Voice-based Web access in rural Africa

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ABSTRACT

Despite its tremendous success, the World Wide Web can still not used by large parts of the world's population. Therefore, many people, especially in rural areas of developing countries, still do not have access to services and information that are available as a result of the World Wide Web. Given the potential of the Web in improving people's lives, a question is how it can be expanded to serve those living in less privileged conditions. Information must then be reachable regardless of infrastructure, allowing access using also interfaces such as radio and mobile phone. There is widespread use and adoption of radio and mobile telephony in Africa and thus, innovative use of these technologies could help in expanding the reach of the Web. In this paper we present three systems, based on open Web standards, designed and built to fit conditions in remote rural regions in Africa namely, a voice-based (i) trading system, using phone and radio as its interfaces, (ii) a voice-web based interactive news and blogging system and (iii) messaging system. The systems have been developed and have been deployed in Mali. All three systems together showcase the importance that innovation plays in order to make Web technologies relevant in the lives of many rural dwellers in Africa. We show the current status and usage of the systems and discuss how these systems represent our steps into bringing the Web to these contexts.

Author Keywords

Web access; Multi-modality; Developing countries;Voice-based interfaces

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation: Miscellaneous

INTRODUCTION

The Web is a major global platform for knowledge sharing and information exchange. But it is not yet truly global, for example it is not accessible in many rural regions in the world such as in Africa. As demonstrated in the Mobile Web for Social Development (MW4D) Roadmap [1] some important barriers still exist. Firstly, the WWW lacks specific **content** relevant to people in underprivileged communities. This is because availability of locally relevant content can be an incentive for people to access and use the Web. Secondly, as the MW4D also identified, **access** barriers to the Web exist which includes illiteracy, language barriers, and technical obstacles.

By the end of 2010, Internet user penetration in Africa reached 9.6%, far behind both the world average (30%) and the developing country average (21%) [2] and even less in rural areas. Especially, the levels in Sub-Saharan regions are very low due to the lack of required telecommunication infrastructure and electricity. When compared with the Internet usage, mobile telephony has found a substantial acceptance in those regions.

In Africa, mobile telephony has become the primary mode of telecommunication [3]. This claim is supported by a research which has shown that in 2009, Africa showed the fastest rate of subscriber growth, introducing 96 million new mobile subscribers in a period of only twelve months [4]. These developments have projected Informations Communications Technology (ICT) services, especially mobile ones, to have the potential to play a major role in furthering social and rural development in developing economies such as Africa [1, 3, 5].

Many success stories (e.g. studies in fishing villages in India [6], in crop markets in Uganda [7], or grain markets in Niger [8]) have demonstrated the abilities of the mobile services to improve the livelihoods of people in underprivileged communities. Mobile telephony has come from a nice-to-have gadget for the upper-class in the late 1990s to "the single most transformative technology for development", according to development specialist Jeffrey Sachs (quoted by [9]).

In this paper we discuss how locally relevant and contextualized information exchange and knowledge sharing, the key benefit of the Web, can be extended to rural Africa through innovative application of web related technologies. This involves speech, language and the exploitation of the Web in combination with the opportunities presented by the widespread use of mobile phones and radio in Africa. We show this by discussing three deployed systems (Mali). For each system, we describe the context and use case behind it, the design, its implementation and evaluation of results and user feedback so far. We show how these systems cater for local needs and can deliver and distribute localized content. From this, we outline some directions for future for mobile voice-based web services.

VOICE-BASED ACCESS TO THE WEB

In areas where the Web is not available, existing infrastructure namely GSM networks and community radio stations can be used to enable knowledge sharing similar to that of the Web in innovation ways. In rural communities in Mali, for example, the sharing of knowledge is mostly done through community radio stations. There have also been a number of initiatives which have sought to use GSM networks to share knowledge by different organisations.

Currently, many development projects delivering mobile services are based on either SMS (Short Message Service) or USSD (Unstructured Supplementary Service Data). An example is the Esoko[1] platform, a market information platform that sends out agricultural information to phones using SMS. Also, Grameen Foundation and telecom provider MTN [10], have partnered up to offer a variety of services offering agricultural, market or health information on mobile phones; similarly, a suite of "life services" (Nokia Life Tools [11]) is available on certain Nokia handsets, providing information relative to education, weather or market prices.

Unfortunately, SMS is not usable for people with low-reading skills. Moreover, speaking languages are not supported by SMS. SMS enables very limited interactions, and, from sustainability point of view, it is very costly for both the user and the content provider. Focusing on speech technologies represents a significant step in providing mobile ICT services to underprivileged communities. As explained in the MW4D Roadmap, voice applications present a set of specific features particularly adapted to the targeted end-user profile. However, as of today, only few experiences (see the Avaaj Otalo [12], Voikiosk [13]) on using speech technologies to provide social development services have been tested.

