

# Chapter 31

## Home Healthcare in Cloud Computing

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### ABSTRACT

*Cloud computing is one of the emerging technologies that has an increasing impact on both private and public sectors. It represents an on-demand service model for delivering computing resources ranging from storage and data access, via computation and software provisioning. This chapter describes an application of Cloud Computing in home healthcare by introducing several use cases and application architecture based on the cloud. A comprehensive methodology is used to integrate security and privacy engineering process into the development lifecycle and to identify challenges for building security and privacy in the proposed cloud-based home healthcare system. Moreover, a functional infrastructure plan is provided to demonstrate the integration between the proposed application architecture with the cloud infrastructure. Finally, this chapter discusses several mitigation techniques putting the focus on patient-centric control and policy enforcement via cryptographic technologies, and consequently on digital rights management and attribute-based encryption technologies.*

### INTRODUCTION

The World Health Organization (WHO) describes in detail (WHO, 2010) how only a few major risk factors account for a significant proportion of all deaths and diseases in most countries, especially those caused by Non-Communicable Diseases (NCDs), that is, diseases that are not infectious and that are strongly correlated with life habits, emotional states, and living environments of pa-

tients. Non-communicable diseases, especially cardiovascular diseases, diabetes, cancers, and chronic respiratory diseases, accounted for 60% of all deaths worldwide (WHO, 2009), estimated around 35 million deaths each year. Total deaths from NCDs are projected to increase by a further 17% over the next 10 years. The growing trend of NCDs, not only in developed countries, but also in low-medium income countries, is an alarming problem that can have serious consequences a)

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on the health of the citizens, b) on the National Health-care Systems, and c) on the productivity of the countries. The field of Preventive Medicine has shown how modifiable behaviors, including specific aspects of diet, physical inactivity, and tobacco and alcohol use, account for over 80% of heart diseases and stroke and type 2 diabetes.

Furthermore, the management of chronic disease is known to be a complex issue once the patients leave the hospitals, due to the problem of adherence to the prescribed therapies in the daily life. A number of rigorous reviews have found that, in developed countries, adherence among patients suffering chronic diseases averages only 50% (WHO, 2003)(WHO, Adherence to Long-term Therapies: Evidence for Action, 2003), and consequences of non-compliance for selected medical disorders are even higher (diabetes non-compliance 98% in US, hypertension non-compliance 93% in US, 70% in UK, asthma non-compliance 28-70% worldwide). The report from the WHO (WHO, 2003) states: "Because most of the care needed for chronic conditions is based on patient self-management (usually requiring complex multi-therapies, the use of medical technology for monitoring and changes in the patient's lifestyle, patients face several potentially life-threatening risks if health recommendations are not followed as they were prescribed."

The facts and figures just described clearly demonstrate the need for health care to move outside the boundaries of the hospitals and care structures, toward a more self-managed scenario, where the patient is participating to the care process and can receive appropriate support also at home and, more in general, in the daily life. Personal support systems could improve the health behaviors of the individuals, even before they become patients. Correct management of diet and physical activity, together with controlled consumption of tobacco and alcohol, are factors important both to prevent chronic diseases (primary prevention) and to slow down the development of actual diseases and avoid

the development of co-morbidities associated with those diseases (secondary prevention).

The authors of this chapter believe that development and deployment of ad-hoc applications "in the Cloud" could help in 1) empowering patients, 2) allowing continuous home-monitoring, and 3) improving health professional-patients links, with a significant impact in patient management, hospitalization reduction and critical episodes prediction, prevention and management. Point 1) means providing patients with self-management tools that actually allow them manage their personal data (medical and non-medical, like physical activity, sleep, etc.), and their personal conditions. Proposed services should allow the patients to understand their situation and conditions and should empower them in managing these situations. Point 2) means that patient can be provided with devices able to upload data, through secure channels, to the Cloud, and these data can become part of the Electronic Health Record (EHR) or part of the Personal Health Record (PHR). Point 3) means that both patients and health care professionals will have specific services, regulated by user-specified privacy policies, to access patients' data and to provide remote monitoring and support.

This document first clarifies the different concepts of eHealth, and what are the possible benefits and barriers to move eHealth applications in the Cloud. From this introduction it will be quite clear that the home healthcare (or remote monitoring) is the most interesting and suitable scenario to study. We will then describe a possible home healthcare application to support one of the most common causes of disability worldwide: depression. The example of depression is critical enough, still being generic enough, to allow us to explain privacy and security concerns that could be adapted to many other applications supporting remote monitoring.

A possible architecture supporting the described home healthcare services will be described, together with its instantiation in the Cloud.

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