

Governance of smart living service platforms: state-of-the-art and the need for collective action

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***Abstract.** Today's smart home concepts are no longer limited to home automation, but increasingly involve smart health, energy, security and entertainment services. Such smart living services are typically offered through sector-specific service platforms that are rarely interoperable and not fully standardized. As a result, an overwhelming variety of service platforms for smart living services is currently on the market. The vast majority of these service platforms suffer from disappointing adoption by both consumers and service providers. This paper aims to provide a structured overview of 42 contemporary smart living service platforms for healthcare, energy, security and entertainment services. We find strong differences between the platforms in terms of technology architecture and governance structure. Technologically, some platforms place the intelligence of the technology architecture within a person's home, while others place it in the telecommunications network or remotely in the cloud. Regarding governance structure, we find that relatively few platforms are completely open for third parties to provide services on and most of them are partly or even completely closed. The main contribution of the paper is to apply concepts from platform theory to analyse the on-going developments in the smart living domain. We argue that the lack of openness and cross-sectorial interoperability of the service platforms, combined with large differences in the technological architecture, explains why smart living services still struggle to make their way to the market. Based on these findings, we argue that collective action for developing common service platforms that cross traditional industries is needed to break the deadlock of smart living service innovation.*

***Keywords.** Service Platforms, Smart Living, Smart Home, Collective Action*

1 Introduction

The vision of smart living is to facilitate comfort living for consumers by providing several ICT-enabled services that combine value drivers of health, energy, security and entertainment services. Looking at energy sector, for instance, considerable attentions especially from governments are given to smart metering and energy

management services in an attempt to enable consumers to proactively control and manage their energy consumption, reduce their electricity bills and benefit the environment. In the health sector, increasing costs of healthcare and elderly care services has triggered many service providers to explore new ways of service offering. In the same way, security service providers are also trying to utilize new communication technology and devices for more advanced security services.

Typically, smart living services are delivered to households through service platforms. Service platforms can be seen as hardware, software, network infrastructure or even a combination of them that host a set of core functions (e.g. data storage, processing power, intelligent decision-making component) deployed by service providers to build, run and deliver value-added services to customers [1]. For example, smart meter can be seen as a prominent example of service platforms that is used specifically for delivering energy management services to households. Though technological advancement, like increasing number of sensor-enabled devices and mobile technology have enabled more flexible and advanced ways of service offering, smart living services are not commercialized on a large scale and there is still no mass market for the services [2].

In order to explore this issue, we choose to use the lens of platform theory. The platform theory suggests that the way service platforms are organized influences adoption and commercialization of the platforms in a market. Especially, the strategies of platform providers in opening or closing a service platform have been widely discussed by several authors [e.g. 3,4]. However, most of the existing studies focus on mobile or computing platform and little attention has been paid to smart living service platforms. In this paper, we aim to shed light on the way smart living service platforms are organized. To do so, we reviewed 42 present smart living service platforms in different sectors of home automation, energy, health, security and entertainment services. Depending on where the core functions of platforms are located, we classified smart living service platforms into four groups of home-centric (i.e. on a hardware device in a home), cloud-centric (i.e. on the internet), telco-centric (i.e. on the telcom network) and hybrid (i.e. a combination of other solutions). Then, we shed light on the governance of these service platforms, particularly mechanisms or rules to control or manage activities around the service platforms.

This paper proceeds as following. In the second section, we provide a background on the platform theory and platform openness. After that, in the third section we explain the methodology used for this research. Then, we provide our results in section four and finally discuss the findings and suggest avenues for future studies.

2 Literature Background: Platform Theory

A platform can be viewed as ‘a hardware configuration, an operating system, a software framework or any other common entity on which a number of associated components or services run’ [5]. It can also be seen “as building blocks (they can be product, technologies or services) that act as a foundation upon which an array of firms (sometimes called business ecosystem) can develop complementary products, technologies or services” [6]. According to Gawer and Cusumano there are two

conditions for a potential platform: 1) it should perform a critical function of the overall system or should solve a crucial technological issue of an industry and 2) It should be 'easy to connect to' and 'build upon' and provide space for new and unplanned usage. What is common in all definitions for platform is the shared reuse of platform components across multiple products and services [7].