This lack of experimentation can be explained by two main factors namely:

- A lack of a standardized free and open-source platform enabling the development of voice applications without advanced programming skills. Examples are proprietary setups like Avaaj Otalo and Voikiosk mentioned above.

- There is also a lack of speech technology elements such as text-to-speech and speech recognition engines in local

languages (see [14]), making the development of voice applications cumbersome due to the need of audio files managements.

The VOICES[2] project was started with the aim to fill the gaps mentioned above. The aim of the project was based on three main thematic areas namely (i) delivering an open-source voice toolbox, and related speech modules (ii) demonstrating the power of this new type of applications on mobile and (iii) helping to identify business models that ensure sustainability of such services. It was envisaged that the three themes will make a step toward exploiting voice applications for social development and opening the power of ICT to people who are out of the scope of currently deployed technologies and services.
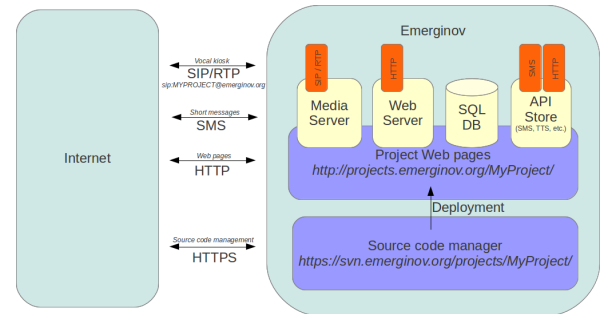

Figure 1. The Emerginov development platform. Credit: emerginov.org

To this end, a standards-compliant mobile service development platform, Emerginov[3] (see Figure 1), was built by partners in the project. The platform is currently in use with plans to package and release it as open-source in the nearest future. The platform provides services such as database backends, remote access for application development, version control and phone channels for applications that require access public switched telephone network (PSTN) interface. The PSTN interface allows access to the applications on the platform through telephone calls. Also partners under the project developed domain specific language packs which could be used use text-to-speech (TTS) engines (see).

We describe in the next sections three systems that we have built and are in use in rural Mali in West Africa using the Emerginov platform and the TTS engines. The systems that were built, RadioMarché, Foroba Blon and Tabale, are systems that were done to satisfy context-based needs. We explain each system and then draw abstractions on it's use and how that has made the Web relevant in these regions.

MARKET INFORMATION DISTRIBUTION

This was a use case on rural farmers in Mali that had a running market information distribution service. The system we built was to mimic the same service through digitizing the information on market offerings per farmer and then making it available both on the Web and sharing it through community radios for broadcast. Among the aims of the system was

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[1]http://www.esoko.com

[2]http://www.mvoices.eu
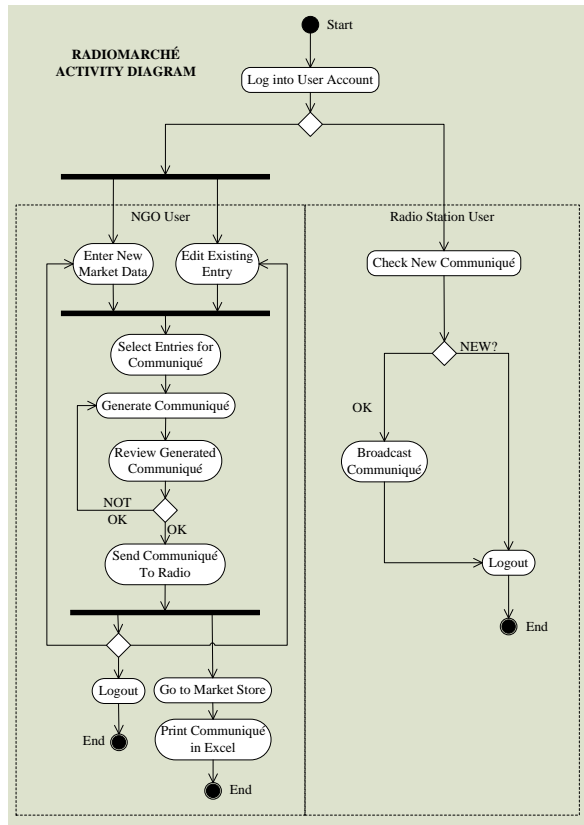
[3]http://www.emerginov.org

Figure 2. Activity diagram for currently implemented system.

to make the initial processes more efficient given the limited time we had under the project to work (the grant was for two and half years). More importantly, we added the ability to provide a digitized version of the information in voice via local GSM telephone networks and thus opening up access to many who are without Internet. The system is called RadioMarché (market on the radio).

