

Architectural Model of e-health PHR to Support the Integrated Cross-border Services

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Abstract. E-Health concepts are emerging technologies useful and desirable for a wider population covered by a large group of users and in many countries. Involved in wider health systems, the Personal Health Record (PHR) concept is very useful both for healthcare institutions and for patients. If the concept is applicable to multiple health systems in more than one country, it can provide controllable exchange of patient health data in order to support the health systems of the countries where it is implemented, taking into consideration the legal regulations of each of the countries for the patients' personal health record data protection. For all this to be a reality, a well-designed IT architecture is needed. This architecture has to support the PHR concepts and ensure the proper collection and use of data for e-health, especially for vital signs of living, data collected from medical devices with sensors, which are available to those who need them. These data have to be connectable to other health systems in the country aiming to improve the patient's health service. Cross4all project of the IPA2 Interreg program 2014-2020 aims to create the conditions for the development of e-health PHR systems in the cross border area that will have the appropriate architecture to support the legal requirements of the countries participating in the project and to improve health and social services in the cross-border regions as a pilot project, applicable to wider areas. This paper highlighted some aspect of the developed cloud architecture for Cross4all project connected with usage of mobile devices.

Keywords: E-Health, Personal Health Record (PHR), IT Architecture of E-Health, e-health digital literacy, Cross4all IPA2 project

1. Introduction

The need of defining e-health services demands a multiview which have to provide a clear understanding of prerequisites for creating such complex structure. These prerequisites should take into consideration the level of health education of the population as well as the real environment in the area in which the project is being implemented. The level of health literacy and the degree of success of such projects are usually straightforward related. The use of devices that monitor the patients' health as a need of e-health services usually requires prior education of the citizens, and therefore it is necessary for the citizens to be prepared for this kind of projects with previous educations of e-health literacy and how to use the devices intended for this purpose. Usage of these data as support of evidence

based medicine might be very useful for the patients and medical practitioner and can increase the level of quality of health services. So, challenges that accompany e-health can bring many benefits to all stakeholders in health, and it's worth paying more attention to.

The concept usually is connected with usage of web service applications for e-Health. In the Cross4all project, cloud environment is used in order to solve the problem of cross border accessibility and to support data collection from different types, medical practitioner data, patient data, collected in different way, sometimes from sensors of medical devices for measuring vital signs of life in patients, many times from remote patients, disabled population, children and elderly people.

The recent papers consider e-health systems as needed help for many areas where the people do not have access to suitable healthcare institutions as well as quality of healthcare systems [1, 2], especially in remote rural areas [3], inaccessible areas that cannot be covered by state's healthcare systems [4, 5, 6].

Some improvements of healthcare system can be done with usage of emerging IT technology [7], including telemedicine in the different areas in healthcare [8], especially when the patients need some specialist's help. Telemedicine is usually applicable in psychology, cardiology, radiology, surgery with robots on distance etc, but the concept demand a huge investment in ICT and healthcare devices [6]. This trend of growing needs for applying e-health concepts demands appliances for many devices for measuring the vital signs of live, which means development of a huge industry of such devices [9], usually controlled and approved by some regulatory body (for example the Federal Drug Association - FDA) [10]. They are usually connected with mobile phones and provide information for medical practitioners with purpose of supporting the evidence based medicine in distance and to increase the patient satisfaction [11].

In the Cross4all project, the concept of e-health is taken into consideration for the cross border areas and high-level architecture is created in order to support such a serious and complex activities. The paper is organized as follows: First section describes the whole Cross4all architecture to support the concept of integrated service for e-Health. The next section explains the conceptual architecture of the proposed model for the project with focus on mobile devices part. Third section is dedicated to some proposed improvement that the model brings for the stakeholders of the project. Finally, some concluding remarks for the paper are taken into consideration and gives some recommendations.

