

Towards Business-Oriented Monitoring and Adaptation of Distributed Service-Based Applications from a Process Owner's Viewpoint

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Abstract. Dynamically changing economic environments require distributed Service-Based Applications (SBAs) to be highly flexible and reactive, so that the utilization of monitoring and adaptation functionalities becomes imperative. While approaches for monitoring functional and non-functional properties from the operational environment have gained a certain degree of maturity, there is still a lack of reflecting business-related aspects. This paper introduces the vision of a generic monitoring and adaptation framework focusing on the interactions between different abstraction layers of distributed SBAs. Starting from the business model perspective, strategic decisions are specified by the business model design in order to constitute the scope for possible operational adaptations at the business process, service and resource layers. Additionally, the monitoring of technical and business-related aspects affects not only the operational layers, but also the business model layer in the long-term.

Keywords: Service-Based Applications, Cross-Layer Monitoring, Business Model Design.

1 Motivation

With distributed Service-Based Applications (SBAs) encountering highly dynamic environments, process owners, who integrate external and internal services into their business processes, must be aware of both, the current status of the entire business process and the environmental changes forcing them to react in an adequate way. This leads to the necessity for utilizing suitable monitoring and adaptation functionalities in order to obtain a flexible and reactive SBA.

Several research approaches have addressed this topic in the last few years, e.g. [1, 2, 3, 4] for monitoring and [5, 6, 7] for adaptation, and the current movement is to combine existing frameworks in order to benefit from their particular strengths [8]. However, even if they are reaching a high maturity, our feeling is that considering only the operational environment does not go far enough. We believe that the next step should be an extension to the business environment.

In one of our use cases with industrial partners from the insurance domain, the claims settlement process of an insurance company is automated and composed by several internal and external services. These are on the one hand human tasks with a connection to the IT infrastructure and on the other hand web services from different providers. Most of the integrated services are substitutable, so that dynamic adaptations can lead to optimizations. The customer satisfaction as well as financial aspects play an important role in this scenario and therefore need to be reflected in particular.

From the viewpoint of the process owner, in our scenario the insurance company, an SBA is built on four abstraction layers: business model, business process, service and resource layer. Resources, like human resources or the IT infrastructure including runtime environments, are allocated to deliver internal services. The latter are situated together with external services and compositions of both of them on the service layer. The business process layer holds abstract representations of the company's core processes which partly or entirely consist of the services or service compositions from the layer below. Focusing merely on these three operational layers, what most of the current monitoring and adaptation approaches do, lacks the important strategic perspective of the business model. However, especially when most of the services within the business process are substitutable, as it is the case in our scenario, an overall optimization can only be accomplished, if the business model perspective is considered as well.

Taking this into account, our idea is to develop a generic framework where monitoring and adaptation of distributed SBAs is accomplished in a cross-layer manner with interactions between the operational layers of the SBA and its business model. Our approach has its seeds in the research project Theus/TEXO funded by the German Federal Ministry of Economy and Technology (<http://theseus-programm.de/en-us/theseus-application-scenarios/texo>).

2 Business Model Design

The term "business model" has been used in several different meanings in the last couple of years. On the one hand, practitioners use the term to describe one or more key components of a real company, without really defining or explaining the meaning of the term. On the other hand, deductive research shapes the scientific landscape on business models since the turn of the millennium and the new economy. In research, the term "business modeling" is sometimes used to describe the business application environment within a company [9] or even to describe the intra-company business processes. Actually, most researchers describe a company's business model as an ontology composed of abstract components like value proposition, partners and customers, financial aspects, internal processes and corresponding relations [10, 11, 12]. For traditional business model research, it is crucial to understand the business logic, not to create a new one. More recent research streams called "business model innovation" or "business model dynamics" consider both, understanding the business logic and utilizing this view to create new opportunities in the market.