Use Case Description

The RadioMarché (RM) [15] m-agro pilot system in the Tominian area (in Mali) was started to augment an already running "legacy" Market Information System (MIS) that was set up by Sahel Eco in 2010. Sahel Eco is an NGO dedicated, among others, to promoting sustainable use of forest resources and develop small businesses based on non-timber forest products. The main product focus of the MIS is on shea nuts, shea butter, honey, wild fruits and nuts. The MIS is used to distribute up-to-date market information via community radio in the area. A Sahel Eco staff member receives offerings from local farmer's representatives in the form of an SMS text message, containing information about a product offer: quantity, quality, price, name of the seller, village, phone number, etc.

The SMS information is entered manually into a collation sheet (Excel in this case). Every week, a communiqué (see) is drafted by the staff member and from a cyber cafe sent to four local radio stations (ORTM Segou, Koutiala, ORTM Mopti, Radio Moutian). Only ORTM Segou is connected to

the internet, Koutiala and ORTM Mopti receive their message by going to a nearby cyber café and printing out the email attachment. Radio Moutian has no internet access whatsoever and so sends over a staff member worker to a nearby cyber café to print out a hard copy of the information.

System Design

We built a system that allows to Sahel Eco manually process the information from the voice/text messages and create the market communiqués in a web form built for the purpose, from which the spoken (audio) communiqués are automatically generated. The activity diagram is shown in Figure 2. The figure shows the series of activities between the NGO and the radio station from when new market information is received by the NGO to when it is broadcast by the radio.

The voice communiqués are made accessible on the Emerginov platform via a phone number from where a direct broadcast by the radio stations via the mobile channel is done. Also built as part of the new system is an archiving functionality that keeps all generated communiqués. Previous versions of the same information (the Excel collated sheet) can also be generated automatically through the system if there is ever a need for it. This was done to ensure that the initial processes were mimicked as much as possible.

Implementation

The system consists of two parts: a web interface and a phone interface. The web interface, among others, provides functionality to authenticate users who can enter new market information data into the system through web forms. The market data can then be composed into audio communiqués which can then be published onto a voice platform which has the phone interface. Other functionality includes communiqué archiving and original excel sheet generation as mentioned in the previous section. The voice platform on the other hand provides functionality to (i) generate audio communiqué(s) (ii) publish communiqué(s) for access by the general public (iii) allow users to record audio messages and many others.

Communiqué Generation

Together with partners under the VOICES project, a template for developing text-to-speech (TTS) systems for low resourced languages, the so-called slot-and-filler method, was developed accomplished for the Bomu and Bambara languages in Mali. This allowed the creation of communiqué in native languages.

An audio communiqué is essentially a single audio file (.wav file) that is generated from the concatenation of a number of other pieces of pre-recorded audio files. The pieces of audio that is recorded is dependent on a number of factors [16, 17]. Some are mentioned below:

1. The system of numbering system of the language involved had to be taken into account. We found out that this is not the same for the Bambara language in Mali as it is in French or English.

2. The number of products to be used in the system. We dealt with a specific number of products.

Figure 3. Implementation of the RM system in Tominian, Mali. On the left, an audio recording and evaluation session is shown. The right part of the image shows part of the hardware setup, including the OfficeRoute GSM gateway.

3. It was important that the generated communiqué represented the natural speaking of a person as much as possible. To that effect, it was not enough to only record words but sentences as well.

4. The pre-recorded pieces of audio files were done in Mali in the voices of broadcast journalists who work with the radio stations. This was done because it was necessary requirement that the voices heard on the radio were those that the community was familiar with.

Once a new communiqué has been generated and published, it is served out through the national PSTN to callers. This we accomplished by interactive voice response (IVR) techniques using the open standardized VoiceXML language. Once this is done, the radio station can broadcast the generated communiqué through their phone to the public.

Implementation Types

The RadioMarché system was realized using two separate technical implementations. In one version, we used cloud-based services (Emerginov) to host the web forms and databases. The local telephone company in Mali provides the system with voice-based access by linking a number of local telephone numbers to this system. The second version of the system is entirely local. This version has the web form and database running on a dedicated laptop. Radio stations that have internet connection can access this network directly via the Web.

The phone channel in the second instance is provided by a voice browser software (currently using the prophecy VXML browser by Voxeo[4]) and a GSM gateway (2N OfficeRoute) device that allows phone calls to be handled by the RadioMarché system on the laptop. The OfficeRoute is connected to the laptop. Figure 3 shows the GSM gateway currently installed on location.