2. Hardware architecture intended to Cross4all project

The project Cross4all address the e-health problems in cross border area, intended to take into consideration the problems of creating the Personal Health Records

(PHR) for patients as an owner of data from two national healthcare systems. For this reason, the proposed architecture is cloud based and distributed. The central point of the system is Cross4all Application server (Fig.1), connected with central Authentication/ Authorization server. Depends of the patient’s country of residence, the patient or its medical practitioner is connected to the server of the municipality or hospital intended for e-health integrated services. In order to increase the e-health and digital health literacy, the servers intended to this purpose are used as a part of integrated e-health cloud system for Cross4all. The concept of splitting data for two (or more) countries is used because of the different laws of protecting of patients’ data in two Cross4all participant countries as well as to different concept of ownership of patient’s data. The intended data should be connected with cloud based systems for e-prescription and e-referral, as a part of the main Cross4all system.

The focus point of our research is collecting data from medical devices intended for distance screening of remote patients. Data collected from medical devices with sensors have to be available to those who need them, connectable to other health systems in the country aiming to improve the patient’s health service. For this reason, Cross4all create prerequisites for usage of these data for general practitioner and other medical staff with consent of the patient cross border.

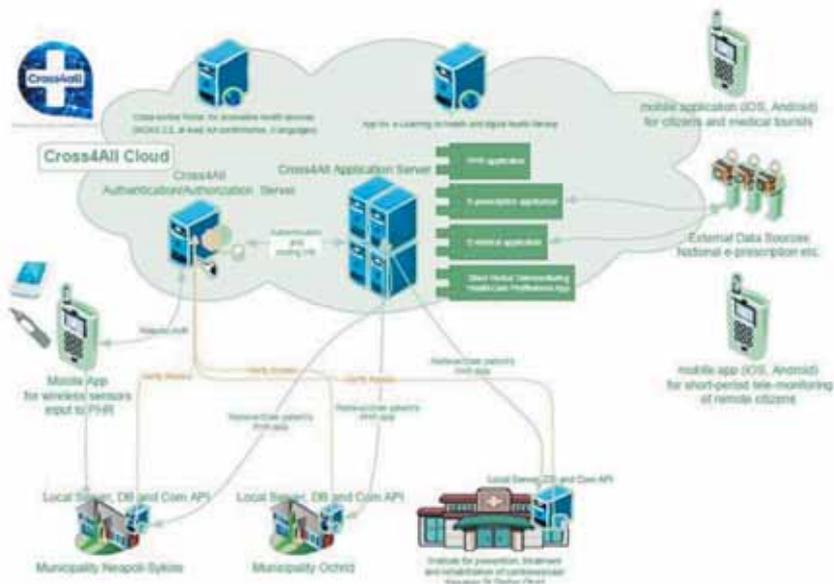


Fig.1 Cross4all high level architecture

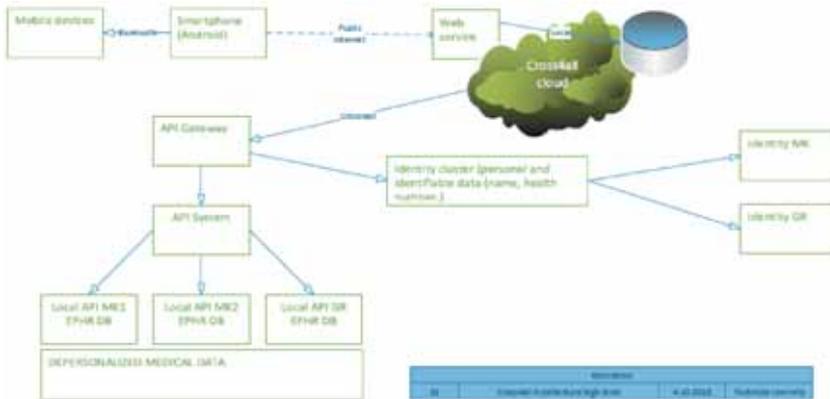


Fig.2 Conceptual Cross4all high level schema

3. Conceptual model for CROSS4ALL

The proposed conceptual model for Cross4all project takes into consideration the concept of ownership of the PHR which differ from the usual used models where the hospitals and state healthcare systems are owners of patients' data. For this reasons, the patient as a participant of the Cross4all pilot, have to have the consent to participate in the pilot program. According to nationality, the patient will have username and password (or similar authentication/ authorization mechanism) in order to have access to the own PHR. The patient will access to own data through Identity cluster. For this reasons, the cloud concept with distributed servers is used as a best solution for cross border system (Fig.2).

