ARCHITECTURE OF A LOW COST TECHNOLOGY SOLUTION INTEGRATING MOBILE FINANCIAL SERVICES WITH *AADHAAR* AUTHENTICATION TO ACCELERATE FINANCIAL INCLUSION IN INDIA

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Abstract: Mobile phone technology is increasingly emerging as a high potential and well suited channel for delivering mobile money and other financial services in a convenient and secure manner, allowing service delivery at low cost and in a ubiquitous manner. It offers the potential to significantly extend the outreach of financial and banking services to millions of people. In particular, the reach and affordability of mobile phones in rural India can be leveraged to meet the basic financial requirements of poor and unbanked people. Aadhaar (the unique bio-metric identity from UIDAI) authenticated mobile financial services along with the Business Correspondent model for service delivery, can address mainstream banks' major barriers to serving the low income market: the need for extensive high cost branch infrastructure, managing high volumes of low value transactions; fulfilling Know Your Customer (KYC) requirements; addressing Anti Money Laundering (AML) and Combating the Financing of Terrorism (CFT); and convenient anytime/anywhere delivery of services, that the banked customers have access to, through ATMs and Internet banking. This paper attempts to explore the potential of mobile technology and Aadhaar in extending banking and micro-financial services to the unbanked.

Keywords: Mobile banking, Financial Inclusion, Agents, Business Correspondent (BC) model, Branchless Banking, Aadhaar, POS/POT, micro-ATM, ATM, Internet banking, Customer Service Point(CSP).

Introduction

In many developing countries, a very large segment of the population does not have access to even the most basic of financial services. The Financial Access Initiative (FAI), a research consortium based at New York University, has identified that 2.5 billion adults (approximately half of the world's adult population) do not have access to formal savings or credit instruments either through banks or alternative financial institutions (such as microfinance institutions). According to Group Savings and Loans Associations: Impact Study, 2010, 'out of the 428 million deposit accounts in India only 30% are in rural areas. With a rural population of 741.6 million, the rural penetration of banking is as low as 18%' (Matthews et al., 2010).

Providing better access to financial services to people in the lower income strata of society is not only vital from the perspective of improving their financial lives but is equally critical for the economic and political well-being of any nation.

Banks and financial institutions usually target customers with regular and stable incomes who can provide float income, such as salaried employees and well established businesses. This is efficient and profitable, as apart from maintaining high minimum account balances, most of these clients conduct high value and less frequent transactions, resulting in lower operating costs (Chakrabarty, 2006).Banks find it difficult to offer these services to the poor (low income/rural) people as they can't maintain any significant account balances and typically have the need for frequent low value transaction (Chakrabarty, 2006; Sibley, 2007).

Moreover, rural communities tend to be sparsely populated and have to travel long distances to reach bank branches incurring heavy transportation and other costs; and sometimes lose a day's wage or earning opportunities. As a result, even where access to banking is available in rural areas, the cost and inconvenience of access is prohibitive. Additionally, poor, with lower literacy levels and limited exposure

to banking, find it extremely onerous to fill out forms or to carry out self-service banking through ATMs or on the Internet. (Kumar, 2009).

While these barriers exist, there is also a greater recognition of the huge potential at the bottom of the pyramid (Wilcox, 2015). It is now better understood that getting low income segments into the regular financial sector is beneficial both for the people belonging to this segment and the financial institutions (Karmakar et al., 2011).

Technology has started to have a pivotal role in broadening and deepening the reach of banking and other financial services; and making financial inclusion a viable reality. A large number of tiny and micro transactions can be supported profitably through the use of technology. Advancement in technology such as core banking, ATMs and mobile connectivity have already had enormous impact on banking for upper class people. Widespread penetration of mobile technologies, fingerprint recognition and their integration with banking infrastructure has the potential to extend outreach of banking services in a low cost and more efficient manner through mobiles phones and to reduce the need for banks to be physically close to their customers (Suoranta and Mattila, 2004; CGAP, 2005).

Technology has been a key catalyst in making agency or branchless banking a reality (Business Correspondent (BC) model in the Indian context). Using technology agents/BCs can perform banking activities on behalf of the banks - opening accounts, providing cash deposit and withdrawal services, adjacent services like micro-credit and micro-insurance (Chaia et al., 2010). Therefore technology enabled devices such as mobile banking, point of sale or transaction (POS/POT) devices and micro-ATMs are rapidly emerging as the new financial service delivery channels. Almost every scheduled commercial bank is aggressively adopting one or the other technology solution along with deployment of Business Correspondent agents for service delivery. This is often termed as agent based branchless banking (Mallat and Niina, 2007; Suoranta and Mattila, 2004; Lyons, 2010).

