E-ducation Without Borders 2005 - Submission # 468

Project Proposal: **One-Button ICT Applications Package for Global Access**

Sub-theme: **E-learning in the Economic, Cultural, and Social Environment**

Authors: **Monica Mallini-Rourke*** **Manisa Pipattanasomporn**

Affiliation: **Virginia Polytechnic Institute and State University**
Alexandria Research Institute
206 N. Washington Street Suite 400
Alexandria, Virginia 22314
USA

Abstract: Only one-fifth of the world's population has access to ICT (information and communication technologies). Limited telecommunications and electricity infrastructures in much of the world are indicative of a "digital divide" which threatens exclusion from economic and social opportunity for most of the world's inhabitants. Formerly, ICT access required an expensive government sponsored infrastructure build-out, but in the advent of distributed power, wireless technologies, and compact, low-power devices, ICT access can be provided almost anywhere. This project proposes development of a package that will deliver ICT applications to rural communities, with an emphasis on natural interfaces and culturally appropriate content. The keyboard-free design, voice-driven menu, audio and video email, and local language content, represent a revolution in the delivery of ICT applications, providing a truly interactive IT experience to all people.

Introduction

The widening digital gap between developed and developing countries is a matter of concern as only one-fifth of the world's population has access to ICT (information and communication technologies). Access to ICT is increasingly viewed as a crucial conduit to various economic and social benefits, particularly important in remote areas that would otherwise tend to be excluded from basic information and services. New models of governance, an explosion of entrepreneurship, access to education, ease of access to markets, and many more benefits are dividends of a revolution in the information age brought about by ICT. However, lack of personal computers and limited telecommunications and electric power infrastructures in much of the world are indicative of a gap, called the "digital divide," which threatens to bring greater isolation and increased poverty, even as others enjoy

* Correspondence e-mail: mmallini@vt.edu

inclusion, opportunity and prosperity. Accordingly, reducing the “digital divide” is a pressing global issue.

Education, enabling technologies, and other correctional initiatives by governments have been thought to hold the key to bridging this divide. In several developing countries (i.e., Bangladesh, India, Sri Lanka), there are sporadic applications of ICT in the areas of healthcare, e-governance, adult learning, and agricultural extension. However, these are either not sustainable or not replicable for the whole country. To enable nationwide Internet access, typically there is a need for a robust national telecom backbone. Historically, such access required an expensive government sponsored infrastructure build-out, but new low-cost networking technologies have entered the mainstream, making it possible to deploy ICT virtually anywhere with a modest investment. This opens up vast opportunities for the private sector to create new markets for 80% of the world’s population by taking advantage of bits and pieces of the nationwide backbone that exists in many countries.

This project proposes development of a package that will deliver ICT applications anywhere, with particular emphasis on remote, infrastructure-poor areas, at a modest cost. This package, featuring touch-screen access to culturally appropriate content, voice-driven menu, interactive voice response in local language, as well as audio and video email, represents a new paradigm in the delivery of ICT applications to virtually all users. No longer does the tail wag the dog, nor is language barrier an obstacle to communication. This project is unique in that it frees everyday people, especially illiterates and the disabled, who need information exchange and ICT services, to conduct their business and their lives from legacy computing interfaces – keyboard and mouse – that belong in the realm of computer programmers and software designers.

Previous and Related Work

At Alexandria Research Institute, we use video conferencing to deliver courses across the Commonwealth of Virginia. Why not conduct examinations across the world? The idea was put to the test in the fall of 2004, when professors at two Virginia Tech campuses overcame geographic and temporal boundaries to examine a doctoral candidate in electrical engineering on the other side of the world. Virginia Tech's newest PhD graduate was able to complete his final exam in his office in Malaysia. Without the innovative use of common tools, the candidate would not have been able to complete his degree or publish his thesis, and the original research may have been lost from the body of knowledge that is readily available. Furthermore, the individual would have been denied full and appropriate recognition for three or four years of work. The successful outcome for all participants and for the scientific community has inspired us to seek to expand the application of ICT to enable more successes.

