Ubiquitous Learning System (ULS) based on Adaptive Media Streaming techniques: Case study at Taibah University

Mohamed Menacer*, Ali Al Mogbel**, Amar Arbaoui*, Oussama Elmarai*, Ammar Abbachi*

*College of Computer Science and Engineering, Taibah University
** College of Education, Taibah University
{mmenacer, amogbel, aarbaoui, aabbachi }@taibahu.edu.sa

Abstract: This paper describes the development of a Ubiquitous learning System (ULS) based on adaptive media streaming techniques. The ULS system has been implemented as a core system within the Ubiquitous Learning Environment used at the College of Computer Science and Engineering, at Taibah University. Students are able to access the various learning services and applications using smart phones, PDAs, laptops, or any mobile devices within the wireless network coverage of the College. Dedicated Mobile Learning Applications and Services have been developed for both students and instructors to use in the Ubiquitous learning environment. Due to the increasing penetration of smart phones and tablets alike, and the enormous usage of video media content nowadays, the need to develop a dedicated video streaming system dedicated to Ubiquitous learning becomes a necessity to support and attract students to use and interact with relevant multimedia learning objects and resources made available at the college. The ULS is an adaptive system composed of three main services: Video-on-Demand (VoD), scheduled programs (WebTV), and Live Event. Depending on the client type, PC-based or Handheld devices, two different streaming techniques are used to ensure reliable media delivery in an efficient and adaptive manner. PC-based clients are characterized by high hardware performance and relatively stable bandwidth compared to handheld devices. In such case, traditional streaming using RTSP over UDP is used. In the case of handheld devices, DASH technology using HTTP is used to dynamically adapt the bitrate to the frequent bandwidth fluctuations due to the nature of such devices and most importantly the mobility of the user. The proposed video streaming system dedicated to Ubiquitous learning environment provides an original approach and offers rich features for learning.
[Mohamed Menacer, Ali Al Mogbel, Amar Arbaoui, Oussama Elmarai, Ammar Abbachi. **Ubiquitous Learning System (ULS) based on Adaptive Media Streaming techniques: Case study at Taibah University.** *Life Sci J* 2014;11(9):102-113]. (ISSN:1097-8135). http://www.lifesciencesite.com. 16

Keywords: Ubiquitous Learning, eLearning, mLearning, Adaptive video streaming, Video-on-Demand (VoD), WebTV.

1. Introduction

Increasing penetration of mobile phones, Personal Digital Assistants (PDAs), and Smartphone has redefined and accelerated the growth of mobile learning or mLearning [1,6]. Ubiquitous learning gives the opportunity to learn where and when you want with a handheld device that is literally with you all of the time. It focuses on the mobility of the learner, interacting with portable technologies, and learning that reflects a focus on how society and its institutions can accommodate and support an increasingly mobile population [2,7].

Ubiquitous or Mobile learning involves connectivity for downloading, uploading and/or online working via wireless networks, mobile phone networks or both, linked to institutional learning facilities e.g. eLearning platforms, virtual learning environments (VLEs), Content Management Systems (CMS), and management information systems (MIS) [3,4,5]. By blending more conventional learning with latest in multimedia technologies to be used in conjunction with mobile and handheld devices, learners can experience flexible learning that extends the use of ICT beyond the classroom. It is an adequate learning solutions for today's mobile learners community. Studies have showed that continuous communication between students and teachers offered new learning opportunities in higher education and has significantly improved the learning process and higher level of achievements [1,4].

Furthermore, Video and Audio applications becomes increasingly more popular due to the ubiquity internet access by the end-user, bandwidth increasing, popularity of mobile and handheld devices, and the enormous demand for watching videos over the internet. This type of applications differs from other data applications in that they are real-time applications, requires large storage, efficient streaming techniques, and much higher bandwidth. A recent study by CISCO shows that mobile data is expected to grow to by over 13-fold by 2017 compared to 2012. Video content specifically is expected to be the major element in the mobile data traffic and growth [8]. Figure 1 shows the rates of mobile data traffic from the different types.

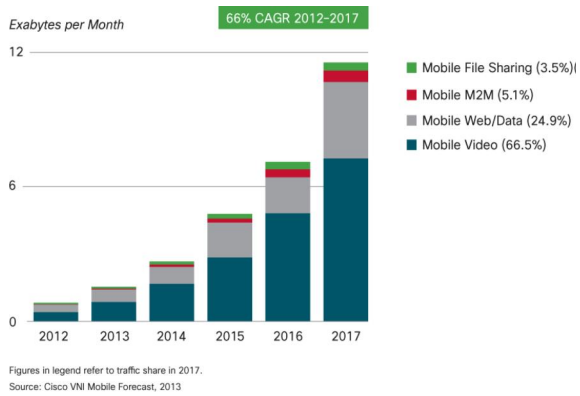

Figure 1: Expectations for different rates of mobile data traffic between 2012 and 2017 [8].

Streaming media services can be significantly affected by various conditions, hence deteriorating the Quality of Experience (QoE). The time-varying bandwidth, buffer size, packet loss ratio and delay are factors that make the streaming process more complicated. In wireless networks, where mobile terminals such as tablets and smartphones have frequent changes in network coverage, distribution of rich media content becomes even more complicated. The bandwidth offered by this type of network is generally lower than wired networks. Even network conditions such as available bandwidth, packet loss ratio, delay and delay jitter vary from time to time [9]. These conditions cause image blocking and sound disruption during playback, which can be unacceptable to the end user.

To enhance the user's quality of experience of watching multimedia content over local networks or internet, video streaming technique is the most important way to deliver media content. Streaming is the method of transmitting media in a compressed form as a continuous stream (with no intermediate storage of the media file) of data that can be processed and displayed in real time by the receiving computer before the entire file has been completely sent. Steaming source can either be from recorded file (Video-On-Demand) or from a physical device like camera (Live Events). A live event requires more resources to deliver content compared to VoD due to the additional time of capturing and encoding on the fly [10].

