Scenario to Serve Remote Areas in Emerging Countries with the Village Internet Service Station

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Abstract. The provision of Internet to remote areas has raised interests for many years and is particularly tough to address when the expected average revenue per user is low. Providing access to internet services in remote rural areas of emerging countries is a challenge for operators. Actually, the segments addressed may be key to their future market growth given the numerous but un-wealthy end-users. However, we tackle this issue in emerging markets by proposing an incremental scenario which conciliates investors' return on investment and end-users' needs and desire for communication. Actually, we first derive a set of requirements from the market segmentation and then specify the architecture for the low entrant segment. Furthermore, we show that there are possibilities to progressively address new segments in an incremental approach of the architecture first deployed. We also propose design to cost scenarios by combining deployed mobile-phone networks and intermittent data link. In every village an Internet service station is shared among all users in the village.

Keywords: Emerging countries, market segmentation, remote areas, mobile network, design to cost scenario, network architecture, Internet Service Station.

1 Introduction

It is essential for operators to be present in emerging countries given the population needs and the huge expected growth. To address the specific needs of these populations, the context inherent to emerging countries must be carefully considered. Actually, there are huge differences between the different populations, in terms of revenues in terms of needs and challenges to address. We thus start our work by recapitulating, in section 2, the market segmentation, in which are highlighted four different segments: "Low Entrant", "Young and Householder", "Self-employed" and "Premium".

Once these segments have been identified, it clearly appears that each segment is related to a different ecosystem. Thus, we secondly give an insight into the emerging countries ecosystem in section 3. In this section, we focus in particular on the population needs and on its available means in terms of revenue, device, and network coverage. We also briefly describe the potential business model. After having studied the ecosystem for the first 3 segments, we thirdly derive requirements that can be

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applied to one or several of the previous segments. Additional business and technical requirements are stated for remote areas. The 2 most numerous segments with the lowest Average Revenue Per User, ARPU, are found there. These requirements are thus mixed to derive our case.

In section 4, we present our architecture scenarios. We combine the "Low Entrant" architecture scenario with remote areas constraints. The solution first capitalizes on already deployed 2G mobile networks, makes the best possible use of the intermittent data link resources and relies on a "hawker" network for large data clumps. Free services and free contents can be delivered over this low-cost technical solution to a cash-challenged population. By adding features to the already deployed architecture, paying services and contents can then be offered to wealthier but still low income end-users. Increments are thus highlighted to serve the "Young and Householder" segment. In any case, we rely on the 2G mobile network for the signaling and the control of the services. The operators are thus implied in the essential functions of authentication and billing.

We finally conclude our study in section 5, and give some perspectives concerning deployments of the Internet Service Station and future studies.

2 Market Segmentation

It is best addressing the emerging countries ecosystem by taking into account the market segmentation. Mobile content and data services require granular customer segmentation if operators are to meet the needs of a diverse customer base. The majority of users rely on prepayment, thus operators have little information on which to build a decent segmentation model. The analytic capabilities of service, delivery and billing platforms appear quite basic, which hinders an efficient segmentation [1], [2]. The classic pyramid socio-economic segmentation accommodates the split between:

- Urban and rural mobile users: rural users tend to be situated in the lower part of the pyramid and nearly all those at the apex are urban dwellers.
- Smartphone and low-end phone users: the smart-phones users again populate the upper echelons of the pyramid
- Enterprises and consumers: the enterprise users tend to generate higher revenues per user and are accommodated at the top of the pyramid.

2.1 The Entrant or Cash-Challenged Target

Low Entrant customers may either live in rural or in urban areas. They only hold basic telephones allowing voice calls and SMS. They further don't own any credit card and thus prepayment is their privileged payment mechanism [3].

