Service Value Networks

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Abstract

The current industry-driven trend of providing flexible e-services lays the ground for the new research area "service value networks" (SVNs). We observe a rising number of industry-oriented publications provided by research departments of large companies such as IBM or SAP as well as the fact that more and more IS conferences offer special tracks on that issue. However, when it comes to formalizing and economically analyzing such SVNs that offer joint complex services to service customers, scientific approaches are in their infancy. We intend to fill this research gap by providing a clear understanding of service value networks by defining their characteristics, their structure, and their components. Mapping these aspects into a formalized model, we intend to establish a reference point for future work in the area of service value networks.

1. Introduction

Tremendous technical and economic developments are radically changing the business models of companies engaging in the software industry and they way they create value. Large monolithic software applications implying license-based pricing models are being replaced by the on-demand delivery of flexible service components operated in service-oriented architectures (SOA). Such modular components can easily be adapted and extended by additional services. Instead of selling license-based full versions based on upfront payments, software is now offered as a service (SaaS).

This conceptual and technical change offers customers the opportunity to purchase services on demand and not bound to a single vendor. Service modules can rather be composed from the offers of different providers tightly focused on required features. Such modularity is one of the most promising answers to the question of how to face rising demands for sophisticated, customized products. Once serving the whole value chain by what has become famous as vertical integration, service providers now tend to engage in networked value creation in ecosystem-like environments we call *service value networks (SVNs)* in the following. This development calls for new cooperation forms in loosely-coupled configurations of legally independent firms. Through specialization, service providers leverage the knowledge and capital assets of their partners and lower the risk of operating in a changing and uncertain environment.

The evolution of such ecosystem-like networked economies brings up new research questions. How do such service value networks form and evolve? Which components do they comprise? Can they still be evaluated subject to traditional notions of network economics, that involve, for instance, concepts like lock-in and switching costs? Incentives for economic entities to participate in such networks need to be studied as well as the investigation of efficient coordination and pricing mechanisms.

We will not be able to answer all of these questions in the present paper. In fact, we zoom out to a higher level. Our intention is to precisely define service value networks as they are induced by above-mentioned trends and developments, thereby laying the ground for a rising research area on a new business trend[1]. Management literature, social, and computer science have developed tons of definitions for all kinds of networks. However, service value networks exhibit special characteristics compared to the known definitions that are not yet sufficiently discussed and formulated. Furthermore, both academics and practitioners still lack approaches to formalize and economically analyze such organizational forms. We intend to fill this research gap by introducing a formalization of SVNs that builds the foundation for further investigation in this field.

To summarize, the contribution of this paper is threefold: First, we clarify what service value networks actually are and how this understanding is related to existing literature. Second, we describe the structure and components of SVNs, both in theory and practice. Based upon that, we eventually introduce a formal framework to model such service value networks.

[1]This trend to be observed in publications of large companies as IBM or SAP as well as the fact that many IS conference offer special tracks on that issue encourage us in our work in providing a basic definition.

2. Definition

Ever since the seminal work of Williamson at least three types of business governance structures have been identified: market, hierarchy, and hybrid forms [1]. In pure markets all information is publicly and instantaneously observable via the price mechanism, which in turn provides a perfect incentive mechanism to align individual profit with economic efficiency. However, by this it is assumed that an effective price mechanism exists in the first place. This is a presumption which is generally not warranted for non-standardized goods and services that involve high factor-specificity (sunk costs), customization, low frequency of trade, or high uncertainty in demand or supply. Traditionally, prohibitively high transaction costs (e.g. due to the formation of incomplete contracts) have been attributed to prevent the existence of such purely market based governance forms [2]. More recently, also the knowledge-based view of the firm proposed that purely market-based organization cannot protect a firm's knowledge and core competencies appropriately.

In a purely hierarchical organization, on the contrary, value is created strictly within the boundaries of the integrated firm. Here, by definition, opportunistic behavior of business partners is not feasible, and thus neither the revelation of knowledge nor the incompleteness of contracts poses impossibility constraints. However, such formal control usually comes at the price of inefficiency and inflexibility, which are both crucial in an increasingly competitive economy. Hybrid governance forms such as networks combine the advantages of market governance, in particular adaptability, incentive compatibility and efficiency with those of hierarchies, foremost control and protection of knowledge and core competencies.

