen a reconstruction, it must be equipped with the required factors in order to make it executable. These factors in turn take over the execution of the respective services. The present discussion shall be limited to the services executable by individuals or IT systems.

For the description of a process of high granularity "it has, among other things, to be decided upon which steps have to be executed by a member of staff of which qualification and function, in which sequence, with the assistance of which software, with what data and in which occasion" (Lehmann and Ortner, 1998a, p. 67). Considering the complexity of this partial itemization and the ensuing requirements for schema languages, a decomposition of the problem, especially in regard to workflows, seems adequate and will help to reduce the conceptual complexity.

In allusion to Jablonski and Bussler (1996), Figure 2 shows a process that has been divided into different segments that have to be analyzed separately. For the adjustment of this model to application domains it may be useful –according to the orthogonality principle– to modify or amplify certain aspects. In general, combining single aspects (i.e. their descriptions) with each other results in the construct as a whole that needs to be modeled.

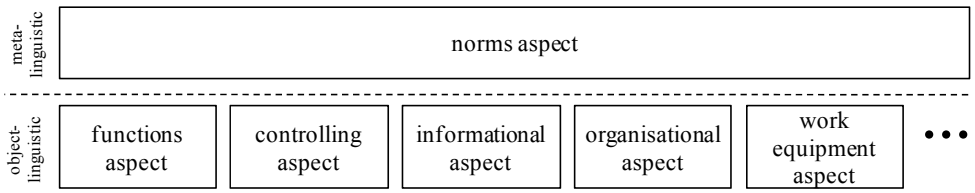

Figure 2: Overview of possible aspects of process modeling

Figure 2 distinguishes between two linguistic levels. The aspects at the bottom level refer to information *about* the processes and their objects (object information). The norms aspect at the top level relates to information *about* the information about the processes and their objects (meta information).

Process reconstruction

For process reconstruction, identifying the processes and their schema modeling should be first priority. The functions aspect as well as the controlling aspect are central to this phase. They can be derived from the definition of the word "process" (cf. Mittelstraß, 1995, p. 385) and can be jointly rendered, for instance, with the help of a business process modeling notation diagram.

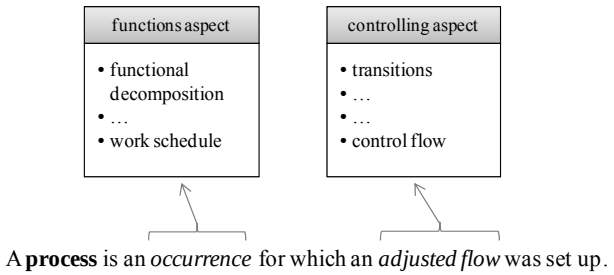

Figure 3: Aspects of a process reconstruction

Functions aspect

The functions aspect describes the functional structure of a process and forms, metaphorically speaking, the skeleton of a process description. Preliminary to the modeling the structural as well as the role characteristics of processes have to be examined. A functional structure is deductively subdivided until all elements of the composite have been itemized, leaving only sub-processes (tasks) at the bottom level which can be connected to executable services.

Controlling aspect

The controlling aspect mainly covers the modeling of the control flow of all elements identified in the functions aspect. According to Ortner, we deal with reconstruction, specification and the use of control flow structures that guarantee a specific sequence for the execution of further services. Regarding the controlling data, apart from the interrelations inside a sequence it is also important to identify possible (status) transitions during process execution. In addition, temporal dependencies and especially required periods (time requirement) need to be taken into account (cf. Ortner, 2007, ch. 5, p. 59).

Process equipment

Concerning process equipment, bottom line sub-processes are equipped with all vital factors (services) to enable execution (see Figure 4) (cf. Humm, 2008, p. 10). The organizational aspect reflects the factors of HB services, the work equipment aspect that of IT services. These allocations can be described with the help of use case diagrams.

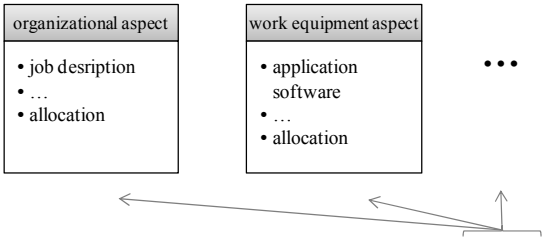

Figure 4: Aspects of process equipment

Organizational aspect

With the help of this aspect, the organizational structure can be defined, including all allocation rules to internal HB services which are linked with functional-aspect elements. These services have to be defined in detail, setting up a job description (prerequisites, objective, rights and duties, stand-in details etc.), finally assigning one or more participants to each unit (cf. Ortner, 2007, ch. 5, p. 64). This aspect of modeling and implementation poses a great challenge. A dynamic and flexible organizational structure needs to be established. Critical analyses and approaches offered e.g. by zur Muehlen (2004) or Bussler (1997).

