168 NETWORKED SMART EDUCATIONAL DEVICES FOR ONLINE LABORATORIES

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ABSTRACT

The advantages of online labs, which also include remote laboratories for educational institutions and research and industry, are well known. Their use leads us to propose, either in addition or instead, the concept of home laboratories or labs at home. In terms of infrastructure and equipment, the miniaturization of measuring instruments and the new standards make it possible to easily network with speed and provide a high quality of service while making their acquisition costs no longer prohibitive. On the online learning environment side, the new situation is that Cloud computing enable educational institutions to use open source, or the social web or software to create a network of learners employing their equipment available at their homes. It also makes the network accessible to other classmates and instructors from anywhere. In this article we present the concept of laboratories at home as we see it in the light of Cloud computing era, the existing norms and standards to take into account as well as to develop to achieve educational goals required for electrical engineering laboratories with what we can be referred to as Networked Smart Educational Devices.

1 INTRODUCTION

Educational institutions are constantly looking for ways to improve learning, making learning a very dynamic process. This has served societies well in that learning no longer takes place in a classroom, but rather the classroom has been extended to include the environment. In this sense, many aspects of learning are no longer localized. Field trips have become an integral component of learning. Another form of learning that has added to the learning process is distance education.

In discussing distance education, one must consider the different disciplines and how well each lends itself to distance education. Disciplines that are laboratory intensive such as the sciences and engineering have included online laboratories including remote laboratories [1]-[3] in the distance learning format. One of the conditions that contribute to constraint in this endeavour is safety. In this case it is always advisable to have supervisor who is an expert in the field of study present during the laboratory exercise to guide the laboratory work. Another constraint is the cost of equipment which for some disciplines is very high considering the type of work being done.

The information age has advanced education beyond expectation as a result of the computer being used as a tool, no different from using a ruler as a tool to measure distances. The multi-

tasking ability of the computer has proved to be invaluable in this case. The ability to network the computer in any one of the topologies of local area network (LAN), metropolitan area network (MAN), or wide area network (WAN) have added to the advantages the computer provides the education environment. To add to this is the wireless connectivity that extends the facility to areas where wired connectivity can be problematic. These developments provide the requirements that will support labs at home [4], and for the same reasons Cloud computing [5] have added to the emphasis.

To push the bounds even further in achieving what might have been impossible a few years ago is the introduction of Smart Technologies [6] to the education environment. Smart technologies have provided devices that have improved the interactive engagement in the education process. The products include smart interactive whiteboard, Smart projectors, Smart collaborative software, Smart wireless slate, and Smart interactive podium, to name a few. Two operative words among this list are interactive and collaborative. These two words are clear indication of activities being conducted in real time and in team atmosphere. This is not to say that individuals cannot do their work on their own. The intention however is to enable sharing of ideas, which is a useful process in the education environment.

Putting all the above together makes available an education environment that will support learning at all levels from K-12 to university, and will also support researchers in their work.

As stated above, education is no longer localized. And to make it even more accessible to the learner, a team of researchers have introduced the Lab@Home [4] concept that brings the education process to the learner in his own environment, his/her home. The versatility of Lab@Home is it combines all the current developments and brings it to the learner, or researcher, at his or her home through cloud computing. Cloud computing is not a new technology, and has been discussed in an effort to bridge the digital divide in secondary education [7]. The strength of Lab@Home is its ability to combine virtual instrumentation in its range of applications. This puts at the individual or the team's disposal access to expensive equipment that the individual, or a less endowed institution may not be able to purchase.

2 THE LAB@HOME ENVIRONMENT

Lab@Home is made up with distributed user stations that connect through their local networks into a 'Cloud'. Laboratory devices, if available can be connected to the computer. The users have the ability to collaborate through the network. A networked conferencing environment can be set up through the Cloud to create a platform named BigBlueButton for the participants. BigBlueButton was the result of a project on an open source software [1]. It does not as yet have the capability to store and share data. The software is adapted and deployed on a Virtual PC which acts as a server, and allows each invited participant to connect and initiate a self or collaborative laboratory session. The functionalities that are implemented are based on a project [8] on real time distributed learning environment. The functionalities are as follows.