2.1. Networks as a Type of Governance Form

As a consequence, *business networks* have been proposed as the superior governance form for today's highly dynamic and complex business world [3]. Business networks evolve from a pool of potential horizontal as well as vertical business partnerships. In this respect they differ both from *strategic alliances*, comprising only horizontal business partners, and *supply chains*, denoting purely vertical relationships. The advantages of business networks compared to more traditional governance forms are manifold:

- Insurance against uncertainty in demand and supply.
- Balancing adaptability to highly complex tasks while maintaining control.
- Protection of business knowledge through modularization.
- Market-based forces as coordination mechanism to ensure efficiency.

A bulk of managerial and academic literature deals with variations of such business networks, whose complete characterization would be far beyond the scope of this paper. Rather here, we identify *Service Value Networks (SVNs)* as a special type of business networks and point out the differences to related organizational forms, which are to described in the following:

Virtual Organizations (VOs) are temporary networks of independent enterprises that bring in complementary competencies and resources for mutual benefit [4]. VOs stress the complementarity of firms' core competencies in the value creation process and the temporary nature of the interaction. However, VOs often suffer from trust related problems and are therefore usually constituted among firms in a closed pool of known network partners.

Smart Business Networks (SBNs) are one way beyond the VO framework and particularly stress the *smart* use of information and communication technology (ICT) as a facilitator to network interaction. Smartness is thereby a relative term, which refers to effectiveness and a comparative advantage through the use of ICT. Moreover, ICT is also seen as an enabler of network agility, i.e. the network's ability to "rapidly pick, plug, and play" business processes [5]. Furthermore, nodes in a smart business network need to meet specific requirements in order to be ready to contribute to ad-hoc joint value creation. This modularity of potential network members allows not only for spontaneous network orchestration, but also for better protection of a firm's core competencies as compared to VOs. Trust problems are thus not as severe and the SBN may therefore recruit members from a more open pool of potential partners. The instantiations of SBNs are also more short-lived than those of VOs. However, like in VOs, the network pool itself is sustainable over time.

Business Webs are defined as "customer-centric, hetrarchical organizational forms that consisting of legally independent but economically interdependent specialized firms that co-opetitively contribute modules to a product system based on a value-enabling platform under the presence of network externalities which are supported by extensive usage of information and communication technologies." [6]. Business Webs stress the internet as the primary channel for business communications [7]. Moreover, the so-called "shaper-adapter configuration" is an important assumption: A shaper (i.e. a focal company or nucleus) controls the central element in a business web, while adapters (i.e. context providers) add complementary elements. A closely related field of research considers *Business Ecosystems* whose quintessence is each participant's ultimate connection to the fate of the network as a whole [8].

In this context, SVNs are a special type of SBNs with features of Business Webs. They exhibit the crucial features of SBNs, such as the smart use of ICT, agility, ad-hoc value creation and sustainability of the network pool. With respect to Business Webs, SVNs share the feature of being enabled through ubiquitously available ICT, foremost the Internet.

However SVNs are distinct to Business Webs because they do not follow the shaper-adapter paradigm and are rather constituted by market-based composition from an open pool of network partners.

2.2. Service Value Networks

Definition 2.1 (Service Value Network) *Service Value Networks are Smart Business Networks, which provide business value through the agile and market-based composition of complex services from a steady, but open pool of complementary as well as substitutive standardized service modules by the use of ubiquitously accessible information technology.*

In the following, we will discuss each part of the definition in detail and thereby highlight the boundaries of service value networks.

Complex services. By a *complex service* we understand the composition of component services. In more detail, complex or composite services typically involve the assembly and invocation of several component services offered by diverse enterprises in order to complete a multi-step business functionality [9]. In turn, *component services* are either other complex services or functionality that is provided via a Web service. The term *utility service* originates from the energy domain, denoting core services such as the provisioning of gas or electricity. Adapted to the area of e-services, the term denotes infrastructure services that provide enabling technologies for ecosystems such as storage capabilities and the provisioning of computing power (cp. Section 3.1).

