

Evolutionary Business Models of e-Cash with Smart Cards

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Abstract

E-purse has been around quite a while, but not propagated widely. On the other hand, special purpose stored-value smart cards have been popular for killer applications like bus, subway, and pay phones. Another angle of e-cash is its possible use and recharge on the Internet. We wish an ideal e-cash system that can integrate both online and offline, applicable to a wide spectrum including the killer applications. So we analyze the framework of e-cash business models and place them into six categories. We evaluate the current business positions with this framework. Then we propose the strategies to find the best path for reaching the ideal business model. The e-cash business models are illustrated through the use of real world cases.

Keywords:

Smart card; Business model; Payment

1. Introduction

Smart cards have been used for the stored value type micropayments. The e-purse approach is attempted by Mondex [14], Visa Cash [16], K-Cash [13] and many other bank consortiums for general purpose electronic payments. In practice, e-purse pilot projects were mainly applied for payment to retailers for offline purchase. Mondex supports the money value transfer between cards even at remote sites on the phone, while most bank-initiated e-purses allow the transfer only between cards and banks.

In spite of extensive attempt of pilot projects, the propagation of e-purse was not as fast and wide as we have expected. Why has this phenomenon happened? Is the general-purpose e-purse approach most feasible for the commercial deployment of electronic payment systems? What other alternative approaches are available? Which approach is most effective? We seek to answer these questions in this research.

The first observation is that there are already too many alternative payment methods (in contrast with smart-card

based stored value cards) readily available to payers such as cash, credit cards, debit cards and electronic fund transfers (EFT).

The second observation is that the special purpose cards for bus, subway, or public phones are successfully deployed, because they are essential to the citizens in the metropolitan area which counts heavily on public transportation. In Seoul, eight million citizens own a RF (radio frequency) type bus card. A similar number of magnetic cards are in daily use for the subway, which began to be used for bus as well. The bus card in Seoul cannot be used in Busan, and vice versa. Under this situation, citizens wish to have one card that can be used for all of the above purposes. Conflict of stakeholder's interest as well as technical incompatibility are the hurdles against the fulfillment of this wish. So we need to analyze the structure of business models and initiatives toward the technical standards.

The third observation is that the need of micropayment on the Internet is expanding. Several solutions such as CyberCash [4] and Ecash [4] are examples of such attempt. Most leading Internet banks also jumped into this e-payment business. Our wish here is the online recharge of the electronic cash (e-cash) on the smart card, so that the stored value can be used both online and offline. Within the authors' knowledge, there exist no such a service in the commercial field yet, although the technology is already available.

The purpose of this research is finding a plan or a path of plans that can propagate the smart card very widely, and use the card for various purposes both offline and online. To meet this end, we need to analyze the various business models of smart card based e-payment business.

The position of business models can be classified by the scope of applications and frequency of use. Initial position of business models can be identified in this regard, and their evolutionary transition strategies can be evaluated.

Through this study, we will be able to identify the reasons why the ideal has not been achieved yet, and discover ways to remove the obstacles. We mainly use the Korean cases in demonstrating the business model evolution.

The remainder of this paper is organized as follows. Section 2 reviews the applications of smart cards. Section 3 formally defines the entities that determine the models of e-cash business. Section 4 categorizes the e-cash business models to six groups, and discusses the evolutionary relationships between the models. Sections from 5 to 10 describe each of the business models with example cases respectively, and propose the most effective path for reaching an ideal business model from the current business positions.

2. Applications of Smart Cards

The number of deployed smart cards is gradually expanding as shown in Table 1 [10]. European and Asian/Pacific countries have adopted and used smart cards more than other parts of the world. In Europe, the smart card has been mainly used for pay phones quite a long time, while in the Asia/Pacific the card has been mainly used for public transportation fare payment.