Work equipment aspect

This aspect serves to take application components external to WfMS's (e.g. IT services) into account, for the automated or partially automated execution of a task. Similarly to the organizational aspect, no individuals are assigned to each job (cf. functions aspect) but so-called work equipment. The work equipment portfolio (internal as well as external software) including all necessary information (requirements, interfaces etc.) can be managed with the help of libraries or repositories. In the context of a SOA these libraries can be amended by one or more service providers.

We must take into account that control sovereignty of WfMS's may be restricted, depending on the granularity and interface set-up of the work equipment involved (cf. Becker and zur Muehlen, 1999, p. 60). Work equipment may include desktop applications or external IT services but also enterprise resource planning, supply chain management or customer relationship management systems.

Object and metadata management

The data involved in a process is represented –on a meta-linguistic level– by the norms aspect represents and –on an object-linguistic level– by the informational aspect (see Figure 5).

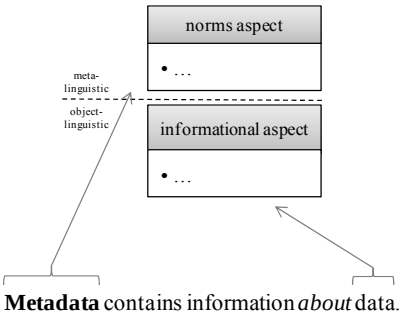

Figure 5: Aspects of data management

Norms aspect

This aspect covers all restrictions, confirmations, rules, conditions and definitions relevant for process execution. These norms may be organizational, e.g. prerequisites or guidelines due to business politics or strategies. In addition, legal or other super-organizational rules or guidelines need to be heeded (cf. Lehmann and Ortner, 1998a, p. 68).

The norms aspect also contains an organizations schema management as well as information about process descriptions and their variants or versions.

Informational aspect

This aspect models the parameters, local variables and data flows inside a process schema or between schemas. Also, conversion functions like currency conversions may need to be accounted for. Regarding WfMS, we can differentiate between the following data categories (cf. Ortner, 2007, ch. 5, p. 62):

- *Control data* solely affects the internal controlling of the WfMS.
- *Production data* is usually stored in a database and can be accessed from inside the WfMS, if needed.
- *Communication data* concerns data exchange between all those involved in the workflow execution.

Central elements of this aspect are data flow, conceptual data schema (integration) and data monitoring (use).