1. Application Sharing: this enables a learner to share his/her entire desktop or windows on his/her networked computer, including connected laboratory user interfaces,
2. White board: Used for annotation and drawing during a synchronous session,

3. Private or Public Chat Rooms,
4. Audio and Video Conferencing: Participants can share their webcam with others,
5. Uploading and Presenting Documents.

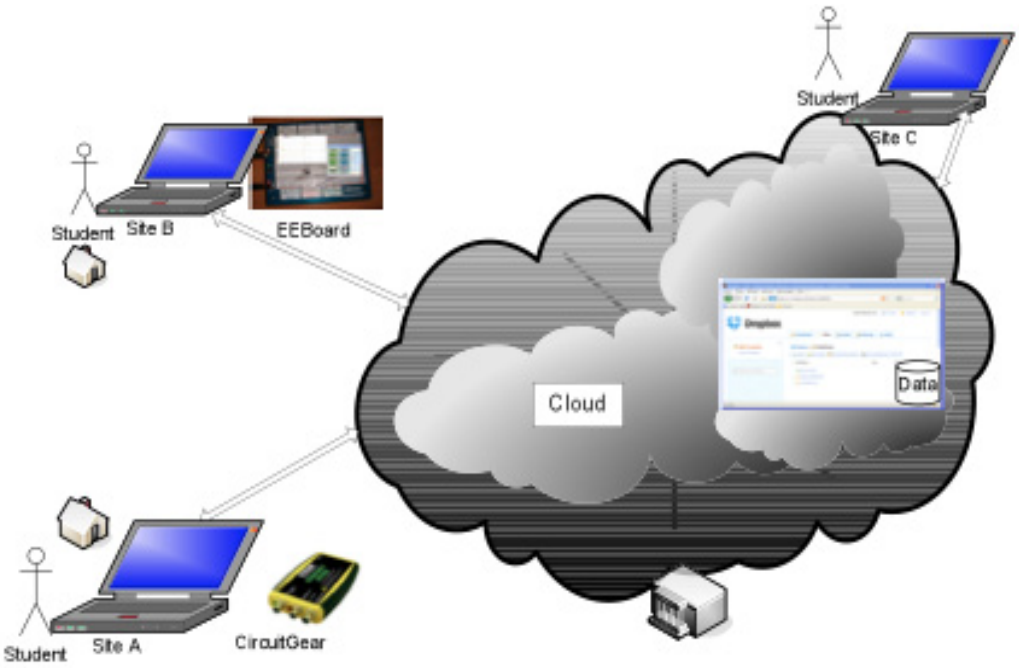

FIGURE 1. *Lab@Home Gobal Architecture.*

To date, BigBlueButton has been used in combination with an open source software [9], a social web software add-on that allows participants of a given learning activity to store and share files and documents through computer networks.

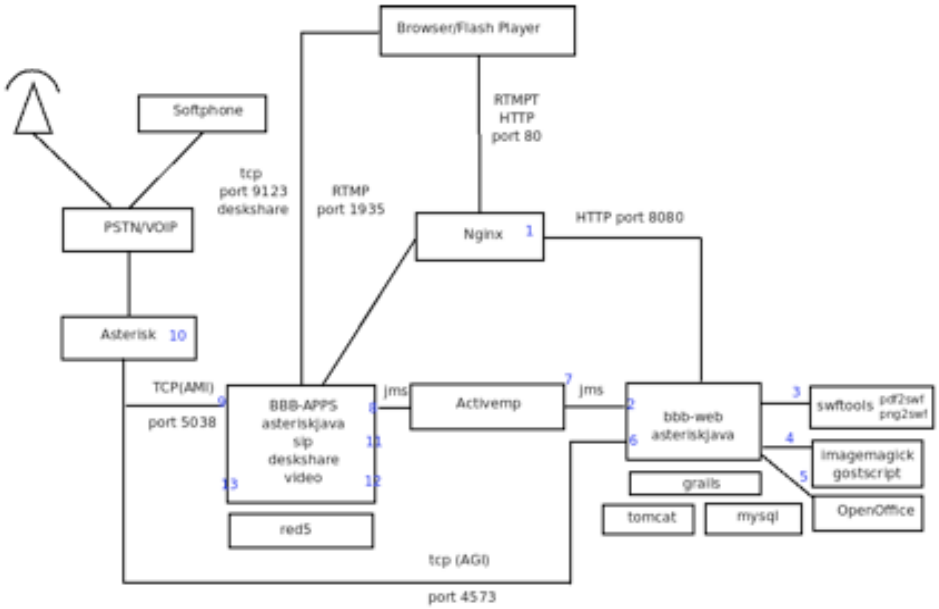

FIGURE 2. *Architecture of BigBlueButton [10].*

BigBlueBotton is a collaborative conferencing system deployed on the VMware virtual machine which is described in [10].

