Mobile Web for Development

Abstract

The availability of low-cost mobile phones and the already broad coverage of GSM networks in Developing Countries are a huge opportunity to provide services, based on Information and Communication Technologies (ICT), that would trigger development and improve people lives. A first step in that direction has been the apparition, last two years, of numerous success stories using mobile phones in development. However, there is still a gap between the development of few services that demonstrate the proof of concept, and the availability of thousands of services in all Developing Countries of the World. This paper explores this gap, and the potential solution to fill it with the enabling of Mobile Web technologies.

In a first part, this paper revisits the current technologies, mostly SMS, used in the mentioned success stories, and their abilities to scale well. In a second part, we present the strength of Web technologies, the challenges specific to this context, and the way to address them. In the last part, we introduce a potential program W3C may start to help enabling the next generation of Mobile Web applications for rural communities of the Developing World.

1. Introduction

The emergence of new Information and communication technologies (ICT), the Web and Internet in particular, in late 80s, has changed the World, offering a new paradigm in communication, exchange and commerce. However, while the new Information Society is still developing today, a new gap has also appeared with those without regular, effective access and ability to use these digital technologies. This is known as the Digital Divide, which is particularly affecting Developing Countries.

On another hand, ICTs are also a great opportunity for the Developing World. Providing minimal services (Health, Education, Business, Government...) to rural communities and under-privileged populations is of major importance to improve people lives, and to sustain development. Using ICTs would be the easiest and possibly only way to develop and deploy those services. It is therefore critical to work towards bridging this Digital Divide.

In this context, the recent explosion of mobile telephony in the Developing World is a great opportunity. At the end of last year, according to the GSMA and ITU, the total number of people having accessing to a mobile phone was around 2.7 billions, and 80% of the World population was currently covered by a GSM network (source [1], [2]). These numbers illustrate the potential of the mobile platform to be the right solution to deploy services now, compared to other options, which are still in development phase (e.g. low-cost laptops). The first measurable results are even already available. A recent study of the London Business School demonstrated the impact of mobile phones and associated services on productivity and social development, showing that 10 more mobile phones per 100 people increase the GDP of a Developing Country by 0.6 percent. However, the potential is far greater than this number. Indeed, it is still quite hard to develop, and widely deploy reliable eServices on mobile phones, targeted at specific communities needs.

This paper will review, in a first part, the strengths and the weaknesses of existing approaches used to deploy eServices on mobile phones in Developing Countries, and will emphasis, in the second part, on the Mobile Web option, its potential, and the challenges associated. The last part will be dedicated to present the next steps W3C ([3]) is planning to implement to address the identified challenges.

2. First generation of ICT-based services on mobile phones

For about two years, the use of mobile phones as a platform to deliver services to underprivileged populations and rural communities has been experienced all over the Developing World, particularly in India and some countries of Africa. Many stories have demonstrated the ability for

ICT-based applications to improve people lives and increase their incomes with simple services (read e.g. [4]).
The type and domain of deployed services are very broad, and spanning the whole society. There are lots of examples in the banking area (e.g. [5]), business (e.g. [6]), health and government / public services. Usually, each service has been the result of a specific project directed by a local or an international NGO, or through a governmental experiment[1].
From a technological point of view, most of the projects are using SMS technology, and some, very few in fact, are voice-based (see e.g. [7]). This section will present in details how each type of applications works, and what the strengths and the weaknesses of each technology are to cope with the specificities of the targeted user community.

2.1 SMS Applications

Today, SMS applications are the most common way used in the Developing World to provide eServices. People, knowing the phone number associated with the service, send an SMS to this number with appropriate keywords, and get back the answer by SMS. Sometimes, when there is no interaction needed (e.g. sending weather forecast), it is just a broadcast of SMS messages to people subscribed to the service.

The reasons of the success of this technology are numerous:

- Ease of use for users: using SMS capability of a mobile phone is very easy and natural for users. People are used to use text-messaging for people-to-people communications, and so using the same mechanism to reach a service is easy.
- Availability on all phones: All mobile phones are able to send and receive SMS.
- Low network requirements: SMS don't need high-bandwidth network, and GSM networks are sufficient to run services based on this technology.
- Low and predictable cost: Both with prepaid Simcard and subscription plans, one always knows how much the sending of SMS costs, and it is usually inexpensive.
- Free push mechanism: Except in the USA, the reception of SMS is free. So receiving data, even if it is split over multiple messages, is free to users.

