# Describing Health Service Platform Architectures: A Guiding Framework

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## Abstract

Health service platforms (HSPs) facilitate new ways of delivering health care, in order to improve care effectiveness and efficiency. HSPs are a sub-type of digital platforms that have a different purpose compared to market-oriented platforms for product innovation or economic transactions. Hence, traditional descriptions of digital platform architecture, such as the layered modular architecture, may not be sufficient to capture the essential features of HSPs. We create an initial framework for describing HSP architectures in a manner that reflects their purpose, drawing from literature on Service-Dominant Logic and architectural patterns. The framework will be used to guide a multiple-case study of HSP architecture. The results of this research will extend current conceptualizations of digital platform architectures and provide a systematic approach for designing or evolving HSP platform architectures in a manner that better meets patients' and other health care stakeholders' needs.

**Keywords**

Health Service Platforms, digital platforms, platform architectures, Service-Dominant Logic, Architectural patterns

## Introduction

Digital platforms are increasingly being used in the health domain for a variety of purposes, such as disease prevention, remote patient care, self-management, and research (Aledavood et al. 2017; Keijzer-Broers et al. 2016; Paganelli et al. 2008; Summers et al. 2018). The use of digital platforms provides the means to move beyond traditional clinical and health information systems, making them available to actors outside of health providers' organizational boundaries, such as patients at home (Nikayin et al. 2013). Digital platforms also facilitate the direct collection of patient data, through sensors or manual input, which supports real-time monitoring and preventive care (Kang et al. 2018). Health-focused digital platforms thus leverage the capabilities of digital technologies to innovate traditional care and research practices in a manner that increases patient participation, access to care, care efficiency, and more.

Literature on digital platforms typically focuses on commercial platforms, which have a purpose of enabling product innovation or facilitating economic transactions (Gawer 2014; Saarikko 2015; Vassilakopoulou et al. 2017). These platforms are characterized as having a layered modular architecture with loosely-coupled components and layers of varied technological nature. Modules interact through interfaces, facilitating change and evolution, which in turn enables actors to create innovative offerings through new combinations of digital and physical components (Yoo et al. 2010).

However, the purpose of health-focused digital platforms goes beyond enabling product innovation or facilitating transactions. Instead, they focus on transforming healthcare delivery in an effective and efficient manner in order to improve health outcomes. Given their role and purpose, we refer to health-focused digital platforms as health service platforms (HSPs). The use of HSPs is part of the digital transformation of health care that is triggering a cultural shift in medical practices by enabling a collaborative relationship between care providers and patients; however, it is crucial to understand and meet the new needs of patients emerging from the introduction of information technology for this transformation to be successful (Meskó et al. 2017). This requires an understanding of platform architectures that goes beyond modules that can

be flexibly recombined into innovative offerings, so as to include service elements that can fulfil the healthcare-related intentions of healthcare actors.

We propose to describe HSP architectures in terms of solution patterns that create value from the perspective of platform stakeholders. This approach draws from S-D Logic (Vargo and Lusch 2008) and a "network-of-patterns" approach to architecture (Henfridsson et al. 2014), which leads to an intentional rather than a functional approach to architecture. The goal of this paper is to develop an initial framework for conceptualizing the architecture of HSPs. The framework will be used to guide a multiple-case study of HSPs, using an iterative approach where the initial framework is used as a guide to enter the empirical world, but is expected to evolve as empirical data and their analysis modify researchers' understanding of theory (Dubois and Gadde 2002).

# Theoretical foundations

We draw from two complementary research streams focusing on digitized artefacts as theoretical foundations for this research: the digitized service innovation stream relying on Service-Dominant (S-D) Logic, and the digital product innovation and digitized product stream that relies on theories and concepts such as modularization and generativity (Herterich and Mikusz 2016). Doing so enables us to relate the digital materiality of HSPs platforms with their purpose, understood through S-D Logic as one of value cocreation.

## *Service-Dominant Logic*

The terms "digital platform" and "service platform" are sometimes used interchangeably, based on the definition of digital platforms as digital environments providing generic functionality for the development and operation of digital services (Tilson et al. 2012; Yoo et al. 2010). From this perspective, services are digital products that are delivered to end users through the platform. A contrasting perspective on service platforms is offered by Service-Dominant (S-D) Logic (Lusch and Nambisan 2015). From the perspective of S-D Logic, a service platform is an enabler of actors' interactive and internal resource integration processes and activities. This perspective builds on the understanding of digital platforms as modular structures that can be flexibly adapted (Gawer 2014) but focuses on platforms' role in facilitating access to digitized resources, as well as their reconfiguration into novel solutions to actors' problems. Moreover, the fundamental principles of S-D Logic imply that these solutions are not valuable *per se*, but are rather part of a process that may lead to perceived value by the beneficiaries of these solutions if and when they are integrated within beneficiaries' existing resources and activities (Vargo and Lusch 2008).

