

From Business Process Models to Capability Models

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Abstract: Enterprises are confronted with rapidly changing situations in regulations, globalisation, time-to-market pressures and advances in the technology. Management and design of capabilities allowing for more flexibility in business services is one way to tackle these challenges. This requires a shift from a business process oriented to capability management oriented view. In this respect this work introduces a business process based capability design strategy, which is a part of a lately proposed capability driven development (CDD) approach. The main contributions of this paper are i) an exploration of the role of business processes in capability modelling, ii) a component-wise structured capability development method based on business processes of an enterprise and iii) a demonstration of the method application in a use case from the utilities industry.

Keywords: BPM, CaaS, Capability Design, Context Modelling, Enterprise Modelling, Capability Driven Development, Method Engineering.

1 Introduction

In a globalized economy, many enterprises are confronted with a turbulent market environment due to rapid changes in regulations, customer demands, time-to-market pressures as well as the advances in technology. For a sustainable competitive advantage enterprises need to adjust their offerings to the dynamically changing circumstances [TPS97]. As a contribution to tackle these challenges and to offer flexible and agile business services capability management and design is considered as a promising approach. In this area the EU-FP7 project “Capability as a Service” (CaaS) develops the Capability Driven Development (CDD) approach that envisions customization of business services on the basis of capabilities and adjustment delivery according to the current context [Bē15].

Business Process Management (BPM) is of growing importance in both IS practice and research. Recently, improving business processes was named the number one priority for CIOs worldwide [NPS11]. CaaS approach aims capturing the factors that are decisive for flexibility, dynamics and variability in business services, which are reflected in business process models in organisations. In order to implement capability management, we argue for the need to shift from a business process oriented view to capability management oriented view, which requires modelling the application context of the business service

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explicitly. The main contributions of this paper are i) exploring the role of business processes in capability modelling, ii) a component wise structured capability development method based on business processes of an enterprise and iii) a demonstration of the method application in a use case from the utilities industry.

The remaining part of the paper is structured as follows: Section 2 discusses related areas. Then section 3 introduces the CaaS Paradigm, compares it with business process as a service and proposes a business process based method for capability design. Following, section 4 illustrates the application of the method in utilities industry. Finally, section 5 summarizes the findings and concludes the work.

2 Related Work

The most relevant areas of related work for this paper are capability modelling approaches (section 2.1) and the role of business process management in capability design (section 2.2). These areas are briefly discussed in this section.

2.1 Approaches in Capability Modelling

Capability is a widely used term in the information systems (IS) literature. Although there seems to be an agreement about what constitutes a capability, it is hard to find a standard definition. The definitions mainly put the focus on “combination of resources”, “capacity to execute an activity”, “perform better than competitors” and “possessed ability” [SKS14].

A general consensus is that the capabilities are enablers of competitive advantage; they help companies to continuously deliver a certain business value in dynamically changing circumstances [St12]. According to [CT12] performance of an enterprise is the best, when the enterprise maps its capabilities to IT applications. Capabilities as such are directly related to the provision of business processes as a service, which are affected from the changes in the application context, such as, regulations, customer preferences and system performance. As service consumers act in rapidly changing environments, the delivery models should be extended with an additional layer that allows for anticipating variations and responding to them. In other words, adaptations to changes in delivery context can be realized promptly if the required variations to the standard processes have been anticipated and defined in advance.

An ongoing EU FP7 project “Capability as a Service in Digital Enterprises” (CaaS) received a lot of attention that envisions context-aware design and analysis of IS using the capability notion. In line with CaaS approach, capability is defined in this work as *the ability and capacity that enable an enterprise to achieve a business goal in a certain context* [Bē15]. Cornerstones of CaaS approach is described in Section 3.1. in detail.

2.2 BPM in Capability Design and Development

Business processes are parts of larger grained business services, which are usually developed for a defined customer group. However, service delivered to one specific customer from this group still has to be adapted due to rapid changes in the business environment. Since the business processes represented as process models underlie the offered business services offered, the service adaptation requires configuration and adjustment of the business processes at runtime level.

