

# Open Service Networks: Research Directions

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## ABSTRACT

Service networks are a new research field which promises to increase our knowledge of service-based systems. Understanding what factors explain the evolution of global service networks can lead to more efficient and balanced infrastructures. The challenge consists in developing a novel perspective by connecting models representing services (e.g. cloud computing and governmental services) into networks. Theories, methods, and applications to be developed will enable, afterwards, to understand, describe, explain, analyse, predict, and control the structure and behaviour of global service networks.

## Categories and Subject Descriptors

H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval—*Information filtering*; H.4.3 [Information Technology and Systems Applications]: Communications Applications—*Information browsers*

## Keywords

Service networks, service systems, service relationships, service science.

## 1. INTRODUCTION

Networks have been playing an increasingly important role in many fields. The Internet, the World Wide Web, and social networks are examples of some of the myriad types of networks that are a part of the everyday life of many people. Service networks are another class of networks of emerging interest since worldwide economies are becoming increasingly service-based and connected. The concept of service network is formally represented as a graph structure made up of services which are nodes connected by one or

more specific types of relationships [3]. Networks are called open since they are reconstructed from information available on the web and are made freely available.

Among financial, telecommunication, and governmental networks, one class of service networks is emerging based on the way cloud computing services are being organized and how they create relationships and dependencies between themselves. In fact, companies such as Netflix, Instagram, Heroku, are dependent on Amazon AWS, and many other companies have their web site on Heroku. Finally, end users become dependent of the networked infrastructure created.

The long-term goal of service network theory and analysis is to understand large-scale global service networks. Well-organized networks lead to increased efficiencies, faster response to market changes, and increased productivity. However, up to now, analysing such networks to identify patterns and undertake large scale optimizations has not been possible. Most of the research in this field has been based on small scale empirical observations and case studies. Service network science can change this state of affairs and explore large scale, automated analysis.

## 2. MOTIVATION SCENARIO

Let us consider the networked society by looking into another specific class of networks: financial service networks. Today's financial networks are highly interrelated and interdependent. Any disorders that occur in one service of the network may create consequences in other services. For example, in 2008, the economic problems initiated a chain reaction that started in the U.S. and caused problems in European markets and took almost Iceland to bankruptcy. Leading financial services closed (e.g. Lehman Brothers investment bank), others merged, and yet new services were created. The configuration and topology of financial service networks changed as a reaction mechanism. The disaster was a surprise for most people, but local information to each financial institution and financial service was available and could have been utilized to anticipate the catastrophe. Unfortunately, an overall view of the global network ecosystem was not accessible to regulators.

Service networks acquires a particular importance since their study and analysis can bring new scientific discoveries on how service-based systems operate at a global scale. The engineering of service networks, in opposition to *ad hoc* con-

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structions, can lead to the creation of networks more fit for purpose.

### 3. BUILDING BLOCKS

The last decade has seen an increased interest in the study of networks in many fields of science. Examples are numerous, from sociology to biology, and to physical systems such as power grids. Nonetheless, the field of service networks has received less attention. As observed by Chesbrough and Spohrer [4], *"the abundance of information about people, technological artefacts and organizations has never been greater, nor the opportunity to configure them meaningfully into service relationships that create new value"*. Only now, the role of Information and Communication Technologies (ICT), and service management, design and engineering has reached a maturity stage which enables to create service network. Open movements, such as open source and open innovation, bring the initiative to share information on services; linked data bring the technology to interlink data globally; semantic Web technologies provide the global platform for information integration; business models contribute with theories to understand the structure of service models; network science sets the theoretical stage for service network analysis. Only now have all the building blocks reached a maturity which makes it possible to initiate the study of service networks. Delaying research on this field will hinder the construction of a more fair and efficient service-based society.

Previous approaches to identify service networks were typically restricted to the manual collection of business data from survey firms, teardown reports or on-site analysis (e.g. Dell supply chain analysis and Apple's iPod supply chain). These methodologies are only suitable to study small, localized structures, e.g. supply chains, and are not adequate to study global service networks.

Three recent developments provide foundations for the reconstruction of open service networks: Service-Dominant Logic (SDL) [6], Linked USDL for service descriptions [2], and OSSR for relationship descriptions [1]. Vargo and Lusch introduced the concept of SDL and showed that our society has been gradually moving from a product-based orientation to a service-orientation where the elements of economical exchange are services and not products as before. This places services at the center of society. Linked USDL and OSSR bring a different paradigm from computer science. They enable to easily integrate distributed service descriptions at a global scale using semantic Web principles. This is essential to bring information on distributed services together.

### 4. IMPACT ON SOCIETY

Understanding how services evolve as networks and the risks and gains of different topologies is also becoming increasingly critical for society [5]. The impact on society can be compared to contributions made in the areas of social networks and power grids/networks. We can identify three main entities who would benefit from research on service networks: 1) governments, 2) regulation bodies, and 3) organizations.

Governments can rely on scientific data to pass more adequate legislations. Understanding the dynamics and laws governing service networks can provide, e.g., authoritative insights on *why* and *how* financial service systems fail. It

can explain how the 2007–2012 global financial crisis propagated throughout global service networks. Network analysis can provide scientific grounds for the engineering of efficient and robust service network topologies to resist adverse environments.

Regulatory bodies can analyse service networks to detect topological patterns such as oligopolies, monopolies, or 'cartels' in service markets. For example, a power-law distribution pattern can be used to identify oligopolies since it implies that only a few large service providers exist, whereas the occurrence of small providers is extremely common. The identification of such network characteristics or anomalies are of importance for regulatory bodies such as the EU which routinely passes directives for European markets on laws to be followed.

Organizations can use service network tools to analyse global supply-chain networks. Currently, the non-existence of global models only enables to study this type of networks from a local, reduced, and naïve view. The development of computational models will give firms a better understanding of the dynamic behaviour of supply chain networks at a global scale.

### 5. CONCLUSIONS

Societies are increasingly becoming service-based and interconnected. As service networks emerge, their analysis will enable to better understand how service structures evolve, grow and change overtime. Service network analysis can provide theories, models, techniques, and tools to contribute to this understanding. From a more practical side, service networks can model, e.g., the way cloud computing services are emerging and how they are structured in terms of relationships and dependencies. Information on these types of networks can lead to the construction of more robust infrastructures against failures such as the recent outage of Amazon AWS that has impacted hundreds of companies such as Netflix, Heroku and many others.

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