To define a business model, we adopt the generic definition of Osterwalder and Pigneur which is used by many other authors as well [13]. According to them, a business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific company. Thus, a business model is neither (only) a process model nor (only) a set of key components of a company. An important part is the formalization of relationships between the components and how environmental and internal changes cause an adaptation of those components. Environmental changes for instance include business strategies (e.g. competitive positioning), market changes (e.g. new competitors, new technologies) and regulations (e.g. new laws). Internal changes include e.g. process and service adaptations and pricing model changes. We assume the business model as a mediator layer between the strategic perspectives and the process view of a company [14]. To further describe this simplified view on a company's business logic, we derive domains shaping a business model [11]:

- The finance domain includes costs, revenues, profits and pricing strategies. It is directly influenced by the realized business processes to create a value.
- It leads to a service and a product respectively addressing specific customers. This domain defines all the values related to the company's environment.
- The people domain describes the company's partners, customers and the roles they represent.
- The assets domain and the workflow domain describe the value creation and which resources are used by the various business processes.
- The rules domain contains organizational aspects like the company's policy.

Additionally, the strategy of a company influences its business model. Most authors in business model research regard the strategy as an external influence [12, 14]. The strategy usually contains e.g. a market (or competitor) strategy



Fig. 1. Business model elements following Kett et al. [11]

and a customer strategy. Figure 1 depicts a derived high level concept of the business model elements [11].

3 Business-Oriented Monitoring and Adaptation

After clarification of the business model layer as the strategic perspective and the underlying business process, service and resource layers as the operational perspective, the question arises how to bridge the gap between these worlds. Following the idea of a combined business model and process monitoring and adaptation, we introduce the vision of a generic framework comprising these layers in a top-down approach as illustrated in figure 2.

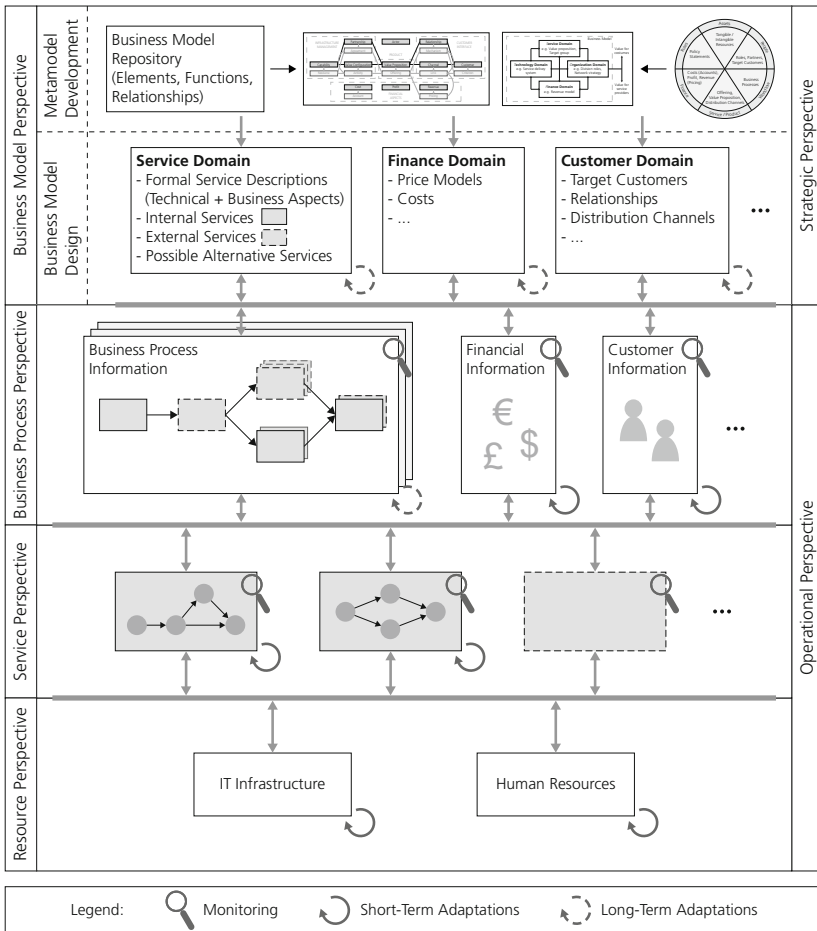


Fig. 2. Generic, cross-layer monitoring and adaptation framework

Monitoring and adaptation functionalities should be applied on all of these abstraction layers with several interactions between them which is explained in more detail in the next sections. The starting point is the business model perspective where strategic decisions are specified by the business model design.

