The Technological Challenges In Mobile Networks And Communications In View Of Unleashing The Full Potential Of M-learning

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The past decade has witnessed a rapid growth of mobile services and subscriptions around the globe, so much so that mobile technology seems to bridge the digital divide very much faster than traditional desktop PCs. Educationalists and institutions have quickly seized the opportunities offered by the mobile technology and numerous pilot projects, each one with its own specificities and educational scenario took birth. Concurrently, new business opportunities appeared for content developers and production of off-the-shelves m-learning products currently categorised as the second generation m-learning products. From mainframe to cloud computing, the ongoing computing paradigm shift be it at the end user or server side has been accompanied by a series of technological challenges if addressed will surely reveal the potential of how the mobile technology can be fully exploited for educational sake. Three main technological challenges from an educational perspective although they can be looked upon by other stakeholders primarily as business cases or as performance issues, are dealt with, in this chapter. Firstly, the coupling of digital audio and video broadcasting technologies with cellular 3G/4G technology could be of paramount gain to highly populated rural and remote areas such as in many African countries but also in mountainous and inhospitable areas in other parts of the world. For instance the massive training of teachers at primary level can be harmonised with such advancement. Secondly, the bigger and bigger share of multimedia content being transmitted opens up avenues for multimedia applications that are commonly recognised to be very efficient and effective in pedagogy and learning. Multimedia streaming or broadcasting is a reality today, however, besides the bandwidth and broadband aspects, the aptitude of multimedia applications remains untapped. Thirdly, the question of how if cloud computing challenges are overcome may lead to competitive edge for educational institutions is attempted. Each challenge mentioned earlier, may in itself contains others such that any technical breakthrough will have a positive impact on the way teaching and learning can take place. The chapter focuses more on the technology driven approach of m-learning while assuming that the educational outcomes and objectives are equally important.

Keywords m-learning; technological challenges, cloud computing

1. Introduction

The impact of any advancement in information and communication technology can be assessed by analysing its impact on education. Technology has been a driver from conventional distance education using printed materials, to online learning through e-learning and to anywhere-anytime learning commonly called as m-learning. The latter seems to be the buzz word in modern modes of delivery and learning, and educationalists are finding broader applications of m-learning that solve challenges such as accessibility or again training of trainers in remote and rural areas. Numerous projects each with its own specific educational scenario have been conceived and implement across the different continents. The advent of the tablets PC and other smarter phones, a technological breakthrough prompted universities to adopt tablets PC within their core activities. In Australia for instance, the University of Victoria has exploited the i-pads a different levels of the programmes curriculum [1]. Do the learning outcomes depend on the technology choice? Can a more sophisticated hand held device make the difference in the final examinations results? By how far the answer is “yes” is debatable and requires deeper studies. The rational of this chapter is not to address these questions but to reveal how advancement in some areas of mobile communications can have a huge direct effect on the m-learning. Mobile operators and service providers have quickly understood the trend and the market forces, and amazingly with the tug of wars among the mobile apps platforms owners, m-learning is producing the bull whip effect in the conceptions and design of new mobile products. For instance pre-paid service for mobile training courses are on the market from renowned telecommunications operators. The study here is moreover limited to the technological challenges rather that to measure or evaluate what would be the impact factor and to which extent the technology selection is influenced. In section 2 we will elaborate in a general manner the current technological challenges in mobile networks and communications and computing followed by focusing attention onto mobile broadcasting issues in section 2.1, mobile multimedia services in section 2.2, and mobile cloud computing in section 2.3. Finally we shall conclude in section 3 before presenting what could be some future work and further research avenues in section 4.

2. Technological Challenges

Just like emerging technologies, technological challenges are relative notion, the majority of today challenges in mobile communications will find answer within 3 to 5 years, what had been unchallengeable years back are today common and
normal, it’s up to the educationalists to maximise the return of the technological progress on m-learning to its full potential and to convert the challenges into opportunities. In almost all frameworks for the implementation of m-learning projects, there is a component which is the technological choice or selection that is more dependent on the finance available than on the educational objectives. Strategies for low cost m-learning projects and fast ROI have made their ways. Attewel [2] has developed a framework where the technology selection depends on transport options, delivery options, platform options and delivery languages. An evaluation framework developed by Economides and Nikolaou [3] considers the usability criteria (user interface, presentation & media, navigation, physical), the technical criteria (performance, sensory systems, compatibility, security, availability, reliability & maintainability) and the functional criteria (communications, information & knowledge, organization & management, entertainment & amusement). We can either categorise the challenges as per the different elements of the frameworks described or categorise them in broader terms with respect to the elements of the ecosystem comprising devices, networks, contents and applications.