The local version has the advantage that the system can be updated and is accessible through the voice channel even in the absence of an internet connection. The fact that the system is completely localized might also improve local ownership and makes the set-up less dependent on telecom partners. Its downside, however, is the limited on the GSM box to allow only four concurrent calls at a time. The cloud-based version

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[4]http://www.voxeo.com

on the other hand has the advantage that it comes with extensive support, robustness and scalability and supports many concurrent call at a time. The two versions of the system are currently both being used in the field. Moreover, one version act as a backup to the other in a redundancy-based setting, increasing robustness of the system.

Usage and Evaluation

In October and November 2012 user evaluation studies were performed for RadioMarché, that was operational since early 2012. NGO Sahel Eco made a tour through Mali in October 2012 and visited five radio stations and collected feedback on RadioMarché through written questionnaires and talked to buyers triggered by the communiqué announcements and broadcast. In November 2012 the team made another tour in Mali, and held face-to-face interviews, demonstrations, production tests and focus group discussions related to the system. The radio stations were interviewed about the RadioMarché system. Additionally, a number of farmers were asked of their opinion on the usefulness of the RadioMarché system to improve communication and trade.

The feedback received was categorized into two parts namely feedback on usability (voice quality, web and phone interface) and the impact of the system (its usefulness and side effects) since its deployment.

Perceived usefulness of the system

The feedback indicated that in general it can be said that the RadioMarché system improves the communication between the producer of non-timber forest products (e.g. honey and shea butter) and its customers and therefore their trade. The communiqués broadcast on the radio are heard by many potential customers. There have been many phone calls to the producers and to the radio stations by buyers who were interested, the past four months, since the communiqués were regularly broadcast.

Also, the system interface is easy to use for Sahel Eco who collects the information from the farmers. The automated communiqué creation is simple and effective. The radio stations find it easy to use the RadioMarché web and the RadioMarché phone interface and download the communiqué and broadcast the message. Up to present this has been tested for French language only with plans to add the Bomu and Bambara versions very soon.

Effects of the RadioMarché pilot on local trade

From the feedback, it was gathered that the radio broadcasts of RadioMarché communiqués create a demand of honey that cannot be met by the producers. This same feedback is given by radio Mopti, Koutiala and Tominian. The radios ask Sahel Eco to stop the broadcasts of communiqués about honey unless a stock is readily available. They also suggest to create sales points for honey in the villages of Segou, Tominian etc. to take the burden off the radio stations who are called by buyers interested in buying honey. Sometimes the buyers want 100 litres of honey, but this cannot be delivered at once. The transport of the honey is also an issue.

The value chain behind the system is not yet organized. The demand for *nere* seeds is also good. The demand for high quality shea butter does still not exceed the RadioMarché offerings. The service has therefore provided new business ideas for Sahel Eco such as setting up a selling point and organizing producers in a better way to maximize profits and to help make the system sustainable.

Discussion on RadioMarché

RadioMarché essentially is a system built to replace an existing one and to make it more efficient and productive. The idea for the system was conceived after a series of field trips and collaborations with the local people which was an important step because the people for whom the system was built had very little idea of what available technologies could help solve their problem. After a few demonstrations and discussions, the ideas for practically implementable use cases were suggested by the locals themselves.

RadioMarché provides a means through which locals without access to the Internet could make content available with the help of simple mobile phones. The economically benefiting nature of the content provided by the locals ensures it's availability for as long as the service is running. It mimics popular and widely used marketing platforms such as Amazon or eBay. The differences are however that this platform is limited to a few number of products and attached to specific geographical regions. However, the idea behind this have worked quite well with the locals and in some instances created more demands for products than anticipated with it's associated new challenges that never came up for consideration.

Our intervention also gave the NGO a cheap alternative to digitize all market relation information from rural farmers and a means to securely archive this also on the web. Hitherto, all such information was either found on a computer which was vulnerable to breakdown, theft or computer malfunction. Another important improvement with RadioMarché is the control it gave the NGO over what an audio communiqué actually contained. This was because, they had had instances in the past where the radio people either gave out the wrong information and created inconveniences for people involved.

Currently, not all manual processes in the previous system has been completely removed. For example, the NGO still continues to receive text messages to manually process them with the system. This limitation is however being worked on to the point where the system will allow users to make their available products known on their own without relying on the NGO to do this. Users will therefore have the option to call the system to sell their products with a phone call.

There are a number of drawbacks however with the system that do not make RadioMarché readily scalable. We recognise these drawbacks and see them as incentives to improve the system. A major drawback is the limited number of products that the system uses and the need to record new voices once a new one is added. Though this seems daunting, it is a task that can easily be done when distance is not a problem. When the distance is a real challenge as in our case, then new

measures would needed such as ways of recording voices remotely. There are issues also about sustainability and who pays the system. With very low income levels in these regions, there has been the need to draw relevant sustainability models in order that the service continues to run beyond the pilot. These and many other challenges come up and have not been completely resolved as yet.

