Web-based Telephony Bridges for the Deaf

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ABSTRACT

A Teldem provides text-based telephony services to the deaf. Despite an array of text-based communications mechanisms on the web, the Teldem is the only means of synchronous telecommunication available to a deaf person. We examine a human-assisted relay that provides a bridge between the deaf and the hearing, and then propose several additional bridges. These bridges take advantage of both standard and cutting edge technologies. We present each bridge's impact on the deaf with respect to synchrony, connectivity, independence, and the Digital Divide. It is hoped that by deploying trials for each bridge, we can eventually provide the deaf with equal access.

1 INTRODUCTION

The Teldem, a Telkom product, is a Telecommunications Device for the Deaf (TDD). The Teldem has a keyboard and a two-line display screen. The Teldem connects to the telephone system just like a normal telephone. However, the keystrokes are converted to tones, sent over the phone line, and then converted back into text on a Teldem on the other side. The sender and receiver see the same text at the same time. Yet, the communication is half-duplex: only one party can type at a time. All communication takes place over the standard Public Switched Telephone Network (PSTN).

The Teldem allows deaf users to participate in a limited fashion in global telecommunications. Modern telecommunications allow a wide range of options over landline, cellular and Internet (see Table 1). Two significant ways in which these options differ have to do with synchrony and whether or not a computer is involved.

Normal voice telephony follows a synchronous protocol, whereby hand shaking or turn-taking happens immediately (or within an acceptable threshold). The Teldem is also a synchronous device. An asynchronous mechanism, like email, voicemail, SMS or fax, does not require/expect immediate feedback or acknowledgement. Semi-synchronous technologies fit in between in that if an immediate response occurs, the protocol appears to behave synchronously. For example, a rapid exchange of email or SMS may appear synchronous, but these mechanisms are equally appropriate for asynchronous interchange. The options and their protocols are laid out in Table 1.

	landline	**cell**	**Internet**
synchronous	Voice Teldem	voice	Chat VoIP
semi-synchronous		SMS	web-board instant messenger
asynchronous	voicemail fax	voicemail fax	Email fax

Table 1 Communication Technologies

One could argue that deafness and its consequent exclusion from voice-based synchronous communications could be replaced by asynchronous or semi-synchronous text-based mechanisms. However, despite the array of options open to global communicators, synchronous mechanisms are absolutely mandatory [4]. One of the reasons is that voice-based communications demonstrate the 5 9's. Further, synchronous communication is the only way to reliably ensure that a communicative exchange is actually successfully taking place. It is imperative to use synchronous mechanisms to provide the deaf with equal access. The problem is how to bridge synchronous communications across the various types of user groups defined by deafness and access to a PC.

This results in four user groups illustrated in Table 2. This grouping assumes people have a telephone and/or cellphone. Several issues arise from this table. PC owners enjoy a whole range of tools that are actually voice-independent. Email and chat are available to both hearing and deaf users. In particular, a deaf user with a PC has access to all possibilities except for voice-based mechanisms. Without the Teldem, a deaf user even with a PC does not have full synchronous connectivity. This makes simple communication, like making a doctor's appointment, extremely awkward.

	Hearing	Deaf
With PC	Teldem voice chat VoIP Video Conf SMS web-board instant messenger fax voicemail email	Teldem chat Video Conf SMS web-board instant messenger fax email
Without PC	Teldem voice SMS fax voicemail	Teldem SMS fax

Table 2 User Groups

A hearing user without a PC still has full access to the telephone network. However, a deaf user with a Teldem only has access to the small pool of Teldem owners. Note that a user from any user group can use a Teldem. However, it's not feasible to propose that every type of user will have a Teldem. It's even less feasible, given financial restraints, for every South African to have real access to a PC. However, it is reasonable to expect that every type of user should somehow get access to synchrony. Therefore, we have to try to grant access from a Teldem to both telephony and the synchronous web tools.

A good place to start, then, is with the Teldem's advantages. Many advantages were clearly identified by the Teldem trails [1]. The most significant was that the Teldem provides synchronous, real-time telecommunications for deaf people. Simple telephone calls are things that hearing people take for granted. The Teldem's socio-economic ramifications are immense. Vocational possibilities increase when a deaf person has the capacity to communicate over a phone line, instead of requiring physical proximity to use sign language. The Teldem enables real-time independent communication that gives the deaf an opportunity to conduct remote communication without the need for a hearing 3rd party to do it for them.

Other advantages include the fact that the Teldem operates over the phone line and is therefore subject to 5 9's of reliability. In addition, the Teldem is fairly inexpensive, at only +R14/month rental. The call charges are the same as a normal phone call. Most importantly, there is no need for third party involvement. These advantages are borne out by the extremely high (80%) take up rate seen by the trial participants [1].

