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Mobile e-Health: The Unwired Evolution of Telemedicine

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ABSTRACT

The movement of telemedicine from desktop platforms to wireless and mobile configurations may have a significant impact on future health care. This paper reviews some of the latest technologies in wireless communication and their application in health care. The new technologies can make the remote medical monitoring, consulting, and health care more flexible and convenient. But, there are challenges for successful wireless telemedicine, which are addressed in this paper.

INTRODUCTION

TIME AND SPACE CONSTITUTE BARRIERS between health-care providers and their patients and among health-care providers. Patients in rural areas, on a space shuttle flight, at accident scenes, en route to a hospital, in a submarine,etc., are often physically remote to appropriate care providers.

Telecommunication technologies have presented themselves as a powerful tool to break the barriers of time and space. With the introduction of high-bandwidth, digital communication technologies, it is possible to deliver audio, video, and waveform data to wherever and whenever needed.

The health-care industry may be poised to adopt wireless devices and applications in large numbers. Wireless technology may provide improved data accuracy, reduce errors, and result in overall improvement of patient care. The number of wireless devices in health care is expected to triple by 2005, according to a study by Technology Assessment Associates.

Wireless-enabled handheld usage by U.S. physicians is likely to climb to 55% by 2005, up from the current 18%.1

The benefits of the wireless technology can be illustrated in a number of different examples.

2 Patient information can be obtained by health-care professionals from any given location because they can be connected wirelessly to the institution's information system. Physicians'access to patient histories, lab results, pharmaceutical information, insurance information,and medical resources would be enhanced,thereby improving the quality of patient care. Handheld devices can also be used in home health care, for example, to fight diabetes through effective monitoring.

Mobile telemedicine is a new and evolving area of telemedicine that exploits the recent development in mobile networks for telemedicine applications.3 It was suggested that the next step in the evolution of telemedicine will be mobile telemedicine systems.4

EXISTING MOBILE TECHNOLOGY

The evolution and current mobile telecommunication technologies were described in a white paper by Trillium Digital Systems, Inc.[5] The paper also explains how the communication industry plans to implement 3G wireless technology to meet the growing demand for wireless multimedia services.

First-generation wireless technology

The first generation of wireless mobile communications was based on analog signaling. Analog systems, implemented in North America, were known as Analog Mobile Phone Systems (AMPS), while systems implemented in Europe and the rest of the world were typically identified as a variation of Total Access Communication Systems (TACS). Analog systems were primarily based on circuit-switched technology and designed for voice, not data. *Second-generation (2G) wireless technology*

The second generation (2G) of the wireless mobile network is based on low-band digital data signaling. Most of the networks are based on circuit-switched technologies developed in different parts of the world: Global Systems for Mobile Communications (GSM) technology developed in Europe, which is a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) technology in North America and Personal Digital Communications (PDC), using TDMA-based technology, in Japan. GSM system is the most popular, which operates in the 900-MHz and 1.8-GHz bands throughout the world with the exception of the Americas where they operate in the 1.9-GHz band.

FDMA is the most common analog or firstgeneration mobile system. It is based on the relatively simple division of the frequency into traffic channels. With FDMA, each channel can be assigned to only one user at a time.

TDMA can divide a single radio frequency channel into six unique time slots, allowing a number of users to access a single channel at one time without interference. By dividing the channel into slots, three signals (two time slots for each signal) can be transmitted over a single channel. In this way, TDMA technology, also referred to as ANSI-136, provides a 3-to-1 gain in capacity over analog technology. Each caller is assigned a specific time slot for transmission.