The aim of this pilot project is to improve the quality of learning by bridging the gap between students and teachers, take advantage of user mobility, and the increasing interest in video media content as a practical, convenient and sometimes efficient learning style due to the nature and size of handheld devices. This is being achieved by using a web-based Multimedia streaming and delivery system as a core for a dedicated Ubiquitous Learning environment. It combines both traditional streaming and DASH technology for delivering media to PC-based and Handhelds clients respectively. For PCs where the bandwidth is generally quite constant and the performance of the device like CPU and Memory are sufficient, in this case WMS is used that implements traditional streaming. However, handheld devices like Smartphone and tablets are characterized by their frequent mobility that causes bandwidth fluctuations [11]. In addition, the performance of these devices is lower compared to PCs; in this case DASH technology is use.

The design, architecture, and implementation of the Ubiquitous Learning Environment, in the College of Computer Science and Engineering (CCSE) at Taibah University, is presented with detailed illustrations of the Ubiquitous Learning System (ULS) providing 3 main streaming system services: Video-on-Demand, Scheduled Program and Live Events.

2. Media Delivery Systems and Techniques

Currently, the use of media delivery systems have become very popular due to the high prevalence of video watching on the internet. One of the most known and accessed video-sharing portals is YouTube, it was created in Feb 2005 and bought by Google Inc. in Nov 2006. It serves more than a billion unique people and over 4 billion hours of video are watched each month making it the 3rd most visited website in the world [12], with 25% being viewed using mobile and handheld devices [13]. Anonymous users can watch YouTube videos but only subscribers (individuals or companies) can upload videos in different media formats (WMV, MPEG and AVI) but media content is delivered in FLV format only. YouTube supports both Video-on-Demand (VoD) and Live delivery methods, it relies on Adobe's progressive download technology [14]. Netflix is another example of media delivery system but somehow different in terms of business model and technology being used. It is a subscription service provider for online movies and TV shows and has reached more than 23 million subscribers in the United States and Canada alone [15]. Netflix uses DASH technology for streaming media content and the average achievable bitrate reaches 3.6 Mbps, which is set to increase with technology advances. Many other media delivery systems exists like Hulu, Vimeo, BBC Videos, MSN Videos, Khan Academy …etc. Some of them contains videos in multiple fields like News, Health, Technology, Sport and others are related to academic media content such as Khan Academy which relies on YouTube system, as the main delivery system.

Watching video can be done in different ways. One is to download the entire video and play it from the hard drive. This approach waists both network

resources and user time. Nowadays, Progressive Download is the most common way to deliver videos. As its name indicates, the media playback starts, from hard drive, before the entire file is downloaded in a chronologi00lical order structure of the most media file formats [16]. Progressive Download presents some weaknesses among which that is does not support both bitrate adaptation and live media services [17]. Also, the video file will be downloaded entirely even if the user watches some seconds only and moves to another one, this leads to useless usage of the bandwidth of the selected video file without being viewed.

Single Bit Rate (SBR) Streaming technique provides multiple links on the same page with different encoding bit rate for the same video file. So the end user can select the appropriate one depending on the available bandwidth. However, the main disadvantage of this technique is that there is no way to adapt the bit rate of a requested stream if the bandwidth conditions change [18,19].

Single Bit Rate Streaming technique provides multiple links on the same page with different encoding bit rate for the same video file. So the end user can select the appropriate one depending on his available bandwidth. In general, there are three bandwidth level offered: High, Medium and Low. For example YouTube offers for several videos the following bit rates: 240b/s, 360 b/s, 480b/s and 720b/s for High Definition. But, in general users do not know their available bandwidth and in most cases they choose either a High Definition Quality which is not supported by the client bandwidth connection or they choose a lower quality stream than their available bandwidth. Another disadvantage is there is no way to adapt the bit rate of a requested stream if the bandwidth conditions change.

Multiple Bit Rate (MBR) streaming allows sending content (VoD or Live) encoded with multiple bit rates in a single stream. This technique improves the viewer's experience by selecting and switching to the best resolution and bit rates that the client connection speed can support in a transparent mode for the client [19,20]. Today's commercial streaming media systems rely on the MBR technique. MBR presents the limitation that it requires a specialized server and uses RTSP protocol over UDP which have issues with Network Address Translation (NAT) and firewalls [20].

In order to cope with the limitations of the techniques described above, a new technology has been developed which is called Dynamic Adaptive Streaming over HTTP (DASH). It delivers videos to consumers by dynamically adapting the video bitrate based on several parameters like available bandwidth, CPU and RAM usage …etc [21]. DASH encodes a video into multiple representation levels with different bitrates; these representations are chopped into small segments called chunks [22]. An XML file called Media Presentation Description (MPD) is required to describe the different individual segment's bitrates, corresponding timing and URLs. The client requests first the MPD file to know the available bitrates [12,13], and selects a specific representation for each chunk to be requested based on its estimated throughput and other parameters. This new emerging technology addresses the different drawbacks causing user frustration such as: long start-up, freezes and buffering, low quality, missed plugin, bandwidth fluctuations especially for mobile devices …etc, and combines the advantages of both traditional streaming and progressive download. It exploits the existing Content Delivery Network (CDN) and proxy cache of HTTP infrastructure and has no issues with firewalls or NATs [22,23].

Figure 2 illustrates the DASH approach that offers several advantages as described above. However, TCP and HTTP introduces a significant overhead to the transmission compared to RTP and UDP which is approximately twice the media bitrate [19,20,21].