VILLAGE CITIZEN JOURNALISM

This second use case was developed around how rural radio stations create content and broadcast it through the radio. Here also, we digitize this knowledge using technologies behind Web and build interfaces (both visual and audio) to allow access to this knowledge. The system is named Foroba Blon[5] (FB). Again, the innovative part of this system is the use of local GSM networks in creating and publishing new information.

Use Case

Community radios in rural Mali do not work like traditional broadcasters. They have very few staff members all of whom have to be able to play all the roles required to run a radio: from being speaker, to radio/broadcasting technicians, to producer of a broadcast, to journalist in the field. In this regard, the notion of professional journalists as known in western countries, or in national broadcasters in developing countries, is not the exact same concept for community radio.

The second key element that is a specificity of community radios is the fact that they are radios for the community. This means that the content broadcast is largely determined by what the community wants. A big part of their programming comes from the community: news, stories, information about agricultural techniques, etc. and an important part of the job of the community radio staff is to go in the field and collect this information from the community. This is a time consuming and costly exercise, especially where communities are isolated and roads are bad and because most community radios operate with very limited resources, not all of them can do as much as they would wish. The aim of the proposed platform was to ease this news collection phase by offering a direct channel between the community and the radio.

Finally, one of the major challenges we identified in the field is the inability for community radios to share content between them. One of the major objectives of the platform is to facilitate the connection between staff of the different community radios, and to ensure a greater reuse of content (news, documentaries) across radios. The platform will then enable a community radio journalist to record a broadcast directly in the field and make it available (via mobile phone) to one or more community radios to broadcast when appropriate. This will allow a better sharing on content, and therefore a greater content for each individual radios.

System Design

The key central use case that emerged was simply the following:

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[5]Put together, the two words in Bambara language (in Mali) depict a space where everyone has the right to speak in front of the chief and the truth can be told, but only if it is done respectfully and politely.

1. Make a system that makes it possible that the general public (citizens in general) phones in by mobile and put in their message whatever they want to say.

2. Make the system possible to allow only trusted users to access and publish voice messages for later broadcast by radio stations they are affiliated to.

3. Lastly, provide a functionality in the system that can be used to organize these messages by the radio people including an option to edit and (later) broadcast such messages.

Foroba Blon was then implemented for two categories of users: citizen journalists and radio station staff and their respective call flow interface design for both services shown in Figure 4. In Figure 4, citizen journalists are taken through an initial authentication phase where new users can be registered by their phone numbers. After registration, they are given options to either listen to old reports or send in new ones. Adding new information for broadcast has functionality that allows the user to record and playback audio until they are satisfied with the quality after which it can be uploaded onto the platform. Listening to reports left on the platform also has functionality that allows the user to move through individual messages and, if desired, delete old reports as well.

The interface is similar to that of radio station staff except a few additions. For the radio station staff, there is an added functionality in the reports interface to broadcast a report directly with a phone. An added web-based interface for administrators is also provided, enabling them to manage the data in the data store. It provides a file list where they can access, listen, broadcast, delete files, and add/update/delete meta-information.

The radio station that has no computer nor Internet, has only a very limited interface to the radio platform, since this is the constraint of a voice interface. He receives a welcome message asking if he wants to hear the last 10 messages, or if they want to manage the welcome messages to the end-users.

Implementation

Foroba Blon service was built on the same infrastructure that the RadioMarché service was running on. As such the only requirement was a redesign of the voice interface on the voice platform and building of other functionality, such as a user registration interface required to allow users to register. It was also did not require new technologies but much reuse of the same technologies and techniques behind RadioMarché. The IVR was built in VoiceXML and web technologies used for the web interface. After the system had been deployed, partners were given an initial training and then given phone numbers on the platform which they could use to access the service.

