A PLAN TO DEVELOP METRO ETHERNET TECHNOLOGY FOR ACHIEVING MOBILE LEARNING (CASE STUDY: IRAN)

Shahriar Mohammadi
Dean of Information Technology Department,
Khaje Nasir Toosi University of Technology, Iran
smohammadi@kntu.ac.ir
Sepideh Imam
M.Sc Student in Information Technology Department,
Khaje Nasir Toosi University of Technology, Iran
Sepid.imam@gmail.com

ABSTRACT

In the developed parts of the world, the demand for broadband communication has mostly been met by newer technologies making use of existing infrastructure such as copper wires. Demand has also been met by the use of newer infrastructure. This paper considers the usage of Metro Ethernet technology to meet the needs of metropolises to achieve high speed internet services with the case study of Iran, that it can be a developmental plan to generalize mobile services like mobile learning with the use of WiMAX technology and Metro Ethernet together, also this plan can extend by next generation networks (NGN).

KEYWORDS

Metro Ethernet, WiMAX, Mobile Services, Mobile Learning, Next Generation Networks.

INTRODUCTION

Education and training is the process by which the wisdom, knowledge and skills of one generation are passed on to the next. This education process has been going on since time immemorial. It is the central process in the conservation and development of human culture. It began at the dawn of time and has continued to today.
Eventually society developed schools and universities as the privileged places where the education process takes place. But recently, training centers for teaching and learning skills that are needed for the functioning of society have developed since every place can be a training center even offices or bus stations. But how is it possible?
Today there are two forms of education and training: conventional education and distance education that can comprise: distance learning (d-learning systems used technology to separate the learner from the teacher, and the learner from the learning group, while maintaining the integrity of the education process), electronic learning (e-learning means the provision of education and training electronically, on the Internet and the WWW) and mobile learning (m-learning), Exactly these modern kind of learning are wonderful developments in technology, In this article I want to focus on mobile-learning and investigate its fundamental substructures that play essential role to implement it in developing countries such as Iran.
Therefore we should determine the network substructures that not only are easy to reach but also has some economical features. Undoubted being cost effective beside other significant properties make Ethernet as a authentic selection hence Iran's Governments try to apply it in two provinces (Qom and Kerman) as pilot centers. Having a plan can help us to use this opportunity to achieving mobile services despite of the plan that necessities make it unavailable in developing countries and it is

circumstances to extend Ethernet with least costs to execute WiMAX and NGN technologies beside Ethernet.

MOBILE LEARNING

Portable computing/communication devices such as laptops, PDAs(Short for **p**ersonal **d**igital **a**ssistant, a handheld device that combines computing, telephone/fax, Internet and networking features), smart phones connected to wireless networks enable mobility and facilitate mobile learning. If properly facilitated, mobile learning can be of great benefit to learners by providing instructional materials and interaction through their mobile devices wherever and whenever they are on the move. It can be beneficial to the instructors also since they can access services and interact with students while on the move.
Naturally mobile computing integrated into e-learning make courses in the universities more accessible and portable. E-book versions are becoming as common as their printed counterparts. As companies work on new usability standards to the e-books, along with the addition of audio, video and text-to-speech components for e-book software, it would mark the widespread adoption of e-books without any barriers in the coming few years. Mobile learning can be used to encourage both independent and collaborative learning experiences. Many learners enjoy the opportunity to use the mobile devices to learn independently of a group setting Mobile learning helps learners to remain more focused for longer periods it is possible that this effect was due to the novelty of using mobile devices and whether this is the case or not will become clearer over time.
Multimedia guides to galleries and museums incorporating movies, images, music, internet access and email facilities on handheld devices is another use of mobile learning. With mobile learning, teaching professionals can connect informal learning experiences that occur naturally throughout a day with formal learning experiences. It also provides the opportunity for using the tools (mobile devices) that most people already carry, that they currently depend on, and that are already part of their social practice. Mobile learning on phones gives mobile learning stakeholders more to do on the tools with which they are already reasonably proficient.

