Chapter 3.15
Mobile Medical Image Viewing Using 3G Wireless Network

Carrison K. S. Tong
Pamela Youde Nethersole Eastern Hospital, Hong Kong

Eric T. T. Wong
Hong Kong Polytechnic University, Hong Kong

INTRODUCTION

Teleradiology is a routine practice for radiologists to make urgent diagnosis by remote viewing radiological images such as computed tomographic (CT), magnetic resonance (MR), computed radiographic (CR), and digital radiographic (DR) images outside their hospitals. Traditionally, due to limited network bandwidth and huge image file sizes, this technique was limited to fixed-point communication using an integrated services digital network (ISDN) and broadband network. Without any prior information, most radiologists would invariably require high-quality display units and lossless compressed images for their clinical diagnosis. Besides the technical issues involved in the uninterrupted provision of a 24-hour teleradiology service, most hospital administrators have to consider a series of management issues on the quality of this service such as data confidentiality, integrity, and accessibility.

This article presents the implementation process of a high-quality teleradiology service using the third-generation (3G) wireless network. In the provision of this service, several high-quality notebook computers with a 15-inch liquid crystal display (LCD) screen of resolution 1,024 x 768 pixels and 32-bit color have been configured to view medical images in the digital imaging and communications in medicine (DICOM) format using a Web browser. These notebook computers are connected with 3G mobile phones so that users could access the Internet using Web browsers through the 3G network at a speed of at least 384 kbps. The users could also use the Web browser for logging into the hospital network through an application tunneling technique in a virtual private network (VPN). When logging into the VPN, for security purposes the network authentication is enhanced by a one-time and two-factor authentication (OTTFA) mechanism. In OTTFA, the user password contains two parts: a personal

password and a randomly generated password. After successfully logging into the hospital network, the user has to log into the image server using another account name and password. The above are all important to ensure the high standard of confidentiality of the system.

The data volume of the image server is about 1 TB, stored in a level-5 configured redundant array of inexpensive disks (RAID). For management of this huge amount of data, the location of each image in the storage unit is stored in a Structural Query Language (SQL)-based database. Each image also has DICOM tags for storage of the patient name, identity (ID) number, study date, and time. After the success of each login, the user can query the image server for related images using the patient's demographic data such as the study date. These are used to enhance the integrity of the system.

There are three image servers configured in a high available (HA) cluster using a load-balancing switch. The user could access any one of the servers for diagnostic purpose using the teleradiology technique. This setting is used to ensure the availability of the service 24 hours a day/7 days a week. The above system has operated for six months, and zero downtime was recorded. This leads to the belief that it is feasible to operate a quality teleradiology system using 3G networking technology with the important concerns of data confidentiality, integrity, and accessibility being dealt with in an effective manner.

BACKGROUND

Teleradiology is the process of sending radiologic images from one point to another through digital, computer-assisted transmission, typically over standard telephone lines, a wide-area network (WAN), or over a local area network (LAN). Through teleradiology, images can be sent to another part of the hospital or around the world.

In a hospital environment, it is not unusual that sometimes certain senior or experienced clinical staff would not be available onsite. These senior clinical staff may standby at home, on business trip, or just on their way to work. For urgent medical cases, remote consultation is required. It is important to have multimedia communication, including voice, text, and picture, between the senior clinicians and the hospital. A reliable, secure, easy-access, manageable, high-speed, standardized, multimedia medical consultation system is required.

PROBLEM

Today, teleradiology is still facing many limitations such as low network bandwidth, limited locations, and implementation issues associated with security, standards, and data management.

Limited Locations and Low Network Bandwidth

Depending on data-transfer rate requirements and economic considerations, images can be transmitted by means of common telephone lines using twisted pairs of copper wire, digital phone lines such as ISDN, coaxial cable, fiber-optic cable, microwave, satellite, and frame relay or T1 telecommunication links.

Today most teleradiology systems run over standard telephone lines. Over the next couple of years, we should see a substantial migration to switched-56 and ISDN lines, which offer higher speed and better line quality than standard dial-up phone lines. Other high-speed lines, including T1 and SMDS (shared multimegabit data services), will also become more popular as prices continue to drop.

However, remote consultation on fixed lines can only be performed in pre-installed locations such as a radiologist's home. A wide-area wireless network can provide a more flexible teleradiology service for the users (Oguchi, Murase, Kaneko,

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