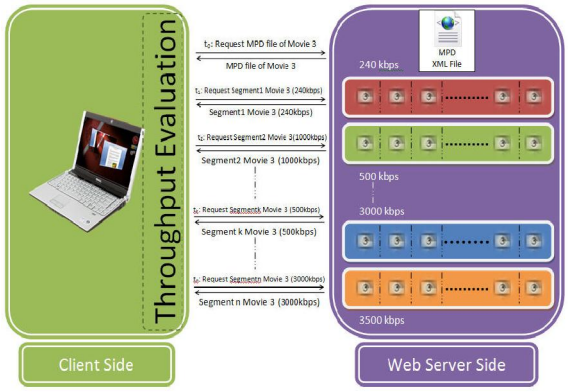

Figure 2: DASH Technology Approach

All the techniques described above can be classified into two categories: Push-based and Pull-based media delivery techniques. In push-based technique, also called stateful techniques, once a connection is established between the client and the server, this latter continuously pushes packets to the client until the end of the video being played or the session expires. Contrary to the previous category, pull-based techniques implement a client-driven strategy in which it requests content and the server role is limited to serving the client requests. Table 1 provides a comparison between progressive download, traditional streaming and DASH, which are currently the most used technologies.

From this table we can see that DASH technology presents more advantages compared to the

two other techniques since it does not require dedicated media servers or networks and it has no issues with NATs and firewalls. Also it supports both video-on-demand and live delivery and bitrate adaptation based on the client conditions. However,

Table1: Comparison between Progressive Download, Traditional Streaming and DASH technologies

Features	Progressive Download	Traditional streaming	DASH
Use of dedicated media servers and networks	No	Yes	No
Support Live	No	Yes	Yes
Have issues with NATs & Firewalls	No	Yes	No
Have issues with scalability	No	Yes	No
HTTP-based	Yes	No	Yes
Bitrate Adaptation	No	Yes	Yes
Need to Manage Large Number of Files	No	No	Yes

DASH has to manage large number of files segmented into small chunks which is time consuming for encoding and uses larger storage space. Progressive download is an HTTP-based scalable technique that has no issues with NATs and firewalls and does not require dedicated servers or networks. However, the limitations of this technique is that it does not support both live delivery and bitrate adaptation. Finally, the traditional streaming techniques are better than progressive download in terms of support to live delivery and bitrate adaptation; however they require dedicated servers and networks and have issues with NATs and firewalls.

3. Ubiquitous Learning

The continuous development in information technology improved the learning process and the way learners acquire knowledge. This development leads to the emergence of several successive learning styles like electronic learning (e-learning), mobile learning (m-learning) and ubiquitous learning (u-learning). Ubiquitous learning is based on ubiquitous technology which provides the ubiquitous learning environment that enables learning anything at anytime from anywhere [15,24]. Nowadays, the popularity of mobile devices and the advancement and widespread of wireless networks improved the learning process by providing high level of mobility for the learner and high level of multimedia content availability. Another definition of ubiquitous learning has been proposed in [24]: "U-learning is a learning paradigm which takes place in a ubiquitous computing environment that enables learning the right thing at the right place and time in the right way". This definition is more specific than the former, by not just making any information available but the relevant information needed by the learner in specific format at the right time and place. One of the main characteristics of the u-learning is interactivity, especially for handheld devices, where the screen is small and does not help to read large texts. Thus the use of alternating interactive learning content like video is a must in such learning environment.

4. Ubiquitous Learning Infrastructure

The Ubiquitous Learning environment consists of the hardware infrastructure, applications and services development and the Ubiquitous Learning System (ULS). The hardware infrastructure consists of two main parts:

a hardware infrastructure with wireless Access Points (WAP) devices and network active components;

Set up, a small scale data center with installation and configuration of a set of servers as delivery platform for the different learning applications and services.

The development and integration of Ubiquitous Learning Applications and Services includes the CCSE e-learning platform, Learning Management System (CCSE-LMS), Ubiquitous Learning System (ULS), Drupal Content Management System (CMS) for the overall portal, and other students' electronic services provided by the University.

The wireless coverage has been designed to cover the areas around the college where usually students congregate which are: the internal areas of the college mainly the corridor and the labs, and the external areas such as the cafeteria and the car parks. The latest in Access Point (AP) technology has been used. With appropriate Power over Ethernet (PoE) solution, only one cable is required to connect the main switch to the access points to deliver both data and power. This high flexibility made the installation and testing of the wireless coverage more practical and a lot more efficient. Moreover, the integrated quality of service (QoS) features provide consistent voice and video quality on both the wired and wireless networks, enabling the deployment of more efficient and quality voice over IP (VoIP), Ubiquitous Learning system and other related video applications.

In the hardware setup and configuration, a small scale Data Centre has been designed, configured, and assembled in one of the rooms in the college building. The Data Center hosted the various systems of the Ubiquitous Learning Environment suitable for mobile devices that can be more efficiently accessed through handheld devices and mobile phones, as shown in Figure 3 below.

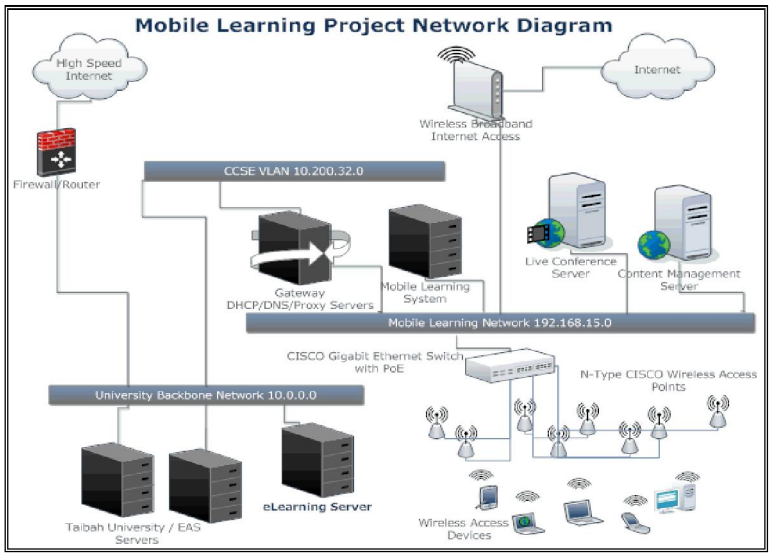

Figure 3: Ubiquitous Learning Environment Infrastructure.

