Pilot Testing Mobile Solutions for Transmitting Digital Data to Online Learners

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Abstract - There are many different tools and platforms used today for Online Learning. The challenge is to pick carefully from a host of alternatives, many of which are costly and inflexible, and make wise use of limited resources. Our goal is to provide courses that are exciting and engage learners. The purpose for this paper is to provide information on three mobile technology solutions that can be taken into the field and used to capture and then transmit real-time digital data back on the Internet to students located anywhere in the world. In this paper we evaluate the performance of three systems: (1) Firetide Mobile Mesh Network, (2) Verizon MiFi Intelligent Mobile Hotspot, and (3) the Librestream Onsight Mobile and Visual Collaboration system. A web conferencing platform, Saba Centra, was used as a virtual classroom enabling transmission of video, audio and other forms of data from the remote sites. Faculty and students can attend a class "live" from anywhere in the world when they connect to Centra on Internet. Video and audio transmissions from mobile field locations can be embedded in Centra and shared with students in real-time connecting from their Internet-based desktops and laptops.

Keywords: Online learning, distance education, mobile learning systems, wireless clouds

This paper is organized as follows. Section 1 (Background, leading into the need for this Study), Section 2 (Searching for the Technology Solution, identifying performance criteria), Section 3 (Field Testing, evaluating three mobile systems), Section 4 (Analysis, review of test results), and Section 5 (Conclusions, selecting the technology solution for a funded proposal).

BACKGROUND

With the advent of Internet and associated technology, online learning has become an attractive option for many learners who because of location, work schedules, limited resources for travel, or other factors in their busy lives are unable to drive to a fixed location to attend classes. One of the most attractive features of online learning is that learners can learn from just about anywhere -- at home, in a library, in a hotel parking lot, or at an Internet hotspot. The possibilities are endless; the only requirement is a connection to the Internet.

A major component of most online learning programs is the platform referred to as the Learning Management System (LMS), Learning Content Management System (LCMS), or Content Management System (CMS). CMS's first were developed about ten years ago as a method for organizing and distributing information to Internet-based learners. Today's LMS's or LCMS's have additional features for management and distribution of content and data, and tools to improve interaction and learning. Two of the most popular LMS's used today are Blackboard (Commercial platform) and Moodle (Open source platform).

Pedagogy or the instructional delivery strategy for teaching and learning is an important component of online instruction. There are two major classifications of tools and software used to provide Internet-based instruction: synchronous and asynchronous. Historically, most educators felt that it was essential to conduct regularly scheduled class meetings throughout the semester. To accomplish this, synchronous (same time/different place) tools were used. Some used an asynchronous tool such as threaded discussion (where learners provided and reacted to posted content on their own schedule.

Today the environment for online teaching and learning is different than it was ten years ago. It has become increasingly difficult to create schedules for same time class meetings because learners connect from different places, in different time zones. If an online class met at 6pm in Greenville, NC Sally in Iraq would be online at her Forward Operating Base at 2am. This problem is exacerbated by other factors faced by working adults torn between conflicting demands from work, family and other priorities in their home life. The trend seems to be for many programs to decrease the number of synchronous sessions in many of their courses and place increased emphasis on asynchronous tools to capture conversations. The problem is that in many cases the extent of interaction is severely limited. Accrediting bodies such as SACS (Southern Association of Colleges and Schools) require interaction in online courses. Asynchronous tools that are exciting for learners to use need to be evaluated an applied in a variety of learning environments. The *Distance Education Advisory Group* and the *DE Innovation Group* in the Department of Technology Systems at East Carolina University has been evaluating tools for improving student interest and collaboration in online classes. Software tools identified for the Version 2.0 toolkit are recommended for use with asynchronous delivery strategies. Tutorials are being developed and are now being evaluated by the department's *Technology Systems Graduate Student Cadre* and applied in some of our graduate courses. Examples of "engagement" tools in the toolkit include: Yammer (Social media Micro-blogging Tool), Blackboard Course Wiki (Collaborative editing Tool), Kindle App (Mobile Publishing Tool), FaceBook (Departmental Social Media Tool), Google Docs (Online Collaboration Tool), and Doodle (Polling and Scheduling Tool).

