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BUSINESS CHALLENGES FOR INTERNET OF THINGS: FINDINGS FROM E-HOME CARE, SMART ACCESS CONTROL, SMART CITIES AND HOMES

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ABSTRACT

Services based on the Internet of Things (IoT) and Machine to Machine (M2M) communications are actively being proposed for several industries. A lot of initiatives are presented for smart cities, smart homes and smart energy systems. But even with advances in new technology and substantial amount of research funding, most of these services are not deployed on a large scale. Innovation is not needed only for the technical solutions but also for the business models and how actors cooperate.

In this paper, a number of projects on smart cities, smart homes and energy systems are presented and compared with some successful cases where new IoT and M2M concepts have been applied. Also, an analysis in presented for the benefits and values that can be identified for different IoT services, including cost saving in service provisioning and ease of use for end-users. It is also studied how drivers, such as improvement in resource utilization, are often hampered by the unwillingness of traditional actors to share a service platform, afraid of losing control over their customers.

Examples show how the business models changed or need to be changed. The co-existence of services from parallel sectors and within the same sector is studied in this paper and further compared with a case of competing solutions for the same service (mobile parking). The application of new technology entails changes in the organization of actors; this paper reveals the decreased relevance of some traditional actors, like communication providers, in the service delivery when IoT and M2M solutions are adopted.

KEYWORDS

Access control, Actor cooperation, Business models, Home care services, Facility management and smart houses, Internet of things, Machine-to-Machine communication, Smart cities, Techno-economic analysis.

INTRODUCTION

There is an increasing interest in the potential opportunities that can be achieved with the integration of smart devices to gather data or automate processes. The type of communications between devices with minimal human intervention is referred to as Machine-to-Machine (M2M) communications. M2M solutions can be applied to improve industrial, commercial or service delivery applications (Wu, et al., 2011). We are also faced with Human-to-Machine (H2M) communications, e.g., when using a smartphone for interaction with sensors for remote monitoring and control of homes or when using mobile ticketing services. Internet of Things (IoT) is a related concept for services with communication between and with connected sensors and smart devices. Forecasts often refer to a figure of 50 Billion mobile devices that will be connected a few years from now[1].

There are numerous incentives that motivate solutions based on IoT and M2M communications. For network operators, there is an increasing interest in the M2M market due to the current saturation of the traditional services and the decline of voice revenues in developed countries (Wu, et al., 2011) and (Markendahl, 2011). But Telecom and broadband operators face many obstacles, since their traditional revenue stream is based on high amount of traffic per users and M2M devices do not generally follow this pattern. Instead, they usually generate very low traffic and operators can expect very low average revenue per user (ARPU). This is forcing the consideration to extend the traditional set of activities beyond connectivity provision and reach revenues in application provisioning (Daj, et al., 2012).

The adoption of services based on smart devices usually entails the need to change the traditional business thinking, due to the transformation of the value network. Determining effective business models in these scenarios to create value from this technological shift is a must (Sharma & Gutiérrez, 2010); otherwise new actors will emerge to fulfil the required activities. M2M motivations are specific to each application and depend on the needs found on each market. For example, in the health care sector, there is an emphasis to change from episodic-care to continuous-care services and to furthermore, minimize costs by remotely taking care of patients at home instead of the traditional care at hospital facilities (Kijl, et al., 2010). In addition, large scale applications related to smart metering, automotive and e-Health count with strong incentives from public funding (TeliaSonera Business Day 2013, 2013).

Information and communication technologies are suitable to deliver M2M solutions and fulfill the most common technical requirements but successful cases are scarce and the forecasts in the estimated number of expected M2M connections has not been met. The authors of this work believe that the main challenges are beyond technology and can be found in the business domain. Improving communication performance and scalability, although necessary, does not correspond to immediate enablers for M2M applications. There are other challenges that still need to be addressed (OECD, 2012). For instance, current deployments are typically dedicated to a single application where each solution exists in a vertical market, leading to higher application development cost and slower market adoption (IERC - Internet of Things European Research Cluster, 2012).

In this study, selected cases in Sweden related to IoT and M2M are analyzed. The cases correspond to key applications such as smart grids, smart cities, facility management, access control, e-home care and mobile payments for parking, see Table I. Studying the business approach that is been taken by different actors involved in the IoT and M2M market will highlight the current role of operators and communication providers in the service delivery. Moreover, by analyzing successful solutions, it will be possible to understand the actions required to enable ambitious projects such as smart cities and smart energy systems.

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[1] Ericsson vision "everything that can benefit from a connection will be connected" and 50 Billion M2M connections by 2020.

Table I. Overview of cases analyzed in the paper

Case	Type of services	Main actors	Service setting
Access control & time reporting	Home care for elderly	Technology provider Home care authority	B2B
e-Home care service	Home care for elderly	Home care authority City IT department	B2B
Smart city Infrastructure	Public utility, media and healthcare services	Local authorities Utility companies, ISPs	B2B B2B2C
Smart houses	Facility management, Public utility services	Facility owner/manager Utility companies	B2B B2B2C
Mobile parking payments	Parking services Ticketing and payments	Parking operators Payment providers	B2B2C

The work will study the interaction among actors and the value networks, with special emphasis in the business roles for communication and service provisioning. This will exhibit how an invariant position before M2M solutions tends to weaken business interaction that will be substituted by innovative market actors. By comparing the factors that have allowed the successful deployment of some solutions and the obstacles that still hamper the implementation of promising applications it is shown how successful cases are based on new definition of roles, this study is essential in order to focus immediate researcher efforts in the appropriate direction. In order to analyze the business challenges for the Internet of Things, the main research questions are the following:

- What types of benefits and values can be identified for different IoT services?
- Which are the drivers and barriers for adoption of IoT services?
- How is the value network organized and what roles are taken by different actors?
- What is the role of traditional actors like communication providers, in the service delivery?

The paper is organized as follows: Next, the related work is presented followed by the methodology, where the analysis approach and the collection of primary data are further explained. Next, the selected cases are described and then analyzed and compared in terms of the level of competition and cooperation, the cost saving related to the services, the values and the competence and business perspective. This analyzing will be followed by a further comparison with other types of services (not related to IoT or M2M). Finally, conclusions and further remarks presented on the last section.

RELATED WORK AND CONTRIBUTION

IoT and M2M solutions, services and business models

Business models and scenario proposals are focused on generic or future markets and the role of new actors in M2M services (Gonçalves, 2010), but not on how M2M solutions can be seamlessly included in existing working services. Most proposals do not consider the complexity in established businesses, the actors needed and the actual benefits that can be achieved. M2M solutions that exist today are those where the value is clear and convey enough benefits by themselves to allow deploying a complete vertical solution, from connectivity to service delivery; this deployment strategy may lead to duplicated infrastructure and high implementation costs. Recently, there has been a strong focus on the benefits of shared and common infrastructure (IERC - Internet of Things European Research Cluster, 2012), (Swetina, 2012), meaning that if a common infrastructure can be used for different M2M applications the initial investment costs will be reduced and the range of future business opportunities will be expanded (Shelby & Höller, 2012).

Moreover, the M2M vendor market is extremely fragmented and solutions must be designed for each specific customer. Many small developers attempt to fill the gap with their own solution, leading to high design and deployment costs and poor economy of scale. Major Standards Developing Organizations (SDOs) are focusing on the need for globally agreed specifications that allow a seamless integration of M2M solutions (oneM2M, 2012), (ETSI, 2012). Additionally, network operators are actively entering the market with the creation of M2M business units and working directly with partners such as system integrators or other operators to expand their footprint (Hase, 2012), (Morrow & Glitho, October 2012).