The downside has been a massive proliferation of technologies and processes adopted by the banks and their BCs, with none of them achieving scale or commercial viability. A number of different solutions and processes for enrollment, authentication, transaction management and security now coexist, with a lack of standardization. This is leading to

greater complexity, higher costs, and poor integration with main stream banking - all resulting into an unacceptable experience for the target unbanked poor customers (Mas and Ng'weno, 2010; Sibley, 2007).

There is a compelling need to have a single standardized technology architecture solution which is scalable, secure and cost effective. A mobile phone based solution integrated with UIDAI to allow online *Aadhaar* authentication (an initiative of Government of India to provide a unique identity to every individual on the basis of their demographic information and bio-metrics) can emerge to be a fitting solution.

This paper examines various agent based branchless banking technology solutions along with their challenges and shortcomings and recommends a mobile based solution, integrated with UIDAI, using *Aadhaar* based biometric authentication.

The paper is organized as follows: Section 2 provides the background and the context; Section 3 analyses various technology solutions for agent based branchless banking; Section 4 discusses the challenges and shortcomings of the existing technology solutions; Section 5 proposes an enhanced technology architecture, integrating mobile financial services with *Aadhaar* authentication; and discusses the advantages and challenges of this solution; Section 6 is the conclusion with directions for future research.

Background and Context
In the past few years, advancement in technology such as core banking, ATMs and mobile based financial services have had enormous impact on banking in developing countries like Kenya, Uganda, Philippines, Brazil, South Africa and so on. In Kenya, M-PESA from Safaricom (a leading telecom operator) has been a resounding success that allows millions of people to deposit, transfer and withdraw small amounts of electronic money, send money home, use or exchange small amounts of airtime, pay utility bills, get micro-credit (M-Shwari) and now increasingly even pay merchants and vendors through their mobile wallet (Lipana M-PESA)(Mas and Radcliffe, 2010). The Philippines too has witnessed success in delivery of financial services through mobile phones. Products, such as Smart Money and GCASH, have enabled large amount of money transfers between urban and rural areas and overseas, leveraging their extensive distribution networks (Bernadette, 2009).

Countries like Sudan, Ghana and South Africa have adopted mobile technology for inclusive   finance.

Latin American countries like Uruguay, Paraguay, Argentina, Venezuela and Colombia are witnessing early success. Several mobile financial products have emerged, for example Tigo cash in Ghana, PagoMovi in Peru, Nipper in Mexico and Oi in Brazil (R. Stone, 2009).

Telenor Pakistan has launched a mobile banking solution, in coordination with Taameer Bank, under the label Easy Paisa. Dutch Bangla Bank in Bangladesh has a mobile banking service with support from mobile operators, Banglalink and Citycell. In less than two years the users of mobile banking services in Bangladesh has reached 5.3 million.

In India, leading banks like State Bank of India (SBI), ICICI, UBI etc. are extending banking services with the help of Business Correspondents such as Eko, FINO, ALW, SAVE, MBS using POS/POT, micro-ATM and mobile banking technology (R. Nyangosi, 2009).

Technology solutions for agent based branchless banking
An agent is usually an outlet or an individual providing banking and financial services and conducting transactions on behalf of the bank or a financial service provider. Often these agents are retail outlets such as kirana stores, mobile airtime resellers, pharmacy stores, supermarkets, convenience stores, lottery outlets and so on.

Depending upon the bank or financial institutions' strategy or business model, an agent can open accounts, conduct transactions such as cash deposit, cash withdrawal, fund transfer, pay bills, balance enquiry or mini statement. Some banks are also able to service government benefit payments through their agents.

These services and processes are facilitated through technology that also ensures security and adherence to regulators. Agent based branchless banking uses one of the following models: (1) Point of Terminals (POS/POT) with our without and Smart Cards (2) Micro-ATMs with *Aadhaar* authentication (3) Internet Banking (4) Mobile Banking (based on USSD, SMS, STK and/or IVR technology)

Based on the model, agents/business correspondents (BCs) are equipped with a combination of point-of-sale (POS)/smart card reader, micro-ATM, mobile phone, biometric (usually fingerprint) scanner and sometimes personal computers (PCs) or laptop that connect with the bank's core banking system using a data connection. Customers can transact at the BC using smart card, magnetic stripe card or just their

mobile. Authentication is done through PINs or biometrics (local or *Aadhaar*).