The Ubiquitous Learning System has been configured and integrated with several other systems and applications (see figure below), from where students can have access to all sorts of applications and services. All the systems and application have been integrated and partly developed to check on the feasibility, utility, and efficiency of such applications:

Content Management System (CMS): A customized CMS based on Drupal package has been configured and customized to host the main interface for the various services and activities under the same roof and will link it to the different sub-systems. This will help in the overall management and delivery of the various applications of the Mobile Learning System, as well as provide a global overview about the project. Most importantly Drupal CMS provides an excellent base for expanding the system as required and effortless.

CCSE LMS: CCSE eLearning platform is based on Dokeos LMS that has been configured and customized for the best delivery of the course materials, ecourses and video lectures. However its contents are not necessarily very useful and efficient for mobile phones in term of contents.

Ubiquitous Learning System (ULS): The ULS is an adaptive system that is composed of three main services for streaming video learning materials: Video-on-Demand (VoD), scheduled programs (WebTV), and Live Event. Depending on the client type, PC-based or Handheld devices. Further content development is required for continuously preparing and archiving of video content. A detailed design of the ULS system is presented in the next section.

eCourses and Lectures Repository: A Repository has been configured and customized in order to store the various eCourses and lectures as well as proprietary contents that are useful the college students.

Student Support Portal: A portal has been customized to deal with various services for technical support and maintenance. A number of student services have been identified in order to provide the students personalized services such: University Student Information System (SIS). Other services have been considered for future implementation.

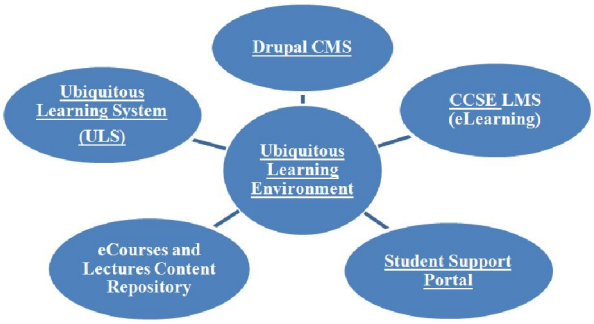

Figure 4: Ubiquitous Learning Environment Infrastructure.

5. Ubiquitous Learning System (ULS): Design and concepts

The overall design of the ULS system is illustrated in Figure 5. It consists of of 4 different modules: Admin, video-on-demand, WebTV, and live events. Admin module consists of the management layer of the hole ULS system. It provides the system administrator with several interfaces from which different entities of the system can be managed, such as : Users, Categories, Divisions, Medias...etc. The video-on-demand (VoD) module allows users to view recoreded medias with trick modes. The available medias in the repository are displayed in wall mode

and categorized. Also, a search engine is available to allow users looking for specific words. The WebTV modules consists of scheduled programs built for each day of the week either manually or automatically by the system administrator. The programs contains both archived videos and live events materials. In the manual configuration mode, the administrator selects directly the media to be played for specific period of time, while in the automatic mode selection is made by category from which randomly selected media is played. Finally, in Live Events module, users watch live medias captured either from a device like a digital camera or/and from captured stream of satellite channels.