The fundamental premises of S-D Logic imply that service platforms could play a dynamic and active role, acting as operant resources that may trigger rather than merely enable service innovation (Lusch and Nambisan 2015). An important focus of this body of research thus concerns the understanding of the structures that allow service platforms to play their role of resource liquefication and resource densification, as well as playing an enabling or active role in actors' resource integration processes (Breidbach and Maglio 2015; Zolnowski and Warg 2018).

The S-D Logic literature on platforms emphasizes the role of platforms as a means to access and possibly reconfigure and create resources for value cocreation through service exchange, which is in line with our research purpose. Yet, there is yet no approach to analyse the architecture of platforms that fulfil this specific purpose.

## *Architectural patterns*

The traditional view of digital platform architecture focuses on its layered modular structure that allows platform technology to be decomposed into loosely-coupled device, network, service, and contents layers (Yoo et al. 2010). Modules are viewed as core or complementary, core modules providing generic, stable functions and peripheral modules providing varied and specialized applications (Baldwin and Woodard 2008). Standardized interfaces govern the behavior of the platform by determining how core and complementary modules interact (Baldwin and Woodard 2008). Instantiations of interfaces such as APIs, tools, and regulations act as distributed control mechanisms, allowing innovations within certain constraints (Mohagheghzadeh and Svahn 2016). This architecture, common to inter-firm, supply-chain and

industry platforms, facilitates component reuse and thus economies of scale, as well as the development of product variants, thus economies of scope (Baldwin and Woodard 2008; Gawer 2014).

This approach to architectural thinking has been characterized as a "hierarchy-of-parts" frame; it views an architecture as the *decomposition* of a complex system into *parts* arranged in a *hierarchy* that can be *aggregated* through *interfaces* (Henfridsson et al. 2014). A complementary approach, referred to as the "network-of-patterns" frame, has been proposed in order to better support the management of technological change in the context of digital technology, which greatly increases design flexibility (through (re)programmability of functions) and scalability (through easy and virtually free reproduction) (Henfridsson et al. 2014). This approach views an architecture as a loosely-coupled *network* of patterns that address system complexity by providing *general* solutions that can be *specialized* to local problem contexts by selectively *inheriting* the properties of one or more generic solution. It thus provides an appropriate analytical lens for investigating loosely coupled resources that can be recombined in line with actors' resource integration needs and desired outcomes. Indeed, while the "hierarchy-of-parts" frame attempts to align platform functions and parts (or components) in a one-to-one mapping, the "network-of-patterns" frame aims to align platform products and their use environment.

The "network-of-patterns" frame has become well-known in software engineering under the name "design patterns"; a design pattern is understood as a generic solution to a recurring design problem (Gamma 1995). Design patterns are thus at a higher level of abstraction than implemented artefacts, leaving specific solutions to be implemented (as code) in response to local requirements. In this sense, design patterns are naturally aligned with the concept of architecture, which stands as an intermediate between stakeholder requirements and design implementations, guiding the organization of resources in a matter that can meet long-term, evolving needs (Nuseibeh 2001). Therefore, the network-of-pattern frame is a valuable building block for developing an understanding of platform architectures that is purpose-focused rather than functionalistic; yet, the ideas of software patterns are not sufficient to capture the breadth of what digital service platforms entail.

## Framework

In Figure 1, we present our initial framework on HSP architectures, combining key concepts of S-D Logic as they apply to service platforms and the network-of-patterns frame. S-D Logic conceptualizations of service platforms and their architectures provide a rich understanding of the way in which platforms may generate valuable solutions for networks of actors (Breidbach and Maglio 2015; Lusch and Nambisan 2015). However, such high-level conceptualizations are far removed from architectural analysis. The network-of-patterns approach provides a solution by capturing digital platform architectures as general solution patterns generating valuable resource configurations in response to actors' problems (Henfridsson et al. 2014). However, being largely focused on software rather than service systems, we need to push the boundaries of the network-of-patterns architecture frame. By drawing upon both theoretical building blocks, we develop an initial framework that captures the service-oriented and purpose-oriented view on HSP architectures.