The Foroba Blon radio platform could in theory be physically hosted anywhere in the world, on any webserver, connected to the Internet. However, in an actual Malian case this is not possible. Firstly, the radio platform has to be accessible using an inexpensive local Malian phone number. Secondly, the
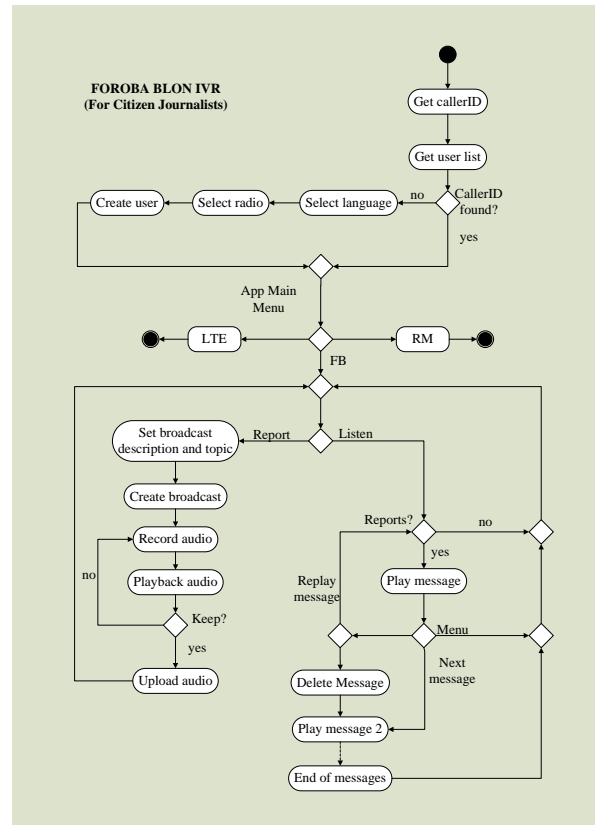

Figure 4. Foroba Blon IVR interface design for citizen journalists.

web service accessed over the Internet must be accessible locally. The local connectivity is usually of low bandwidth and high latency, making voice web services hosted in data centres in the US or Europe, too slow for proper deployment in Mali.

For these two reasons, the system had to be hosted locally in Mali. In the absence of good and reliable data centres or hosting providers in Mali, the radios can decide to deploy the service locally at their premises.

We also observed during the early field testing with Radio ORTM Segou (a radio station part of the pilot) that a visual representation of the call flow was needed to adequately train both the radio staff and the correspondents on the field. This visual aid was key in facilitating easy access by the first set of correspondents, and was also realized that we could cut down subsequently on training time. Due to this, the visual aids were given to each correspondent to their respective locations to enable new correspondents to understand the call flow of the service easily in their own local language (French and Bambara in this case).

After the implementation, the end users of Foroba Blon include:

- Radio journalists from Radio Ségou and Radio Moutian, and Radio Seno, for whom the system was developed.

- Listeners of the radios who want to use the interactive

voice-based system to provide messages to the radio based on interactive programs e.g. "letters to the editor".

- Trusted reporters or *animateurs* who help the journalists by making reports in the villages. These reports are broadcast on the radio.

Usage and Evaluation

Initially, during the pilot phase scoping exercise, we had planned for three radio stations. However based on the excellent responses and keenness shown by additional radio stations that list has now been extended to four. These include Radio ORTM Segou, Radio Moutian, Radio Sikidolo and Radio Saniya also in Mali. In addition to the radio stations we also engaged with a very successful blogger in Mali, Boukary Konate who maintains the popular blog fasokan[6] extending the count to five.

Since the inception of the project we have realized the importance of the organizational setup to roll out Foroba Blon suite of services. There has been sufficient buy in from the top, e.g. the radio management as in the case of ORTM Segou or Saniya Communications – the holding company of Radio Saniya. In addition to this organizational buy-in there also is the need for active correspondents who are linked to such radio stations to gain the real value of such voice based services.

It is expected that where this structure is present the uptake of services would be more due to the catalysing role being played by these correspondents within the local communities. Where such field support is absent the diffusion of real value may take a longer curve. Owing to this organizational learning we decided to drop the general public version of Foroba Blon as it requires extended training, and it is expected that radio stations with a strong correspondent community network will show the best results during evaluation.

Also, during the face-to-face meetings after the launch of the service discussions revolved around several additional features and functionalities for the platform. Some of these that are now to be incorporated in the subsequent iteration are;

- Sharing of broadcasts (like podcasts) amongst the different radio stations.

- Diaspora: Sharing the broadcasts for the diaspora.

- Archiving the broadcasts and making them avail on request.

Discussion on Foroba Blon

This service was designed such that once a community shows interest in it, all that would be required is registering their various *animateurs* and field workers within the system and taking them through an initial training program.

Community radios play an important role in the regions where Foroba Blon was deployed. For rural dwellers, the system provides an avenue to make their voices heard on everyday community and even national issues. It stimulates user

involvement in community building and promotes useful debates and interactions. The essence of this service is much akin to mainstream popular social services such as web blogging. The difference in our instance is the mode of access to such a service and the scope it takes.

Whereas a typical web blog is for all with web access, Foroba Blon is geographically tied to a specific region depending on where it is deployed. However, information from community radios spreads quickly because people in these areas listen to them on almost a daily basis which makes it an important medium of information exchange, a similar advantage that the Internet provides. Providing this service to a number of communities solves a specific problem by facilitating information spread to a specific number of people using the same technologies that are behind the Internet. This service could be expanded to several other communities with similar prevailing infrastructure conditions to form a mesh of information streams from rural community radios.