**Real time processing:** Real time mobile applications are considered mainly to boost the mobile workforce productivity. The example of in-memory analytics whereby business intelligence reporting is processed in live memories and transferred to handsets in sub seconds has not been fully exploited for educational purposes. There exist very few applications of in-memory analytics, just to mention the example of the U.S. higher education which has used simple analytics for admissions, building models that use data from standardized tests and transcripts to predict which applicants are most likely to succeed [4].

**Power consumption:** power consumption remains the major constraint for handheld devices. For instance the average battery life time for a tablet is 8-10 hours. The fact that he mobile phone relies on a finite energy source, that is the battery and low bandwidth network renders connectivity quite unreliable and might be ad hoc in some environments. There have been substantial technological advancements in this area; IBM [5] has revealed the improved lithium air breathing cells that will undoubtedly boost the life time of batteries and operational time of handsets. It is known that connectivity with the network consumes the biggest share of the consumption compared to running of native applications and multimedia gaming. The paradox is that the mobile handset will be called to be an always connected device in the paradigm shift towards mobile cloud computing.

**Network bandwidth and network latency:** these are more sensitive in wireless networks compared to wired network as in the former connectivity is intermittent due to propagation issues like fading, shadowing, multipath propagation and weather conditions. The response time R of in executing a remote application normally respects the equation (1): \[ R = \frac{\text{Payload}}{\text{Channel Bandwidth}} + (\text{No. of Apps. turns} \times \text{RTT}) + \text{Cs} + \text{Cc} \] (1)

The channel bandwidth is allocated by the ISP, therefore only the local authority can impose QoS standards to assure a minimum service level. The number of applications turns highly depend on the computer programme design, while the average round trip time(RTT) is a function of the distance of the client to the nearest hosting server and the network infrastructure. Apart from network bandwidth, the options left to optimise R are to use techniques such as caching and dynamic user interfaces or lightweight programming and other middleware to reduce the server side computing time Cs and the client side computing time Cc. One major obstacle had been the bottleneck in performance introduced by the REST and SOAP protocols coupled with the CPU intensive XML files. More need to be done to offload XML load an optimised the web service invocation based on these protocols.

**Augmented reality:** the superimposition of virtual reality onto physical reality and vis versa commonly referred as augmented reality has proven to be a formidable concept and learner experience in m-learning. At the very beginning of augmented reality, difficulties were mostly on the user interface design [6] and the location based issues how to fetch appropriate information from the database and display the same in real time. To have a better idea, let’s imagine a learner in the field of air pollution, a given time and location the learner can with its camera embedded in a 3G phone obtain the temperature, geographical data and other relevant chemical components measurements displayed on the screen, we see here a multitude of data some measured instantaneously and others queried from a database.

**Mobile Holograms:** they are indeed a revolution in mobile 3D video and tele presence; a 3D hologram out of a mobile hand held projected in the air or any physical surface will be true in 2015, claimed by Paul Bloom [5], IBM’s CTO for telecommunications research. What can be found on the market, are the tilt based [7] and the LCOS display [8] technologies for mobile holograms. Implications are huge for the business community as well as for educational institutions. This is defiance to the definition of mixed reality and immersion. How can these holograms be tilted by a mobile handset be useful in a learning activity? To which extent it provides the user or the learner the feelings of a real life entity? Such questions will surely prompt new research avenues. We can imagine that holograms can partly solve practical activities or labs that are often targeted as the very poor in distance education and open learning (DEOL), [9].

**Reliability in mobile and pervasive environment:** Much less is known about reliability in mobile and pervasive environment. Researchers have laid down the taxonomy of computer systems research problems in pervasive computing aiming mainly at functionality. The elements appearing are derived for distributed computing like fault tolerance, then mobile computing like location sensitivity, and lastly pervasive computing like smart spaces and invisibility. The real
challenge here is to establish metrics that can quantify and model reliability similarly to the software engineering discipline. Any evolution in this area will improve m-learning products.

