TELECOMMUNICATIONS BRIDGING BETWEEN DEAF AND HEARING USERS IN SOUTH AFRICA

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Abstract: This paper presents a description of telecommunications for Deaf people in South Africa by contrasting the situation in the developed world. We explain the main motivations for providing a locally appropriate solution. Research activity began with a community-based field trial of TTYs. The recommendations of the trial motivated an innovative approach to provide synchronous and accessible relay services. Drawing from international technological developments, we designed a software solution called the SoftBridge. We employ iterative Action Research cycles to drive technological modifications to the SoftBridge and to encourage adoption by the end-user community.

Keywords: Deaf, telecommunications, relay, South Africa, Action Research

1. Introduction

Information and Communication Technology (ICT) developments have recently exploded to yield potential telecommunication opportunities for Deaf people in ways that were only imagined not so long ago. The state-of-the-art technology promises multimedia (text, voice and video) and multifunctional devices for home, work and mobile systems for the Deaf. Internet-based devices and protocols are rapidly augmenting and replacing Public Switched Telephone Network (PSTN) based solutions and services. Pager and cell phone Short Message Service (SMS) are becoming prevalent for Deaf users because of their wireless mobile nature (Nelson and Underschultz, 2003). The unbridled success of text messaging has fueled demand for visual-based wireless communication to support sign language-based remote communication. Text and sign language relay services exist, but they are not ubiquitous (Bergmeister, Dotter, Hilzensauer, Krammer, Okorn, Orter, Skant, and Unterberger, 1999).

As long as two Deaf users have the same non-audio (text, video) communication device or service, they do not need a relay service. These services include TTY, SMS (text messaging), email, chat, fax and video telephony. However, when either one of the Deaf people has a different device/service, or the other person is a hearing person and uses a different mode or language, a relay service is required. State-of-the-art technology for Deaf relay telephony converts text and video to speech (and back) via either the PSTN or the Internet. Most of these services employ a human relay operator to convert a Deaf user's text/signing into speech, and a speaking user's speech into text/signing. Some systems are even semi-automated.

Examples of text-based relay over the PSTN include the Royal National Institute for the Deaf's Typetalk at British Telecom (www.typetalk.org), TalkingText (www.talkingtext.net), AT&T TTY Relay Service (www.consumer.att.com/relay), Australian Communication Exchange's (ACE) National Relay Service (NRS), and Sprint Relay (www.sprintrelayonline.com). PSTN–based relay has also found its way to mobile devices, e.g. Vodaphone's service for the Nokia 9210i (www.vodaphone.co.uk) and the Mobile TextPhone (Andersson, 2001). Over the Internet, text-based relay examples include services from Sprint and AT&T.

These companies also offer video relay services over the Internet, along with Sorenson (www.sorensonvrs.com). Many Internet-based video services make use of Microsoft's NetMeeting. Other video projects include UmptiDumpti (Foster, Mudgett-DeCaro, Bagga-Gupta, de Leuw, Domfors, Emerton, Lampropoulou, Ouellette, van Weert and Welch, 2003; Verlinden, 2000), Wisdom (Bauer and Kraiss, 2001) and ACE's NRS video trials (Spencer 2000). The Total Conversation service, from Omnitor (www.omnitor.se) combines all of these types of services and is active in promoting ITU standards to this effect.

The video services obviously allow sign language into the system, especially for Deaf-to-Deaf remote communication. Several other research projects are working sign language into automated parts of the relay. Examples of these projects include Visicast (www.visicast.co.uk) with Tessa (Cox, Lincoln, Tryggvason, Nakisa, Wells, Tutt, and Abbott, 2002), an airport security system (Lancaster, Alkoby, Campen, Carter, Davidson, Ethridge, Furst, Hinkle, Kroll, Leyesa, Loeding, McDonald, Ougouag, Schnepp, Smallwood, Srinivasan, Toro, and Wolfe, 2003), and the commercial service from SignTel (http://signtelinc.com).

2. Pre-requisite components

Access to these cutting edge ICT services assumes the awareness, availability, accessibility, affordability and appropriateness (www.stakes.fi/promise cited by Bergmeister et al., 1999) of the following components: end-user devices, network access, relay services and user skills. These conditions easily apply in the best case scenarios in the developed world where a selection of end-user devices includes a variety of TTY alternatives, cellphones with a wide array of features, personally owned multimedia PCs and laptops, videophones and a good selection of handheld devices. Landline, cellular and concomitant Internet connectivity is ubiquitous. Broadband access via ADSL and cable is widespread. Relay services in the form of both text and video relay are available with highly skilled operators.