Standardized service modules. In order to be plug-and-playable, the utility services must provide standardized interfaces for interchanging machine-readable parameter values.

Steady but open pool of complementary and substitutive services. Services must register (or be registered) with the service value network in order to be eligible for composition. This set of registered services form the steady pool from which a complex service is composed. However, the registration is open for any service which meets certain minimum requirements, such as modularity provided through a detailed interface specification. Moreover, it is also feasible that the service value network itself will actively browse the service landscape for eligible services and register them automatically. In particular, in this context *steady* means that the SVN maintains a list of services (including their interface descriptions), also if there is no current service composition request in the network. *Open* however, refers to the fact that no service can be excluded from the network, as long as it meets the publicly known minimum requirements.

Agile and market-based composition. *Agile* service composition refers to the network's ability to orchestrate a complex service ad-hoc and demand driven. At the time of the request, the SVN will search for an optimal path through its network of registered services. Here optimality is evaluated in terms of efficiency, i.e. the allocated complex service should maximize the sum of consumer and producer welfare. This can only be achieved if the service orchestration is driven by a market-based approach, e.g. by means of a reverse auction.

Ubiquitously accessible information technology. Finally, the SVN must be run on and by ubiquitously accessible information technology, such as the Internet. This requirement comes as a direct consequence from the openness of the service pool and the call for efficiency. If any service meeting the requirements of the SVN shall be allowed and encouraged to register with the SVN, the SVN itself cannot rely on proprietary and protected information technology.

3. Evolution and Structure of Service Value Networks

To foster a fundamental understanding of the service value network concept[2], Figure 1 depicts the main components and their interdependencies in a simplified manner.

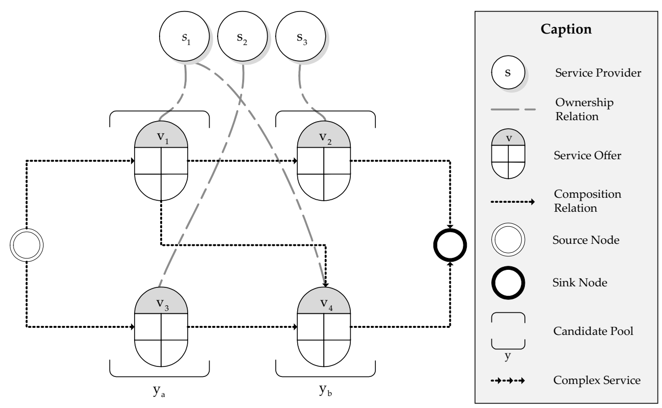

Figure 1. General Service Value Network Model

A service value network consists of a set of *service providers* ($s \in S$) that supply a portfolio of *service offers* ($v \in V$) that provide described functionality. Each service provider can own one or multiple service offers indicated by an *ownership relation*. The example in Figure 1 shows a service value network with four service offers (v_1, v_2, v_3, v_4) that are owned by three service providers (s_1, s_2, s_3). Service offers that are substitutes – i.e. providing roughly similar functionality – are clustered in *candidate pools* ($y \in Y$). A candidate pool is a set of potential service offers that are substitutes and can therefore be replaced on-demand. Service offers that are compatible, i.e. they are interoperable regarding their interfaces and input and output capabilities,

[2]For a detailed analysis of SVNs with special focus on the definition of value and its creation enabled through coordination mechanisms, the interested reader is referred to [10]

expose a directed *composition relation*. Service offers – clustered into candidate pools – and their connections form a graph-like structure that is directed and acyclic starting from a source node and ending at a sink node. Each feasible connected set of service offers within this graph is called a *path* and represents a possible instantiation of a *complex service* consisting of functionality from each candidate pool. According to the example in Figure 1 a complex service can be instantiated either by a composition of v_1 and v_2, or v_1 and v_4, or v_3 and v_4. Components and roles in the service value network context are explained in detail in the remainder of this section.

