Community Telecommunications
Part II: Technology, Architecture, and Design
6 January 2006

This Paper is the second of a three part series on Community Telecommunications, specifically on expanding telecommunication services into rural communities in developing countries, with a focus on voice services. Whereas the Part I provided a backdrop and overview of a new technical and business model, this Part II focuses specifically on the technology, architecture and design components. A third Paper is planned that will focus on the Business Model component.

In summary, the overall approach being proposed is that of taking a community-centric orientation that seeks to provide the local community with an IP-based network, and then connecting this network to the Internet for gaining key services. It seeks to establish the intra-community needs first and then built out from there. It also proposes that this be done in a massively parallel approach with potentially hundreds, if not thousands of communities coming online over a relatively short period of time.

In part, this series of Papers is being developed based in part on work being undertaken through USAID's Last Mile Initiative (LMI). Specifically the materials presented in this paper come out of currently-active LMI projects in Mongolia and Vietnam. In that these are active projects the information reflected in this 4 January 2006 version of the paper is preliminary and will undergo further refinement as implementation proceeds forward and eventually is evaluated as to its success and possible changes that may be considered for future deployments.

Basic Network Configuration/Components

The core technologies for the proposed Community Telecommunications network are primarily; 1) an Internet Protocal (IP) network in lieu of a circuit switched network, 2) Voice services that are provided through Voice over IP (VoIP) in lieu of custom hardware-based switching, 3) Wireless distribution, be it WiFi and/or WiMAX in lieu of terrestrial land lines, and 4) for the more remote locations, satellite-based backbone/back haul for connecting the rural system to the Internet. The following provides a basic network overview of the configuration/components:

Local Wireless Network/Phones—As conceived and tested, the local community wireless network is comprised of a switch (or access to a central switch) a single router, a series of wireless antennas and repeaters, and phones…VoIP phones, and in most cases, WiFi phones. The type, number, and placement of the antennas is a factor of the local environment, and may include WiMAX for distribution and WiFi for access, or may include a pure WiFi-only network, possibly a mesh.

Satellite Connectivity—With the placement of a small VoIP switch locally off of the router, actually the community could have a fully functional network, though would not have any connectivity outside of the local area coverage provided by the wireless network. This satellite component provides two key elements; 1) it's part of the solution for reaching outside of the community, and 2) by connecting the community to the Internet it allows for relocating the switching such that it can be centralized to where a single switch can support multiple communities (e.g., not every local community has to have its own switch).

VoIP Switching—The third component is the actual VoIP switching that allows for calls to be routed between the user community, whether they are within the local community or with those residing on other networks…including other similar IP-based community networks, mobile users, or PSTN users. As proposed, the configuration is such that a single VoIP switch can provide support to hundreds, if not thousands of local community phone systems/customers (think SKYPE with VoWiFi phones in lieu of their soft phone that sits on a PC). In fact, as conceived, a single soft switch can provide the needed switching for hundreds, even thousands of community phone systems located in dozens of different countries. It is equally feasible for each country to set up their own central VoIP switch to handle the local community networks within each specific country.

Interconnection—With the VoIP switching to handle the routing of traffic between the customers relying on the community networks, there is the need to add an in-country interconnection capability to those wanting to terminate calls to those relying on other networks (fixed or mobile). This requires what is in essence a smaller VoIP switch that provides interconnection with the PSTN and mobile networks within the country, as well as to international destinations.

It should be noted that while the above focuses specifically on providing voice services to the most rural community, being that the network is IP-based, this same convergent network can also provide a wide-range of other value-added Internet services. This can be e-mail, WWW services, etc.

Technologies

The above discussion on Network Configuration/Components started with an identity of several core technologies, including the Internet, VoIP, WiMAX/WiFi, and satellite. Together these newer technologies provide a unique opportunity that is just now capable of being realized, for expanding communications into the most remote areas of any country in the world. Further, these off-the-shelf technologies allow this to be done at a cost that is literally pennies-on-the-dollar for what has been possible in the past. This combination allows these networks to reach sustainability…possibly without any use of public funds typically made available through universal service/access regimes. The following provides a quick description of the key technologies deployed in the proposed approach, along with some implementing considerations.

Internet—The fundamental component of the Internet that provides the needed shift for opening up the possibilities as reflected in this series of papers is the packet switching of the Internet. This is in lieu of the circuit switching that has dominate voice communications for over a century. With the ability to now use this IP-based network for voice services, the most dominant demanded service (voice) can now be provided on a substantially reduced cost. And this single convergent network can also be used for delivering other value-added services, making the network even more cost effective. The one issue needing attention basically is the prioritizing of packets to support real-time applications on the Internet such as voice (and video). There are solutions for this and clearly this must be built into the solution set.