Challenges of existing branchless banking technology solutions
The challenges and downside of the currently deployed technology solutions are brought out below.

Challenges of ATMs
The use of ATMs is restricted to urban or semi-urban areas because they are very expensive and deployment to cover even large sized villages (population of 10,000 or less) is not commercially viable. The operating costs including cash management, cash insurance, security and maintenance are also very high. ATMs need high and continuous power and high quality and guaranteed connectivity, both of which are either unavailable or difficult to ensure rural India. The processes for opening bank accounts and distribution of ATM/debit cards to rural consumers are arduous and hugely expensive. ATMs also do not allow many banking services to be available other than cash withdrawal, balance enquiry and in the higher end ones cash deposit. In addition rural/low-income people lack financial literacy and have difficulty in remembering or safekeeping PIN numbers for ATM access. Even though the Reserve Bank of India has allowed white labelled ATMs to be setup by third parties on behalf of banks, it is unlikely that on account of the aforesaid challenges much rollout happen into the uncovered geographies and population.

Challenges of Internet kiosk banking
Several banks have developed frontend banking applications for conducting basic banking over Internet. This technology model has been extended to the rural unbanked regions by setting up a manned (usually an agent) kiosk with the most basic infrastructure constituting personal computer, printer, scanner, Internet connectivity and power back-up. The cost of setting these up, though lower than ATMs, is still prohibitive. Moreover the challenges of poor power and connectivity as in the case of ATMs prevent kiosk banking from becoming an effective delivery mechanism.

Challenges of POS/POT, micro-ATM and Mobile
POS/POT, micro-ATM and mobile based technology solutions for extending banking and financial services to the unbanked have been in development and trails since 2006. Although in many respects they are better than branch, ATMs and kiosk banking, they too have several drawbacks and challenges. These are brought out in the following table showing a comparison of

Table 1: Comparison done on the basis of inputs collected during survey and pilot study, (Source: own)