Technical solutions only represent part of the overall user and business context. M2M solutions can hardly be offered as a standalone service, they need to be integrated in the overall context. Therefore, services are often part of a complex value constellation where the traditional provider-customer model does not apply (Leminen, et al., 2012). This makes cumbersome the tasks of analysing where the real value and benefits are. The real economic benefits are yet unclear in many applications

An additional characteristic that should be taken into consideration for the business relationships regarding IoT and M2M applications is the fact that most solutions are not directly oriented to end consumers. Most of the potential benefits of device interconnection are for product manufacturers and the different types of services suppliers. The asset of device connectivity is data availability. In M2M applications data can be used for remote diagnosis, tracking, monitor usage and status of products; this allows the provision of improved and customized services, reduction of expenditures and optimization of working times. End consumers do not behave passively but are rather part of the aftermarket and deliver feedback to manufacturers and service providers in the co-creation of values (Heapy, 2011), (Mejtoft, 2011).

There is a common view of the benefit of infrastructure sharing and global partnerships, but all the major efforts are still oriented in connectivity instead of being service-driven (Diercks, 2012), (Zhou & Rodrigues, 2013). Most of the large scale projects are pilots that prove the benefits but fail to become widespread implementations (Kijl, et al., 2010); deployed solutions count with their own tailored approach but there are few ready-made solutions that are simple to integrate and are dedicated to particular industry segments.

There is research gap in the quantification of values and benefits that can be achieved with large scale applications such as smart cities or smart grids. There is also a need to study whether if successful cases can be replicated in different markets including different companies or different countries setups; this is fundamental in order to achieve scalability and economy of scale. Lastly, the lack of inter-application coordination remains as the most difficult bottleneck to overcome.

Business Models and Business Networks

Business model approaches and definitions usually contain the same key elements. The Business Model Ontology (BMO) proposed by Osterwalder and Pigneur (Osterwalder & Pigneur, 2005) argues that a business model should express the business logic of a specific firm describing: ″the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams″.

The business model definition proposed by Chesbrough and Rosenbloom (Chesbrough & Rosenbloom, 2002) has been used for the analysis of a large number of companies. The definition contains the following elements: i) The value proposition, ii) the market segment, iii) the cost structure and profit potential, iv) the firm organization and value chain, v) the competitive strategy and vi) the position of the firm in the value network. This approach is also discussed for innovation of business models (Chesbrough, 2007).

The analysis of "values" is also supported by the contributions in (Normann & Ramirez, 1993), (Peppard & Rylander, 2006) where actors create value in networks rather that in a "value chain".

Business networks and interaction between market players have been studied by business and market researchers like Ford, Gadde, Håkansson, Johansson, Mattsson and Snehota since the 1980´s. This analysis to a large extent builds on the so called ARA model with Actors, Resources and Activities (Håkansson and Snehota, 1995), (Ford et al, 2007).

A similar and extended business network approach is described by Zott and Amit (Zott & Amit, 2010). They analyze the business model dynamics in terms of "Activity design themes" indicting the main driver for a change: novelty, lock-in, complementarities, and efficiency. Zott and Amit also the "Activity systems" of the business model from different perspectives:

- the content refers to what activities that are performed,
- the structure describes how activities are linked,
- the governance describes who performs the activities.

Cooperation between competing firms is usually denoted "co-opetition". Different types of co-opetitive relationships between competitors are described in (Bengtsson & Kock, 2000). The analysis deals with markets with few large actors, the dairy industry in Finland and the brewery industry in Sweden. The relationships are characterized as being cooperation dominated, equal or completion-dominated. In (Luo, 2007) co-opetition is characterized in terms of intensity and diversity. In (Gnyawli, et al., 2008) a framework is described where co-opetition occurs with high or lower intensity between the partners. Mobile operators compete on a national telecom market with few other actors. A co-opetition dynamics framework for analysis of patterns of cooperation and competition is proposed by (Bengtsson et al., 2010). The dimensions of cooperation are degree of complementarity, degree of trust and the tie strength (i.e. the characteristics of interaction between parties in terms of duration, frequency of contracts. The dimensions of competition are degree of symmetry, degree to which parties perceive each other as competitors, intensity in competition, and degree of hostility existing between parties. Both cooperation and competition can be weak or strong and the different combinations are used for the analysis.

In this paper, mobile and Internet services enabled by IoT and M2M solutions will be analyzed. One contribution is that we focus on digital services in a Business-to-Business (B2B) or Business-to-Business-to-Consumer context (B2B2C). Another paper contribution is to cases with a multitude of co-existing services and providers, in some cases from different industries.

METHODOLOGY

Our approach is based on analysis of a number of cases described in the introduction. We use empirical data from a number of expert workshops and interviews with both providers and users of IoT services, see below. We base the analysis on ideas from the following sources of business model and business network research: i) the business model definition proposed by (Chesbrough & Rosenbloom, 2002), ii) research on actors and activities (Ford, et al., 2007), (Zott & Amit, 2010) and iii) research on co-opetition (Bengtsson & Kock, 2000), (Bengtsson et al., 2010).

Analysis approach

In the analysis we will highlight specific elements in the business model definition proposed by (Chesbrough & Rosenbloom, 2002):

- For the value proposition the key aspect is the end-user value
- For cost-structure and profit potential we focus on cost savings
- For the value network and position of the firm we highlight two aspects indicating what actor that has the dominating position in the value network: i) Control of the customer interface and billing relation and ii) Control of the service platform.

The ARA model (Håkansson and Snehota, 1995), (Ford, et al., 2007) and the Activity system perspective (Zott & Amit, 2010) provide information about the distribution of activities among actors, what activities that provides a certain type of value and the interaction patterns between different actors. The actors perform certain activities using some type of resources. The control of a resource and the responsibility for the related activities are often closely linked. This analysis will provide insights about the following aspects:

- What activities and actors that are included in the value network
- How the roles are distributed among actors,
- The interaction patterns between actors

For description and analysis of patterns of cooperation and competition we use the co-opetition dynamics framework proposed by (Bengtsson et al., 2010). Both cooperation and competition can be weak or strong and the different combinations are used for the analysis. A typical example of “co-opetition” occurs when both cooperation and competition are strong. This situation will result in tensions between the partners, “high degree of hostility and symmetry” (Bengtsson et al., 2010), and high degrees of trust and tie strength, meaning that parties are willing to cooperate.

Data collection

Data on business model aspects and obstacles has been collected from expert workshops and interviews. The workshops were organized within projects where the authors participate. The applications focus on Internet of Things (IoT), M2M, smart energy systems, smart cities, smart homes, home care services and access control.

1) *Business models for IoT*

The Marketing Technology Center (MTC) organized a workshop in December 2012 on digital platform strategies with participants from Assa Abloy, Ericsson, Sandvik, Volvo, ICA banken, PostNord, Kinnevik and KTH.Interviews about IoT services have been done 2012 with AssaAbloy, Ericsson, IBM and Volvo. The first author 2013 organized two workshops on business models for IoT services together with MTC and SSE. The participants came from major Swedish companies like ABB, AssaAbloy, Electrolux, Ericsson, Maingate, N4G and Sandvik.

2) *Smart energy systems*

A workshop on smart energy systems for households was organized by the first author in November 2011 with 25 participants from Swedish electric power companies, mobile operators, ABB, Ericsson and NEC. Interviews were held with representatives from Vattenfall, ABB, Ericsson and the mobile operators Telia, Telenor, Vodafone and Wireless Maingate. An additional interview about M2M solutions with focus on smart metering has been done in 2013 with representative from Vodafone.

