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Portable Devices, Sensors and Networks: Wireless Personalized eHealth Services

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Abstract. The 21st century healthcare systems aim at involving citizen and health professionals alike entitling especially the citizens to take over a higher level of responsibility for their own health status. Applied technologies like, e.g., Internet, notebooks, and mobile phones enable patients to actively participate in treatment and rehabilitation. It's not any longer just health cards; it's an ongoing standardized personalization of health services including application of portable devices, sensors and actuators stipulating the personalized health approach while offering chances for practicing high quality wireless personalized shared care. The path from cards to personalized and portable devices tackles aspects like health advisors, RFDI technology, the EHR, chips, and smart objects. It is important to identify criteria and factors determining the application of such personalized devices in a wirelessly operated healthcare and welfare, the paradigm change from cards to secure wireless devices to mobile sensors, and the citizen's acceptance of underlying technologies. The presentations of the workshop jointly organized by EFMI WG "Personal Portable Devices (PPD)" and ISO/IEC JTC 1 "Study Group on Sensor Networks (SGSN)" therefore aim at introducing technical approaches and standardization activities as well as emerging implementations in the addressed domain.

Keywords. eHealth, pHealth, device, wireless service, sensor, interoperability

1. Introduction

Cards have widely been used in healthcare applications for about 40 years. Regarding the mobility of both patients and data, such portable devices have long been considered best choice. Many countries in Europe and beyond are still planning the introduction of reader-dependent (contact) and contactless patient data cards with or without medical data. The European Health Insurance Card (EHIC) is being introduced in almost all EU countries. The electronic EHIC is currently under European (CEN) standardization.

It has been a long way from the invention of cards in the late 1960s to a new generation of personalized portable devices supporting Europe on its way to a united and healthier continent. Mobile phones are well-known and well-applied for different

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purposes in many countries. Sensors and sensor networks already applied in various domains help providing both health services and collect personal and patient-related medical information [1]. Personalized portable (wireless) devices (PPD) are more and more going to play an important role in the context of modern Health Information Systems and the pathway towards the future moving the "wireless patient" into the center of all processes in the healthcare and welfare sector [2]. Electronic Health Records (EHRs) enabled to store and process data recorded by sensors support a wireless provision of healthcare and welfare services, and a standard-based personalization of these services is a pre-requisite for guaranteeing a seamless care access for all.

2. Objectives

The ways of making use of such devices are as manifold as the types of devices. In addition to "traditional" healthcare and welfare approaches, new requirements speedily arise from the establishment of wireless health solutions in general, and from portable wireless sensors in particular. Specific networks for sensors will be implemented for permanent data capturing and data analysis. Solutions from industrial domains like transportation can be adopted and adapted to health service scenarios. Sensors need to store not only raw data but also the variance of data outside some predefined levels as these data items may indicate a very specific health situation [3].

The term of "emergency data" shall be defined in a different way in this respect. Analogue to traffic lights, the patient status can be divided into a "green", "yellow" and "red" status. Collected data lead to only initiating alarms in "red light" situations of serious health problems. Otherwise, data shall continuously be collected, stored, pre-processed, and transferred upon request (e.g., once a day, a summary report is being transferred into the patient's EHR). Sensors actively support this way of controlling patients on a 24/7 basis being connected to monitoring offices via sensor networks.

3. Methods

The requirements for safe and high quality care as well as efficiency and productivity of health systems under the well-known constraining conditions are expected to be realized by increasingly distributed and specialized health services that become strongly oriented on the actual personal health status and the needs of the subject of care. Those health services are provided independent of time, localization, and distribution of resources in a highly communicative and collaborative way called eHealth. Personal health must be supported by mobile computing for ubiquitous communication, by pervasive computing for comprehensive and pervasive care as well as autonomic computing for adaptive personalized system design enabling ubiquitous care altogether [4]. Different levels for interoperability shall be provided thereby extending the interoperability chain up to the subject of care as demonstrated in the personal care paradigm's context [4]. The information about status and processes directly or indirectly related to the subject of care has to be documented in a computer-readable format, and stored in repositories – the EHR. Such EHRs have to be implemented in EHR systems which are sets of components for realizing the mechanisms for creating, using, storing, and retrieving an EHR. EHRs and EHR systems for personal health even have to address not only

primary and secondary care aspects but aspects of lifestyle, prevention, wellbeing, dietary aspects, and large mobile monitoring data streams.

A paradigm change from present paternalistic disease management focused health care is underway. Major targets of the next generation eHealth are early detection of diseases and changes in functionality, prediction and pro-active prevention of diseases. In 2020 ubiquitous care is reality in secondary, primary and personal care settings. Pro-active prevention and (personal) health and wellness prediction require much wider information than what is collected and available today. This also means a new generation EHR. Pre-emptive healthcare services require knowledge of individual's normal functions in order to provide an early detection. The future ubiquitous ICT makes it principally possible to collect any kind of personal(ized) information. This information is considered a combination of person's legal electronic health record, information collected by a body sensor network (BSN) from motes, life-style information, location information, social care information, sleep data and signals received by implanted nano-sensors. Typical sources of this information are intelligent ambient analyzers, wearable and implanted sensing systems such as, e.g., the personal portable health devices. This group of devices makes it possible at any time to collect, store, transfer, and process information about personal health and wellness in any environment, even in such a way that the person may not even be able to recognize the ongoing data collection and processing – a security and privacy threat. The information produced by such a PPDs is a necessary enabler for pHealth, but from other side it also creates certain new security and privacy protection needs. Even in the future ubiquitous pHealth environment it is necessary that the person is always aware of who has used or disclosed personal information when, why and what kind of information exactly. Because the pHealth environment is very dynamic, it is also necessary that the subject of information has a possibility to dynamically control at a fine-grained level the use and disclose of information collected via the PPDs. Any successful use of PPDs in pHealth setting thus sets new requirements both for the eHealth infrastructure and for the information models used with the PPDs. The related new security, safety, and privacy protection requirements need to clearly be addressed in advance.

