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Citizen Centric Architecture Approach - Taking e-health forward by integrating citizens and service providers

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Abstract

In this paper, two related research problems will be discussed in the development of e-health services: First, an architectural approach is needed to provide a holistic view for solving the ICT challenges in e-health development. Second, solving the needs of the citizens should be the focus of the architecture solution. To overcome these problems we suggest a Citizen Centric Architecture (CCA) approach for providing a holistic and appropriately balanced view of the integration. Naturally, enterprises' information systems and citizens' information systems are the key elements of CCA. In addition, for solving the topology challenge brought by a large number of involved parties, a role of trusted third party is proposed to provide an environment for the information exchange and service mediation among the various parties. We believe this approach will enable the large scale growth in citizen centric e-health services that is poorly facilitated by the prevailing models: the improved integration of information will attract more citizens and health care service providers, which in turn, improve the health care information and quality of service.

***Keyword*:**

E-health, Information integration, Citizen informatics, Health care service provider.

Introduction

The term e-health is used to refer to a range of ICT enabled health care services and related businesses. It is in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies [1]. Successfully implementing e-health is believed to have many benefits both for health care service providers and for citizens.

Not surprisingly, e-health faces numerous challenges from social, economical and organizational reasons [2]. According to Eysenbach [1], challenges for the health care information technology industry are mainly (1) B2B: improved possibilities for institution-to-institution transmission of data; (2) B2C: the capability of consumers to interact with their systems only; (3) C2C: new possibilities for peer-to-peer communication of consumers. Haux has also stated the future of health information systems should go from health care professionals to patients and consumers [3]. In other words, achieving e-health would not only require the successful integration of range of health information systems, more important, it should enable the integration of information between service providers and citizens.

As user generated content and consumer health informatics are becoming more relevant in e-health, there is an increasing need of integrating information between citizens and health care service providers. However, current research work related to health information integration has mainly focused on the side of professionals (B2B), with little attention to supporting B2C and C2C communication. Health care, as any other business, needs an architectural solution to guide the changes in all key areas: business models, process design, information management, applications and information infrastructure. Therefore, this paper tries to find out what would be the architecture approach for supporting e-health development, which would solve those appearing challenges.

Methods

The research methodology applied here is design-science, which aim at creating relevant artifacts to bridge the theory and the practice [4]. We start from analyzing the citizens' needs in e-health information systems, and then further investigate current architectures from the perspective of how well they support integration. We aim at designing an artifact, which visualizes the architecture approach needed to support future e-health development.

Step 1: analyzing citizens' needs in e-health

The integration challenges in e-health service development from citizens' point of view can be analyzed by using the B2B, B2C and C2C scenarios as starting point:

- B2B: Most of the citizen's information is in the service providers' hands and it is fragmented into a number of service providers' information systems. Thus, B2B integration is important also for citizens, as it creates integrated access for their own health data. Without proper integration among the organizations neither a service provider nor citizen him/herself can access up-to-date and comprehensive information, which in turn may cause errors in clinician decisions and create many other problems.

- B2C: While the service providers can have a good and specialist view on citizens' health in their respective areas, the people themselves naturally know their own life situation, experiences and expectations best. Possibility to combine the relevant health related information that citizen can provide and the information for the service providers in easily accessible form would both help to serve citizens needs better and to help clinicians and other providers to improve the experienced quality of service. Meanwhile, citizens want to be more proactive and they increasingly seek health information on the Internet [5]. One of the trends is transforming the relationship between physicians and patients [6] as more self-care enables both to reduce health care costs and improve the efficiency. However, without good support of B2C integration this will be hard, if not impossible to achieve.
- C2C: In addition people to interacting with their health service providers they also have the desire to share their experiences, express themselves and seek support from others with common interests. The rapidly development of Internet technologies has enabled them to do it online using tools like SNS, discussion groups, wikis, and blogs to share health knowledge, stay informed and rate health care services etc [7].

In summary, an appropriate and multi-perspective architecture vision should help provision of the key integration needs listed above from the citizens' point of view. In the following we will discuss this extension in the context of the common enterprise architecture frameworks.

Step 2: extending the scope of Architecture

Architecture has been defined as "The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution" [8]. An Enterprise Architecture (EA) is used for dealing with the increasing complexity and improving the communication among stakeholders related to information systems in an enterprise. So architecture should help to define highest-level concepts of system integration. Enterprise architecture is normally divided into layers. The most popular way of dividing layers is: business architecture, information architecture, application architecture and technology architecture [9].

Architecture issues have mostly been discussed in the scope of enterprise. In the context of IT, an enterprise can be a whole corporation, a division of a corporation, a government organization, a single department, or a network of geographically distant organizations linked together by common objectives [10]. Therefore, it differs from individuals or citizens. As shown in Figure 1, we can classify architecture issues into two main categories according to the needs of integration: integration inside an enterprise and integration between enterprises (B2B).

