Digital Wallet: Requirements and Challenges

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Abstract

In this position paper, we describe the requirements and challenges of deploying a nationwide digital wallet solution in Singapore. We discuss why Singapore is ready for a digital wallet and identify the key challenges in building and deploying a digital wallet. We then discuss one of the key challenges, supporting peer-to-peer cash transactions between individuals using a digital wallet, in more detail and end the paper with our proposed solution.

1 Introduction

Consider the following scenario: "Jill is at the supermarket checkout line. She fumbles through her wallet to find credit card X, rejecting many other cards in the process, to pay for the transaction. Later in the day, she falls victim to a pickpocket who steals her wallet. Jill is now in a state of panic; she has to remember which cards she had in her wallet and then manually cancel those cards."

The above scenario highlights problems with a physical wallet; namely that finding particular items is time consuming, and revocating a lost wallet is extremely hard. In addition, managing multiple monetary and identification implements is not easy. Monetary implements include cash, debit and credit cards, and stored value cards while identification includes national and/or state identification cards and driver's licenses.

A solution would be to replace the physical wallet with a digital wallet integrated into an existing mobile device like a cell phone. This digital wallet would allow the owner to carry multiple monetary and identification implements. These implements could be quickly searched by name, type, or other keywords. In addition, with the right software, these implements could be managed far more effectively. Finally, security would be enhanced as all data on the digital wallet would be encrypted and back up options would make recovering from loss easier.

However, the idea of a digital wallet is not new [1]. Indeed, Japan and South Korea have already rolled out cell phone-based digital wallet solutions [7]. Consumers in those countries can use their cell phones to pay for groceries, order drinks from a vending machine, and even identify themselves at airline ticketing counters. Other countries, such as America and Sweden, are slated to roll out digital wallet-type solutions within the next two years.

In this position paper, we describe the challenges in deploying a comprehensive nation-wide digital wallet solution in Singapore. In particular, we focus on enabling person-to-person payment schemes which, as far as we know, have not been deployed anywhere yet. We end the paper with a short description of our proposed solution and research plan.

2 The Singapore Factor

Recently, the convergence of four phenomena have made Singapore ready for a digital wallet solution. First, Singaporeans are very tech savvy and almost all of Singapore's population, $\approx$ 98.4%, carries a cell phone according to statistics released by the Infocomm Development Authority of Singapore [2]. Singaporeans are thus more likely to use a digital wallet if it is integrated with their cell phones; similar to solutions provided in South Korea and Japan.

Second, cell phone technology is now mature enough to support a digital wallet solution. In particular, the cell phones have the computational capability, battery lifetimes, memory, input mechanisms, and a usable screen necessary for such a solution. In addition, newer cell phones are being developed that incorporate near field communication (NFC) chips such as Sony's FeliCa chip [8]. This chip provides highly secure, very short range, very low power, extremely easy to set point-to-point contactless communication between devices.

Third, every major bank in Singapore offers Internet banking services. These banks are also constantly looking for ways to increase the number of online financial transactions they receive as these are cheaper for them to process. A digital wallet solution achieves this and also allows the banks to leverage more out of their existing Internet banking infrastructure to support current banking products and to introduce new services that could help differentiate themselves.

Finally, in Singapore, the financial regulatory bodies who are the key stake holders for a digital wallet-type solution are actively seeking to integrate as many financial services as possible. This active participation from the large financial and regulatory bodies is crucial for a successful deployment as the Japanese and South Korean experiences have shown.

The key stakeholders in Singapore are the Monetary Authority of Singapore (MAS) [3] and Network For Electronic Transfers Pte Ltd (NETS) [4]. MAS is the government agency in charge of Singapore's financial sector while NETS is an independent organization, owned collectively by the major Singaporean banks, that runs a national point-of-sale debit card system used by at least 80% of the population. Our preliminary discussions with the CEO and CTO of NETS suggest that they are keen to provide a digital wallet-like solution that integrates all current payment schemes. Also, they see a combined digital wallet solution as the perfect channel to deploy new payment models and schemes.

3 Key Challenges

The four phenomena mentioned in the previous section, collectively, strongly suggest that Singapore may be ready for a digital wallet. However, there are three key challenges that must be overcome first. They are:

Mass Market Appeal: Ensuring a mass market appeal for the digital wallet is important to leverage scale economies and the network externality effect[1]. One way to increase the mass market appeal is to make the digital wallet usable for all day-to-day transactions. Hence it is important to support both point of sale transactions and peer-to-peer transactions between individuals. Both of these require support from financial institutions, retailers and government bodies; coordinating

[1]Utility of the digital wallet is influenced by one's social network. If a majority of the participants in a person's network are not digital wallet ready, then one has to still use cash for monetary exchange

these stake holders is a real challenge. It should be noted that the Korean and Japanese methods to increase mass market appeal may not work in Singapore due to differences in industrial organization and cultural preferences[5, 6].