| Characteristics	POS/POT	micro-ATM	Mobile
Device cost	High in the range of Rs.15,000 to Rs.20,000	Very high in the range of Rs.25,000	• Low with data enabled mobile costing Rs.5,000 • Mostly BC/agents already own a mobile
Maintenance cost	High as they can be serviced only at equipped service centers and not at remote locations	Same as POS/POT	Mobile can now be serviced in small towns or even at villages
Power and connectivity requirements	Short battery life needing frequent charging. Good connectivity requirements due to non-optimized data transfer.	Short battery life needing frequent charging. Data transfer more optimized compared to POS/POT	Longer battery life and can be quickly charged. Data transfer possible over narrow bandwidth connection and more optimized.
Interoperability	• Not interoperable and proprietary software • Customer account and device have one-on-one mapping • Communication protocols between smart card and device non standard	• Interoperable within the same service provider • With Aadhaar seeding, can be interoperable across service providers	Can be made fully interoperable using *Aadhaar*, just like micro-ATMs
Ability to prevent duplicate, ghost and fake customers/beneficiaries	Cannot prevent fraud and ghost users as biometrics are stored locally with local authentication	*Aadhaar* based authentication significantly more secure and robust	Can achieve same level of authentication as *Aadhaar* enabled micro-ATMs
Online / offline transactions	Online as well as offline	Online only	Online only
Value added services	Additional features such as biometric recognition optimization and electronic KYC not possible	Enhancements such as best finger detection and fusion finger for efficient fingerprint detection and electronic KYC for efficient, convenient and accurate account opening possible	Enhancements available for micro-ATMs can be extended to mobile based architecture
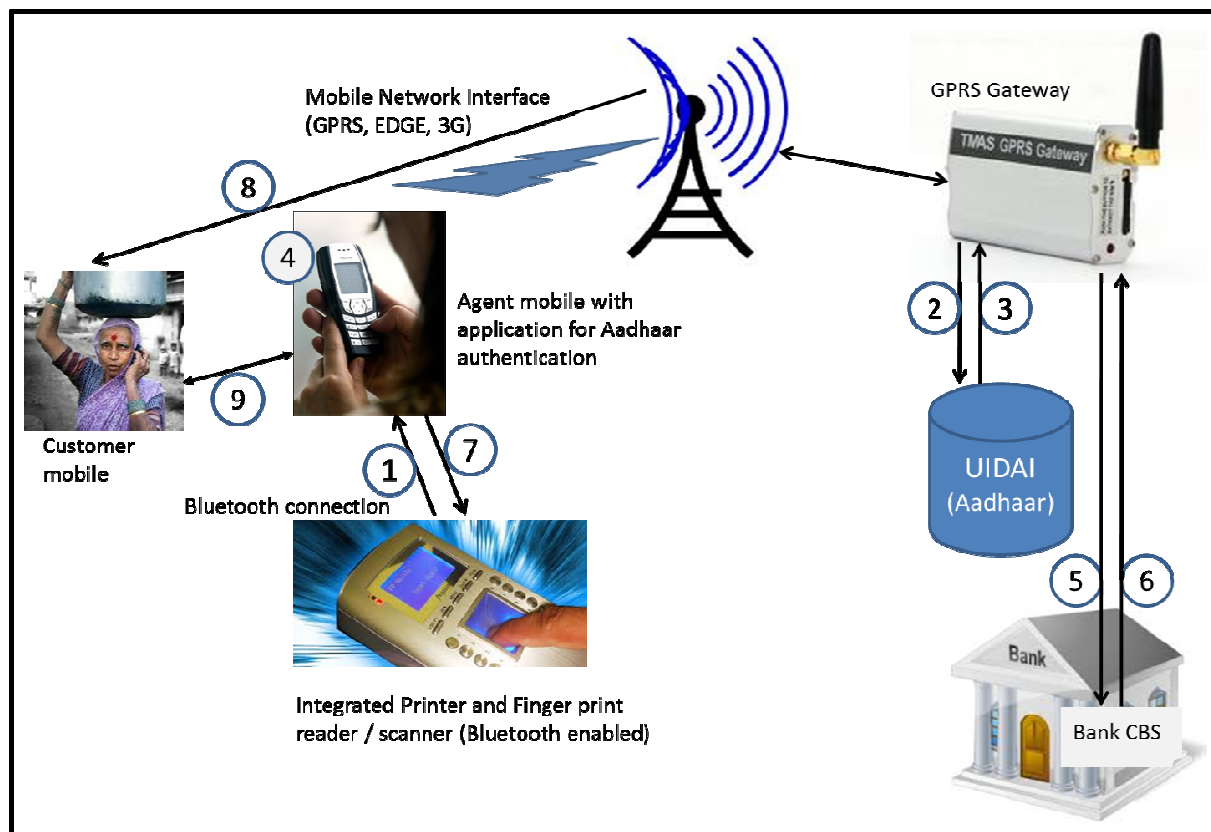
Figure 1: Architecture Proposed (Source: own)

challenges of POS/POT, micro-ATM and mobile technology solutions. It is obvious from these comparisons that none of the existent technology solutions is optimal for extending branchless banking to the rural unserved poor. In the following sections we detail out a solution that has the strengths offered by the prevalent models and can address several of their challenges, thus having the potential to be a superior model.

Proposed architecture of integrated mobile based financial services with *Aadhaar* authentication -- A low cost technology model to accelerate Financial Inclusion in India

The proposed technology architecture is a solution combining the advantages of (a) mobile phones in terms of online and real time transaction capability, lower and constantly reducing costs as the technology moves to next generation of mobile devices, near

ubiquitous adoption, benefits from global innovation (e.g. superior data enabled smart phones now becoming inexpensive and witnessing early adoption in rural areas) and (b) *Aadhaar* authentication, which is superior to the biometric recording, storage and management; and authentication mechanism employed by kiosk or POS/POT banking.

This proposed architecture is exhibited below, followed by a description of processes for transaction initiation, authentication and fulfillment. (1) The beneficiary fingerprint is captured by the bluetooth connected finger print scanner and the mobile application sends it (along with the beneficiary Aadhaar number, directly captured through the mobile application) to UIDAI's CIDR system through the GPRS/EDGE or 3G network and GPRS gateway. UIDAI receives the Aadhaar number and fingerprints for authentication. (2) UIDAI

authenticates the *Aadhaar* number and biometrics of the beneficiary. (3) UIDAI sends a confirmation message to the mobile application. (4) After positive confirmation of the biometrics, the BC agent enters the amount to be deposited or withdrawn and sends the message. The message is routed to the bank's CBS through the mobile network and the GPRS gateway. (5) The bank CBS receives the message, validates the account (based on *Aadhaar* number, which should have been seeded to beneficiary account earlier) and checks for balance in the

