Chapter 19

TOWARDS PERSONALIZED SERVICES IN THE HEALTHCARE DOMAIN

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1. Introduction

Healthcare services are designed for enabling the provision of medical care to the patient. The traditional healthcare services are based on the doctor-centric paradigm. Essentially, they enable healthcare providers to assess patients' health status based on information derived from medical examination and information stored in patient's electronic Medical Health Records (eMHRs) [1]. Hence, it is crucial for patient's health data to be digitalized and organized in such a way allowing their exploitation by the healthcare provider at a later point of time [2].The doctor-centric healthcare services enhance healthcare providers' diagnosing skills and enable them to give patients accurate treatment directions aiming to their earlier and safer de-hospitalization.

However, patients suffering from chronic diseases require healthcare services for prevention of emergent events before they become life-threatening. The diagnostic and treating nature of doctor-centric healthcare can not satisfy this requirement. Additionally, the doctor-centric paradigm fails on accomplishing the rising demand for the provision of low cost healthcare services to different population groups [3]. These deficiencies generated the need for adopting a different type of healthcare services in which the patient is the core entity. In consequence, the doctor-centric paradigm shifted to the patient-centric paradigm.

Patient's normal and productive life constitutes the main objective of the patient-centric paradigm. To achieve that, the deterioration of patient's health condition should always be prevented. This requirement implies the provision of personalized healthcare services to the patient at the right time, right place and right manner without temporal and spatial limitations [4]. The continuous and uninterrupted provision of healthcare services is achieved via ubiquitous computing and networking technology.

In addition, the personalization of healthcare services is achieved by exploiting the use of user profiles incorporating the preferences and the interests of the user (e.g. patient, doctor, nurse) as well as contextual and bio information related to the user.

Finally, in the context of patient-centric paradigm, the notion of context-awareness is required since contextual information is essential for deployment of personalized healthcare services.

2. Related work

Studying the evolution of e-health systems through last decade, it is noticed that the whole research focuses on the improvement of accurate detection of emergent events. To achieve that, the aspects of personalization and context-awareness are introduced in e-health systems. Moreover, the notion of personalization is used for effective decision making regarding the proper management of emergent events. Below, it is exposed how the feature of personalization is captured in various projects.

AMON [5, 6]
This project introduces a portable telemedical monitor providing advanced care and alert. The innovation of this project is a wrist worn device that incorporates a number of sensors and the appropriate software for online analysis and emergency detection. The feature of personalization is detected on algorithms analyzing patient's vital signs, taking into account patient's profile (age, gender, fitness and medical history) and activity information (aerobic and nonaerobic state). The result of this kind of personalized emergency detection is the reduction of false negative or positive alarms. In case an abnormality is detected, data are sent for further analysis and evaluation to Management System of Telemonitoring Center. The measured data are compared to previous medical results in order the initial diagnosis to be produced. If needed, the doctor is alerted for evaluating the initial diagnosis based on patient's profile stored on server. The patient's profile includes medical records, such as medical history, medications and other personal information like ways to contact the patient.

WEALTHY [7, 8]
In this project, research focuses on sensors. The goal of this work is the design of a wearable healthcare system which enables the simultaneous measuring of multiple vital signs and further exportation of needed parameters for alerting incidents detection. The introduced personalization in alerting functions enabled the delivery of targeting set of information. The whole procedure leads to creation of synoptic health status tables for each patient which can be used as basis for development of efficient personalized healthcare monitoring and alerting systems.