Stake Holder Dynamics: Any successful digital wallet deployment will need the cooperation of multiple stake holders such as banks, retailers, regulatory bodies, and consumer. This is a challenge because satisfying the business and strategic goals of multiple stake holders is difficult. For example, bank A may choose not to be a part of a consortium where competing banks play a leading role. In addition some stake holders may have already invested in alternative technologies and may not be in a position to make further investments. For example, the Land Transport Authority of Singapore has already deployed a NFC-based stored value card solution for public train and bus fare payment. Achieving buy-in from all stake holders may require the support of the government and regulatory bodies. Fortunately the Singaporean government is receptive towards digital wallet-type integration efforts.

Furthermore, Singapore has different stake holder dynamics when compared to Japan and South Korea. In particular telecommunication service providers in Japan and South Korea are vertically integrated in to centrally administered companies called "Zaibatsus" or "Chaebols". Such vertical integration makes it easier to deploy a digital wallet solution as a single organization provides all necessary services. For example, in Korea, LG Telecom manufactures NFC-enabled cell phones, provides telecommunication services and handles mobile payments. However, in Singapore, the telecommunication firms are not similarly vertically integrated; necessitating a different approach to managing stake holders.

Compelling user experience: The third challenge is designing a digital wallet that consumers want to use. This requires a usable interface, and support for all financial transactions that a user may want to perform. We plan to reuse some of the user interfaces and design principles developed in Japan and South Korea. However there are many important features that still need to be created. These include comprehensive backup and restore solutions, integration of a large number of monetary and identification implements, and support for peer-to-peer cash transactions. Support for cash transactions is particularly vital as Singaporeans perform a large number of these transactions daily. For example, this is the most common payment mode when paying for taxi rides and when paying for food and drink. As such, consumers would resist using a digital wallet if they still had to carry a conventional wallet for cash transactions. We discuss the challenge of supporting peer-to-peer cash transactions in the next section.

4 Supporting Cash Transactions

From the consumer's perspective, cash transactions have many benefits; they are fast and easy to perform, they provide a built-in spending limit, and they are anonymous. The anonymity factor is crucial for consumers who, for various reasons, want certain transactions to remain anonymous while the spending limit is used, for example, by parents to limit their children's spending.

Supporting cash transactions require two key technology components; 1) a mechanism for placing cash in the digital wallet, and 2) mechanisms for transferring that cash to a retailer or another digital wallet. We plan to offer two ways to place cash on a digital wallet. In the first way, consumers can top-up the cash on their devices at specific top-up machines. The cash will be

stored in a cryptographically secure manner on their devices. They can use the debit or stored value cards held in their digital wallets to pay for the cash top-up. These top-up machines might either be stand-alone machines or integrated with existing automated teller machines and self-service bill payment machines.

We also plan to offer an online method for adding cash to the wallet. This would allow a consumer to plug her cell phone, containing the digital wallet software, into a computer, log into her bank's online portal, and transfer cash directly into her cell phone. We are currently discussing various methods of achieving this online cash transfer with the financial institutions. We also plan to extend these two methods, top-up machines and online mechanisms, to support removing cash from the cell phone and returning it to a bank account.

To support peer-to-peer cash exchange, we plan to use the phone's NFC capability together with an easy to use peer-to-peer cash application which we will develop. Using the application, the payer can enter how much cash she needs to send to the other person. The payer then taps the cell phone of the payee and the cash is transfered instantaneously using NFC. The recipient is then informed of the exact amount transfered.

Developing this peer-to-peer mechanism will require solving a number of challenges. For example, from a technical perspective, how do you ensure that the transfer of cash to and from a digital wallet takes place securely, atomically, and idempotently? Furthermore, what happens to cash in a digital wallet when the wallet is lost? Is it possible for the owner of the wallet to not be penalized for the stolen cash (which is encrypted and thus cannot be used except by the owner) without compromising the anonymity of cash transactions? Finally, there are also the regulatory challenges of issuing digital cash. For example, is digital cash identical to physical cash? If so, who provides the financial backing for the cash? In addition, how do you ensure that a financial institution is able to verify and accept digital cash issued by another institution? We are currently investigating solutions for these and other related questions.

5 Proposed Solution

Our proposed cell phone-based solution will have the following features:

Leverage new cell phone technologies: There are two key emerging technologies that we plan to leverage. The first are NFC chips [8] that are already appearing in new cell phone models. These chips provide very close range (a few inches at most), low power, easy to setup up point-to-point communication. We plan to use NFC as the communication medium for exchanging monetary and identification information, such as credit card numbers and receipts, with other devices.

The second key technology is the introduction of secure programmable chips in new cell phones. This will allow the cell phone to securely store both "virtual cash" and the phone owner's monetary and identification implements. This chip will ensure that thieves are unable to access the digital wallet embedded in the stolen phone. This assumes that the cell phone owner secures his digital wallet with a good password. In the near future, as biometric scanners, such as fingerprint readers, get smaller, cheaper, and more reliable, they could be integrated into cell phones and used for quick, easy authentication. These technologies will help make the digital wallet more compelling for end users, by providing ease of use and security, and increase its mass market potential.