However, there are also some weaknesses associated with this way of providing eServices. These limitations can be classified in two sets, those inherent with the use of textual information for both the input and the rendering, and those specific to the SMS technology.

Concerning the use of textual information, there are 3 major problems:

- Illiteracy of populations: In order to use SMS, people have to be able to write and read. This is a big problem when the aim is to reach populations where there is a high level of illiteracy. That said, while this would be a problem if we want to reach each individual, it could be of less importance in the case of community-shared phones, which is a very usual case in the Developing World (a well-known example is the phone-Ladies in Bangladesh. Read [8]), where the need would be to have only one person with the abilities to read and write.

[1] It is interesting to note that the case of m-banking notably differs. While now lots of operators in e.g. Africa are offering a full official currency-based m-banking system for their customers (see e.g. M-Pesa at [9]), the system originally came from the field, as a side effect of the capability offered to people to transfer airtime from one simcard to another (read e.g. [10] about it). People then were using airtime as a new currency, and were able to buy and sell goods, send and receive money to and from family, relatives, friends… and so on. This specific case emphasis the need to empower people that will discussed later in this paper.

- Limited input capabilities of mobile phones: This is a general problem, not specific to the Developing World. Mobile phone keypads are very limited to type text information, and this is preventing people to enter quickly an important amount of data.
- Internationalization: This is also a general problem with textual information not specific to either mobile phones or the Developing World. Inputting or rendering non-Latin characters is a global challenge which is out of the scope of this paper. Detailed information on the actual state of the art can be found at [11]. The importance of this aspect has been illustrated by a recent story on the boom of SMS since the availability of read and write in local language in Ethiopia (see [12])

Out of these limitations which are common to all textual approaches, there are also specific weaknesses inherent to the SMS technology:

- Discoverability of services: People who are not aware of existing services have no way to find them, to find the right phone number to call and the right keywords to enter, and so on.
- Interoperability between operators: While sending person-to-person SMS is not a problem between operators, sending SMS-data across operators is a clear limitation of this technology (Read [13]). For example, banking systems based on SMS are working between users of the same operator only (Read [14]).
- Lack of standardization for application development: there are no standardized platforms or programming languages and libraries to develop SMS applications. There are few free/open-source environments (an example at [16]) and few commercial ones (an example at [15]), but the knowledge required to develop those applications is very specific to each platform.
- Infrastructure requirements for hosting and deployment of SMS services: Each SMS-service needs its own specific infrastructure. Due to the above-mentioned interoperability problem, and also due to the lack of widely available and affordable hosting services, the setup and deployment of a new service requires a quite heavy infrastructure (a computer to host the application, a GSM modem, a GSM subscription…) not particularly appropriate with the conditions available locally (PC are expensive, electricity problem, …).
- Limited User Interaction: SMS applications are a perfect fit for simple query-based services. People are entering one or two keywords and get the answer. Given that there is no direct interaction, no online-help of any kind, people have to remember the keywords and the format to enter them, and so the list of these keywords has to be limited. Complex multi-cycles interactions in such stateless environment are almost impossible to implement. The availability of only “raw” text (no style or decoration techniques available) could also be a problem to attract user’s attention on important points.

While SMS-applications are clearly the most used techniques to offer eServices today, we think that this is due to the lack of better solutions. Given the mentioned intrinsic weaknesses, we can’t see how it could be possible to deploy a big numbers of services at a large scale, targeting a population of millions of people.

2.2 Voice Applications

Unlike other types of applications, Voice applications don’t have any specific module on the mobile phone. People are just placing a traditional phone call at a specific phone number to reach the voice platform from which the service is accessible. From there, navigation through the application is done either by voice input (the user speaks to the application) or by pressing the phone keypads. This type of applications has some specific strengths:

- Easy to use for illiterate people: the usage of Voice applications doesn’t require the ability to read or write

- Easy input mechanism: The voice of the user or just pressing one key of the keypad are the most easiest and natural way of interacting with an application.
- Low and predictable cost: the cost of the usage of the applications is the cost of the phone call, based on the length of the call. So people know exactly how much they are paying for accessing a service, and voice service is the cheapest service.
- Low network requirements: Given that the network is just used for its voice service, they are no requirement on the characteristics of the network.
- Operator Independence: As far as the operator is allowing its user to call any number in the world, all voice platforms in the world are accessible from any phone.
- Standardized application development: There are now easy and standardized ways to develop Voice applications based on VoiceXML technologies ([17]), which would work on all Voice platforms complying to this standard. This family of markup languages takes also advantage of the power of the Web, and could be used to provide Web access to people not being able to read and write.