MediNet [9, 10]
In MediNet project, the concept of personalization is thoroughly explained and defined. The proposed mobile healthcare system provides a personalized self-care process to patients suffering from diabetes and cardiovascular disease. The process applied in MediNet system has been designed in the spirit of personalization. Moreover, patient's vital parameters are analyzed in personalized perspective. Finally, patient's interface has been modified in order to accomplish patient's per-

sonal preferences and needs. Regarding personalization in system's process, it is achieved in two levels. The common characteristics of patients having the same disease constitute the first level of personalization. The so-called *Group Level* personalization is defined as a macro-form of personalization enabling coarse-grained decision based on parameters such as type of disease, sex, age group and severity of disease. In a second level, personalization is confined on individual patient's characteristics. The *Individual Level* of personalization constitutes the further refined form of, where decision are made on parameters such as lifestyle, disability, socioeconomics position, prognosis, location and daily activities. Furthermore, MediNet system personalizes parameters in the dimensions of patient's profile, patient's context and location, content and goal of treatment process. Patient's interface has been developed in a personalized way as patient's personal characteristics, preference and capability are taken into consideration, besides engine's recommendations.

<u>HeartCycle</u> [11, 12]
This project represents a conceptual approach of a Personalized Health System (PHS). The proposed PHS system provides professional healthcare at home. The PHS is represented through two intervening closed loops corresponding to patient and healthcare provider. Essentially, the two closed loops are a patient-oriented platform in collaboration with and a healthcare provider-oriented platform. Personalization is detected on the provided services, i.e. measurement, detection and prediction, analysis and decision, therapy and feedback. The continuous reconfiguration of optimal treatment plan for each patient is the ultimate expression of personalization in this project. HeartCycle system consists of Heart Failure Management, Guide Exercise and Assessment subsystems. In these subsystems personalization is expressed through the architecture.

<u>SEMPATH</u> [13, 14]
In this project the concept of personalization is approached as a process continuous estimation of the best treatment scheme given patient's health status and context. The utilized technology to achieve personalization is ontology and rule-based techniques.

<u>CHRONIOUS</u> [15, 16]
Within the context of CHRONIOUS project, an enhanced model-platform was designed for forthcoming chronic disease management systems. Besides personalization, CHRONIOUS platform captures better the features of context-awareness and ubiquity. The CHRONIOUS project aims at the establishment of a personalized coaching healthcare system. CHRONOUS system advises users on adjusting their lifestyle to their health status requirements. In CHRONIOUS system, it is defined that use of profile makes personalization feasible. Profiles' content is an accurate description of patient's health status. Profiles are used on identification of emergent conditions and on suggestion of proper treatment plans. The intelligent part of CHONIOUS system, i.e. Smart Assistant Device and Clinical Framework makes use of profiles, where vital signs analysis and understanding takes place. In

CHRONIOUS project, the feature of personalization is enhanced regarding therapeutic plans making decisions because besides patient's vital signs, nutrition habits and drug intake are taken into consideration.

MiCARE [17]
MiCARE is a contemporary project meeting the challenges of modern healthcare. This project approaches the concept of personalization from a different point of view. By definition, personalized services are designed and provided in such a way in order to meet user's current needs and preferences. In MiCARE project, personalization is expressed in services, i.e. each personalized service is approached as a different integration and orchestration of inherited services over heterogeneous systems. However, in the context of MiCARE project, personalization is also expressed through the assignment of the roles to the appropriate medical staff given time, location and procedure.

Mobihealth [18, 19]
MobiHealth project attempts to incorporate the features of specialization, customization and personalization on the provided healthcare services as these features are widely considered as success criteria. Therefore, each provided application is targeting to a different group of patients. That is achieved as each patient is monitored by sensors specialized for his/her disease and the sensoring data are analyzed in a personalized way so as the feedback is provided. To achieve that, in MobiHealth project has been developed a context-aware service platform enabling adaptability of service delivery to user's current location, time, activity, preferences and needs. In that way, the patient takes a more active role in health process, which is the ultimate goal of personalization. The feature of personalization is introduced in the proposed platform in order to enhance the scalability of the supported services which will cover the needs of niche healthcare cases requiring simultaneous monitoring of small number of patient to large scale chronic disease management process.