For many faculty members, creating a distance learning course is always a fresh and exciting adventure. New ideas, software tools and learning platforms create optimism for the future. The challenge is to make things better though applied research, testing and improvement. It's a world full of opportunities for online and offline synchronous and asynchronous learning. There appears to be no end to the growing list of new innovations in technology at our disposal.

But there is a missing link -- It deals with capturing content that is alive, in real-time and meaningful. It deals with transmitting the excitement of technology in practice in a real world directly to the desktops and laptops of online learners located throughout the world. It is possible and it can be accomplished through technology. The may be to use *The World as a Learning Laboratory.* That is what this project is all about.

SEARCHING FOR A SOLUTION

Finding the best combination of synchronous and asynchronous tools for learning may be a good beginning. There is also need to place increased emphasis on asynchronous tools that are highly interactive. But just using a good LMS and an exciting toolset of interactive asynchronous tools is not enough. What is also needed is a method for bringing content from the outside world in real-time back to the desktop or laptops of learners connected to the Internet. It would be possible to travel to a field location (i.e., construction jobsite, manufacturing factory, or shipping port), take pictures of things going on, or record audio and video. These digital files could then be taken back to campus and uploaded to a server for viewing on web pages. An alternative might be to find a video and show it to the students. None of these are as effective as the real thing, being there when the activity is going on. The goal is to capture a real-time activity – imagine pouring concrete, using waterjet cutting to trim frozen cake, or transferring fragile packages from ship to shore. There must be a substitute for just being there!

Our approach was to search for technology solutions to the problem, and then to design a pilot project. Here is what it was all about:

There were three major objectives for this pilot project.

1. To evaluate the effectiveness of a mobile wireless mesh network monitoring system and share live data from remote sites with online learners.
2. To evaluate the mobile conductivity and effectiveness of the MiFi 3G intelligent mobile hotspot technology for capturing remote data from the field.
3. To evaluate the usefulness of the Librestream Onsight mobile collaboration device as a tool for on-site workers sharing real time data with online attendees and diagnosing the issues they found and resolve them immediately.

MOBILE SYSTEMS TESTED

Firetide Wireless Mesh Network

We learned that a mobile wireless mesh system can be used to create a wireless cloud. Users with PC's, laptops, personal digital assistants, and other devices that are able to connect to the internet can operate within the parameter of the cloud. The cloud enables a direct connection from the device to the Internet. If multiple clouds are connected, much like lengths in a chain, users may access the Internet from any cloud. In a wireless mesh network topology, multiple mobile mesh nodes are deployed across a large area. Each node in the network acts as a wireless router connecting to each of the others. Even if one of the nodes breaks down, the remaining nodes will reconfigure themselves automatically and route the data to the final destination. This is why the Mesh network is considered reliable for data transmission. Another feature of mesh is that the clouds can be moved to capture new activities on the remote worksite. The nodes may be carried on a field vehicle and moved from one area to another. In addition, with the elimination of the need for physical cables to interconnect multiple devices, the network makes truly wireless connectivity available when cables are not allowed in a workspace.

The first test of the Firetide Wireless Mesh Network [Firetide, 3 and 4] was at the Croatan Construction site on the East Carolina University campus where a new dining facility is now being constructed. This was a perfect environment for this test. It was close to the College of Technology and Computer Science and equipment could be rolled on a cart to the work environment without transportation expenses.

In the test, two Firetide wireless mesh routers were used to evaluate the effectiveness of a wireless mesh network monitoring system as a tool for sharing live construction site data with online learners. The function of these routers was to serve as two mobile mesh nodes. We referred to one of these routers as the *mother node*. The mother node was physically connected to Internet in the Austin Building located in close proximity to the Croatan construction site. A second Firetide router, we referred to as the *mobile node* was connected to a Cisco wireless router, powered by a portable power supply, and placed on a moveable cart next to the Croatan construction site. The mobile node was then used to communicate with the mother node and obtain Internet connectivity.

Figure 1. Firetide Wireless Mesh Router

These two nodes were used to generate seamless and interconnecting mesh clouds. Student learners, faculty, and construction jobsite workers who carried laptops were able to enter the construction site and connect directly to the Internet. Figure 2 illustrates the wireless mesh network topology. During the test, we carried a laptop equipped with a Logitech webcam into the construction site and captured live audio and video.