Another important aspect is the mobility of users and the mobility of services but also the mobility of tissues, drugs, blood bags, and devices as such. Intelligent Transport Systems (ITS) is a global development to deploy technology in transport infrastructures, in boxes and containers, and in vehicles in order to make transport and travel cleaner, more efficient, safer and more secure. Such an ITS utilize combinations of computers, communications networks, sensors, positioning and automation technologies that collect and generate data in order to relieve traffic congestion, to ensure safety and to protect the environment, while providing transport related services and applications [5]. The technology of ITS facilitates and manages the interaction of boxes, containers, and vehicles which can be located, identified, assessed and controlled. The same may be applied to human users (e.g., patients, elderly people, people with disabilities), who can employ ITS, for instance, for navigation, travel and weather information, and their specific monitoring capabilities. Supported by a sensor network, the distributed sensor nodes interacting with each other and with other infrastructure acquire, process, transfer, and provide information extracted from the physical world. Taking care of important elements of the treatment of patients (the human blood), a wireless sensor node documents and monitors the cool chain of such the blood bag. Before transfusion, a physician checks the temperature characteristics as an additional safety measure. The temperature characteristics can also be checked on blood bags sent back to the blood

bank. This helps to determine whether the blood bag has to be disposed. Today, when there is uncertainty about the cool chain the blood bags will be disposed as a safety measure. Additional in case the temperature gets too high or too low the wireless sensor node could give an alarm or informs the blood bank. This helps increasing the quality not only of blood bags but also of organs, tissues, and drugs in the near future [6].

As the domain of personal health is to be addressed, personalization and effective user management will be critical to the uptake of eHealth systems towards personalized portable health service provision. Adapting an eHealth system to the individual user is very essential for making the system safe and easy to deploy and to use as an effective support to independent living. Personalization can thus enhance the user's trust in the system, and make it more readily accepted. It can range from simply setting an alarm volume according to the user's hearing abilities and the ambient noise level, to the complex tailoring of the user's entire eHealth environment. The personalization is achieved by maintaining and updating, e.g., a user profile which depends on, and is dynamically adapted to, the user's context, the general and special preferences, physical and mental abilities, and other relevant parameters. The profile can then be used by eHealth services and devices to ensure a uniform user experience irrespective of context. The unique approach to achieve the goals of personalized eHealth systems is the combination of three important areas: standardization of ICT, human factors, and eHealth services. The Human Factors and eHealth Technical Bodies of the European Telecommunications Standards Institute (ETSI) have created two Specialist Task Forces, STF342 [7] specifying an architecture for personalization and user preferences in general, and STF352 [8] which standardizes the information and preferences for personalization of eHealth systems in particular.

4. Expected Workshop Results

The workshop, jointly be organized by EFMI and ISO/IEC and supported by ETSI, aims at analyzing topics of portable devices, sensor networks, EHR's role in the personalized provision of health services, and the personalization of the devices. The presenters explain their strategies of implementing personalized health service provision based on portable nano, micro and macro devices. Attendees from countries with such strategies already in place are able to compare their aims and goals with those of other regions and the respective policies on the EU level. Countries without such a strategy can learn from others on how to implement portable device scenarios, and on how to use existing European and international standards.

The workshop aims at addressing people involved in card/token/devices/sensor business in the healthcare and welfare domain, and anybody interested in these topics. In particular, informatics specialists and computer scientists, people involved in related standardization, ombudspersons, medical doctors and health device technicians intended, engaged to or responsible for the analysis, design, implementation and use of distributed health information solutions including cards, tokens, sensors, actuators, networks, and related portable health devices should attend the workshop.

The invited speakers actively contributing to the workshop are Bernd Blobel speaking about "PHR Solutions for Recording Personal Information Beyond Primary and Secondary Care", Pekka Ruotsalainen addressing "Personal Portable Health Devices in future pHealth", Asbjørn Hovstø focusing on "Intelligent Transport including Support for Sensor Networks", and Françoise Petersen bringing forward the

"Standardized User Profiles for Personalization of eHealth Systems". It's Peter Pharow chairing the workshop, introducing the PPD topic, and welcoming the speakers.

5. Conclusions

Personalized portable devices, sensors and actuators as well as the underlying networks enable personalized health service provision. Applications from other domains stimulate the respective paradigm shift also in the healthcare and welfare domain. The workshop addresses technical, medical, organizational, legal, and standardization aspects of personalized portable devices (PPD) and sensor networks. Facilitated by the group of domain experts presenting their different views, the workshop allows a comprehensive look into the near future of personal and public health service provision.

One of the most important aspects of health is that the users feel comfortable with the health services provided to them. This implies that eHealth and pHealth services fit with the users' lifestyle and preferences. Without mechanism allowing the users to personalize their eHealth experience, a one-size-fits-all solution will be provided only meeting the precise requirements of a very small proportion of the users.

A pHealth system can help the users to live an independent life in their normal environment at home, at work, driving, out doing errands or sport. As consequence, the users' context will be much more variable than when the client is institutionalized. Since the appropriate reaction in one context can be ineffective or even detrimental in another context, the pHealth system registers or enquires about the users' context when necessary, and acts according to context needs. This is what pHealth is all about.

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