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HOW LOW SHOULD YOU GO? - CONCEPTUALIZATION OF THE SERVICE GRANULARITY FRAMEWORK

Michael Glöckner
Leipzig University, gloeckner@wifa.uni-leipzig.de

André Ludwig
Logistics University, andre.ludwig@the-klu.org

Bogdan Franczyk
Leipzig University, franczyk@wifa.uni-leipzig.de

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Complete Research

Glöckner, Michael, Leipzig University, Leipzig, Germany, gloeckner@wifa.uni-leipzig.de

Ludwig, André, Kühne Logistics University, Hamburg, Germany, andre.ludwig@the-klu.org

Franczyk, Bogdan, Wrocław University of Economics, Wrocław, Poland; Leipzig University, Leipzig, Germany, franczyk@wifa.uni-leipzig.de

Abstract

With an ongoing division of labor and concentration on core competencies in logistics, the flexibility and quality in logistics services can be increased in terms of contracting specialists for each step in a supply chain. In order to participate in such an environment and act successfully on the market, it is essential for logistics service providers to follow a service oriented paradigm and modularize their service portfolio from static end-to-end solutions to a flexible set of modular services. One of the main challenges is to find a 'suitable' level of granularity for the modularization of existing logistics services. In this paper a conceptual framework of service granularity levels is developed. A systematic literature review is conducted in order to find existing concepts of service granularity. Findings are analyzed and finally synthesized towards their suitability for logistics services. Domain specific composition is supported by the logistics service map concept that contains catalog and construction kit for modular services. The paper's contribution is a Service Granularity Framework dedicated to specialized scholars of service science and practitioners of logistics.

Keywords: Service, Granularity, Framework, Logistics, Literature Review.

1   Introduction

The service based industry logistics (Gudehus and Kotzab, 2012) is facing the trends outsourcing, division of labor, and concentration on core competencies (Langley and Long, 2015). The expected benefits are a higher flexibility (Solakivi, Töyli, and Ojala, 2013) due to interchangeable stakeholders, and a higher quality from specialists for every task of a supply chain (Wilding and Juriado, 2004). The adoption of a service-oriented paradigm (as desribed by Erl (2008)) can lead to an increased performance (Kumar, Dakshinamoorthy, and Krishnan, 2007) of logistics service providers (LSP), in order to remain competitive and to participate successfully on such a flexible and service oriented market. Accordingly, services must be of modular character as this paradigm is based on encapsulation, composability, loose coupling, and reusability (Erl, 2008). Hence, modularization of their service portfolio from static end-to-end solutions to a flexible set of modular services is essential for LSP. Service modularity promises to achieve other benefits alongside increased flexibility in terms of cost and time reduction in planning and operation, and enhancing customer satisfaction by customized solutions while improving the efficiency of service systems (Blok et al., 2010; Meyer and DeTore, 2001; Voss and Hsuan, 2009).

Two major challenges arise in the context of service modularization. First, in order to have modular services for composition, it is necessary to decompose existing process portfolios and descriptions in advance. The extend of decomposition is a demanding issue. The challenge is to find the 'suitable' set of granularity levels for the modularization due to the trade-off between re-useability and (de-)composition effort (Steghuis, 2006). Hence, such a set is not depending on a particular number of levels. Rather the characteristics of the granularity levels - and the contained services - are of importance. Literature provides a number of papers and viewpoints concerning service granularity. In general service granularity can be defined as the scope of functionality exposed by a service (Papazoglou and van Heuvel, 2006), but a useful conceptualization of service granularity is missing as shown in the literature review of this paper. Second, evidence for the logistics domain is missing as well, thus, a further challenge is to extent the results and concepts of service granularity with both theoretical and empirical insights of the logistics domain. Finally, application and testing is provided by the logistics service map, an approach that combines a catalog and a construction system for modular logistics services. The paper's contribution is a *service granularity framework* for service oriented industries, such as logistics. Following the paper classification of Wieringa et al. (2006) the paper is a combination of 'proposal of solution' and 'evaluation research' as a novel framework for (de-)composition is proposed and applied to a problem domain. The paper's goal is to foster a granularity-driven delineation and description of services by answering the question: "What is the 'right' set of granularity levels for modular logistics services?" with the following particular research questions (and the used methods in parenthesis):

1. How can service granularity in existing literature be conceptualized? How can the concepts be consolidated within one single framework? (*method: systematic literature review*)

2. How can such a framework be applied to the logistics domain in order to improve handling service granularity of logistics networks? (*method: conceptual modeling based on logistics service map*)

After briefly introducing the reader to service modularity in section 2, the conducted systematic literature review is described and presented in section 3. Section 4 consolidates the concepts and presents the service granularity framework. In section 5 the framework is applied to the logistics domain. Section 6 concludes the paper and gives implications, threads to validity and an outlook on future research.

