Mobile e-Learning for Next Generation Communication Environment

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ABSTRACT

This article develops an environment for mobile e-learning that includes an interactive course, virtual online labs, an interactive online test, and lab-exercise training platform on the fourth generation mobile communication system. The Next Generation Learning Environment (NeGL) promotes the term “knowledge economy.” Inter-networking has become one of the most popular technologies in mobile e-learning for the next generation communication environment. This system uses a variety of computer embedded devices to ubiquitously access multimedia information, such as smart phones and PDAs. The most important feature is greater available bandwidth. The learning mode in the future will be an international, immediate, virtual, and interactive classroom that enables learners to learn and interact.

Keywords: 4G; interactive course; mobile e-learning; NeGL; virtual online labs

INTRODUCTION

The development of new approaches and technologies to support distance learning are undergoing now. In particular Web-based and mobile asynchronous learning environments and virtual classrooms via the Internet have been adopted widely. Static information as an instructional delivery method is the current trend in e-learning. Learners using these kinds of conventional learning methods are only able to browse through the mass static information. This is passive learning by reading online.

In the last decade, technologies enabling e-learning have increased learning location flexibility. Wireless communication technologies further increase the options for learning location. Advances in wireless communication technologies have provided the opportunity for educators to create new educational models. With the aid of wireless communication technol-
ogy, educational practice can be embedded into mobile life without wired-based communication. With the trend in educational media becoming more mobile, portable, and individualized, the learning form is being modified in spectacular ways (Gang & Zongkai, 2005).

In the third generation cellular system (3G) environment (such as Universal Mobile Telecommunications System, UMTS), the data rate reaches 2Mbps while the user is standing and 384Kbps while the user is moving slowly. Multimedia streaming, video conferencing, and online interactive 3D games are expected to attract increasing numbers of users. Such bandwidth is not sufficient for these increasingly popular applications and would be the major challenge for wireless networks. The 3G bandwidth has great problems with interactive teaching (Bos & Leroy, 2001).

In the future, wireless network traffic is expected to be a mix of real-time traffic such as voice, music, multimedia teleconferencing, online games, and data traffic such as Web page browsing, instant messaging, and file transfers. All of these applications will require widely varying and very diverse quality of service (QoS) guarantees for the different types of offered traffic (Dixit, 2001).

For these reasons, a fourth generation improved mobile communication system is necessary. The 4G system can support more bandwidth than other systems. It has advantages like authentication, mobile management, and quality of service (QoS). How to implement future distance learning environments for the fourth generation mobile communication system is the question. In this article, we distinguish four kinds of interactive courses, virtual online labs, interactive online tests, and lab-exercises training platform to deliver over the fourth generation mobile communication system. The fourth generation mobile communication system can use a variety of computer embedded devices to ubiquitously access multimedia information, such as smartphones and PDAs. Most important is that have more bandwidth. Hence, it supply ubiquitous learning environment (Girish & Dennett, 2000).

These new functions can improve the latency and location limits during transmission. Our proposed Next Generation Learning Environment offers learners the opportunities to use all kinds of mobile nodes that can connect to an Internet learning equipment system for access using All-IP communication networks. The Sharable Content Object Reference Model (SCORM) is used to compose information. Hence, as you can imagine, the condition of the learning mode in the future will be an international, immediate, and virtual interactive classroom that enables learners to learn and interact.

The article is organized as follows. We first describe the environments for mobile learning, followed by the virtual online classroom. The 4G testbed system design analyses are dealt with, and then the mobile e-learning results are discussed. The last section concludes the article.

ENvironments for Mobile Learning

Several investigations have focused on how to support great service for mobile e-learning. How many services will be able to fill the bill? In this session, we are introducing that mobile e-learning environment possesses many unique characteristics as follows (Tony, Sharples, Giasemi, & Lonsdale, 2004).
• Better adaptation to individual needs
• Ubiquitous and responds to urgent learning need
• Flexibility of location and time to learn
• Interactive knowledge acquisition
• Efficiency due both to re-use and feedback
• Situational instructional activities
• Integrated instructional context (Chao, Wu, & Kao, 2004)

The mobile e-learning system includes interactive courses, virtual online labs, interactive online tests, and lab-exercises training platform on the fourth generation mobile communication system. As shown in Figure 1 the following sessions will present each part:

• **Interactive course system:** In learning history learners could experience interactive learning only in the classroom. The e-learning systems support only a single way for learning. These ways cannot support learning anytime and anywhere. We therefore developed an interactive course system to do that. Learners can choose which chapter they want to learn in this system. This learning method is not limited by the environment.

• **Virtual online labs system:** Generally speaking, experiments must be conducted in a laboratory. Learners are thereby limited to a specific learning area. To solve this problem special equipment is required. How can this problem be overcome? We simulated an experiment on laboratory all the time by Flash program. This virtual online lab platform supports step-by-step experimentation. Learners are therefore not restricted in the laboratory.