VoIP Soft-switch—With the IP-network serving as the transport, there is the need to provide the voice services over this IP-network. Here the focus is on routing the packets to/from those making the call, maintaining a quality of service (QoS) sufficient to maintain an acceptable quality of call, and also providing interconnection off of the Internet for calls being made to the

PSTN and/or mobile customers. While VoIP has been emerging for a number of years, most of this has been through a hardware-based solution using H.323 protocol. The major change taking place this last year has been a growing level of support for the new Session Initiation Protocol (SIP) and a movement away from H.323. This provides for a range of benefits, one being the lowering of costs, improving of quality, shifting to software based solutions, more efficient use of band width, etc. In fact, voice/video is only one user of the SIP. This new approach has also brought about a substantial level of competition in the VoIP marketplace with the lowering of switching costs even further. In addition, Open Source VoIP solutions are now available. SIP now appears to have gained momentum over the H.323 standard and is expanding rapidly as to gaining a broader user base with an expanding number of vendors/firms providing even richer solutions.

WiMAX & WiFi—Initially the Wireless Fidelity (WiFi) standard (IEEE 802.11) was put into place to satisfy relatively limited access for indoor use, with a range on the order of 100 meters around a given Wireless Access Point (WAP). This was primarily a target market rationale, but also a frequency interference consideration (since these operate in what is considered an unlicensed frequency in most countries. However, over the several years there have a growing number of outdoor deployments of WiFi such that currently entire metropolitan areas are "hot spots" and in rural Oregon there is an area of approximately 600 square miles that has WiFi coverage. More recently there has been the emergence of a new WiMAX standard (IEEE 802.16) designed specifically for outdoors, and with broader coverage areas and greater capacity. At present there are a number of firms committed to this new standard, with a range of companies currently making what are considered pre-WiMAX products. For purposes of this proposal there is a preference for relying on a pure WiFi approach. This is due in part to; a) the current lower cost structure of WiFi products, b) less issues associated with the frequencies, c) the current availability of portable WiFi phones, and c) not having the requirement to build small WiFi "hotspots" off of a broader WiMAX network. Also, more recent cost-effective WiFi mesh implementations capable of extending the reach of WiFi networks provides larger-scale coverage off of WiFi for reaching well beyond concentrated local communities. This will change in the near future as the WiMAX certifications take place, WiMAX products drop in price, and even WiMAX phones come into the marketplace.

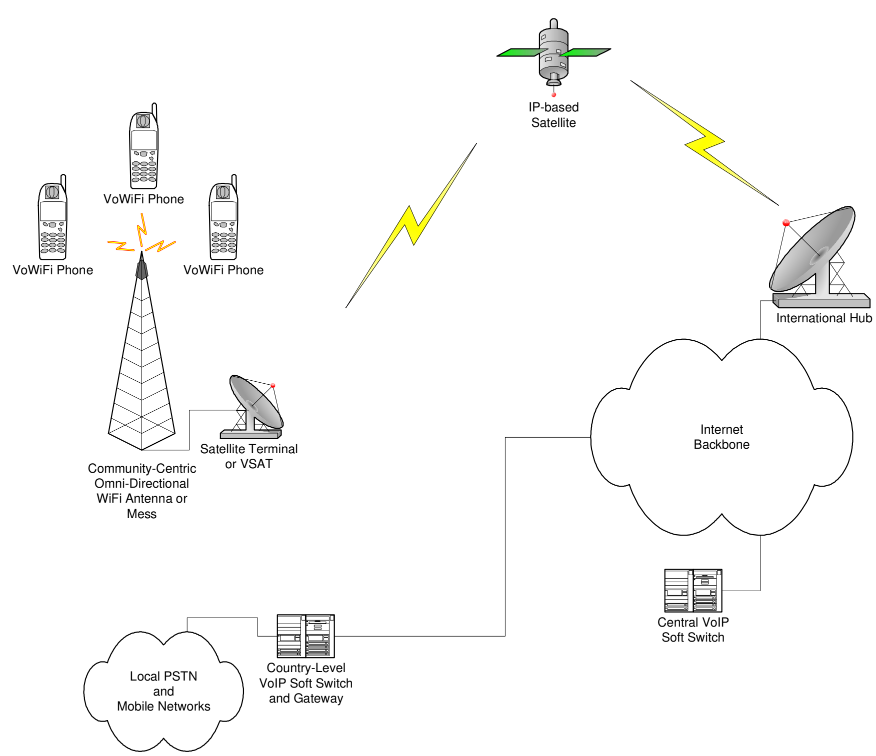
VoWiFi Phones—With the growing populating of VoIP switching and WiFi networks, the more recent enabling technology development has been SIP-based VoIP/WiFi phones. These look very similar in size to a mobile phone offered through any number of commercial wireless carriers (e.g., Cingular or Verizon). In fact, one of the current dynamics within the cellular marketplace is the soon-to-be emerging dual-mode handsets that provide digital cellular service as well as VoWiFi capabilities, including switching between the two networks while retaining a call. For purposes of the Paper, there is a preference towards using the small VoWiFi phones, recognizing that at present the costs of these are a bit high, but starting to drop. The advantage is that they can be powered by solar where needed, and can operated directly off of the community WiFi network without having to add additional hardware associated with relying on non-WiFi based VoIP phones. However, this approach of setting up a small antenna to capture the WiFi signal, pull it into a router, and then into an ATA and a standard phone is a plausible solution as well.