Today there are several communication technologies which are used in mobile devices. Their abilities vary vastly as data transmission range, I investigate some of them:

1. **Global System for Mobile Communications (GSM)** is one of the leading digital cellular systems. GSM has become the world's most widely used mobile system in use in over 100 countries. It provides integrated voice mail, high-speed data, fax, paging and short message services capabilities, as well as secure communications. It offers the best voice quality of any current digital wireless standard.
2. **General Packet Radio Service (GPRS)**. A packet-linked technology that enables high-speed wireless Internet and other data communications. GPRS provides about four times greater speed than conventional GSM systems.
3. **WiMAX** will explain later.
4. **Bluetooth** wireless technology is a short-range radio technology. Bluetooth makes it possible to transmit signals over short distances between telephones, computers and other devices and thereby simplify communication and synchronization between devices.
5. **3G** is short for third-generation technology. It is used in the context of mobile phone standards. A 3G service provides the ability to transfer simultaneously both voice data (a telephone call) and non-voice data (such as downloading information and exchanging email). 3G networks are known as UMTS (Universal Mobile Telephony System).
6. **4G** is the next technological strategy in the field of wireless communications. A 4G system will upgrade existing communication networks and is expected to provide a comprehensive and secure IP based solution where facilities such as voice, data and streamed multimedia will

be provided to users on an "Anytime, Anywhere" basis and at much higher data rates compared to previous generations.

Because of outdated infrastructures in developing countries, operating mobile services put an extravagant cost upon governments but if they purpose this project as a joint one, certainly invest once and utilize twice. For instance it suffices to choose Ethernet equipments with a providential sight for expanding to WiMAX and NGN technologies; in continuance I will describe these ways.

ETHERNET

Ethernet is the dominant cabling and low level data delivery technology used in local area networks (LANs). First developed in the 1970s and later described as a formal standard by the IEEE. Following are some Ethernet features:

1. Ethernet transmits data at up to ten million bits per second (10Mbps). Fast Ethernet supports up to 100Mbps and Gigabit Ethernet supports up to 1000Mbps. Many buildings on American universities are wired with Fast Ethernet.
2. Each device on an Ethernet network operates independently and equally, precluding the need for a central controlling device.
3. Ethernet supports a wide array of data types.
4. To prevent the loss of data, when two or more devices attempt to send packets at the same time, Ethernet detects collisions. All devices immediately stop transmitting and wait a randomly determined period of time before they attempt to transmit again.

Carrier Ethernet is the use of high-bandwidth Ethernet technology for Internet access and for communication among business, academic and government local area networks. Carrier Ethernet can be deployed in three ways:

1. Conventional or “pure” Ethernet
2. Ethernet over Synchronous Digital Hierarchy (SDH)
3. Ethernet over Multiprotocol Label Switching (MPLS)

Conventional Ethernet is the least expensive type of system but it can be difficult to modify or expand. Ethernet over SDH can be an ideal solution in regions already having an SDH infrastructure. However, most SDH-based systems are comparatively inflexible and may not offer the desired level of bandwidth management when network communications volume fluctuates rapidly and dramatically. Ethernet over MPLS offers superior scalability and bandwidth management.

Carrier Ethernet has minimal configuration requirements and can accommodate individual home computers as well as proprietary networks of all sizes. Most major network hardware vendors offer Carrier Ethernet equipment. The use of Carrier Ethernet technology within a metropolitan area network (MAN) is known as Metro Ethernet. Because it is typically a collective endeavor with numerous financial contributors, Metro Ethernet offers cost-effectiveness, reliability, scalability and bandwidth management superior to most proprietary networks.

Metro Ethernet can connect business local area networks and individual end users to a wide area network (WAN) or to the Internet. Corporations, academic institutions and government agencies in large cities can use Metro Ethernet to connect branch campuses or offices to an intranet. A typical Metro Ethernet system has a star network (which all nodes are connected to a central computer) or mesh network (which devices are connected with many redundant interconnections between network nodes) topology with individual routers (A device that forwards data packets along networks) or servers interconnected through cable or fiber optic media.