Payment Models: For peer-to-peer cash exchanges, we will use the mechanisms described

in Section 4. For point-of-sale transactions, we plan to develop a NFC-compatible "reader pad" that can be deployed in retail stores. When payment is required, consumers place their cell phone on/near the pad and all their valid payment options appear on a display. They then select the payment method they plan to use (cash, specific credit card, etc.) for the transaction. The pad transmits the transaction request to the appropriate financial institutions using existing banking protocols provided by NETS, Visa, Amex, and Mastercard. The consumer can provide any neccessary signatures using a digital signature pad located next to the reader pad. Once the transaction is verified and completed, the receipt is automatically sent to the cell phone and stored for future reference (the consumer can also request a printed receipt).

This payment method is similar to existing models used in many supermarkets. The main difference is that our solution integrates all payment implements and doesn't require consumer to hunt for the appropriate amount of cash or payment card. The advantage of this method is that it is easy and familiar for consumers (Singapore has been using NFC for public bus and train services since 1998) and it is very secure. An adversary will have to be located inches from the cell phone and the reader pad and will be easily spotted. If necessary, additional encryption will further protect the communication stream. These simple payment models make the digital wallet compelling for end users and satisfies stakeholder dynamics (existing infrastructure is reused).

Other Considerations: This paper lists some of the challenges in deploying a digital wallet. Many others have been omitted due to space constraints. For example, certain identification implements, such as a drivers license, can only be entered into a digital wallet by a trusted authority. Consumers should not be allowed to create their own authentic license.

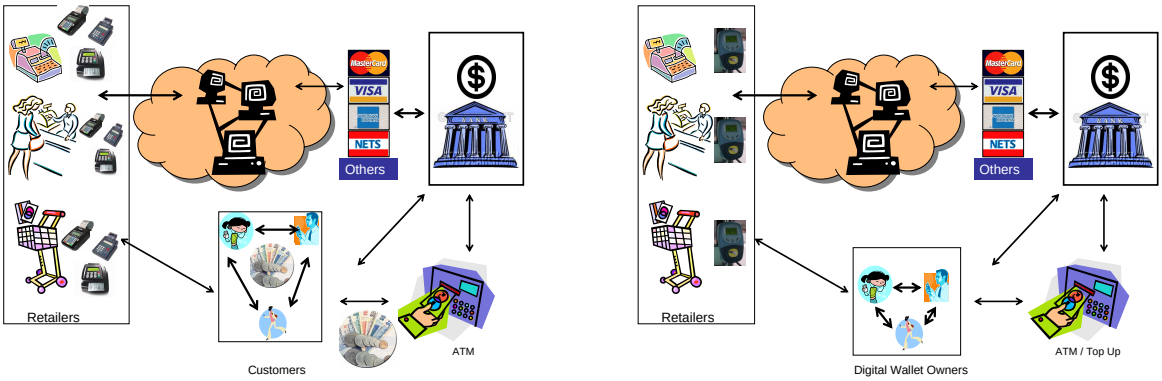
Another important consideration is the usability of the digital wallet. We plan to reuse some of the UIs developed in Japan and South Korea as those have proven to be usable. In addition, consumers must be able to manage the items located in their digital wallet; for example to add or remove a new credit card. We are currently designing software that will make this easy for consumers. All these solutions will help improve the user experience and mass market appeal.

Finally, a service to backup and restore a digital wallet would provide protection against hardware and software failures and theft. However, such a service, is not trivial to deploy. For example, where would the backups be stored? Would they be stored on the consumer's home machine, on a bank's server, on a 3rd party service provider's server, or on a server provided by some governmental agency? Each of these choices will result in different tradeoffs and solutions. We are in discussion with various stake holders to understand their position on this matter.

5.1 Solution Overview and Project Status

Figure 1a shows the current infrastructure while Figure 1b shows our proposed solution. Our goal was to reuse as much of the existing infrastructure as possible to reduce the burden on stakeholders and improve the mass market appeal.

We plan to achieve this by reusing the back-end infrastructure that routes credit card and debit card information between retailers and financial institutions. We also retain the existing ATM networks and online banking solutions. The changes we propose are as follows; a) retailers will be provided with a single NFC-enabled point-of-sale device that replaces the current separate machines for credit cards and debit card purchases, and b), we extend the physical ATM machines to



(a) Current Infrastructure (b) Digital Wallet

Figure 1: Overview of Proposed Solution

also provide cash topup/removal services for digital wallets. In addition, we are also considering methods to extend existing online banking solutions to support the digital wallet.

Our project is in the preliminary stages. We have completed the feasibility analysis and have identified the key technologies and infrastructure that need to be developed. We have also established contact with the key regulatory and financial institutions and received their blessings to proceed. We plan to have a fully working system, including the digital wallet software and the additional infrastructure components, that can be deployed for testing within a year.

6 Conclusion

In this position paper, we identify both the benefits as well as the key challenges with developing a digital wallet solution. We are currently developing a prototype solution that incorporates the features described in Section 5. We hope to test and deploy the first generation of our solution within a year.

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