**Authentication & Privacy:** security in communications is vital when it comes to payments and financial liability; authentication is one important factor when it comes to delivery of authorised course contents. The issues of intellectual property rights (IPR) and plagiarism are directly concerned. How to we authenticate a user/learner in a multiuser session? It’s advocated that learning is social and emotional activity and team work is highly effective and often a must in some disciplines. One of the discrepancies identified in m-learning has been the isolation of the user/learner although collaborative tools such as chat and blogs have facilitated interconnection. If one considers the tremendous impact of social networks on the web, it is easy to feel the need of social networks in the teaching and learning activities. Ensuring privacy or authentication meets with tougher obstacles as networks are transforming rapidly and today the architects are faced with highly heterogeneous architectures. As a matter of fact, mobile station for prometric examinations do exist but with the assistance of an examination administrator, we are not yet in the era where a mobile learner can sit for an examination fully authenticated by the network system.

**Addressing in heterogeneous networks:** besides the security issues mentioned above the heterogeneity of Wireless Wide Area Networks (WWAN) has introduced a new problematic, the addressing mechanism of mobile users. There are currently two network layer protocols namely the Mobile IP (MIP) and the Session Initiation Protocol (SIP) competing. MIP is preferred for large scale systems architecture whereas the SIP is more convenient for smaller scales with unified communication. With the roll out of IPv6 and new security features such as the DNSSEC for domain name servers, enterprises will have to re-think their security strategy given the smart phone today extends the physical boundaries of the enterprise network. For example, in the case of extending access of a LMS to the mobile workforce, appropriate addressing and data management should be in vigour to avoid any intrusion via a reverse tunnel to the enterprise network.

**Applications development:** content and applications have always been the drivers to any telecommunication technology. The clear example is the Wireless Application Protocol (WAP) at its outset whereby less than 4% of the business community could weigh its benefits and return. Today, the combination of Internet with the mobile seems to be the ideal platform for the killer app. However, both the server side and the client side of the mobile communications are undergoing radical changes with the coming of cloud computing. There is a paradigm shift in the software engineering of applications and hosting of data. Several platforms just to cite here, Android for Google, Windows Azure for Microsoft and AWS for Amazon are in the race. The main mobile technological challenges from an m-learning perspective are mobile broadcasting, mobile multimedia services, and mobile cloud computing; these are made explicit in the coming sections.

### 2.1 Mobile broadcasting

So far the convergence of mobile and broadcasting has retained a TV centric approach, with interactive features and a mass market ready to pay for charges and services. The response/interactive features were initially Quiz Calls-in, SMS voting, Show voting and Videotext chat [10]. More advanced features such as ticketing and download of content and services pave out their ways. Educational content broadcasted on mobile devices has not been common although much is available for the traditional TV channel, for example in Mauritius we have the knowledge channel broadcasting educational documentaries and tutorials on a daily basis. It is known that broadcasting offers a much larger coverage than mobile cellular networks and has proven to be a key technology in reaching remote and rural populations. The advent of digital broadcasting has opened up new avenues in terms of unified communications and ability to interconnect with the Internet via IP networks, for example IPTV on smart phones. At the outset, the transmission was dedicated to fixed terrestrial terminals through the DVB-T and DVB-S, T for Terrestrial and S for Satellite, then later was adapted by broadcasters to the DVB-H, H for handheld to suit hand held devices. New products join the market in 2006-2007 with the different variants of the DVB technology.