Within the EIT ICT Labs action line “Smart Energy Systems”, the first author organized a workshop October 2012 on “Smart grid value modelling and business models”. The 20 participants were from Ericsson, Alcatel-Lucent, SICS, DAI Labor, Fortiss, Siemens, TU Berlin, TU Delft and KTH.

3) *Smart city intiatives and smart houses*

Within the Stockholm Royal Seaport project expert workshops on business models for smart cities and smart houses were organized November 2012 and May 2013. The participants represented Acreo, e-Centre, Ericsson, the city of Stockholm, Swedish ICT, SICS, Stockholm School of Economics (SSE) and KTH. At these workshops, useful results from projects on e-buildings were presented (Forsström, 2013).

4) *Home care services*

When it comes to home care services primary data from interviews 2010 with the mobile operator Telia and the solution provider Phoniro have been used (Markendahl, 2011). This is complemented with data from interviews June 2013 with the home care authority in the city of Malmö and the solution and service provider IntraPhone. In addition, secondary data from e-home care services in the city of Västerås has been used (Forsström, 2013).

5) *Mobile parking payments*

Mobile parking payment providers and parking operators have continuously been interviewed since 2010 about payment and ticket solutions. This includes the payment providers Easypark, Mobill and Tele-P and the parking operators in Stockholm, Västerås, Linköping and Gothenburg. During 2012 and 2013, 10 interviews have been conducted by the first author.

CASES

In this section, selected cases of different IoT and M2M applications are described based on participation in related research or in-depth studies of the cases. The cases illustrate diverse types of obstacles and problems that arise when trying to implement new technological solution in markets and services that are based on relations and activities that do not consider the new requirement.

Mobile Phones for Access and Time Reporting – the case Home Care and the Phoniro solution

A solution developed by the Swedish company Phoniro uses mobile phone to open doors, removing the need to store physical keys by using Bluetooth communication between the phone and the electronic lock[2]. This solution is used for home health care in over 30 municipalities and towns in Sweden to improve convenience and efficiency.

The Phoniro in-home lock module is added to the existing lock without causing any damage to the existing door and without any cabling and it is powered by a battery. This means that the lock will work also at power failures and where there is no radio coverage for the mobile network. The health care staff uses a Bluetooth enabled phone to open the door by typing a password on the phone. The password also acts as a digital identification card. If the mobile phone is stolen entrance using the phone is prohibited. The key and access control information is distributed over the air. The user of the home care service can use a traditional physical key or a remote unit. The visits are recorded and used for time reporting and security assurance of who enters the home. Linked to the access control system is a web based portal service that enables relatives to monitor who enters the home of the care taker (Markendahl, 2011).

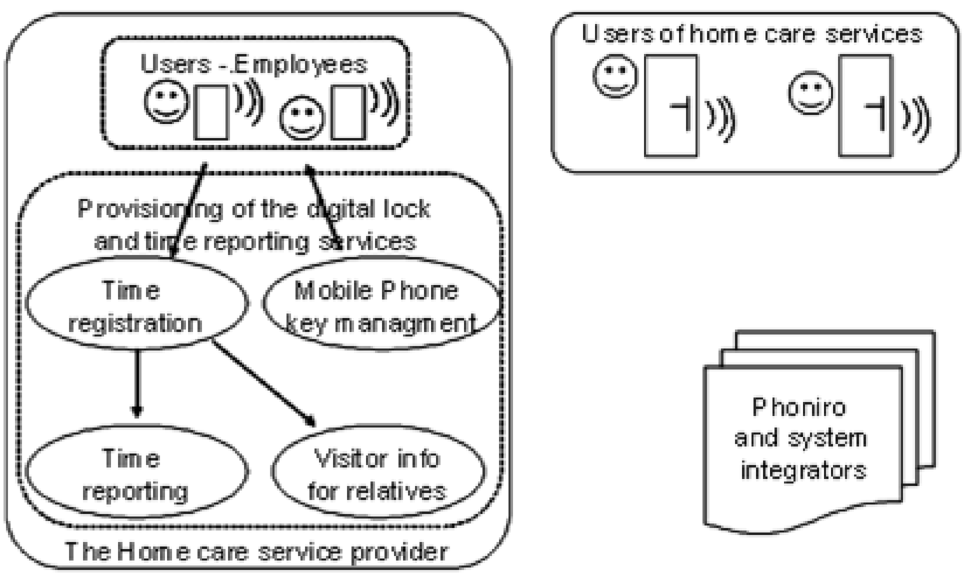

Figure 1. Actors and activities for home care service with digital locks and time registration

The system saves a considerable amount of time for the home care staff. There is no need to go to the central office and collect keys, the time reporting is done in real time and hence no need to go to the office and do the reporting. During a pilot project clear time savings were found, cases with up to 3 hours of time saving per working day was reported.

[2] www.bluegiga.com/solution?g=Consumer&n=Phoniro

For some years the mobile operator TeliaSonera promoted services where electronic keys in mobile phones were combined with time registration and reporting. For the home care sector, Telia marketed this service called *Telia Kvittens Hemvård*. However, all services within the time registration and reporting area were phased out after 2010. Ongoing projects were handed over to the business partner Avista time. The motivations for Telia to change strategy include the following factors: low sales, lack of suitable phones, complex product for the sales force and long sales cycles in the public sector.

The home care services with digital locks, mobile phone keys, time registration and reporting target users within the own organization. The home care staff opens the door of the customer using the *Phoniro Phone application* in the phone. The system is managed by the *Phoniro Admin* software. This includes authorization for the staff to access the locks of the customers and management and processing of time registration data. Once the application is installed, the mobile phone keys can be issued without any involvement of Phoniro, unless the home care authority wants Phoniro to be a service provider. The keys (the authority to open a specific lock) can be managed and issued by the home care authority.

The actors and relations are shown in Figure 2. The actual end-user, the user of the home care service, is not directly involved as user in the service provisioning. There are three different actors that benefit largely from the system; i) the home care provider and its staff, ii) the home care authority, and iii) the relatives of the elderly person. A very big value is that home care authorities can prove that the patient is getting the agreed care and that relatives can monitor who enters the home of the patient over a web-based portal.

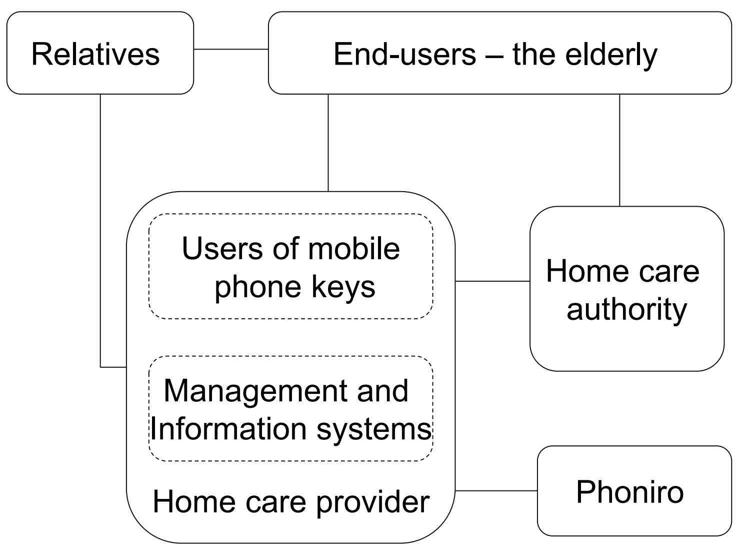

Figure 2. Actors and relations for home care service with time reporting and portal for relatives

e-Home Care in the town of Västerås

The Swedish town Västerås is developing an e-home care service for elderly people. The home care customer needs assistance several times per day but with ICT technology and video communication some of the daily physical visits can be replaced by a video conversation with the home care staff.