3.1. Service Providers and Service Offers

The number of service providers offering various types of utility, elementary and complex services in ecosystem-like environments is constantly increasing. Exemplarily, Amazon offers utility services based on their infrastructure as a computing and storage services called Elastic Compute Cloud (EC2) (http://aws.amazon.com/ec2/) and Simple Storage Service (S3) (http://aws.amazon.com/s3/) that are accessible and manageable through simple highly standardized interfaces based on REST and WSDL. In most cases, such cloud computing infrastructures are organized in a cluster-like structure facilitating virtualization technologies. Nevertheless, there are service providers that focus on offering computing on-demand through a server Grid such as the Sun Grid Computing Utility (http://www.network.com/). Among providing pure utility services, providers such as RightScale (http://www.rightscale.com/) often enrich their offerings through value-added elementary services for managing the underlying hardware (i.e. scaling, migration) that are accessible via Web front-ends. Service providers such as StrikeIron (http://strikeiron.com/) offer a comprehensive portfolio of elementary and complex Web services that provide functionality in the context of communications, customer relationship management (CRM), data enhancement, e-commerce, finance, and marketing. Especially in the financial sector, companies like Xignite (http://www.xignite.com/) sell data services providing financial information such as real-time stock quotes, options, historical data, commodity prices, mutual funds, currency rates, and financial market indices.

Nevertheless, not only rather simple, but also complex services supporting multi-step business processes are offered modularized in an on-demand fashion. For instance, providers like salesforce.com (http://www.salesforce.com/) or Netsuite (http://www.netsuite.com/) successfully entered the business software market with their entirely Web-based on-demand CRM suites. Components offered within these suites can be dynamically composed to customized complex services. AppExchange (http://www.salesforce.com/appexchange/), the service marketplace offered by salesforce.com, offers a range of pre-integrated complementary services provided by 3rd-party vendors grouped around the core service Salesforce CRM.

3.2. Service Requester

The open and dynamic character of service value networks enables customers to request customized complex services from whatever service value network they prefer that satisfy their needs and match market requirements. Service requesters can create their complex services by composing adequate service components from multiple candidate pools in a plug-and-play fashion in order to receive added value. Requesters are not forced to provide solutions covering the whole range of a business process any more. They are now able to complement their service portfolio by requesting complex services from service value networks (cp. Example 3.1).

3.3. Candidate Pool

The structure of service value networks, characterized by their participants and their interrelations, is not static and predefined but formed on-demand in a short term, goal-oriented fashion. The formation process requires a steady pool of distributed and loosely-coupled service providers that offer predefined functionality through modularized services to be ready on call. In order to participate in service value networks, i.e. participate in candidate pools to be ready for service provisioning, service providers must register at a central registry and satisfy a set of minimum requirements such as interoperability through well-defined interfaces based on Internet standards. The process of registration can be activated by switching initiators, meaning that also an operator of a central registry might query and pro-actively invite suitable service providers to join a candidate pool. The open character of service value networks allows any service provider to potentially participate in value creation as long as minimum requirements are met.

Candidate pools group service offers of multiple service providers by functionality and capabilities exposed. Service offers covering the same spectrum of functionality (e.g. login/ID services such as OpenID (http://openid.net/) and Google Accounts (https://google.com/accounts/)) are categorized in identical candidate pools. These services are replaceable and represent service substitutes from an economic perspective. The actual formation process occurs when a concrete service request is addressed to the loosely formation of service providers. Based on the required functionality and capabilities described by the request, feasible candidate pools are iteratively arranged in a way that they together contain the potential to jointly generate desired value. A coordination mechanism is required to chose a single service offer from each candidate pool based on a set of rules in order to efficiently instantiate the requested complex service to be provided to the service requester.

3.4. Complex Service

The final outcome produced by a service value network is realized through a sequence of modularized service offers from a set of iteratively arranged candidate pools (cp. Figure 1), that is, a complex service. This final outcome is the added value generated for the service requester.