Even though 3G becomes available in big cities, Low Entrant customers' subscription is limited to 2G. They have an intermittent access to a data network (IP), which means they are not permanently under network coverage, moving from 2G areas to white network zone areas. In some countries, they even have smart-phones and access to the data network via hot-spots, for example via some retailer's hotspots. In

such a case, the hot-spot must benefit from a link to an ISP, which can be a satellite, a WiMAX or a 3G link. Having numerous retailers is essential to best serve people even in remote areas.

For this segment, the business model is to offer free content to improve the image of the operator in a given country. Revenues can be obtained by advertising. We suggest delivering free on demand content or free services to this segment. The delivered content is limited to on-demand or delinearized content because the data network coverage is not always possible. Low Entrant end-users are mainly interested in content and services related to their everyday concerns, thus we should focus learning, democracy and health, sports and entertainment.

2.2 Young and Householder Target

Most people within this segment are "cash challenged" and earn low incomes and thus typically avoid subscriptions. However, some of them may have some money and will thus be qualified as "low income users". This population holds second-hand mobile-phone, yet some phones may have multimedia capabilities (e.g. J2ME toolkit, Bluetooth…). These users generally have more than one SIM card.

Prepayment should be deployed so that the operator, or a third-party content publisher, can generate revenues. Alternatively, the end-user can pay in cash at a retailer store. Advertising should also be supported to generate alternative revenues. As in the previous segment, the delivered content is limited to free services and on-demand content, because the data network is often not permanently available. Furthermore, we should focus on learning, democracy and health, sports and entertainment.

2.3 Self-employed Target

The “Self-employed” population is technically aware and earns modest means. It lives mostly in urban areas and has access to 2G or 3G networks. Self-employed customers use second-hand mobile-phones having multimedia capabilities (e.g. J2ME toolkit, Bluetooth…). Yet they do not own any credit card. These customers should be delivered both live and on-demand content. As in the previous segments, learning, democracy, health, sports and entertainment services should be privileged. The proposed business model is the same as for the ”Young and Householder” target.

2.4 Premium Target

The Premium customers are technically aware and earn important revenues with regards to the average population. They live mostly in urban areas. These customers use a mobile-phone that has multimedia capabilities (e.g. J2ME toolkit, Bluetooth…) and further own a PC, a TV. This segment further subscribes to 2G and 3G data (IP) and each user can have more than one SIM card. Usually Free-To-Air, FTA, satellite is available for TV. The motivation is to re-use the numerous Free-To-Air channels available in satellite distribution and plug into it the possibility to retrieve Content on Demand, CoD.

Table 1. Overview of the four segments

Segment	**Low-entrant**	**Young and Householder**	**Self-employed**	**Premium**
Population	Young and numerous. Very low income. High illiteracy.		Technically aware. Modest means.	Technically aware. Important revenues.
Geographic area	Urban and rural		Urban	
Language	Mainly vernacular. Mainly oral.			National, international
Device	Single second-hand mobile-phone	Second-hand mobile-phone with multimedia capacities.	3G second-hand mobile-phone with multimedia capacities.	Mobile-phone with multimedia capacities, TV, and PC.
Service	Health, Education, business, on-demand contents and Sports		Live and on-demand. Business, Sports, Education.	
Payment	None	Prepayment		Pre & post paid
Access type	2G only. Possibly intermittent via hot-spot.		2G, and 3G, wifi, wimax, satellite More than one SIM card.	
Business model	Improve operator image, Offer free content, Advertising.	Prepaid content. Advertising.		
Constraint	Strong basis of retailers required.		Raise business interest	Availability of broadcast channels

3 Requirements

3.1 Requirements for the "Low Entrant" Segment

The immense majority of these users have a single device which is the mobile phone. They live in rural and urban areas and are not permanently under data network coverage. They furthermore have no money to "waste". However, access to Internet for health, education and business is demanded by this population. Thus we suggest providing them a free service. For a higher chance of success, we recommend starting with a simple understandable proposition. Then, the transition path towards paying services will be ensured by other segment of populations.