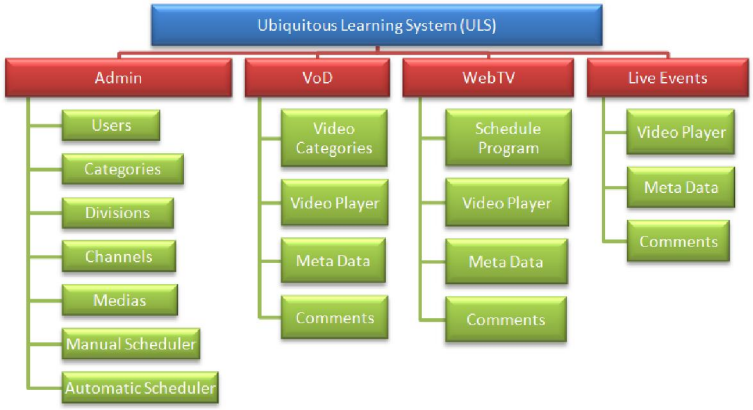

Figure 5: Ubiquitous Learning System Overall concept

6. Ubiquitous Learning System (ULS): Architecture and infrastructure

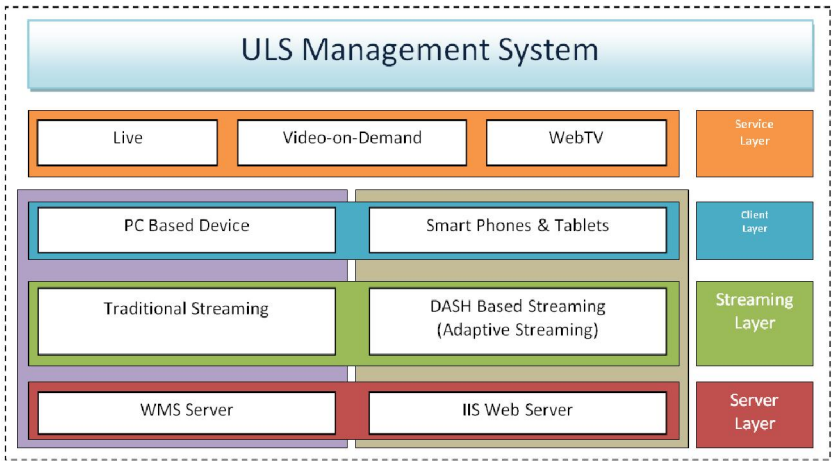

Figure 6: Ubiquitous Learning System Architecture

The overall system architecture is illustrated in Figure 6. The proposed Ubiquitous Media Delivery System provides support to both PC-based and handheld client devices. For PC-based devices traditional streaming with RTSP protocol over UDP is used since the available bandwidth on these devices is much better and relatively stable. However for handheld devices, DASH approach (HTTP protocol) is used to cope with bandwidth fluctuations due to the nature of the device and user mobility. Microsoft solution has been used for this purpose, where Windows Media Service (WMS) is used for traditional streaming. WMS is characterized by several features like caching and proxying to improve end user experience and reduce load on origin server and network. Furthermore, it also provides archiving and play while archiving is possible, fast streaming and advanced forward/rewind, high scalability, support server side playlist and advertising. To implement DASH approach, IIS Smooth Streaming feature that runs under IIS Web Server, has been used.

The proposed Media Delivery System provides users with three main delivery services: Video-On-Demand (VoD), WebTV with a scheduler, and Live Events broadcast. Figure 7 illustrates the overall acquisition and delivery Infrastructure for the Ubiquitous Learning System. It consists of three phases: Content Acquisition and storage, Content Preparation, and streaming and Content Delivery. For

the first phase, multimedia and video content is acquired either from a live source like a camera or a live Satellite TV channel, or by uploading recorded videos in different formats (wmv, mp4, flv). Both types of video sources are stored in a central repository. In the content preparation phase, uploaded videos are converted, if needed, to wmv format which is used by Windows Media Server. This format can be streamed to PC-based clients. The resulting wmv type videos are then converted to mp4 format required by IIS (Windows web server) Transform Manager for delivery and streaming to handheld and smartphone devices. The last phase consists of video content delivery to different types of clients. If the client is a PCs-based client, WMS streams the requested content either using RTSP or HTTP, since they are both supported by WMS. The HTTP protocol is used in the case of handheld devices using IIS Smooth Streaming system for DASH delivery method.

The ULS System main delivery mode modules are: Video-on-Demand (VoD), WebTV or Scheduled Programs, and Live Events Broadcast:

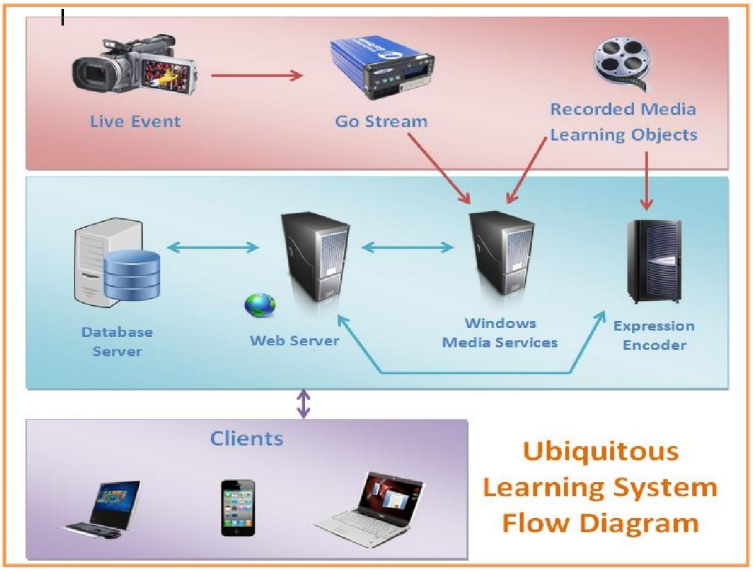

Figure 7: Acquisition and delivery Infrastructure for the Ubiquitous Learning System

A. Video-On-Demand

VoD module is a YouTube like system, where users can watch recorded videos with trick modes to fast-forward, rewind, seek and play. The videos are grouped into categories with unlimited subcategories which are created dynamically by the system administrator. The video upload is open to both members and anonymous users. Mandatory metadata is added for each uploaded video that describes the main features of the video, which in turn is displayed to the users for as additional info. The videos pictures are displayed in a wall mode with a description of the selected video shown below the video player. The flowchart diagram of the VoD module is illustrated in Figure 8.

B. Webtv (Or Scheduled Tv Programs)

The WebTV module consists of scheduled programs that broadcast both recorded videos and live events to clients. The system admin configures weekly programs schedule for each day. The scheduling process can either be manual or automatic. In manual scheduling, the admin selects a duration for playing a video and choose a specific video having duration greater than or equal to the specified time period.

However, while building an automatic program, the admin selects a specific category with a specific duration; an algorithm is used to randomly select videos from each category in the program. This would help in weekly maintaining and automatically re-programming and building schedule programs of the WebTV. The scheduled program (video title and duration) is clearly displayed alongside the video player on the WebTV user interface. The user has no control on the webpage, scheduled program, as well as the trick mode features which are disabled. The WebTV flowchart diagram is illustrated in Figure 9.

C. Live Events Broadcast

Finally, the live module aims to stream media live. The media can be either a live stream of some famous channels or a live event while the source is a camera. For the latter case, we have used a streaming device called GoStream to capture the signal from the source camera and then publish it to the clients. Figure 10 shows the functional diagram of the live streaming module.