While simple services may provide simple functions such as credit checking and authorization, inventory status checking, or weather reporting, complex services may appropriately unify disparate business functionality to provide a whole range of automated processes such as insurance brokering, travel planning, insurance liability services or package tracking [11]. A complex service is composed of multiple primitive services[3], often requiring an interaction or conversation between the user and services, so that the user can make decisions [12].

Example 3.1 (Payment Processing) *Consider a manager of a mid-size company that distributes flowers over the Internet. As payment processing is not a core competency of the company, the board decides on the integration of third-party services into existing business processes in order to decrease costs of operation and maintenance. The diagram in Figure 2 sketches an excerpt of the service components of an exemplary complex service that provides payment processing functionality.*

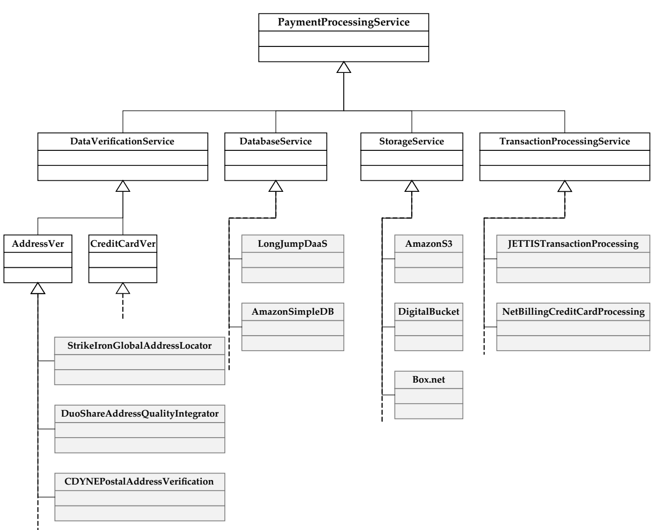

Figure 2. Payment Processing Service (Static View)

The PaymentProcessingService facilitates service components from StrikeIron (http://strikeiron.com/), Duo Share (http://duoshare.com/) and CDYNE (http://cdyne.com/) to verify the customer's address and credit card information. Customer data is stored and managed using a StorageService and a DataBaseService from third-parties. Exemplary services from decentralized storage providers are Amazon S3 (http://aws.amazon.com/s3/), Digital Bucket (http://digitalbucket.net/) and Box.net (http://box.net/). Services for organizing and managing customer data are Amazon Simple DB (http://aws.amazon.com/simpledb/) and Long Jump DaaS (http://longjump.com/daas/). The actual execution of the financial transaction through the TransactionProcessingService is provided by JETTIS Transaction Processing (http://www.jettis.com/) and Net Billing Credit Card Processing (http://www.netbilling.com/).

The process behavior of the payment processing complex service is depicted in Figure 3. Customer data is validated in the first step. After validation the actual transaction takes place and the customer's credit card account is charged by a transaction processing service. The change in state must be updated consequently in the internal database of the company. A database service updates corresponding customer data that is stored using a decentralized storage service. For each step of the complex service there is a potential pool of suitable candidates to fulfill required business transaction. The result of each transaction is passed sequently to the successor service. In order to successfully instantiate the complex service the overall transaction requires a service candidate from each pool.

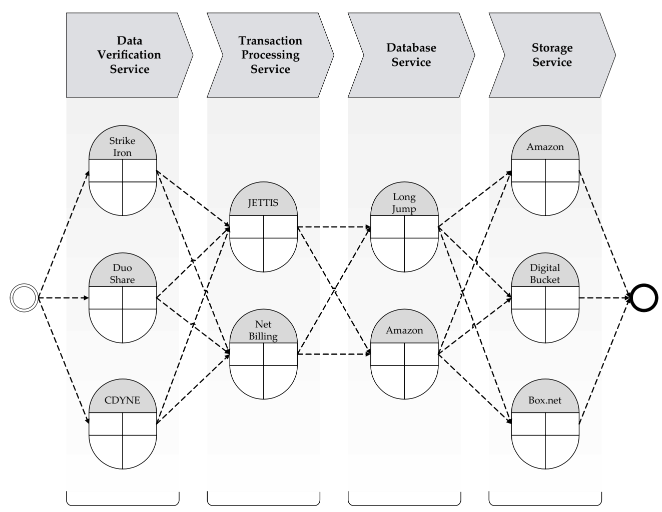

Figure 3. Payment Processing Service (Dynamic View)