There are currently several efforts to bridge the digital divide in developing countries. In India, for instance, according to Rajora, Gyandoot is a project initiated by the state government of Madyha Pradesh to set up an intranet system that connects rural cyber kiosks throughout the Dhar district of India. In the Gyandoot network, each kiosk has a computer configured, for example, as in Table 1, at a total cost of $1500 per kiosk. Currently, wireless in local loop (WLL) is the technology of choice for ICT connectivity. The intranet provides a variety of local data, including information about the district, current market prices for crops and livestock, weather reports, and a village newspaper. E-government services include access to a host of local government services: driving license applications, registration of births and deaths, application for income, caste and domicile certificates, and public complaints. These services are priced from 5 or 10 rupees. Other offerings include bus and railway timetables, telephone directory, public safety information, and job vacancies.

The Gyandoot project is a prime example of a highly cost-efficient, economically self reliant, user financed community network. It has so far enabled more than half a million rural citizens, especially with e-governance and e-commerce. Gyandoot has demonstrated the value and feasibility of empowering villages with ICT.

Table 1. Technical specifications for a typical Gyandoot kiosk

Computer	CPU	Pentium Celeron 400 MHz 32 MB RAM
	Storage	4.3 GB hard drive
	Media Player	48x speed CDROM
	Monitor	14” color
	Printer	132 column 240 COS 9-pin
Connectivity	Telephone	Connected to a WLL subscriber unit
	WLL	Speed 35/70 kbps
Backup Power	UPS	Built-in 160V AVR, 4-hour capacity

In the northeastern states of India, the government of India has set up satellite-based Internet connectivity in the form of Community Information Centers (CICs) for low economic development areas. Each CIC is equipped with a satellite, interface unit, hub, server, modem, UPS, generators, and several computers. There are currently more than 450 CICs in place in the region, as of 2004. The purpose of this project is primarily to provide Internet services, such as email, remotely administered lectures, online courses, e-medicine, weather information, employment notification, and edutainment. CIC users pay nominal fees to support operating expenses to sustain the project.

Grameen Cyber Society, a community development initiative in Bangladesh, has launched a pilot community at Beraid in the Dhaka district. There are a total of ten computers, a printer, and a scanner in use at the Beraid telecenter. The community uses telephone lines to serve the Internet with anticipation that Wi-fi technology will be installed in the near future. At present, the community is able to access online crop market prices, weather forecasts, and a chat server, which provides long-distance chatting between friends and relatives.

Although quite a few ICT activities are established in several remote areas, a gap between what is available and what is needed is noticeable. Apparently, a computer, keyboard and mouse can intimidate a villager, who is semi-literate or illiterate and wanting to use the power of the Internet to send email, talk to their relatives, or contact a city hospital. Imagine a computer interface that makes use of not only the local language, but also touch-screen features, speech-driven menus, and audio and video emails to cater the needs of these villagers; there will be a "digital divide" no more. To initiate this new paradigm, audio and video streaming will require the luxury of large bandwidth; upcoming new technologies (including broadband telecom and electric power technologies and end-user equipment) must be thoroughly investigated, so that the affordable new infrastructures can be combined with bits and pieces of the existing Internet backbone to provide broadband data stream at a modest cost.

Available and Emerging Technologies

These successes indicate that ICT can be a tremendous asset to people, even a vital link to information and communication, in support of livelihood and personal health, comfort, safety, and happiness, much as the telephone was in the last century. However, rural populations tend to remain underserved by ICT. Even today, telephones are not widely available in much of the world due to sporadic infrastructure. Wireless technologies have matured to the point where they can be exploited to fill the gap, as demonstrated by the worldwide explosion of cellular telephone use. Likewise, wireless technology will play a key role in the delivery of ICT services to rural communities. The villages of northeastern India did not wait for wireline services to be rolled out because they are ready *now* to enable economic development and improve the quality of life. The evidence demonstrates that there is a ripe worldwide market for ICT applications, and the project proposed herein provides a means to deliver. The following technologies will provide a bridge between existing fragmentary infrastructure and what is needed to support ICT applications.

Telecommunication Infrastructure

Wireless local loop (WLL) and IEEE 802.16 are the most two promising and emerging technologies for bridging the last-mile gap. Both technologies have an ability to connect a village located as far as 35 km from the local exchange. While WLL has a limited bandwidth of 35/70kbps, 802.16 can support 24Mbps for an individual user. With this speed, streaming audio and video can be transmitted with ease. Since most countries have existing Internet backbone, these wireless technologies can bridge existing discontinuous networks, serving the majority of the population promptly.