Table 1 - Market Share of Smart Cards by Region

	1998	1999	2003
Europe	71%	66%	51%
Asia/Pacific	19%	20%	36%
Latin America	5%	7%	7%
All others	5%	7%	6%
Total Percentage	100%	100%	100%
Total Number of Cards(Millions)	75	83	115

The global market size of smart card applications by category is summarized in Table 2 [10]. We can see that major applications were in the areas of communication and transportation. Communication is the most prevalent sector at present, but the growth rate has decayed due to the propagation of hand phones. On the other hand, the applications in the areas of transportation, retail, and university are growing very fast. According to Tables 1 and 2, communication and transportation are two killer applications, which the general-purpose e-purse cannot penetrate yet. That is why the e-purse has not propagated widely yet.

Table 2 - Global Smart Card Activity by Market Sector (\$ billions)

Category	1998	1999	2003	1998 - 2003 (growth rate)
Communication	4.5	5.0	7.6	11 %
Transportation	0.3	0.5	2.5	53 %
Retail	0.2	0.3	1.5	50 %
Universities	0.1	0.2	0.7	48 %
All others	0.1	0.1	0.3	25%
Total	5.2	6.1	12.6	19.4% (average)

Typical application projects are listed in Table 3. Two global e-purse business makers are Mondex and Visa Cash. They

have adopted different Chip Operating Systems (COS). Mondex adopted MULTOS, while Visa Cash adopted Java Card. Recently the functions of the smart card are expanding in scope beyond e-purse. The smart card can be used for authentication, loyalty programs, and so forth.

Table 3 - Typical Applications of Smart Cards

Sector	Location	Status
Banking	Hong Kong (Mondex)	Major Institutions - Hong Kong Bank - Hang Seng bank Status - 250,000 cards - 7,000 merchants
	Australia (Visa Cash)	Major Institutions - Bank of Australia - National Australia Bank First launch of Visa Cash cards; Use co-branded cards (Warner Bros.)
	Spain (Clip Card)	40 Financial Institutions Various Programs (bus, train, taxi, public telephone, gas station, etc.)
University	Hong Kong	University - University of Hong Kong Application Areas - Student Purchases - Identification
	U.K.	University - Exeter University Application Areas - Student Purchases - Identification - Voting
Retail	Netherlands (Easy Pay)	Major Institutions - Shell Nederland BV - The Netherlands Contactless payment scheme; Pay for fuel in gas stations

3. Formalization of Smart Card based e-cash Business Models

Let us formally define the models of smart card based e-cash business. According to Timmers [6], a business model is usually defined as:

- Architecture for the product, service and information flows, including a description of the various business actors and their roles
- A description of the potential benefits for the various business actors
- A description of the revenue sources

In this research, we adopt the Entities/Process framework to specify business models. The entities usually with the attributes imply variables, and thus need to be assigned values. The process defines the relationship between entities and messages exchanged between them. By specifying the entities and processes, a business model can be defined as illustrated in Figure 1.

Typical entities in e-cash business are:

1) Who becomes a *brand*?

The brand might be a *dedicated brand company* (like Mondex, Visa Cash, or K-Cash), or a *special operating company* like bus or subway fare collectors.

2) Who issues the cards?

The cards may be distributed through the *bank branches, kiosks, or convenient stores*. Usually they need to establish a franchise relationship with the brand company.

3) *Anonymity* of the card?

Anonymous card may be shared by multiple users. For a card to be *Onymous*, the card should bear the owner's identification like a certificate.

4) *Bank's Online Interface* with Stored Value Cards

No interface, Kiosk, ATM (Automated Teller Machines), or *Cyber bank on the Internet*

5) Who and where to recharge the cash value?

The stored value may be recharged by the *card-writers* installed in the *bank's branch or kiosks*. In this case, the franchise should secure the stored value from a brand in advance. For a direct recharge from a bank or brand online, the *Internet bank* may be used.

6) Which *card type* to adopt?