A MESSAGING PLATFORM

The third use case was to support Sahel Eco with a system to send out broadcast messages to the phones of members of an event in their own language(s). Again, this platform (named Tabale[7]) was implemented using Web technologies to be used for sending out short messages.

Use Case

A registered number of farmers in a certain region (e.g. Tominian area, Mali) is notified by a voice message about time and place of events by Sahel Eco. Farmers can phone back and retrieve the info-message asynchronously. The message is (optionally) issued in several languages.

A staff member from Sahel Eco prepares a voice message telling about the event and a list of farmers, including their phone numbers. The Sahel Eco member then issues the voice message. All farmers who are on the list receive a phone-call with the message. They are asked whether they can attend the meeting. They can also listen to the message again, and leave a message. They can phone later to this phone number to retrieve the message again.

System Design

Figure 5 shows the call flow design for Tabale. The person organizing the event(e.g. the Sahel Eco Webmaster) creates a message for the convocation of farmers for the event. S/he creates a user-list of farmers and their mobile phone-numbers. The message is then issued to the users. Users can phone back later to hear the message again.

A system was then to be built that does a few things. First, it allows a user to a create a user-list and enter user-names and their attributes (phone-numbers and optionally language prefs, group name); Sahel Eco (or webmaster) can create a voice message, delete the message, change the message in the language of the callee. Secondly, the system can automatically calls all participants who are part of a scheduled event

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[6]http://fasokan.com

[7]Tabale is the king's drum again in Bambara language and is used for summoning when there is an emergency or an important event or meeting.

Table 1. Summary of systems deployed.

System	Description	Users	Interface(s)	Launched	Impact	Web-like feature
RadioMarché	A market audio information distribution platform that uses the radio stations as the medium information broadcast.	Built for and used by an NGO.	A web interface for the NGO. + A voice interface for the radio and the public.	Since November 2011	**Merits**: Improved marketing of farm products. **Demerits**: Fixing only a part of a chain of challenges.	e-Marketing on eBay or Amazon.
Foroba Blon	A rural radio/citizen journalism platform.	Built for and used by rural community radio stations.	A web interface. + A voice interface for citizen journalists.	Early 2012	**Merits**: Encouraging better communication of rural the citizenry. **Demerits**: Complex voice interface design.	Online blogging like Wordpress or Blogger.
Tabale	A audio message broadcast platform that sends pre-recorded audio messages to telephones and to which receivers of messages can respond.	Built for and used by an NGO.	A web interface for the NGO + an voice interface for callees.	Late 2012	**Merits**: Broadcast simple, language-independent, short audio messages easily to phones. **Demerits**: Designed for a specific set of languages.	Message broadcast such service such as Twitter.

and delivers a voice message left by Sahel Eco; if there is no response on the initial call, the message is left in the participant's voice mail. The message left by Sahel Eco is also accessible by mobile phone by calling a number assigned to it through a phone dialogue interface. Thirdly an optional functionality allows message issued to be delivered in a default language and in also second language. Local French was used as the default.

Implementation

Tabale was built with technologies behind RadioMarché and Foroba Blon. The system also shared the same infrastructure behind the other two systems. Some selected staff from Sahel Eco were taken through an initial training and then were asked to demonstrate its use unaided. After a few trials, comments on usability were noted and some resolved on the field. Other initial hurdles had to do with bandwidth and internet connectivity which could not be easily resolved.

Usage and Evaluation

In November 2012 the first phase of the Tabale system was deployed in Mali, tested and evaluated by the end-users. User feedback was collected from: main users at Sahel Eco who work from the capital, Bamako, and five contact persons of Sahel Eco in the distant Tominian region.

A number of issues on usage came up after the launch. These bothered mainly on interface design issues both for the web form and the phone interface itself.

- **Issue**: There are three reply options: Yes - attending, No - not attending, Don't know. Don't know can mean either a)

the farmer does not know if he will attend or b) the call was not answered yet (no reply, hung up). **Request**: Different status for: (a) received message but still pending (b) has not received message.

- **Issue**: Many phones switched off for periods due to battery management issues. When voice mail picks up the phone, the system does not register this. Many people here never used their voice mail and don't even know it is there. **Request**: We would like the system to perceive "no answer" or "voice mail picked up". And sets this as status; then calls again after x hours. If voice mail picked up TB should ONLY leave the recorded message because the reply and leave message options do not work.

The importance of the system to Sahel Eco was immediately known to us on the day that initial tests were being carried out. Other possible future applications of the service have been suggested.

