The Mobile Web to Bridge the Digital Divide?

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Abstract: One of the most promising directions to bridge the Digital Divide is to provide eServices on mobile phones. This paper compares the three major ways of providing applications on such devices: using SMS, Voice and Web technologies. The Mobile Web being seen as the most promising option for the future, we explore, in the second part, a potential program for a new W3C Initiative to leverage the adoption of this technology. This program is structured around three major items: enabling browsing capabilities on existing and future phones for emerging markets, exploring how to build and deploy useful eServices by taking into account human aspects like social and cultural specificities, and building capacities through education for developing countries to develop and deploy their own eServices. To conclude, we also present the business interests of each actor of the mobile market (handset manufacturers, network operators, browser makers, service providers, and users) to participate in this potential future initiative.

Keywords: Mobile Web, Mobile Phones, eServices development and deployment, Digital Divide, Developing Countries

1. Introduction

The “Digital Divide” is defined as the gap between those with regular, effective access and ability to use digital technologies and those without. An important step in the direction of filling this gap has been the deployment of mobile networks all around the world. For example, as of today, more than 80% of the World's population is covered by GSM, and more than 2.4 billions of people have access to a mobile phone (Source [1]). With one million additional people newly subscribed every day, it is expected that by the end of 2010, almost 4 billions will have access to mobile phones.

While accessing phone services is very important, the gap will be more completely filled when access to a higher level of information technologies will be widespread. If there is a general agreement among specialists that mobile phone is the right device to deliver eServices to rural communities and under-privileged populations, the nature and the support of those eServices still need to be defined.

As of today, there are three major ways of developing and deploying eServices on mobile phones:

1. SMS applications: people are sending requests by text-messages to a specific phone number, and get the result with a new text-message they receive. (Example at [2])
2. Voice applications: people are calling a specific phone number on which is connected a voice platform and with either voice or keypad inputs, they can have the information they are looking for.
3. Web applications: people have a Web browser on their phone and a data-service plan which connect them to the Internet and allow them to browse the Web.

This paper will explore, in a first part, the strengths and the weaknesses of each approach, and will emphasis, in the second part, on the Mobile Web option, seen as the most promising way to bridge the Digital Divide. We will also explore what are the blocking factors and what are potential directions to enable the Mobile Web in Developing Countries.

2. Objectives

This paper is not presenting the results of scientific researches, neither it is a detailed approach to cope with a specific problem. It should be considered as a white paper describing the major directions of a potential initiative W3C ([18]) may launch in a near future. This project is an attempt to formalize and integrate the results of the discussions which took place during the W3C International Workshop on the Mobile Web in Developing Countries ([21]) in December 2006.
The aim of this paper is to trigger discussions with experts in this area, in order to reach consensus on what should be the roadmap to eventually bridge the Digital Divide. The set of directions explored here should be considered as a preliminary program aimed at gathering feedback and building a critical mass of participation.

3. Which Mobile Applications for the under-privileged?

Providing minimal services (Health, Education, Government...) to rural communities and under-privileged populations in Developing Countries is of major importance to improve people lives, and to sustain development. Since many years, we know that using Information and Communication Technologies (ICT) would be the easiest and possibly alone way to develop and deploy those services. Now, with the explosion of mobile telephony and the incredible penetration rate of mobile phones in the Developing World (Read [4], [5]) compared to PC or even fixed-line telephony, it is clear that those devices are the natural mean to support and provide services. A recent study of the London Business School ([5]) 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 probably far more important than the current usage. Indeed, it is still quite hard to develop, and deploy reliable eServices and reach targeted communities. We will present in this paragraph the three major ways of providing applications on mobile phones with their respective strengths and weaknesses.

3.1 - 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.

There are numerous successful stories in various areas like banking ([7]), business ([2]) and government ([8]). The reasons of this success are numerous ([9]):

- Easy to 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.
- Available 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 which are also common with the approach described in section 3.3 of this paper:

- 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 [10]), where the need would be to have only one person with the abilities to read and write.
- 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. There are ongoing researches on how to improve input speed with limited keyboards, but this is out of the scope of this paper. An example of such work can be found at [12]
- 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].

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 [6]) 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.

3.2 - Voice Applications

Unlike the two other types of application presented here, 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 Independency: 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 ([16]), 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 which are directly relevant to the Developing World, 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 ([17]), 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 were appropriate, such applications would require investment at a country level.

3.3 - Web Applications

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 ([18]), has a mission to work toward the Universal Access (the Web for everyone 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 ([3]).

However, providing access to the Web may not be a goal by itself for rural communities. The aim is to provide eServices to these populations, but using the power of the Web as the support for facilitating the development and the deployment of these services may be the right way to overcome the current limitations of e.g. SMS applications.

There is no point to try to develop all the strengths of the Web, but just to focus on those which are the weaknesses of other approaches:

- Discoverabilities of services: Search engines and portals are the natural existing ways to discover existing and new services.
- Operator Independency: 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.
- 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.

- Good user interface: It is very easy to create complex interaction between the user and the application through multiple cycles.