Process-centric development and management of application systems

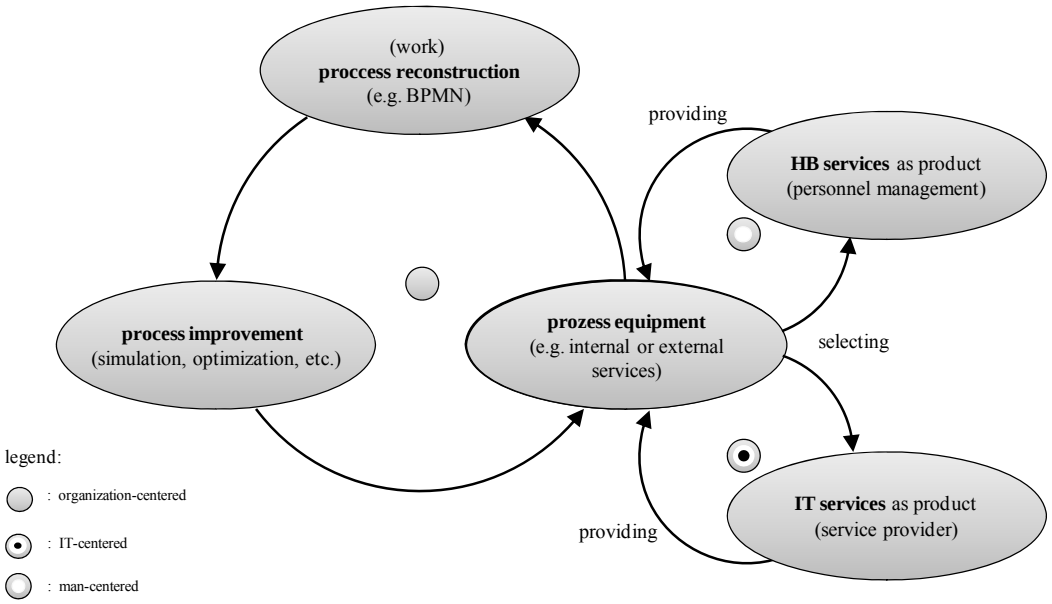

Figure 6: Process-centric development or application systems (Ortner, 2008, p. 2)

In conclusion, Figure 6 shows the items discussed above from a wider perspective. Inside an organization, process reconstruction is conducted for various reasons (requirements). On this basis, process improvement can be achieved through simulation, for instance. The new and improved process must then be made executable by equipping it with internal or external HB and IT services.

USE OF WORKFLOW MANAGEMENT SYSTEMS

Depending on the used process description language, a business process needs to be transformed into one or more workflows to ensure their controlling on a technological basis.

Business process turns workflow

The transformation of business process to workflow, or rather their schemas, takes a central part in the development of WfMS's. This step connects both disciplines according to the understanding of BPM and WfM here presented. Against the background of data flow with feed-back from the execution system (see Figure 8) we can say that "business process management meets workflow management" (cf. Link, 2008).

Differences in describing business processes and workflows

Because of the differences that exist in the description of these two concepts a concise differentiation is of great importance. Often, the divergence is played down to a trivial transformation step, e.g. for marketing purposes. A quote from Baeyens highlights this in an exemplary way: „the gap between the analysis and the implementation of business processes is far bigger than the marketing of today's workflow tools might suggest" (Baeyens, 2008, p. 1). According to Böhm (2000), this gap can be divided into two dimensions, one directed at content, one at form.

Definition differences with regard to content

Generally speaking, the divergence already becomes obvious when the respective purpose of each model is analyzed. Business process models are useful for documentation as well as the related know-how transfer and are "directed towards clearness and explicability" (Böhm, 2000, p. 32). Redundancies are thus accepted and are in parts even necessary. The recipients of these schemas are individuals.

Some of the most important defects regarding content that may occur in the modeling of business processes are listed below (cf. Böhm, 2000, p. 32f.):

- *Partial description:* For better understanding and overview, descriptions often only render process parts. Usually, a person is able to compensate for this incompleteness, seeing the larger context.
- *Subjective rendering:* Modeling is greatly influenced by the understanding of the persons doing the modeling. They make a subjective choice of relevant phenomena and thereby use means of expression that seem useful to them. Often, this cannot be avoided as specification languages often lack formally defined semantics.
- *Low specificity:* For certain concepts, abstract descriptions are often more than sufficient. Depicting the integration of a word-processing software, for example, it is unnecessary to specify the system with its interfaces. This would mean no added informational value for the human reader.
- *Low degree of detail:* Especially in the context of comprehensive business processes, a low degree of detail is often opted for in order to be able to render the entire procedure. For greater clarity, allocations to the organizational structure are frequently conducted on the basis of organizational units or roles rather than single positions.
- *Implicit interrelations:* Diverse correlations inside a model are seldom described explicitly. Mostly, they can be deduced from the given context.
- *Lack of precision:* This defect concerns nearly all of the elements described above. Items such as condition, time, status, differentiation, result or set of values arise from the context and are not especially important for the understanding of the human recipient.

With regard to the defects mentioned above and their dimensions, one should make sure that the intended purpose of the descriptions is achieved as closely as possible.

Contrary to a business process, a WfMS refers to the recipient of a workflow schema. The purpose of such a schema lies in the correct executability of a workflow machine. In order to achieve this, however, higher schema content requirements are inevitable.

Basically, the following three requirements have to be fulfilled (Böhm, 2000, p. 34):

- *Flawlessness:* The workflow schema represents a direct set of rules for the WfMS. The system does not allow for any interpretation and also processes potentially faulty descriptions (e.g. operations etc.).

- *Completeness:* In business process models, special cases that occur only rarely are often left out of the description. A WfMS, however, can only handle what has been set down explicitly in the workflow schema. If exceptions exist, they have to be accounted for one way or another.
- *Predictability:* Specifications concerning allocations or decisive parameters –a conditional branch in the control flow, for example– must be effectively predictable or else must be requested by the user. A phrasing such as "in urgent cases" cannot be interpreted by the system.

