Telemedicine Network Implementation with SOA Architecture: A Case Study

Edward Guillén, Jenny Ubaque, Leonardo Ramirez and Yaneth Cardenas.

***Abstract*— The remarkable growing of telemedicine implementations around the world allow users to enjoy better health services in an unimaginable way by increasing attention, patient comfort and opportunities to achieve good diagnosis among other advantages. This paper shows an implementation of a telemedicine service with Service Oriented Architecture (SOA) for cardiology reformulation designed in different phases as a case study.**

***Index Terms*— Service Oriented Architecture, e-health, Telemedicine implementation, Web services.**

I. Introduction

THE need to improve medical attention in the health care system is becoming increasingly important, not only in hospitals buildings but also for having more dynamic and efficient processes, being the technology its first partner, the main advantage is the cost reduction of medical institutions and patients [1]. This is possible with the telemedicine systems that are defined as a service that "*utilizes information and telecommunications technology to transfer medical information for diagnosis, therapy, and education* [2]". The system allows improving health care of a population by reducing implementation cost and distributing medical specialist location [3].

Telemedicine network design is applying with the principles of scalability, availability, and security [4]. The architecture is organized with Service-Oriented Architecture (SOA) and the platform is based on a business model.

In faculty of medicine at Military Universidad Nueva Granada implementation of teleconsulting for patients with cardiovascular disease was decided because this kind of disease has become one of the largest causes of death in the world [5]. Teleconsulting service is offered to heart patients allowing faster and efficient attention process.

Based on the aforementioned situation, an interoperable, infrastructure independent web platform is developed [6]. Faculty of medicine requirements are the first elements to begin platform develop process, therefore design is made with a layered architecture.

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II. Platform Development Requirements

The platform was created according to the established requirements, and the initial design was based on the Unified Modeling Language (UML) which allows recognition between each mechanism and the existent relationships in the developing software [7, 8].

Table I shows the requirements in the provided service, the operation and security requirements will be evaluated on three aspects:

--Priority: How important the requirement is for platform development. Possible values are: 0-Low, 1-Medium Low, 2-Medium High, 3-High.

--Risk: Evaluates a security parameter of the requirement according to the risk in the platform development. It is evaluated as follows: Low, Medium and High.

--Status: Indicates the status of the requirement on the development process, their evaluations levels are: Defined, Approved, Verified, Draft, To be reviewed.

According to UML model, the role that is involved in the teleconsultation service process is identified. To recognize the process, it is necessary to establish a diagram of the scenario. The scenario shows the profiles identification for teleconsultation. In the case a *Patient* is visited by a *Control Assistant*, both of them access to the web platform and teleconsultation process begins; the data needed by the *Medical Specialist* is taken by the control assistant in order to interact with the patient. Information is stored in a database server that works together with an email server, an audio server and video streaming server: servers must be monitored constantly. These control and management operations during the process will be done by a person called *Administrator*.

According to the previous statements, the roles are simplified as follows:

--Patient: Person that is directly benefited from the service, who will receive the provided service [9]

--Control Assistant: Person in charge that manages the teleconsultation process between the patient and doctor. Assistant arrangements appointments, and he visit the patient where is located and establish the video conferencing process. Vital signs will be assessed and measured by health care assistant in order to perform the medical consult, reformulation and / or remission [10].

--Medical Specialist: Who make diagnosis, prescription or medical care remission by using videoconference. If it is necessary, he can arrange an appointment with non-telemedicine alternative [11]

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TABLE I
ESTABLISHED REQUIREMENTS

Cod	Description	Priority	Risk	Status
REQ_ 0001	it requires a telemedicine service for cardiologic reformulation	3	Low	Ap-proved
REQ_ 0002	It requires a flexible service for each of the actors involved in the teleconsultation process	3	Low	Defined
REQ_ 0003	It should provide teleconsultation service from the patient desired place [1]	3	Medium	Ap-proved
REQ_ 0004	providing the service on a web platform is required	3	Medium	Defined
REQ_ 0005	The platform must be flexible and in accordance with users.	3	Low	Verified
REQ_ 0006	a Control Assistant that provides service to the patient and takes the required data to give him a diagnosis is nesessary	3	Low	To be re-viewed
REQ_ 0007	it is required to mantain security for medical information, software and persons involved in the process...	3	High	Draft
REQ_ 0008	The management of medical information must be on the HL7 standards	2	Medium	Defined
REQ_ 0009	It should have a process of electronic medical record (EMR), based on HL7 CDA	2	Medium	Defined
REQ_ 0010	the consultation process should be done through video conferencing	2	Medium	Ap-proved
REQ_ 0011	Connection must be ensured for the different processes required for service in the platform	2	Low	Draft
REQ_ 0012	Should be considered different user profiles for a teleconsultation service according to the actual process of formulation	2	High	Ap-proved
REQ_ 0013	Interoperability is required according to the profile assigned	2	Medium	To be re-viewed
REQ_ 0014	Each user has a unique ID	1	Low	Draft
REQ_ 0015	Service is required to have a projection to business.	1	Medium	Ap-proved

--Administrator: is in charge of service control and operation as well as software and hardware involved in the process.