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Broadcasters, mobile operators, service and content providers and the regulators should collaborate and view the convergence as shared business opportunities as for mobile operators to engage in broadcasting technologies require massive investment and standardisation and consensus over mobile TV system remains a complex and difficult issue. Spectrum allocation is often ambiguous in many countries mainly for the mobile broadcast services in the VHF/UHF band. Cellular broadcasting technologies such as Multimedia Broadcast Multicast Services (MBMS) and High Speed Downlink Packet Access (HSDPA) already comprise uni-casting and multicasting in view of 4G and next generation networks (NGN) but not suited for broadcast of real time streaming devices. The transition of the current Internet Protocol IPv4 to IPv6 networks scheduled for year 2011 worldwide and compliant handheld devices will further enable
multicasting subsequently facilitating individualisation or personalisation of TV programmes. Advanced multiple access schemes such as the Orthogonal Frequency Division Multiple Access (OFDMA) and multiplexing and modulation techniques, like Code Orthogonal Frequency Division Multiplexing (COFDM) and Quadrature Amplitude Modulation (64-QAM) and sophisticated multimedia compression techniques (addressed in sub section 2.2) have boost up the data rates and make efficient usage of the bandwidth, moreover what comforts operators for the future is that the trend from broad band to ultra band networks should favour not only unidirectional transmission systems but also point to point and multi-points systems. Two different educational scenarios where mobile broadcasting can add value to m-learning are discussed here.

The first scenario is whereby a distinguished professor in a very scarce area is giving a talk in a conference whereby there is a panel of members comprising people from the industry and the private sector. Presently, a webinar would be adequate and sufficient to diffuse the talk and the debates on the web. The second scenario is the conduct of an online examination for a proficiency computer skills course at a fixed schedule for the candidates in remote locations assuming that source of electrical energy is not a restriction. Both scenarios require reliable connectivity but more importantly near-real-time streaming rather than downloading as we are dealing with a real time situation. Given that we are tackling here a unified communication system that is audio, text, video combined, the Quality of Service (QoS) has to be somehow assured be it programmatically by the operator or stipulated within regulations guaranteed by the authoritative body, for instance high fidelity audio privileged in case of podcasting; just to point here that in many countries there is an absolute dearth of any QoS framework in the interest of the consumers. More confronts come from the constraints due to the different usage framework on mobile phones just to mention the small screen display ~ 2 inches, long advertisement up to 8 minutes and average usage time of 10 minutes. We have seen in section 2 that advancement in holograms and augmented reality will shape new content format adaptable for the user or learner with new mobile multimedia experience, a topic which is itself another challenge that is elaborated in the next subsection.

2.2 Mobile multimedia services

Mobile multimedia services are expected to reach 66% of mobile transactions in 2015. Well known services are the Multimedia Messages (MMS), gaming and mobile video in 3G networks. These services have been the key features and sales arguments for smart phones contrary to feature phones where multimedia were simply an accessory. According to Cisco’s prediction depicted in figure 2, mobile video will outshine all other types of transactions. Besides mobile TV, video on demand (VoD) services including YouTube type small format videos to longer educational videos will occupy a sizeable portion.

![Figure 1](source: Cisco VNI Mobile. 2011)

Challenges reside with the platform media players, content formats and technologies for distribution are changing continuously and the latest technologies are not always upgraded by the platforms in a timely manner. Moreover, interoperability of handsets is not secured by platforms which are upgraded only once or twice yearly. Given that media player is the core of multimedia, platform media players will be virtually replaced by downloadable media players. The multimedia market wants higher video quality and resolution, seamless experience everywhere, and realistic video experience.

- higher video quality and resolution: the coding efficiency has been increasing during the past decade; the newly born technology is the High Efficiency Video Coding (HEVC) which provides a more efficient representation of overhead.
- seamless experience everywhere: already on the market; the HTTP Live Streaming (HLS), Smooth streaming and HTTP dynamic streaming, the next technology is the Dynamic Adaptive Streaming or Adaptive Bit Rate over HTTP standard that has not conquered the market.
- realistic video experience: the 3D video trend supported by holograms; major challenge is to sustain increasing data rates and high efficiency coding technology for multiple view information of one scene. For 3 DV, depth information is required in addition to several view information to synthesize a scene for specific viewpoint on the fly [11].
It’s astonishing that mobile multimedia has no footprint in m-learning, the paradox is that there are content in e-learning mode but due to multiple constraints such as the ones inherent to handsets and bandwidth, the mobile learner has no little multimedia experience with educational video. In this particular context the challenge is more on the educationalists to design video content adaptable to the handsets and learners with defined learning outcomes and objectives, bearing in mind the design in some areas may be dictated by the technology, for instance the duration of streaming a video conference, in addition, the instructional designing of mobile video content requires multidisciplinary competencies which are more expensive for an institution on its own to produce. For successful mobile video services, devices, network, applications, and content must work together [12]. Looking at the business aspects of mobile multimedia, the mobile phone has evolved from a hardware device to a service device and probably more for revenue generating device with the vulgarization of m-payments, more than technology and open universities; the business could be a more pertinent driver for mobile multimedia in education. Operators have found successful business mobile TV business models to make mobile TV presently available everywhere; we can therefore forecast rich multimedia experience to the users/learners. The development IP Multimedia Subsystems (IMS) in All IP networks is a major catalyst to the transportation of rich multimedia content different from podcasts or vodcasts. In fact, mobile multimedia as a mode of delivery is paving its way and swallowing a bigger share in distance education and open learning (DEOL), so much that printed or .pdf or .ppt format are less preferred to video content, nevertheless the technology selection to access the content is either through downloading or streaming. The factors that determine the choice between downloading and streaming are on demand content, live content, maximum content size and quality, stored in memory, content repeat, viewing delay, server, and protocol/transport.