In order to ease adaptation of business services to new delivery contexts CaaS approach uses the notion of capabilities, which links business goals to business processes and actors. For this purposes, there is a need to study or develop methods that explicitly helps to define (a) the potential delivery context of a business processes, (b) the potential variants of the business processes for the delivery context and (c) what aspect of the delivery context would require what kind of variation or adaptation of the business process at hand. All three aspects require design and analysis of capabilities with particular focus on business process models.

The way methods are applied within CaaS is an extension of the method conceptualization proposed by Goldkuhl et al. [GLS98] consisting of concepts, activities and a notation. The concepts specify what aspects of reality are regarded as relevant in the modelling process, activities describe in concrete terms how to identify the relevant concepts in a method component and the notation specifies how the result of the procedure should be documented.

We conducted a systematic mapping study by analyzing 112 journals and 24 conference proceedings on the methods for design and development of capabilities. One part of the mapping study observed amongst others role of BPM in the field of capability management and exposed a stable course over the observed 15 years. However, the works put the emphasis mostly on the maturity models assessing and evaluating the quality of business processes. In the contrary, only few articles propose methods that support development of capabilities with a specific attention on business processes. [NPS11] and [Or12] investigate BPM topic from the Dynamic Capability point of view and present a framework, which supports the design of BPM capabilities. The framework consists of three activities, namely sensing, seizing and transformation, which are further elaborated in sub-capabilities. [Ad09] offers a method for IT capability based business process design, which consists of 8 steps. The works described provide a good starting point to design capabilities based on business processes but still cannot be taken solely as capability development methods in line with the method conceptualization of Goldkuhl [GLS98]. The two main reasons behind this is i) the lack of important concepts and outputs of the activities in the proposed approaches and ii) loosely description of the roles and notations, which are used to represent the concepts. As a result, we identified the need to engineer a capability development method based on the business services of an organisation, which are in designed and modelled as business processes.

3 From Business Process Models to Capability Models

3.1 Capability as a Service – A Novel Paradigm

Operating in a changing environment increases the importance of business agility in terms of customization, adaptation and adjustments. Organisations need to take contextual variations such as local legislations, location, work schedules and changes in regulations into account when offering their services. In this respective CaaS project aims to design the business services responding to the change needs in accordance with the current context. To this end, a Capability Driven Development (CDD) approach is being developed which enables organisations to design services based on the notion of capability that are adjusted according to the current context. CDD consists of both a methodology, comprising enterprise modelling, capability design and capability delivery, a suite of tools, e.g. a capability modelling tool, a platform for context monitoring, and a Capability Navigation Application that calculates indicators and performs automatic runtime adjustments [SKS14].

The CDD is based on the capability meta-model (CMM) presented in Fig. 1, which is developed on the basis of industrial requirements and related research on capabilities [St12], [Zd13] and evaluated in numerous use cases [Es14]. A *capability* is defined by specific business services represented as business process models, an application context for these business services and goals of the enterprise to be reached. They are required by enterprise *goals* and their delivery is supported by *patterns*, which realize runtime adjustments of the capability in the business context. The business context is represented by a number of concepts. *Context set*, which is basically set of *context elements* including their ranges, defines the relevant context for capability delivery. The permitted values of the context elements are specified in *context element range* class and measured by *measurable property* class. Context elements are related to different business drivers that cause variations in processes. *Variation aspect* identifies the causes and types of such variations and *variation point* locates the positions of the variations in the business service model. Process variants are adjustments of a master process (e.g., a reference process) to specific requirements building the process context [Rv07].

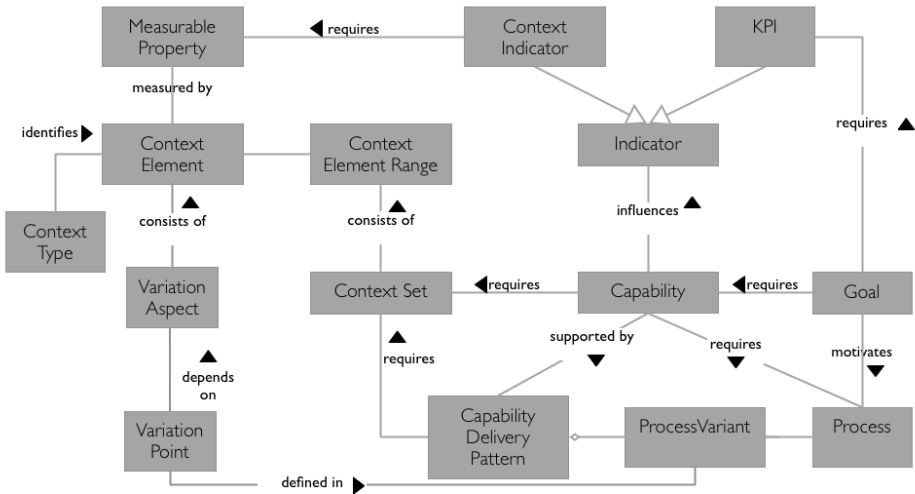


Fig. 1: Simplified view of CDD Meta model based on [Zd13]