Following the UML notation, a dynamic model is developed by using a flow chart that describes the procedure that carries out the provision of teleconsultation services step by step. The diagram shown on Figure 2, introduces each of the applied phases in teleconsultation service, from the Web service logon to the logoff service in prescription or remission procedures. It is necessary to communicate the responsible person of this phase with the corresponding system.

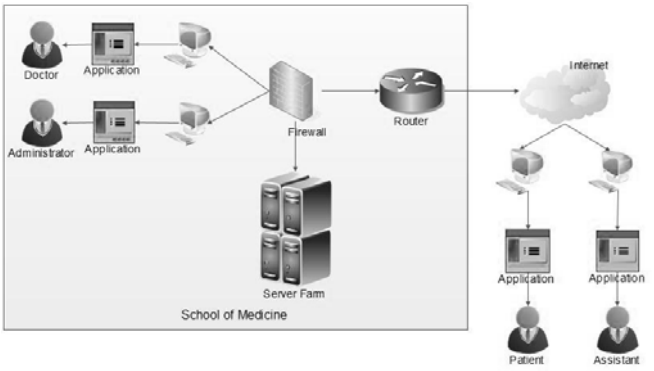

Fig. 1. Profiles identification according to the stage to be managed to provide telemedicine service.

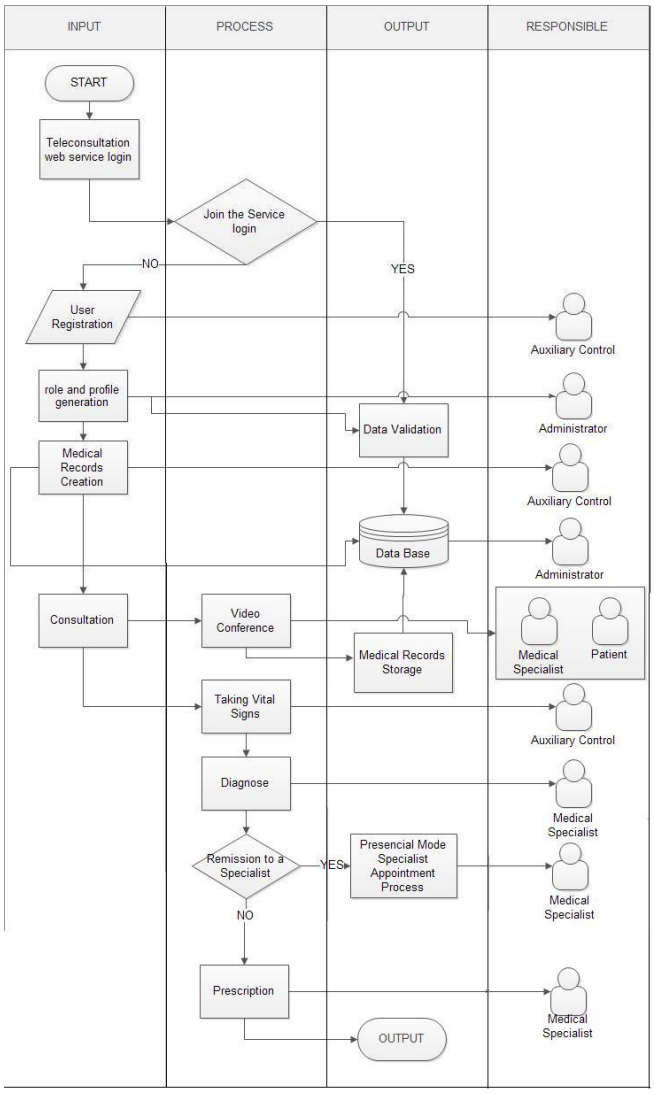

Fig. 2. In-out process chart for adjudicating the profile responsible.

III. NETWORK ARCHITECTURE DESIGN

The beginning of the web platform is developed over SOA in order to manage behavior between the business model and infrastructure software with dynamic change if necessary [12]. The scalability is not only for technical purposes but also for enterprise goals. SOA steps are detailed in next items.