Pure Ethernet technology in the MAN environment is relatively inexpensive compared with Synchronous Digital Hierarchy (SDH) or Multiprotocol Label Switching (MPLS) systems of similar bandwidth. However, the latter technologies can be applied to Metro Ethernet in urban areas willing to devote the necessary financial resources to the task.

3.1 Economics of Ethernet

This drive toward higher bandwidth services is leading to fierce competition for customers. Wire line carriers are not the only suitors for residential and business service needs; cable companies and wireless providers are also vigorously pursuing the same market. Because these high-bandwidth pipes offer the potential for value-added service offerings, they prove to be very "sticky" and improve customer retention. It is often the case that the first carrier to deliver the service to the customer, wins that customer for a very long time.

The fast time-to-market of Mid-Band Ethernet allows any wire line provider to reach the customers with a next-generation service alternative long before the competition by using their existing infrastructure, therefore locking in the customer's revenue stream. Ethernet has long won the battle to become the natural link layer protocol for IPbased applications and services. IEEE 802.3 Ethernet standards have evolved to extend electrical and optical interface speeds from 10 Mbps to 10Gbps and beyond. Interface cards and Ethernet switches are ubiquitous and offer very high capacity at a very inexpensive cost per bit, resulting in Ethernet's near total domination of enterprise and campus area networks. Enterprises now wish to interconnect multiple sites and connect to the public Internet while maintaining the performance of their applications, and Mid-Band Ethernet allows this. For years now, many carriers have been replacing and phasing out their old infrastructure migrating their customers to a less expensive, more reliable Ethernet IP/MPLS infrastructure. In figure 3.1.1 you can see the reference model for delivering carrier Ethernet.

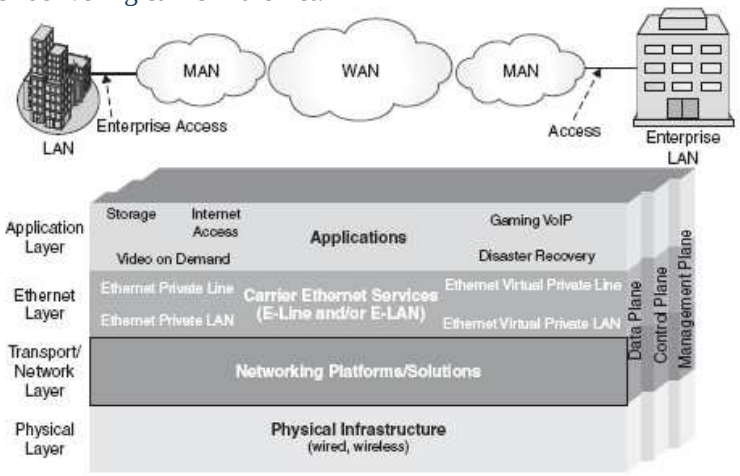

Figure 3.1.1 Reference model for delivering carrier Ethernet

3.2 MPLS

Multiprotocol Label Switching, or MPLS, was developed in the late 1990s. It is a packet switching technology that has both connectionless and connection-orientated characteristics and that sits somewhere between the second and third layers of the OSI model. Although originally designed to transport IP traffic, MPLS has developed into one of the key technologies in delivering Carrier Ethernet services accordingly its utilization is significant and effective on expanding networks. In figure 3.2.1 the architecture of national IP/MPLS network in Qom province is available.