2   Background of Service Modularity

Service Granularity is an essential subtopic of service modularity. Hence, a brief introduction is given. Service modularity has been the focus of extensive research recently conducted by Dörbecker and Böhmann. They comprehensively describe concept, effects, measurements and design principles of service modularity. In two literature reviews they analyzed the concept and effects (Dörbecker and

Böhmann, 2013) as well as related measurement approaches (Dörbecker, Tokar, and Böhmann, 2015) of service modularity. Results show the origin of the modularity concept in other contexts (i.e. products, networks and software, (Baldwin and Clark, 2000; Schilling, 2000; Ulrich, 1994)) with several effects (e.g. cost reduction, customization, flexibility, re-design/re-usability or standardization (Blok et al., 2010; Meyer and DeTore, 2001; Voss and Hsuan, 2009)). Even though logistics is example domain of some papers (see Dörbecker and Böhmann (2013)), no domain-specific aspects are included in the results. Further, they present a *Framework for Service Modularization* (Dörbecker, Böhm, and Böhmann, 2015), which they refine and extend by taking empirical experiences into account (Dörbecker and Böhmann, 2015). The first version of the framework consists of the phases of (1) element analysis, (2) module design and (3) architecture design. In order to focus on the inherent granularity problem and to make the approach more efficient, the pre-phase of 'framework calibration' is added in the extended version, i.e. first rough guidelines are set in order to reduce analysis and design efforts in the actual method. Essence is to work on a more abstract level forward and backward through the modularization phases and their input: (1) elements, (2) inter-dependencies, and (3) modules, with regards to goal-orientation of the architecture. The resulting points of orientation help to reduce efforts of modularization by only focusing on relevant elements, inter-dependencies and modules for a certain architecture. Those decicions in advance are influenced by the expected benefits and the resulting narrowed analysis objective. But still, a conceptualization of distinct granularity levels is missing.

With the extension of their approach, Dörbecker and Böhmann tackle the granularity problem in service modularization in terms of putting effort into preliminary considerations in order to reduce the effort during actual modularization phases. By defining decision points and guiding questions for crucial phases of modularization, they support the process but still leave a (too) high degree of freedom. A conceptualization of service granularity is missing and thus, focus of the following sections.

3   Systematic Literature Review

The method, which has been used to get a comprehensive overview of theoretical aspects and existing concepts of service granularity, follows the *systematic literature review* proposed by Vom Brocke et al. (2009). Figure 1 shows the methodological approach and its setup in the paper. After setting the research scope and describing the review incorporating the taxonomy of Cooper, the topic is conceptualized. Afterwards, the search itself, and the analysis and synthesis are presented. The used databases, keywords and exclusion criteria are described thoroughly in order to enable reproducibility and to ensure rigor, completeness and thoroughness of findings and to encourage other researchers to reuse the findings.
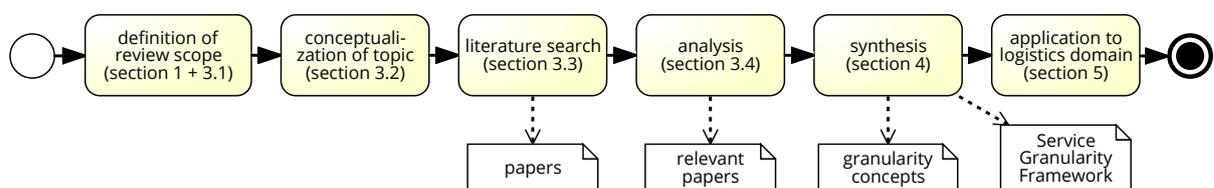

Figure 1.   The systematic literature review approach following Vom Brocke et al. (2009).

3.1   Review Scope

The research scope of the review is to collect and analyze theoretical aspects and concepts of service granularity as already outlined by the first research question in the introduction. The conducted review can be described by the taxonomy of Cooper (1988) depicted in Figure 2. The literature review in this article (1) focuses on existing research outcomes in the field of service granularity. (2) goal is to integrate the resulting findings with requirements of the logistics domain. The (3) organization of the review is

conceptual, as concepts and their comparison and interpretation are investigated. Neither a historical development over time nor the methodological aspects and foundations are investigated. (4) Neutral perspective is taken. Results of the study are presented to (5) audience of specialized scholars in the field of Information Systems in general and service oriented architectures in particular. Further, practitioners in the field of service management in general and logistics in particular are addressed. Due to a limitation on a handful of literature databases, (6) coverage can be described as representative.

Characteristic	Categories			
(1) focus	research outcomes	research methods	theories	applications
(2) goal	integration	criticism		Central issues
(3) organization	historical	conceptual		methodological
(4) perspective	neutral perspective		espousal of position	
(5) audience	specialized scholars	general scholars	Practitioners / politicians	general public
(6) coverage	exhaustive	exhaustive and selective	representative	central / pivotal

Figure 2.   Taxonomy of literature reviews (Cooper, 1988) and appropriate categories marked grey.

3.2   Conceptualization of Topic

The conceptualization of service granularity within the systematic literature review is an iterative process. The concept of service granularity evolves step by step from new insights unfolding by ongoing analysis of literature. Particularly of interest is the question of how to perceive granularity of services and by which distinct aspects service granularity can be defined and influenced. Objective is to derive a service granularity framework to give guidance to researchers and practitioners in granularity issues. This helps developing services in order to decide if further composition or decomposition is needed for services on particular levels with particular characteristics. Approaches, insights and concepts proposed by several authors are taken into account and synthesized for conceptualization. The generic definition of Papazoglou and van Heuvel (2006) is considered working definition and starting point: service granularity is the scope of functionality exposed by a service. The final concept of service granularity and the developed framework can be found in section 4 after the presentation of analysis.

