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On behalf of the e-Health Technical Committee (TC) of the IEEE Communications Society (ComSoc), we wish our members a very instructive reading of this letter.
The contribution for this edition is coming from France. The author is sharing his ideas on the provisionning of advanced eHealth services in the Cloud Computing. This work is a join collaboration between reseachers in France and Brazil in the area of eHealth.
Members of the eHealth community are invited to contact the author for further information or collaborations.

We also welcome all our members to share their research activities and field experiences through this open newsletter and to open up new opportunities for discussions and collaborations.

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AN INTELLIGENT SYSTEM FOR DECISION MAKING AND SERVICE PROVISION FOR E-HEALTH USING THE CLOUD

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I. INTRODUCTION

The advance in pervasive computing and network communication has influenced the data collection growth nowadays. Modern devices of the type of smart-phones, smart-home devices, smart-televisions and wearable devices can be connected in public and private networks, increasing the capacity to monitor the environment and those who use these devices.

Besides the sensory data, meta-data about these sensors, such as GPS-system accuracy, and contextual information, such as current weather, can be aggregated to the collected data as well. With the advent of portable devices packed with medical sensors (e.g. smart-phones, smart-bracelets) [1], it is possible to make use of the data produced from these devices to support health care assistance.

We present LARIISA, an intelligent system, to support health care services by supporting health care governance and igniting processes, actors, and services involved using data remotely collected from these devices. In LARIISA, sensory data, such as vital signs, GPS-locations, and accelerometers are structured along with their contextual data and meta-data in order to be reasoned and trigger services in response to some context or situation. For instance, falling detection or the wellness determination for elderly that triggers the nursing assistance service in the scenario of unusual behavior detected using accelerometers [2] or smart home devices [3].

LARIISA is an evolving framework that has been developed along five years, aiming to support health care governance by providing relevant information for decision making. Inits latest development cycle, LARIISA evolved to support a scenario of a context-aware health care governance, collecting data from several data sources, sensors and interacting with patients through a digital television interface [4]. The results demonstrated the suitability and contribution of this approach to support scenarios involving different assistance actors in the health care supply chain, for instance, by identifying regional dengue fever outbreak and grounding public healthcare investment in a specific region.

The enhanced architecture for LARIISA hereby proposed aims to extend the benefits of this original project by improving its situation and context-awareness, and providing an extensible platform to subscribe different services and information alerts related to health care assistance. For this reason, we propose an architecture designed to support servicesubscription and registration, allowing applications to be programmed based on services provided by the platform. In addition, the new LARIISA provides mechanisms to describe health care assistance work flows to respond accordingly to the patient's situation and context. Intensive data-analytic system, such LARIISA, needs to address some architectural issues, like scalability and complexity in the deployment process. In this context, cloud computing presents advantages for addressing these shortcomings.

Cloud computing elasticity allows dynamic configuration and deployment of basic IT services to form complex business processes. This way, cloud computing's elasticity enables businesses to deploy the desired complex process autonomously and dynamically adapt the IT services to deliver requested functions without worrying about the infrastructure's cost and maintenance. Moreover, the cloud's auto scaling mechanisms deliver the exact amount of needed resources while maintaining the Service Level Agreement (SLA) contracted between the Cloud rovider and the Cloud Consumer. These benefits, alongside the Pay-as-You-Go business model, made the cloud an innovative, cost efficient, and flexible delivery model for business processes. Although pervasive environments have limited computational capabilities, they generate large amounts of sensory data. Therefore, the need for ubiquitous unlimited computational and storage capabilities to aggregate, process and store the large amount of collected data. The complementary characteristics of both, pervasive environments and the cloud

computing, allowed them to converge [5], envisioning to deliver sophisticated IT services on demand.

II. SYSTEM ARCHITECTURE

Besides patients and decision makers, several third-party actors participate in the functional scenarios of the new LARIISA system. Each of them have different information needs and plays different roles in the health care supply chain. Moreover, actors in this proposed version of LARIISA are not just information consumer, but contributors who feedback the system with relevant information both coming from health care assistance and patients.

The proposed architecture in this paper was designed following the SOA approach. A Service Oriented Architecture (SOA) aims to model a system in the form of reusable services that deliver applications and business functionality. These reusable services are functions accessed through a well-defined and implemented interfaces. Multiple services can be combined in order to provide more complex services.

LARIISA's architecture is divided in three layers: Data Service Platform (DSP), Service Platform (SP), and Application Platform (AP), as presented in Figure 1. In the base, the services related to the data collection and transformation processes are disposed organically and highlight the importance to provide each functional step as a service. Data acquisition come from different data sources, including medical data source (that should be safeguarded), linked data (triple stores), traditional transaction databases, data streaming (like social networks), environmental sensors, wearable devices, desktop, smart-phones, smart-televisions applications, and devices connected to television set-top-boxes. LARIISA's architecture provides a public publisher/subscriber conector where new data sources can be connected.