3.5. Coordination Mechanism

In environments with distributed, self-interested entities that jointly contribute to an overall goal, mechanisms are needed that coordinate procedures from multiple parties

[3] See also Section 2.2 for a definition of complex services.

with possibly colliding objectives. Service value networks are a prominent example of such complex environments and their success therefore highly depends on adequate and efficient coordination mechanisms. According to [13], *coordination is to manage the dependencies of activities*. It is obvious that various facets of coordination forms exist that have to be chosen according to the characteristics and requirements imposed by the type of environment. As stated before, the continuum of coordination ranges from market-based approaches to hierarchical control [1]. Market-based approaches manage the activities of distributed, self-interested (utility-maximizing) economic entities only indirectly by institutionalizing a rule set that incentivizes market participants to act in a desired manner (social choice) in order to achieve an overall goal. Nevertheless, there are situations in which this 'liberal' form of coordination results in inefficient outcomes. In this case, the economic entities need to be consciously organized in more hierarchical forms to streamline activities in an efficient manner.

The problem of efficiently choosing adequate service offers from candidate pools to instantiate a complex service that meets the requirements imposed by the service requester is a well-known problem to coordination. Service providers are self-interested, act rationally and therefore try to maximize their individual utility without accounting for a system-wide solution (e.g. a solution that maximizes welfare). Thus, the design of adequate coordination mechanisms is crucial to the efficiency and success of a service value network.

Example 3.2 (SVN Realizing a CRM Complex Service) *This example shows the formation of a service value network that is ready to instantiate a complex service based on the requirements imposed by service request. A service requester requires a complex service that scans calendar entries within the upcoming week with regard to future meetings within a company. Based on the the meetings' descriptions, the complex service queries soft skills of all meeting participants by browsing their profiles in social communities. Gathered information is then updated in a CRM data base that is stored by on-demand storage infrastructure (Figure 4).*

A set of service providers participates in the service value network by offering services grouped in candidate pools. Google offers its Google Calendar service (http://google.com/calendar) and Google App Engine (http://code.google.com/appengine/) which provides a scalable infrastructure for service development and storage. The social community platforms Facebook (http://facebook.com/) and LinkedIn (http://linkedin.com/) provide services to browser profiles of registered users. Amazon offers flexible storage capabilities through its Simple Storage Service (S3). As depicted in Figure 4 the requested complex service can be realized in four different versions by selecting feasible service combinations (e.g. Google Calendar, LinkedIn Browser and Amazon S3).

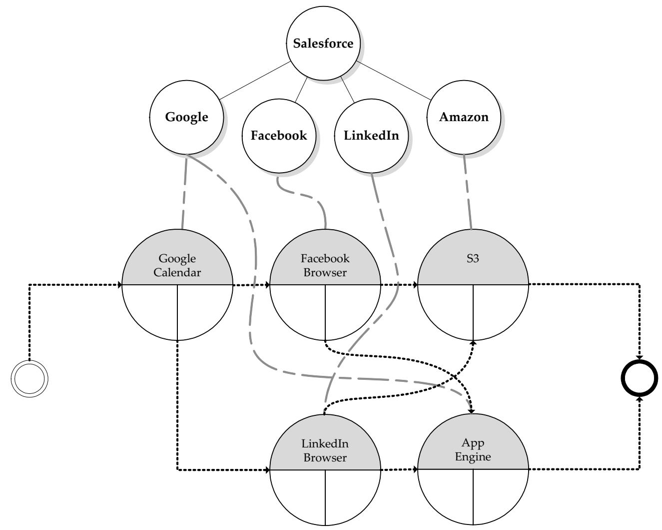

Figure 4. Example of a Service Value Network Realizing a CRM Complex Service

4. Model and Formalization

A service value network is described by means of a simplified state chart model [14] and is aligned with the representation in [15]. State charts have proven to be the preferred choice for specifying process models as they expose well-defined semantics and they provide flow constructs offered by prominent process modeling languages (e.g. WS-BPEL) and therefore allow for simple serialization in standardized formalisms.