It turns out that the video conversations work fine for some types of communication, e.g., checking if medication is taken, reminders, and the first contact in case of alarms. However, this solution requires that the home care customer knows the person on the other side of the video screen. In a pilot project one of the visits during night time could be replaced by contact using the e-Home care services. This meant 300 less visits per day where 100 visits were made by care. The town of Västerås estimates that the annual cost savings for the 300 e-home care customers will be up to 2 M€ while providing the same quality of service (Forsström, 2013).

However, it turned out that the traditional business model for Internet access services did not provide the proper solution. Less than 30% of people of age above 70 years have Internet connection at home, they are not used to it and are not willing to either pay or use it. These customers also tend to mistrust the installation staff of the ISP, mostly since they do know the persons. For the ISPs the e-home care service represent a very small and price sensitive market segment, in addition these customers require a lot of help and customer care. With this setting, the home care authorities will act as helpdesk but do not have any responsibility on the technical side (left side of Figure 3).

Hence, a new business model and offer was developed for the e-home care services. The customers do not need to order or pay for a private broadband subscription, instead they are offered e-home care as part of the overall home care package. The installation of the equipment is done by the well-known (and trusted) home care staff. The IT service department of the town of Västerås buys broadband connectivity capacity and acts as service provider for the home care authorities and is fully responsible for the technical solution (Forsström, 2013). This setting is shown on the right side of Figure 3.

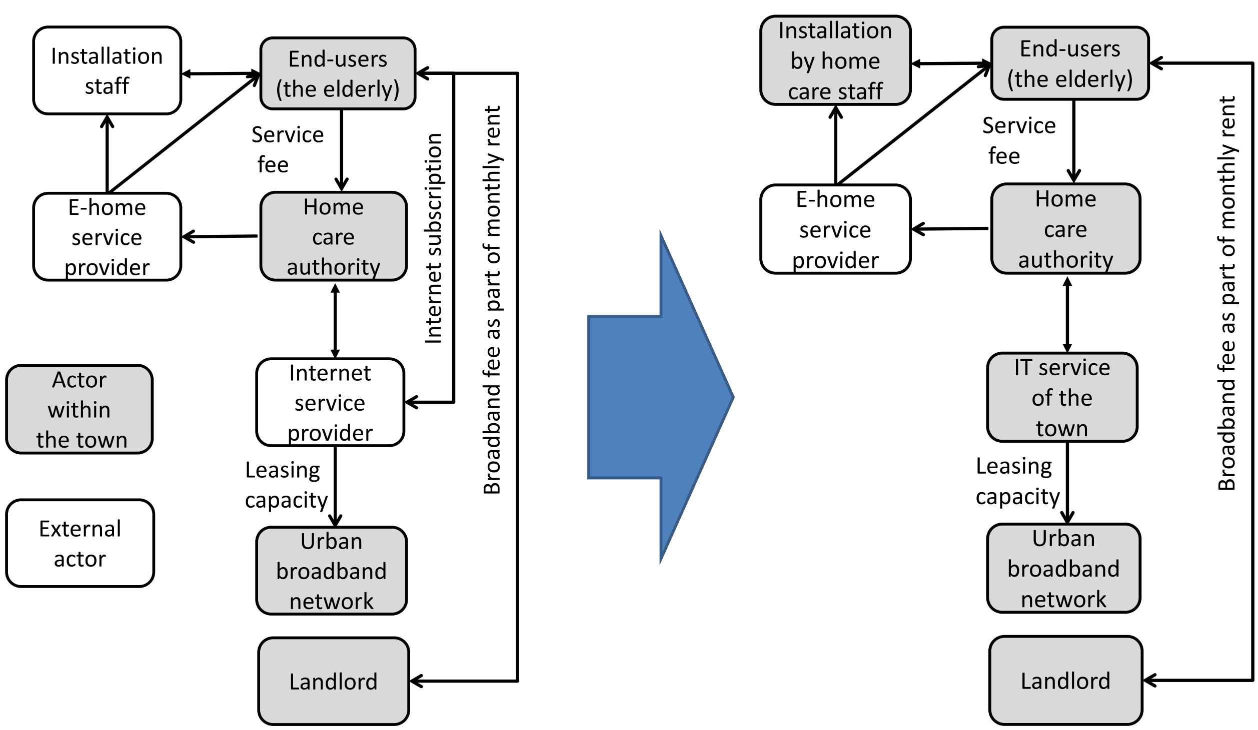

Figure 3. Change of actors and responsibilities for the e-home care service, from (Forsström, 2013)

Smart Cities – the case Stockholm Royal Seaport

A new urban district – Stockholm Royal Seaport – is developing in eastern Stockholm. A former brownfield industrial area of 236 hectares is being transformed into a state-of-the-art waterfront area. Key aspects are sustainable living, business and recreation[3]. Different public utilities and services are to be provided by actors form different sectors, e.g., energy, telecom, media, healthcare and transport. One issue and challenge that has been identified is the fact that actors with different sectors tend to think on terms that "our services" should be provided by "our infrastructure". This leads to multiple service infrastructures, causing parallel stove pipes as shown to the left in Figure 4.

This challenge has been identified and discussed by ICT and telecom companies. These actors propose one common shared infrastructure (see right hand side in 4). We believe that the "stove pipe" approach, especially within the walled garden of an existing big actor, is an obstacle to both the development and adoption of IoT type of services. The approach with a shared and open infrastructure looks more cost-efficient and open to innovation solutions.

The shared infrastructure also opens opportunities to markets that are currently restricted by the entry investment costs in infrastructure. This change entails a mayor technical and business challenge but the consortium of the project is actively working in the determination of the requirements, architecture, roles and specifications necessary to adapt and develop the shared communications infrastructure according to the needs of all the actors involved.

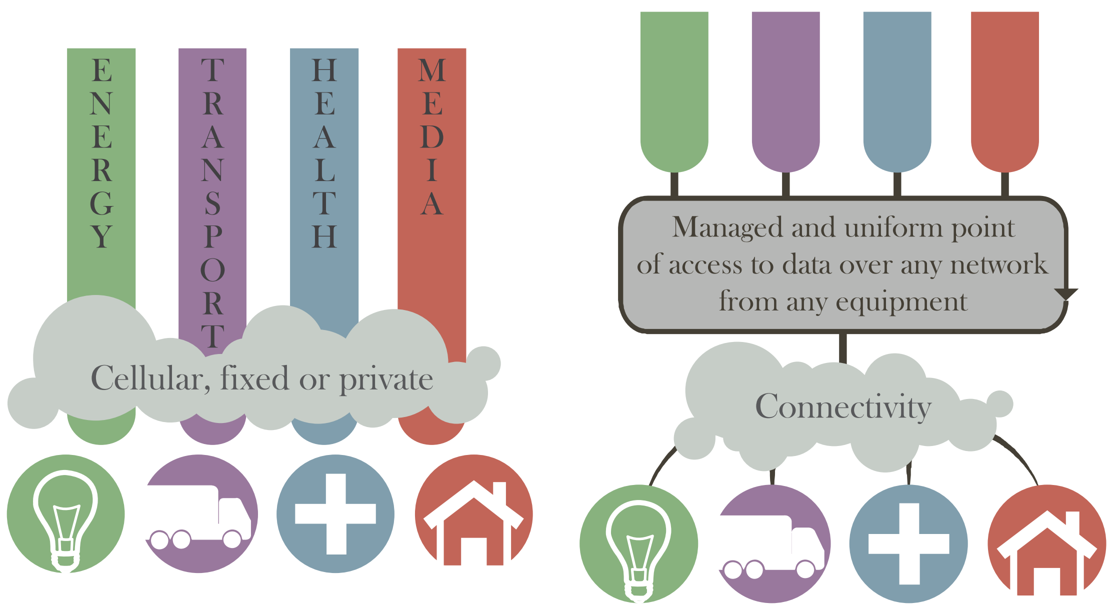

Figure 4. Parallel separate service infrastructures for each sector (left) and shared common and open infrastructure (right).