Definition differences with regard to form

Divergence in the formal dimension can also be deduced from the different recipients. It is evident that only the WfMS's have to interpret workflow schemas for which a formally defined workflow language is needed. This language should fulfill the following prerequisites (Böhm, 2000, p. 34):

- *Syntactic correctness:* This means that workflow schemas –being a certain specification of a workflow language– employ the correct syntax of this language and that it can be verified accordingly.
- *Described expressions:* Of all syntactically correct workflow schemas (expressions) of a workflow language usually only a subset is used due to technical feasibility. This subset defines the described expressions.

Transformation and data backflow

The difference between business processes and workflows have been described in depth in the section above. Böhm (2000) selects the notation shown in Figure 7 in order to illustrate the transformation step from business process to workflow with regard to the dimensions "content" and "form" identified above.

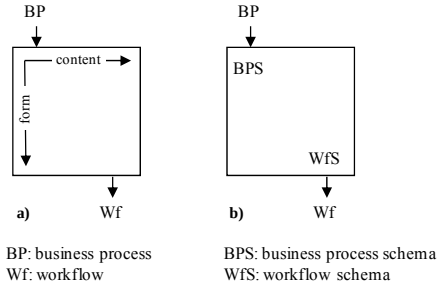

Figure 7: Transition of business process to workflow

As part a) of Figure 7 shows, the horizontal arrow represents the differences with regard to content and the vertical arrow the formal differences. Part b) illustrates how the outer box must be interpreted. On the outside of the bow we find the relevant aspects of the field of application (business process and workflow). On the inside the focus lies on the field of description – that is why we deal with corresponding schemas here.

Business processes represent the starting point, while workflows stand for the point of aim. The latter may be adjusted, depending on the requirements. The position of the starting point is determined by the given preconditions (character of the business process modeling etc.).

To establish a workflow schema or to reach the point of aim, several constellations are possible with regard to the languages used and the conversion process. These constellations may be (cf. Böhm, 2000, p. 55ff.):

- *One* language, *one* business process schema or workflow schema.
- *One* language for business process schema *as well as* workflow schema (e.g. jPDL).
- *Multiple* languages for schemas, *manual* conversion (e.g. BPMN to jPDL).
- *Multiple* languages for schemas, *automatic* conversion (e.g. BPMN to BPEL, limited scope).

Figure 8 integrates the transformation step described above into an overall view. Here, the disciplines BPM and WfM are connected in such a way that, on the one hand, the "cloud" reflects the necessary transformation steps. On the other, the data backflow of the execution system also plays an important role, especially with a view to the analysis and optimization of business processes.

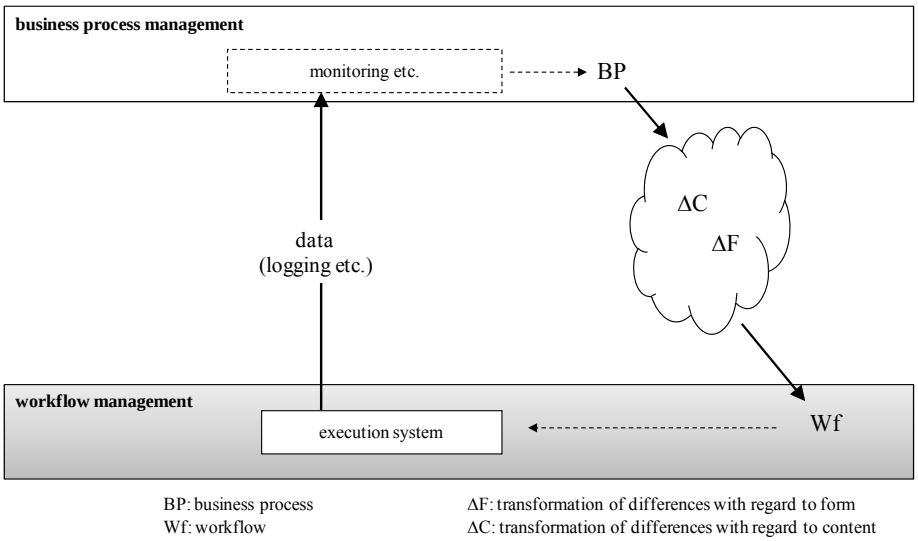

Figure 8: BPM meets WfM (according to Böhm, 2000, p. 35)

WFMS'S IN SERVICE-ORIENTED APPLICATION SYSTEM ARCHITECTURES

According to their workflow schema, WfMS prompt individuals or IT systems to perform certain tasks. With a view to approaches to SOA, the entire IT service landscape available can be controlled with regard to the execution and according to the work equipment aspect. Within the setting of a service-oriented application system architecture that also takes individuals into account, we can resort to HB services –in the context of the organizational aspect–, and control them, too.