There are, however, places in the developed world where not all of these components are operationalized. For example, many European countries do not provide relay services. The reasons for this are not technological, but rather financial and/or political (Bergmeister et al., 1999). There is a shortage of trained sign language interpreters, e.g. in the United Kingdom, there are 130 qualified interpreters for an estimated 55-60,000 signers (Bergmeister et al., 1999). Many Deaf people have difficulty with typed text because of a history of inferior education and poor literacy skills. Although all of the pre-requisite components are not necessarily present in every developed country, the potential for their use by Deaf people is there. This is clearly not the case for the developing world.

3. The South African situation

The South African population is approximately 44.8 million of whom 55% live in urban areas (www.statssa.gov.za). South Africa has a peculiar blend of developed and developing world conditions. While there is availability of cutting edge technology for some, most of the population experience the less advantaged side of the Digital Divide. For example, ADSL is available for domestic use in several urban centres, but over half of the households have no telephone in the dwelling. Furthermore, about 10% of South African households simply have no access to a phone at all (www.statssa.gov.za). According to the ITU, in 2002 there were about 18.6m telephone and cellular subscribers, or 41 per 100 (http://unstats.un.org/unsd/databases.htm). Incredibly, about 14 million of these people are cellphone users. About 2 out of 3 are sharing handsets or using community service phones (www.unileverinstitute.co.za). To put these figures into perspective, consider that the UK has 143 telephone/cellphone subscribers per 100 people. Despite a decade of democracy and transformation, the demographic breakdown of telecommunication access clearly shows that there remains a legacy of differentiated distribution across population groups. This is most clearly indicated by the fact that virtually all households with no access are black Africans, and when they do have access, it is most likely a cellphone only. The divide is just as dramatic across rural and urban South Africa.

In South Africa, there are just over 3 million PCs, or 7.26 per 100 people. This is extremely low given a comparison with the UK's 24 million PCs, or 40 per 100. Additionally, the distribution of PCs in South Africa follows the same population group patterns as telephone ownership. Given this telephone and PC situation, it is not surprising that the number of Internet users per 100 in South Africa is only 6.82, in contrast with 42 for the UK (http://unstats.un.org/unsd/databases.htm).

The Universal Service Agency (USA) was established in 1996 to help ensure more widespread access to all telecommunications services, e.g. voice, fax, Internet etc. Public access facilities (telecentres) were to be run in partnership with members of the local community in rural areas with households without 'reasonable access' to a telephone. Reasonable access was defined as a distance of 30 minutes walk or 5 km to the nearest public phone. The USA set up about 90 telecentres, however, the majority operate sub-optimally: in a recent survey, out of a sample of 47 telecentres only 23% actually offered telephone service (Mike Jensen, ICT consultant, 2004, personal communication). The restricted nature of telecommunications legislation and policy, such as the Regulations Telecommunications Act, 2001 does not offer much help. Voice over IP and wireless Ethernet remain restricted, even though their use and deployment is evident.

4. The Deaf in South Africa

There are widely differing quoted estimates of the size of the Deaf population in South Africa. In 1994, the Central Statistics Service mid-year estimate suggested that there were 4 million people with hearing impairment: 402,847 'profoundly Deaf', 1,208,539 'extremely hard of hearing' and 2,417,078 'hard of hearing' people in the country. Of these, 1,611,386 were thought to use South African Sign Language (SASL) as a first language. However, the 1996 and 2001 national census statistics show 383,408 and 313,583 Deaf people, respectively (www.statssa.gov.za). This suggests that the 'profoundly Deaf' group from the 1994 estimates are in fact the Deaf community who use SASL as their preferred language. This is a higher proportion of the population than found in the USA or EU, possibly because of differences in healthcare, immunization, etc.

The South African Constitution and related legislation such as the Integrated National Disability Strategy (Office of the Deputy President, 1997) boasts one of the most proactive approaches to access for disabled people. However, much of this sentiment remains at policy level and implementation lags far behind. The demographics of the South African Deaf community must be placed within the general South African socio-economic structure. 30% of all Deaf adults are functionally illiterate as a result of inadequate educational practices (Asmal, 2004; Glaser and Aarons, 2002). The vast majority of Deaf children never attended school or attended school at a very late age (Asmal, 2004; Kiyaga and Moores, 2003). Education for Deaf children only became compulsory in 1996 (Aarons and Akach, 2002). About 65% of all Deaf adults are unemployed, and many of those with jobs are underemployed. This impacts negatively on the socio-economic status of the Deaf community. Regrettably, there are still very few teachers who are equipped to teach Deaf students through the medium of SASL. There are also very few sign language interpreters at tertiary level educational institutions (Asmal, 2004). Unfortunately, when the telephone/Internet access conditions are combined with poor literacy, ICT skills are difficult to cultivate.