[3] From the webpage http://stockholmroyalseaport.com/

Smart Houses and Facility Management – the case Halmstad

In many buildings, a number of parallel services are provided with separate systems, infrastructures and services providers. The Swedish e-home project in Halmstad addresses the “stove pipe” problematic within the very same industry sectors (Forsström, 2013). This is shown on the left side of Figure 5, where several parallel applications are present, such as air and water metering, energy optimization, elevator monitoring, fire and security alarms, triple play service, electronic locks and access control to commons areas. In this case, different services are provided with entirely vertical technical solutions to handle network deployment and operation, connectivity, billing and customer relationship.

The proposed solution is a horizontal and open business model using a shared common infrastructure. Any service provider can offer services using the common communication infrastructure that is operated by a neutral actor, a communication operator, as shown on the right side in Figure 5.

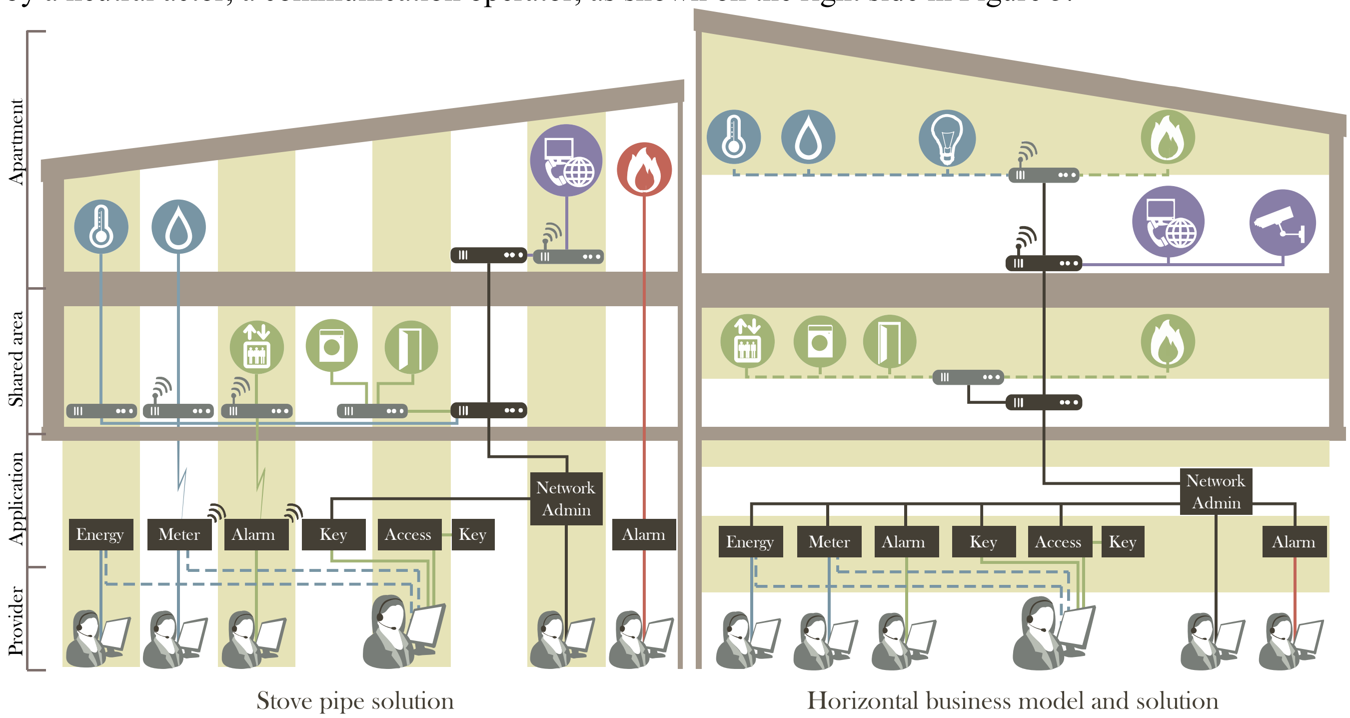

Figure 5. Solutions for facility management in smart houses and homes. Stove pipe solution (left) Horizontal business model with a common infrastructure and a communication operator (right).

Smart Energy Systems – Value Modelling of Smart Grids

Business and value modelling of smart grids were done 2012 within the EIT ICT Labs Action Line Smart Energy Systems. The objective was to do a cost-benefit analysis and the value & business modelling analysis of smart energy concepts in an overall business context. Up to this date, no public reports have been released for the project but the work it is based on research similar to (Weimer, et al., 2012). The common finding is that savings by “smart algorithms” are quite small; a household may save 10%. For the smart charging of Electric Vehicles (EVs) the "hard" value is small, around 10€ per month savings for consumer, depending on the driver profile. However, the “soft” value is much higher, an incentive to buy an EV and combine it with private system for renewable energy generation. The study also reveals a number of “system failures” in the energy production strategy. For example, the price strategy in Sweden does not support consumers to move load to where the energy is greener; on the contrary, the lowest price is when energy with high CO_2 emission is imported.

Payment Solutions for Parking Services

Consumers and parking operators are faced with a multitude of options for parking tickets and payments including parking permits, parking tickets purchased in machines using cash/debit cards and different forms of mobile phone services. The mobile phone solutions include SMS tickets, parking subscriptions and the use of special parking apps, as shown on the left part of Figure 6.

The parking subscriptions are provided by Mobile Parking Payment Providers (MPPP) like EasyPark and Tele-P that have agreements with parking operators. In order to use the parking subscription the user needs to register to the MPPP and open an account. On registration the user provides registration number of one or several cars, a mobile phone number, a credit card account or a billing address. In order to use the service, customers call or send a SMS to the MPPP when a parking session starts and ends. The parking session is registered and put into a database. For this type of solution, a number of benefits can be identified for different types of actors. All users benefit from the “cashless-ness”, no risk to get a parking fine and to only pay for the true parking time. For businesses, the solution with aggregated monthly bills leads to less administration. Parking operators can reduce the number of ticket machines and get lowered operational costs due to less maintenance costs and less cash handling.

For conventional paper tickets and permits the control procedure is straight forward, but for the mobile phone solutions the situation is somewhat more complex. For SMS parking tickets and for mobile parking subscriptions, the “ticket” exists as a data record in the database with active parking sessions. The parking company can check parked cars through their registration number and see if the there is an active ongoing parking session.

Even with this multitude of solutions and providers, the parking companies manage to daily ticket and permit control. The ticket control staff has handheld devices connected to data bases with parking session and car registration data. By entering the registration number of a car information is provided on valid parking permits or sessions or if the car has been stolen, (right hand part of Figure 6).

