Chapter 7

Sensor Grid Enhancement with Data Management System for Ubiquitous Healthcare Computing

Nikolaos Preve
NTUA, Greece

ABSTRACT

A Wireless Sensor Network (WSN) can be deployed to monitor the health of patients suffering from critical diseases. A wireless network consisting of biomedical sensors can also be implanted into the patient's body and can monitor the patients' conditions. These sensor devices, apart from having an enormous capability of collecting data from their physical surroundings, are also resource constraint in nature with a limited processing and communication ability. Therefore, it is necessary to integrate them with the Grid technology in order to process and store the collected data by the sensor nodes. This chapter proposes the SEnsor Grid Enhancement Data Management system, called SEGEDMA, ensuring the integration of different network technologies and the continuous data access to system users. The main contribution of this work is to achieve the interoperability of both technologies through a novel network architecture ensuring also the interoperability of Open Geospatial Consortium (OGC) and HL7 standards. According to the results SEGEDMA can be applied successfully in a decentralized healthcare environment.

1. INTRODUCTION

Wireless Sensor Network (WSN) is a widely used technology for applications that collect and process data from the physical world (Akyildiz, Weilian, Sankarasubramaniam, & Cayirci, 2002). They allow the physical environment to be measured at high resolutions and greatly increase the quantity and quality of real world data and information for applications. Important applications of wireless sensor networks include environmental and habitat monitoring, healthcare monitoring of patients, weather monitoring and forecasting, military
and homeland security surveillance, tracking of goods and manufacturing processes, safety monitoring of physical structures and construction sites, smart homes and offices and many other uses that we do not yet imagine. Sensor devices in a wireless sensor network are resource constrained since they have limited sensing capability, processing power and communication bandwidth. However, with a large number of such devices being deployed and aggregated over a wide area, a wireless sensor network has substantial data acquisition and processing capability. Thus, WSNs are important distributed computing resources that can be shared by different users and applications.

There are many platforms on which the WSN technology has been used and healthcare monitoring being one among them. As suggested by many researchers and scientist across the world, this technology has a potential to create great impact on many aspects of emergency medical care. Sensor devices have been used to capture continuous, real time vital signs from a large number of patients, relaying the data to handheld computers carried by Emergency Medical Technicians (EMTs), physicians and nurses. Moreover due to their small size and energy efficiency it is easy to integrate them into the location of a patient.

Grid Computing was coined in middle 1990s in order to denote a proposed distributed computing infrastructure for advanced science and engineering by Foster, Kesselman, and Tuecke (2001). The unified definition of the term “Grid” and the definitions often address different application areas. In recent years Grid computing has raised interest worldwide in the academic world, industry, and government with fast development cycles. In particular, a variety of applications ranging from aerospace, astronomy, bioinformatics, chemistry, environment, finance, physics and healthcare have been identified. The current technological achievement aims at the definition of a global infrastructure able to share geographically distributed resources such as data, storage, computers, software, tools, applications, instruments and networks with a secure manner at anytime and anywhere. Major efforts, huge resources and funds have been put into research and development (R&D) of core Grid computing technologies, Grid infrastructures and Grid applications in a variety of science fields including healthcare and life science. The Grid software layers are shown in Figure 1. The integration of Grid and HealthCare (HC) has created a new area called HealthGrid by Breton, Dean, and Solomonides (2005), who showed the great impact on almost every aspect of healthcare, from diagnosis, treatment, primary-acute care to social services.

Recently, Breton et al. (2005), and Abbas (2003) have introduced Grid technologies in many healthcare areas including medical applications. The Grid builds an infrastructure that provides resources to medical personnel who access them following the necessary policies in HC. These resources may include computational resources, storage, equipment, and human resources specialists. The access to a medical resource could be given to the clinicians when entering into the Grid system. A healthcare information system can specify certain policies such as authentication, authorization and auditing which are enforced according to a service level agreement.

From the integration of the above technologies the emerging research area which includes the extended Grid computing in the wireless networks is the Sensor Grid. At this process we can have a WSN which is connected with the conventional wired Grid fabric. Sensor Grid
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