The possible card types are: *Contact Only Card, Contactless Only Card (RF card), Hybrid Card* (Contact and contactless card capabilities in a card with separate memories), and *Combi-Card* (Contact and Contactless card capabilities in a card with a shared memory). The combi-card was not available till a few years ago, but now it is commercially available and economically feasible.

7) *Application scope* of cards

Single Purpose, Multiple Purposes (more than one purpose, but limited to a few purposes), and *General Purpose e-Purse*

8) Who collects the revenue streams?

The stored cash values in the cards may be collected by transferring to the *operating company's* cards or *bank* accounts either in real-time or batch. There may exist a *clearing center* if more than one bank is involved.

Beside the above entities, more issues can be considered:

- Who pays for the infrastructure deployment?
- Who is liable for lost, stolen, or malfunctioning

cards?

- What other information should be stored in the card beside the e-cash?

Using the above entities, we can design an e-cash business model as illustrated in Figure 1. From the formalism's point of view, the business model selection problem can be regarded as a constraint satisfaction problem (CSP) [5]. However, CSP cannot represent the entire specification of business model adequately. Another formal approach for the business model building can be Case-Based Reasoning (CBR) approach [4], which also requires the rules-based adjustment.

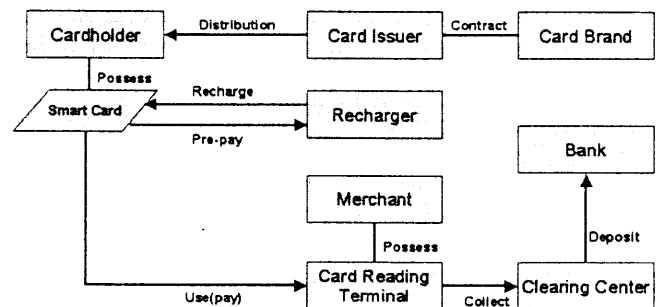


Figure 1 - Entities and Process of e-Cash Business Models

In the next sections, let us analyze typical e-cash business models, and investigate the evolutionary deployment process.

4. Positions and Ideal of e-Cash Business Models

The position of e-cash business model can be categorized by considering the spectrum of applications, number of uses, and usable platforms. In this regard, the *ideal position* that we would like to reach is *the deployment of highly used e-cash cards that can be used for a wide area of application on all necessary platforms*. To contrast the currently available business models with the ideal one, let us define six typical business models.

Model 1) Single Purpose Card/ High Use/ Offline Use/ Offline Recharge

A bus or subway card belongs to this category. The bus card system in Seoul will demonstrate this model.

Model 2) Multiple Purpose Card/ High Use/ Offline Use/ Offline Recharge

A transportation card that can be used for both bus and subway belongs to this category. The Hanaro card in Busan, the second largest city in Korea, will demonstrate this model.

Model 3) General Purpose e-Cash Card/ Low Use/ Offline Use/ Offline Recharge

The e-purse cards by Mondex and Visa Cash belong to this category. Mondex and Visa Cash will demonstrate this model.

Model 4) General Purpose e-Cash Card/ High Use/ Offline Use/ Offline Recharge

If the Model 2 and 3 can be compatible, the Model 4 can be generated. The merger of K-Cash (developed by Korean banks) with the Seoul bus card can demonstrate this model.

Model 5) General Purpose e-Cash Card/ High Use/ Offline Use/ Online and Offline Recharge

If the e-cash in Model 4 can be recharged online through the Internet bank as well, the Model 5 can be realized. Within the authors' knowledge, there is no commercialized system by Model 5.

Model 6) General Purpose e-Cash Card/ High Use/ Online and Offline Use/ Online and Offline Recharge

If the e-cash in Model 5 can be used online in the cyber stores, Model 6 – the *ideal model* – can be realized. In other words, Model 6 can be realized by merging Model 4 with the pure online debit card system.

The business models currently implemented are Model 1, 2, and 3. To evolve toward the ideal Model 6 starting from these positions, we need to study and remove the hindrance. We also need to study what is the best path to reach the ideal.