3.3   Literature Search

The systematic literature review focuses on Service Granularity (SG). Databases are selected considering the criteria discussed by Dieste, Grimán, and Juristo (2009): content regularly updated, availability, quality of results. In order to ensure high quality, criteria are taking databases into account that are mostly journal-focused (e.g. science direct, web of science, springerlink, emerald) as they are likely to appear to be of higher quality than conference proceedings (Levy and Ellis, 2006). Only full research papers published within the time frame from 2000 to the present and in English language are considered. 130 papers are found (access date: 09.11.2015). The searched databases, the exact search terms and the related amount of papers found, analyzed, and categorized can be found in Table 1. During analysis, further citations appeared to be of interest where 9 more papers are selected from (forward and backward search). The total number of papers analyzed is 139. Papers are sorted exclusively to only one of the three categories. Criteria of category (1) - and thus exclusion criteria - are either papers that just mention SG as an 'important aspect' without giving a detailed description OR do not mention SG at all OR are duplicates. Consequently, 118 papers are sorted out completely. Category (2) comprises papers that reveal a more detailed description of SG and hence, help to build a deeper understanding of influencing aspects ("detailed description"). This category involves 10 papers. Finally, category (3) contains 11 paper with a strong influence on the perception of service granularity for the final results. They contribute information to the conceptualization and add value to answering the first research question ("granularity conception").

Table 1.   Used databases, search terms, and amounts of papers sorted out or considered.

databases	not detailed not at all duplicates	detailed description	granularity conception	total	search term "service granularity"
science direct	48	0	2	50	title OR all fields
http://www.sciencedirect.com/					
web of science	10	2	0	12	title OR publication name OR topic
http://apps.webofknowledge.com/					
Springerlink	53	6	2	61	exact phrase +* title
http://link.springer.com/					*it is not clear whether fields are combined by logical AND or OR
Emerald	7	0	0	7	anywhere OR title OR keywords OR abstract
http://www.emeraldinsight.com/					
other	0	2	7	9	forward and backward search
total	118	10	11	139	

3.4 Analysis

The 21 not excluded papers are briefly introduced and described in the following 2 subsections. The 10 papers of category 2 are presented in 3.4.1 and the 11 papers of category 3 are introduced in 3.4.2.

3.4.1   Detailed Description (category 2)

The majority of articles examined discusses service granularity in a general abstract way. Commonly described is the essential trade-off between fine-grained services (increased network traffic, more difficult handling of errors, difficult service governance) and coarse-grained services (lower re-usability, more complex maintainability, higher likelihood of redundancy), see e.g. Kulkarni and Dwivedi (2008) and Steghuis (2006). Conclusion of those cases advice a balance between level of abstraction, likelihood of change, complexity of the service, and the desired level of cohesion and coupling.
Some other articles present measurements to compare granularity e.g. quantified as a combination of the number of components/services invoked, number of resources' state changes, (Bianchini et al. (2014), Feuerlicht (2011), Katzmarzik (2011), and Sindhgatta, Sengupta, and Ponnalagu (2009)). This makes granularity measurable, but still leaves room for interpretation and does not enable the decision for distinct characteristic levels. As well, automatic service identification (e.g. with the help of clustering, multi-objective particle swarm optimization) enables the change of granularity of services/tasks/ etc. but still those approaches do not provide guidance for the 'right' distinct granularity (e.g. CHATLA et al. (2011), Kim and Doh (2009), and Wang and Z. Li (2014)). Further, use cases are presented (e.g. Feuerlicht (2007)) bringing granularity into business case study context and solving one specific problem, but lack in generalization of the solution and deriving advice and guidance for a broader field of application (e.g. for a certain domain) on how to organize service granularity on distinct levels.

3.4.2   Granularity conception (category 3)

Erradi, Kulkarni, and Maheshwari (2007) introduce a 'service oriented decomposition process' with two iterative steps (1) service identification and (2) service granularity. During service identification a meet-in-the-middle approach is used to match services resulting from existing IT applications (bottom-up) with services decomposed from business processes (top-down) to business activities. The mapping is done on a (not explicitly named) level, where the granularity of IT-services is similar to the granularity of business activities. Their intersection contains 'fulfilled' services. 'Additional' services contain the IT functionality that is not yet matched to a specific business requirement and thus, has to be re-evaluated

towards either retirement or extension of business service portfolio. Services from business processes that are not matched by any of the application functionality are named 'unmet' services and reveal gaps of IT services that require new development. Concerning service granularity, services exposed to other systems should be adequately generic for a higher degree of reuse by several processes and/or users, while they should provide operations that correspond to business functions. Further emphasized is a *canonical schema* that is essential to enable a consistent representation of key business entities and to reduce syntactic and semantic mapping overheads between services. Moreover, Erradi et al. recommend *service metadata management* in order to support governance and identification of services based on business function.