OLDES [20, 21, 22]
This project aims to provide elderly people with personalized proactive and prospective health services through a proper implementation of tele-monitoring, tele-assistance, tele-healthcare and tele-medicine. OLDES project addresses the challenge of personalization through developing a health and care social platform meeting older people (i.e. user), caregiver and social network's needs and preferences. In this project, it has been studied the perspective of co-production, i.e. a socially-organized, situated driven methodology enabling open interventions of dynamically created multi-agency user communities. In order communication and information sharing between care agencies to be enhanced an advanced user profiling system, called Knowledge Management (KM) is introduced in OLDES platform.

EPI-MEDIDS (2002-2009) [23, 24, 25]

EPI-MEDICS project focuses on the development of a Personal ECG Monitoring embedding intelligent decision-making techniques for early detection of cardiac events, generation of proper alarm levels and forwarding of alarm messages to relevant healthcare providers. EPI-MEDICS is designed to the direction of ubiquitous, wearable and personalized healthcare. Decision making EPI-MEDIC system is personalized because patient's vital signs are evaluated by taking consideration of patient's risk factor stored in patient's health record. Moreover, the fact that the system interacts with the patient in order to be aware of his/her symptoms, enhances EPI-MEDIS system's personalization. EPI-MEDICS' personal monitor is supported by a web server where they are stored the patient's recorder vital signs, user information, clinical history etc. Healthcare provider while attending patient, he/she accesses EPI-MEDICS web server in order to observe the patient's personal data or to adjust decision making criteria of alarm generation. That kind of personalization entered in EPI-MEDICS system enables better handling of medium alarms.

MyHeart [26, 27]
In the context of MyHeart project, a framework for Personal Healthcare Application is being developed. In MyHeart project, personalized algorithms that take consideration of user's needs, goal and profile provide the appropriate feedback and consequently the desired personalized service.

Based on the aforementioned projects, the main objective of the current e-health systems is to assist patient on prevention, diagnosis, treatment, and lifestyle management. This enables patients to be more conscious regarding their health status without being socially isolated.
Current e-health systems are multi-state, event-driven platforms providing telemedicine services through healthcare applications [28]. The provided services which aim on prevention are characterized as proactive and those provided services which target on diagnosis and treatment are characterized as reactive [9]. Thus, healthcare monitoring and lifestyle management services under the view of prevention from emergent events are considered as proactive services. On the other hand, detection of an emergent event and activation of the appropriate treatment plans are reactive services.

3 Personalized Healthcare Services

The patient-centric paradigm considers the patient to be the core entity of healthcare environment. As depicted in Figure 1, the healthcare environment is composed by diverse collaborating entities required for the provision of personalized healthcare services to the patient. Essentially, the health status of patient constitutes the heart of personalized healthcare services because it is the inception for their provision [29].

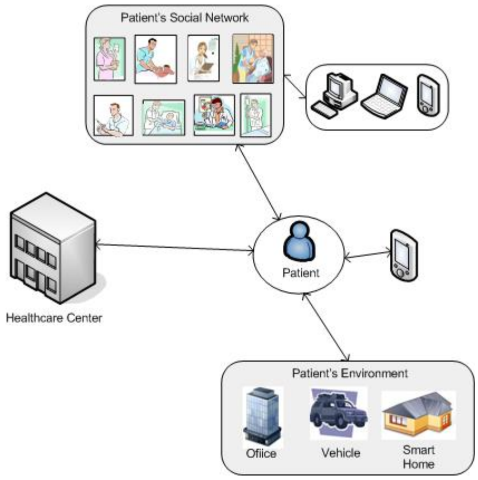

Figure 1. Healthcare Environment in Patient-Centric Paradigm [28].

As defined in [28], the entities included into the healthcare environment are:

- Subjects: The patient as well as a number of individuals serving pre-defined roles during the execution of the service. The group of all involved individuals for each case is referred as "patient's social network". Subjects can also be any healthcare provider taking the roles of medical professionals (e.g. doctors, nurses) and the roles of caregivers (e.g. relatives, volunteers). Each role defines the contribution of each subject on the provision of required personalized healthcare services.
- Objects: ICT (Information and Communications Technology) components deployed around the subjects. They consist of bio-sensors, context-aware sensors, GPS, mobile terminals, etc. They yield also the complementary real time information required for the provision of personalized healthcare services.
- Operational Domains: Places, where the personalized healthcare services are provided. These domains are divided into patient's personal space (e.g. homes, offices, vehicles) and medical units (e.g. healthcare centers pharmacies etc).