Advantages of the proposed technology architecture

This technology architecture offers several advantage: (a) Banks can easily scale up their branchless banking deployments and reach out to a wider population at lower cost, as more than 60 percent of the rural and low-income population has access to a mobile phone and understands its value and convenience. This would require little or no infrastructure cost to banks or government, as compared to alternates such as micro-ATMs to be provided to every agent or access point. (b) The architecture allows consumers/beneficiaries to conduct self-service transactions, if able and willing to do so, and an agent is only required for cash deposit and withdrawal. These could be in the nature of utility payments, bank/MFI loan repayments, micro-pension payments, small value receipts and transfers, and even proximity merchant payments which is a large and untapped market, offering several high potential use-cases. (c) The technology architecture can be expanded to any kind of service needing authentication of a person, for example, distribution of G2P subsidies for fuel (cooking gas, kerosene, diesel and petrol); issuance of government certificates; distribution of subsidies in kind (In East Godavari district of Andhra Pradesh, a very successful model for distributing rations under the public distribution system is being run with *Aadhaar* authentication); other forms of government payments envisaged in future, such as fertilizers. (d) Once a general purpose *Aadhaar*-enabled micro-payments system is established, a variety of other financial instruments such as micro-credit, micro-insurance, micro-pensions and micro-mutual funds can also be implemented on top of this payments system.

Potential challenges and requirements with the proposed model

There would also be certain challenges to be addressed to enable the proposed technology model

account, in case of withdrawal transaction. (6) The CBS carries out the transaction in the system and sends a confirmatory message to the mobile application. (7) The mobile application completes the transaction and sends a message to the printer for printing a receipt. (8) The CBS sends a confirmation message to the mobile phone of the beneficiary informing the details of the transaction. (9) In case of a self-service transaction, the beneficiary can initiate the transaction directly through his mobile phone.

to be effective and scalable. These are explained below: (a) The model can be most optimal if existing mobile devices can be utilized instead of replacing them with new high end mobiles, that can handle applications, over-the-air downloads and have higher memory. (b) The menus and flows are now reasonably standardized for POS/POT devices and the same is largely being adopted for micro-ATMs. The user interface, menus and flows for mobile devices would have to be designed again keeping the form factor in perspective and thoroughly testing it before large scale introduction. (c) Interoperability among banks: Banks should be interoperable to enable inter-account transfer. Currently IMPS offers an instant, 24X7, interbank electronic fund transfer service through mobile phones. IMPS facilitate customers to use mobile instruments as a channel for accessing their bank accounts and put high interbank fund transfers in a secured manner with immediate confirmation features. This facility is provided by NPCI through its existing NFS switch. The same facility can be leveraged to provide inter-bank transfers. (d) Cost-effective BC Network: Revenues earned should be shared proportionately among banks, bank branches, BC's and their agents to make the system sustainable and profitable.

Conclusion

Technology has enabled the emergence of a range of solutions to extend the outreach of banking and financial services to the poor unbanked population through branchless and mobile banking models. However none of the solutions adopted in India have achieved scale or witnessed widespread adoption. Prevalent solutions have deficiencies ranging from high costs to proprietary protocols and lack of integration and interoperability.

The architecture proposed in this paper for integrating mobile financial services with *Aadhaar* authentication is a potential solution that builds on the strengths of existing solutions, while addressing their deficiencies and challenges. It is a low cost,

ubiquitous, standards based interoperable solution that can accelerate financial inclusion. If implemented efficiently, it can be a fitting solution to extend outreach with secure delivery of several new financial and non-financial services, needing mass user authentication at scale, for urban to remote rural demographics.

Future research directions

The proposed technology architecture provides directions on further work that can be undertaken to test the model and rollout at scale. There are also pointers to a number of areas where the solution can be modified and enhanced. Additional research and development can be undertaken on the following lines: (a) Develop the mobile applications for various operating systems like Android, Windows, iOS, Java and for porting on featured phones, in addition to smart phones. (b) Design of an integration interface between the mobile application and UIDAI *Aadhaar* platform for user authentication. (c) Developing user interface and menu structure of the mobile based solution and testing its acceptability through consumer research. (d) Optimizing mobile user interface to make it more illiterate-friendly to allow self-service adoption in the future. (e) Adaptation of the architecture for various use cases needing authentication of a person. These could be issuance of government certificates; distribution of subsidies; other forms of government payments envisaged in the future; and even business to business (B2B) or business to consumer payments (B2C, such as refunds).

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