The deployment of chip cards for micropayments in electronic marketplaces

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The implementation of a user-friendly, trustworthy electronic payment system is, without any doubt, a critical success factor for the global breakthrough of electronic shopping applications. The paper presents the interim results of a European research project (Eureka EU 1483) that focuses on the development of an integrated payment system for electronic marketplaces, specifically for the business case of the Electronic Mall Bodensee, an existing mall with more than 400 partners, companies as well as organisations, and universities, in the Lake Constance region. At a very early stage of the project, partners from different groups of stakeholders agreed, that existing systems cover a certain functionality for medium-sized amounts of money but lack an efficient method for micropayments. A dedicated study on existing payment systems in general showed a market concentration on payments via credit card. Since the focus has especially been laid on the needs of small and medium enterprises (SMEs), finding an open solution for micropayments has been identified as the biggest challenge. The paper depicts the business needs for micropayments giving an insight in current European projects on chip cards and electronic cash which could be implemented as a possible solution. Based upon the Eureka project and workshops with banks, the authors offer a process model for the implementation of mechanisms for micropayments into electronic markets and derive some conclusion about the factors which influence its eventual success.

Introduction

The Internet will, undoubtedly, play an important role for the dissemination of electronic commerce. A lot of trading can be performed via electronic networks and, as in the case of information services or software delivery, be settled on-line. So far, electronic shopping has not reached a real breakthrough and therefore a lot of companies are hesitant to invest large amounts of money into the new medium Internet.

Forecasts on the development of Internet Commerce are quite optimistic, granting the implementation of enabling payment systems a high value. „By the year 2000, consumers, businesses, governments, and educational institutions world-wide will use electronic cash (E-cash) for 9 billion payment transactions. By 2005, E-cash transactions will escalate to almost 30 billion. The impact of E-cash will be widespread on both banking and commerce," states Michael Killen, president of a market research firm. The CEO of PerfectData stated in an announcement in November 1996: „Internet currency transactions will exceed $20 billion annually by the year 2000.".

The availability of trustworthy and efficient payment systems are one major success factor for companies to utilise the potential benefits of electronic commerce. Payments within business transactions are always secondary transactions originated by a primary (market) transaction. Therefore, it is a very important issue to integrate electronic payment systems into the business process.

Content and structure of the paper

The results on the application of micropayments as depicted in the paper were derived from experiences with the Electronic Mall Bodensee (EMB), an example of an existing electronic marketplace[1]. In the first section, a description of the empirical framework is given. The following section contains

[1] http://www.emb.net

an analysis of existing cash systems followed by some explanations why they are still lacking wide acceptance. A description of current projects on cash cards gives an introduction to the authors' proposition that they could serve as an appropriate solution for the implementation of micropayments. Based upon the chip card alternative, a possible process model is presented. The final conclusions give an outlook into the future of micropayments.

Payment systems in electronic commerce represent a highly dynamic field in which a lot of research still has to be done. Therefore, most of the references relate to empirical research (e.g. project results), recent articles or electronic news.

Definitions

Electronic Cash

In a modern economy money has to fulfil three basic functions. It is a medium of exchange, a unit of account and it serves as a store of value (Schmid, 1988). Today, a large amount of the world's money deposits is already stored electronically by means of databases, etc. The term „electronic cash" focuses on two specific aspects. First, it is money meant for payments and value transfer as suggested by the word „cash". Secondly, it is a form of stored money and therefore serving as a value store as implied by the traditional definition of money.

Micropayments

Within this paper, we will refer to the term of „micropayments" as private (anonymous) payments of small amounts (smaller than approx. 10 US$) with flexible divisibility which are suited for payment of information services and software products on the Internet. Due to their electronic nature, they are especially useful for odd sums.

Since electronic money raises the risk of double spending, money laundering and tax evasion the payment process cannot be completely anonymous. The user must be identified by the issuing bank. We will thus use the term "private payments" indicating that the payer is anonymous towards the merchant (Law/Sabett/Solinas, 1996).

Payment Systems

The definition of payment systems as it is used within the European project SEMPER is the following: "A payment system deals with all operations that have to do with controlling the movement of money from the payer to the payee inside the digital system." (Abad Peiro/ Asokan/ Waidner, 1996, p. 5).