3.2 A Business Process Based Method for Capability Design

The CDD applies modular approach to methodology engineering and documentation by dividing the methodology into several method components. In doing so the method user could focus on those parts of the method that are needed and select the components relevant for a specific tasks “on demand” from a repository. Hence, the method is composed of three method components, namely “define scope, develop/ update enterprise models” and “context modelling”.

The business process based capability modelling method proposes that the starting point of the capability design is a process underlying a business service. The business service is further refined and extended by adding context awareness and adaptability, so as to establish a capability that can deliver this service in varying circumstances. Many organisations at this level have already defined and modelled business processes that are implemented to offer business services. Hence, the method assumes that the digital enterprise that aims to offer capabilities has services modelled and implemented as business process models. The method consists of the following components.

Component 1: Define scope. The organisation offers services based on business processes that are already modelled. In order to design the capabilities by means of business processes the capability designer first selects the service and sets the scope of the capability design. The selection can depend on various factors, such as optimising the services with high process costs or managing services that frequently change and require the adjustment of business processes. After selecting the service the define

granularity activity sets the abstraction level, at which the processes supporting the business service to be improved are identified and analysed. Different ways to describe granularity levels in business processes exist in the literature. Our method adopts the decomposition approach proposed by [Fr13], which differentiates between a main process, which does not belong to a larger process and is decomposed into sub-processes. Regarding the business goals and offered capabilities needed to reach them, the method user most probably models at main process level. Nevertheless, the main processes might be refined by sub-processes in the next activity “identify processes. For this purpose 5-policies approach proposed by [HBR10] can be applied, which describes a general strategy for identifying processes. The approach can be adjusted for the chosen granularity level in the activity before. It should be noted that capturing possible variations of the processes are not included in these activities, but are subject to the third method component, context modelling. The “Define Scope” method component uses the “Business Process Model and Notation” (BPMN) 2.0.

Component 2: *Develop/ update enterprise models.* This method component analyses the enterprise models to make sure that selected business process models are up-to-date and applies changes if required. Moreover, the capability designed should be aligned with the goals that an enterprise aims to achieve. To check if business goals are satisfied during the capability delivery, KPIs are used to measure the achievement of goals. This step analyses and updates the goal models as well as KPIs, if any exist. If no goals model is available, then they can be developed based on the guidelines proposed in [Sa14]. Since an alignment of goals is required on the business service level, method user should rather model the capability related goals and not the enterprise objectives on a general basis. The last activity relates goals, business process models, KPIs and capabilities, which is used as input in the next method component. This method component uses BPMN 2.0 and 4EM Notation [Sa14] to represent the important concepts such as goals, processes and KPIs.

Component 3: *Context Modelling.* A capability is defined by specific business services, a defined application context for these business services and goals of the enterprise to be reached. In this method the capability designer models the potential application context where the business service is supposed to be deployed. For this purpose the designer executes three activities subsequently, namely find variations, capture context element and design context by applying the BPMN 2.0 and context modelling notation as proposed in [SK14]:

Find Variations. Identifies the variability in the business process models and focuses on their possible variations. By further specifying the variability in the following activities component, the method user aims to develop a context element. For this activity, the method user requires business process models, goals model, KPIs and a defined capability as an input. The output produced is a business process model including the process variants and variation points. We propose the following guidelines to support the method user on what constitutes a process variant and how to distinguish variability from standard decisions.

- Different than a decision point, a process variant is always relevant for capability delivery. If a decision point is identified that is important for capability delivery, then the method user checks depending what the decision is met, i.e. event-based, context-based or data-based. In order to do so, the condition expression at the decision point is evaluated. Context-based resolution of the decision point indicates that the subsequent task should be modelled as a process variant.
- The decision point is represented with a standard gateway if its resolution is data- or event-based.