The operator could even try to make a market name with audiovisual delivery to these people. It is difficult to predict whether Digital Rights Management, DRM, will be mandatory or not. Yet DRMs may be required, even if the content is free-of-charge to comply with the regulation. One can manage the distribution of the content by restricting the delivery to authenticated SIM cards owner. In most countries, the problem of limiting the redistribution of content produced locally must be addressed.

For example, in Benin, local content is submitted to DRM while Hollywood blockbusters are not. This would need to be checked specifically per country basis. We thus consider the DRM requirement as optional. Some few people may have a TV set with Free To Air channels. However, we assume that there is fewer opportunity in this content value chain for operators as it would require expensive equipment for the end-user. Eventually, the mobile 2G network coverage is often present when the density of population is high. This is good news for investors which can re-use this infrastructure.

3.2 Requirements for the "Young and Householder" Segment

For this segment of population, the assumptions remain the same as for the "Low Entrant" segment, except we now assume end-users have some limited money they would be ready to spend in services and contents related to entertainment, learning, democracy and health.

3.3 Requirements for the "Self-employed" Segment

For this segment of population, the assumptions are different from the previous ones as it targets rather wealthy users that can afford expensive devices, including second-hand 3G devices. Living in urban areas, these end-users can have access to on-demand and live content. Still, they might not own a TV set.

3.4 Additional Requirements for Remote Areas

The solution must minimize the need for energy. For example, one scenario could ensure that the end-user handset battery will be charged enough for displaying a whole content before having to recharge the battery.

While often covered by 2G mobile networks, the data link is rarely available. Thus the solution must try to make the best of the 2G mobile network large presence in emerging countries and put forward a proposal to overcome the lack of data link. It should be noticed that even for "off the grid" areas solutions have emerged to cope with the lack of energy [4].

Partnerships with various organizations to drive the deployment of these shared-user model initiatives would enhance the success. These can be local or international partners providing micro-loans to local entrepreneurs or charitable and development organizations acting as the sponsors of such projects. This is well-known as in the Village Phone partnerships in Bangladesh and Uganda and the PayPhone Lady joint projects in East Africa.

4 Scenario for the Remote Areas

We consider in the following sub-section 4.1 rural and low income end-users. We thus assume end-users have no smart-phone and have no permanent access to data network nor to 3G network coverage. Most often, people do not own any PC or TV.

The goal of this section is to outline an architecture for delivering internet and contents to the Low Entrant segment. This scenario can be thought as the first step of a two-step scenario, the second step being described in the Section 4.2. The solution though not designed to deliver services for self-employed and premium segments can benefit from the presence of a self-employed person who can play the role of retailer within the remote community.

4.1 Intermittent Data Link - The Village Internet Service Station

This scenario is designed to fit with the lack of network and the low amount of money that the users can afford to get the service. We thus choose to provide a simple and cost-efficient architecture, providing the users with limited but essential functions. In addition, the operator should seek partnerships to benefit from the help of a network of retailers who are connected to a data network. These retailers will motivate the users to try the service and help them to use the services, as for instance downloading Content on Demands, CoD. It is also important to notice that this scenario does not require the user to have a SIM card. When trying to create a "Village Internet" we were faced with 3 major issues:

- The business model
- The network architecture
- Applications that could run on the network architecture

Operators tend to struggle when dealing with big populations with low income as it is not their usual target. To provide data services to African rural population a new approach had then to be found. A strong point with this market segment however was the very strong sense of community and sharing. So instead of trying to address every member of a given community it is easier to address the community as an entity. This was for example the approach taken by MTN when they designed the village phone offer. We decided to extend this approach to internet services and create "village internet", for further reference we design as village a subset of a rural community. A village shares geographical proximity but ultimately is a business entity (i.e. the bigger the business is the smaller the cluster becomes, ultimately becoming a 1 family cluster or 1 person cluster like in Europe but requiring a new approach for the network component). In every village one self-employed person buys and rents an Internet service station that is shared among all users in the village. This corresponds to one user with a higher ARPU that operators can easily address. We call it: the Internet service station owner. He will play the role of retailer.