There are mainly two different kinds of payment systems: debit and credit. In a debit system you first withdraw your money from the bank account saving it onto a different data store that can be used for electronic shopping. In a credit system, you spend the money first and get the bill later (Singleton, 1995).

The empirical framework

The business case of the Electronic Mall Bodensee (EMB)

The Electronic Mall Bodensee (emb.net) project was launched in January 1995 to develop and implement a regional, electronic marketplace in the region around the Lake Constance based on the vision of the „Bodenseeleitbild“ (IBK, 1994). One major goal is to strengthen the economic power of the region, utilising the potentials of the new telematic infrastructures of the information age. The Electronic Mall Bodensee (EMB) is a regional, but multi-national project that realises an open electronic marketplace for a specific region - the Lake Constance region, that covers part of Austria, Germany and Switzerland - in the heart of Europe. It is based on Internet technology.

An in-depth discussion of different aspects of regional marketplaces, its relation to the emerging global infrastructure and the EMB can be found in (Zimmermann, 1996).

The EUREKA project Paysyst

The experiences realised within the EMB project serve as an important empirical base for the EUREKA project Paysyst (EUREKA project no. 1483)[2]. Its goal is the development of generic services for integrated payment systems in open telematic infrastructures. Basically available and proven architectures, concepts, and standards are evaluated. As a major result Paysyst will deliver a business concept for an integrated payment system, as well as a prototypical implementation on one of the involved electronic market platforms. Project partners are two Swiss banks, a university research institute, two electronic mall organisations, an EC solution provider, and a software developing company.

Micropayments from a business point of view

The missing link

The need for micropayments can be derived from the typical Internet-Surfer profile. Cybercustomers tend to be impulse and experience-oriented and it is most likely that they are receptive to „impulse“ items which can be typically found in the low-price segment (digital goods and services). As early as in 1994, the Economist stated that „What they lack is the means to buy from their keyboard, on impulse“ (The Economist, 1994).

The clear message stated by most of the contributing companies within the EMB project is their need of micropayment mechanisms to enable them to sell products and thus gain a profit. For suppliers in the medium and high price segment, e.g. a local wine retailer, the EMB offers means for the secure transmission of credit card information. But there are a lot of low-cost information providers, for example a regional weather forecast service, which are ready to broaden their product range into higher-quality information and are longing for micropayment services.

Delta Consulting Group, the main operator of the EMB, estimates that the number of suppliers could be easily tripled having implemented a fully integrated payment system that covers micropay-

[2] http://eureka.belspo.be/cgi-bin/query35.sh?1483, detailed project results can be found in (Himmelspach/ Runge/ Schubert/ Zimmermann, 1996a,b)

ments as well as secure credit card transactions. Examples for innovative products could be systems on a pay-per-x basis, such as pay-per-use (software), pay-per-play (games) or pay-per-view (weather forecast).

Spontaneous purchases

Micropayment systems should enable spontaneous purchases without prior registration of the customer. Especially in the future with global web access via public Internet terminals, a hard disk based solution will prove not to be practical at all. A movable token with a defined interface will be the only viable system design.

Cost

Cost of micropayments must be infinitely low because of the very small transaction amounts in question. Cost of today's payments exceed, in most cases, the respective value being transferred. „Electronic-money systems must be able to handle high volume at a marginal cost per transaction" (Flohr, 1996).

Odd sums

A related problem can be found in odd sums and the need for a unique currency for cybershopping. (Flohr, 1996) states that „Everything may work fine if transactions use nice round dollar amounts, but that changes when a company sells information for a few cents or even fractions of cents per page [...]".

Products

Taking into consideration the existence of different kinds of payment systems, we have to take a closer look at the possible goods which are tradable via Internet. The greatest part of today's products are intangible because they eliminate the problem of physical logistics being delivered directly over the Internet during an on-line connection or by e-mail. As mentioned before, micropayments are especially useful for intangible goods, which can be classified according to their possible charging system:

Table 1 Micropayment facilities generate new products on the Internet

products	charging system
games	pay-per-play
software, applets, estimations	pay-per-use
weather forecast, news, time schedules, announcements, general information	pay-per-view (pay-per-click, pay-per-document)
software, images	pay-per-download

Looking at the market for charged telephone information (weather, quotes, time schedules, etc.) the question, whether these products could be successfully traded via Internet, can be easily answered.