Galster and Bucherer (2008) introduce the *Business-Goal-Service-Capability Graph* for alignment of business requirements and services. Business features are derived top-down from top-level business goals. These business features are to be matched 1:1 with service features that consist of service capabilities, which further consist of top level services. Summarizing, they introduce a 7-level hierarchy reaching from strategic goals down to basic services. The most interesting point is the combination of two different characteristics - i.e. *3 requirement-layers* (problem domain) and *3 service-layers* (solution domain) - via a *common level of abstraction* (level 4 in the middle), i.e. a connecting mapping level that enables a 1:1 connection between both domains (problem and solution). Hence, business requirements and services are aligned. The levels can be refined internally, but characteristics of the contained entities remain the same. There are criteria for the levels on both side next to the connection layer, i.e. business features shall be measurable and service features shall be comparable to those business features. Ma et al. (2009) propose an approach of 3 Levels for internal use as well that comprises (top-down) service, activity, and operation.

The *meet-in-the-middle* approaches are also emphasized by Huergo et al. (2014) to be more complete as they evaluate models from the highest level to the most detailed one. Furthermore, a distinction is made between granularity in service hierarchy and in service types. Combined with the measures of service width and depth introduced by Heinrich and Zimmermann (2012), *two orthogonal dimensions* of service granularity can be derived.

The stop criterion for the top-down decomposition should be chosen after Granell, Díaz, and Gould (2010), when a given process is specific and yet functional enough to not to be split again, since a *further division would not make sense*. Haesen et al. (2008) argue from a bottom-up and business value perspective that the composition of multiple fine-grained services causes more overhead in general for the consumer. Further, the properties of fine-grained services are characterized as significantly hindering cross-enterprise integration by Papazoglou and van Heuvel (2006). Also Haesen et al. (2008) mention that services with rich functionality are easier to be used and have higher reuse efficiency because of the larger contribution to business processes. Hence, companies try to bundle multiple services into *packages offered to consumers* with increased business value granularity. Hence, some services have a characteristic for internal use, while other (more coarse-grained) services are meant to be useful to customers and thus, bear a more external characteristic.

Cai et al. (2014) present a multi-granularity space in the context of multi-tenancy in SaaS. They state "it is necessary to build hierarchy relationships among services of different granularity to response to tenants' multi-granularity requirements". Hence, the idea of a *hierarchy* of different granularity levels arises.

A further interesting finding is the approach of J. Liu et al. (2015). While granularity characteristics of other authors analyzed mainly focus on an either horizontal or vertical granularity, they divide granularity into *four categories*: atomic service, and service of either process, goal or role granularity. So this approach can be seen on a high abstract level able to cover a horizontal granularity (process) and a vertical/hierarchical granularity (role) and also the goal-oriented approach of Galster and Bucherer (2008).

The big amount of papers being sorted out during analysis possibly results from the difficulty of finding the 'right' granularity and the discussed demanding trade offs. Thus, it seems authors don't want to commit to specific details. But as the example of Dörbecker and Böhmann (2015) shows, a certain predefintion and determination in advance can help giving guidance, reduce effort, and thus foster service granularity.

3.4.3 Discussion

Summarizing the papers of category 2, the majority of the existing approaches perceives service granularity as the simple amount of functions being bundled by a service isolated from affected aspects and context. Contributions towards a substantial contemplation concerning different roles and perspectives, business contexts, and the resulting consequences are rare. Summarizing the papers of category 3, the existing body of literature towards service granularity concepts is extracted and presented. Consequently, the first part of the first research question is answered: There is no comprehensive concept of service granularity. Nevertheless, papers of category 3 reveal first concepts, that are to be taken into account for the development of a service granularity framework. None of the 21 papers set their focus on the logistics domain.

Key aspects analyzed are the concepts, definition and distinction of *vertical* and the *horizontal* granularity. Heinrich and Zimmermann (2012) propose a metric for measuring the granularity of IT services. In fact, they discuss a width metric and a depth metric and combinations of them for measuring service granularity. Taking this into account, it is appropriate to distinguish between a horizontal granularity for service on the same level (referring to and measured by the width) as well as a vertical granularity for services on different levels (referring to and measured by the depth). Huergo et al. (2014) describe this as granularity in service hierarchy (vertical) and service types (horizontal).

Haesen et al. (2008) describe different service types that are to be considered in a comprehensive framework, i.e. data granularity (input or output), functionality granularity (default or parametrized), and business value granularity.

Another influencing aspect is the overall *perspective*. Either choosing a top-down, a bottom-up or a hybrid meet-in-the-middle perspective (Erl, 2008; Huergo et al., 2014) of design and composition or decomposition is analyzed and finally related to the granularity. The perspective includes also a distinction of granularity for different stakeholders and their individual perception. Galster and Bucherer (2008) inspire with their idea of a common level of abstraction between two different stakeholders and a quantity of 3 levels for each stakeholder. The canonical schema as well as the service metadata management (following Erradi, Kulkarni, and Maheshwari (2007)) can be implemented on the common level of abstraction.

4 Synthesis - Conceptualization of Service Granularity

4.1 Horizontal vs. Vertical Granularity

When focusing on granularity, the term 'provider' and its perception is of high importance. It has to be emphasized that the term provider is in the current context explicitly not equal to organizational borders. It is more likely to be an abstraction and can also refer to one of several departments within a company, a group of firms, a network, or something in between.

Composition of services of one stakeholder or service provider (i.e. provider-internal) is defined as *horizontal granularity*. The number of bundled functions increases, thus the granularity is increasing. Within the horizontal granularity, a further distinction can be made by applying the definition of different service types, i.e. data granularity (input or output), functionality granularity (default or parametrized), and business value granularity.