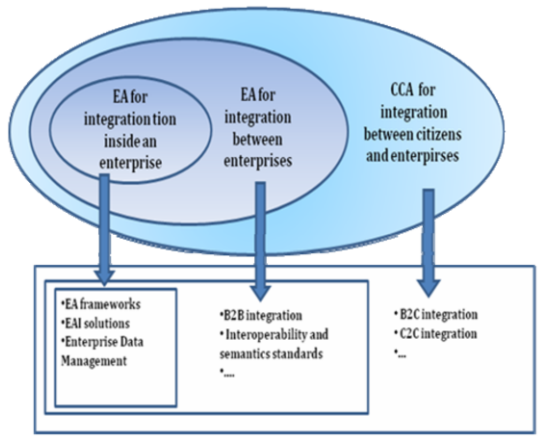

Figure 1- Extension of an enterprise architecture based on the needs of integrating citizens' information

- Architecture for integration inside an enterprise: The development of an architecture starts from the integration needs inside the enterprise. Since Zachman's Framework [11], many EA frameworks have been developed for solving increasing complexity caused by fragmentation of information systems. Integration inside one enterprise usually happens vertically along each layer, so that lower layer provides consistent functions needed by the higher layer.
- Architecture for integration between enterprises: More and more the integration between businesses has raised needs in architecture solutions for achieving better collaboration between enterprises. Integration should happen horizontally in each layer among the organizations to support the business process [12]. Sometimes those two cannot be clearly distinguished. Topics like Business Process Management (BPM), Data Warehouse design, EAI implementations consider both the integration inside the enterprise and among enterprises.

A fundamental principle that can be applied to architecture is: "Always design a thing by considering it in its next larger context - a chair in a room, a room in a house, a house in an environment, an environment in a city plan [13]." With the growing amount of citizen generated information and increasing demand of citizen empowerment, extending the scope of architecture is the natural result of an architecture evolution. As figure 2 shows, while the current architecture issues remain, the extended architecture is meant to solve the integration between service providers and citizens, as well as the integration among citizens or communities of citizens.

Results: Citizen Centric Architecture

Health care service in its essence is all about people. Citizens are the final ones who determine how well the service providers have done their work, i.e. what value have they actually

produced. When the healthcare information systems cannot support the communication of B2C and C2C, the goal of better quality of service would be hard to reach. The observation that the world of health information is still managed in very unbalanced way, putting too much focus in the world of enterprises (or service providers) and ignoring the needs of citizens serves as a good starting point for improvement.

Based on the study we propose to add the citizens into the current scope of Enterprise Architectures, the extended architecture would be called Citizen Centric Architecture (CCA). Also, a Dual Model is sketched for visualizing the integration between citizens and health care service providers. As showed in figure 2, the Dual Model contains two basic elements: Service providers' information and systems and the citizens' information and systems that should work in complementary and harmonious interaction.

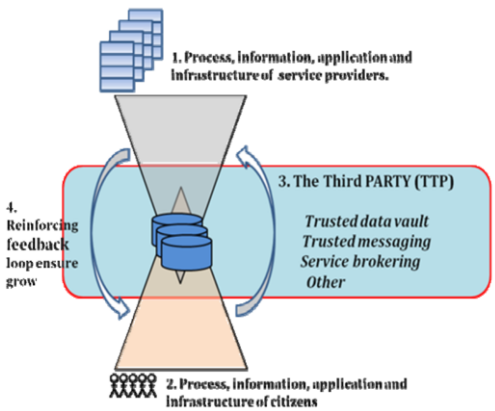

Figure 2- Dual Model of Citizen Centric Architecture

In addition, as CCA is meant to integrate a large number of citizens and service providers the issue of integration topology becomes especially challenging. Integration topology is needed when the design of integration context should specify the locations, structure, and channels to connect all the elements together to form a coherent whole [14]. When the number of parties is increasing the preferred topology is to use a hub in the middle to minimize the number of connections. Therefore, one new element is introduced for connecting many service providers and many citizens together: the "Trusted third party".

Enterprise Information Systems:

Citizens typically use more than one health care service provider in their life. Thus, having access to integrated health care information is the fundamental requirement for clinicians to make the correct diagnoses [15]. In health care, achieving interoperability among health care information systems still has a long way to go. Existing systems are experiencing transition from integration of hospital information system into interoperability of health information systems [3,16]. Promoting Electronic Health Record (EHR) is one of the big steps forward for automating and streamlining the clinician's workflow [17]. Many standards of EHR have been developed for improving the level of interoperability.

Citizen Information Systems:

For achieving citizen empowerment and communication with various service providers and communities, an information management system which could help them to own, create, manage and share information with commonly available and easy to use formats and tools is vital. With the tools and approaches knows as Web 2.0, the user/citizen-generated content has become popular and the idea widely accepted. Service consumers have also become producers.

Similarly, in health care the focus is starting to shift from service providers' side to citizens' side [18]. Citizens need to have better information support in order to be more active in their own care. The counterpart of EHR in the citizen's world is the Personal Health Record (PHR) that is being promoted to help citizen to become more active in their own cares [19]. Some have used the term PHR 2.0 to refer to applying Web 2.0 into the PHR systems [20].

