A Web-based Architecture Enabling Multichannel Telemedicine Applications

Fabrizio Lamberti Bartolomeo Montrucchio Andrea Sanna Claudio Zunino
Dipartimento di Automatica e Informatica,
Politecnico di Torino, corso Duca degli Abruzzi 24,
I-10129 Torino (Italy){lamberti, montru, sanna, c.zunino}@polito.it

ABSTRACT
Telemedicine scenarios include today in-hospital care management, remote teleconsulting, collaborative diagnosis andemergency situations handling. Different types of information need to be accessed by means of etherogeneous client devices in different communication environments in order to enable high quality continuous sanitary assistance delivery wherever and whenever needed.
In this paper, a Web-based telemedicine architecture based on Java, XML and XSL technologies is presented. By providing dynamic content delivery services and Java based client applications for medical data consultation and modification, the system enables effective access to an Electronic Patient Record based standard database by means of any device equipped with a Web browser, such as traditional Personal Computers and workstation as well as modern Personal Digital Assistants.
The effectiveness of the proposed architecture has been evaluated in different scenarios, experiencing fixed and mobile clinical data transmissions over Local Area Networks, wireless LANs and wide coverage telecommunication network including GSM and GPRS.

Keywords: Telemedicine, mobile computing, Electronic Patient Records, Web technologies, Java.

1. INTRODUCTION

Telemedicine applications are a valid method to improve the quality of the delivered sanitary assistance. Mobile telemedicine is in particular useful both in places where standard telephone service is not easily available, and when emergency care is required. In order to build a global architecture for providing remote teleconsulting, collaborative diagnosis and emergency situations handling, many different technologies are required.
In particular, the Java programming language together with XML and XSL technologies can be useful for accessing telemedical systems by means of different devices, from personal computer to Personal Digital Assistants (PDAs). Personal mobile telemedicine systems using wireless

Figure 1: System overall architecture.

communication links have been employed in several applications and have been extensively studied [1, 2, 3].
Current development in telecommunications is toward the adoption of General Packet Radio Service (GPRS), a standard from European Telecommunication Standards Institute (ETSI) [4, 5] which basically provides a packed-switched bearer service in a GSM network.
Wireless LANs are instead used where a local network can be built and accessed (e.g. in a hospital); an example of wireless LAN is IEEE 802.11 [6].
A mean to help communication among different actors is Web technology. An example of using the Web for remote monitoring is reported in [7], where a system for live broadcasting of ECG signals over the Internet is presented. It uses a portable holter device, a browser-based Java Applet and a server application. Another example is in [8], which also consists in a portable data acquisition and preprocessing module and a Java-based client-server platform. In [9], the methodologies for making the Internet a tool for manipulating biomedical data are explored. In particular the choice of an appropriate database management system (DBMS) is addressed, since databases have to be accessed over the Web. Pollard [10] develops a hardware/software prototype for real time acquisition, wireless transmission/reception and connection to the Web. In [11], medical data representation is performed by means of XML and XSL, and the proposed system is implemented on Linux platform.
The novelty of our approach is to combine all these elements, in order to develop a complete architecture enabling advanced telemedical applications. Java, XML and XSL are used to ensure software portability and effective data presentation on etherogeneous access devices, while a middleware and a storage levels guarantee information availability in various healthcare scenarios.
This paper is organized as follows: Section 2 presents the proposed architecture, Section 3 highlights client-side functionalities, while Section 4 reports about server-side applications. In Section 5, a detailed description of the designed database for clinical data storage is provided.

2. SYSTEM OVERALL ARCHITECTURE

The system has been organized by following a three-tier-based architecture (Figure 1), an evolution of the client-server scheme with an additional level, the middleware. By handling data transfer from client/presentation level to storage level, the middleware makes access to data transparent to the client level. Web technology acts as communication mean for the entire architecture. The three levels can be outlined as follows:
. **Presentation level**: it consists of a Web browser and of its extensions (Applets and JavaScripts) which acts as user interface for accessing the clinical database.