Despite these specific features, there are also issues that may delay the adoption of voice technologies in a near future:

- Discoverability of services: like for SMS, people who are not aware of existing services have no way to find them, and to find the right phone number to call. However, this problem is of less importance in the case of Voice applications, as with the power of technologies like VoiceXML and the Web, it is possible to consider deploying portal applications: People would have just to know the phone number of the Voice portal from which they could access a list of services that could be easily/automatically updated.
- Cost of application hosting: While the development of voice applications is easy and affordable, the hosting is extremely expensive. Setting a voice platform on which run the application, with a good voice recognition software and a good speech synthesis engine is very expensive. It is, of course, possible to use one of the existing hosting services in the World, but it doesn't make too much sense in the context of Developing Countries, where users would have to make expensive international phone calls to reach the service. Such platforms should exist at the country level, but still requires heavy investments.
- Availabilities of languages: most of the power of Voice applications is coming from the ability to process and generate natural languages. Unfortunately, as of today, speech recognition has some success in the most used languages (English, Spanish, French…) but is not available for other languages. It is the same for speech synthesis. Even if there are ongoing work on internationalizing SSML (e.g. [18]), we are not at a stage where this is a reality now.
- Hard authoring and design: While it is quite simple to develop basic, keypad-driven Voice applications, using the full capabilities of speech recognition is another degree of complexity. Writing grammars and complex interactions needs good experience in usability to avoid bad user experiences. Understanding that users are not "visualizing" the content is one of the key difficulty in voice application design.

Eventually, Voice applications clearly have the right potential to help in some specific areas, particularly to tackle the literacy problem. However, particularly in the speech synthesis domain, further research is necessary before considering voice technologies as the recommended way to provide eServices. Even if the technology was appropriate, such applications would require investment at a country level, and the complexity of application development will still be a barrier to enable local people. Like for SMS, Voice applications are a potential solution in some specific projects, but we don't believe that it has the potential to be the right solution to provide a huge number of services all around the World.

While all the existing success stories demonstrate the potential of mobile phones to be the most promising platform to deliver services to rural and under-privileged populations of Developing Countries, we doubt that the current technologies would allow a large scale development and deployment of applications. Moving from “islands” of successes as it is today, to a World where thousands of services are available, usable and useful for under-privileged populations is a huge challenge which could hardly be tackled by SMS or Voice applications. We believe that only the switch to Web technologies will allow this transition, and we will present, in the next section, the roots and rationale of this view.

3. The next generation of mobile applications: the Mobile Web

The Web is clearly an incredible space of communications and exchange as well as an endless source of information. For that reason, W3C, the standardization organisation for all Web core technologies ([3]), has a mission to work toward Universal Web Access (the Web for Everyone, at Anytime, from Everything). Enabling Web access from mobile phones is part of this mission, and is the specific work item of the W3C Mobile Web Initiative ([19]).
However, providing access to the Web may not be a goal by itself for rural communities. The aim is to provide services to populations using the power of the Web as the support for facilitating the development and the deployment. Among its numerous features, the Web has indeed some specific strengths in this context:

- Discoverabilities of services: Search engines and portals are the natural existing ways to discover existing and new services. Given the state of the Web today, their scalability has been largely demonstrated.
- Operator Independence: As far as the operator is providing a data service plan with full Web access, there is no interoperability problem.
- Easy development of services: Using e.g. standardized interoperable markup languages like HTML, Forms, CSS to create content, using programming languages like PHP, ASP, Perl, Python, and databases to manage information is very easy due to free availabilities and a huge amount of resources. This is probably one of the strongest argument that explain the growth speed of the Web, Allowing anybody with minimal knowledge to create Web resources ensure the availability of a huge number of information. Where SMS and Voice applications require heavy and expensive platforms, specific knowledge and skills, developing Web content would be far more accessible, and the effort required to empower local people will be far smaller.
- Easy hosting and deployment: Once the application is developed with above-mentioned tools and technologies, there are thousands of very inexpensive / free hosting services over the Web. Here again, where SMS and voice platforms requires investment at a global level, it is very easy for anybody to host his applications and content. Moreover, no further advertisement would be required to make this content available, thanks to search engine.
- Good user interface: It is very easy to create simple-to-use but complex interaction between the user and the application thanks to e.g. HTML forms. As previously presented, making usable voice applications is a real challenge, and the limited capabilities of SMS do not allow multi-cycle interactions.