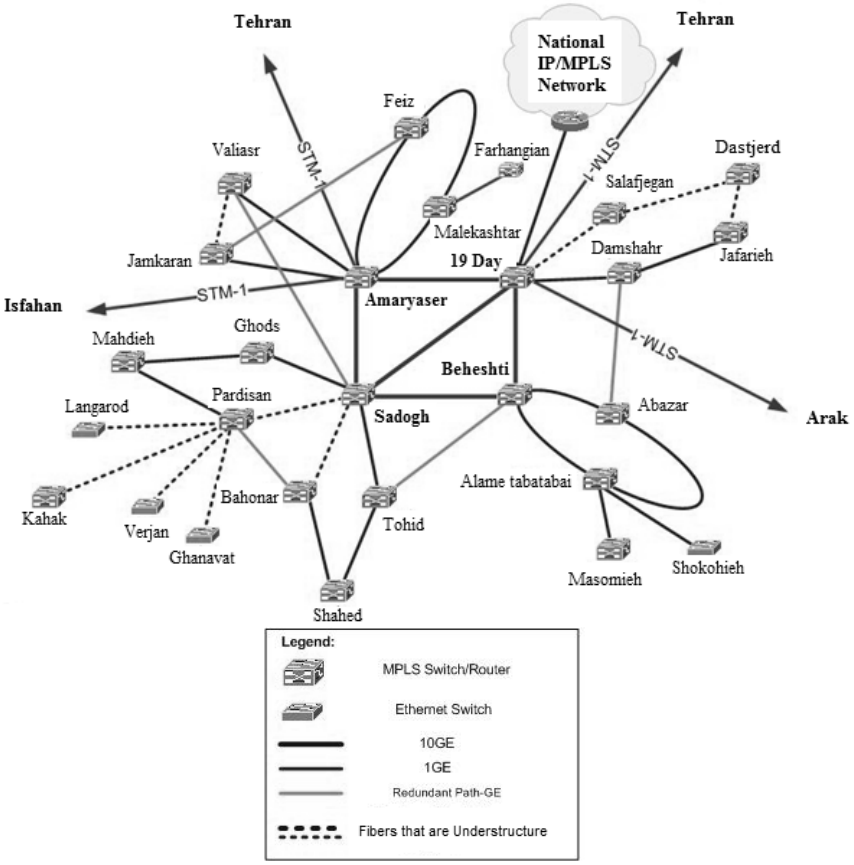

Figure 3.2.1 Qom province's IP/MPLS network architecture

WIMAX

In parts of the populous world with undeveloped communication infrastructure, growth in bandwidth demand is no less intense. However, delivering bandwidth by deploying wired infrastructure in these parts of the world is equally cost prohibitive.

Broadband Wireless Access (BWA) technology has been seen as the technology that can meet the broadband needs of much of the world. It is expected to meet the broadband needs of nomadic and mobile users always hungry for more bandwidth. It is also expected to serve as a medium to deliver broadband communication to populations without access to wired broadband services. Even for the masses with other means of broadband access, it creates an opportunity for alternate carriers to enter a market even if they do not have access to the wired infrastructure.

WiMAX is a BWA technology that has gained a very wide acceptance among major broadband service providers and equipment manufactures. Because of its technical soundness and its wide acceptance in the industry, it is poised to be the most widely deployed BWA in the world. Also WiMAX is a shared medium point-to-multipoint multi-user wireless communication technology where multitudes of devices share a common medium to serve their communication needs. WiMAX offers a multiple access protocol that is highly flexible yet highly efficient in its use of limited resources. It allows for a diverse set of physical layer protocols, each of which makes very efficient use of the spectrum. Throughout next section, I discuss some of the salient features of WiMAX, including its ability to deliver carrier-grade Ethernet services.

4.2 Carrier Ethernet Services over WiMAX

Multiple Access Control (MAC) is the protocol that defines the method of access to the shared medium by multiple devices. WiMAX provides a fairly sophisticated MAC protocol that enables efficient utilization of resources, while being independent of the details of the Physical Layer Protocol (PHY). Unlike other popular MAC standards that do not have a central controller, WiMAX uses a central controller, referred to as the Base Station (BS), which coordinates access to the wireless medium by all other devices, referred to as Subscriber Stations (SSs). Communications from BS to SS, referred to as downlink (DL), and communications from SS to BS, referred to as uplink (UL), are scheduled by the BS. In Mesh networks, a central controller, referred to as the Mesh BS, schedules all communications (Mesh also allows for distributed scheduling).

WiMAX has a wide set of applications, both in urban and rural environments where other technologies have limitations of their own so it could be a valuable help to utilizing mobile services even in rural environments.

In many of the urban commercial environments of developed countries such as the U.S., several office towers are connected to broadband infrastructure like fiber-optics networks. Tenants of such buildings can enjoy access to broadband services such as Ethernet services. However, even in such urban commercial environments, less than only 10 percent of the buildings fall under this category. Tenants of the remaining 90 percent of the buildings are left without access to fiber and are limited to traditional services.