Electric Power Infrastructure

Small-scale power generating units can support ICT connectivity in an area with unavailable or unreliable electricity. Various generating technologies that can provide on-site power suitable for ICT include solar photovoltaics, wind turbines, engine generators and fuel cells, with battery storage. Selection of these technologies will depend heavily on locally available resources, i.e. solar insolation, wind speed, and fuel availability. With the development of small-scale distributed power generation, wireless communication technologies, and compact, low-power end-use devices, ICT access can be provided almost anywhere.

Proposed Project

This project proposes development of an appliance with the necessary software that will deliver ICT applications to rural communities, with an emphasis on natural interfaces and culturally appropriate content. Figure 1 conceptually illustrates a design of a one-box, one-button ICT package, replicable for global access. Major elements of the package include a monitor with touch-screen capability, a disk drive, a CD/DVD drive, built-in audio, and a web camera for VDO applications, built-in microphone for voice-driven applications, a cordless phone for VOIP applications, printer/fax/scanner, CPU, and one on/off button. A low-power-consumption USB light and an electricity outlet are provided. In addition, the desk is closable to conceal all equipment when not in use.

The functionality of this appliance reflects the way people want or need to interact in today’s world. One may ask, “why not just develop infrastructure in rural areas to support use of the telephone, or better still, picture phone?" The reason is that the telephone is strictly a synchronous device. As evidenced by the popularity of voice mail and text messaging, it is no longer necessary or desirable to have both communication partners present simultaneously. Furthermore, one does not always need to interface with a *person*, when a device is capable of nearly instantaneous information storage, retrieval, and processing. The new paradigm features asynchronous operation. This design will provide a natural interface between users of ICT and the information that is accessed or exchanged.