Capture Context Element. This activity investigates the concepts and aspects of the context by eliciting the factors that cause variations in the processes, which are identified in the *Find Variations* activity. CDD Approach defines context as any information characterizing the situation of an entity [De01]. In line with this definition we assume that characterising information as such can stem from the factors of change, since they mainly cause variations in the business process models. Additionally, the configuration of a particular process variant depends on the context, in which the process is being implemented [HBR10]. Thus a substantial analysis of change factors reflected in business process variants is required to capture a context element. The following guidelines are proposed for this kind of task:

- The influence of the identified factor must be vital for the execution of the capability to reach a goal.
- The change factor must be measurable, i.e. its value must be retrieved from an information system.
- Context element is an external influence on the process, which should not exist as a process instance or data in BPM.
- Context element causes a variation in the process, when its value changes.

In some cases it is challenging to distinguish between process variables and context elements, for which we propose the two guidelines:

- A process variable is produced during the activities of a given process and managed by the application system. On the other hand a context element or (contextual data) is an external influence on the process itself, which should not exist as a process instance or data in the system.
- A context element can act as a filter and determine which variables have to be gathered from process instances.

Design Context. This activity defines a way to categorize a context element, such as if it is of static or dynamic nature. Defining the context type might have an influence at run-time. For instance, the value of a context element, which is dynamic, can be assessed in shorter time frames than the values of a static context element. Moreover it links the capability under study to the contextual influences by creating a “container” (a context

set), including the permitted ranges of the context elements for capability delivery (context element ranges) and what attributes to measure to enable reasoning about the context elements (measurable properties). Finally, the properties of the context elements relevant to capability design (context indicators) are identified.

Fig. 2 illustrates the component wise structured capability design method, based on the business services and hence on the process models of the organisation under study. Experiences gathered during the method engineering phase are detailed in an earlier work [SK14].

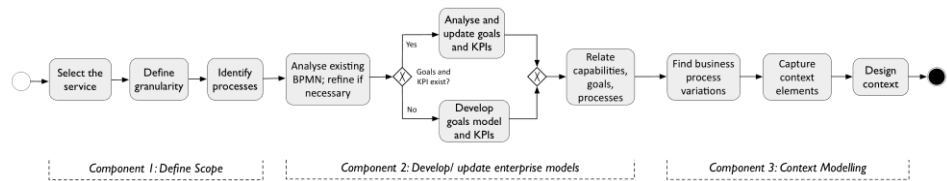


Fig. 2: A Business Process Based Method for Capability Design

4 Method Application in a Use Case

In order to illustrate the applicability of the process based capability design method introduced in section 3.2, an example use case of the industrial partner SIV.AG is described.

4.1 Use Case Description

SIV.AG from Rostock (Germany) is an independent software vendor for the utilities industry and offers different kinds of services to their clients. The target group for these services is medium-sized utility providers and other market roles of the energy sector in Germany, Bulgaria, Macedonia and several other European countries.

The company owns a business service provider (BSP) offering business process outsourcing (BPO) services, i.e. performing a complete business process for clients outside of the organization. The BSP as such provides services for the customers running kVASy®, SIV's industry specific ERP platform. Integrated with the business process environment, the “native” kVASy® services providing business logic for the energy sector are implemented using a database-centric approach. Different deployment models are used including a provider-centric model (kVASy® and the business processes are run at SIV), a client-centric model (kVASy® is installed at the client site and the manual work of the business process is performed at SIV) and mixed models (e.g. kVASy® in the cloud, work and process performed partly at the client and partly at SIV).