In addition to a network coverage that does not spread across the whole territory, the population might not easily adopt new telecommunication services. To overcome these issues, we suggest relying on the Internet service station owner who will provide hotspots and help the end-users in having access to the service. The next challenge was to get a data network to our "village internet", for this we derived the concepts of data ferries. As presented in [5], we showed that using hawkers was a cost efficient solution to bring large amounts of data to specific users. We also showed that with 2G mobile networks we could bring some interactivity to services when needed.

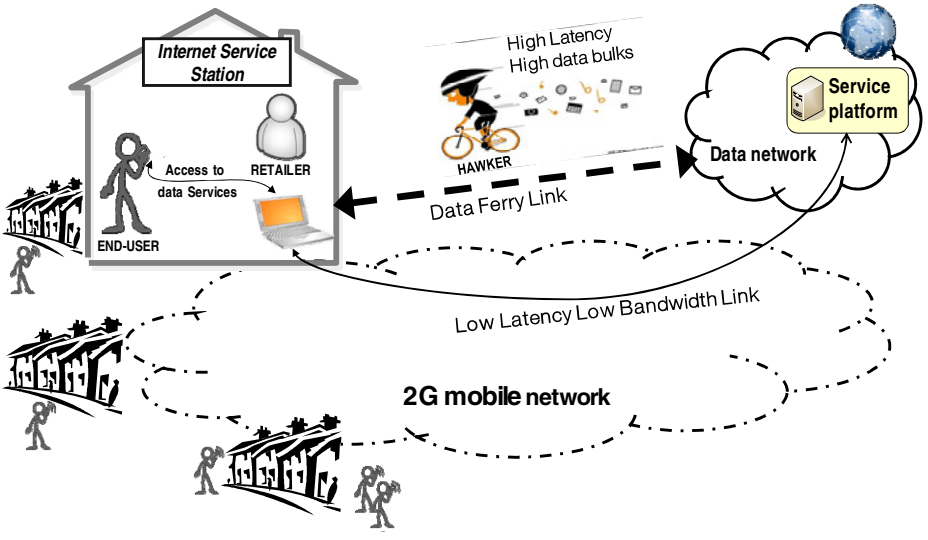

Fig. 1. Intermittent data link - Architecture for areas deprived of data network link

Our "village internet" station would thus use 2 distinct networks: the first one being a 2G+ network for small volume of data and for real time signaling, the second one would be a network of "hawkers" for large data clumps.

A "hawker" is a person travelling the country to ferry data to remote areas deprived of data network access. In our case the "hawker" would not need a high end device since the targeted device is known and should offer USB ports. The hawker network would thus only consist of travelers carrying USB keys. As far as network coverage is concerned, the 2G coverage should be the same as of the already deployed village phones (using Yagi antennas to extend coverage where needed). The hawker network has a virtually infinite coverage range but the higher the range is the more latency in transfer happens (note we are speaking in days here not in milliseconds). Due to the nature of our hawker data link the number of "village internet" station would be however limited also.

An issue with the internet service station we just imagined is that the network connecting it to the rest of the word is congested by design. This is however an issue that African population shares as a whole. Even at a "country" level for example the international peering available for Niger is only 60 Mb/s. This implies that the usual Over The Top, OTT, players are not adapted for African networks as they tend to optimize their services for speed in North America and Europe. So our internet service station would need its own subset of applications designed to operate on our dual network environment.

Those applications should be designed in 2 modes, "online" and "offline". Online mode is almost the typical web applications barring some restrictions on how data is stored and the need to be able to deal with requests coming from the offline application. The application in offline mode is the one dealing with users. As such, the offline application only has access to its own sub-domain (local databases and

storage) and some remote fetching methods published by the framework (such as login, short Message and content Ordering). Through the framework (API allowing developers to handle the multiple networks and the intermittent network link), the offline application can request updates or content to be delivered through the data ferries. May the online application be updated (by its developer or due to its nature (for example allowing internet users to post content), the update will automatically be spread to villages by data ferries.

