# A Study of the Recent Technological Advancements for the Near and Far Future of u-Healthcare Systems

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#### Abstract

This paper presents a discussion of the significant trends to technological developments that hold relevance to the evolution of u-Healthcare systems and analyzes the opportunities they may offer to enhance real-time healthcare services. The developments in digital revolution are identified such as location based services, Mobile IPv6, wireless body sensor networks, the evolution of wireless technologies, and smart devices. The convergence of this these technological developments have given a direct impact to the near and far future of uhealthcare systems.

**Keywords:** Mobility Management, location based services, wireless body sensors, wireless technologies, u-Healthcare systems

# 1. Introduction

The influence of technological developments and digital revolution such as wireless and networked technologies, cloud computing and mobile devices have been subsequent and leaded the society towards an era of computing where it can almost do "anything you want". Caregivers, healthcare professionals and patients have been allowed for mobility and make the monitoring and delivery of healthcare services easier, real-time and more effective that could provide a lifeline for isolated and helpless patients.

This paper presents a discussion of the significant trends to technological developments that hold relevance to the evolution of u-Healthcare systems and analyzes the opportunities they may offer to enhance real-time healthcare services. The developments in digital revolution are identified such as location based services, Mobile IPv6, wireless body sensor networks, the evolution of wireless technologies, and smart devices. The convergence of this these technological developments have given a direct impact to the near and far future of u-healthcare systems.

The rest of this paper is organized as follows: Section 2 discusses the most recent technological advancements for u-Healthcare system; Section 3 outlines the convergence of

Recent Technological Advancements for the Near and Far Future of u-Healthcare Systems; and the concluding remarks in Section 4.

# 2. Most Recent Technological Advancements for u-Healthcare Systems

#### 2.1. Location Based Services

Location-based services (LBS) refers to the general class of computer program-level services that includes specific controls for location and time data as control features in computer programs [6]. Since there are certain diseases that tend to occur in any place, health information and services needs to be delivered in real-time and location of the patient must not be a barrier. LBS for healthcare can increase patients and older people's self-confidence and autonomy with the help of Wireless Body Sensor Networks capable of monitoring and measuring health conditions.

#### 2.2. Mobility Management

Mobile IP is a standard that allows users with mobile devices whose IP addresses are associated with one network to stay connected when moving to a network with a different IP address. When a user leaves the network with which his device is associated (home network) and enters the domain of a foreign network, the foreign network uses the Mobile IP protocol to inform the home network of a care-of address to which all packets for the user's device should be sent [3].

The mobile IP protocol allows location-independent routing of IP datagrams on the Internet. Each mobile node is identified by its home address disregarding its current location in. While away from its home network, a mobile node is associated with a care-of address which identifies its current location and its home address is associated with the local endpoint of a tunnel to its home agent. Mobile IP specifies how a mobile node registers with its home agent and how the home agent routes datagrams to the mobile node through the tunnel [3].

Mobile IP is most often found in wireless WAN environments where users need to carry their mobile devices across multiple LANs with different IP addresses.

Mobile IPv6 is a version of Mobile IP - a network layer IP standard used by electronic devices to exchange data across a packet switched internetwork. Mobile IPv6 allows an IPv6 node to be mobile- to arbitrarily change its location on an IPv6 network- and still maintain existing connections [3]. IPv6 (Internet Protocol version 6) is the successor to the well known IPv4 protocol, commonly known as IP.

#### 2.3. Wireless Body Sensor Networks

A wireless sensor network (WSNs) refers to spatially distributed autonomous devices using sensors to monitor physical or environmental conditions (such as temperature, sound, pressure, *etc.*) that incorporates a gateway that provides wireless connectivity to remotely distributed nodes [1, 4, 5]. WSNs utilize wireless protocols depending on the application requirements that include available standards such as 2.4 GHz radios based on either IEEE 802.15.4 or IEEE 802.11 (Wi-Fi) standards or proprietary radios, which are usually 900 MHz.