[6]

CDMA is a form of multiplexing, which allows numerous signals to occupy a single transmission channel, optimizing the use of available bandwidth. CDMA employs analogto-digital conversion (ADC) in combination with spread spectrum technology. Audio input is first digitized into binary elements. The frequency of the transmitted signal is then made to vary according to a defined pattern (code), so it can be intercepted only by a receiver whose frequency response is programmed with the same code. This enhances privacy and makes cloning difficult. The CDMA channel is nominally 1.23 MHz wide. CDMA networks use a scheme called soft handoff, which minimizes signal break-up as a handset passes from one cell to another. The combination of digital and spread-spectrum modes supports several times as many signals per unit bandwidth as analog modes. CDMA technology is recognized as providing clearer voice quality with less background noise, fewer dropped calls, enhanced security, greater reliability, and greater network capacity. 2G wireless networks are digital and expand the range of applications to more advanced voice services, such as Called Line Identification.

2G wireless technology can handle some data capabilities such as fax and short message service at the data rate of up to 9.6 kbps, but it is not suitable for web browsing and multimedia applications. *Second-generation (2G1) wireless networks* The data rate of 2G circuit-switched wireless systems is very slow for today's Internet usage. As a result, GSM, PDC, and other TDMA-based mobile system providers and carriers have developed 2G1 technology, which is packetbased.

It increases the data communication speeds to as high as 384 kbps. These 2G1 systems are based on the following technologies: High-Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS), and Enhanced Data Rates for Global Evolution (EDGE) technologies.

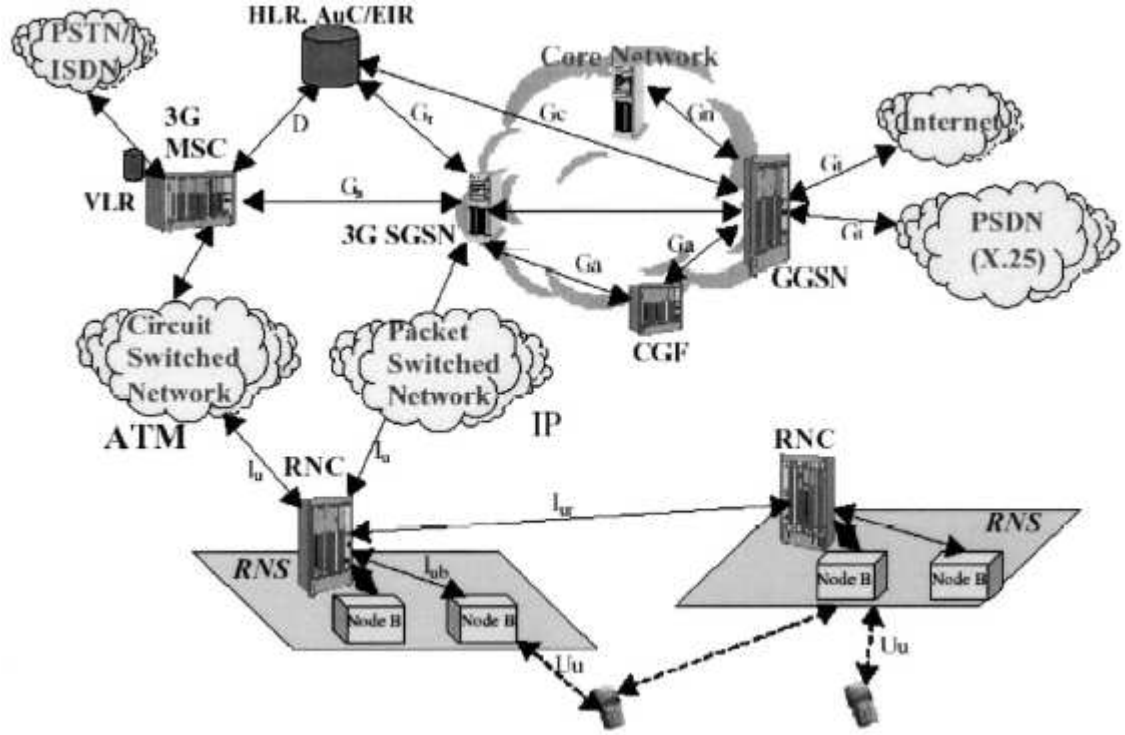

FIG. 1. 3G wireless network architecture.