Discussion on Tabale

Compared with the other two systems previously mentioned, Tabale is a relatively new service that has been deployed by us. It is essentially a voice version of popular micro-blogging services on the Internet. Once instances of the services have been deployed at various locations, it provides a quick way of sending out pieces of voice information to different target groups of people on their mobile phones to which they can choose to respond or not. Its broadcast functionality makes it very handy to communicate entire communities very quickly and in their own language.
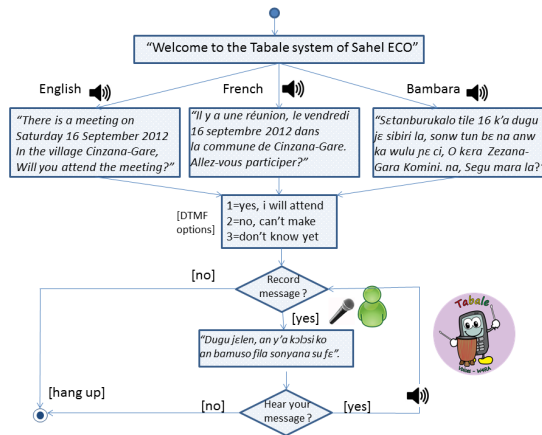
Figure 5. Tabale call flow design. This simplified version was used in training new users of the system.

This "voice twitter" service has the added advantage usage regardless of language and literacy in modern systems. The use of simple mobile phones to deploy this service also means that many more people who otherwise could not be communicated with easily could possibly be a thing of the past. It presents many opportunities for governments to communicate in cases of a disaster or for health related initiatives such as mass immunization.

DISCUSSION AND CONCLUSION

The three systems described (see Table 1) provide the ability for local stakeholders to access Web information via speech using simple mobile phones. Thereby, we have adopted a bottom-up approach involving significant amounts of field work. Although we do not provide universal browser-like access, we argue that by focussing on specific use cases, we promote local uptake and usage. Starting from specific use cases allows us to optimize user interaction and ensures that the systems are actually used since they address real-world problems. Although they do not provide a universal access through the web (as a generic web browser would), through these three use cases, we have investigated the feasibility of a voice interface for three user tasks that are analogous to user tasks prevalent on the (Social) Web:

- RadioMarché provides access to a market place, where people can trade goods. This is analogous to marketplace web sites such as Ebay.com and Amazon and more.

- Foroba Blon allows users to disseminate messages amongst various radio stations. Listeners can be informed on recent activities and events within and around a community or even national issues. This is analogous to web blogging site such as Wordpress, Blogger, etc.

- Tabale allows users to invite people to events, who in turn can confirm or deny their presence and leave a message. This is a functionality that can also be found in Facebook, or event organisation sites such as eventseer.com. Beyond event creation, it can also be used to disseminate short messages to many people at a time, a service that micro-blogging sites such as Twitter offer on the web.

The RadioMarché, Foroba Blon and Tabale Web/mobile services exemplify our approach of making the most of existing technologies to empower people and local communities. Rather than relying on future technologies, or targeting a small part of the population (those connected in 3G and/or possessing high-end handsets), we connect the 2G world. Indeed the existing infrastructure in sub-Saharan Africa is mostly 2G and the migration to 3G (let alone 4G) will not be undertaken soon on a large scale across the continent. In the long term, the three different projects described thus aim at empowering grassroot organizations and local developers to favour the emergence of digital, mobile-centric ecosystems, through 2G-based open source technologies.

Building the web and associated services on now locally available infrastructure and technologies aims at reducing the barriers to their adoption in the communities. Training sessions that were organised at some points during deployment were only designed to help them use the specific service that had been built. Generally, the approach here has been that the widespread familiarity with usage of mobile phones should be enough for the adoption of such services. This is to be contrasted with pretty common strategies where entirely new gadgets and devices are introduced, presupposing a certain interest for technology or people who are technologically savvy.

Our experiences continually reveal how important it is to take the context within which the system will operate into account. An example is that, for RadioMarché, it was a hard requirement to record the voice of the real persons that were known by the community for everyday radio broadcast. As a result, it was not possible to record any other voice(s) for the purpose. This clear limitation was what was traded for user acceptance and usage among local people.

Non-functional requirements play a major role in identifying what needs are to be satisfied among news users. This is especially so when developers of such systems have very little knowledge of the communities within which they will operate. In many of such instances, such projects have been shown to always fail [18]. This can be partly overcome by setting the right environments for local user participation and possible co-creation. By involving as many potential local users as possible right from the beginning of such projects, a lot of context-based factors that have the potential of derailing such projects can be taken care of.

In summary, with the Internet very far from many of these rural regions in the foreseeable future, one needs to rethink and flexibly recombine technologies and do things generally differently in order to attain the goal of increasing the reach of the Web, benefits of information exchange and knowledge sharing. Using bottom-up and partnering/co-creation approaches focused on localized and contextualized use cases is one way to do so.

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