4.1 Teldem trials and implications

Providing telephony services to the Deaf in South Africa is challenging (Tucker, Blake and Glaser, 2003). The majority of this community experiences poverty, illiteracy and little or no access to ICT. The South African telco, Telkom, provides a locally produced text telephone called the Teldem. Field trials revealed that the Teldem does provide real-time communications between two parties, Deaf or not (Glaser, 2000). Because both parties must use a Teldem, there is a relatively small "calling circle". The monthly Teldem rental charge is currently R19.21 (€2.44), but the installation of landlines and the duration-based call charges remain significant obstacles to an essentially poor community. The most over-riding recommendations from the Deaf participants in the Teldem field trials were a) the need for the placement of Teldems in public offices and more importantly, b) the provision of a relay service. However, neither the South African government nor Telkom are willing to subsidize a human-mediated relay between the Teldem and the PSTN.

4.2 Mobile text messaging

In the absence of a relay service, SMS and prepaid cellphones have become the predominant means of Deaf telecommunication. In line with developed countries, many believe that SMS provides adequate, inexpensive Deaf telephony. The exponential growth of text messaging on cellular handsets is being followed up by several developments for landlines. *TalkingSMS* is a service that converts text messages to voice on landlines in South Africa, and was seen as a way to link Deaf and hearing users (Norton, 2002). This service is also being piloted in the UK (Leyden, 2004). Another development is a fixed line SMS service that Telkom is planning to launch in November 2004. It will allow SMS from Telkom SMS capable telephones to similar devices, and to and from GSM devices (Attie Burger, Telkom, 2004, personal communication; De Wet, 2004). A similar initiative is happening in India (Kumar, 2004).

However, SMS cannot effectively substitute for real-time synchronous communication. Rapid SMS exchanges can approximate semi-synchronous communication, but in reality, SMS is functionally unreliable. One never knows if the other party has actually read a message or not. SMS may be useful in some Deaf Telephony situations, but it is not applicable to all situations, particularly where synchronous, acknowledged communication is required. In addition, SMS is not appropriate for more formal communication requirements (Tucker et al., 2003). An explanation for the popularity of SMS despite its clumsy nature is the socio-cultural context in which the text becomes relevant to people's lives (Sun, 2003). This is particularly evident in the South African Deaf community, as the cellphone doubles up as both a dwelling and mobile device.

4.3 Video interpreting

Telephone Interpreting Service for South Africa (TISSA) is a video-based remote interpreting system that was piloted in 2002 (www.dac.gov.za/about_us/cd_nat_language/language_planning/tissa/english.htm). TISSA incorporated the eleven official South African languages, as well as SASL. The service provided access to government services in one's own language. An interpreter in a remote location, via a telephone (or in the case of SASL, an ISDN videophone), bridged communication between hearing and Deaf participants in the same community location. This is distinct from video relay interpreting where callers are not in same location, a service that has never been available in South Africa.

5. Motivations for our approach

Given the climate of Deaf telephony in South Africa, we opted to design an Internet-based relay service with breakout to the PSTN. This relay would satisfy a number of goals: to increase connectivity options for the Deaf, to provide synchronous communication, to fully automate the relay without any human mediation (Glaser and Tucker, 2001), to be low cost, to offer multimedia and multi-functional capacity and to support mobility. Synchrony and connectivity are intrinsic properties of any type of relay. Human resources (relay operators), as well as personal end-user devices, increase costs dramatically. Automation of the relay with Automatic Speech Recognition (ASR) and Text-to-Speech (TTS) can decrease costs, but the use of ASR is still problematic. Internet-based solutions are also easy and cheap to build. A further aspect to reducing costs is a community-based rather than individualistic model of computing often found in the developing world. This goes beyond the need to take into account the ethnographic differences of individual users to realize that an end-user machine will be used by many people rather than an individual. Thus, one has a Community Computer (CC) rather than a Personal Computer (PC), a Group Digital Assistant (GDA) rather than a Personal Digital Assistant (PDA) (Tucker et al., 2003). For a GDA this implies having multiple personalizations, as with the Simputer's smart card arrangement (www.simputer.org). The longer term motivation is to keep in sight multimedia interfaces and multi-functional devices, especially on mobile handhelds. This would address, amongst other things, the express wish of the Deaf to have SASL-based, rather than text-based solutions.