There is an increasing number of service companies selling their products via audiotex systems using 8xx-services (e.g. 842-, 848-numbers) offered by the Telecom companies. There is no reason why these companies should not have the same or even a bigger success going on-line in the Web due to the fact that they enlarge their number of potential customers.

The international context

The example of First Virtual shows that internationalisation is really an issue. After a one-year experience in electronic commerce the company decided to expand their payment system. „Future enhancements will include internationalisation (for languages and currencies), additional mechanisms for buyers to pay into the system and for sellers to receive payments, and better support for extremely small transactions, sometimes known as 'micropayments'." The Economist states: „Ideally, the ultimate e-cash will be a currency without a country (or a currency of all countries)" (The Economist, 1994). A very obvious example for the necessity of international payment solutions can be observed in the EMB project. Although it's a regional marketplace, the merchants are from three countries with three different currencies.

Chip card-/ smartcard-based payments

None of the numerous projects on payment systems has already come out on top. There are multiple developments but all of them are still in their infancy. A comprehensive analysis of the current developments can be found in (Wayner, 1995) or (Furche, Wrightson, 1996) and on the respective Internet sites. It is likely that only a few of the proposed solutions will be accepted by the users. Success factors are, e.g., security, speed, privacy (anonymity), internationalisation, and ease of use (Panurach, 1996). Above all, the critical success factor is **user acceptance** and it is most likely that users tend to accept a payment method they are already familiar with more easily than a new one - no matter how sophisticated it might be. This grants a good probability of success to the proposed system on the basis of chip cards, namely the Swiss (or German) ec-card as described in the preceding chapter.

There are basically two different approaches to implement electronic cash in an electronic shopping environment. Either the electronic cash is downloaded onto the computer and stored as an electronic token on the clients hard disk or an external token, like e.g. a smartcard can serve as a cash container and the money is directly transferred from the card to the merchant (directly into the bank account or onto an electronic token on the seller side).

International overview

In Europe, banks are using two different technologies, namely the magnetic strip card and the chip card. At present, there are around 30 systems in practical operation. Examples are VISA Cash Card (USA and Australia), Clip Card (Europay in Spain), SIBS in Portugal, Mondex in Great Britain, Hongkong and Canada, Chipknick in the Netherlands, Innovatron in Russia, SSB in Italy, Avant in Finland, Multibanco in Portugal, PME in France, DANMONT in Denmark, Proton in Belgium, CASH in Switzerland or GeldKarte in Germany (Krebs, 1996 and Sperlich, 1996). The paper gives a detailed description of the latter two projects in Switzerland and Germany.

As a lately published article in the Computer Zeitung states, Europay, Mastercard and Visa developed a specification for chip cards, the EMV 96. The public-key-encryption in the card as well as in the reader enables an off-line plausibility check, so that the security hole for the transfer over the network is removed and private (anonymous) payments may be realised (Computer Zeitung, 1996). The Visa-Cash card had already been tested during the Olympic Games 1996 in Atlanta.

The Swiss Cash Card

Switzerland is in an extremely well suited position for establishing a country wide coherent chip card system for the banking industry. They owe their advantage to a company called Telekurs which was founded by all Swiss banks meant to foster the development of common banking projects and standards. The Telekurs is in charge of the Swiss bank card design and has lately initiated a project for a common electronic cash card („CASH"). The new cash card uses the well established and accepted ec-card, a magnetic strip card which already enables customers to use ATMs all over Europe. The functionality of the ec-card has so far been based solely on the magnetic strip. The new Swiss ec-card will additionally have a chip implementation. The chip does not affect the original functionality, but will permit some extra features as, for example, the electronic storing of cash. The two systems (magnetic strip and chip) are completely separate from each other. The big advantage lies in the improved customer comfort of having to deal with only one card with an expanded functionality.