TABLE 1. *Description of the Architecture of BigBlueButton.*

1	*Nginx (engine x) proxies bbb-web bbb-apps to support RTMPT (RTMP Tunneling) server out the bbb-client*
2	*Grails application that handles creating conference and scheduling. Also,handles login and logout when joining the conference.*
3	*Responsible for converting PDF prensentation slides to Flash*
4	*Responsible for converting PDF presentagion slides to Flash in case SWFTools is not able to convert.Also, generates the thunbnails.*
5	*Responsible for converting .doc .ppt & .xls files to PDF presentation slides.*
6	*The AGI (Asterisk Gateway Interface) queries the database to determine if the dialed in voice conference number is valid or not .*
7	*Message conduit between bbb-web and bbb-apps*
8	*Red5 application responsible for synchronizing all the participants in the conference.*
9	*The AMI (Asterisk Management Interface).Listen for user events (joined/left,mute/unmute, talk) and issues commands (mute/unmute, kick user) to Asterisk.*
10	*Voice conference server .*

3 LAB@HOME AND DISTANCE LEARNING

Distance has always been a constraint to learning in that life conditions make it difficult for some people to relocate to cities where education is accessible. The same argument can be advanced for some people in their professional and business activities where they are unable to get time off to attend classes at university and college campuses. Distance education and online courses have proved to be a necessity for such people to upgrade themselves.

With the advent of modern technologies in recent times, this area in education is being put to very efficient use, and in developing nations this mode of learning can be views as critical. This is in light of the fact that many major cities are over populated and decentralizing the learning activities will help redistribution of the population, and needless to say, it will afford more people the opportunity of contributing the the development of the nation.

The foregoing makes Lab@Home an appropriate technology in that it makes available the facility needed for learning at any time and in any place including the premises of some business enterprise, and the home. Through the virtual environment, participants can access sophisticated hence expensive equipment that they would otherwise be denied. Lab@home makes possible the experiential learning that is an essential component of education in the sciences and engineering. As shown in Figure 1, multiple participants can engage in a research project and share data. This environment also makes it possible to hold a laboratory session for which the instructor can be connected to the students through the Cloud. By use of Smart Technology devices [6], the instructor can engage the students in an interactive session. E-learning (electronic learning) can be effectively employed in cases where the students have a research project that requires them to access information from libraries or research laboratories. The social networking tools that can be accessed by connectivity through the Cloud will provide access to free resources that will enhance the teaching and learning process for all participants. The positive learning environment that is created will promote learning in various modes such as being a participant in a team or on one's own with assistance from the instructor.

Many third world nations are actively seeking development, and they all realize that educating their youth is one of the approaches to achieve this goal. Among the numerous advantages that can be gained are improved economies. As they become active participants in the world market, not only will they be consumers, but they can also process their raw materials to finished products which will fetch better prices at the market. For this to happen, industries can seek the assistance of universities and colleges to help train their employees. Industries in these nations can take advantage of Lab@Home to connect to universities and colleges for this purpose. Through such partnerships, they can build a highly skilled technical manpower after the fashion of many developed nations, notably the US. This has been the result of such partnership between college and industry that has led to commercial knowledge transfer to industry [11].

All this can happen at some cost which the individual cannot bear, and in many instances, smaller companies may not be able to absorb. It is however a situation that those governments can include in their plans for development, and assist their universities and colleges, industries, and their people to achieve. In the African environment such cooperation will be a major step that will help in making the African nations equal partners in the world economy.

4 CONCLUSION

Advances in technology have led to improvements in education, and such advances have been in part as a result of innovative ideas generated at universities and colleges. One such innovation is the Lab@Home platform that enables participants to connect through the computer cloud for educational pursuits. Lab@Home takes advantage of smart educational devices to provide users with current technologies to further their education. It enables users to work either in teams or on individual basis, and to consult with an instructor as the need arises. It can be used in environments in both developed and developing nations. It provides a positive educational environment that assists both the learner and the instructor in the learning process.

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