By creating the village internet service station we took the first step in bringing low cost internet to rural populations. As mentioned earlier the next steps would occur when the business grows and more and more users become interested. Possible future work would imply connecting our station to a local wifi mesh bringing new types of high speed local services as described in the next section.

4.2 One Step Forward: Permanent Data Link – Overall Description of the Scenario

The IP connectivity brought to the retailer's premises is obviously the main issue to consider. For the most remote areas this data link is barely available since no one can afford it or by lack of network coverage. Thus, we recommended overcoming this difficulty by relying on an intermittent access through a network of "hawkers" as described in section 4.1.

Now, we consider a case when the retailer devices have access to the open Internet. Any network can be used for this purpose: satellite return-channel, WiMAX, long range Wifi, DSL network and 3G, for example with a 3G router. One possibility is to rely on a satellite-based connection [6]. Another possibility, which should generally make more sense for mobile operators business is to provide it based on a 3G offer.

The end-user owns a mobile phone with any SIM card. Its phone has a Wi-Fi or Bluetooth connectivity.

Full access to the services is possible through the Internet Service Station over this data link. The end-user fetches the data and can begin its service at the retailer's premises. At his convenience, the end-user can also first fetch the data at the retailer premises and begin his service session later. He is authenticated by the 2G mobile network and can pre-order his services (see "services control" in Fig.2).

If there is an additional marketing requirement for it, it may be possible to restrict this service to end-users being the operator's subscriber (e.g. in order to have cheaper SMS, in order to use USSD instead of SMS…). For instance, in case of content delivery, this basic mobile phone will have to embed a light software and have storage capabilities. Its battery capacity should further allow viewing the whole content without access to the electric network. Please note that the device may be shared between several end-users.

The retailer is most often a self-employed person who owns a device connected to the Internet and can thus provide access to a Wi-Fi hot spot. Then, the retailer device may for example be a Home Gateway, a 3G router or a satellite equipment.

The architecture we recommend is depicted in the following figure.

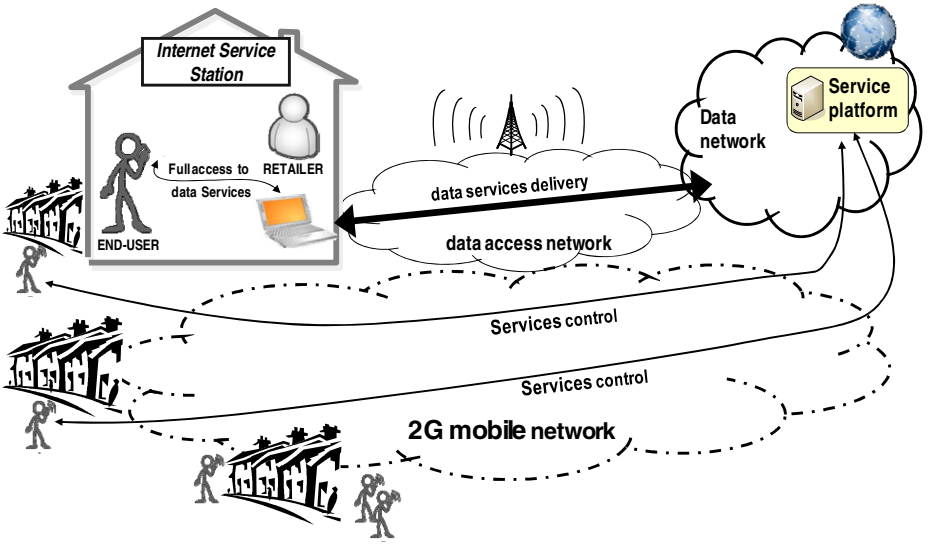

Fig. 2. Permanent data link - Architecture for remote areas

The Strengths, Weaknesses, Opportunities and Threats, SWOT, related to this architecture are depicted in the following table.