The integration of services into composite services of other stakeholders (i.e. cross-organizational) is defined as *vertical granularity*. The granularity increases with the number of bundled functions. But, now characteristics and requirements change, as more stakeholders are involved. In contrast to the horizontal granularity, which aims at internal service composition, the vertical granularity focuses on hierarchical integration with other stakeholders. Thus, special emphasize is put on cross-organizational service composition, which results in characteristics of internal and external views on services.

4.2 The Service Granularity Framework

The concept of horizontal and vertical granularity is the main input of the conceptualization. The *Service Granulareity Framework* with three different provider levels (Top, Middle, Bottom) and a virtual common-mapping-level between different providers is introduced. Each level is defined by its dimensional focus (vertical or horizontal), its purpose and the characteristics of the contained elements.

The *provider levels* are defined as follows:

- **Top:** the top-level has a clear *dimensional focus* on vertical granularity. Its main *purpose* is the external representation of internal (composite) services, and the offering and connection of services to the next upward provider in the hierarchy. If no further upward provider exists, this level contains all composite services and functionality available in a service oriented environment or network. In this case, the next upward connection possibility is the end consumer of a service. The *characteristics* of the services contained in this level must comply with the common standards set in accordance with the upward provider by the next upward common-mapping-level (if existent) or in accordance with the demand of the end consumer.

- **Middle:** the middle-level has a clear *dimensional focus* on horizontal granularity. Its main *purpose* is the internal composition of atomic services (that may be invoked from external providers) in order to create composite services that meet the demand of external providers or end consumers. Granularity is not restricted on this level. Internal services can be composed or decomposed in a hierarchy of a multitude of (sub-)levels. The *characteristics* of the services contained in this level must comply with the provider-internal standards.

- **Bottom:** the bottom-level has a clear *dimensional focus* on vertical granularity. Its main *purpose* is the external representation of internal atomic services to a provider on next lower hierarchical level, and the demand and invocation of services from the next downward provider in the hierarchy. If no further downward provider exists, this level contains the most basic services and functionality of a service oriented environment. The *characteristics* of the services contained in this level must comply with the common standards set in accordance with the downward provider by the next downward common-mapping-level (if existent).

The *common-mapping-level* is defined as follows:

- **Common Mapping:** the common-mapping-level has a clear *dimensional focus* on vertical granularity. Its main *purpose* is the connection of two providers. It is situated between two providers, connecting the upward provider's bottom-level with the downward provider's top-level. It contains the commonly shared service standard (e.g. description, interfaces, etc.). The common-mapping-level is of virtual nature, as it does not contain services. Composition on this level is not allowed. It enables only 1:1 connections between two providers. It can be either created by the collaboration of two providers or (pre-)specified by a third party or service system. The *characteristics* of the elements (not services!) contained in this level set the common standards in accordance with the downward provider's top-level and the upward provider's bottom-level. The canonical schema as well as the service metadata management of a service network can be implemented on such a level.

With the given definitions, service systems and their inherent granularity can be conceptualized. Figure 3 illustrates the metamodel of the conceptual framework with its elements (levels and types of service granularity), and their relations. Multi-hierarchy is possible as after each three provider levels a new common-mapping-level - and thus, a further hierarchy level - can be established (see Figure 4). The total number of levels (n_l) can be calculated in dependancy of the number of provider-hierarchies x with the formular $n_l = x * 3 + (x - 1)$ with $3 * x$ provider levels per provider-hierarchy and $x - 1$ common-mapping-levels between each 2 different provider-hierarchies. Hence, even complex service systems can be described and conceptual scalability is possible. There's no explicit starting point, hence a meet-in-the-middle approach is possible for (de-)composition. As the framework connects several existing concepts it is able to describe the existing approaches comprehensively and interrelate them (see discussion in 3.4.3).
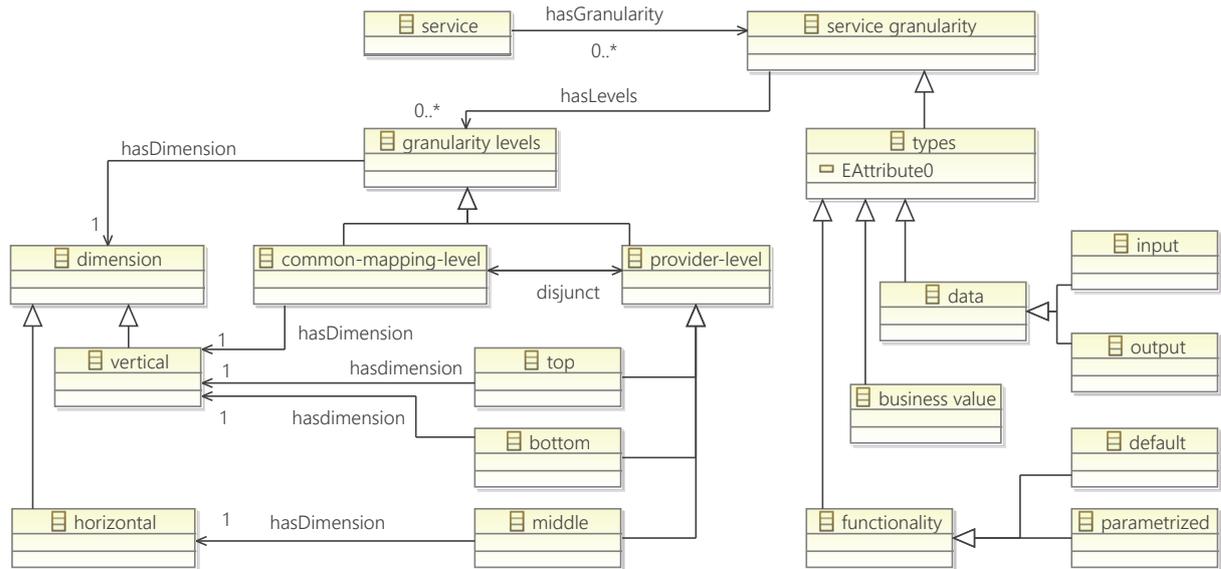
Figure 3.   Conceptual framework of service granularity (types of granularity from Haesen et al. (2008)).
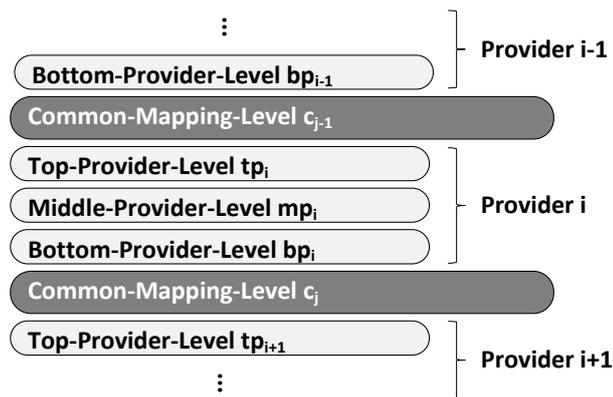