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A. *Conceptual Model*

To begin SOA architecture design, it is necessary to define three elements with specific function and disposition inside the model as is shown in Figure 3 [13]. The first element is the *service provider* that is in charge of establishing the service requirements. The consumer interacts with the platform and it is linking to the services provided by the system. Finally, the service broker counts the service usage by interacting between the interface and database. The main goal is to maintain the service and their actions under control.

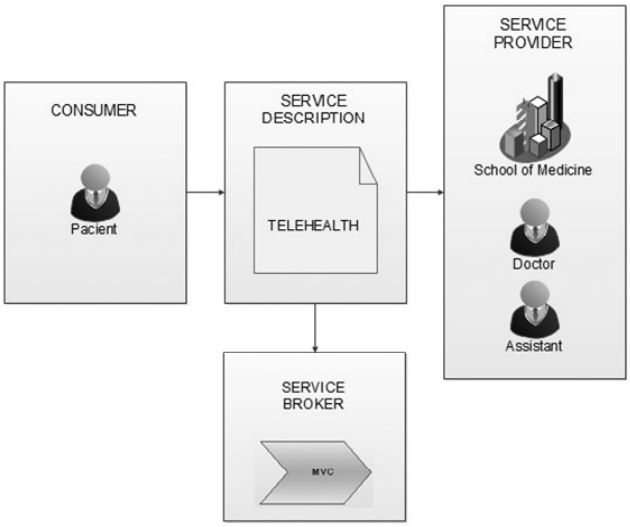

Fig. 3. Components description in the Conceptual Model. Service Provider, Service Description, Customer Service and Service Broker

B. *Model View Controller*

For an efficient architecture, it was decided to keep the three layer model described by the Model-View-Controler, MVC [14]. The figure 4 shows the MVC process. User develops individual roles according to services to interact with the application. The application must be updated according to the developed process. The process produces requests that interact with the controller's phase. In the same way, the process is becoming in the intermediary between the requests that users generate and the servers that gives the requested information. With the new generated processes, the model layer works in the administration and storage of medical information that is generated and requested.

C. *Service Oriented Architectures*

The requirements and models were established previously, and then the network architecture was developed. The web platform to develop will be based on SOA architecture that allows cost reduction because it is possible to use one of the layers to the legacy system [15]. Flexibility in the location is also possible without the need of medical professional presence and accomplishing medical information security levels as required in HL7 standard Clinical Document Architecture (CDA) [1]. Figure 5 shows the designed architecture in seven layers with the elements that composes each layer. These layers are defined as follows:

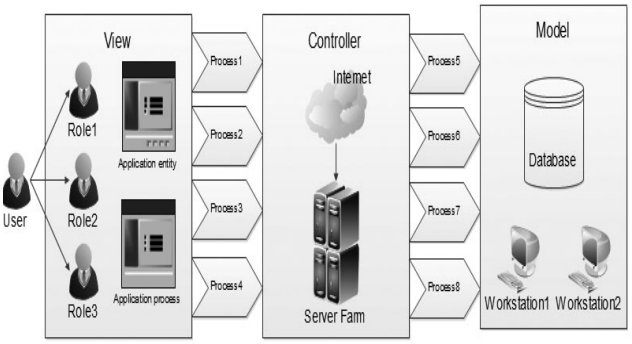

Fig. 4. Components description of the Conceptual Model. Service Provider, Service Description, Customer Service and Service Broker