In the context of patient-centric paradigm, the deployment of personalized healthcare services, as depicted in Figure 2, exploits information stored in the patient's profile and the profiles of any subject of patient's social network. If this information is related with real-time acquired context information (e.g. temperature, geoposition, etc) then the service is characterized as Context-Aware. Finally, the application of ubiquitous computing upon patient's context data acquired anytime and anyplace leads to the development of ubiquitous personalized healthcare services.

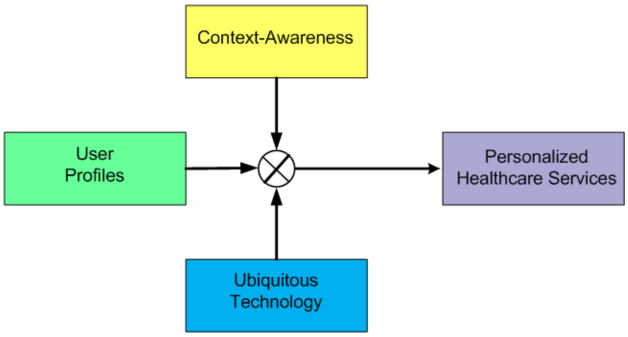

Figure 2. Main Features of Personalized Healthcare Services.

Especially each subject is represented by his/her corresponding user profile including his/her own attributes and properties. User profile of patient stores all information required for personalization of healthcare services, such as his/her health status, prevailing environmental situations, lists with preferred participants to his/her social network, carrying device's capabilities etc. User profiles of other subjects contain information determining both their capability and willingness to participate in the provision of personalized healthcare services for the patient. For instance, doctor's user profile may include information regarding his/her availability for providing healthcare service.
Context-Awareness is an enabling technology for personalized healthcare services. Essentially, context-awareness is an indispensable feature of personalized healthcare services because it guides them how to be customized [30]. A personalized healthcare system can not make the right decision for the patient’s treatment without the appropriate contextual information. Usually, contextual information is captured by sensors.
Ubiquitous computing is a new technology paradigm incorporating distributed computing and mobile computing. The main objective of ubiquitous computing paradigm is to bridge the gap between virtual world and physical world integrating seamlessly information and communication technologies with people in their daily lives. Ubiquitous computing is crucial for the personalized healthcare services in order to be provided to anyone, anytime and anywhere without location and time constraints [31].
Personalization on both proactive and reactive services indicates a unique integration of different service components provided by different healthcare providers in services satisfying users’ needs and preferences. This integration implies the orchestration of different healthcare providers in a treatment scheme with predefined roles delivering the treatment plan [29]. The selection of appropriate healthcare

providers for the adoption of the predefined roles in the treatment scheme is a personalized procedure based on the patient's preferences and current needs.

4. Personalization in Patient-Centric Paradigm

4.1 Profiles in Healthcare

Profiles constitute the main mean for the expression of personalization in healthcare services. The deployment of personalized healthcare services is enabled by the use of the profiles of the participating entities that are either directly or indirectly related to the patient when an event is detected denoting that his/her health condition is critical and a ubiquitous healthcare service should be provided [29].