One of the important characteristic of a service platform is platform openness; the degree in which a platform is open to third-party complementary providers. There are different understandings of platform openness. Eisenmann et al. describe platform openness as the extend that a platform is open or closed in response to: I) participation of other firms in providing complementary products and services on platform and II) the extend of interoperating with other rival matured platforms [4]. Greenstein states that the main difference between open and closed platform is "in the policies governing information about pervasive standards embedded in the platform" [8]. While for open platforms, there is not any restriction in accessing to such information, in closed (or proprietary) platforms, such information can be accessed only by platform providers. Ballon and Van Heesvelde discuss openness with regard to control over two critical assets of platform, namely technical assets and customer information. Then, they distinguish four types of 'Neutral platform' in which the technical assets and customer information are open to other actors for value proposition. In the second type which is called 'Broker platform', only technical assets are accessible by other parties and platform providers control customer information. For the third type, 'Enabler platform', only access to customer information is open and technical assets are controlled by platform providers. Finally, in 'Integrator platform', all the assets are closed to outside actors [9].

Although opening a platform may stimulates adoption of the platform, it intensifies the competitive pressure and may reduce the incentives of complementary providers for investment on the platform [10,11]. Boudreau argues that while granting access to platform for complementary products and services significantly foster innovation and increase the incentives to invest on the platform, giving up control of the platform and opening it to outside contributors for development, commercialization and ownership has less positive impact on innovation [3]. As such, decision to open or close a service platform is critical and depending on the market situations or potential parties, platform providers would apply different strategies.

In this paper, we use lens of platform theory, especially platform openness, to study how service platforms are organized. We view platform openness on different levels. From a technical point of view, a platform is open if it allows third-parties to access technical specifications and/or core functions of the platform for developing applications or offering services to end-users (i.e. Technical openness). From organizational perspective, an open platform allows participation of different roles (i.e. platform providers, service providers, application developers) for development, commercialization and usage of platform.

3 Methodology

In this paper, we review and classify 42 contemporary smart living service platforms as on the market in October 2011. The service platforms from energy; e-health and independent living; security; entertainment and telecommunication; and home automation groups has been included in this classification. We used information from news media and blogs, which follow the trends in smart living domain, as the primary source of data in this paper. This provided us with a rich and up-to-date source of information on on-going trends and developments. We also searched grey literature like websites of organizations and standardization bodies for whitepapers, technical notes, documents and reports that contain information related to smart living service platforms. After collecting data, depending on whether the core functions of the platforms are located, we classified them into four main groups of home, cloud, telecom and hybrid service platforms. Meanwhile, we also paid attention to the technical openness of the platform as well as organizational openness.

4 Findings

4.1 Home Automation Service Platforms

Home automation service platforms are the most recognized service platforms that are used for offering generic home automation services like lighting, ventilations, energy and security management services. Table 1 shows a number of these service platforms as in the market.

Table 1. Home Automation Service Platforms

Service Platform	Platform location	Platform openness	Partnership
ZyXEL smart home gateway	Home-centric	Closed	Cuculus
Control 4 system	Home-centric	Open	YAMAHA, Pioneer, Saflok, ONKYO, LiteTouch, Sony, NuVision
IPbox	Home-centric	Closed	ProSyst's, OSGI Alliance
iRoom iDock	Home-centric	Closed	N/A
Hi System	Home-centric	Closed	N/A
MoMas Honeywell	Home-centric	Closed	N/A
Shaspa Bridge	Hybrid	Open	IBM, Marvell, WAGO MOXA, Omnio, Devolo, Enocean alliance member
Android@ Home	Mobile-centric	Open	Hardware partners including Lighting Science

Apparently, most of the service platforms in this group are home-centric and closed. However, recently Google announced an open mobile service platform, Android@Home, for Android mobile or tablets that allows users to control and

interact with appliances at home. The vision of Google is to connect different devices to its service platform and then allow developers to freely build several innovative home automation services on the platform. While most of the current home automation service platforms are closed, Google's attempt in developing an open service platform may stimulate innovation and foster the growth of market in the smart living domain.

4.2 Energy Service Platforms

The smart meter is the most well-known service platform in the energy sector that is intended to raise awareness of electricity consumption of consumers and stimulate energy saving behaviour. Besides smart meters that are typically provided by utilities, a wide variety of service platforms are offered to end-users for energy management purposes (Table 2).