The „CASH" project aims at substituting EFT/ POS-payments which are today quite common in shops and patrol stations in Switzerland. These payments require an on-line connection with the respective ec-card issuer (the customer's bank) to check the PIN and the current account balance, directly shifting the money from the clients account and transferring it to the seller's account. EFT/ POS-payments are rather expensive due to hardware devices and telecommunication cost. Their use is restricted to the home country of the issuing bank.

Now, a new hardware device (the VP-Terminal) is available for the merchants. This device can be integrated into the merchant's cash terminal to enable an automated transaction between the cash register and the card reader/ writer. The CASH-Card was designed to cover payments under 25 Swiss Franks (20 US$). Incentives for its use and acceptance are speed and ease of use (no PIN and on-line-authorisation is required). The process comprises the following three transactions:

1. Charging transaction

A chosen amount of money is being transferred onto the CASH-Card. Presently, charging is only possible to the debit of an existing Swiss bank account. A special „white card" for tourists is planned. Maximum amount is 300 Swiss Francs (240 US$).

2. Payment transaction
Payment at the point-of-sale. A transaction log is being written onto the card as well as onto the VP-Terminal. This enables Telekurs to refund amounts of expired or broken cards after a certain time.

3. Clearing transaction
The transaction log of the card device is being transferred to the Telekurs which then realises the payment clearing. The validity of transactions is being checked and a shadow balance is being recorded. To guarantee payment, clearing must be accomplished at least every eight days. Communication devices are a modem and telephone lines.

Table 2 The new Swiss ec-card

System/ Functionality	Advantages	Disadvantages
ec-card (magnetic part)/ Identification (PIN check)	Magnetic strip is cheap and reliable, system is compatible all over Europe	On-line communication: expensive, time-consuming Customer must remember PIN Magnetic strip is readable to thieves (PIN can be found out)
CASH-Card (chip) Electronic cash container	Fast access, on-line communication with bank is not required, impersonal (spending is not traceable for the merchant)	Chip standard is restricted to Switzerland (competing and incompatible projects all over Europe), capacity for data is still limited, only operation for electronic cash is planned (at the moment)

Card readers/ writers are offered by the Telekurs at a price of around 100 Swiss Francs (80 US$). 0.7 percent of the amount transferred plus 2 Rappen (0.016 US$) per transaction are to be paid by the merchant.

Telekurs admits that the card could be extremely well suited for an operation within the EMB and is therefore thinking about a pilot project (approx. in March 1997). The original CASH-system performs an authenticity check based on symmetrical and asymmetrical keys. Telekurs states that there is a lot of communication between the reader in the VP-terminal and the card during payment transactions. Consequences for a web-based solution would be that the inherent functionality of the card reader/ writer should not be transferred to a client- or a server software due to a high risk of manipulation. We would suggest using a hardware solution including a „mini“ VP-terminal connecting it to the users PC in the same way as to the merchant cash register.

Experiences gained from the German Cash Card pilot

The German GeldKarte (supported by the German banking industry) is very similar to the Swiss CASH-Card in terms of design and functionality though the systems are not compatible. Last year, the organisation in charge of the KeldKarte project, the SIZ, launched a regional pilot project

(Krebs 96). The experiences gained from the pilot are very similar to those made for electronic commerce on the Internet in general:

- The acceptance of the new payment means is strongly associated with the number of accepting points of sale. Only when there is an overall possibility for cashless payments, consumers are willing to substitute money for the card.
- There are a number of psychological impediments to usage of the new medium. Money that cannot be touched is not real to many people.
- Additionally, the fear of manipulations, loss of the card, and violation of privacy plays an important role in terms of user acceptance.
- Accompanying information and marketing campaigns are of big importance otherwise a breakthrough cannot be achieved.
- Merchants are often not willing to pay the extra cost (5 Pfennig [0.03 US$] as a minimum or 0.3 %) for every transaction although this amount is very small compared to credit card fees (2.5 % to 4 %). On the other hand they do not bear the risk of a customer calling back the money, as it is possible today in the case of LSV payments.
- It is important that one card covers a multiple set of functionalities (e.g. money, tickets, discounts, telephone, vending machines).