Hence, a service value network is represented by an k-partite, directed and acyclic graph $G = (V, E)$. Each partition $y_1, \ldots, y_K$ of the graph represents a *candidate pool* that entails service offers that provide the same (business) functionality. The set of N nodes $V = \{v_1, \ldots, v_N\}$ represents the set of *service offers*[4] with v, i, j being arbitrary service offers. Services are offered by a set of Q *service providers* $S = \{s_1, \ldots, s_Q\}$ with s is an arbitrary service provider. The *ownership information* $\sigma : S \rightarrow \mathcal{P}(V)$ that reveals which service provider owns which services within the network is public knowledge[5]. There are two designated nodes v_s and v_f that stand for source and sink in the network. The set of edges $E = \{e_{ij} | i, j \in V\}$ denotes technically feasible service composition such that e_{ij} represents an interoperable connection of service $i \in V$ with service $j \in V$[6]. If two services are not interoperable at all, they are not connected within the network.

[4]The terms *service offer*, *service* and *node* are used interchangeably

[5]The reverse ownership information $\sigma^{-1} : V \rightarrow S$ maps service offers to single service providers that own that particular service

[6]For the reader's convenience the notion e_{ij} is equivalent to $e_{v_i v_j}$ representing an interoperable connection of service $i \in V$ with service $j \in V$.

A *service configuration* A_j of service $j \in V$ is fully characterized by a vector of attributes $A_j = (a_j^1, \ldots, a_j^L)$ where a_j^l is an attribute value of attribute type $l \in \mathcal{L}$ of service j's configuration. Attribute types can be either functional attribute types or non-functional attribute types (e.g. availability or privacy). A service's configuration represents the quality level provided and differentiates its offering from other services. According to [16], a service configuration can be defined as follows:

Definition 4.1 (Service Configuration) *A service configuration A_j of a service $j \in V$ selects a value a_j^l for each attribute type $l \in \mathcal{L}$ of a service and thereby unambiguously defines all relevant service characteristics. The choice of configuration might affect the functional and non-functional aspects of a service and is a major determinant of the price.*

Furthermore let c_{ij} denotes *internal variable costs* that the service provider that owns service j has to bear for that service being interoperable with service i and for the execution of service j as a successor of service i. The representation of a detailed cost structure of service providers is intentionally omitted which serves a better understanding and does not restrict the generalization of the model. It is assumed that the representation of internal variable costs reflects the service providers' valuations for their service offers being executed in different composition-related contexts.

Example 4.1 (Context-Dependent Cost Structures) *In order to illustrate the idea of context-dependent cost structures of service providers, Example 3.1 is consulted, whereas the complex service is reduced to the first two business transactions,* data verification *and the* transaction processing. *Figure 5 shows the service value network with service offers and corresponding costs dependent on the predecessor service. Data verification can be performed by either StrikeIron (s_A) and its service offer A or CYDNE (s_B) offering service B. The execution of the actual monetary transaction is done by Net Billing (s_C) offering service C.*

A mandatory step of the overall payment processing service is the credit assessment. As a precondition, a transaction processing service has to check if the customer is credit worthy in order to charge the corresponding account. The credit assessment has to be performed at a central authority (e.g. Equifax, Experian or Trans Union) and generates variable costs each time it is executed. In the concrete scenario, Net Billing has to bear higher costs of 0.8 *in case it is executed as a successor of the Sales Force data verification service as it does not provide a credit check in advance. In contrary, the service offered by CYDNE is capable of performing a credit check which results in lower internal costs for Net Billing of* 0.5.