The *operators for the hindrance removal* in this study are *standardization, merger, and acquisition*. *Standardization* means to establish a common technical standard so that the cardholders can use a card for applications that were not compatible before. The standardization can be realized by enhancing the technical capabilities and economical feasibility. *Merger* means two merging brands co-exist after the merger. There may need a flag on the card and a clearing center to identify which e-cash belongs to whom. *Acquisition* means one dominant system subdues the other, and the winning system will be applied to both systems. The merger and acquisition notion here does not precisely coincide with the financial M&A, because the financially acquiring company may adopt the system of the acquired company.

5. Model 1: A Single Purpose Bus Card in Seoul City

A most simple business model, Model 1, is a single purpose card. The purpose may be for bus fare, subway fare, public phones, and a chain of stores. A key success factor for the single purpose card is its essentiality. Otherwise, the system would not have even considered. So by nature, the single application is a killer application like the public transportation card in a metropolitan area. We demonstrate Model 1 with the Seoul Bus Card system, whose architecture is depicted in Figure 2. The Seoul Bus Card system is the first stored value card implementation for bus fare collection in the world, and is very successful.

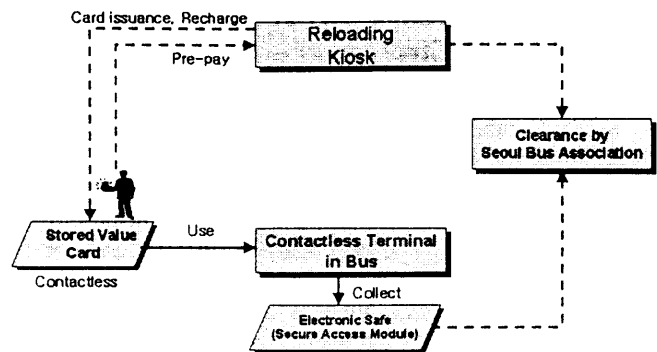


Figure 2 - A Single Purpose Seoul Bus Card System

Key Entities of the Seoul Bus Card System:

- Card Brand: Seoul Bus Association
- Card Issuer: Offline kiosks near the bus stations
- Card Anonymity: Anonymous
- Online Interface with Banks: None
- Recharging Station: Offline kiosks
- Card Type: RF (contactless only)
- Application Scope: Seoul bus fare payment only
- Collector of e-Cash: Seoul Bus Association
- Collecting Scheme from Reader Terminals: Physical withdrawal of electronic safe card

The Seoul bus card service started in 1996. 8,203 buses of 442 routes owned by 86 companies adopted the bus card in 2000. The number of cards issued amount to 8.8 million. 3,266 recharging kiosks near the bus stations are operated by sales persons, who also sell newspapers, magazines, and some groceries. The cards collected 50% of normal bus fares, and 40% of deluxe bus fares. It took 16.8 billion won (\$14 million US dollars) of investment. Even though 30,000 cards were issued per day, it took 300 days to distribute cards in the beginning stage.

Evolutionary Expansion to Subway

While the bus card is widely propagated, another essential micropayment implemented was the subway fare card. The subway station mainly used the magnetic striped card to collect the fare. Interestingly, Kookmin Bank has implemented credit card for subway fare collection by skipping the authorization for micropayment. In addition to these payment methods, the subway toll machine recently began to accept the Seoul Bus Card as well, even though the clearing processes are separated. The subway toll machine just installed another stored value collector on top of existing entrance gates. In this sense, the two systems are not physically integrated, although Seoul citizens can use the bus card for both bus and subway.

6. Model 2: A Multi-Purpose Transportation Card in Busan City

A slightly more sophisticated business model is the Multi-Purpose Card. A card may be used for multiple types of public transportation like bus, subway, and highway tolls. An example of this approach is deployed in Busan city as depicted in Figure 3. The card name is Hanaro Card, which means "one card" in Korean. Note that the brand belongs to multiple banks, and thus there is a clearing center before these banks which really exchange the e-cash to real cash.