Mobile multimedia courses are particularly useful whereby the course content needs to be displayed in a unified manner, that is audio, video and text. Courses like anatomy or archeology are in fact effective in the m-learning mode. As discussed earlier the advent of 3D possibilities on handsets will bring an extra dimension to the learner experience. “Stanford University researchers recently released the program code for ClassX, software that converts static videos of class lectures into interactive online video streams. The researchers simplified the recording equipment to a tripod, a wireless microphone, and a high-definition camcorder. The software enables the viewer to zoom and pan around the room during playback, and it also works in the cloud, requiring only a Web browser for access. The ClassX Web site currently contains 25 courses, as well as seminars and workshops. The software divides the original video into smaller parts and considers each of them its own video stream. The server stores the parts in different resolutions, and reduces the amount of information sent while streaming by transmitting only those parts that a user requests. ClassX automatically analyzes the video using computer-vision algorithms, putting the parts back together. The system is still experimental as the researchers are working on how the software will handle the unpredictability of wireless networks, devices’ reduced battery life, and the limited computing power of mobile devices.” quoted from ACM Newsletter, June 2010. The hitch with multimedia content is it requires huge storage capacity and in contrast with limited space on handsets new storage and data management models are required, one of the challenges in this sphere remains issues regarding the mobile multimedia database (MMMDB); how to represent database object efficiently or how to conduct efficient multimedia data retrieval [13], the future of MMMDB seems to tend towards the mobile cloud computing.

With the new paradigm of applications delivery, native and platform players will certainly be of the past. However how far openness is relevant in cloud computing and what are challenges awaiting different stakeholders, the next subsection attempt to answer these questions amongst others posed by this future and emerging technology.

2.3 Mobile cloud computing

Cloud computing is an emerging technology in the natural evolution of Service Oriented Architecture(SOA), the Internet of Services and Grid Computing but with more opportunities than barriers for the development of business as well as of education. More than merely data centres, cloud computing introduces a complete paradigm shift in applications delivery and software engineering. The main features of cloud computing are elasticity, virtualisation and reliability. Three well rooted types of services from the cloud are the infrastructure as a service (IaaS), the platform as a service (PaaS) and the software as a service (SaaS) offered by different types of cloud namely private, public, hybrid and community [14]. The service model for cloud is certainly capturing other sectors beyond the 3 pioneers just mentioned, so one can foresee education as a service (EaaS). As a matter of fact a pilot project is underway in Mauritius by one of the telecommunications operators to commence with an educational cloud and eventually move to a health cloud and other sectors. It’s true that most developing nations will remain consumers rather than service providers for at least 10 years since the inception of cloud computing in year 2009. What makes cloud computing particularly attractive for the business and corporate is removal of the capital expenditure (CAPEX) in their IT budget and costs models such as pay as you go and pay as you grow proposed by the cloud owners. Thus the elasticity in terms of scaling down or scaling up resources combined with virtualisation of run time environment allow organisations to outsource a huge chunk of their IT infrastructure as well as any applications development. Often qualified as unlimited computing the cloud may be conceptualised as a huge black box processing machine with security and assurance just like the bank where a customer will deposit his/her money in full confidence. The cloud has also the merit to reduce the carbon
footprint of computers and servers in the sense that companies do not look into investing in local servers infrastructure and adopt thin clients for their employees, referred as green IT nowadays. Due to inherent constraints of mobile handsets, cloud computing seems to be a blessing for mobile applications; since the cloud does all the processing, storage and updates, therefore mobile phone serves for display exclusively. The case for native media players had been discussed earlier whereby in a more conventional technology set up, updates of media players and formats were happening on an average not before a period of 1 year. Technologists and operators are very much conscious about the transformations to be brought by mobile cloud computing (MCC). Thus the challenges and opportunities can be classified as technical and non-technical for the different stakeholders at diverse degrees; telecommunication operators, providers, resellers, adopter and consumers within the cloud echo-system. The fact that cloud’s main aims are to provide ease of service and cost reductions, these motivate and shape the technological challenges to be surmounted.

