Environments for Mobile Learning

Han-Chieh Chao
National Dong Hwa University, Taiwan, R.O.C.

Tin-Yu Wu
National Dong Hwa University, Taiwan, R.O.C.

Michelle T. C. Kao
National Dong Hwa University, Taiwan, R.O.C.

INTRODUCTION

As we enter the electronic age, technologies enabling e-learning have increased flexibility of learning location. Wireless communication technologies further increase the options for learning location (Johnson & Maltz, 1996; Wu, Huang & Chao, 2004). Advances in wireless communication technologies have recently provided the opportunity for educators to create new educational models. With the aid of wireless communication technology, educational practice can be embedded into mobile life without wired-based communication. With the trend of the educational media becoming more mobilized, portable and individualized, the learning form is being modified spectacularly. The mobile learning environment possesses many unique characteristics (Chen, Kao & Sheu, 2003):

- **Urgency of learning need:** The wireless applications can be used for an urgent matter of learning, such as linking problem solving and knowledge. Otherwise, the learner may record the questions and look for the answer later in the library, on houseline with a computer or from the experts.
- **Initiative of knowledge acquisition:** Frequently, information provided by wireless applications are based on the learners' requests; that is, information on demand. Being based on the learners' requests, together with the help of current state-of-the-art I/O devices, such as Radio Frequency Identification (RFID), Voice Extensible Markup Language (VXML) and so forth (Page, 1993; Andersson, 2001), interactive personal information can be communicated between learners and the databases so that the wireless application can provide closely related information in time and in need.
- **Mobility of learning setting:** Wireless devices are developed to be more and more portable. Therefore, the educational practice can be performed at any time and any place and always on, such as on a tour bus, camping area, exhibit room, and so forth. All kinds of field trip situations can be facilitated. This kind of learning setting can be preplanned or be opportunistic in nature.
- **Interactivity of the learning process:** Through the interfaces of voices, pointing, mails, icons, even videos, the learner can communicate with experts, peers or other materials effectively in the form of synchronous or asynchronous communication. Hence, the expert is more reachable and the knowledge is more available.
- **Situating of instructional activity:** Via wireless applications, the learning could be embedded in daily life. The problems encountered, as well as the knowledge required, are all presented in authentic context, which helps learners notice the features of problem situations that make particular actions relevant.
- **Integration of instructional content:** The wireless learning environment integrates many information resources, and supports learners to do non-linear, multidimensional and flexible learning and thinking. It especially facilitates complex and ill-structured learning content, such as cross-subject, theme-based learning activities.

WIRELESS TECHNOLOGY

Next-generation wireless networks (2.5G, 3G, B3G, 4G) offer the promise of high-speed access to mobile hosts along with IP-based data services, the General Packet Radio Service (GPRS) communication network

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that can transmit data and speech sounds at the same time with limited bandwidth and third generation of mobility communication network (Khan, 2001). The powerful third-generation mobility network, 3G, has much larger wireless bandwidth capabilities and more multi-media services than the Global System for Mobile Communications (GSM)/GPRS cell-phone system. 3G features a bandwidth of 2M bits/second when users are motionless, a bandwidth of 384k bits/second when users move in a low speed, and a bandwidth of 144K bits/second when users move at a high speed (Andersson, 2001). More than that, GSM can combine Wireless Local Area Network (WLAN) to accomplish a double network with WLAN and a cellular network (Wang, 2001). The bandwidth offered by a double network with WLAN and a cellular network enables learners to enjoy all kinds of service on the Internet, anytime, anywhere.

While these technologies are enabling mobile e-learning options, there are problems, including bandwidth, Internet Protocol (IP) and roaming limitations. Bandwidth problems can be solved simply by Internet Service Providers (ISPs) developing the backbone of broader bandwidth.

NEXT GENERATION INTERNET PROTOCOL—IPv6

Providing enough IP addresses for worldwide use is presenting challenges, given the limitations of the current Internet Protocol, version 4 (IPv4). With universal access and use of the Internet, IP has to offer the capability for worldwide use of Internet resources. In the early 1990s, the Internet Engineering Task Force (IETF) had already identified difficulties with maintaining the Internet with IPv4. With a global population of more than six billion, the 42 million possible IP addresses are insufficient to meet the needs of users needing one or more IP addresses. The next generation of IP, Internet Protocol version 6 (IPv6) allows 5.4×10^{28}, more than enough for everyone (Deering & Hinden, 1995). While IPv6 has been around for a number of years, it is not yet widely adopted. In the meantime, dynamic allocation of IPv4 addresses for mobile users increases the number of possible addresses and may be sufficient for the near future. However, not only have Europe and Asia Pacific put great attention on IPv6, but the United States (U.S.) Department of Defense (DoD) announced in June 2003 that it will convert all of its systems, networks and applications to IPv6 by 2008 (French, 2003; DoD CIO memo, 2003). This action raises the interest of the U.S. Department of Commerce (DoC) and Department of Homeland Security, which led to the DoC Request for Comments on Deployment of Internet Protocol, version 6 in January 2004. U.S. commercial companies foresaw potentially billions of dollars in upgrades and have started to bring out all kinds of IPv6 products, such as, routers, switches and so forth.

Besides the abundance of addresses, IPv6 carries some other advantages: IPv4 can not enable the speed and efficient application processing required for e-learning. These problems are being solved by Mobile IPv6 (Chao & Chu, 2001; Chao & Huang, 2003; Chao & Chu, 2003). IPv6 uses a new method for transmission, Anycast Protocol (Doi, 2004), which differs from the current Unicast and Multicast Protocol because it transmits packets using sophisticated metrics for finding the least-delay time path, route with the lowest price or less routing hop. At the network level, Anycast determines load balance and uses techniques related to the Domain Name Server (DNS) to transmit information. Adopting Anycast will enable learners to get connected to the Internet and utilize e-learning applications in a much faster and more efficient way.

Internet Protocol Security (IPSec) is widely used in IPv6, and those features are embedded in IPv6's extension headers so that end-to-end security can be achieved without interruption. IPv6 resolves some of the Internet security problems that can detract from e-learning applications (Huang, 2000; Arkko, 2004). IPSec utilizes two security protocol, Encapsulating Security Payload (ESP) and Authentication Header (AH) to enable confidentiality, information integrity, identity of package sources, access control, protection of replay and traffic flow confidentiality. The Encryption Algorithms and Conformance Requirements of Hash Algorithms method, Internet Key Exchange (IKE), Security Association (SA) and others enable learner privacy. Moreover, the providers of mobile learning can use the identification offered by IPSec and the Authentication Authorization Accounting (AAA) function to authenticate users and allocate functions (Wang, Chen, & Chao, 2004).

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