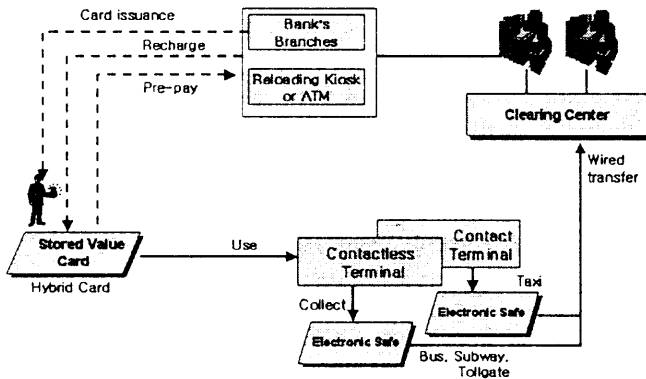


Figure 3 - Multi-Purpose Transportation Card Model

Key Entities of Hanaro Transportation Card System:

- Card Brand: Banks in Busan
- Card Issuer: Banks in Busan
- Card Anonymity: Basically anonymous with hidden card identification for clearing purposes
- Online Interface with banks: ATM
- Recharging Station: Banks' branches, subway ticketing stations, and offline kiosks near the bus stations
- Card Type: Hybrid and RF (contactless only)
- Application Scope: Bus, subway, tollgate, and taxi
- Collector of e-Cash: Banks through the clearing center
- Collecting Scheme from Reader Terminals: Batch transfer of the collected values from the electronic safe card to the clearing center

The Hanaro card was deployed in 1996, and it is used for 3700 buses, 976 subway entrances, 400 taxis, 400 mini-buses and 24 tollgates collecting more than 50% of fares. The total number of passengers per month is 31 million for urban buses and 22 million for subway.

To buy the Hanaro card, cardholders pay 2,000 won (about \$1.8). Minimum rechargeable amount is 5,000 won (about \$4.4). To the card users, the fares are discounted by 3-8% for bus, and 15 - 25% for subway. The card plans to expand

its application to public phones, vending machines, parking, etc.

7. Model 3: General Purpose e-Purse Card Model

In contrast to the single and multi-purpose models, the general-purpose e-cash card (known as *e-purse*) model pursues a wide spectrum of cash substitution at supermarkets, vending machines, parking lots, and restaurants. A typical example of this model is Mondex as depicted in Figure 4. The entities of Mondex and Visa Cash are summarized as follows:

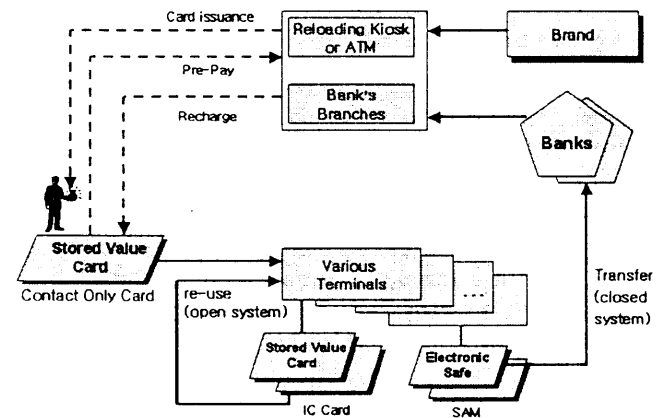


Figure 4 - A General Purpose e-Purse Card System

Mondex Card Case

- Card Brand: Mondex Card
- Card Issuer: Banks' branches and dealers
- Card Anonymity: Anonymous
- Online Interface with banks: ATM for recharge
- Recharging Station: Kiosks, banks' branches and ATMs
- Card Type: Contact Only
- Application Scope: General purpose e-purse
- Collector of e-Cash: Issuing banks
- Collecting Scheme from Reader Terminals: Batch transfer to issuing bank or another card

Mondex adopted its unique MULTOS card [15] with its own COS unpublicized for the security reason. Thus, this has limited its compatibility with other e-cash cards. Without changing its standard, Mondex could not accommodate the standard that other killer applications have adopted.