Technical Challenges: the very restricted perception that cloud computing poses only two major challenges that are security and bandwidth is not completely true. Nevertheless, security remains a severe obstacle and seems to be getting more complex for multiple reasons. Clouds provide for multi-tenancy where subscribers share networking resources and applications. Moreover the availability of unlimited amount of computational resources makes the cloud infrastructure vulnerable to threats such as distributed denial of services (DDOS) and flooding. Therefore research towards security solutions in governance and architecture [15] are crucial. For instance the subscriber should be able to audit its applications on the cloud, so proper governance mechanisms are to be developed. Resource management & manageability including data management is another difficult task to get through, it’s precisely determinant to the service level agreement requested and expected by the subscribers. The heterogeneity and scale of the cloud requires automated administration and control over applications. Furthermore the clouds accept normally small replicable datasets and large read-only datasets, given that there are few update and analytics feature data integrity and consistency are at stake [16]. The barrier here lies in distributed data models and representations adaptable to the cloud system. The problem may get worse with multiple clouds interconnected. How to move software to data and vis versa are real research questions? As spell out earlier the cloud philosophy is “minimising cost and maximising value”, to do so elastic scalability and resource optimisations through virtualisation need to operate to their full potential, as a matter of fact, these are still technically a herculean tasks as scaling is achieved only through horizontal replication, thus wastage of resources in the upper layers. Most of the problems discussed in the is paragraph need to be addressed with the help of new programming models and APIs, even security and bandwidth issues which are hardware and network architecture dependent and relative parameters within the equation of the cloud delivery model. Programmers need to come up with innovative programmes design and deployment that will allow interoperability among devices, enable software and data management by taking into account scalability, elasticity and other features of the cloud. In parallel, the newly proposed APIs should enable smooth migration of huge datasets from the Grid or enterprise storage areas towards the clouds. As the study in this chapter relates only to technical challenges we will only state the non-technological challenges; the formulation of global standards, regulations, new business process models, business models, cost models, legislations, innovative teaching and learning methodologies, and the impact on the global economy. There are presently some academic initiatives to promote cloud computing in the academia, namely the IBM Cloud Academy [17], project mission is to provide an organization for K-12 schools and higher education institutions that are actively integrating cloud technologies into their infrastructures to share best practices in the use of clouds and to collaborate with partners to create innovative cloud technologies and models”, and upholds the concept of state education cloud. Another initiative, “National Cloud Computing Initiative” comes from India government with the one of the objectives is to broaden access to university programmes to massive number of students who are not able to find a seat in a local university. In India, only one percent of the students go for the post graduation and 0.1 percent for PhDs. Almost 20 percent of the engineering graduates is unemployed. How to make education useful and reduce the talent gap by 50%? How technology can substitute the need created by shortage of 200,000 schools? How to increase the quality of teaching so that the number of PhDs goes up to 1% level? [18]. By so doing it is expected that students can choose the best course contents and lecturers and also help the lecturers to innovate new modes of delivery.