These specific strengths let us think that Web Technologies are the most appropriate way for future large scale, low-cost development, deployment and availabilities of ICT-based services on mobile phones.
However, there are very few success stories today about Web usage on mobile phones in Developing Countries. This is due to the existing challenges requiring appropriate adaptation of

existing standards, and new ways of developing content and applications. We will explore in the next section of the paper what are these challenges, and which actions could be engaged to tackle them.

4. Challenges of the Mobile Web for Development

The strengths of the Web are obvious, and its incredible success in the last ten or twelve years illustrate them. The recent take-off of Mobile Web access in the Developed World is also an evidence of the importance of Web access on mobile phones. As underlined in the section 2 of this paper, the potential of the mobile platform in development is also clear. The question is to know if these two aspects fit together, and if the Mobile Web is a promising opportunity for Developing Countries.
Lots of people are indeed doubtful on the potential of the Mobile Web to be a solution to improve people lives, and leverage development of rural communities (read [20], [21]).
We will review in the following the usual problems people are considering.

4.1 Cost of data access

Lots of people think that data service and web-capable handsets are very expensive, and rural communities would never be able to afford them for Web browsing. This is true, if we consider only the cost of the access. The critical aspect is the return on investment. It is very unlikely that a crop producer in rural India would spend the required money to surf the Web for entertainment, because he would consider the money wasted, and not invested in his basic needs. At the opposite, if accessing a service to declare his new children costs him a day of salary, but the travel to the nearest office would require more than a day, then he would surely go for the online version. This specific aspect has been very well studied in the literature (see [4] and [22]). Moreover, the overall model of the mobile telephony, concerning the voice service, is here to illustrate these theories. 4 or 5 years ago nobody would have bet that Developing Markets could be a business opportunities for Mobile players, and now they are considered as the most beneficial ones. All the models which worked for the voice service (community shared access, phone ladies model [23]…) are able to work for data access too. So the cost of data access should not be a problem only if valuable content and services are available to potential users.

4.2 Availability of high-capacity networks and high-end handsets

If we look at how the Mobile Web has been evolving in Europe, US or Japan last 2 or 3 years, we can see that the trend is to aim at providing the same user experience as on a classical desktop machine. Device manufacturers, operators, browser makers… all mobile players are working in that direction. Given that Web content in 2007 are highly multimedia, with video, sound, picture and so on, high capacity networks and powerful devices are indeed required to access those. Are these requirements the same in our context? Probably not. One would not need sound and video, or color screen to provide useful services to community. And therefore, GSM should be perfectly ok to deliver quickly that kind of services. Again, the success of the SMS applications illustrates this aspect. Unfortunately, as of today, all the low-end devices, targeted at Emerging markets don't have a web browser. Such capability appears usually in the expensive devices. This is clearly a problem, and a potential limiting factor. But is it technically challenging or costly to provide basic browsing capabilities on low-end phones? We tend to think that it is not. Indeed, what is really required is at least a minimal browser being able to render xhtml basic, css mobile, and probably also a simple image format. Late 90's, all mobile phones had such minimal capabilities with the availability of WAP browser. It was not Web standards, but a specific markup (WML), but it was very close to xhtml-basic. So having a similar capacity today on all phones is not a hard thing to do, is not technically challenging, and does not require a very

powerful handset. The current lack of such a minimal browser is most probably due again to the lack of demand from users, because of the lack of useful content.

As we can see, the critical problem is to make useful content for rural communities, content that would help people in their daily lives, and allow them to get more income and afford the service. In the last part of this section, we will focus on defining what is a useful service or useful content.