Visa Cash

- Card Brand: Visa Cash Card
- Card Issuer: Banks' branches and dealers

- Card Anonymity: Anonymous
- Online Interface with banks: ATM for recharge
- Recharging Station: Kiosks, banks' branches and ATMs
- Card Type: Contact Only
- Application Scope: General purpose e-purse
- Collector of e-Cash: Issuing banks
- Collecting Scheme from Reader Terminals: Batch transfer to issuing bank

- Card Issuer: Banks' branches
- Card Anonymity: Onymous
- Online Interface with banks: ATM for recharge
- Recharging Station: Kiosks, banks' branches and ATMs
- Card Type: Contact Only
- Application Scope: General purpose e-purse and Seoul bus card
- Collector of e-Cash: Issuing banks
- Collecting Scheme from Reader Terminals: Batch transfer to issuing bank

Unlike Mondex, Visa Cash adopted Java card which can run a Java-based operating system and Java applets. This platform is theoretically very attractive, and opens the room for other applications in the future. However, the killer application did not need to implement this high level platform so far. So the Visa Cash Card is not compatible with major applications, thus it experienced low penetration as Mondex did.

Discussion

A predicament of this model is its low acceptance by users, mainly because the killer applications have implemented their own systems themselves. Nevertheless, the e-purse companies push the pilot projects trying to implement the infrastructure of card readers/writers.

It is not clear whether the e-purse companies in Model 3 can create an economical scale of demands without including the killer applications. The only exit seems that they change their standards to be compatible with the killer application cards. But this will change the identities of these brands, so it is very difficult for the traditional e-purse companies to find a path toward Model 4 maintaining their leadership.

8. Model 4: General Purpose e-Purse Card Usable for Killer Applications

Model 3 can progress to Model 4 by adopting the killer application. The killer application systems are well established already and have a slight incentive to be compatible with the e-purse standards. So the e-purse provider has to adjust to the killer application standard. In this regard, K-Cash that is under deployment by Korean banks belongs to Model 4 because it will maintain the compatibility with the transportation card.

K-Cash

K-Cash is a standard that Korean banks have adopted in cooperation with the national clearinghouse. Its pilot is under deployment in 2000. The maximum value to store is 200,000 (about US\$180). A wise plan with this card is its having kept the standard compatible with transportation cards in Seoul. Its characteristics are the followings:

- Card Brand: K-Cash initiated by Korea Clearinghouse and participating banks

Since the standard of K-Cash was established after the deployment of the transportation card, the request to be compatible with the transportation card was very keen. So they have made the applications compatible. A reason why this architecture becomes feasible is that the combi-cards became available and economically feasible in 2000. However, it is not clear yet how the reimbursement process of e-cash can be implemented. It is a very sensitive issue between the stakeholders.

9. Model 5: E-Purse Card Rechargeable on the Internet

So far, the above models – Model 1 to 4 - did not consider the recharge on the Internet. To recharge the e-cash on the Internet, the cardholders need the cyber banking service and combi-card. The combi-card is essential because the contactless reader/writer is too expensive for the cardholder to buy for his/her own use. With the combi-card, the cardholder can recharge through inexpensive (less than US\$10) contact type reader/writer. The stored value can be used both in contact and contactless manner.

By extending Model 4 with the Internet based recharge, Model 5 can be implemented as depicted in Figure 5. Note that the e-cash on the card is used for only off-line payments.