Based on the features of the participating entities, it is essential the existence of a profile structure for each entity. Thus, the generic healthcare profile structures are the following:

- Subject's Healthcare Profile: This profile corresponds to the patient and the patient's social network categories. In general, the Subject Healthcare Profile contains[29, 32]:
    - Personal information: data about or related to the individual (e.g. name, address, age, identifying number), which are extracted by electronic Medical Health Records (eMHRs).
    - Preferences: choices made by the individual about a given parameter (e.g. time, location) that will define or modify the behavior of the personalized service. More complex preferences can be expressed in the form of rules, activities and roles.
    - Rules: statements that can be automatically interpreted in order to define or modify the behavior of the personalized service.
    - Security: specific obligations, access policies and preferences regarding security.
    - Contextual information: Information related to patient's situation and influence on
    - Indexes: Pointers associating a subject with a patient social network.

- Operational Domain Profile: This profile corresponds to the Operational Domain category and it is distinguished to:
    - ✓ The Medical Unit's Profile may contain information about [28]:
        - Identification information (e.g. name, address);
        - Critical conditions that can be handled (e.g. cardiac arrest, heart attack);
        - Available equipment and facilities;
        - Schedule of the on duty healthcare center.

- ✓ The Patient's Personal Space Profile may contain information about [28]:
  - Identification information;
  - Supporting healthcare services;
  - Available equipment facilities;
  - Available members for support;
  - Context Information.

  The types of Patient's Personal Space profiles are [28]:
  - Smart Home Profile: This profile corresponds to the Smart Home category;
  - Office Profile: This profile corresponds to the Office category;
  - Vehicle Profile: This profile corresponds to the Vehicle Profile.

Especially, the subjects move from one operational domain (situation) to another throughout the day (e.g. at home, driving, working). In each of these situations, they may have different needs for how they would like their ICT resources arranged. Thus, a subject can have several situation dependable profiles whose activation and deactivation is based on rules. [32]

4.2 Profiles Management System for Personalized Healthcare Provision

The data of the above mentioned profiles may be stored among a number of different storage locations (e.g. mobile devices, PDAs, service provider's databases) [32]. Wherever the data is stored, a profile management system will ensure that the profile data is synchronized when it is required [33].
Hence, in the healthcare domain, a profile management system is required for the efficient support and provision of personalized healthcare services to patients remotely. It is considered that each participating entity in the provision of the healthcare service has its own profile. Thus, the proposed profile management system makes use of a number of *User Healthcare Profiles* and *Patient's Personal Space Profiles* [29]. The incorporated data of each profile are stored in distributed databases.
The patients are being monitored by the system in order any critical event to be detected timely. When such an event is detected, a patient's social network profile (referred *group profile* in [28, 29]) is triggered to be created. This profile's structure allows healthcare systems to compose multiparty group-working schemes with pre-selected behaviors of all involved subjects [29]. In the group profile, each subject has a specific role with defined activities. The intention of each subject to participate or not is detected by his current individual profile. The dynamic creation of group profile describing the behavior and roles of all the participating entities in the group for the provision of personalized healthcare services to the patient enables the real time collaboration of the participating entities.
The main objective of the profile management system in the healthcare domain is the creation of group profiles in order to provide high quality and reliable personalized healthcare services to the patients [29]. The group profile is created based

on the indexes stored in the User Healthcare Profiles. Each patient's profile contains an index to a group profile that is triggered whenever an event is detected. The events are related to the patient's health condition and they denote that the patient needs a medical advice or care due to aggravation of his/her health condition. The group is formed through certain management, scheduling and notification events [29].

The profile management system integrates the following mechanisms: *Profile Creation*, *Profile Update*, *Event Handler*, *Role Assignment*, *Group Profile Create*, *Group Profile Update* implemented by agents as depicted in Figure 3 [28].