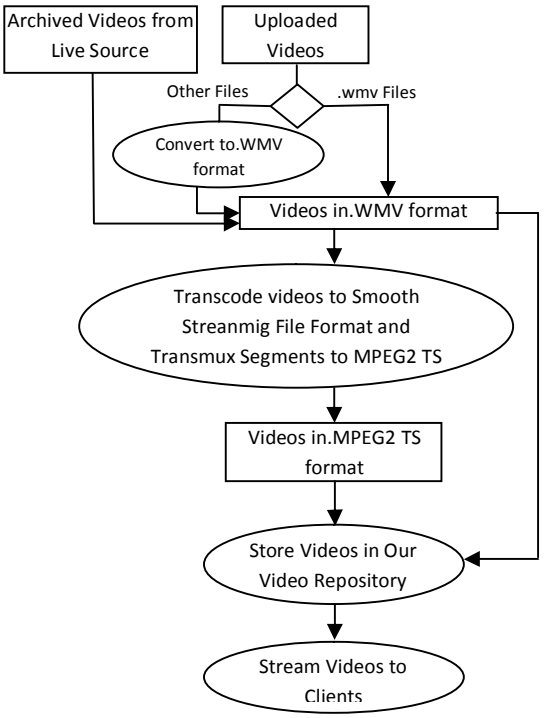

Figure 8: VoD Flowchart Diagram

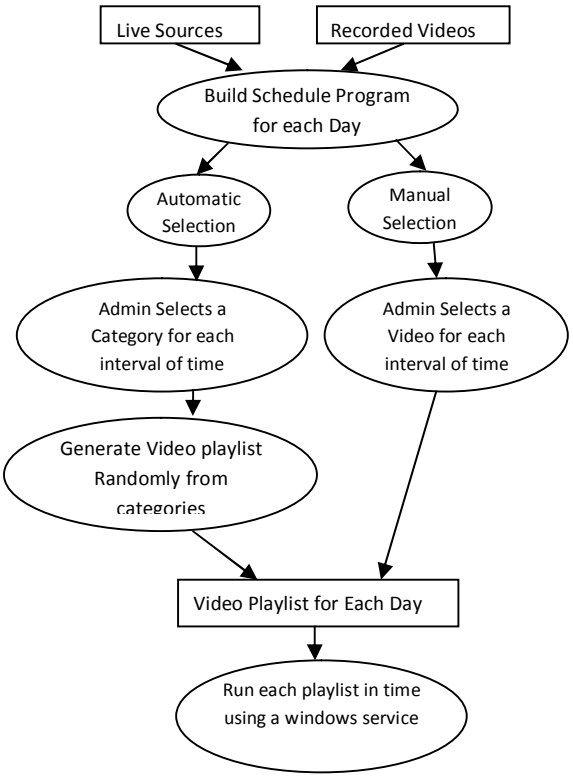

Figure 9: WebTV Flowchart Diagram

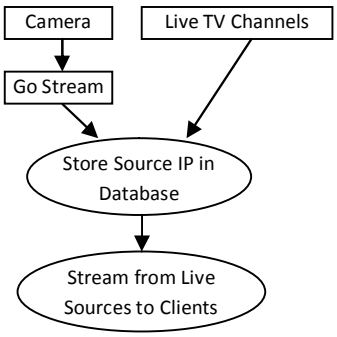

Figure 10: Flowchart Diagram of Live Streaming

D. Repository And Filing Structure

A repository for the ubiquitous Learning videos and resources has been build and structured in order to cover the various colleges and departments of the university. A wide range of related videos has been collected such as: academic lectures, talks, presentations, as well as educational videos from trusted websites. The videos are grouped into academic fields and specialities related categories and subcategories such as: computer sciences, education, engineering, medicine, …. The latter are created dynamically by the system admin, the subcategories levels are unlimited. The video upload is open to both registered members and anonymous academic staff and students, however, all uploaded videos are scrutinised by the system administrator for validation before being stored and used.

Figure 11 illustrates an example of the filing structure for the ULS media content. The different media files are stored in a shared folder in a separate server and organized per section. For each section, a folder is created that contains all uploaded media for that section. For each uploaded media, a folder is named with a unique ID in the database. Inside each media folder several folders are created and named with the extensions for the different file types.

For example, if the user uploads an.flv file type, the system generates a Unique IDentifier (UID) for this media file and creates a folder with the corresponding UID. Inside this folder the system creates another folder named FLV that contains the.flv files. Then, a conversion to.wmv file type is performed and stored in a folder named WMV which is created to save all the.wmv file types, this format is needed for PC-based delivery. For handheld devices, mpeg2ts format type is required for IIS Smooth Streaming, thus a conversion to this format is performed as well and a new folder named MPEG2TS is created. A JPG folder and file is also automatically created to be display as a thumbnail.