3.1 Business Model Perspective

Although business model ontologies have gained acceptance to represent business models over the last years, almost no software tool exists to support the graphical modeling of a service-centric business model which is directly related to the underlying business processes and incorporates process performance measures. Related approaches in terms of business modeling include business process modeling (e.g. IDEF, ARIS etc.) and meta-modeling approaches of a business (e.g. Porter's Value Chain etc.). Performance aspects are realized by tools like the Balanced Scorecard by Kaplan and Norton and Business Activity Monitoring approaches. There is only a few research which combines these approaches in order to provide additional opportunities like business model adaption. Samavi et al. for example describe an approach which relates the strategic goals of a company with the operational alignment of the business model [14].

More important, there is a lack of tools providing the feasibility to execute automatic adaptations of business processes on the basis of an event-based monitoring with the help of a pre-defined business model instance. Such tools would extract the scope for an adaptation out of the business model elements. For example, for pricing adaptations of the business process and its integrated services, the finance domain would provide a possible set of pricing strategies to be used as the adaptation logic. Partner adaptations would extract the set of possible partners involved in a process out of the people domain. This idea requires the modeling of a business model via the different domains we introduced in the preceding section. There is no specific process knowledge required in this stage. Those tools are intended to be applied by managers and business analysts to review and steer the market strategy and to get a detailed understanding of the company's environment (customers, competitors). Another important application can be venture capitalists, in order to understand and evaluate the business logic of a new start-up and to understand critical success factors [15]. A well-known approach is introduced by Gordijn utilizing value streams [16]. The disadvantage here is the lack of integrating measurements and indicators about the status of the business model. Therefore, the model is not dynamic and cannot be used permanently. Actually, this methodology does not aim at supporting an on-going business, but specializes on brainstorming activities for the evaluation of business model ideas.

For a tool-supported business model design, we are going to develop a more detailed ontology based on [10] and [11]. This will result in a metamodel development stage shown in figure 2 on the top layer. The metamodel consists of business model components, relations and measurement indicators in order to provide a generic toolset for construction of a business model. The business

model design layer uses any metamodel component from this business model repository to provide a design environment for business model visualization.

The business model perspective is subsequently connected to the underlying business process perspective constituting scopes for adaptation functionalities and showing information on business performance. These scopes correspond to the modeled service domain, the finance domain, the customer domain etc.

As an example from the service domain, it is possible to model a set of alternative partners for the execution of an external service which is included in the business process. Partner-related information for instance can comprise a quality rating or former partner relationships. For a manager or business analyst, this information is crucial in order to decide which partner to choose for an external service within the business process. The next step is to link all the chosen partners and their services to the related business process activities and to decide which of these partners and their services are used initially for process execution. The other linked partners and their services constitute alternatives and currently stay "on hold". This information is stored in a formal service description containing business and technical aspects.

An example from the finance domain is the modeling of different price models for the offering of the business process to the target customer. The latter as well as e.g. customer relationships and possible distribution channels are modeled in the customer domain of the business model design.

Adaptations on the layers below are only possible within these scopes, i.e. if exchanging an external service by another one or switching to another price model would lead to an optimization, this can only be accomplished with respect to the priorly defined business model.

3.2 Business Process, Service and Resource Perspective

From the operational perspective, the strategic decisions from the business model design represent restrictions for potential adaptations. Monitoring on the business process layer is performed not only on functional and non-functional information gathered from the business process itself, but also on business information as e.g. financial or customer-related aspects. Examples include the monitoring of costs and revenues in case of time- or usage-dependent pricing of external services as well as of customer satisfaction and feedback.