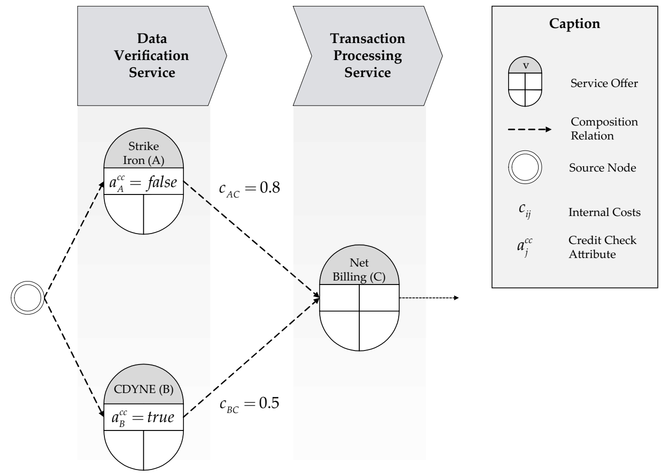

Figure 5. Context-Dependent Cost Structures of Service Providers

The instantiation of a complex service is represented by a path from source to sink within the service value network. Let F denote the set of all feasible paths from source to sink. Every $f \in F$ with $f \subset E$ represents a possible instantiation of the complex service[7]. A first example for such paths was shown in Section 3.

Definition 4.2 (Service Value Network Model) *A service value network model is an acyclic, k-partite and directed graph such that*

$$G = (V, E) \tag{1}$$

with the set of nodes V representing service offers and the set of edges E that denotes technically feasible service compositions. G contains two designated nodes v_s and v_f representing source and sink such that every feasible path $f \in F$ connecting both nodes is a possible instantiation of the complex service.

For illustration purpose, Figure 6 shows the model of a service value network with service offers $V = \{v_1, \ldots, v_4\}$ and service provider $S = \{s_1, \ldots, s_3\}$. Every feasible path $f \in F$ connecting source node v_s and sink node v_f represents a possible realization of the overall complex service.

5. Conclusion

The actual industry driven trend in providing flexible e-services lays the ground for the new research area "Service

[7] Focusing on the presence or absence of a particular service $i \in V$, F_{-i} represents the set of all feasible paths from source to sink in the reduced graph G_{-i} without node i and without all its incoming and outgoing edges. In contrary, let F_i be the subset of all feasible paths from source to sink that explicitly entail node i.

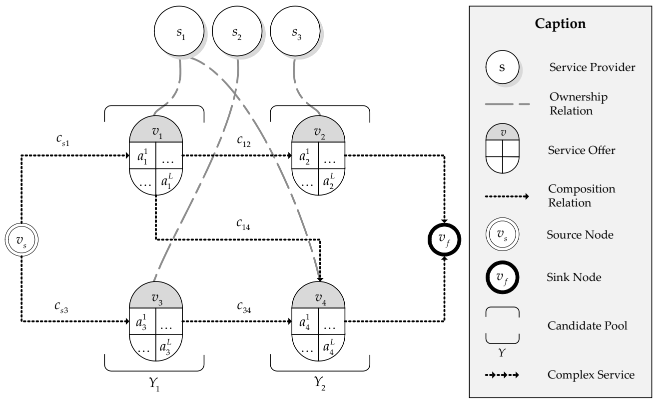

Figure 6. Service Value Network Model

Value Networks". Since this research area is still in its childhood only some work has been published – what is still missing is a common definition of service value networks and their differentiation from existing management literature on networks in general. With the present paper we aim to close this gap.

First, we gave a brief introduction to the management networks litature and provided our defintion of SVNs as business networks which provide value through agile and market-based composition of complex services. Second, we described the evolution of SVNs and explained the service providers, service requesters, the steady pool of services as the individual components of such a network and complex services respectively. We have provided examples to illustrate our understanding. Third, we presented a formal model which is a basis for the analytic, experimental and simulative research in the field.

Overall, the paper contributes to the work in the field in clarifying the understanding, and as such, provides a reference point for future work. Current and future work does and will comprise developing coordination and pricing mechanisms for complex services [10], [17], building appropriate business models for platform providers of service networks, and studies of network formation [18], [19] and incentives mechanisms to foster the evolution of desired networks.

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