The guiding framework illustrated in Figure 1 shows how the "network-of-patterns" approach to digital platform architectures anchors the S-D Logic view of service platform. Indeed, the resulting framework implies that empirical investigations of HSP architectures should take into account the multi-stakeholder network surrounding a given HSP, the way in which digital components within the HSP may form general solution patterns for these stakeholders, the instantiation of these patterns as valued resource configurations, and the many-to-many relationships between general and instantiated solutions. This is in line with S-D Logic's beneficiary-centric definition of value, and HSP's purpose of enabling healthcare delivery in a manner that will be perceived as efficient and effective by healthcare actors.

In the framework, the service platform level is composed of a series of networks of digital components (e.g., software) and liquefied resources (e.g., business rules) needed to generate specific resource configurations. The latter are sets of operand and operant resources that can be integrated by platform beneficiaries. The framework should not be understood as a process model however; for example, while a general solution pattern is shown to meet a given problem-in-context, the articulation of that problem may actually arise as a consequence of actors identifying a new need following their experience with a given instance of resource

configuration. Moreover, the generation of a given resource configuration may require platform actors to contribute new resources in the platform, which is not captured in the framework.

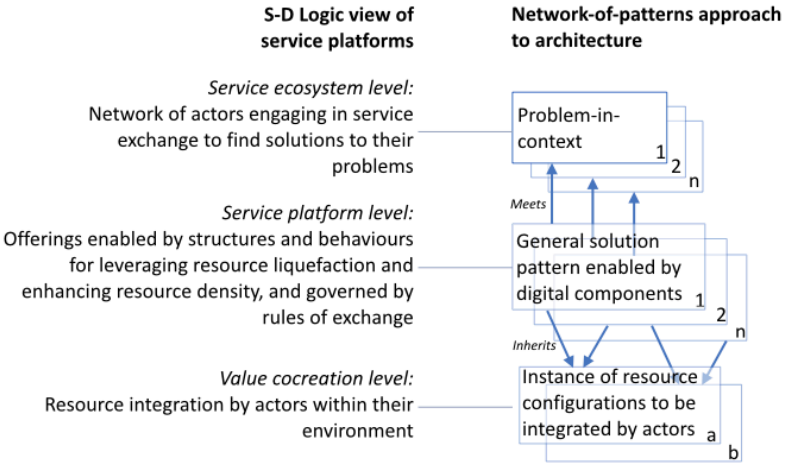


**Figure 1. Guiding framework of HSP architectures**

## Methodology

We will undertake a descriptive case study of an HSP, guided by a framework derived from key concepts of S-D Logic and architectural patterns. The case will focus on a representative HSP that supports remote patient care, disease prevention, and research. The research question driving the case study will be "How can HSP architectures be articulated in a manner that reflects their health-related purpose?". The proposition underlying the study will be that articulating an HSP architecture as series of solution patterns (Henfridsson, Mathiassen, & Svahn, 2014) better reflects how this architecture enables service innovation for its stakeholders than the traditional articulation of digital platform architectures as layered modular components (Yoo, Henfridsson, & Lyytinen, 2010).

The unit of analysis of the study will be the architecture itself, each solution pattern acting as an embedded unit with the study (Yin 2014). The medical and research programs in which the platform is situated will serve as the context of the case study. Commitments from a case of an HSP in Canada have been arranged. The ability of the guiding framework to provide a more adequate approach to HSP architectural description than that provided by the more traditional hierarchy-of-parts frame reflected in the layered modular description of digital platform architectures will be assessed by treating the latter as a rival explanation for the study's findings (Yin 2014). Doing so will increase the validity of the results and may help to further understand how these two approaches are complementary (Henfridsson et al. 2014).

## Conclusion

As Health Service Platforms (HSPs) are being increasingly used in the health domain, it is important to ensure that they are designed in a manner that leads to improved care efficiency and effectiveness. HSPs are more than facilitators of transactions and innovation; they should be designed and evaluated on how they ultimately enable new ways for actors to access and combine resources for desired health outcomes. As a first step towards that goal, this study aims to develop an approach to describing HSP architectures in a manner that is aligned with their purpose, rather than their function. We present an initial framework derived from S-D Logic and architectural patterns to guide a case study of a representative HSP. Combining these two building blocks potentially produces two main theoretical contributions: pushing the architectural patterns ideas towards service rather than software systems, and operationalizing S-D Logic for architectural analysis. Moreover, the results of this research will extend current conceptualizations of digital platforms to the health domain. At a practical level, they will provide a systematic approach for designing or evolving HSP platform architectures in a manner that better meets patients' and other health care stakeholders' needs.

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