In the context of education through mobile cloud computing, may be not all of the problems pointed out area of equal importance, the best way to gauge will be to across pilot projects on education clouds. For such educational projects to be successful, they need to align with the aims of cloud computing. For example, applications whereby there is high scalability and pervasiveness will have a higher chance to succeed with the cloud. If we consider for example a cloud for access to research materials and journals, coming federating from different sources, it can be proved to be very effective from an institutional point of view. It can be noticed with this example that the cloud can be a catalyst to bring down institutional barriers regarding research amongst researchers from different institutions. Figure 2 below depicts a scenario under construction for a university cloud for research and online education at the University of Technology, Mauritius (UTM).
The university cloud shall transform the applications storage and delivery within the campus through virtualisation of the WLAN and interact with regional educational clouds from neighbouring countries. On the left hand, the cloud serves all activities on the campus; they include administrative tasks, bandwidth and network monitoring, library online services such as access to past examinations papers, computer labs access to platforms, example the distribution of ERP interfaces remotely connected to Magdeburg University from Germany. There are also display screens across the campus on which notices and messages will be broadcasted, likewise, the computer labs are equipped with CCTV cameras; recordings will be stored and monitored via the cloud. Projects submissions, archiving of reports and students markings, website and intranet hosting, LMS hosting are amongst services that will be cloudified. On the right hand, the university cloud is linked to other regional cloud to promote research collaboration and access to specialised articles and journals. In addition, distance education is delivered; the model adopted is to provide courses relevant to the mass such as computer proficiency skills and research methodologies in an open mode at no costs. Such courses aim at bridging the digital divide and leveraging computer literacy skills of the entire population thus meeting government vision to make the country a cyber island and an educational hub. The cloud will host the learning materials in different formats in including multimedia materials in “moodle” learning management system (LMS) accessible via an Internet browser. In this particular model, the student may take a certification examination at a symbolic fee in any prometric centre recognised by the university. The figure also shows outreach stations of the university connected and served by the cloud at the main campus. Video conferencing and IVR will form another cluster within the cloud infrastructure. As it can be seen the IT infrastructure is very cloud centric where resource intensive storage and networking applications in teaching and learning and university administration are realised. Higher educational objectives like computer literacy and education for all has become a reality with the convergence of mobile and cloud computing.

3. Conclusion

This chapter has addressed various technological challenges in the field of mobile networks, communications and computing from an m-learning perspective. We have seen that some of them seems to be more or less achievable in a short or medium term such as real time processing of data, but some others remain more twisted and require extensive research and technological breakthrough, for instance as it has been mentioned not much can be done currently to improve the battery lifetime of a tablet, therefore beyond 8 – 10 hours the learner needs to find a physical connection to recharge its batter, consequently it engenders a limitation on anywhere or anytime aspects of pervasiveness. The three challenges namely broadcasting, multimedia services have been treated more deeply. We have drawn the attention of the reader if the overcome challenges are mapped with the different component of technology selection in any m-learning framework, this would facilitate a project manager to make the best decision in technology choice e to match the learning outcomes, taking into account that cost is a major factor. It has also been shown that in the case of mobile broadcast a larger population can be reached, as a matter of fact the massive training of primary teachers in Africa can be a realistic option, moreover that will definitely accelerate in the process of bridging digital divide. As far as multimedia services the progress in that domain will provide the learner with an unprecedented learning experience. The impact of multimedia content in education is highly significant and can overcome barriers in delivery and compensate to some extent the elements such as eye- contact or body language in a face to face delivery mode. However, the current most exciting opportunity is the mobile cloud computing, this new paradigm of computing and content delivery will bring changes to network design considerations, impact on the handheld devices, and to business models. We foresee therefore education as a service (EaaS) emerging and a radical transformation of distance education delivery that can answer to existing challenges.
4. Future Work

There is indeed a big scope for future work and research in understanding the challenges posed by the mobile technology for the betterment of education. Of course looking only through the technology prism may not bring answers to educational questions and problems. Some projects are in the pipeline to better exploit and understand the limits of current mobile technology, these are namely: improving writing skills using touch screen on tablets PC, attracting interests of foundation courses students with tablets PCs, multimedia streaming of proficiency programmes using a university cloud infrastructure, authentication & privacy for m-exams and mobile data collection for analysing the carbon footprint in the coastal sea of the island of Mauritius.

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References

[1] In Your Hands iPads for Learning, Getting Started Classroom ideas for learning with the iPad, Victoria trials. Published by Student Learning Division for the Department of Education and Early Childhood Development Melbourne, June 2010.