2 GAPS

Despite the advantages, glaring problems need to be addressed in order to grant equal access to the deaf. We can characterise the gaps according to several criteria. *Connectivity* issues refer to the limited Teldem user community. Teldem access is restricted to Teldem users. The small pool of Teldem users creates a vicious cycle. Potential users are reluctant to acquire a Teldem because there are so few people with whom they can then connect. This acts as a barrier to increase the pool size. Access to non-Teldem users and mechanisms would encourage increased Teldem uptake. Deaf users are excluded from voice-based *synchrony*. Their only opportunity for synchronous connectivity is the Teldem. Because the connectivity circle is limited, the synchrony circle is consequently restricted. An increase in connectivity would result in a concomitant increase in synchronous access. The Teldem offers fully *independent* communication to other Teldem users. Yet in order to break into the voice-based connectivity circle, a South African deaf person relies on a hearing person to make telephone contact on their behalf.

The Internet offers many text and video-based opportunities for deaf-friendly communication. It is, however, unlikely that the *Digital Divide* – especially in South Africa – will narrow any time soon. Therefore, it seems unrealistic to expect the Internet to magically provide communications for the deaf. In addition, the Teldem currently has no connection to Internet or to PCs. If the Teldem could interface to the Internet via the standard PSTN, the connectivity circle could grow, the synchronous circle could grow, and the prospects of independence grow as well.

3 BRIDGES

We propose a series of bridges to make this possible. The bridges begin with a system already in place where a human operator relays communication from a Teldem user to a hearing party on a telephone. Then we introduce various forms of PC and Internet software solutions that offer connectivity from the Teldem to the Internet. The final bridge is the ultimate goal whereby text and speech are automatically converted and relayed between text and voice users in real-time.

The series of bridges are not meant to be incremental. Nor are they mutually exclusive. Each bridge brings with it a unique profile of advantages and disadvantages with respect to the gaps identified earlier. These gaps serve as criteria for the motivation and analysis of each bridge.

3.1 Teldem to PSTN via Human Relay

This bridge requires a human operator to convey the conversation between deaf and hearing parties. Telcos in other countries already deploy this service. Examples include TypeTalk by BT, Relay Service from AT&T in the USA, and the National Relay Service in Australia. It works like this: A deaf Teldem user dials an operator to request a call to a hearing party. The operator has both a Teldem and a telephone. The operator sets up a regular phone connection to the hearing party. Then the operator relays the voice to text, and vice versa, using the Teldem and telephone (see Figure 1).

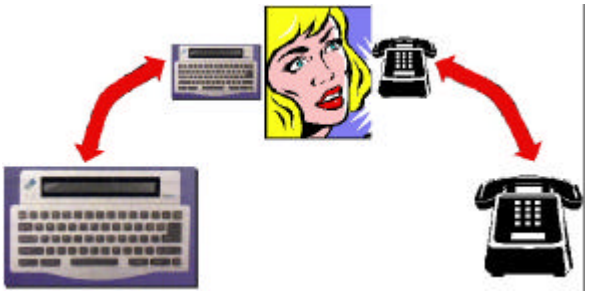

Figure 1 Human Relay for Telephone

Although this bridge requires full dependence on a third party, the synchrony circle is opened up to include the entire telephone public. The Human Relay includes the deaf completely into the hearing connectivity circle. Another interesting aspect is that not having a PC does not prevent the deaf from participation.

Yet the dependence factor introduces a number of disadvantages. First, the deaf user is entirely dependent on the human relay to establish and translate the communication. Confidentiality and emotional overlay is at the discretion of the operator. Furthermore, delay is inherent in the relay process. Lastly, this is an expensive and labour intensive solution.

3.2 Teldem to Chat via Human Relay

This bridge uses a human operator to relay to and from Internet chat tools (Yahoo!, mIRC, AOL IM, etc.) rather than the telephone. A Teldem user dials up the human operator and requests a target party on a chat tool. The human operator has a Teldem and a PC to access the Internet. The operator logs in to the chat system and attempts to establish a link with the specific userid. If the user is online, the operator merely relays text between the Teldem and the PC (see Figure 2).

Figure 2 Human Relay for Chat

This bridge forges connectivity into the Internet rather than the telephone system. It is, however, semi-synchronous at best because a) the intended recipient may not be online and b) the traffic is substantially delayed by both the relay process and the service itself. The independence of the deaf user is completely compromised. However, this bridge does offer a way over the Digital Divide via the Teldem.

3.3 Teldem to PC

This bridge directs communication from a Teldem directly to a modem attached to a PC. We are still exploring whether or not existing communications packages can link up to the Teldem with a TTY interface. It appears that work like this is underway here in South Africa. However, the Royal National Institute for the Deaf [5] in the UK claim they "are currently researching into the area of PC software." Providing the PC software can be found or developed, the PC software acts as a virtual Teldem (see Figure 3). Therefore, a Teldem user can communicate synchronously with any user with a PC. The deaf user is completely independent, and the connectivity circle has grown from the Teldem community to include the ever-growing PC community. However, the Digital Divide in South Africa remains a restrictive factor on the connectivity circle. Most importantly, this is the first bridge without a relay.