Figure 4.   Resulting generic bundle of conceptual service granularity levels for each provider.

5   Application in Logistics

In the following section the developed Service Granularity Framework is applied to the logistics domain. This creates a proof of concept and gives advice for practitioners on how to tailor the service granularity framework to a logistics service network. After briefly introducing the requirements of the logistics domain, the logistics service map is presented as a concept for management and engineering of modular services in logistics. Finally, the framework is applied to a generic example of a logistics network consisting of a logistics integrator and several LSP.

5.1   Requirements of Modular Services in the Logistics Domain

Domain-related requirements are included to ensure suitability of the application to the logistics domain. With an ever increasing cost reduction in outsourced logistics (Langley and Long, 2015), LSP are facing an increased economic competition. Thus, their *privacy concerns* are on a high level (C. Liu, Q. Li, and Zhao, 2009) e.g. regarding their price politics. Further to pricing aspects, importance of information and

know-how is emphasized. They are either proprietary and for *internal* use only or information and aspects are *externally* shown and provided to customers and/or collaboration partners in a cross-organizational business collaboration, e.g. see Norta et al. (2015). Furthermore, services are, firstly, characterized by the inclusion of external resources and know-how and an intensive contact to as well as integration of customers (Hipp and Grupp, 2005). Secondly, logistics networks are of dynamic character, as the loosely coupled LSP work together in a flexible way on demand (Solakivi, Töyli, and Ojala, 2013). Hence, the urgency of *collaboration* arises in order to maintain competitiveness and to participate successfully on such a customer oriented service market. *Common communication* is necessary within a network in order to increase efficiency of collaboration, visibility of available services in the network, and to increase value cocreation (Rai et al., 2012). At the very top-level, the whole *portfolio of services* available in the network has to be presented, as described in the approach of Kohlborn et al. (2009). Retrieval of atomic services and the related operating LSP (bottom-up) as well as recognition in case a specific function required by the customer is not available in the network (top-down): both capabilities are essential when creating composite services and demand for an *alignment* between top-level service portfolio and basic logistics function available in the network. Hence, a meet-in-the-middle approach is suitable. Summarizing, granularity issues in logistics have to consider different perspectives, internal and external aspects, as well as collaboration and privacy concerns.

5.2 Logistics Service Map

Offering a customizable approach for a logistics integrator, the logistics service map (Glöckner and Ludwig, 2013) satisfies the needs for supporting engineering and management of logistics services. This implies the creation of atomic services that can be composed to composite services. The conceptual aspects, like catalog function and the retrieval of services, are included with the structured categorization-pattern and the modular service construction functionality. Further, the service map postulates different granularity levels and viewpoints from basic service description up to a category overview. However, a more detailed description of the different granularity levels (number and characteristics) is missing. Fig. 5 shows a screenshot of the service map prototype. In the upper right, services can be chosen from the catalog and put into the editor in the lower right via drag-and-drop. Service-specific information and attributes can be displayed when changing the selected granularity to a more detailed level to foster planning and monitoring. Moreover, the unique standard of the available set of services within a network and the visualization foster a precise mediation and communication between all stakeholders during the whole service life-cycle. Service governance and meta-data management is unified by a given meta-model (Glöckner, Augenstein, and Ludwig, 2014).
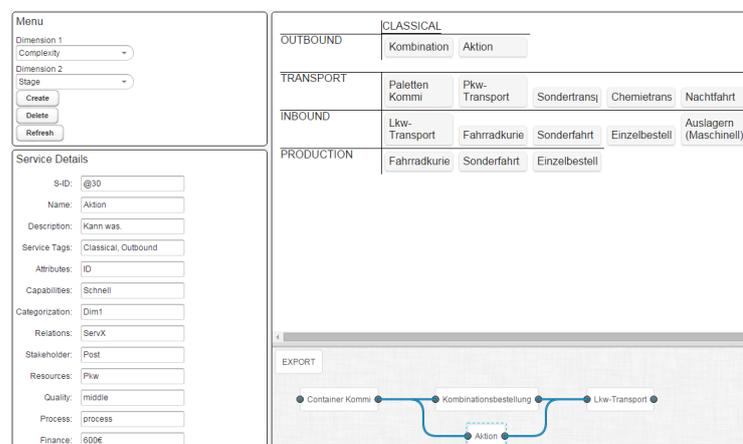

Figure 5.   Visual snippet of the service map prototype.