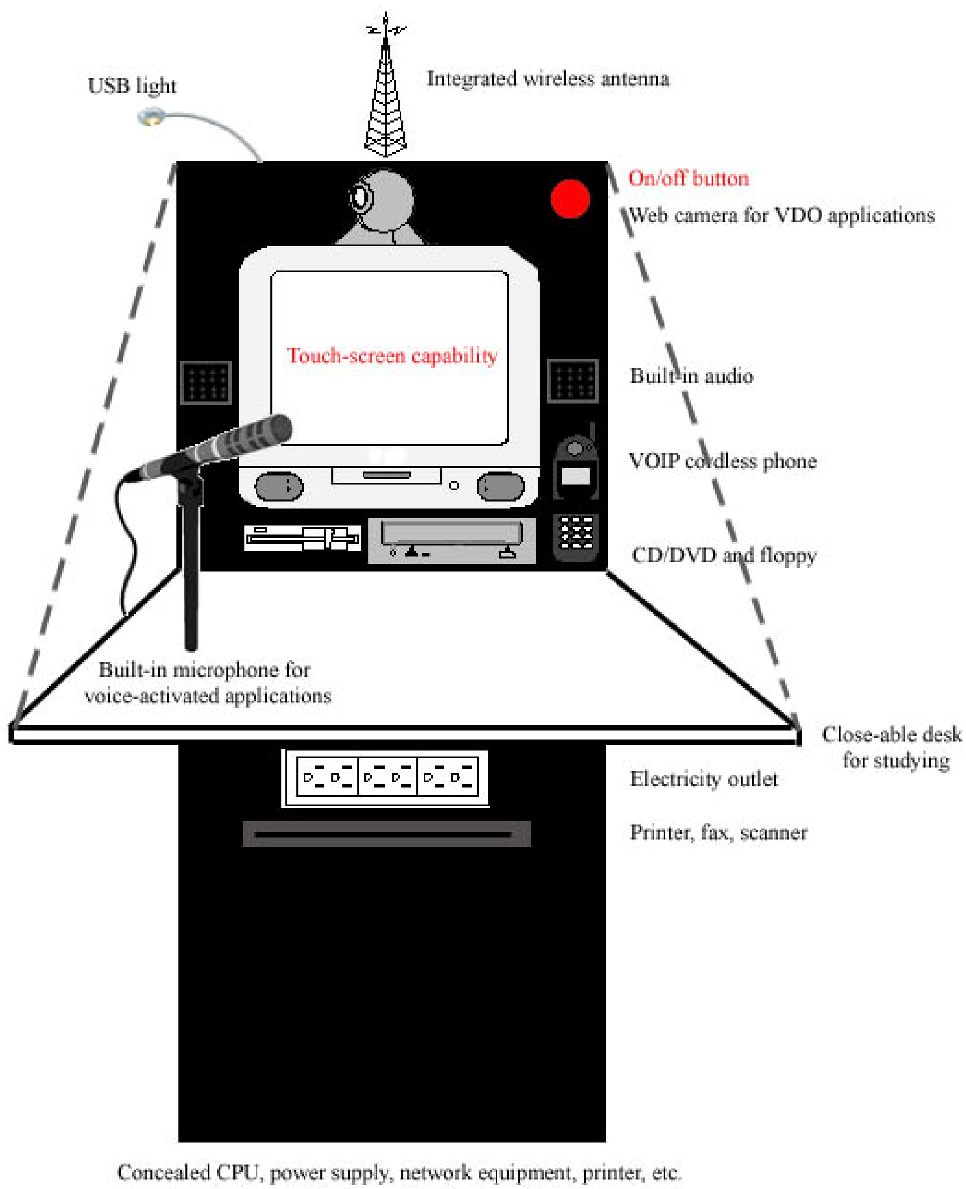

Figure 1. One-box one-button access to ICT

Figure 2. Applications menu with touch-screen support

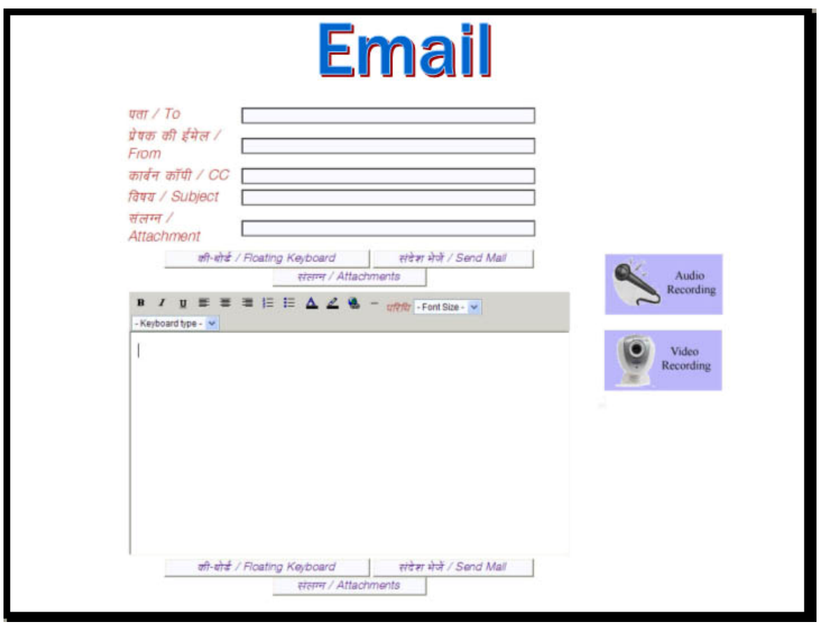

Figure 3. Sample application with local language and audio/video interfaces

Figure 2 shows an example of the touch-screen/voice-driven menu. Once the computer is on or the on/off button is pushed, the computer will say the available options. Users can then select the required option either by touching the screen or saying the word in their local language. The supported applications may include e-Mail, e-Learning, e-Medicine, e-

Government, e-Information, and Internet access. Figure 3 shows an interface for an e-Mail application.

In order for the local needs to be met through the touch-screen and voice-driven interface, collaboration with local population and local software developers is a must. This will allow the creation of a user-friendly software interface that is compatible with local culture, illiteracy level, and specific needs.