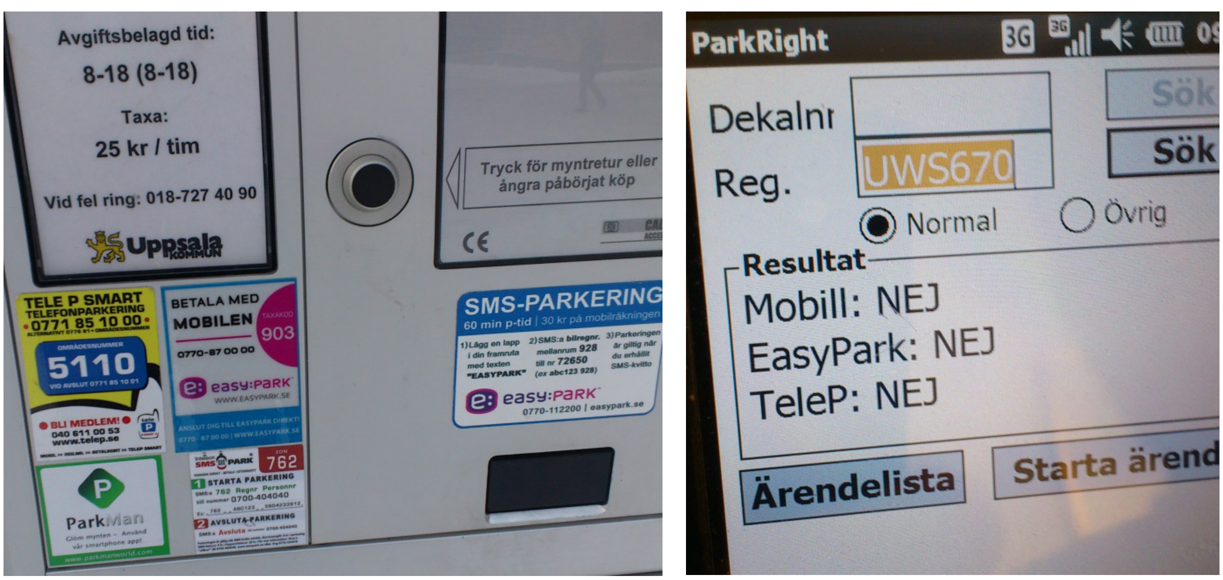

Figure 6. Ticket machine illustrating multiple payment solutions for parking (left) and a snap shot showing the user interface of the handheld device for the ticket control staff (right).

Hence, we have the interesting situation where multiple solutions from multiple providers compete for the very same type of service: payment of parking fees. The solutions co-exist, also when the mobile payment solutions compete with the solutions and services provided by the parking operators themselves.

The mobile parking subscription is interesting from another perspective. It is a payment solution that does not involve any banks and it is a mobile service that does not involve any mobile operators, see Figure 7. The service is provided by an intermediary actor that has knowledge about parking services and establishes business relations with the service providers, e.g., the parking operators, garages and municipalities. The payments by end-users are done using a separate payment solution. No billing through operators is used like in the case of traditional SMS payments.

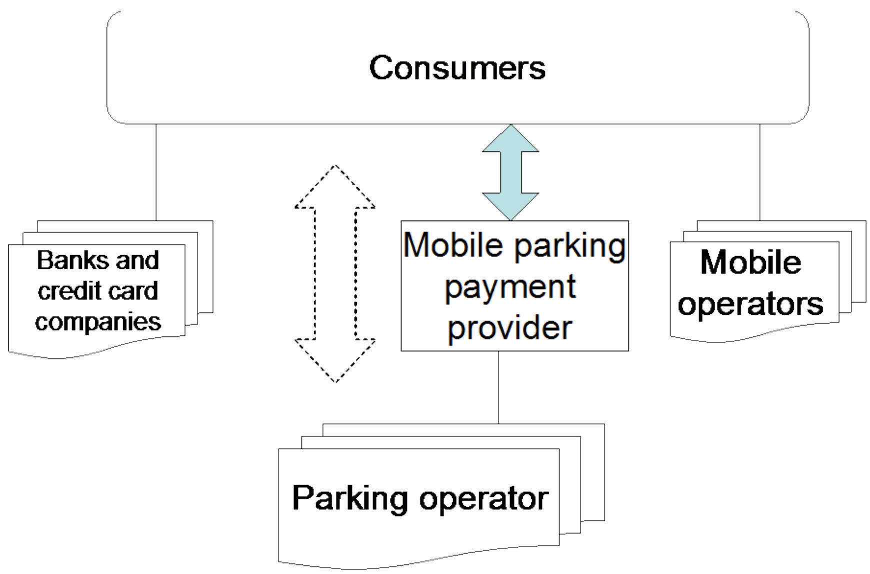

Figure 7. Actors and relations for mobile parking subscriptions, the blue arrow indicates “billing relation” and the lines indicate other types of business relations

ANALYSIS AND COMPARISON OF CASES

Overview of values and position of the actors

The analysis of the cases reveals some similarities and patterns, especially when it comes to values and benefits. These patterns also imply that some conclusions can be drawn about the business model and the position of actors, as seen in Table II. For the mobile parking and e-home care cases the benefits values to end-users and providers are large and clearly identified, hence they represent drivers for adoption of these services. For the smart city and smart house cases the benefits are unclear.

The home care authority has a clear role and a strong position as service provider controlling both the customer interface and the service platform. For the mobile parking payment cases it is possible to identify a number of intermediary actors that take the key roles: the mobile parking payment provider, payment providers and SMS ticket providers. For the smart city and smart home cases the roles are more unclear and. Another important aspect is that the position of traditional operators is weak. Mobile operators are not involved at all in the provisioning of mobile parking payments or access control and time reporting services using mobile phones. For the e-home care case the ISP was excluded from the value network, its role was taken by the local authority.

Table II. Comparison of cases

Business model aspect	**Access control & time reporting**	**e-home care service**	**Smart city case**	**Smart house case**	**Mobile parking payments**
End user value	Large	Same	Small	Small	Large
Cost savings	Large	Large	Unclear	Small	Large
Control of customer interface	Home care authority	Home care authority	ISPs, Utilities	Unclear	Payment provider
Control of the service platform	Solution provider home care authority	Home care authority	Unclear	Unclear	Payment provider

Cost savings and other values

Smart energy, smart grid and smart metering solutions have got a lot of attention both from the energy and ICT industry as well as from academia. The smart energy projects and workshops indicate a foreseen low level of benefits of the smart systems. Savings in electric power consumption are in the range 5-10% and corresponds to a reduction of the electricity bill of 10-20 € per month. The benefits of smart control of houses may also be difficult to estimate and hence the motivation for investments in new solutions may be low. We believe that the relatively small benefits and cost savings of "smart solutions" for consumers will not, by themselves, drive the introduction of these services. Lower energy consumption is hardly a major driver for the energy providers since it means reduction in their sales.

On the other hand, the home care case illustrates quite large cost savings while maintaining the same service quality. The annual savings in the e-home care case were more than 20 M€ for 300 elderly, i.e., around 7000€ annual savings per user of the e-home care service. For the case related to time saving due to less visits or remote assistance from the office, the time saving was up to 2-3 hours per day, i.e., 25-35% of the total working hours. If we assume that the annual costs for an employee is around 100 000 €, then these savings corresponds to 25-35 000€ per year.