According to the SIZ, the new cashless payment system implies advantages for all parties:

- Once the cash card is globally accepted, consumers can always dispose of the right amount of cash, never having trouble with carrying the right coins or bills in their wallets.
- The risk of counterfeit money decreases.
- The chip card can also serve as a smartcard with multiple functionality (e.g. identification, authentication, etc.).
- No PIN or signature is necessary, no filling in of cheques (faster settlement).
- Waiting periods at checkout counters diminish.
- Extra functionality (e.g. discount system) enables improved customer links.
- Reduced risk of shoplifting and vandalism on vending machines (electronic cash cannot be manually stolen).
- Reduction of telecommunication cost.
- The introduction of the new European currency, the „Euro“ will be facilitated.
- Bank related transaction cost decrease.

Suitability for micropayments in electronic marketplaces

The following table evaluates possible payment systems in respect to their suitability for micropayments comparing the CASH-Card with the two micropayment solutions Ecash and CyberCoin. While Ecash is one of the most mature systems, CyberCoin was introduced in autumn 1996.

Table 3 Suitability of different payment schemes for micropayments

	Ecash	**CyberCoin**	**Cash Card**
System architecture	certificates for digital coins downloaded on local hard	electronic wallet (special software) with electronic coins,	cash card and card reader, no additional software required

	disk, requires special software	CyberCoin account is necessary	
Set-up cost	US$ 11 - 25 (customer) US$ 150 - 500 (merchant)	no set-up cost for customer	approx. 50 US$ (card reader)
Cost per transaction	US $ 0.4 - 0.28 (merchant) US $ 1.08 - 2.02 (customer) (Himmelspach et al., 1996b)	connection cost plus fees: merchant: 0.08 - 0.31 US$, minimum of 2.5 % customer: no fees	connection cost plus fees: merchant: 0.7% plus 0.016 US$ customer: no fees
Acceptance/ chance of success in the market	resonance has been lower than expected, each bank generates own currency, pilot project with Deutsche Bank	co-operation planned with Oracle and Netscape, one currency for all banks	good chance of success due to countrywide distribution (in CH), users will be familiar with the medium
Accounting via:	bank account (must be opened at a co-operating bank)	credit card or bank account at co-operating bank	existing Swiss bank account
Privacy (anonymity) guaranteed	yes (only issuer of coins knows the identity and logs transactions)	yes (only CyberCoin knows the identity and logs transactions)	yes (shadow balance is stored by Telekurs)

Process model for the implementation of cash card-solutions for on-line-micropayments

An on-line payment transaction generally involves four parties (payer, payee, issuer, and acquirer) (Janson/Waidner, 1996). The presented process model reduces the number of parties to three, namely the client who has to pay (payer), the seller who receives the payment (payee), and the bank who does the accounting (thus serving as issuer and as acquirer at the same time). In the described process model for micropayments several new intermediaries enter into the scenario. An electronic mall guarantees the payment infrastructure and a clearing centre performs the clearing between the mall and the bank.

Requirements

Unlike most payment systems the cash card scenario requires only one additional hardware device. The big advantage is that neither any additional software needs to be installed nor that a preceding registration process is needed.

VeriFone, as an example, is about to produce a personal ATM (P-ATM), a smartcard reader/ writer which connects to any standard telephone line even allowing consumers to interact with their bank account to download „cash“ securely. The card reader turns the PC into a point-of-sale terminal. The new VeriFone device already supports cash cards from Mastercard, Visa, and the British Mondex system (Computer Zeitung, 1996).

Another solution is the card reader being included in the keyboard. Key Tronic Corp., a producer of computer keyboards, will produce specially designed keyboards with VeriSmart (by VeriFone) software in it.

Experts agree that, within short, all PCs will be equipped with card readers. Waidner, technical manager of the SEMPER project, states: „Mittelfristig werden aber PC serienmässig mit Kartenlesegeräten ausgestattet sein, so dass diese [elektronischen Geld] Börsen auch im Internet eingesetzt

werden können“. (Waidner, 1996) [Within some time, PCs will be equipped with card readers per default, so that the existing electronic wallets can be used in the Internet]. Keeping in mind the fast dissemination of the CD-ROM it becomes clear that the market catches up with the customer requirements very quickly.

Process

The payment flow is uni-directional within the depicted system. The card is being debited in the VP-Terminal (cash card reader/ writer). The money is being collected in a cash database on the electronic mall server. After a certain period of time, the clearing process with Telekurs is initiated which hands the respective amounts over to the banks where they are credited to the merchants’ accounts. Refunding onto the cash card is not possible.