WiMAX network can be used to extend the reach of fiber beyond where the fiber terminates, extending the plethora of services that can be made available to tenants of other buildings. This can be accomplished in at least three different ways. In all these method, a BS would be installed on the rooftop of the building or tower with access to the fiber infrastructure. In the first case, the single carrier SC-PHY (the single-carrier PHY standard (SC-PHY) was the first PHY standard developed by IEEE 802.16, which referred to it as WirelessMAN-SC. It was designed to operate at frequencies between 10 GHz and 66 GHz) technology could

be used to extend services from the BS to the building in Line-of-Sight (LOS) of the BS, from where it would be distributed to the tenants of the building, using the building's internal networking infrastructure as illustrated in figure 3.2.1. In the second case, the OFDM-PHY (One of the techniques that has gained significant ground combating the effects of multipath is Orthagonal Frequency Division Multiplexing (OFDM). In this technique, the physical channel is split into large numbers of sub channels and the data transmission is multiplexed among the multiple channels) technology could be used to extend service from the BS to the building or directly to its tenants that are directly reachable from the BS, though not necessarily

in line-of-sight of the BS. In the third case, the WiMAX Mesh technology could be used to extend the service from the BS to the building or tenants that are reachable from the Mesh network. Regardless of which method is employed, the wireless network can be used to extend the services offered on the fiber-optics network, such as Carrier Ethernet services, to the users of the wireless network.

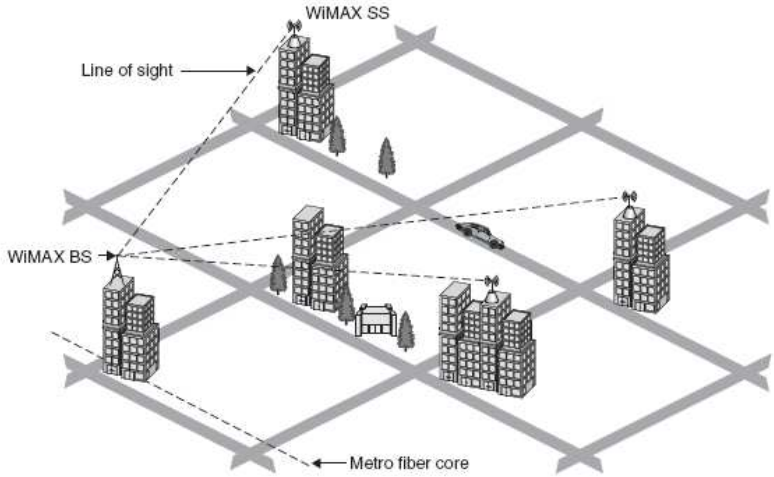

Figure 3.2.1 Fiber extension with WiMAX

4.2.1 Urban Fixed and Mobile Broadband Services

In urban environments of developing nations, even though sufficient economic conditions exist to demand broadband services, the cost of building wired infrastructure is prohibitive. The wired infrastructures have another fundamental limitation: they cannot provide nomadic or mobile broadband services. As small devices like cameras, PDAs and laptops become ubiquitous; the need to provide mobile or seamless nomadic services becomes more important. Although such mobile broadband services are already provided by some wireless operators, the bandwidth provided is fairly limited.

As mentioned above WiMAX based on OFDM-PHY and OFDMA-PHY are well positioned to serve the needs of urban stationary as well as mobile users. In a dense urban environment, such as the one shown in Figure 3.2.1.1.