In particular the BSP deals with intercompany business processes between partners in

the utility market that requires exchange of messages about energy consumption or customer master data. The exchanged messages have to be both syntactically and semantically correct before being processed further. In case of a faulty message the BSP might act as a clearing centre involving the manual interaction of a human agent. The decision whether to route a case to BSP currently depends on contextual factors, such as the policies between the BSP and the client, the available resources on both sides and the number of transactions to be cleared. This service area of BSP has to implement potential variations of the clients' way to perform business. One variation is the need to adjust the standard software systems for the organizations in question, which implements the core processes. The second cause of variation is the configuration for the country of use, i.e. the implementation of the actual regulations and bylaws. The third variation is related to the resource use for implementing the actual business process for the customer, i.e. the provision of technical and organizational capacities. Last but not least, the fourth variation is the application of the solution that remedies the faulty message, which is carried out by the knowledge worker at BSP. In this case the outsourcing business services need to be dynamically routed; i.e. it should be resolved at run-time whether the individual case should be routed to the BSP. This decision is based on run-time data such as the backlog size of the customer, the type of service supported and the type of the exception, which essentially need to be captured as a capability model. The possible variations and the simplified view of the use case is illustrated in Fig. 3.

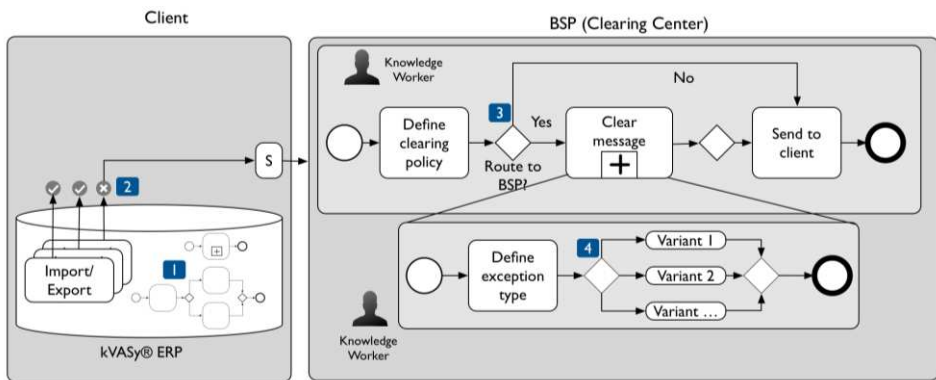


Fig. 3: Four Variation Types and a Simplified Clearing Process

4.2 Method Application in Utilities Industry

This section describes the activities needed to design capabilities of SIV.AG based on the existing business process models.

Component 1: Define scope. The scope of the capability delivery is to increase the throughput of energy consumption data messages (MSCONS). For this purposes “exception clearing in market communication” service is selected, as, which envisions

offering dynamic support in exchange of messages where faulty processes must be cleared by the BSP considering the agreements between SIV and the client. The granularity level is chosen as “main processes” and business processes are extracted from the process models focusing on the conditions i) whether to route the faulty MSCONS message to BSP and ii) how this message is cleared by a knowledge worker in BSP. This is shown simply on the right hand side of Fig. 3.

Component 2: Develop/ update enterprise models. A goals model has to be developed from the scratch in the SIV case. This required the involvement of the domain experts and product owners to the modelling sessions as well as the analysis of secondary data. Moreover, indicators are defined to measure to what extent the goals are achieved. An excerpt of the SIV’s goals model is depicted in Fig. 4, which for brevity reasons does not include KPIs. In addition to that, the business process models that are influenced by the goals are analysed, which did not require further update.

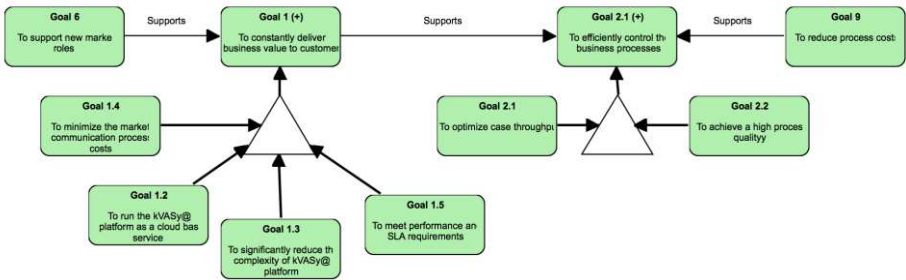


Fig. 4: SIV Goals

Component 3: Context Modelling. In the first activity, the variations in the business process models are analysed. We found out that depending on various aspects such as contract type and customer’s market role the clearing process of a faulty message can be routed to the external BSP or to the client itself. In this respect, the business logic where to route the faulty case is represented as a variation point, followed by two variants, (Clear message/ Send to client) which is illustrated as Nr. 3. in Fig. 3. While the outcome of this variation point is just a “Yes/No” decision, the inference logic behind may be quite complex. In order to resolve this question, the knowledge worker neither analyses the data produced by the process executed at client nor meets the decision based on a single, independent event. The case is resolved by the analysis of the contextual-data, i.e. the comparison of the situation in which the faulty case was generated with the contractual agreement of the client with BSP. This contextual data is external to the process, for the capacity of the BSP is not known a priori and they are not produced during the execution of the process. Thus, next activity “Capture context element” elaborates the concept of context by studying the change factors and capturing them as “context element candidates” first.