Potential Impacts

This new paradigm features the ultimate high-level language, a natural language interface. For example, a villager can touch or say words, and those words or other appropriate content will appear on the screen, thanks to the voice-activated input feature. As long as a computer user can speak and understand the touch-screen icon, there is no need to type input using keyboard or mouse, and there is no need for an end-user to know a programming language. In addition, within the limits of available bandwidth, exchange of audio and video streams is a possibility. One can also listen back to one's message before sending an email. Communication by exchanging recorded audio and video files can tremendously help rural dwellers or guest workers all over the world contact remote friends and family or gain access to medical services, markets, or a variety of products and services without any misunderstandings.

Moreover, among the potential benefits made possible by this new paradigm are significantly improved quality of life, widespread access to information, healthcare services, education and government, greater efficiency in governance and commerce, improved government accountability to citizens, and access to ICT by the disabled. It is particularly noted that ICT will play an expanding role in emergency planning and disaster mitigation. If such vital services are to become universally available, it is imperative to develop a method for deploying ICT to underserved populations.

Historically, public warning systems have relied on "low tech" mass warning devices, such as sirens and horns, combined with radio and television broadcasts to relay emergency messages to populations. Such methods are no longer adequate due to population growth and evolving communication preferences. In any case, they depend on a central authority's ability to receive and disseminate accurate, timely information. ICT can enable such capability.

Rather than build a dedicated public warning network, it makes sense to utilize existing devices and infrastructures as part of a comprehensive public information system. Existing electronic devices with wireless communication capability can be used to deliver warning messages quickly, efficiently, and effectively in areas of risk when natural or manmade hazards are detected. Public information kiosks can be key components of this network.

Drawing inspiration from the Internet, individual cellular phones, ICT appliances, and Internet kiosks may participate in a public network. A kiosk may employ sensors to measure weather or seismic data to transmit to a central location. When a kiosk receives an emergency broadcast from the public warning network, it will deliver an appropriate warning message. Messages will also be relayed to other devices within range in a peer-to-peer fashion. A device should be able to communicate with its peers and with centralized dispatch centers to send and receive warning messages and data.

A public emergency information network enabled by ICT will improve the efficiency of emergency response efforts and rescue operations, potentially reducing the loss of human life.

Conclusion

The Organization for Economic Co-operation and Development has concluded that the growth of economic opportunity as an outgrowth of the Internet relies on universal and affordable access to infrastructure. At this time, a sizeable gap between existing infrastructure and that which is needed for global ICT access still exists.

As a means to bridge this gap, we have proposed the development of a device which is capable of delivering ICT applications and services, even in the presence of a lean infrastructure, by taking advantage of existing infrastructure, and filling the gaps with wireless technology. This end-user device represents a new paradigm in the delivery of ICT applications, especially for semi-illiterate or unschooled populations. The unique features of the proposed one-box, one-button ICT package are the touch-screen, the keyboard-free design, voice control, audio and video email in local language. The device may participate in a public emergency response network. The replication of this simple device, together with the use of emerging wireless communication technologies and small-scale power generation, will bring about a revolution in the delivery of ICT applications to all people.

References

Agarwal, P. K. "Building India's National Internet Backbone." Communications of the ACM 42.6 (1999): 53-58.

Gogoi, Anup K. "Remote Lectures and Online Laboratory Experiments through CIC Networks." Proceedings of the International Workshop on Nationwide Internet Access and Online Applications. Dhaka, Bangladesh. May 2004 <http://www.ari.vt.edu/internet/Paper.htm>.

Mohiuddin, Ghulam. "Lesson Learnt: Grameen Cyber Society." Proceedings of the International Workshop on Nationwide Internet Access and Online Applications. May 2004. Dhaka, Bangladesh. 9 Dec. 2004 <http://www.ari.vt.edu/internet/Paper.htm>.

OECD Science, Technology and Industry Directorate. Information Technology Outlook 2002. Paris: Organisation for Economic Co-operation and Development, 2002.

Paltridge, Sam. "Local Access Pricing and the International Digital Divide." OnTheInternet. October 2000. The Internet Society. 9 Dec. 2004 <http://www.isoc.org/oti/articles/1000/paltridge.html>.

Peterson, Shane. "Beyond Wires." Mobile Government: A supplement to Government Technology. Nov. 2002: 8-11. Folsom, CA. 9 Dec 2004 <http://www.govtech.net/magazine/sup_story.phtml?magid=17&id=29381>.