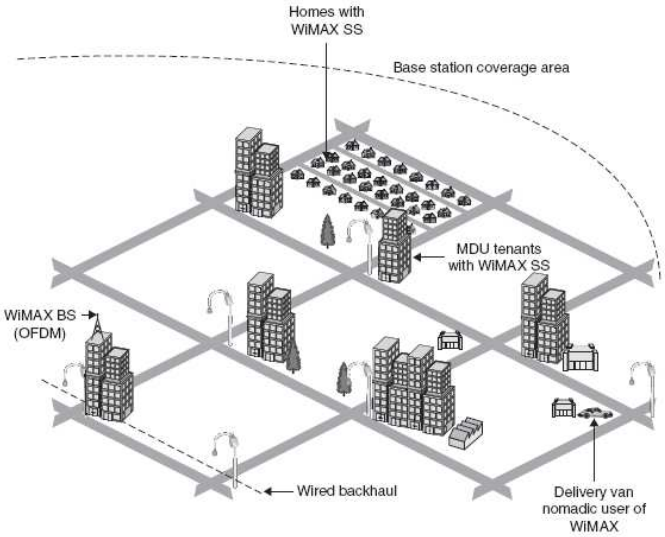

Figure 3.2.1.1 Urban broadband services with WiMAX

ETHERNET RUNS ON NEWST TECHNOLOGIES

Ethernet is rapidly becoming the standard interface for handoff from service providers to customers. Where all services are delivered over Ethernet interfaces, the cheapest access technology is generally to deploy Ethernet switches. But in order to scale such a deployment, carriers need to deploy a carrier-class technology into the metro core. Because most service providers wish to offer IP services as well as Ethernet services, they often deploy IP/MPLS routers into the metro edge and core and use them to interconnect the access layer of Ethernet switches.

5.1 Ubiquity of IP

Enterprises continue to adopt more and more IP-based applications and dramatically grow their consumption of packet network capacity. Business applications such as file sharing, training, storage networks, and video conferencing are all growing in coverage and bandwidth requirements. Voice over IP (VoIP) is just starting to replace analog voice as the primary mechanism for telephony. All carriers are in the midst of rolling out more and more VoIP applications and removing their dependence on traditional voice services. On the residential side, VoIP is also a driving application, as is IP television (IPTV). With IPTV, consumers can watch digital high-definition video over their broadband connection. This triple-play of services not only is the goal of every carrier but also is a worthwhile occasion to achieving modern kind of learning due to IPTV or similar services will help customers to find their slightly lessons and contents.

All of these applications have similar requirements, high bandwidth, high reliability, and highly controlled QoS with low latency. Ethernet provides the technology that has enabled all of these applications in the LAN, and with Mid-Band Ethernet, across the WAN as well; even service providers are able to apply last generation of mobile technologies to establish mobile services. In the next session I'll explain its plan.

5.2 NGN

Next Generation Networking (NGN) is a broad term to describe some key architectural evolutions in telecommunication core and access networks that will be deployed over the next 5–10 years. The general idea behind NGN is that one network transports all information and services (voice, data, and all sorts of media such as video) by encapsulating these into packets, like it is on the Internet. NGNs are commonly built around the Internet Protocol (IP), and therefore the term "all-IP" is also sometimes used to describe the transformation toward NGN. So Next Generation Networks are based on Internet technologies including Internet Protocol and Multiprotocol Label Switching (MPLS) as mentioned before.

From a practical perspective, in the core network, NGN implies a consolidation of several transport networks each historically built for a different service into one core transport network (often based on IP and Ethernet). It implies amongst others the migration of voice from a circuit-switched (A type of communications in which a dedicated channel (or circuit) is established for the duration of a transmission) architecture to VoIP and also migration of legacy services.

5.2.1 IP NGN and Carrier Ethernet

Service providers worldwide agree that the Carrier Ethernet and IP/Multiprotocol Label Switching (MPLS) technology will pave the way to next-generation networks.

They are facing increasing challenges brought on by service convergence and stiff market competition. To maintain growth and profitability, service providers need to:

1. Accommodate surging demand for broadband services
2. Maintain competitive residential and business service offerings
3. Avoid service commoditization by offering new and premium services
4. Strengthen profitability by increasing revenue while reducing total cost of ownership
5. Migrate existing services to more cost-effective Carrier Ethernet service

6. Protect and grow business services in parallel with consumer services

As we know the Carrier Ethernet network supports all network services equally well, including:

1. Residential services
2. Business services
3. Mobility services
4. Wholesale services

For this reason I advocate a more flexible approach to Carrier Ethernet design that minimizes the total cost of ownership of the access and aggregation network while supporting a broad range of applications and services.