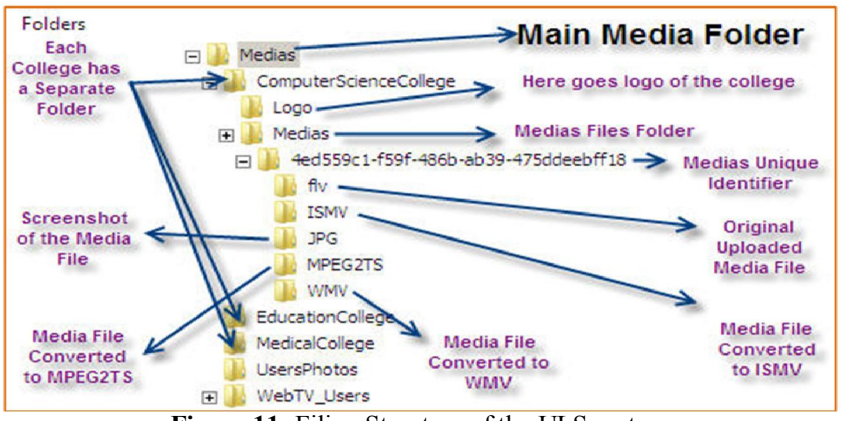

Figure 11: Filing Structure of the ULS system

7. Implementation and Results

To implement the proposed Ubiquitous Media Delivery System, a web-based application has been developed using Microsoft Visual Studio 2010 with.Net framework v4.0. It has been deployed on Windows Server 2008 and hosted by IIS Web Server. The streaming process is done by Windows Media Server for PC-based client and by IIS Smooth Streaming Server for handheld devices. To convert uploaded videos from different formats to.WMV format Microsoft Expression Encoder 4 Pro SP2 has been used. The encoding of the original video with multiple bitrates and segmentation to small chunks process is also done by Microsoft Expression. However, the conversion to MPEG2TS format, supported by apple and android devices, has been prepared by IIS Transform Manager extension. Finally we have used Microsoft SQL Server 2005 as DBMS to manage the ULS system and media repository. For PC-based clients, windows media player has been integrated in the ULS user interface. However, for handheld devices clients, an HTML5-based player that supports adaptive streaming has used for this purpose. A Notification module has been developed as well, in order to keep registered user informed about programs and new events in ULS system, once they are locally connected to the intranet. The new events are displayed as a categorized list and sorted by date from the newest to the oldest event.

Figure 12: Video on Demand Service User Interface

Figure 13: WebTV Service User Interface

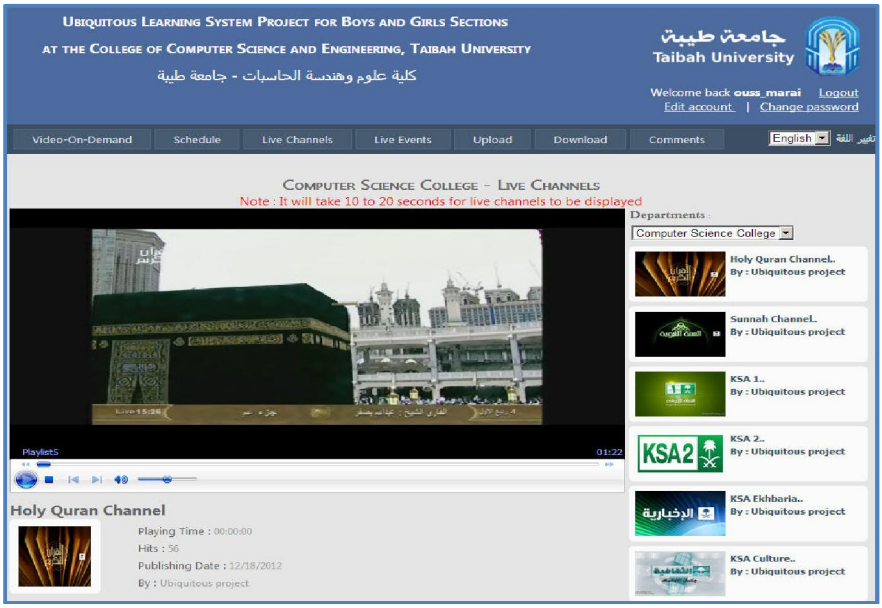

Figure 14: Live Channels Service User Interface

Figure 12, 13, and 14 show the different user interfaces respectively for Video-on-Demand (VoD) with uploaded videos are categorized and displayed in wall mode, WebTV with the scheduled program of the day (video title, start time) being displayed in the right pane but the user has no control over the player, and Live Events Broadcast with live streaming of mainly internet-based or/and satellite educational and news TV channels at this stage. Furthermore, a live digital camera with a dedicated hardware encoder (GoStream SURF encoding system) has been configured for streaming live events that can be used to broadcast live lectures from any site at the university.

Figure 15 and 16 show some sample user admin interfaces that allow the system administrator to schedule a daily/weekly program for the WebTV and to upload or validate media content. The media source can be a video file, audio file, a link to YouTube media, live event from camera or live from Satellite TV channels.

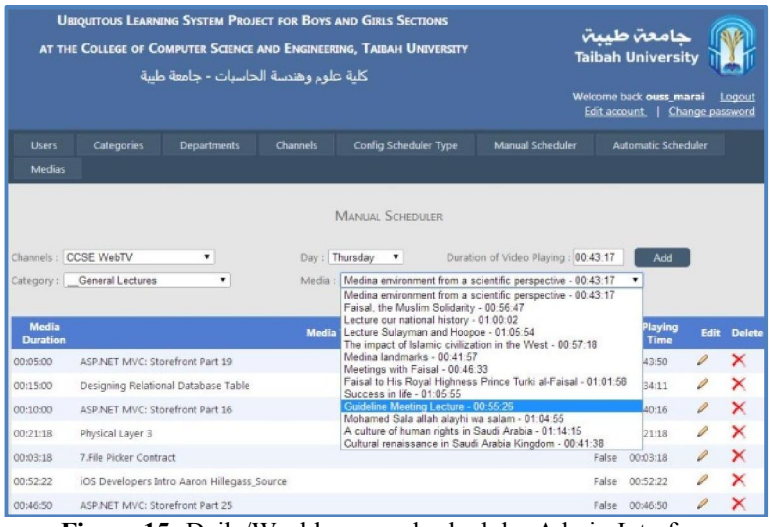

Figure 15: Daily/Weekly manual scheduler Admin Interface

Figure 16: Media Upload and validation Admin Interface

8. Conclusion

In this paper, the design, architecture and implementation of a Ubiquitous learning System (ULS), based on adaptive media streaming techniques, have been described. The latter system has been integrated as a core system within the Ubiquitous Learning Environment used at the College of Computer Science and Engineering, at Taibah University. The three main media delivery services have been developed that are: Video-on-Demand (VoD), WebTV or Scheduled Programs, and Live Events Broadcast. The VoD service allows users to view available videos in the categorized repository with all playback features. In the WebTV service (Scheduled Programs), the admin can build a daily/weekly schedule of recorded media or live sources from camera or satellite TV channels. The third service is Live Events that allows the broadcast of live streams of lectures/events from either a camera or live TV channel. Traditional streaming for PC-

based clients, as well as DASH technology to handheld devices has been integrated in order to adapt and optimize the streaming options available to the different types of client devices. Additional notification module has been developed to keep, students and academics alike, informed about new live lecture, talks, and events in general. Furthermore, The ULS System has been developed with very useful features for scheduling programs that allows Institutions/Organizations/Individuals to create and build their own customized video/TV programs. A customizable filing structure with built-in repository has been designed to populate, enrich, and expand with possible categories and subcategories of different multimedia types.