Satellite—As discussed above under Network Configuration/Components, while it is plausible to set up a community-only network, and this would satisfy a portion of the local needs, there is the need to add value to the network by allowing the residents to reach outside the community, and even outside their network. In the most rural communities this will mean the reliance on satellite to gain the needed access. While satellites have been around for several decades, the most recent developments have been a series of newer satellites that provide native IP services at a substantially lower cost that has been possible in the past. One such service is the IPStar satellite services off of several satellites out of Thailand. Another service is the Regional-BGAN and the even newer BGAN services from Inmarsat. The key here is to: a) gain access for calls outside the local community, and b) gain access to VoIP switching that can be centralized…rather than every local community having to have its own VoIP switch. This provides a tremendous cost advantage and in doing so, improves the sustainability. It also provides greater stability of the voice services. Initial tests indicate that the network can be configured such that there is a very low amount of satellite traffic required to connect local intra-community calls, with no traffic required to sustain the call once the connection is made. And with the newer SIP-based VoIP switching and phones, calls outside the local community require a data stream on the order of only 10kbps. The sensitivity on both factors is basically usage-sensitive costs and the need to keep this at an absolute minimum. While satellite technology provides connectivity to the most rural locations, obviously where there is terrestrial infrastructure, be it optical fiber, cable, copper, or microwave, these solutions should be used and provide a cost-beneficial solution over the typical usage-based satellite service.

Encryption—While not an essential part of most deployments, with the network relying on the Internet Protocol, it is now possible to encrypt all calls at a near-zero cost. This can be put into place for those situations requiring an even high level of security…and with the VoIP/WiFi combination, recent technology advancements allow this security requirement to be met over off-the-shelf technology and an open network.

Architecture/Design

The following reflects a high level network diagram of an emerging design being put into place as part of USAID's Last Mile Initiative (LMI) projects in Mongolia and Vietnam. It is anticipated that there may be some variations of this to accommodate local concerns, however tests conducted up to this point reflect that this is a viable approach for delivering cost-effective communications into the most remote areas of developing countries.



Conclusions

In many ways what is considered a highly "disruptive" set of technologies to the current telecommunications infrastructure in the more industrialized countries, and viewed as a specific threat by the major carriers, is at the same time perhaps the most "enabling" set of technologies for connecting those living in the rural areas of developing countries, ever. This new combination of the IP network delivered through lower-cost satellites, the VoIP services delivered through soft-switch technologies on this network, in combination ith the wireless distribution through WiMAX and/or WiFi, and the emerging VoWiFi phones, provides perhaps for the first time, a technology set that has the potential for realizing the vision set by Sir Donald Maitland early in the 1980s, when he chaired the Independent Commission for Worldwide Telecommunications Development and ultimately issuing "The Missing Link" report in December of 1984.

Even our preliminary testing and trails of the approach have demonstrated that from a pure technology perspective, this is very doable, and can be implemented in a very short time frame. From here the next challenge is to explore whether or not this be done in a cost-effective and sustainable manner. It's clearly an approach that is substantially less costly than reliance on traditional circuit-switched solutions and even some of the current hard-wired packet-switched solutions. But is it cost-effective enough to become implemented on a grand scale? And if yes, what exactly is the business model that could make this type of deployment possible? This topic will be addressed in Part III of this series of Papers.

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