Table 2. Low Entrant SWOT

Strengths	– Attract customers and limit churn – Possibly free of charge for the end-user – Rural end-users are eligible to this service – Possible evolution for paying content – Light identification is sufficient
Weaknesses	– Need a permanent data link – Possibly no direct revenue for the operator – Need for advertisement – Specific mobile handsets that must embed multimedia soft – Retailers must be properly trained – Limited to CoD files of small duration
Opportunities	– Improve operators image – Local Contents – Take advantage of mid-range multimedia features phones – Telecom manufacturers are proposing solutions [7]
Threats	– Lack of affordable mobile phone compliant with our requirements – No qualified retailers' network

4.3 Open Issues

The retailers' business model needs to be deeply studied. As a matter of fact, operators often need to have a direct relationship with the end-user. Thus the retailers shall not process the whole transaction on their own.

One noticeable limitation is that the end-user can not benefit from live services. However, CoD can be downloaded at the retailer's premises and will be consumed later. To cope with the storage capacity of the low phone devices, short duration CoDs should be privileged. We propose to deliver free content to these customers. This enables to deliver audiovisual contents even to people that can only afford 2G short subscriptions, which will help in attracting new customers and limiting churn. Local contents either national or regional should be privileged since they are adapted to the people's culture, language and concerns (e.g. FM and wiki-radio). For some services this can be a problem since the low-entrant end users will not necessarily own a device that will have the ability to receive content.

4.4 Two Steps Forward: Increments to Deliver Services to the Young and Householder Segment

This step provides a network solution where the end-user still does not have permanent data network coverage. With respect to the architecture settled in previous section, the main new function needed here is a payment mechanism. Of course this also imposes to include an authentication function of the person who pays for the service. In this scenario, the DRM function is mandatory for the delivery of contents. Like for the previous segment, local content should be privileged. Still, the operator should seek partnerships to benefit from a network of retailers.

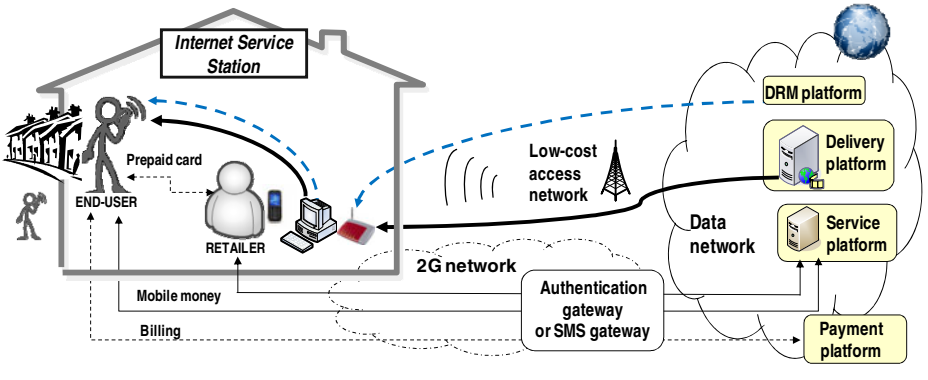

Fig. 3. Permanent data link - Architecture for remote areas

4.5 Additional Elements in the Architecture

We propose an architecture that is very similar to the previous one, with the following additional elements:

- Payment Platform: will be in charge of hosting payment accounts. It may be implemented by Orange Money.
- SMS Gateway: gives the possibility to pre-download CoD at the retailer's shop.

If the user wants to download a big file (e.g. CoD) and the IP network has a really poor bandwidth, it will take a high amount of time to download the file. In order to make it possible to deliver big files, we think that a mechanism authorizing pre-download of the file at the retailer's premise should be possible. The first solution is based on SMS. A possible implementation of such a scenario is the following: when outside the retailer's hotspot, but when under 2G coverage, it should be possible for the application in the end-user device to order a pre-download of the CoD file by sending an SMS with the name of the wanted CoD and the identity of a retailer, which would be its mobile phone number. When the service platform receives this SMS, it should in turn send a SMS to the retailer to ask him to download the file.