Although there have been some problems in setting up the hardware and wireless infrastructure that is due to many raisons, the project has been implemented successfully. However the time for testing and the overall technical evaluation of the system has been somewhat affected. This project can enhanced and improved by continuous feedback and acquisition of quantitative information from students about their perception and learning experience through mobile devices. The major outcome of the Ubiquitous Learning environment is that it has been well received by students and a fair satisfaction has been achieved. Many areas of improvements have been identified to make the system easy and efficient to use with rich media content suitable for mobile learning. Finally, The system is ideally suited for Institutions and Organizations to create their own media delivery and repository system dedicated to learning Quran and Islam in general.

Acknowledgement

We would like to thank the Deanship of Scientific Research, at Taibah University, for funding this project, and the College of Computer Science and Engineering for their unconditional support during the implementation of Ubiquitous Learning research project.

References

1. Nikolaou, “Evaluation of handheld devices for mobile learning”, International Journal of Engineering Education, 2008.
2. J. Brown, R. Branon, J. Haag, C. Raasch, “Creating a Successful mLearning Strategy”, mLearn Conference, 14 June 2010.
3. E. Tremblay, "Educating the Mobile Generation – using personal cell phones as audience response systems in post-secondary science teaching". Journal of Computers in Mathematics and Science Teaching, 29(2), 217-227, 2010.
4. Callaway, "'iTunes university' better than the real thing". New Scientist, 18 February 2009.
5. S. Clark, M. Westcott, "Using short podcasts to reinforce lectures". The University of Sydney Symposium, 2007.
6. S. S. Adkins, "The US Market for Mobile Learning Products and Services: 2008-2013 Forecast and Analysis", Ambient Insight, 2008.
7. J. Brown, D. Metcalf, "Mobile Learning Update". Learning Consortium Perspectives, 2008.
8. Cisco White Paper, “Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2012-2017”, http://bit.ly/bwGY7L, last visited on 15th January 2013.
9. K. Gao, W. Gao, S.He, Y. Zhang, “Real-timesmoothing for network adaptive video streaming”, Visual Communication & Image Representation, pp. 512-526, 2005.
10. C. Begen, T. Akgul, M. Baugher, “Watching Video Over the Web Part I: Streaming Protocols”, IEEE Computer Society, Mar-Apr. 2011, pp. 54-63.
11. http://www.youtube.com/yt/press/statistics.html. Last Access: 4/10/2013.
12. Müller, S. Lederer, C. Timmerer, "An Evaluation of Dynamic Adaptive Streaming over HTTP in Vehicular Environments", ACM Multimedia Systems (MoVid’12), Chapel Hill, North Carolina, USA, Feb. 2012, pp. 37-42.
13. Müller, C. Timmerer, “A VLC Media Player Plugin enabling Dynamic Adaptive Streaming over HTTP”, ACM Multimedia Systems (MM’11), Scottsdale, Arizona, USA, Nov-Dec. 2011, pp.723-726.
14. Menacer, O. Elmarai, A. Arbaoui, "Development Concepts of a Media Management System Dedicated to Quran and Islamiq Education". CTITDubai, December. 2013.
15. K. Sakamura, N. Koshizuka, “Ubiquitous computing technologies for ubiquitous learning. In Wireless and Mobile Technologies in Education”, IEEE International Workshop on WMTE 2005.
16. T. D. Backer, “Dynamic Adaptive Streaming over HTTP on the Android platform”, Master’s Degree Project, Jun. 2012.
17. T. Stockhammer, “Dynamic Adaptive Streaming over HTTP – Standards and Design Principles”, ACM Multimedia Systems (MMSys’11), San Jose, California, USA, Feb. 2011, pp. 133-143.
18. Timmerer, C. Griwodz, “Dynamic Adaptive Streaming over HTTP: From Content Creation to Consumption”, ACM Multimedia Systems (MM’12), Nara, Japan, November 2012.
19. W.Sun, Y. Lu,, F. Wu, "Bit-stream switching in multiple bit-rate video streaming using wyner-ziv coding", IEEE International Conference in Multimedia and Expo, 2006
20. C. Huang, P. A. Chou, & A. Klemets. "Optimal control of multiple bit rates for streaming media". In Proc. Picture Coding Symposium. December 2004.
21. S. Akhshabi, A. C. Begen, C. Dovrolis, “An Experimental Evaluation of Rate-Adaptation Algorithms in Adaptive Streaming over HTTP”, ACM Multimedia Systems (MMSys’11), San Jose, California, USA, Feb. 2011.
22. M. G. Michalos, S. P. Kessanidis, S. L. Nalmpantis, “Dynamic Adaptive Streaming over HTTP”, Journal of Engineering Science and Technology Review, Sep. 2012, pp. 30-34.
23. C. David, M. J. Egenhofer. "Geo-mobile queries: Sketch-based queries in mobile GIS-environments." Web and Wireless Geographical Information Systems. Springer Berlin Heidelberg, 2005. 143-154.
24. S. A.Yahya,, E. A. Ahmad, K. A.Jalil, U. T. Mara, “The definition and characteristics of ubiquitous learning: A discussion”, In International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2010.