Pipattanasomporn, Manisa. Efficient Resource Development in Electric Utility Planning Under Uncertainty. PhD thesis, Electrical and Computer Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. December 2004.

Rahman, Saifur. "Alternative for Internet Connectivity in Schools: Some Research Findings." Invited talk at DOLIT Thematic Group. Washington, DC: World Bank, 26 Nov. 2003.

Rahman, Saifur and Monica Mallini-Rourke. "Power for the Internet." Proceedings of the IEEE ACE Conference. Kolkata, India. 20-21 Dec. 2002.

Rahman, Saifur and Manisa Pipattanasomporn. "Alternate Technologies for Telecommunications and Internet Access in Remote Locations." Proceedings of Med Power 2002. Athens, Greece. 4-6 Nov. 2002.

Rajora, Rajesh. Bridging the Digital Divide: Gyandoot – the Model for Community Networks. New Delhi, India: Tata McGraw-Hill, 2002.

Vonderheid, Erica. "Reddy Applies Technology to Help Ordinary Folks." The Institute Dec. 2004: 8-9.

Wagner, Dan and Robert Kozma. "New Technologies for Literacy and Adult Education: A Global Perspective." NCAL/OECD International Roundtable, Philadelphia, 12-14 November, 2003.

Acknowledgement

The authors wish to recognize their PhD supervisor, Dr. Saifur Rahman, for his inspiration, guidance and support in the preparation of this work.

ABOUT ALEXANDRIA RESEARCH INSTITUTE

Alexandria Research Institute (ARI) is a Virginia Tech enterprise located in Old Town, Alexandria. It provides a platform for Virginia Tech's engineering and computer science researchers to interact with counterparts in academia, government and industry around the Washington Capital region and also serves as a gateway to the R&D base at the main campus in Blacksburg. Currently, ARI is involved with research in computer networking, data visualization, fiber-optics, wireless & telecommunications, satellite systems, digital library, medical informatics, energy and the environment and more.

ARI complements its research activities with teaching by providing a base for graduate students (both MS and PhD) in engineering and computer science. ARI also hosts seminars, workshops and lectures by its faculty as well as government program managers, industry researchers and overseas visitors.

Saifur Rahman is the Director of Alexandria Research Institute at Virginia Tech where he is a professor of electrical and computer engineering. He also directs the Center for Energy and the Global Environment at the University. Professor Rahman is currently serving as the vice chair of the IEEE Publications Board. He has served on the IEEE Power Engineering Society Governing Board for five years first as the Vice President for Education and Industry Relations and then as the VP for Technical Information Services. He served as the chairman of the IEEE Lifelong Learning Council in 2002. He is also a member-at-large of the IEEE-USA Energy Policy Committee. He has published over 300 papers and is frequently an invited speaker on topics including conventional and renewable energy systems, electrical load forecasting, system planning, critical infrastructures, Internet connectivity, and global learning.

ABOUT THE AUTHORS

Monica Mallini-Rourke is a BS graduate in mechanical engineering and electrical engineering of Texas A&M University. She holds the MES degree in electrical engineering from Lamar University, Beaumont, Texas. She has worked in the electric power and petrochemicals industries and is currently working toward the Ph.D. degree in electrical engineering at the Alexandria Research Institute of Virginia Tech. Her research interests include critical infrastructures, electric power requirements of the Internet, distributed energy resources, and the hydrogen economy. Monica is a past Chair of the IEEE Beaumont Section and currently serves as Vice Chair of the Washington-Northern Virginia Chapter of the IEEE Industry Applications Society.

Manisa Pipattanasomporn received the B.S. degree from the Electrical Engineering Department, Faculty of Engineering, Chulalongkorn University, Bangkok, Thailand in 1999. She received the M.S. degrees from Energy Program, School of Environmental Resources and Development, Asian Institute of Technology (AIT), Bangkok, Thailand in 2001. She has completed the Ph.D. degree in electrical engineering at the Alexandria Research Institute of Virginia Tech in January 2005. Manisa serves as Secretary of the Washington-Northern Virginia Chapter of the IEEE Power Engineering Society.