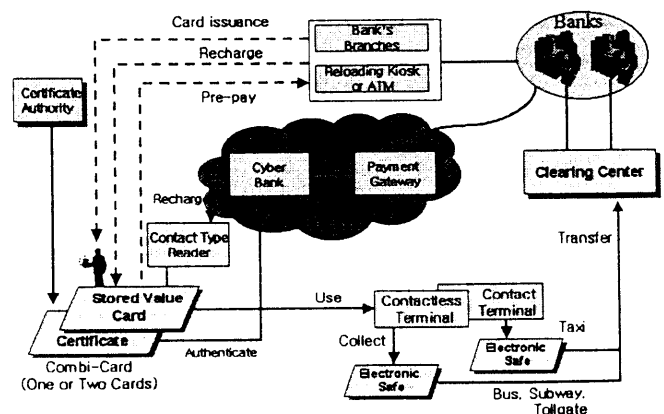


Figure 5 - E-Purse Card System Rechargeable on the Internet

To recharge from the cyber bank account, the cardholders need identification for authentication. The cardholders may be authenticated by a password or certificate which may be stored in the smart card. If the certificate is stored in the e-purse, the card becomes onymous. To keep the e-purse anonymous, we need a separate card purely for identification purposes. Eventually, we can expect that people will have at least one identification card on the chip to use credit cards on the Internet. Nevertheless the e-purse better stay anonymous to reduce the damage of lost cards.

10. Model 6: Ideal e-Purse System

To move from Model 5 to Model 6, the ideal model, we need to add the capability of using the stored value on the Internet as well as offline transportation and at stores. For this purpose, the e-purse needs to accommodate the pure cyber cash usable in the e-stores. The architecture of this model – an *ideal e-purse system* – is depicted in Figure 6. To implement this architecture, a consistent standard of e-cash for both cyberspace and physical space should be reinforced.

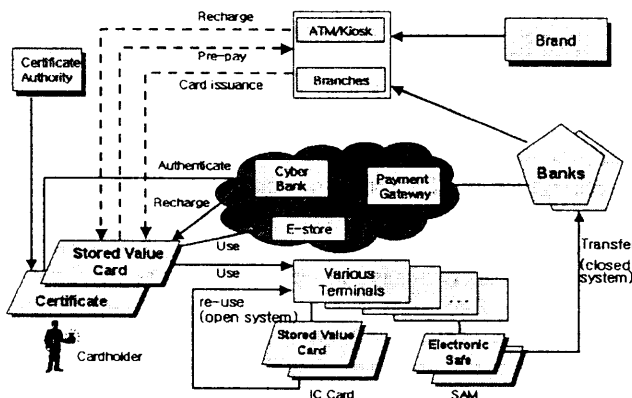


Figure 6 - An Ideal e-Purse System

There is no reported Model 6 implemented yet, although some similar pilot projects are attempted. In 1998, Wells Fargo Bank tested the feasibility of purchasing on the Internet using the Mondex card. The Bank of America also planned to test recharging on the Internet using Visa Cash. However, there was no announcement of successful result yet. According to this research framework, these attempts can be regarded as transition from Model 3 to Model 5 or 6 directly. Because of the same reason mentioned in Model 3, Model 6 cannot be accomplished without passing the stage of Model 4.

11. Conclusion

We have classified the models of e-cash business into 6 types, and analyzed the framework of the evolutionary process toward the ideal business model. Type 1 (single purpose) evolves to Type 2 (multi-purpose). These types are applied to killer applications. However, Type 3 (general

purpose e-purse) began with its own standard, and did not change to be compatible with killer applications. So the e-purse could not be propagated as wished. Type 3 can evolve to Type 4 (general purpose e-purse usable for killer applications as well) only if the Type 3 e-purse adapts to killer applications. Type 4 can evolve to Type 5 and 6 by integrating the Type 4 e-purse with cyber banks and e-stores.

Through this framework, we can plan the e-cash business model suitable to its environment. For instance, in Korea, the transportation card is a must to most of citizens. So this application can be a good starting point. In Europe, the transportation or pay phone card may become a good starting point. Using the framework proposed in this paper, we can design an effective evolutionary path toward an ideal business model.

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