For the smart city and smart home cases, cost savings is a driver for using a shared infrastructure. As mentioned, cashless payment using mobile services imply cost savings for the parking business. Parking operators can reduce the number of ticket machines and get lowered operational costs due to less maintenance costs and less cash handling.

Comments on additional values

Initiative for smart cities, smart houses and smart energy systems are often motivated by improved resource utilization and related cost savings. Even if these savings are low, green and energy efficient solutions are seen as a value of its own since they contribute to energy saving and a sustainable society.

The time savings in the home care cases do not only result in cost savings but also lead to faster response, less stress for the staff and a better overview of the mobile work force. Home care authority can keep track of the hours of home care that the elderly are receiving. Mobile payment solutions improve user convenience in terms of: no need for cash, no risk to get a parking fine and to only pay for the true parking time. Companies will benefit from aggregated parking bills for all employees.

Activity systems and activity design themes

Using the analysis approach by Zott and Amitt (2010) looking into the content, structure and governance of the Activity system we can make the following conclusions.

- For the two home care cases content in the form of new functionality requiring new activities are added. The objective is to improve the working processes and the activity design themes are both novelty and efficiency. When it comes to the structure and governance of the activity system, the value network is centered on the home care authority. In both home care cases the operator type of actor initially participated but later on was excluded or did decide to withdraw.
- The mobile parking payment solutions represent new ways to handle parking tickets and payments. Hence new activities are required and they are performed by a new actor that creates a new structure with parking operators and billing companies. The key asset here is the agreements with the parking operators. Besides novelty and efficiency the activity design themes can be said to be complementary and lock-in, the latter due to the fact of special subscriptions for mobile parking payments.
- For the smart city and smart house initiatives efficiency seems to be the major activity design theme characterized by an activity system with new content, structure and governance. However, both the activity structure (how activities are linked) and the governance (who is doing what) are very unclear. The solutions seem to be driven as technology projects where the issues concerning business models and actor cooperation are identified in a late stage of the project.

The level of competition and cooperation

The different cases illustrate different situations when it comes to cooperation and competition. Hence, we can suspect that IoT services would emerge quickly for the cases of cooperation but with low level of competition. Figure 8 illustrates the case where the service providers are from different sectors or within the same sector but providing different services. This would be a very promising situation for the actors: shared costs but no competition. However, it seems like this is not the case. The smart city and smart house cases are similar since there are multiple non competing service providers that share a common infrastructure, but still it does not take off.

Applying the co-opetition analysis framework by Bengtson et al (2010) we can identify differences in how weak and strong competition and cooperation are combined. For the smart city and smart house cases the infrastructure cooperation is weak to medium but the competition is weak or non-existing since actors provide different services (in some cases also in different in sectors). The combination of low level of trust and weak ties (due to no previous experience of cooperation) together with weak competition means that there is no pressure to improve the services or solutions; this is also mentioned in Bengtsson et al (2010).

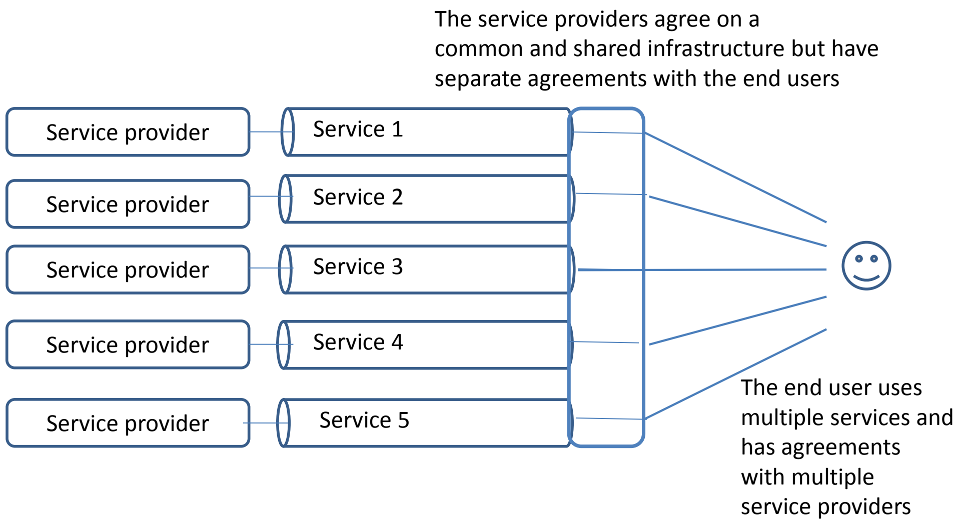

Figure 8. Service providers that do not compete and that share infrastructure

In the smart city and facility management cases, conflict arises from several service providers that traditionally generate revenue with dedicated service platforms and their own infrastructures. Hence it is expected to see a fragmentation of ICT and M2M services for smart homes and cities, even if these services technically are very similar. But having independent service infrastructures benefits the end customer because is easier to change providers. This change is also beneficial for more specialized services that are not profitable enough to deploy their own infrastructure and finally, overall resources usage is optimized and energy consumption is reduced. Moreover, having a shared infrastructure does not impede service providers to maintain the direct relationship with end consumers.

The home care cases illustrate another generic situation with low level of competition, where end-user may not have any options when choosing provider of the home care services. The competition is low but still high value end-user services emerge and, as the cases show, the business model and roles of actors may change in order for the service to take off.

The mobile parking services represent an interesting case with a challenging situation for the payment services providers. Besides the multitude of solutions and providers leading to a high level of competition for the very same service, the payment providers are faced with quite low revenues (1-5€ per hour) and where most of it is intended for the actual parking service itself. Still new solutions are presented and new actors enter the market. The parking operators have developed a solution for the parking control staff that handles the multitude of solutions, Figure 9.

For the mobile parking payment case the multitude of solutions and providers is an example of strong competition and weak cooperation. The cooperation is established through a technical solution provided by the parking operators. This implies low level of trust and weak ties which would lead to little information exchange and wish to improve the common solution (Bengtsson et al, 2010).

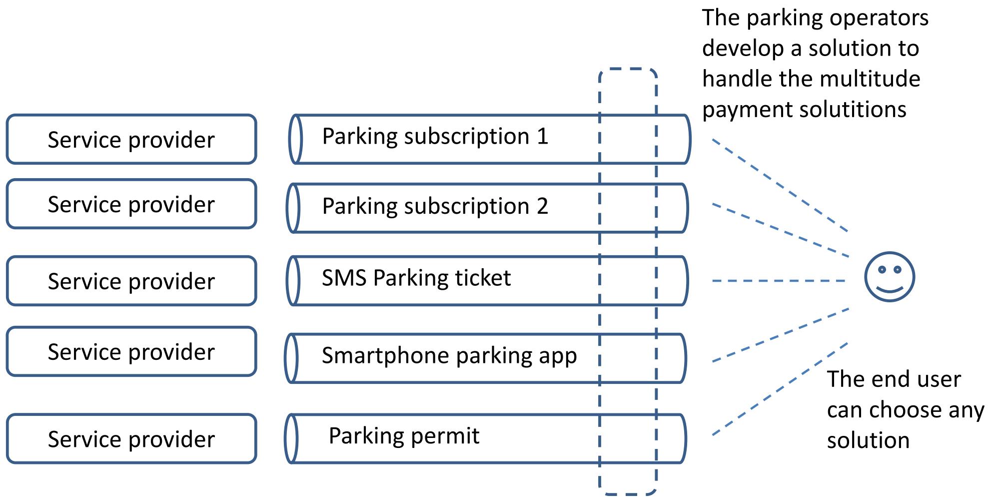

Figure 9. Service providers that compete within the same sector and service, i.e. payments

Competence and business perspective

The two home care cases both illustrate one specific ICT solution with large end-user and home care staff benefits combined with large cost savings. For the Phoniro case a mobile operator was initially involved but later on decided not to provide this service. Instead, the service can be provided by the solution provider (Phoniro) or by the home care authority itself.. In order to make the e-home service to work, a change in the business model and actor responsibilities were needed. In both cases we can see a transition from a situation with “home care service supported by ICT” to “an ICT service integrated into the home care service”. Both the control of customer and user interface and the service platform moved from an “operator” to the home care provider. These cases show that the traditional roles and responsibilities of the “operator” were not feasible for the new service. Neither the mobile operator nor the ISP had the competence or skills to be part of the overall service. The implementation of IoT and M2M solutions involves changes in the traditional business thinking. For example, mobile solutions are usually hampered due to the lack of a proper IOT or M2M business model. Traditional models are based on the provider-customer perspective like the one shown at the left on Figure 10.