However, out of the general problems of textual applications described in section 3.1, there is also a set of specific blocking factors for the Mobile Web to be widely adopted in Developing Countries:

- Network requirement: As of today, good web browsing experience requires high bandwidth (GPRS/EDGE/3G) not widely available in Developing Countries.
- Phone requirements: Mobile browsers correctly implementing W3C standards are working on high-end phones. The memory, computing power, and screen requirements for those browsers to provide a good user experience are very high and really available only on smartphones.
- Human factor: Like for other technologies, taking into account the human factor is of primary importance. While concepts like URI, Navigation, and Hyperlinks may be considered obvious to people with a past PC-based browsing experience, they also could be a barrier for those without any experience in accessing the Web.

As of today, there are very few web-enabled mobile phones in Developing Countries. The major reasons are probably the first three or four cited above. However, there are also successful stories ([19]) about Web usage through the old WAP 1.0 access which demonstrate the potential of such approaches. We will explore in the next section of the paper what could be the enabling factors for the Mobile Web, and what would be the benefits for all actors.

4. Enabling the Mobile Web in Developing Countries

In this part of the paper, we are going to revisit each of the blocking factors we identified in section 3.3 and propose potential options to remove them.

4.1 – Enabling Web browsing on phones

Obviously, the first step is to understand how it could be possible to enable Web browsing on mobile phones existing in Developing Countries. Without Web browsers on phones, there is no point discussing the interest of the Mobile Web.

A first position could be to think that the situation would naturally evolve without any action. Given the fact that the current phones available in the Developing World are the phones which were in the Developed World 3 years ago, one may think that in 2-3 years from now, features-phones would be the basic developing markets handsets. That's possible indeed, but the evolution could also be different. Indeed, we can observe today that handset manufacturers are now developing specific product lines for Developing Countries. These products, like also the GSMA Emerging Market Handset programme ([20]), are focusing on low-cost and robustness, and there is no web browsing capabilities enabled. So there are also chances that those product lines would become the most widespread devices in Developing Countries. So it is very important to understand why the Web access feature is not enabled.

We discussed this issue at a recent Workshop on the Mobile Web in Developing Countries ([21]), and the reasons which came out where the following :

- Phones could host a WAP 1.0 browser but there is almost no WML content available, and so there is no demand for such feature.
- Phones limited capacities in memory and computing power are not able to host modern mobile Web browsers.

- Even if, the capacities were enough, accessing the Web through a GSM data network would be a so bad experience that nobody would use it.

From these three remarks, the solution is obvious: we would need a web browser with a size of a WAP 1.0 browser, but being able to render light (text-only) Web content - i.e. supporting (part of) (x)HTML and CSS at least. Such browser would fit on low-end phones, and would not require high-bandwidth. The exact characteristics of such a browser would need further work. First of all, it would be important to collect data about phone characteristics currently on the market or planned to be released in the next year. Then from those characteristics, it would be possible to define and standardize a specific XHTML profile ([22]) that would include the appropriate piece of XHTML and CSS.

As explained above, there are 2 directions to follow here. First of all, it is important to work with international organizations which are defining the specifications of phones aimed at emerging markets, for them to integrate in their requirements browsing capabilities. An example of such organizations is the GSM Association ([28]) and its Emerging Market Handset Program ([20]). Liaison and Cooperation between W3C and GSMA would be a key for the success of any initiative.

Then, if this would ensure that future phones have Web capabilities, this would not solve the case of the existing phones on the market today. Given the importance of the grey market, and second-hand phones, it is very difficult to estimate how long it would take for new phones to reach the majority of users. For that reason, it is of major importance to cope with the current market as it is today.

The question is to know what the market is, and if there is just one market or some characteristics depending on the region. As a first step, we should gather data on available phones, and find out what are the minimum characteristics we could rely on, in terms of display, memory and CPU power. From such numbers, we would be able to define the requirements for a Web browser to be deployed at a large scale.

One may think that a Web browser with limited capabilities would mean specific contents aimed at those browsers, which would define, in some ways, “the Web for the under-privileged”. This would be a wrong view of the aim of this program. Since its creation, W3C has always been fighting for the One Web Vision. Particularly, in the mobile world, W3C has been fighting against approach like WML, creating walled gardens. Our idea here is to provide a minimal way of accessing the entire Web. Of course, this would not be the Web of entertainment, with video, sounds, and nice photos, but the Web of information, enabling people to access any web sites and get the information embedded in the rich page. If authors are following appropriate guidelines ([23], [24]) to make accessible, mobile-aware content, they could design rich pages, with big graphics, and multimedia content for full web browsers, and let people with limited-capabilities browsers accessing the information described in the document. Classical examples are sites like eg Mappy or Google Maps delivering driving instructions: Clearly, having a GPS plus a real-time updated map is the best way to go, but having a list of textual instructions would also allow a user to reach his destination.

4.2 – Enabling eServices for under-privileged populations

Creating such a profile that defines the characteristics of a lightweight web browser is the first step but not enough to leverage developments of eServices for under-privileged populations. Indeed, as we mentioned it in section 3.2 and 3.3, it is fundamental to take into account human factors. People would use services if they are configured on their phone by default and if the user interface is easy and correspond to their expectation.