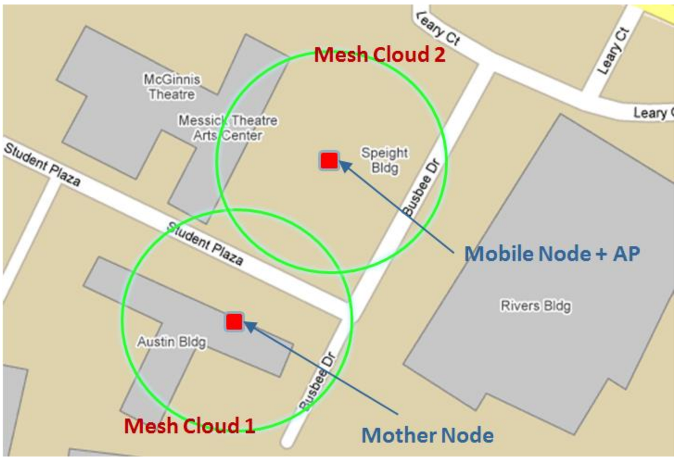

Figure 2. Wireless Mesh Network Topology

This data was then transmitted back on the Internet to viewers using the Saba Centra online learning platform [Centra, 1 and 2]. The resulting picture shown in Figure 3 was then transmitted to viewers connecting to the Centra platform from anywhere in the world. This process enables live capture of video and audio data and real-time discussion and interaction. Refer to Figure 3.

Figure 3. Real-time Transmission from the Croatan site on the Internet using Saba Centra

Verizon MiFi 2200 Intelligent Mobile Hotspot

Many of us have used WiFi technology to connect wirelessly to the Internet using mobile devices-- laptops, Smartphone's, iPads, iPhones, and PDAs at home and from public hotspot locations. However, these devices must stay within the range of a WiFi network; otherwise they will lose Internet connectivity. On the contrary, the 3G MiFi Intelligent Mobile Hotspot allows access to people surfing the Internet wirelessly anywhere that cellular service is available. Depending on the density and proximity of the remote site to cell towers, this could mean that more options for flexibility might be available for connecting than would be available using WiFi.

In our second pilot test, we evaluated the mobile conductivity and effectiveness of the mobile hotspot technology for capturing remote data from the field. A Verizon 2200 MiFi Intelligent Mobile Hotspot was used in the test [Verizon, 7 and 8]. This Mobile Hotspot is a small device that supports up to five WiFi devices. Whenever it connects to the Verizon wireless network, users are able to connect to the Internet with their mobile devices. Refer to Figure 4.

Figure 4. Verizon MiFi 2200 Intelligent Mobile Hotspot

For testing its reliability and speed of broadband connectivity, static pictures and dynamic videos were taken using a laptop and webcam in the Croatan construction site. Figure 5 shows a captured picture.

Figure 5. Captured using Verizon MiFi Intelligent Mobile Hotspot

Librestream Onsight Camera

In the first and second tests (Mobile Mesh and Mobile Hotspot systems) a laptop and webcam were used to capture and transmit the desired video and audio to learners located in remote locations. One problem with both of these approaches was that the equipment was cumbersome to transport and carry to the field sites.

In the third test we evaluated a device that can be easily carried and handled by operators. This is the Librestream Onsight Mobile Collaboration System [Librestream, 5 and 6]. The major component in the Librestream system is the Onsight camera. The camera serves as a computer and camera, providing a wireless network connection so that real-time video and audio can be transmitted from the field on the Internet to online learners. For evaluating its effectiveness in live media transmission, three experiments were conducted, connecting the device to the campus WiFi network in different locations. The Librestream camera is shown in Figure 6 below:

Figure 6. Librestream Onsight Camera

Testing was conducted in locations in the Engineering Prototype Lab (Figure 7), Technology Systems Networking Lab (Figure 8), and in the hallway of the Science and Technology Building (Figure 9). A fourth test, using mobile hotspot technology with the Librestream camera was also conducted using the Verizon MiFi 2200 Intelligent Mobile Hotspot in the Croatan construction site on campus (Figure 10).