Table 2. Energy Service Platforms

Service Platform	Platform location	Platform Openness	Partnership
FIOS (Verison Telecom)	Hybrid (Home and Network)	Closed	
Microsoft Hohm	Cloud-centric	Technically Open	Ford, Blue Line Innovation
Nucleus energy monitor	Home-centric	Closed	Relationship with utilities, which could recommend the device as part of smart-meter programs
Google PowerMeter	Cloud-Centric	Open	Several utilities and device manufacturers, like First, SanDiego Gas & Electronic, eGauge,etc.
AlertMe	Home-centric	Technically Open, Organizationally Closed	Google and several investors including Nucleus energy monitor, Good Energies, British Gas supplies
PowerCost Monitor	Home-centric	Closed	Google, Microsoft
Current Cost EnviR	Home-centric	Closed	Google
Digi gateway	Home-centric	Closed	Google
EGauge	Home-centric	Closed	Google
eMonitor	Home-centric	Closed	Google
The Energy Detective	Home-centric	Technically open, organizationally closed	Google
WattsUp	Home-centric	Technically open, organizationally closed	Google

Wattvision Power Monitor	Home-centric	Closed	Google
PlugWise	Home-centric	Closed	
Philips Dynalite	Home-centric	Closed	Philips acquired Dynalite Australian lighting company
iControl OpenHome	Home-centric	Open	A member of OpenSMA program for stimulating home automation market Invites key third party to develop new solutions supporting the Platform
Cisco Home Energy Management	Home-centric	Closed	Duke energy, IT vendors, operators, system integrators and retailers

Comparing to the home automation platforms, there are more cloud-centric or hybrid solutions for energy services. However, closed and home-centric platforms are still dominating in energy market. Striking is that partnership in energy domain is weaker than home automation domain and it tends to emerge only when large vendors, like Google, Microsoft or Cisco, are involved. Additionally, most of the platform providers are partner with Google, which implies that open and cloud-centric platform from dominant vendors are more likely to be adopted and used by other companies.

4.3 Healthcare Service Platforms

Healthcare service platforms are responsible for exchanging data between household and service providers. The data is collected from connected devices and sensors (e.g., camera, portable wireless devices, motion, Infrared and/or wearable sensors, and blood sugar or heart rate readings) at home. The core functions on the service platform are used to send real-time information from home to health-care service providers. Then, depending on the status, service providers can deliver specific e-health services to a household through a device at home, internet, or mobile phone. Table 3 illustrates a number of healthcare service platforms.

There is a more tendency to cooperation and partnership for healthcare service platforms. This can be explained by the fact that often technical vendors providing healthcare service platforms don't offer health services and need care providers to adopt their solutions for service delivery. As such, the main intention for partnership could be to provide solutions that address needs of service providers.

Interestingly, a more number of open and cloud-centric service platforms exist in this domain. Most of the cloud-centric platforms are primarily provide general health services, like keeping a record of medical documents, laboratory tests or even control physical activities. Typically, these platforms mainly target certain groups of people, like fitness enthusiasts or tech-navy patients and their care providers. Thus, it is more

difficult to get critical mass of users and encourage widespread usage of platform. For instance, Google Health stopped its platform due to a low rate of adoption [12].

Table 3. Healthcare Service Platforms

Service Platform	Platform location	Platform Openness	Partnership
ZyXEL smart home gateway	Home-centric	Technically closed, Organizationally open	Cuculus
Vignet	Hybrid (mobile and cloud)	Technically closed, Organizationally open	IBM, Nonin Medical and A&D, Continua Health Alliance
Google Health	Cloud-centric	Open	Allscripts, Anvita Health, etc.
Microsoft HealthVault	Cloud-centric	Technically open, Organizationally closed	Circle of sharin, Mayo Health Manager, Omron, etc
Dossia	Cloud-centric	Open	500 companies
ShareCare CareSite	Cloud-centric	Technically closed, Organizationally open	Home care, assisted living organizations, insurers, hospitals, social welfare
TeleStation Hub (Philips)	Home-centric	Technically closed, Organizationally open	
Active Life Home	Hybrid	Open	Device providers and research centers

4.4 Security Service Platforms

Security service platforms have been around for many years, but they have often offered simple alarming services. However, newer platforms, like Alarm.com, ADT, offer more adaptive types of services like audio/video control of residence through internet or mobile access. (See Table 5)

Table 4. Security Service Platforms

Service Platform	Platform Location	Platform openness	Partnership
Alarm.com	Home-centric	Closed	N/A
ADT	Home-centric	Closed	N/A
WoonVeilig	Home-centric	Closed	N/A
Home Safety Alarm	Home-centric	Closed	N/A

It appears that security platforms are the most closed type of platforms for smart living services, which are primarily located at home as we couldn't find any cloud or hybrid solutions. Moreover, there is no partnership going on in this sector, which implies that service providers bundle services with their proprietary platforms.