WSN applications include health care, utilities, and remote monitoring. In health care, wireless devices make patient monitoring and healthcare easy and more effective. Wireless networks applicable for u-healthcare systems can be classified into three groups:

- In-body networks are used for communication between sensors implanted in body and a receiver outside body. Examples of which are implantable pacemaker and ICD, and smart capsule that are used to transfer bio-information, which can measure in the body, to an external device.
- On-body networks are used for communication between sensors attached on body and data gathering devices. Examples of which are bio-shirt, wrist watches, and ring sensors attached on body to transfer sensing data to a local processing.
- External Networks are used in home and mobile healthcare that communicates between sensors, devices or a location processing unit on personal can communicate with a remote server.



(a) Wearable sensors



(b) In-Body Sensors

Figure 1. Wireless Body Sensors

Compared to wired networks, wireless networks seem advantageous as a communication network for u-Health. Wireless network can be used between each layer of u-Health service model. Sensors which measure health condition in sensing layer transfer sensing data to a gateway node or directly to an external server. Then the gateway node delivers the data to a central server with mobile network.

#### 2.4. Wireless Communication Technologies

The recent developments in wireless communications have delivered an "anywhere and anytime connectivity". It involves the transmission over a distance without the help of physical connections or any forms of electrical conductors. Some of these wireless technologies that together are furthering the anywhere and anytime access to digital communication that are being miniaturized are advent of Wi-Fi, 3G or the 3rd Generation Networks, and RFID tags (radio-frequency identification) [2, 8].

These new developments in wireless networking and computing will facilitate remote patient monitoring which collects disease-specific metrics (healthcare information) from wireless biomedical devices used by patients in their homes or other settings outside of a clinical facility. Remote monitoring systems typically collect patient readings and then transmit it to a remote server for storage and later examination by the healthcare professionals.

#### 2.5. Smart Devices

The technological breakthroughs in the miniaturization of processors, networking technologies, memory, displays and sensors have made possible for the mobile devices to become more powerful. Most popular portable and mobile devices nowadays such as Netbooks, Smartphones, personal digital assistants (PDAs), portable media players, global positioning systems (GPS) and mobile internet devices.



Figure 2. Smart Devices

The incorporations of these developments in a healthcare environment would lead to active and real-time delivery of healthcare needs regardless of the location of patients.

# **3.** The Convergence of the Recent Technological Advancements for the Near and Far Future of u-Healthcare Systems

Combining location based services, Mobile IPv6, wireless body sensor networks, the evolution of wireless technologies, and smart devices allow taking advantage of Ubiquitous Computing to enact Ubiquitous Healthcare, or u-Healthcare.

The concept of u-Healthcare integrated with these new technologies presents a new Healthcare system model that keeps track, manage, and interpret an individual's health history and offer health maintenance advice and service tailored accordingly. Thus, automatically interfacing with different diagnostic devices, gathering contextual data through patient interaction, and storing readings in the patient's lifelong medical record, the model is a comprehensive solution that can significantly improve the effectiveness of a ubiquitous healthcare and the quality of life of patients.

These technological developments such as location based services, Mobile IPv6, wireless body sensor networks, the evolution of wireless technologies, and smart devices that leads to the era of ubiquitous computing integrated into healthcare described as u-Healthcare could provide and facilitate real-time and enhanced healthcare monitoring and services.



Figure 3. Technological Advancements for u-Healthcare Systems

The application of emerging advancements in location based services, Mobile IPv6, wireless body sensor networks, the evolution of wireless technologies, and smart devices has lead to efficient, reliable, and emergent healthcare systems. An efficient utilization of these emerging technologies simplifies the monitoring and treatment of patients and enables a high quality, reliable and emergent medical services.

# 4. Conclusion

In this paper, the significant changes in u-healthcare management and services was driven by the digital revolution and subsequent developments in location based services, Mobile IPv6, wireless body sensor networks, the evolution of wireless technologies, and smart devices. These technological developments lead to the era of ubiquitous computing integrated into healthcare described as u-Healthcare could provide and facilitate real-time and enhanced healthcare monitoring and services.

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