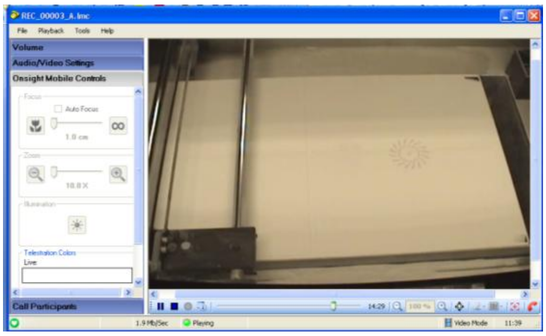

Figure 7. Testing in ENG Prototype Lab

Figure 8. Testing in TSYS Networking Lab

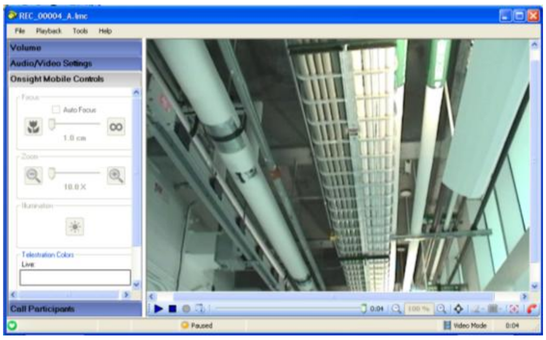

Figure 9. Testing in the Technology and Systems Building hallway

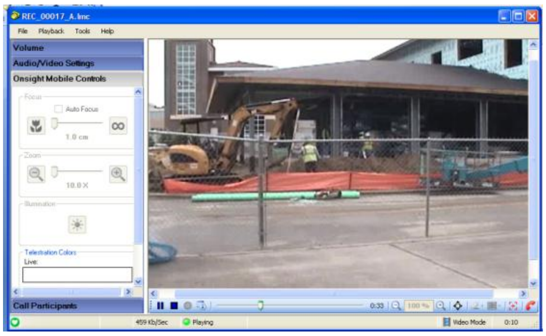

Figure 10. Testing in the Croatan Construction Site

DISCUSSION OF SYSTEMS

Mesh Network

In order to provide an Internet connection in an area, one node of a mobile mesh network must be hardwired to the Internet. This is what we refer to as the mother node. This node shares its connection with other multiple mesh nodes that scatter over the area. One of the advantages of this approach is that the nodes can be moved, thereby creating a mobile Mesh network. But it is not always possible to use this technology. Cable or DSL or better connectivity is needed for the mother node. Some field sites could be without Internet connectivity, and the use of wireless mesh network technology would be infeasible. The density of buildings and equipment in the work areas also influences the ability to transmit and receive information.

Mobile Hotspot

Mobile hotspot technology is very useful when a field location does not support WiFi. Small devices, such as the Sprint Wireless Aircard, AT&T Laptop Connect Card and T-Mobile webConnect USB Laptop Stick, have been developed for people wanting to easily access the Internet through the cellular network. In this pilot we tested the Verizon Wireless MiFi 2200 Intelligent Mobile Hotspot. It is small and can be carried in one's shirt pocket. After turning on the device, it will automatically connect to Verizon cellular network and is ready for surfing the Internet. It is easy to use, however users need to not only buy the device but also pay the activation fee and sign up for an annual contract.

Librestream Onsight Camera

With its integrated IEEE 802.11b/g networking capability, the Librestream Onsight camera can help on-site instructors to share video and audio with students located in remote fields in real time. The quality of the imagery is outstanding, but overall cost for the system puts it out of the range of many users ($5,000+)

CONCLUSIONS AND FUTURE WORK

In this paper we discussed testing of three mobile technologies, Firetide Mobile Mesh Network, Verizon MiFi Intelligent Mobile Hotspot, and the Librestream Onsight Collaboration and Communication System. Each of these technologies can be used to bring activities from the working world to distance education students. We provided a brief evaluation of the effectiveness of each mobile technology as a tool for sharing captured remote data from the field. We also compared many of the advantages and disadvantages of the three technologies. Based on this foundation, our next step will be to develop a ruggedized kit box containing components for capturing video and audio data: mini-computer, a headset, and a high definition digital video camera. Instruments will also be added depending on the end user's environment. Because of the portability and efficiency of the technology, we will be concentrating more completely on the use of the MiFi Mobile Broadband technology to obtain an Internet connection. Live streaming is not necessary in most of our applications. Whenever remote data is required to be shared with online learners, the kit box can be carried into the field and used to capture the necessary data. Moreover the box is watertight and crushproof so it can be shipped everywhere in the world without damage.

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