The third party

When the number of involved parties grows large, the benefits of having a third party acting as a hub or intermediary become obvious. For the service providers the third party provides a flexible integration mechanism with least amount of risks, provided they are experienced as trustworthy and providing value for money.

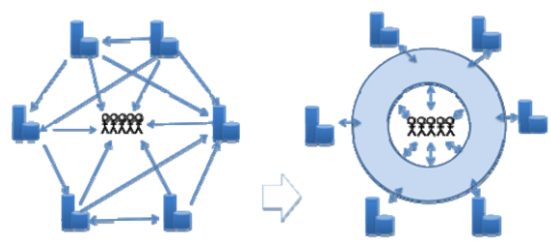

Figure 3- The third party minimizes the connections and builds a trusted and community platform

For the citizens, the third party can provide substantial help in a variety of activities and lowering the barrier of use. These include locating the relevant services and information sources, setting up explicit or implicit contracts with them for service use, integrating them, providing a single point for authentication, and also providing payment services both for providers and users.

In addition to the intermediary services it is also well positioned to provide the citizens an environment for storing, managing and sharing their own information.

The third party needs to follow two principles in order to build smooth communication and interactive collaboration between the service providers and citizens:

- Trusted environment: There are two key steps in creating a trusted environment. First, the service providers and citizens should be able to trust the third party. They need to consider it to be safe to transfer their data in the platform offered by the third party. Second, the third party should build the trusted relationship between the service providers and the citizens.
- Community environment: With the success of Web 2.0, people have experienced the power of social networks in enhancing collaboration and communication. This is also one of the ultimate goals of e-health. In CCA, the third party can take the responsibility of building community environment and enable social relationships among the professionals and the citizens. It has been already suggested that Web 2.0 approach and tools should be adopted into health systems [21].

Achieving growth by reinforcing feedback loop

Adequate volume and penetration in the population is vital to success, as in any other citizen service that requires network effect. Economically, only when the scale of integration is up to certain degree, the communication between citizens and service providers would benefit the society. Further, from dynamic point of view, a right solution for bridging the communication is needed to ensure the growth of the number of users over time. That is, the more citizens and service providers join in, the more benefit each party would achieve. That, again, would attract more citizens and service providers to join. While the motivation of the suggested CCA approach and dual model has been described above as enabler of citizen centric health services, we believe that the trusted third party is essential in creating the reinforcing feedback loop and such services to become reality in a large scale.

Discussion and Conclusion

The contribution of architecture research to health care service would have strategic significance on providing a high level solution for advancing the ICT revolution in healthcare sector. "It is increasingly difficult to practice modern medicine without information technologies [22]." While applying architecture frameworks and approaches for alignment of business and IT have been common in other sectors, it has not been much realized and discussed in the health care sector. Thus, this research may have deep implication for further development of e-health.

Realizing that solving the needs of citizens is the foundation of e-health development, the scope of the architecture need to be extended to integration of the citizens' information. In Dual Model, the role of citizens' and their information is given equally important position as that service providers'.

The benefits of CCA can be summarized into:

- Improving the two-way communication between citizens and service providers and providing an environment for service and information integration, management and sharing, facilitated by the trusted third party as a vital element of CCA.
- Stimulating and enabling necessary changes in service providers' current architecture at various layers. With CCA service providers can efficiently reach, utilize and mange the information generated by citizens and use it to improve the quality of service and reduce the costs.
- The third party can offer a secured platform for citizens to organize and manage their own information. In addition to being able to create their own content, more power and responsibility will be transferred from health care service providers to citizens' hands. They can collect information from different service providers conveniently, manage and distribute it as needed providing benefit to all parties.
- Enhance the citizens' capability to communicate with all relevant entities, including also other individuals and communities with common interests, in addition to the service providers. CCA is meant to facilitate processes, information, applications and infrastructure to be designed for citizens. This would help them to identify and locate the needed services, be empowered to manage the service process, and eventually to improve the quality of their own life.

Current Dual Model cannot yet provide explicit methodology of establishing an integrated platform among health service providers and citizens. At this early phase, Dual Model serves as the purpose of providing a high-level guidance in long term and encourages further research work in Citizen Centric Architecture, which can be generally applicable in any industry and service domain.

In last recent years, several PHR tools such as HealthVault by Microsoft, Google Health etc have launched to the market. However, the adoption of those applications was not smooth and fast as expected. Missing a comprehensive architectural approach would be a partial reason, as one single application solution is not enough to build an interactive communication among millions of service providers and citizens.

As stated, research works about architectural approach are not many in the domain of healthcare services. Possible future works related to CCA are plenty. What we would like continue is to conduct empirical investigations in order to better evaluate and validate CCA approach. As CCA changes both citizens and service providers' workflow, modeling and analyzing the process changes are necessary works in future study. Last but not least, to put CCA into real use, a feasible business model of CCA should also be further explored.

Acknowledgments

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