In order to promote the development of usable eServices for rural communities, the next step would be to setup a joint group between people experts in Mobile Web technologies, and people experts in human factors (anthropologist, people with ground experience…) to create best practices and guidelines to design eServices for rural communities, along with tools to support those guidelines (validators, checkers …).

The aim here is not to create new technical guidelines to help people authoring web documents for limited-capabilities browsers. As we explained in section 4.1, there are already existing technical guidelines for accessibility and Mobile Web ([23], [24]). The idea here is to understand how to take into account aspects like social and cultural specificities to design E-services that would be useful and usable for targeted populations.

We are anticipating that such usability aspects are probably specific to the region it applies. So it may be interesting to develop a general methodology as well as some specific hints based some regions of the world (sub-Saharan Africa, Latin America, south-east Asia…).

4.3 – Enabling Communities

The importance of standardized technologies, like the one proposed in section 4.1, with appropriate extra information on how to use them, like tools and guidelines proposed in section 4.2 are of primary importance to enable communities to develop their own applications or services. Indeed, lots of studies like [26] demonstrate that only people from a specific community know what would be the most important services for this community. So it is a key factor to teach people how to develop their own applications.

Unfortunately, as [27] is showing, most of computer science courses at Universities of Developing Countries are teaching to students how to develop PC-based applications, enabling them to develop applications for the developed World, but not for their countries or their communities where the need is. With the availability of a standardized platform to run eServices for all, we should promote and participate in the development of computer science courses that would teach to students how to design Web applications for mobile phones:

- Teaching server-based programming languages (PHP, Perl, …)
- Teaching guidelines defined in section 4.2 for user interface design
- Teaching how to host and run at a large scale those services

The aim here would be to develop appropriate training courses and work with local universities for them to integrate those courses in their education program.

4.4 – Enabling Business

We defined a work program in section 4.1, 4.2 and 4.3 in order to enable the Mobile Web in Developing Countries, and to overcome the weaknesses of current SMS-applications. The proposed actions need a concerted effort from all the players: handset manufacturers to install defined browsing capabilities, browser makers to develop lightweight browsers, network operators to configure phones and web browsers to be ready for usage… and all this work for a result that could be seen disappointing, only text-based applications. Why would key-players engage in such a program?

The answer is obvious: for business reasons.

- For operators, the history shows that voice services always reach a saturation point, and this will happen in Developing Countries like it happened in the Developed World. ARPU will only increase with data-services, and value-added solutions on 2/3G

networks. If 5 billions of people are just using voice services and SMS, there is no future for the business here.

- For handset manufacturers, if there is no need for features-phones, then also selling very low-end phones is not going to be profitable.
- For browser makers, there is currently to market for them with SMS applications. It is their interest to invest and participate in the bootstrapping process of enabling the Mobile Web.
- For service providers, it will be very difficult to develop appealing value-added services based on SMS interfaces.
- For users, if there is no 2/3G network deployment, no inexpensive features-phones, no web-browser on their low-end phones, that means no future evolution towards a full Web access, with graphical interfaces, user-friendly applications, multimodal easy-to-use interfaces …

As this section demonstrates, there is need now to organize a concerted effort between all parties, including developing liaisons with other international organizations as mentioned in section 4.1, like this has been done in the W3C Mobile Web Initiative ([3]).

5. Conclusions

As we stated in the introduction of this paper, more and more people are using the Web today, but a significant number of people still do not have regular, effective access and ability to use digital technologies. There are probably multiple ways of tackling this problem known as the Digital Divide. The One Laptop Per Child initiative ([29]) believes in the spread of very cheap laptops, and mesh networking. Microsoft, with its FonePlus project ([30]), believes in a new type of mobile phones which can transform themselves in computer by plugging on them a keyboard and a TV set. Here, we are exploring a potential third direction taking advantage of the already installed 2.4+ billions of mobile phones and the power of the Web.

This paper presents how and why the Mobile Web could overcome some of the limits of SMS applications, which are currently the alone type of mobile applications largely deployed in developing countries. We are then proposing a preliminary program with 3 major directions:

- Enabling the Mobile Web on existing and future mobile phones available in emerging markets
- Building and gathering expertise in developing and deploying usable and useful E-Services for under-privileged populations and rural communities
- Building capacities, through education, for local people to be able to develop their own services.

Our idea is that enabling the Web 0.1, the Web of information, the same Web Tim Berners-Lee created in 1989 at CERN, on mobile phones in Developing Countries would initiate a process and seed the market which may result in the enabling of the Web 1.0, 2.0 or 3.0 in the next few years.

To conclude, it is important to note that there are other limits of SMS applications which still exist today with the Mobile Web: the literacy requirements, the internationalization problems, and the limited input mechanism inherent to mobile phones. While the last two problems are not specific to developing countries and should be tackled by other W3C activities (Internationalization [11] and the Mobile Web Initiative [3]), the problem of literacy will require exploratory work and as such, may be part of the work on guidelines for developing eServices.

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