When the patients have to use mobile devices for collecting data of screening and measuring vital signs, they will use intended devices connected with Bluetooth to tablets/ mobile phone for data collection and API gateway connected with Cross4all cloud to connect to the local cloud services and provide data for medical practitioner (Fig.2). The general practitioners will have the possibility for e-prescription for the patient or make some e-referral in distance, according to data they can see and access to state healthcare systems or hospitals' systems (Fig.3). The specialists also can have the access to PHR of the patient if the patient gives the consent. The prerequisite is the patient to have Internet connection (Fig.2).

The Cross4all system as a pilot system have to provide experience for usage of PHR from the patient as owner and to provide a clear understanding of that is the concept applicable in the wider community or not. The Authentication and authorization server have to provide the right streaming of data collecting in national cloud based servers in order to satisfy the national low regulation for patient data protection and national health low (Fig.4).

The intended e-learning for e-health and digital health literacy system have to increase the patients' knowledge for using the concept and implement the intended system. The cross border portal has to inform the citizens cross border for health services possibility in cross border areas. The project can support many scenarios for using these digital assets for citizens and a wider population with disabilities because of implementation of WCAG2.0 standard in all project's digital assets (Fig.1).

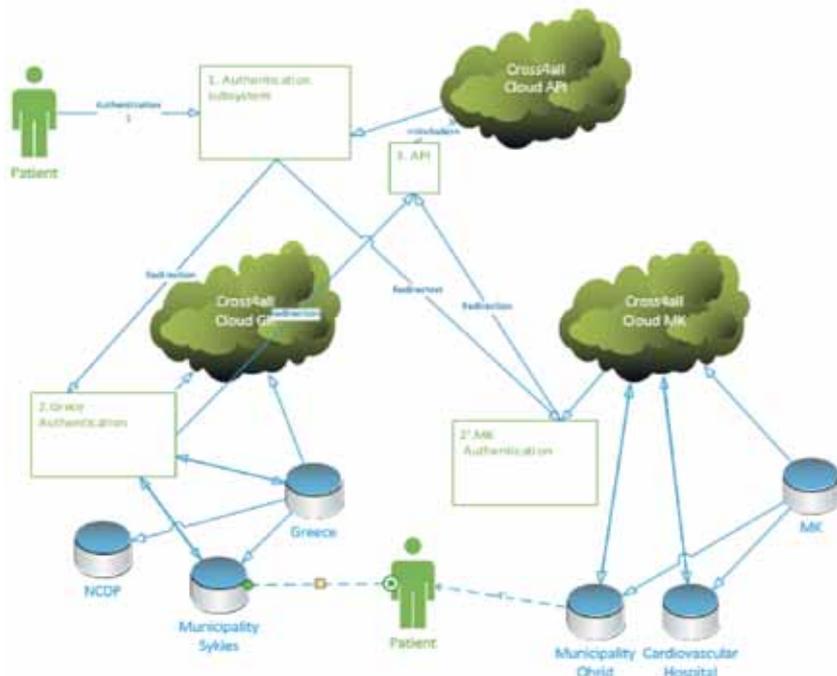


Fig.3 Conceptual Cross4all schema for mobile devices for measuring vital signs

The principles on which the proposed high level architecture is based are translated into the following steps:

1. User's authentication according to that the users gain the API from national Cross4all system and the role which the user has in the Cross4all system (patient, medical practitioner.)
2. The system recognizes the user and makes redirection to appropriate Cloud system from the counties of owner to PHR, as patient.
3. The API service communication starts
4. All sensitive and private data are collected in the national Cloud based system with a patient's consent, in the database servers in the states from which the patient belong.

The Cross4all project integrated model validation is planned to be done the last quarter of the next year in the cross border area of the project implementing countries in municipalities and hospitals. The planned activities have to improve the designed architecture during the implementation of pilot in Ohrid and Sykies municipalities and to address and remove any obstacles or problems that will be detected on the real project environment in implementation on the pilot program. For this reasons, the teams for pilot project implementation have to be done with participants of the medical practitioners, software developers and patients as holders of PHR.