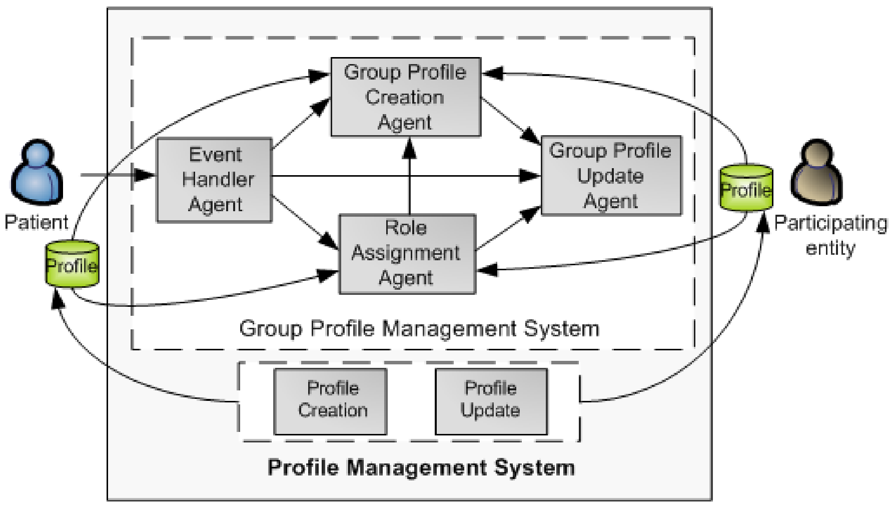

Figure 3. Profile Management System [29].

The profile management system based on the profiles and the current context activates the appropriate mechanisms for the management of the group profile of the entities that will participate in the provision of the healthcare service to the patient. These mechanisms deal with the context information management, as well as the individual and group profile management [28]. The deployed profiling mechanisms are based on the gathered context information, on the presence of organized and structured profiles, and the assignment of roles for the creation of group profiles [29]. Different profiling mechanisms are activated according to individual's profile, which changes, as individual's current context changes. These profiling mechanisms can be considered as simple components that can be integrated to implement personalized services [29].

The profiling mechanisms [28, 29] are described below:

- Profile Creation: Every individual is considered to have his/her profile and is added to the system as user. The profile is initially created by fundamental data that then are completed from supplementary sources. During the creation, information and preferences are also gathered from services and devices in order to populate the profile. The creation can be based on a) explicit methods where the user actively defines the attributes, b) implicit methods where the prefrences are inferred by monitoring user behavior or c) combination of explicit and implicit [32]. This procedure is usually enhanced be the usage of templates in its first steps.

- Profile Update: Since the individual profile is established, it is continually maintained either manually or automatically with the usage of monitoring components, which enable its update. Moreover, this mechanism supports services and applications to automatically suggest updates to the profile. It is important to ensure that the values of the attributes meet the user's preferences for the current context.

- Event Handler: This mechanism is responsible to detect and handle the events that trigger the creation of the group profile. These events are related to the transition of the patient's health condition from one state to another. An event can be defined as a significant change in specific bio or contextual information captured by the corresponding bio or contextual sensors. This mechanism is used to evaluate the events in order the appropriate decisions to be taken. For example, an event can denote that the patient needs a medical advice or attention and care due to aggravation of his health condition. Thus, this mechanism activates the creation of the group profile for the provision of personalized healthcare services.

- Role Assignment: This mechanism assigns roles to the potential entities of the group in order the creation of the group profile to be achieved. It defines the roles that are required and invites the potential entities in order to build the group. Each role has its competences as when a conference is convened. The patient (his health condition) and the formed group function as the convener and the participants of the session respectively.

- Group Profile Creation: This mechanism is used for the creation of the group profile. The activation of this mechanism is event-driven. Whenever an event (e.g. the patient's health condition is deteriorated) is detected by the event-handler, the group profile is created based on the pointers that are stored in the patient's profile. The entities of the group that will participate are specific. The information stored in their profiles determines whether an entity meets the conditions in order to participate. A coordinator is also defined in the group depending on the roles that participate for the provision of a UH service. For instance, if an emergency service is delivered, then a medical professional (e.g. doctor) will be responsible to coordinate the group in order all the participating entities to collaborate efficiently.

- Group Profile Update: This mechanism is used for the update of the group profile. After the activation of the group profile, collaborative actions may follow such as decision-support and profile-sharing depending on the patient's health condition. In addition, the attributes of each participant may change dynamically over time. The participants' presence is constantly verified. Moreover, if a new event is detected by the event handler, an additional role may be required and as a result another entity will be added in the already formed group.