With this approach, a logistics network is supported in retrieving services in different use cases. (a) Add a new LSP to the network and match its offered services to the existing set of services in a logistics network by adding the new LSP to the provider list of the particular service. (b) Develop a new composite service to meet a specific customer's need by selecting and composing services from the service catalog with the help of the editor. (c) Find compensational service or provider when realizing the urgency for re-planning or elimination of errors because of unpredictable disturbance in the network. (d) Detect the need to find further specialists when customer requirements can not be matched to existing services.

Summarizing, there are the perspective of the service providers on the one side and the perspective of the network, the logistics integrator and its customers on the other side. The service map concept seeks to align both perspectives in order to foster mediation through a common set of services that are available within a logistics network. Hence, a network character with internal and external views as well as a combined top-down and bottom-up perspective is emphasized.

5.3 Application of the Service Granularity Framework to the Logistics Domain

The developed framework is applied to the logistics domain by taking the requirements of logistics domain and the logistics service map concept from the former subsections into account. The example network consists of two LSP on one hierarchical level and the logistics integrator on the next higher hierarchical level. The service map concept seeks to align both hierarchical levels in order to foster mediation through a common set of available services within a logistics network. Hence, internal and external views as well as a meet-in-the-middle perspective, as well as mediation and alignment is outlined.

The service granularity framework is transferred to a logistics network comprising 2 exemplary hierarchical levels. Using the formular of section 4.2, the conceptual description contains $2 * 3$ provider levels and $2 - 1$ mapping levels, resulting in a framework with 7 levels of granularity (see Figure 6 and Table 2). The first three levels on top are dedicated to the hierarchy of the logistics integrator ('provider levels'), whereas the bottom three levels represent the hierarchy of the participating LSP ('provider levels' as well). The level in the middle (darker gray) acts as the 'common-mapping-level' containing the connecting entities between the two hierarchies of LSP and the logistics integrator. Table 2 gives typical examples of possible services for each particular granularity level. Assuming that logistics services are not further outsourced, the two LSP on the lower hierarchy form the basis of the network. Their basic level contains the most basic
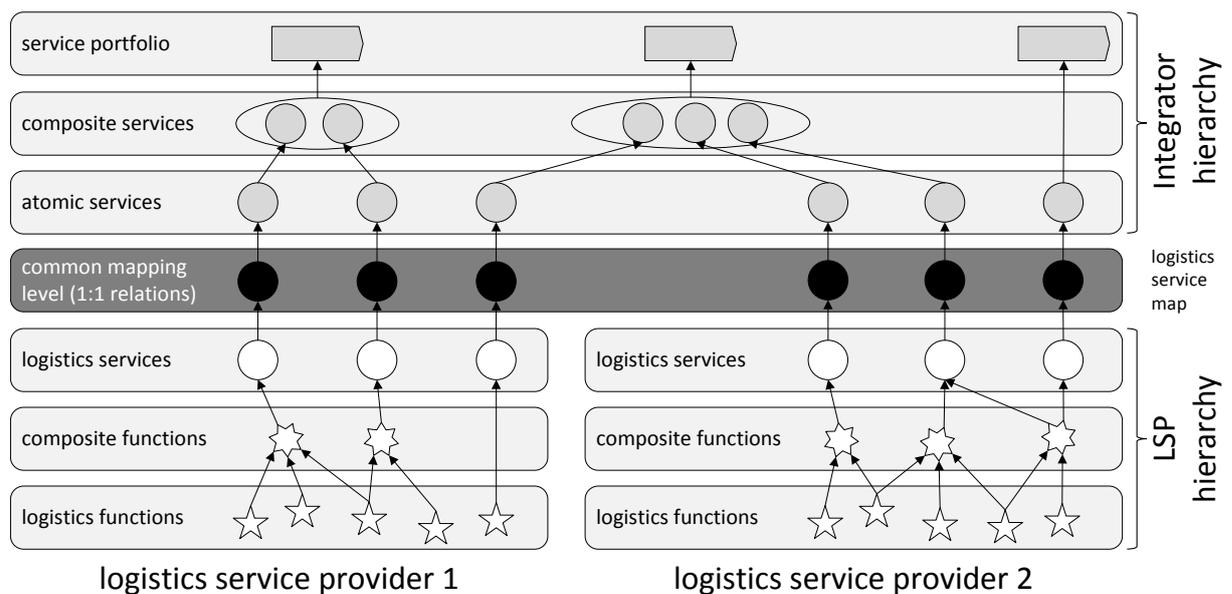

Figure 6.   Service granularity framework applied to the example logistics service network.