4.5 Entertainment and Communication Service Platforms

ICT advancement and increasing broadband connection to houses have motivated many content providers to provide online and on-demand audio and video services, like Amazon Instant Video, Blockbuster on Demand and CinemaNow [13]. The growing demands for the Internet TVs and increasing amount of online contents have also triggered many leading electronic manufacturer to deploy internet-enabled service platforms (e.g. Google TV, Yahoo TV) on their TVs to make them smarter. Such TVs acts as service platforms and eliminate the need for set-up boxes or any other devices. (See Table 6 for more examples of entertainment service platforms)

Table 5. Entertainment Service Platforms

Service Platform	Platform Location	Platform Openness	Partnership
ZyXEL Full HD Digital Media Streamer (USA)	Home-centric	Closed	
Google TV (USA)	Home-centric (Software platform on TV)	Open	Sony, Logitech
Yahoo Connected TV (USA)	Home-centric (Software platform on TV or digital receivers)	Open	AT&T, Tivo, Sony, LG, Samsung, Toshiba, and Vizio
Philips Net TV (The Netherlands)	Home-centric	Closed	
Apple TV (USA)	Home-centric	Closed	

The Internet TVs enable TV manufacturers to gain more profits from online TV content providers [14]. Therefore, this may be an opportunity for TV manufacturers to become the platform providers for audio and video services. This trend of using home-centric service platforms (i.e. internet-TV, set-top boxes) to access online entertainment contents may change the role of cable companies and ISPs from platform providers for entertainment services to only internet service providers.

5 Discussion and Conclusions

The results of this study show that several small and large vendors seek to position their platforms and services in this market. As a result, there are several discrete closed platforms that just fill a niche of customer needs. Even in one sector, we found several disparate platforms with different technical architecture used to deliver similar types of services to end-users. Given intense competition in this growing market, even those few open platforms also limit third-party service providers or developers to specific standards and rules in order to preserve competitive advantages. This trend has made it difficult for small companies and developers with no platform access to enter into this industry and develop and offer innovative services to end-users [15].

The closed pattern for the platforms was more noticeable for the home-centric service platforms, especially in energy and security sectors. This infers that usually service providers in these sectors are not dependent on other parties for service delivery. We found more tendency for open and collaborative platforms in the health sector where caregivers or service providers utilize third-parties' platforms for service delivery. Comparing to home-centric service platforms, the network-centric and cloud-centric service platforms are more likely to be open to third-parties service providers and application developers (e.g. Google health service platform). This can be the result of technical architecture that allows for more open approaches.

What most of smart living service platforms have in common is that they all need a communication infrastructure to communicate data and information between service providers and households. They also need to be interconnected to a set of controlling devices and sensors for end-user service delivery at home (e.g. energy, health or security services). As such, there are possibilities for service providers to share such common functions and requirements for service delivery on common service platforms. While, advancing technologies, like the 'Internet of Things', cloud computing and 'Platform as a Service', could enable the common service platforms of future for smart living services, driving such innovation is primarily matter of organizational issues than technological constraints [16]. Simply put, organizational coordination and collective action on a trans-sectoral level is required to make the vision of common service platforms to happen [17]. This would require building trust between partners, setting rules and mechanism to prevent free-riding [18] and creating incentives to promote collective action for such common service platforms [19].

Besides inter-organizational collective action, formal law regulations and policies from government and/or regulatory authorities play an important role in enabling the vision of common service platforms for smart living services. One relevant issue in this domain is that sharing distributed service resources (i.e. network infrastructure, service platform and devices) may not be in the interest of all involved actors only if there is strong added value or perhaps enforcement from market competition or regulations. Moreover, there is a lack of interest from actors to solve the problem of interoperability mainly because of related costs, complexity, reliability or competition concerns [20]. As such, policy and regulation coordination (i.e. horizontal policies like macro-economic, competition and IPR policies) can be part of solution for collective action to emerge in this domain and thus solve the issues in this complex situation [21,22].

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