4.3 Usable Content

Before being useful, a service or content has to be usable. The usability aspect, heavily explored in the application design literature (see e.g. [24]), is particularly critical when developing services towards users without technological background. Indeed, the users targeted by our work are clearly people of rural communities in Developing Countries. Those people usually present two specificities: no previous computer experience, and no technical background (in computer science, and computer-based application in general).

In the specific context of Web applications, the user interacts with both the browser, and the Web content loaded. Therefore mobile browsers and Web applications have to be accessible and natural for those without previous desktop experience, and without technological background.

Concerning browsers, there are different issues to consider. Usually, the configuration is the first problem. While placing a phone call or sending/reading an SMS is almost obvious on all handsets for almost anybody in the World, configuring a terminal to access the Web is very far from being natural and easy. Only expert users can do that configuration themselves directly. So given that this is already a problem for most of users in Europe or US, it is hard to believe that this would not be also a problem of a higher degree of magnitude in Developing Countries.

Then, the interaction with the browser is also a problem. All the usual menus and interface have been defined by reproducing what exists on usual desktop applications. The notion of URI is also less than natural. It is not possible to believe that people would enter a meaningless string of characters by hand, through the keypad.

To end, the way of rendering Web content has also to be redefined. As said earlier, the current trend in the Developed World is to focus on providing the same experience as on desktop. For instance, towards reaching this goal, browser makers are developing zooming interface ([25]). These kinds of interfaces are very successful to allow anyone to access on a small screen content which is defined for big desktop screen. But are such zooming interfaces natural for those who never been on the Web before? This is questionable. A new way of interactions with the browser should probably be defined, and there are ongoing researches in that direction (read [26]).

Concerning Web content itself, the problem is identical. There are some challenges that are related to the specificities of the mobile platform. These challenges are currently addressed by the W3C Mobile Web Initiative ([19]) and are not specific to context of this paper.

There are also specific challenges inherent to the targeted users. It is essential to understand what is natural, in terms of interaction between the user and the content for those who never used ICT-based applications (read [27]). Here again there are few ongoing researches in that area, but not related to the specificity of Web content. It is therefore critical to revisit these researches and their applicability.

To end, there are also specific challenges on content accessibility which are currently addressed by the W3C Web Accessibility Initiative ([28]). However, further work is needed concerning the problem of illiteracy which is particularly affecting Developing Countries.

4.4 Useful Application

While offering usable content and browsers is a mandatory step to make the Mobile Web relevant, the major goal is still to provide useful applications which would really improve people lives. The question is to understand which (type of) services or content would be considered as useful by targeted populations.
It is very unlikely that we could define a list of applications that could be considered useful by all, all over the World, from Kenya to India, or from Bolivia to Sudan. Of course, there might be some particular examples. M-banking is surely one, because it is a common process worldwide (exchanging money) and therefore making such a service available to all is very important. But for other services, there are probably big domains to tackle (education, health, public/government, business…), but trying to define a list of services to provide to communities would surely not work (see e.g. [29]).
At the opposite, if we analyze the success stories we mentioned before, we can see that they are sharing the characteristic of enhancing existing behaviors or way of working or living. Attempts to radically change the habits are usually not working. All the successful projects are usually the result of in-depth analysis of a community, with the involvement of local NGOs working with the community for a long time.
That said, there is probably a place for general guidance. Each project has developed its own expertise, but there are surely commonalities, and a way to define some guides that would help the identification of the areas where a service will be useful. It should be possible to gather expertise which has been developed through the realization of existing projects, plus theoretical knowledge from e.g. the ethnology field, to develop guidelines on identifying areas where ICT-based services could help and leverage development of specific communities of the Developing World.
The case of public/government services is notably different. It is not up to a specific community to define the government services. This is up to the government bodies to analyze the mandatory interactions between the citizen and the state and then provide those services to the communities to ease their communications with the state. If Government working on eGovernment framework wants to take advantage of the eServices to leverage and facilitate the interactions and relationships with rural communities, and if they want that to make their program successful, they have to take into account the specificities of the mobile channel, and the way to make usable services as described in the previous sections, and that at the early stage of requirements, and not as an add-on at the end of the program. W3C is currently starting to explore the area of eGovernment framework (see [30]) and will take into accounts the specificities on the Developing World, and the case of M-government as described here.