We determined three main factors influencing the routing decision. *FI, clearing policy*

that the client agrees upon with BSP defines clearly by whom the exception should be cleared. This is strongly related to the dynamic support in message clearing. *F2, operating platform* is included in the contractual agreement, whereas currently its change does not necessarily have an impact on the routing decision. The final factor *F3* consists of parameters, which are actually produced during process execution, such as backlog threshold of the client and the properties of the message throwing an exception. Although one can favour the treatment of such parameters as process variables, their interplay with *F1 clearing policy* is decisive for the message clearing capability. All contracts in SIV case include specifications about the message types, message versions, application references and backlog threshold. These comply with the guidelines proposed in section 3.2 and are thus identified as context elements.

The next activity Design Context specifies selected context elements. For this we defined the attributes that have to be measured in order to provide values of context elements (measurable properties) and the boundaries of permitted values for the context elements (context element ranges). After the expert evaluation we gathered the context element ranges defined for a customer in a context set, which should dynamically support the routing decisions. We benefited from defining the context elements only once, which are more or less similar in each of the clients and changing the ranges of the elements based on the clearing policy of the client. A tabular view of context set of the use case is shown in Tab. 1. It should be emphasized that currently a tool for capability modelling is being developed, which allows for the modelling of the context in line with the notation proposed in [SK14] and meta model introduced in section 3.1.

Context Element	Context Element Range	Measurable Property	Routing Decision
Message Type	MSCONS	UNH.S009	IF {Message Type = MSCONS} \wedge {Application Reference = VL} \wedge {Threshold = Exceeded} THEN apply Variant 2
Application Reference	VL, TL, EM	UNB.S005	
Backlog Threshold	Exceeded	Backlog Size	

Tab. 1: Context Set for SIV Case

5 Conclusion

Managing rapidly changing situations in business service offerings is a serious challenge. Today's enterprises adjust their services on the implementation level, which requires manual intervention, such as updating the software implementation or customizing the business processes. This has three main disadvantages. First, adjusting business services for each customer's specific application context requires an organisation's resources. Second, large numbers of business process models are

developed that usually include recurring parts and thus are variants of standard processes. Third, the meaning of models which are supposed to support stakeholder communications deteriorates since the solutions are rather designed on implementation level. In this work, we motivate the notion of capability and its design based on the business processes as a solution. A capability is defined by specific business services represented as business process models, an application context for these business services and goals of the enterprise to be reached. For this purposes we introduce a component-wise structured method that i) is motivated by the business process of organisations and thus requires a profound analysis of business process models and ii) emphasizes the modelling of the application context, where the business service is supposed to be deployed.

For the use case defined in section 4 the business process models required for capability delivery were made available to the researchers. Moreover, we executed semi-structured interviews with enterprise architects, domain experts and business service managers. Regarding our experiences on method application, we became aware of the need to differentiate between process variables and context elements, since both types of parameters originate during the execution of the process but have different design and runtime implications. For this purposes, we provided guidelines on what constitutes a context element and which parameters should be treated as process variables. These parameters were analysed in detail to decide whether they qualify as context elements or process variables. Concerning the *modelling of process variants*, the use cases have also proven that the values of such parameters have an influence on the decision logic and it is sometimes confusing to distinguish variability from business processes decisions. To solve this problem the term variation point and an initial set of guidelines were introduced.

An earlier work motivated two more capability design methods, namely the goals based and concepts based method. The goals based capability design can start with analyzing the existing goal hierarchy and/or setting new goals and then defining how they should be reached in terms of capabilities, business processes and which context properties should be considered. In concept-based method, capabilities may be designed by analyzing the existing knowledge structures and their relationships with the application context. A detailed comparison of these three different strategies can be found in [Es15].

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