Table 2. Seven service granularity levels of the example logistics service network.

Nr	Name	Description	Example
7	service portfolio	comprehensive logistics capabilities	automotive logistics in a particular region
6	composite services	service that fulfill complex customer demands	supply chain for particular product modules
5	atomic services	services that are available in a network	transportation, inbound, or warehousing
4	common mapping level	mapping entities	logistics service map
3	logistics services	services, LSPs offer to customers, services that are presented externally	inbound
2	composite functions	mix'n'match of logistics functions	unloading + quality check + labeling
1	logistics functions	finest in-dividable logistics functions, where part steps don't make sense	unloading + putting the entity to a particular destination

logistics functionality of the network that can not be split further (see also level 1 in Table 2). Functions can be composed by the LSP (level 2) until they reach a level of granularity of logistics services that are externally presented to customers, or the logistics network in our case (level 3). The logistics network sources the available logistics services of all LSP in the network as its atomic services (level 5). These are combined to composite services in order to fulfill complex customer demand (level 6). All atomic and composite services together shape the service portfolio of the logistics network that can be presented to the end consumer of the logistics service network (level 7). The important point of interaction between LSP and the logistics integrator (or network, respectively) is located on the common-mapping-level (level 4). With its mediating, aligning character and being viewable and accessible by the connected stakeholders, the logistics service map concept can be located on this level.

Summarizing, with the service granularity framework and especially with the given use case, a general guidance on how to handle service granularity in service provider networks, such as of the logistics domain, is given. A *Service Granularity Framework* is defined for conceptualization of and working with service granularity in general, and in the logistics domain in particular. Results may also be transferred to networks with more hierarchical levels. Other service oriented domains with similar requirements could benefit from the framework as well. With the description of the framework and the examples a given logistics service can be adequately characterized and asigned to a distinct granularity level. With the assignment the need for further (de-)composition for specific purposes can be revealed. Consequently, the second research question is answered.

6 Conclusion and Outlook

The paper's objective is to find the 'right' set of granularity levels in order to facilitate composition and decomposition of modular logistics services. In order to provide scientific evidence a systematic literature review on 'service granularity' was conducted. 139 papers about service granularity were found in total. Only 21 of them delivered detailed description or concepts. Even though different dimensions of granularity (horizontal, and vertical) are implicitly described in literature, there exists no explicit conceptualization of service granularity. An explicit definition of vertical and horizontal granularity has been synthesized. Subsequently, service granularity is conceptualized and the service granularity framework is developed. Special emphasize is put on cross-organizational service composition. Provider-levels and the common-mapping-level are defined by their dimensional focus, purpose and characteristics

of the contained services or entities. Finally, the developed framework is applied to a generic logistics use case in order to make results tangible for practitioners of the logistics industry as well.

The research questions presented in the introduction are answered by implementing suitable methods. The first research question is answered with a systematic literature review. A conceptual Service Granularity Framework is developed, mainly influenced by Erradi, Kulkarni, and Maheshwari (2007), Galster and Bucherer (2008), Heinrich and Zimmermann (2012), Huergo et al. (2014), and J. Liu et al. (2015). The second research question is answered with the help of conceptual modeling based on the logistics service map in order to tailor the results to the specific needs of the logistics domain. An applied generic use case illustrates the possibilities for service oriented industries and proves the applicability of the concept to logistics.

The systematic literature review reveals some threats to validity that are related to:

- Completeness: publications may have been left out because of the database selection considered. Further, technical limitations of the involved search engines are to be mentioned that can not be estimated nor influenced by the researchers. Moreover, mostly journal-focused databases are taken into account, as conference proceedings often tend to be seen as of lower quality (Levy and Ellis, 2006). 'Springerlink' with a rather mixed characteristic of journals and conference proceedings shows a higher hit ratio and also the considered papers in general are more likely to be from a conference proceeding. Hence, further research shall be expanded to more conference-focused databases.

- Reliability: in order to reduce bias, evaluation and interpretation of publications was conducted by all the authors. But even though a multi-revision strategy was adopted, analysis and synthesis are based one the opinions of the research team (human beings), and thus are not beyond bias.

Implication for research is, to the best of our knowledge, the first conceptual framework on service granularity. We hope to contribute a new perspective to the scientific discussion as well as a useful artifact to the research community. As the framework connects several existing concepts it is able to describe the existing approaches comprehensively and interrelate them.

We intend to encourage practitioners to understand the consequences of modular logistics services. Implications for practitioners result in a guidance on how to deal with service granularity in logistics networks. Further, guidance is given for assigning services with regards to their characteristics to a distinct granularity level. Hence, service engineering and management is facilitated and the need of further (de-)composition can be easily revealed. This could result in a higher flexibility of LSP and a higher service quality that leads to a higher customer satisfaction and increased competitiveness. Modularity is a widely discussed issue in literature, but applying the concept to business is still a demanding challenge in logistics.

Future research will focus on the mapping entities on the common-mapping-level. The definition of logistics specific service descriptions, inter-dependencies and interfaces is crucial in order to apply the developed framework. The application of the framework in use cases creates practical evidence and will lead to detailed feedback for further improvement. Extension of the literature review on more conference-based literature databases will improve the service granularity framework, as well.

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