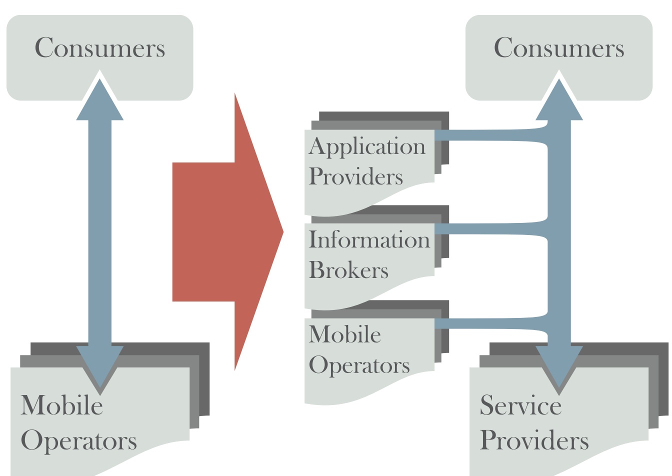

Figure 10. Example of change of business thinking from a provider-customer model to the approach “supporting the provider-customer relation of the core business of another actor”

But as real cases, such as the e-Home care in Västerås, demonstrate, these types of services are often part of a complex value constellation, where the end customer is not directly involved with the communication provider, as shown at the right of Figure 10. Other changes in the traditional business perspective include the approach shift from stove pipes solutions to common infrastructure development, as described in the Stockholm Royal Seaport and the Facility Management (Halmstad) cases.

DISCUSSION AND COMPARISON WITH OTHER SERVICES

After comparing the different cases presented in this paper, we see that the supposedly beneficial scenario, i.e., with low level of competition combined with sharing of costs, does not automatically results in a large growth of these types of services. At the same time, the home care cases with low or no competition are not characterized by low levels of change and innovation. On the contrary, both new ICT solutions as well as new working processes are taken into use and new business models and patterns of actor interaction emerge in order to provide the service. Hence, we reach to the conclusion that it is not the level of competition that is the key factor to enable the proliferation of services. Instead, our analysis of the selected cases indicates that key factors are the benefits and the added value, for both end-users and providers; these are the drivers in the home cares cases. For the smart city and smart house cases, the values and benefits are more unclear.

Another aspect for the smart city and smart house cases is the sharing of a common infrastructure. Here we can compare with other services and sectors such as mobile communication and the airline industry, where competitors share or make use of the resources of another actor. One example is mobile roaming, meaning that users of one operator can access the network of another operator. International roaming is used everywhere and no conflicts exist since the actors operate on different markets. However, when national roaming is discussed or proposed by regulating authorities then operators new operators agree but the others oppose. Operators with investments in build-out networks do not want to lower the entry barrier for a new player, the issue is the market position for actors competing at the same market.

However, in many countries, e.g., Sweden and United Kingdom, competing operators agree to deploy and operate a common mobile network that is fully shared. The cooperation is very tight and includes base station towers, radio equipment and in some cases even the radio frequencies used. There are however large differences between countries with respect to how much of the resources that can be shared, it is very common that the radio equipment and the frequencies are not allowed to be shared.

Nonetheless, when tight network cooperation is used, each mobile operator has full control of the user access to the network, the traffic, the customer relations and the customer bill. The operators do not see the resource sharing "as such" and the potential risk for less control in the service provisioning as a problem. The challenges are related to different views on where and when to invest (Markendahl, 2011).

Decisions on investments for shared infrastructure in smart cities and smart homes needs to be investigated with more detail, including the decision making and how to share investments and the risk involved. This would especially be the case if actors provide different services (and in different sectors), i.e., the usage can be different and there is no single revenue to be used as base for distribution of costs. Another issue is the ownership and control of in-house infrastructure; for example, if one actor installs some device, e.g., a smart meter or some home control box, it is necessary to assess what are the incentives for the installing actor in letting other actors access that device's information.

Another example of resource sharing between competitors can be found in the airline industry. Airline companies use the same flight but with different flight numbers, e.g. one can buy a SAS ticket to a SAS flight and end up flying in a Lufthansa aircraft with a Lufthansa flight number. It seems like actors can cooperate very closely as long as they have full control of their "own" customers and revenues.

CONCLUSIONS

The definition of IoT and M2M systems and platform architecture has been largely focused on solving potential technology limitations in order to provide connectivity to devices. However, after comparing the cases presented in this paper, it can be seen that no enough efforts have been focused on the service delivery and there is little consumer perspective in many of these technological solutions.

Once the different cases have been discussed and compared, it can be understood that there is no direct relation on the level of competition and the proliferation of certain types of applications. What is clear is the fact that when the benefits and added value are substantial, services and solutions emerge and become a profitable business. But when the value is unclear or the benefits are marginal, solutions and services are hampered due to the high entry costs to the market.

Furthermore, after analyzing all the cases presented in this paper, it is clear that small solutions can be successfully deployed when they involve evident high values. Nonetheless, when it comes to the integration of different solutions and the evaluation of large-scale application, there is a remaining open research challenges for IoT services and M2M communications. Shared infrastructure should work for horizontal service components that are common across diverse vertical businesses and coherent vertical application should be build out of this horizontal components.

All successful cases have been addressed with tailored solutions, this makes clear that solutions should be dedicated to particular industry segments and it is not feasible to create a new solution to fit every application-specific requirement; mainly because solutions involve thorough understanding of the industry and its specific needs. But, in order to reach economies of scale, applications should be specific for each industry and at the same time be reusable in different markets. The business solution on successful cases should be evaluated in other market setups to assess their scalability.

In response to the research questions stated in the introduction, we have presented different benefits and values that have been identified for IoT services; general findings include cost saving in service provisioning, ease of use for end end-users, improved efficiency in resource utilization and real-time access to service delivery information. When it comes to drivers and drivers, it has been shown that high level of cooperation and low level of competition is not necessarily a driver for the adoption of IoT services, this can be appreciated in the smart cities and facility management cases. Also, when the expenditure reductions are clear, service adoption takes off. An important barrier remains in the change of organization for traditional service providers that are neither used nor eager to share a service platform.

After studying the different cases, there is a pattern in which the actor that holds the predominant position is always the service provider. It can also be appreciated in the access solution and home care service that the service provider needs to cover more roles than in conventional type of services in order to establish service. Finally, there is an evident weakened position of the communication providers in these types of services, since such solutions are not part of their traditional revenue stream and they are unwilling to expand their activities beyond communication provisioning.

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