The collected monitoring information is used by the process owner on the one hand for visualization purposes and on the other hand for automated short-term adaptations which can be conducted on the following layers:

- Business process layer: Adaptations regarding business-related information, e.g. switching to another price model in the finance domain or changing the advertising campaign in the customer domain. If such an adaptation leads to an optimized business process based on a specific criterion, e.g. costs or customer satisfaction, there is no need for an adaptation on the service layer, otherwise it could be required as well.

- Service layer: Adaptations of the service composition, i.e. recomposition or substitution of an external or internal service according to the alternatives specified in the service domain of the business model which therefore represents a restriction for the adaptation functionality. This could also imply that an internal service is replaced by an external service or vice versa. If this is not enough for optimization, adaptations on the resource layer could be executed as well.
- Resource layer: Adaptations of the resources, e.g. automatic reallocation of IT infrastructure or reorganisation of human tasks in internal services.

Furthermore, it is also possible that the monitored information leads to long-term or manual adaptations which are situated on the following layers:

- Business model layer: Adaptations of the business model from a strategic point of view, e.g. searching for new partners to deliver external services, renewing the price model, redefining the target customer or distribution channel.
- Business process layer: Redesign of the business process, i.e. fundamental modifications of the business process or business process activities.

4 Conclusion

As discussed in the last chapter, our vision of a generic monitoring and adaptation framework for SBAs from the process owner's viewpoint is a cross-layer approach taking into account not only the operational perspective, but also the strategic perspective through the consideration of the business model. As there are inevitable interdependencies between the different layers, all of them need to be addressed by the framework (neglecting the resource perspective), and their interactions are an integral part of our vision.

For the monitoring and adaptation of the operational environment, the existing state-of-the-art approaches are suitable, as they have already gained a high degree of maturity. However, they have to be extended with the following capabilities in order to meet our requirements:

- Monitoring of business-related aspects, particularly financial and customer information, i.e. usage of additional information sources.
- Better integration of monitoring functionalities on different abstraction layers.

In addition, more research needs to be conducted in the following areas:

- Formal service description which comprises technical as well as business-related aspects and the alternatives given for each specified service.
- Modeling of business model components in such a manner that the information can be extracted in an automated way in order to be usable for specifying the scope for adaptation functionalities.
- Support for the process owner in modeling the monitoring and the adaptation model on the different abstraction layers with an appropriate design tool.

In our opinion, the research community in the area of monitoring and adaptation of SBAs should move more towards the business aspects and integrate them into their approaches. From an industrial viewpoint, this is a crucial step for a comprehensive business process optimization.

5 Roadmap

In order to turn our vision of a generic, cross-layer monitoring and adaptation framework into reality, several research activities are required and will be executed in the near future.

Firstly, we are going to define models for the business model design which derive from our metamodel development and can be used as a reference on the business process layer. This has to be done for all of the relevant business model domains, e.g. finance domain, customer domain, etc. In the service domain, this also includes the evaluation of existing formal service descriptions regarding the ability to specify technical and business-related aspects as well as to integrate partners in case of external services and to consider alternative services when needed. First research approaches in this field were already introduced, e.g. in [17] and [18]. If they are not feasible for our requirements, a new formal service description has to be developed for our purpose.

The next step is to evaluate monitoring and adaptation approaches for the operational perspective. The most relevant criterion for complying with our vision is the possibility to be extended on the business environment. Another important issue is the seamless integration of the monitoring functionality into the existing IT infrastructure of the process owner. In this context, we have developed a concept for consuming the monitoring functionality as a service from a specialized monitoring service provider [19].

In addition, a design tool has to be implemented for supporting the process owner in modeling of the business model design as well as the monitoring and adaptation model.

Finally, we are going to abstract from our use case scenario in the insurance domain in order to gain a more generic approach.

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