Thus, the profile management system will enable the profiles to be [32, 33]:
- Created (mention data editing, e.g. creation templates update etc.).
- Stored: The data should be stored in a secure manner with user agreed levels of privacy applied to the availability and distribution of that data.
- Accessed: Ideally, profile data should always be available, overall networks, from all supported devices and services, including fixed and mobile services allowing service continuity and optimal user experience. The access control needs to respect principles regarding user control and legal policies.
- Synchronized: Data at different locations should be kept consistent, which may be ensured by synchronization of data and transaction security. However, although the profile data (or copies of profile data) can be distributed amongst devices and services, it should be possible to ensure that users can have the concept of centralized profiles which cover all of their devices and services.

Moreover, the profile management system:
- synchronizes all the profiles of involving entities in a provision of a personalized healthcare service.
- controls the access of different entities on patient's profile respecting his preferences and legal policies. There are general policies that define what access the entity may have to the patient's profile. However, these policies can be overwritten if the patient has defined related sharing preferences stored in his profile.

There is a variety of stakeholder entities with different objectives regarding the way they exploit/take advantage of the profile management system [33].
- End-users want to personalize their provided healthcare services in order to get the maximum of expected user experience.
- User profile providers offer all required mechanisms in order to define the users' preferences in their user profiles.
- Network providers not only take advantage of profile management system because they exploit them for personalizing their services but also they enhance profile management system functionality by providing them services such as storage and transfer of user profile and service data, data synchronization and capability negotiation.
- Service and device providers use profile management systems for personalizing their service and device, accordingly. Profile management systems, in their turn, take advantage of them for updating user profiles.

Therefore, the profile management systems provide benefit to users, primary, but also to different types of third party providers certificated by users to manage their profile content and certificated users exploiting profile information owing stakeholder.

4.3 Scenario of a Personalized Healthcare Service

In this section, we demonstrate a real world scenario depicting the way a personalized healthcare service is provided to a chronic patient. This scenario is designed to focus on the fundamentals of the personalized services without considering advanced functionality, such as the ubiquitous computing.
Christos is a 57 year old man living in Lesvos, an island of East Aegean Sea far away from the Greek mainland. 15 years ago he was diagnosed with diabetes but he was under poor glucaimic control. Besides that, six months ago he had a heart attack for which he was transferred and hospitalized to Hippokrateio General Hospital in Athens.
In that hospital, Christos was submitted to Coronary artery bypass surgery. He dehospitalized 4 weeks later with instructions for strict control of his arterial pressure, blood sugar and cholesterol. Moreover, he was advised to quit smoking immediately, lose weight and in general follow a healthier way of life.
Christos' wife, Mary, contributes to his rehabilitation by helping him have a healthier nutrition and quit his bad habit as well as comply with his medical treatment.
Even if, Christos complies with medical advises, the fact that he is a diabetic patient makes him vulnerable to the appearance of a life-threatening event of silent ischemia. That is the major problem for the diabetics because it may develop while the patient has no symptoms or pain of any kind. As a result the condition goes undiagnosed and untreated and has higher probabilities for lethal.
For these reasons, Christos should be continuously and uninterrupted monitored by a system in order any critical event to be detected timely.
We consider a Smart Home to be the environment supporting the required telemonitoring system. It is equipped with the appropriate sensors for gathering context and bio information as well as integrates the essential residential networks for the provision of requested healthcare services remotely. A bio EKG monitor could identify myocardial strain and alert the patient or his relatives at an early stage. Moreover, an acute coronary event could be diagnosed by the doctor while the patient is still on his way to the hospital providing time for early intervention such as thromvolysis. In addition blood pressure, blood sugar and cholesterol levels can be monitored at any time so that any doctor can alter the medication, providing better control for patients living far away from the general hospitals of Athens.
In addition to Mary, a number of other individuals contribute in order Christos has a healthy living. For instance, his diabetologist assesses Christos' biosignals for calibrating his glucaimic control. Obviously a social network is organized around Christos for providing him the appropriate healthcare services. Each participant in Christos' social network is represented by his/her profile which determines how it contributes on Christos' rehabilitation. Table 1 concentrates all participants of

Christos social network and defines the actions required to be accomplished in each case.
Based on this scenario, we consider the use of Christos' profile, a number of profiles of doctors and nurses related to Christos and a set of profiles of Christos' relatives e.g. his wife.