To summarize this section, we don't believe that rural communities of the Developing World would find today a real value to access existing Web resources from their mobile phone. However, Web technologies on mobile phones are a great opportunity to deploy a big numbers of application at large scale and low-cost, enabling anybody to start and run new services. In order to make this potential a reality in a near future, specific work has to be engaged, particularly in the area of Human-Computer Interaction (HCI) applied to the targeted users, and in the area ICT for development (where and how ICT can leverage development).

5. Next Steps
As underlined in the previous section, to make the Mobile Web relevant, usable and useful for rural communities of the Developing World, it is essential to engage work in different directions:

- Making usable mobile Web browsers.
- Defining guidelines on how to make usable Web content and applications for people without previous computer experience, and without technological background.
- Defining guidelines on how to identify needs and requirements of communities in terms of ICT-based services.

Obviously, those broad directions have to be refined to establish detailed and achievable goals and deliverables in a short and realistic timeframe. W3C will propose the creation of a specific Interest Group ([31]) to address the definition of this roadmap.
In order to be successful, such initiative should also integrate some other critical steps we will explore in this section. Indeed, the success of the approach, like for any work at W3C, will rely on the participation of key players, and essential stakeholders. Here, we need to engage different communities which are not yet working together:

- Mobile players: clearly handset manufacturers, browser makers, and network operators are key actors to work with in order to ensure that results would be implemented. W3C is already connected this community in its Mobile Web Initiative
- Those with field expertise: local and bigger NGOs, local communities, those involved in specific projects… there is already a number of people who already drove successful and unsuccessful projects, and acquired a specific expertise on having rural communities taking advantage of ICT. It is essential to build on existing expertise, and involve those with this expertise.
- International organizations which are working at a worldwide level: While the above mentioned organization are working at a local level, and are particularly aware of the specific aspects of the communities they are working on, it is also important to involve those working at a higher level, and at the worldwide level. These organizations, while missing detailed field expertise, have a more global view on what is the Digital Divide, and what are the region or continent-wide actions that could have some impact. They also usually have direct links with local implementers of their program.
- Academics from the Developed and Developing World: lots of the topics mentioned in this paper are still in the research area, and it is critical to involve academics exploring them. It is also very important to engage people who are developing curriculum at universities for them to include the results of this work.

The involvement of representatives from all these communities is essential to ensure that all aspects of the problem will be tackled.
Another critical step to take into account is the dissemination. As mentioned in a previous section, a huge number of useful services will effectively appear only if lots of people know how to develop them. It is important to work on the appropriate technologies, but without empowering people, it would have no effect. In our context, the targeted audience is clearly IT sectors of Developing Countries, students and future actors of these countries too, and people from all over the World who are interested to work in the development sector. It is therefore critical today to work on setting up new curriculum at Universities of the Developing World that would teach students how to develop ICT/Web-based applications on mobile phones.

Concerning the problem of illiteracy, as mentioned before, it is obviously another key point to take into account in order to provide services to billions of people.
However, this is by itself a huge domain not specific to the Developing World, even if they are more affected. Clearly, here again, Web technologies are far more able to cope with this issue than e.g. SMS applications. There are ongoing researches exploring for instance the use of meaningful icons (see [32]). W3C, in the Web Accessibility Initiative, is aware on the importance of this issue (see [33]), and this is a subject we will focus on in the future.

6. Conclusion

Clearly the mobile phone and the availability of GSM networks in Developing Countries are a great opportunity to bridge the Digital Divide, and to provide minimal services to rural

communities. While the proof of concept has already been made through numerous success stories, the technology used so far, SMS, will not allow a large-scale, low –cost development and deployment of services. Today, only the use of Web technologies on mobile phones would help reaching this goal. However, some adaptations are required to make the Mobile Web relevant and useful for the targeted communities. This concerns mostly the interfaces between people without prior experience with ICT and without technological background, and the applications (mobile browser, and Web content and applications). It is also critical to develop expertise and guidelines on how to identify the exact needs and requirements of specific communities in terms of ICT-based services. Eventually, a particular attention should be set on empowering people and enabling them to use the materials we will develop.
W3C is planning now to launch a specific Interest Group to focus on building the appropriate community with representatives from all parties, and define in details a roadmap that may be tackled by a new activity or initiative in a near future.

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