Figure 3 Teldem Emulation on PC

3.4 Teldem to Chat via Gateway

In this bridge, a Teldem dials into a web-based call centre. The call centre relays text from the Teldem to a chat tool (see Figure 4). This requires an embedded virtual Teldem interface that can request a destination target from the Teldem user. The call centre performs

the chat tool mechanics in a virtual terminal on behalf of the deaf user. This bridge automates the Teldem to Chat via Human Relay bridge. The significant advantage of this bridge over the relay is the independence granted to the Teldem user. The connectivity, synchrony, and Digital Divide issues remain the same as for the human chat relay.

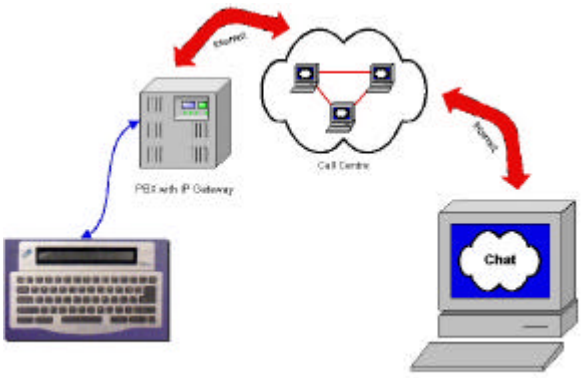

Figure 4 Chat Gateway

Obviously, this bridge requires substantial system design and development. The model for development is the H.323 or SIP to SS7 gateway that allows a VoIP application to connect to the PSTN. In that case, the gateway is transparent to the telephone. In our case, the Teldem treats the call centre as just another Teldem, and the call centre masquerades as a chat client on behalf of the Teldem user.

3.5 Teldem to PSTN via Voice to Text

This bridge adds automated voice to text (and back). This technology has been around for quite a while, but is still not in widespread use. With respect to the previous bridge, the chat tool gateway is replaced by a full-on PSTN gateway that can also convert voice to and from text. This gateway would be even more similar to the H.323 and SIP gateways now being marketed by the likes of Siemens, 3Com, Cisco, etc.

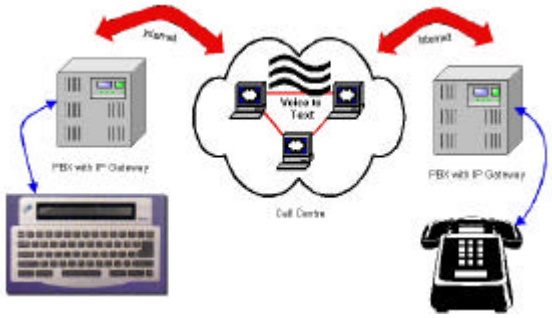

Figure 5 Voice to Text Gateway

Despite the magnitude of the technological challenges involved to produce this bridge, the benefits are manifest. In essence, we have come full circle back to the first bridge between the Teldem and the telephone, but without the human relay.

This bridge would achieve synchrony, connectivity, independent communication as well as lifting the necessity for the deaf user to have any device other than a Teldem.

4 TRIALS

In order to test the efficacy of these bridges, we intend to build on the Teldem trials by conducting a trial for each bridge. First, the technology required by each bridge will be developed and tested. This will be followed by user trials. Each trial will target the four user groups defined above. The singular constant behind all of the bridges is that one party will always consist of a deaf party using a Teldem to interface into the system. The purpose for the trials is to investigate the usability of each bridge, and to formulate comparisons across the different bridges.

The primary research question to the users is - "Would you subscribe to this service?" This applies to both Teldem users and the parties on the other side of each bridge, both hearing and deaf. In addition, we are interested in devising a methodology for measuring the Quality of Communication. We believe that the following issues contribute to the perceived quality of the exchange over a given bridge: presence, influence of 3d party, delays, interface usability, and cost. We also want to ask the users how they would improve each bridge.

5 CONCLUDING REMARKS

Hearing people use the telephone widely, despite the ever expanding range of alternate possibilities. This is because it offers a particular kind of communication that is not available with any of the other options. It is synchronous i.e. communication happens in real time. At the end of a call, both parties are aware of the interaction that has just occurred. This is not what happens in either semi-synchronous or asynchronous methods, where the outcome of a communicative attempt can be delayed for an extended period. Although many of our daily communicative interchanges may well be successfully achieved on the latter systems, we continue to rely on the fact that we have easy access to synchronous options. Until such time as hearing people relinquish all need /want for real time communication, this cannot be denied to deaf people if a policy/ philosophy of equal opportunities and access is to be upheld. We are hopeful that despite the technological challenges, bridges can be built to provide equal access to the deaf.

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