4. Expected improvements for the Cross4all stakeholders

The project expectations have a wide range of improvements for the stakeholders of healthcare system for cross border areas. The benefits can be expected with the implementation of the project for stakeholders as patients, municipalities, health institutions, the cross-border region tourists. Some examples that can be mentioned in this paper are the possibilities for e-prescription for the patients abroad (for health truism, travelers, passengers.) who need some drugs and the medical practitioner can prescribe those drags and then patient can get them from Pharmacy, increasing of e-health and digital health literacy for the citizens, using of e-referral system cross border, using information for available healthcare service etc. For the municipality the benefits are connected with satisfaction of medical practitioner in municipality as well as for the patients, the possibility of giving services for foreigners and increasing the level of healthcare knowledge of citizens covers in distance the healthcare services for distance patient and disabled patients with e-health service [11]. The medical practitioner will have access to patient data and can provide evidence base healthcare and increase the quality of service for patients etc.

The planned activities in the first period will cover some medical and drugs information and similar emerging issue in healthcare. The e-learning system for e-health and digital health literacy will improve the self management of the patients' health in cross border area. The knowledge gained from this project can be also used for some improvement of the national healthcare systems.

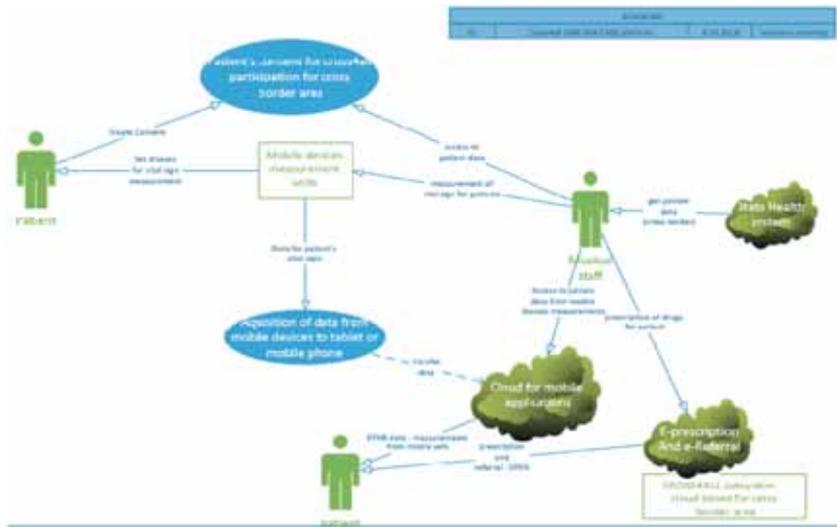


Fig.4 Use case scenario for integrated e-health cloud based Cross4all system

5. Conclusion

Architecture design of CROSS4ALL project tends to meet the demands of a cross border e-health concept, health institutions demands and cross border citizens in order to provide a base for a new concept of patient's ownership of Electronic Personal Health Record (PHR). The country specific issues also have to be satisfied. The usage of patient's data should be regulated with a patient's signed Consent for participation in Cross4all pilot project.

The wide range of digital assets is planned to be developed in the project intended to cover a needs of patients and medical practitioner as main stakeholders as well as to help in increasing the e-health and digital health literacy in the cross border area.

With the data acquired from devices for measuring vital signs of live, connected with tablets or mobile phones, stored in the cloud databases used in Cross4all project, the patients and medical practitioner will have a data for PHR that can be used for increasing the quality of services, as evidence based medicine and detection the irregularities in patient's health behavior. These data can be seen also as precise monitoring health data for the citizens who are not in situation to gain healthcare services because of distance location or some disable people who can get a help at home, on distance using the e-health services which Cross4all will provide. Using e-prescription and e-referral Cross4all system, medical practitioner can give some drugs or recommendation for future patient's activity no matter they are in the country or abroad.

Cross4all system also allows fastest intervention of physicians in sense of precise the necessary therapies for the patient, in time, detection of causes / consequences for occurring anomalies in human health and possibilities for analyzing depersonalized data for the purposes of patient behavior statistics and future suggestions for state health actions (first in the cross border regions).

Patient benefits from Cross4all digital assets are valuable because they receive their PHR and can carry with them, reducing the risk of inappropriate treatment by the doctors they refer to and increasing the quality of the service they receive from medical practitioner because they will be empowered with their electronic PHR and can practice evidence-based medicine.

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