6. SoftBridge

We have developed an application server platform that embodies these motivations (Lewis, Tucker and Blake, 2003). The SoftBridge server provides a generalized mechanism for bridging multimodal exchanges. Just as the Internet Protocol treats all forms of data as packets, the SoftBridge treats all media types in a uniform manner, as messages. The SoftBridge framework provides for the conversion of one media type to another, e.g. text to voice. Message transfer is based on XML and the Jabber Instant Messaging (IM) protocol. The current prototype is built with the .Net framework and adaptation services are provided with standard web services (see Figure 1 below). Another interesting feature of the SoftBridge is the ability to approximate synchronous exchange with asynchronous mechanisms. We call this semi-synchronous communication. While the SoftBridge is a generalized platform, we have been developing clients to support automated relay.

The Deaf user can use a standard IM client such as Exodus (http://exodus.jabberstudio.org/) to send text messages to the SoftBridge server. These messages are converted to voice by TTS software. Currently, we are using a variety of TTS engines: www.microsoft.com/speech, www.cstr.ed.ac.uk/projects/festival and www.nuance.com. The voice is passed to a handset for a hearing user via an H.323 PSTN breakout. In the reverse direction, the hearing user's voice is converted to text by an ASR engine, and passed on to the Deaf user's IM client. Of course, the breakout also supports soft clients on IP networks, but our main concern is to provide connectivity for the Deaf in the South African environment.

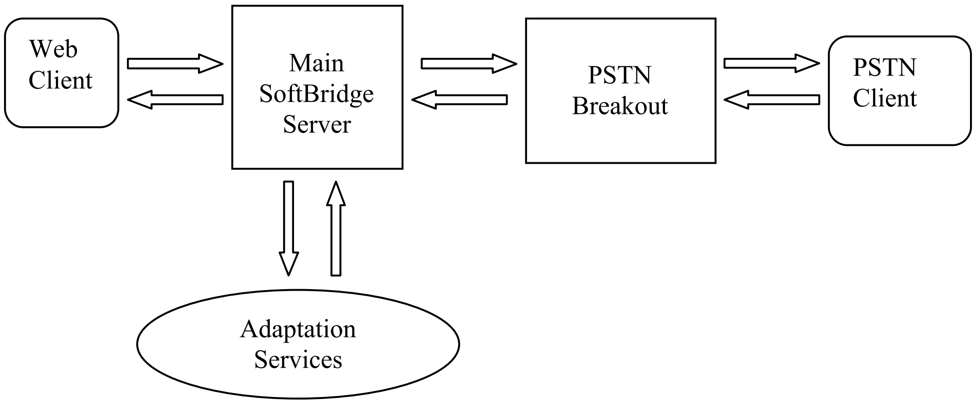

Figure 1, SoftBridge architecture

We are actively engaging a local Deaf community, the Deaf Community of Cape Town (DCCT). The DCCT community lives within the lower socio-economic spectrum described earlier, as do the hearing people with whom they wish to communicate. We are employing Action Research cycles to provide us with information on how to tailor system functionality (Tucker, Glaser and Lewis, 2003). As neither the Deaf nor the hearing participants in this study have ready access to PCs and the Internet, the SoftBridge services are accessed via Community Computers at the DCCT community centre in Cape Town. We also must terminate relay calls to the PSTN. The PSTN gateway is also resident at this site, utilizing an ADSL line. Because the project is currently supported by research funds, access and use is free of charge. Members of the community are being invited to participate in ICT literacy training to enable them to use this service independently. A Deaf individual has been identified to facilitate the use of the system.

We have recently decided to replace the ASR component with a human operator to ensure accuracy of transmission. As the ASR and TTS components are provided by web services, we have built human interfaces to the ASR web service for the operator. The SoftBridge represents bridging between various communication modalities, and is not limited to text and speech for Deaf and Hearing users. The SoftBridge, and the approach to building it and its client interfaces, can be applied to bridge other problems of generalized Deaf telephony.

7. Future work

The SoftBridge is designed in order to easily add features and capabilities for end-user devices and network access. Work is underway to port the SoftBridge to an open source Java-based platform. Additional features include SIP-based real-time connectivity for both text and voice, video capabilities, mobile handsets for the Deaf (cellphones and PDAs) and the eventual inclusion of fully automated speech-to-text facilities. If the SoftBridge approach satisfies the goals described above, it is hoped that the community-centered approach will encourage the Deaf community to take financial responsibility for the sustainability of the project.

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