On the basis of the open-source WfMS "JBoss jBPM", Figure 9 illustrates various integration and connection alternatives in an exemplary manner. In the center of this reflection stands the appropriate differentiation between "tasks" (for human activity) and "actions" (for IT system activity).

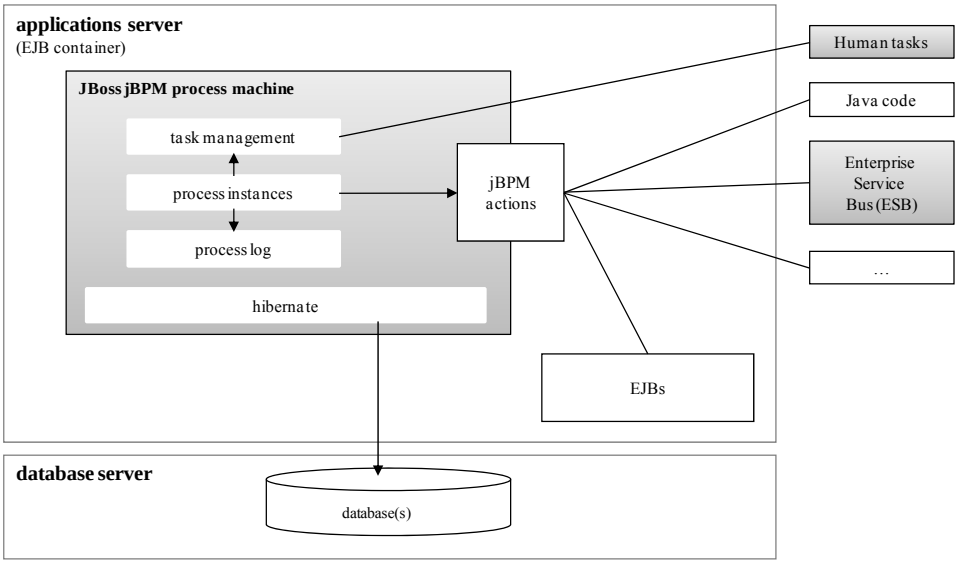

Figure 9: Integration and connection of Jboss jBPM in the setup and running of an application system (according to Rücker, 2007, p. 500)

JBoss jBPM provides a workflow definition language (jPDL) of it's own for the description of business processes. It is based on XML and can be modified or extended according to the requirements. However, the elements already predefined offer sufficient modeling potential for a wide range of use cases (cf. van der Aalst, 2007).

When a process machine instantiates a workflow schema various systems are activated depending on the schema. An HB service, for instance, is administered through a task management module, prompting the relevant individual or group to perform a specific task.

When implemented, the jBPM actions shown in Figure 9 refer to a simple Java class, a so-called Plain Old Java Object (POJO). For the implementation, it can resort to all java-compatible alternatives, including for example the request of IT services (via Enterprise Service Bus) or of external applications as well as applications (Enterprise Javabeans) of the local framework, e.g. an application server (cf. Rücker, 2007, p. 498f).

CONCLUSION

It has become evident that WfMS's –together with a developed BPM– provide approaches and technologies that enable to meet the challenges of emerging disciplines. In the context of IT with a service-centered orientation there already exist numerous time-tested solutions and architectures. The service-centered orientation of performance know-how (HB services) used by individuals for the performance of a task has only just started.

The advantages of the discussed use of technology for HB services are manifold. The centralized controlling and monitoring aspects are important for flexible business processes, just the same as their auditability. On this view, there is also the possibility to provide internal and request external services. Onwards, the facet of reusability is as well essential for this kind of architecture.

To achieve these objectives, different approaches need to be investigated as to how organizational structures can be made more dynamic in order to reach –inside a process-centric business organization– the required degree of resiliency (agility and robustness).

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