A Concept of eTraining Platform for Cardiology Learning based on SOA Paradigm

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Abstract: This article discusses the problem of realization of future forms of education, like eTraining services. The construction of such services is complex. The individual modules are created by different teams using different technologies. Therefore, the focus was on the use of Service Oriented Architecture in this kind of applications.
There is a reflection on an applicability of SOA in the construction of combined services in this paper. The analysis of the demand for services is presented. The process of composition of services is discussed and architecture of the system is proposed.

1 INTRODUCTION

The current software education system needs to integrate different solutions coming from different sources. The existing solutions are created based on broad and deep knowledge in a certain domain. It is very important to integrate the knowledge included in different sophisticated applications in one system. This article presents a proposal for integration software solutions in eTraining system. The eTraining differs from other typical eLearning solutions by fulfilling some Real Time requirements. The eTraining software includes simulators and visualizations that animate the real environment.

So for the eTraining it is important to build flexible software systems meeting the following key parameters to the appropriate extent:

- agility – the ease of adapting to changes;
- scalability – utilising resources proportionally to the load;
- reusable components – components may originate from different development sources and it is possible to select the component for the set service type;
- efficiency – the efficient use of resources, including working in real time (e.g. EDA);
- lightness - allowing for activities and the functionality to be reduced to the customer's needs;
- flexibility – consists in selecting solutions appropriate for the current needs.

The effective implementation of a software architecture should account for the SOA paradigm (Reference, 2009), in which the functionality of the system is described by the service concept in a way independent of the operating system or the programming language. In the SOA paradigm, the system is made up of loosely connected services which constitute components that can be reused many times and may occur in various compositions. The emergence of SOA provides (Jin, 2010) a better solutions for independent information resources, duplication development problems and integrating and reusing the educational resources.

2 ANALYSIS OF THE DEMAND FOR SERVICES

Modern technologies give the opportunity to develop skills using the virtual simulators. This also applies to medical. A student or a doctor can practice skills using the simulators and training

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systems. The main feature of this method is that it does not need the presence of the patient and hence the following advantages:

- exercises can be done at any time, at home, outside of a hospital or clinic,
- no patient is subjected to activities that are harmful or potentially harmful (e.g. radiation, administration of contrast), or may be unpleasant.

The use of simulators helps in spatial orientation, handle manipulation, and introduces the topic. It is also possible to provide the data corresponding to several modality and obtained by different devices, which will facilitate student in using of various instruments amassed by various centres.

In this article we present a proposal for a comprehensive system of eTraining for cardiologists. While the issue of eLearning is well established now, eTraining systems are not popular yet. In the cardiology, basic examinations can be selected for virtual training, before student will start to perform in the real world. It is possible to compose an educational course for both students and as a part of training for experienced users. Virtual simulation of an examination is no substitute for real training with real patients, but it can prepare for the real examination and can reduce the time of education. It should be noted that attendance at the real examination is necessary, but learning of each case can take a long time on waiting for an occasion. By using a training system student can learn in less time many cases of disease entities, which in the clinic are rare.

3 SPECIFICATION OF SERVICES

The application of a comprehensive eLearning and eTraining in the domain of cardiology should be composed of several modules performing different stages of learning and training:

- a training system for heart sounds – the aim of this element is to introduce to the technique of listening to the heart in two aspects:
  - location of application of the chestpiece (bell and diaphragm modes)
  - determining the diagnosis, if a heart sound is associated with pathology or normal,
- ECG training – the goal of this part is to present sample electrocardiograms (obtained from the real medical examinations or generated by a simulator); in the educational part: student's task is to acquaint with prepared by experts electrocardiogram examples (Emergency Medicine Educator Online), in the training part: student's task is to give the correct diagnosis. An example of similar ECG training module is available in the Internet (Supraventricular Tachycardia Simulator).
- echocardiography training – it consists of two modules:
  - educational module – it provides several sets of 1D, 2D, 3D and 4D echocardiograms for normal and pathological cases.
  - training module – it enables virtual training for echocardiography, there are two ways of perform this examination, so training can be divided into:
    - the transthoracic echocardiography simulator ,
    - the transesophageal echocardiography simulator - an example of such kind of simulator (web based version) is described in (Kempny, 2010).
- angiography training – it also contains of two modules:
  - in the educational part user can acquaint with angiography, the sets of images should be available to study normal and pathological cases,
  - the training part can help user to train in conducting minimally invasive cardiac procedures.
- Computed Tomography and Magnetic Resonance Imaging – these modalities are the basic medical examinations, which often provide the necessary data to make a correct diagnosis. It is possible to share real examination results for students, even anonymised, but it is associated with certain inconveniences and copyright problems.

The solution to these issues is to create a Web-based service, which has an access to the hospital PACS system (Picture Archiving and Communications System) and generates the appropriate 2D and 3D visualizations for selected modality (Piórkowski, 2009).

The system can provide questionnaires for users. Additionally, there can be allowed for user or an anonymous person to submit own comments. Anonymous comments, however, should be moderated. These treatments will help in the debugging and improving clarity of data and models in the system. Other possible options include blogs, as well as the ability to place advertisements.

4 SERVICE COMPOSITION

Monolithic solution, based on one selected

technology, may require rewriting some existing solutions to one technology in order to join them. The SOA methodology solves this problem by the concept of service composition, which determines the interaction of many services that are implemented in different environments. This feature is a distinct advantage of the methodology and therefore SOA is the correct way of implementing a complex system eCardioTraining.