Table 1: Analysis of the scenario

Stakeholder	**Relationship to Client**	**e-health Profile**
Christos (patient)		• He uses a tele-health monitoring package in order to monitor his blood pressure, blood sugar and cholesterol levels in order to make alterations of his diet and medication (diabetics alter the dose of insulin based on self-monitoring). • The system alerts him, whenever acute changes of his bio markers take place including silent ischemia.
Mary (Wife-caregiver)	Health Profile (monitored health data, smoking condition, diet)	• She helps Christos to follow all the medical instructions. • She arranges Christos special diet of low sugar, low fat, low salt. • She deprives from Christos his smoking facilities. • She is informed of any dangerous life threatening event so that she can transfer Christos to hospital in case of emergency. • The system helps Mary to form her shopping list according to Christos' needs for low sugar, low fat, low salt diet.
Diabetologist (medical professional)	Health Profile (monitored health data, smoking condition, diet)	• He supervises Christos' health condition. • He makes alterations on Christos' medical treatment. • He reminds Christos to make check-up twice a year.
Pharmasist (medical professional)	Diet, glucose levels	• He determine Christos' needs for insulin and make arrangement for insulin supplies.
Cardiologist (medical professional)	Health Profile (monitored health data, smoking condi-	• He diagnoses a myocardial infarction while the patient is still on his way to the hospital having time to prepare for treatment in time to prevent myocardial

	tion, diet)	necrosis.
Community Doctor (medical professional)	Notifications for emergent events	• He arranges Christos' transportation to a general hospital including the appropriate medical equipment.

To achieve personalized services, the e-health tele-monitoring system creates dynamically a group of eligible subjects (e.g. doctor, wife) to provide care to Christos when his health condition requires it. The proposed Profile Management System is used integrating the following mechanisms: Event Handler, Group Profile Creation, Group Profile Update.

If the current state of Christos health condition justifies the sharing of the emergency-related information from his profile, this information may be necessary to be shared with a participating entity (e.g. doctor). The sharing will be based both on general policies that define what access the participating entity may have to Christos's profile and on Christos's sharing preferences.

5. Conclusions and Future Directions

This chapter presented the basic aspects of the personalized healthcare services that are provided through the novel ICT infrastructures. The deployment of patient-centric healthcare services is a multidisciplinary task requiring the contribution of different technologies and the collaboration of many entities. From a technology point of view, personalized healthcare services exploit context-aware, user profile structures within a ubiquitous healthcare environment.

The main objectives of these services are the support of patients, especially elderly people and people with chronic diseases, in order to have an independent and safe way of life as well as the efficient collaboration of all healthcare providers involved in the treatment process. Current applied personalized healthcare services focus on facilitation of persistent patients' health status monitoring and on customization of treatment based on patient's needs and preferences. The personalized healthcare services also facilitate the self-help purposes. In addition, they facilitate the collaboration of diverse authorized subjects, objects and operational domains for the provision of accurate and timely-critical healthcare assistance.

In this chapter, we focused on the necessity of the profiles of any subject, object and operational domain involved in the establishment and provision of personalized healthcare services. Furthermore, we analyzed the structure and the functionality of a profile management system for these services. Finally, we demonstrated an operational scenario for the provision of personalized healthcare services under real world conditions.

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Index terms (alphabetically):

Context-awareness
Patient-centric
Personalization
Profile
Profile management system
Ubiquitous
Etc.