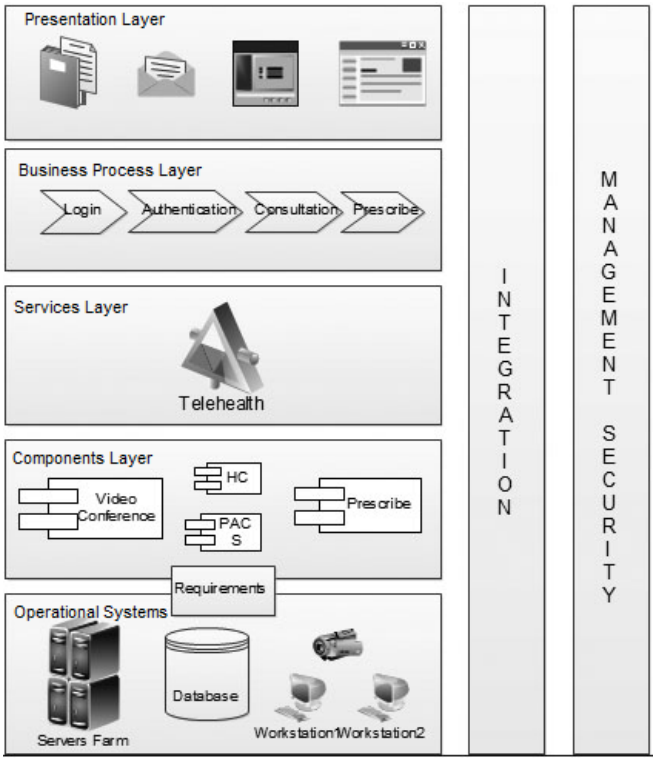

Fig. 5. Service layered architecture based on SOA teleconsultation

--Operational Systems: contains all new hardware devices or reusable equipment of the faculty with enough resources to provide the service [16].

--Components Layer: encloses all necessary elements for providing the service, including databases for electronic health records management (EHR), audio and video streaming server [16].

--Services Layer: contains the service to provide, for example telehealth service [16].

--Business Process Layer: In this layer, each service node or entity is employed to provide teleconsultation in an efficient way [16].

--Presentation Layer: This layer describes each interface and users interaction within teleconsultation process [16].

--Integration Layer: This layer is the unification of the previous layers through negotiation protocols, routing algorithms and security management. Thanks to this phase, the information management is more secure and efficient [16].

--Management, Monitoring and Quality of Service: With this layer, it is possible to measure efficiency parameters in the proposed architecture and into the MVC[16].

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IV. Application

With the given requirements, SOA architecture is implemented as a first step and the web platform was putting into service as a second step.

In the figure 6 navigational map interface is shown based on the patient profile who is the main user.

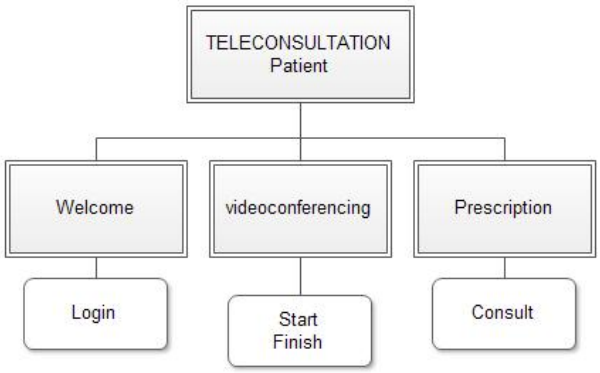

Fig. 6. Navigational Map for the patient

Figure 7 shows the navigation map for a doctor who is responsible of creating an electronic medical record based on the established standards by the national law and working together with CDA standard of HL7 [17]. The entire process is implemented with security standards to protect recorded medical information. The medical specialist gives his diagnosis according to previous profiles.

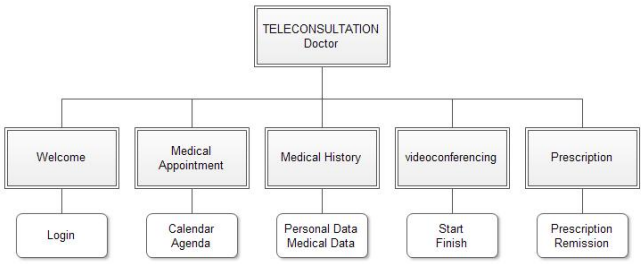

Fig. 7. Navigational Map for the Doctor

Finally, the interface and database must have a relationship according to permission levels; it's implemented with the markup language XML. Fig 8 shows a scheme of teleconsultation with the steps of the whole process.

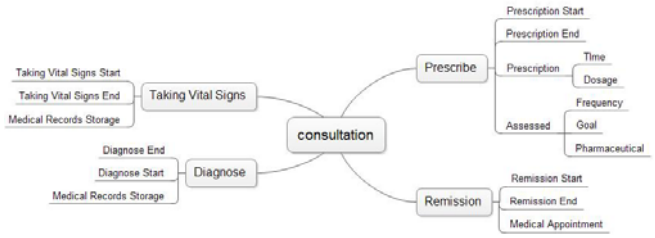

Fig. 8. XML Schema for teleconsultation [3]

V. Conclusion

Each application to provide a telemedicine service must have a specific architecture; SOA management allows scalability and enables to attach different services in a simple way. Implementation allows having a telemedicine centre or virtual hospital very similar to a real one. Complementarily, it is an interoperable service that could be flexible for any kind of user classified in a specific role, according to user needs and keeping security and regulatory parameters established by control agencies.

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