• **Interactive online test system:** An online interactive testing system is used to examine the teaching effect on students. The instructors can know how many learners were impacted via the testing system. Learners can obtain the learning effect on themselves.

• **Lab-exercises training platform:** The learners have more items for experimentation. NetSmooth Inc. developed a complete solution called NetGuru platform to tackle this issue. The learners can access the lab-exercises training platform via pre-arranged authorization.

A communication system is required to transfer the learning data. The most common communication platform used by students is the third generation cellular system. The data rate reaches 2Mbps while the user is standing and 384Kbps while the user is moving slowly. This kind of system does not have enough bandwidth and no All-IP core network. Therefore, we developed...
a 4G testbed system that can support high transfer bandwidth.

VIRTUAL ONLINE CLASSROOM
Today there is much work going on in the field of virtual online classrooms around the world. The Web-based virtual classroom via the Internet as an instructional delivery method is a popular trend. Traditional learning methods only allowed the student to browse through mass static information. This is passive learning. In this session, we will introduce an interactive virtual classroom that includes the interactive course, virtual online labs, an interactive online test, and a lab-exercise training platform. For more information, see the virtual online classroom interactive Web site: http://6book.niu.edu.tw/ (6BOOK).

Setting up the Interactive Learning course Web Site Platform
The Internet has uni-location and unlimited time features. Early online teaching materials included video lessons captured by DV, e-books, poster messages, and so on. These materials were used via the Internet. However, these approaches are single direction learning. These approaches are not good approaches for learning. These ways cannot attain learning anytime and anywhere. Therefore, we developed the interactive course system to do that (see Figure 3). The learners can choose which chapter they want to learn in this system.

Figure 2. The interactive virtual online classroom Web site
It can repeat whatever the learners want. The course collocates the interactive online test with interactive capability. The learners can learn anytime and anywhere unlimited by the environment.

Learners can select the chapters that they want to learn or review rapidly. They can study the chapters in order or preview or review any chapters, in any order. They can save all of their previous study processes. During learning, the system supports sliders with hints and oral explanations. Learners can control their learning speed and repeat it at will. Learners can see clearly just like taking the classes live (see Figure 4).

**Setting up Virtual Online Lab Exercises**

Generally, learner lab exercises must be conducted in a laboratory. They cannot perform experiments without a laboratory. This reduces a lot of opportunity to learn. Therefore, we used FLASH to produce a series of online lab exercises, explaining the lab exercises from the beginning and performing the exercises with detailed background voice and subtitles. There are explanations in great detail for each exercise. These explanations include the experiment goals, steps, and approaches that can help learners understand the background.

Most important, the learners can control the speed at which the lab-exercises proceed by themselves. Relying on online lab exercises, learners can perform lab exercises an unlimited number of times. They can perform experiments anytime from anywhere. The instructors do not have to spend time to prepare lab exercises or setup

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equipment. If learners have any questions about the exercises, they can use hyperlink to text to the Web site for answers. This teaching platform covers both theory and lab exercises interactively.

**Setting up On-Line Exercises**
The Virtual online lab exercises and interactive learning Web site platform help learners study efficiently. This system is able to identify the learning effect. We developed online interactive exercises for each chapter. These exercises identify the comprehension of each learner for the instructor that uses these teaching materials. The system tutors learners that do not exhibit complete lesson understanding. Learners can also know clearly what areas should be enhanced and the content of each chapter by practicing the exercises.

**Lab-Exercises Training Platform**
The lab-exercises training platform is set-up using the NetSmooth Inc. test platform. This platform supports another solution with lab exercises for learners. The proposed Net-Guru platform helps instructors to conduct network courses easily with Web-based tutorial courseware. It also assists students to strengthen the concepts of network with hands-on lab experiences (Chiang, Liang, Wu, & Chao, 2005).

The pragmatic lab exercises for the IPv6 training platform use a small-sized personal computer. There are some characters as follows (shown in Figure 7):

- All necessary lab hardware equipment is bundled together. No PC is required.
- Large-scale training labs are supported with multiple Netguru sets.
Figure 5. The virtual online lab exercises

Figure 6. The online interactive exercises platform
The default setting is easily restored to initiate another lab work.

- Built-in 3 hosts and 3 hubs. (Each host has 3 NICs)
- Each set of NetGuru supports 3 groups to do Lab work.
- Simply connect monitor, mouse and keyboard with NetGuru to start Lab work instantly.