The system, which is composed of many services requires a process of composition of services for individual users. It is important to define user roles and privileges in the system:

Anonymous user (and any other) can explore resources, view ECG, echo, angio, CT and MR imaging, hear the heart beat sounds and simulate examinations.

Registered users:

- medicine students: the accounts may be set up for all students to support education through eLearning and eTraining. Doctor / educator determines which cases are presented (normal and pathological variants), and then performs a test for students using the system,
- trainees: use the system primarily to retrain in - need to review all options of normal and pathologic anatomy, prepare for the examination of specialization,
- physicians: participate in training courses, need some variants of normal and pathological anatomy, it is possible to test the certificate confirming skills,
- physicians – specialists: need to review all options of normal and pathological anatomy, as problematic or unusual situations, there is available a consultation (or optional comments) in case of a difficult clinical case,
- physicians – scientists and educators: prepare new sets, use the system in the teaching process, moderate a forum (on special)
- administrators - create accounts, grant rights to users, moderate the forum.

4.1 The Process of Service Composition

In the case of proposed system construction service composition process is a static process. Services are composed precisely for each role. Combining services can take a place for a comparison of modalities for the same patient or the same disease entity. Displaying ECG waveform is often associated with echocardiogram or CT and MR imaging. This process is illustrated in Figure 1.

In presented case (Figure 1), the user can enable the module with ECG waveforms for all 12 lines in the analysis of echocardiography (S3) for a given disease entity. The standard echocardiography uses only one ECG line. Similar activities are provided for medical imaging, angiography, CT and MRI.

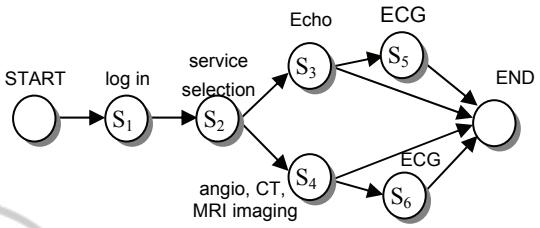

Figure 1: Complex service scenario.

The services composition need not be limited only to one modality. Comparative analysis may include the use of selected or all prepared modalities. The number of possible situations is the number of possible subsets of services and, therefore, further considerations may be a subject of future work.

4.2 Dynamic Service Composition

Assuming, however, a further extension of the system modules, or create customized roles, dynamic composition is possible. For example, a physician educator can compose and order services for a weekend training course. Then he should be able to select appropriate materials, a set of services and their place in the context of the topic of training. The selection criterion can also be an approximate training time (statistically obtained, based on the experiences of users), matched to a time frame.

5 SYSTEM ARCHITECTURE

ETraining system consists of several subsystems. Each of the subsystems may act autonomously. The creation of such simulators takes a long time and usually is carried out by different teams, using different technologies. The idea behind the use of SOA is to combine the subsystems into one system without rewriting them into a single platform. For this purpose, constituent services are released, which can cooperate with each other and exchange data even though they are developed in different platforms. These services get data from the same database and the same PACS system. The design of the system is illustrated in Figure 2, according to the model S3 (Arsanjani, 2007). The first layer (1) is the

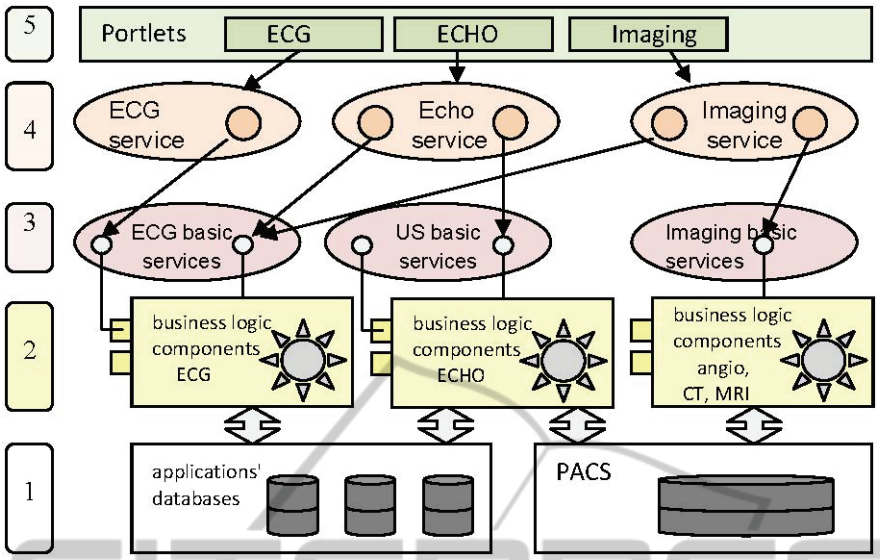

Figure 2: S3 diagram for eCardioTraining system.

layer that provides data. There are placed specific components that implement the processing logic in the second layer. Third layer provides the basic services that in the process of choreography are combined in a service (the fourth layer) supplied to the customer (the fifth layer).

6 CONCLUSIONS

Cloud computing together with building reusable software components is the fastest growing part of IT industry, offering benefits for both customers and IT solution providers (Chang, 2010). Due the short development cycles it is necessary to integrate parts of legacy software into new systems (Werewka, 2011). The paper states that before starting any SOA or cloud computing software development, it is necessary to undertake high level decision making and planning proposed in the paper. The described proposals may be used as a starting point for beginning of similar projects.

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