This option is particularly interesting in remote areas where the user always visit the same hotspot.

4.6 Payment Mechanism

We recommend the "Pay as you go" mechanism which is a pre-payment technique allowing the end-user to buy short duration content. Several implementations can be foreseen for this mechanism:

- Scratch prepaid cards: When the end-user wants to buy a specific service, he buys the card to the retailer 1€, 2€ or 3€…
- Mobile money: The end-user transfers money from his account to the service provider account thanks to a transaction done with his mobile phone. This is in the same vein than Orange-Money [8].

Advantage: In both cases, the retailer does not intervene in the monetary transaction when the service is ordered. In the former case, the retailer may be more motivated to sell scratch cards by benefiting from wholesale buying. In the latter case, mobile transfers are cheaper. Drawback: It is not easy to secure the transaction of delivering a service over an unknown network. However it may be possible to re-use the mechanism used by World Food Program in Zambia [9]. Typically, a first payment code and a service identifier is sent in a SMS by the user in order to gets its service. Once the content has been successfully retrieved, the mobile phone software automatically sends another SMS to terminate the transaction.

It may also be questionable whether a cache is needed or not at the retailers' premises [10]. Indeed it may be that some application tricks allow to fill the retailer's cache before the end-user requires the file, for example with a pre-download mechanism as previously described.

Another open issue is about DRM. We believe that a DRM implementation is technically feasible; the major difficulty will first be to know whether right-owners of the content will accept the risk of delivering files with DRM on mobile phones. Indeed,

even though DRM provides a certain level of security, one can never be sure it will not be broken. The second difficulty will be to identify an integrator ready to implement and be responsible of DRM for this scenario.

The Strengths, Weaknesses, Opportunities and Threats related to this architecture are depicted in the following table.

Table 3. Young and Householder SWOT

Strengths	– 2G and 3G not needed for the end-user – Attract customers and limit churn – Monetize operator's services – Architecture in delta with previous segment – Authentication via MSISDN is not necessary – Rural end-users are eligible to this service – Incremental scenario with respect to the "low entrant" scenario
Weaknesses	– Specific Mobile handsets must embed multimedia soft – The retailers need to be properly trained – Limited to users that are ready to occasionally buy some CoD. – Limited to CoD files of small duration (depending on the storage)
Opportunities	– Deliver local services & contents – Take advantage of middle-range mobile phones – Value the operator's image (RSE) – Telecom manufacturers are proposing solutions [7]
Threats	– No qualified retailers' network

5 Conclusion

We tackled the provision of data link to remote areas in emerging markets. To overcome the low average revenue per user, we proposed an incremental low cost architecture. The village internet service station takes the first step in bringing low cost internet to rural populations. To comply with the low-cost constraint this solution capitalizes on already deployed 2G mobile networks, makes the best possible use of the intermittent data link resources and relies on a "hawker" network for large data clumps.

Starting with shared enablers and a shared platform allows launching a service while minimizing the related cost. It allows operator to reinforce its position and make a market name while serving a numerous population deprived of internet access. This win-win approach thus conciliates investors' return on investment and end-users' needs and desire for communication. This solution will further allow operators to get feedback from end-users and gather statistics about their real usages.

This study has already led to two different PoC (Proof of Concept) presented in [5] for a Hawker solution which ferries data in white network zones and presented in [6] to bring contents to the low entrant segment.

We identified the wiki-radio service as a good candidate to test the interest and feasibility of this solution. Indeed, this service is of high interest in remote areas – local news, remote communities with own interests and language, voice quality – and gathers the technical and economical challenges since it addresses the least wealthiest segments. We are currently leading a study for a deployment in Mali with local actors. Also, possible future work would imply connecting our station to a local Wifi mesh bringing new types of high speed local services.

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