NetGuru integrates hardware, lab software, and training media into one complementary training set. We equipped the system with common use software to easily implement network services, such as routing, DNS, VPN, DHCP, NAT, Firewall, and so on. With build-in Ethereal tools for packet analyzing, learners will reinforce their conception about the packet structure. Based on the online commands, the environment will restore and default setting to initiate another lab work easily. In past days, while establishing a network environment, we not only needed computers, but also the heavy and complicated equipment configuration. With NetGuru, the TCP/IP lab environment can be easily set-up requiring no PC. We scaled down the size, and the small footprint allows easy relocation. Thus, we can set-up the TCP/IP lab environment anytime and anywhere. As we mentioned before, with multiple sets of NetGuru, large-scale training labs can easily be supported. NetGuru also supports extended network devices. Instructors can design other advanced lab work for use with this system.

4G Testbed System Design Analyses

We propose a fourth generation mobile communication testbed system. The system can support greater bandwidth than other systems. It has advantages like authentication, mobile management, and quality of service (QoS).

This session will introduce our fourth generation communication testbed system. We followed the specification defined in 3GPP to design our system. This system is composed of two main components:

![NetGuru platform framework interface](image-url)
RAN (Radio Access Network) and Core-Network. RAN includes RNC and Node B. The Core-Network then includes SGSN (Serving GPRS Support Node), GGSN (Gateway GPRS Support Node), and HSS (Home Subscriber Server), as shown in Figure 8.

At RAN, Node B works like the access point of wireless network, providing the ability for UE (User Equipment) to connect to the core network through radio interface, each RNC can work with single or multiple Node B to form a RNA. RAN is then constituted by these RNS.

At the core network, SGSN is responsible for tasks such as connecting to the core network with single or multiple RAN, access control, location management, routing management etc. GGSN is an interface responsible of connecting core network and outer network, also routing traveling packets. It is also responsible for mobility management (Uskela, 2001).

HSS is a data center responsible for recording the operations of the entire network. HLR is its main component. Its function is to store the user’s identity, location, and registered services that are allowed to the user.

Since the radio frequency used by a 3GPP cell phone is a licensed band, a legal license must be acquired. Therefore we used 802.11g which belongs to the ISM band instead. Through broadcasting UDP packets to simulate the radio network, and because the protocol stack of the simulation

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**Figure 8. The cross-layer coordination plane**
Program is executed in UE according to the 3GPP standard, all generated packets are identical to packets generated by an actual 3GPP cell phone. UE enables us to acquire the flow chart of packets generated through the data exchange process between UE and the network. Figure 9 shows the entire system (3GPP, 3GPP TS 23.228, 3GPP TS 23.234).

Measurement Results with Mobile e-Learning

Wireless networks and mobile systems will continue to have explosive growth in the future. The traffic is expected to be a mix of real-time traffic such as voice, music and multimedia, and data traffic such as Web page browsing, instant messaging, and file transfers. All of these applications will require widely varying and very diverse quality of service (QoS) guarantees for the different types of offered traffic. Therefore, the mobile e-learning environment will be replacing traditional e-learning. We proposed a fourth generation mobile communication testbed system with advantages such as high transmission rate, robust wireless QoS control, wide cover area and supply IMS technology. Next generation communication technology can supply a variety of portable devices to ubiquitously access multimedia information, such as smart phones and PDAs. All Learners can use portable devices to log-on to the virtual classroom. Figure 10 shows a portable device surfing the virtual classroom via 4G.

In this session, we measure the mobile e-Learning system results via 4th generation core network. The scenarios are the UEs ability to connect to WLAN. Two scenarios are used for this measurement.

The first scenario is that the UE connects to the core network through WLAN. We measure the end-to-end delay of voice packet delivery. We captured the packets

Figure 9. The fourth generation mobile communication testbed system
using the Wireshark protocol analyzer. We installed the protocol analyzer at the end of the core network client to capture the packet and decode the voice stream.

End-to-end delay refers to the time cost used for a packet to be transported across a network from the source to destination. For voice packet transmission, we calculate the end-to-end delay according to RFC 3550. Figure 11 shows the end-to-end delay for voice packet delivery in WLAN.

The second scenario is that the UE connects to core network through WLAN. We measure the throughput of video packet delivery. These results show the transported bandwidth in the 4G testbed system, as shown in Figure 12.

**CONCLUSION**

The explosive development of the Internet and wireless communications has made personal communication more convenient. Mobile computing uses the Next Generation Learning Environment (NeGL) to set up learning systems. We proposed a mobile e-learning system that includes interactive courses, virtual online labs, interactive online testing, and a lab exercise training platform via the fourth generation mobile
communication system. It offers learners opportunities to use all kinds of mobile nodes or anything that can connect to an Internet learning equipment system to be accessed using All-IP communication networks. In order for Content Object Reference Model (SCORM) to compose information, the 4G can use a variety of computer embedded devices to ubiquitously access multimedia information, such as smart phones and PDA. Most important is that more bandwidth is available. As you can imagine, the condition of the learning mode in the future will be an international, immediate and virtual interactive classroom that enables learners to learn and interact.

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6BOOK: http://6book.niu.edu.tw


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