Use of IP NGN and Ethernet together is the most scalable approach to delivering NGN services that in this article is presented.

Mobile networks also are moving to broadband IP infrastructure. As service providers deploy 3G, WiMAX, Wi-Fi Hotspots (any location in which Wi-Fi technology both exists and is available for use to consumers), the aggregation network must scale to support backhaul (transition of voice and data traffic from a remote site to a central site) of broadband wireless data. Carrier Ethernet is the preferred technology for broadband wireless backhaul as described in section 4.2.

So Mobile service providers need to build a robust yet flexible IP transport network that takes advantage of packet economics. At the same time they must also support 2G, 3G, and emerging 4G technologies. To achieve these goals, mobile service providers must evolve their RAN (Radio Access Network is the ground-based infrastructure required for delivery of third-generation (3G) wireless communications services, including high-speed mobile access to the Internet) transport from traditional circuit-based technology to a packet-based solution and WiMAX is one of them.

5.2.2 Mobile IP: WiMAX

As mentioned before WiMAX is a fourth-generation wireless solution based on the IEEE 802.16e standard for delivering advanced broadband wireless services in emerging, high-growth, and developed markets. Mobile IP technologies can be used to provide ubiquitous service and enable service providers to deliver a persistent connection for users, independent of their location.

CONCLUSION

In the future we expect to see continued convergence across residential, business, and mobile services. Today most customers have separate mobile and landline phone service; however, in the future many service providers will offer a converged fixed-mobile service. Customers will subscribe to a single phone service that will be delivered either to their cell phone depending on their location and their preferences. Similarly, service providers will preferred converged video services that will be delivered to an HDTV (Short for High-Definition Television, a new type of television that provides much better resolution than current televisions based on the NTSC standard), PC, cell phone, or wireless PDA based on customer preference The overall industry trend will be any service, any screen, with fully personalized services and integrated multimedia applications for both business and entertainment and one of these important applications is Mobile Learning that today encounter(confront) with the lack of substructures. For instance Iran's government selected Ghazvin, Tehran and Fars provinces as pilots for NGN implementation while we have it's substructures in two other provinces (Qom and Kerman) so we could economize project's outlay. I investigated in this article developing countries just with a provident plan can advance along developed countries with least costs.

ACKNOWLEDGEMENT

I am heartily thankful to my supervisor, **Dr. Mohammadi** (Dean of Information Technology Department in K.N. Toosi University of Technology whose encouragement; guidance and support from the initial to the final level enabled me to develop an understanding of the subject.

REFERENCES

Book

Halabi S., 2003. Metro Ethernet. Cisco Press, Indianapolis, USA.

Kasim A., 2008. Delivering Carrier Ethernet : Extending Ethernet Beyond the LAN, McGraw-HILL, New York, USA.

Journal

Chen G. and Chao P., 2009. Augmenting paper-based learning with mobile phones. In Interacting with Computers,Vol. 21, Issue 3, pp 173-185.

Motiwalla L., 2007. Mobile Learning: A Framework and Evaluation. In Computers and Education, Vol. 49, Issue 3, pp 581-596.

Uzunboylu H.et al, 2009. Using Mobile Learning to Increase Environmental Awareness. In Computer and Education, Vol. 52, Issue 2, pp 381-389.

Conference paper or contributed volume

Attewell J., 2005. Mobile Technologies and Learning: A Technology Update and M-Learning Project Summery. Technology Enhanced Learning Research Centre. London, UK.

Fu R. et al, 2009. Carrier Ethernet Network Control Plane Based on the Next Generation Network. First ITU-T Kaleidoscope Academic Conference. pp. 293 – 298.

Georgiev T. et al, 2004. M-Learning - a New Stage of E-Learning. International Conference on Computer Systems and Technologies, Rousse, Bulgaria.

Jacob S. M. and Issac B., 2008, The Mobile Devices and its Mobile Learning Usage Analysis. International MultiConference of Engineers and Computer Scientists, Hong Kong.

Parsons D. et al, 2006. A Framework for Assessing the Quality of Mobile Learning, Institute of Information and Mathematical Sciences", Massey University, Auckland, New Zealand.