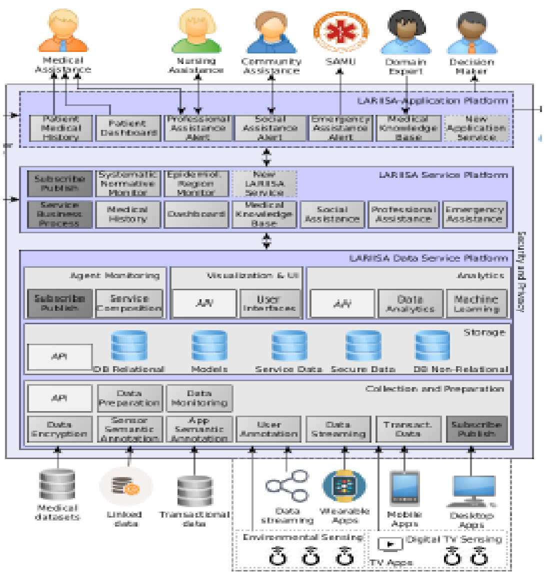

Figure 1 LARIISA architecture

Each phase in the functional flow of LARIISA have functionalities that are provided as services. In the ’Collection and Preparation’ module, data encryption, semantic enrichment, stream processing, and functions to prepare data are available. In this case, for instance, data cleaning and context-awareness processing can be done in this module. Since the system is based on its proactive behavior, data monitoring in this module is responsible for triggering agents to analyze the data being stored or streamed. In the ’Storage’ module, different services to store and retrieve information are available, considering information safety, integration and structure. ’Analytics’ module provide services to cluster, classify, and identify patterns and data models. In ’Visualization and UI’, data and information representation API can be accessed in order to format the data differently. These API will provide visual components to show information and to interact with users. The ’Agent Monitoring’ module is the core of the pro-activity in the system. This module is normally triggered by ’Collection and Preparation’ through its ’Data Monitoring’ functionality. The services in this module are driven to perceive data, patterns, and models in order to trigger services in the ’Service Platform’.

These functions can be combined differently to provide different results, such as summary for health care decision makers, health status to doctors, and health care agents. In this sense, we propose an architecture that incorporates the concept of Enterprise Service Bus (ESB) to support the service composition in LARIISA. ESBs are architectures based on open standards, message exchange, and integration of distributed and independent services. They aim to provide routing, invocation and mediation services to facilitate the interactions of different applications and services in a secure and reliable manner [8]. Figure 1 shows a simple ESB scenario.

The second layer, Service Platform (SP), is the bridge between data services and applications based on ESB. In practice, the SP acts as a mediator between the health care assistance business process and the technical implementation details needed to collect, store and analyze data. Besides that, the SP is responsible for orchestrating the business process that decides which application in the AP needs to be triggered and messaged, and what components in the SP needs to be activated to deliver functionalities demanded in the pplications available in the AP. This is still a technical layer (higher than DSP) that needs to be operated by administrators, servisse managers, and developers who want to provide a scenario that involves health care assistance.

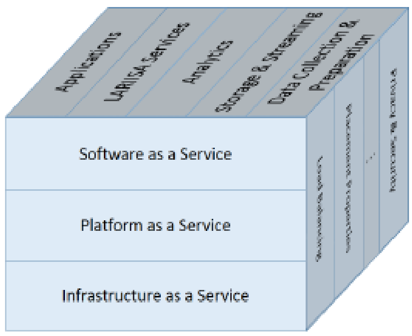

Figure 2 The cube representing the cloud business process

The developer needs to interact with the SP and AP in order to know what services in SP he/she will use to ignite applications in the AP, and, if needed, develop new servisse in the SP using DSP API. Developers are also responsible for developing applications that will make use of the services provided in the SP. The Service Manager is responsible for adjusting parameters of applications in AP and services in SP, while making sure that actors in the health care assistance process have their needs and expectations reflected in the business process defined in the SP. Administrators are responsible for updates and maintenance of the platform in general.

The third layer, Application Platform, is a platform where actors in the health care supply chain have functionalities and interface to interact with LARIISA directly. Some actors will only receive information and their actions will not be counted into the system, such Decision Makers. Other actors will demand and receive information from the system, like doctors and other health carers. In this category, patients can

allow specific individuals to have access to their profile based on trust and familiarity, for instance, community or relative assistance can be triggered and monitor patient's situation based on their granted access.

III. SERVICE ARCHITECTURE

In a cloud environment, the cloud service stack (Software as a Service, Platform as a Service, and Software as a Service) and the service level agreement can be used alongside the functional model described in Section III, in order to deliver LARIISA's services via the Cloud. Therefore, LARIISA can be viewed as a 3 dimensional cube as shown in Figure 2. The cube consists of:

1) LARIISA functional model: It describes the information flow throughout the system. We can distinguish several main components in the functional model: (a) data collection and preparation, (b) storage and streaming, (c) analytics, (d) services platform, and (e) applications.

In a cloud view point, each of these component can be treated as a sub process block delivering its required IT service. Each sub process block hides the underlying computational model (basic IT services) needed to deliver the requested task.

2) The computational model: It represents the cloud computing service stack. This model describes the underlying virtual network on which the functional model runs. It contains the specifications of virtual machines (physical requirements, operating system, etc.), virtual links (bandwidth, etc.), and virtual machines postconfiguration requirements.

3) The service level agreement (or non functional requirements) model: It describes the provisioning parameters of the functional model, the post provisioning initial configuration, and finally the Key Performance Indicators (KPIs) and Service Level Objets (SLOs) to take into account when enforcing the contracted violation penalties and the requested Quality of Service (QoS) level during run time. This model defines the architecture of within each component and its evolution during run time.

IV. CONCLUSION

The previous version of LARIISA [4] delivered an inteligente system for decision-making in a public health management environment. In [10] the authors propose a data integration platform for the LARIISA. The aim of this proposed platform is to enable the integration of a large variety of health information databases with different governance issues involved, enabling interoperability among these multiple sources of data.

Making use of this platform, the framework on this paper will be able to correlate information stored in different databases of private or public companies. It would permit the system to find additional information of a specific patient (e.g. via SUS ID) to collect more health information related to a specific patient, thereafter taking a decision more accurately. By applying modern concepts of data mining, SOA and ESB, this proposed platform aims to reach scenarios as social assistance or emergency alerts based on the patient's wellness perception which are conceived by data interpretation and situation awareness.

As future work, we will focus on implemented the proposed architecture. The framework presented on this paper has the purpose of joining Continua Health Alliance [11], a non-profit, open industry organization of health care and technology companies.

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