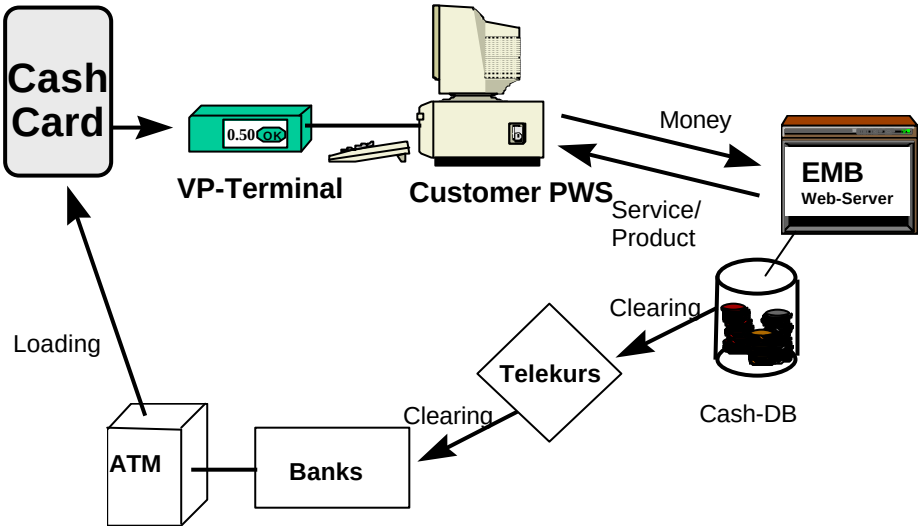

Figure 1 Process model for micropayments in an electronic marketplace

Customer’s view

The customer enters into the EMB and selects a service. He/ she selects payment by cash card. The services are individually charged on a pay-per-x basis, requiring the customer to click an „PAYMENT OK“ button. The amount on his/ her cash card is decreased by the amount agreed upon and logged into the cash database on the web server to the credit of the seller.

Merchant’s view

The merchants’ duty is to secure that the services offered are always up to date (e.g. in the case of weather information). Once a customer receives a bad or outdated service he/ she will most likely not return, thus doing harm to the business. This is a self-control mechanism which should work effectively. Money collection is fully taken over by the electronic shopping platform. Merchants’ profits are comfortably transferred to the respective bank accounts.

View of the electronic mall

The EMB serves as a cash depot in this scenario. Money is stored in form of data sentences in the cash database. After eight days clearing with the Telekurs is performed and the cash database is emptied.

View of the Telekurs and participating banks

The cash supply onto the ec-card takes place at cash machines to the debit of an existing bank account. Banks must provide the infrastructure in form of compatible ATMs. The Telekurs distributes the incoming money to the recipient banks.

Résumé of the depicted cash card solution:

- Synergies are evident
- The stumbling blocks are known
- A country-wide standardisation is realised (the ec-card has already been distributed)
- Customers are accustomed to use their ec-card (accepted solution)
- Only very little new infrastructure is needed on the client's side (a special VP-Terminal or a new keyboard), banks will establish the infrastructure anyway

Conclusions

Undoubtedly, electronic solutions for micropayments are crucial for the success of electronic shopping applications. As shown before, it is more likely that a user accepts a payment method already familiar with from every days life than a new one. Thus we suggest the cash card-based solution because these cards will be used in Germany and Switzerland on a global scale from the beginning of 1997. (Panurach, 1996) states, that the question of whether a system is adopted depends largely on the details of the transaction and the needs of the people conducting the transaction. „On the consumer side, survey data shows that the single most important factor is wide acceptance of the system. Thus, it may be that any system, whether formally standardised and secured or not, could gain market dominance and remain in that position by virtue of its being the ad hoc standard." Telebanking via the Videotex-system in Switzerland as well as in Germany is a very good example of such a tendency. Although net traffic is completely open (there is no encryption) there are a lot of users granting a higher value to comfort than to security.

Another big advantage of the cash card system is the fact that personal shopping habits cannot be traced or tracked by the merchant server. Payment is realised privately (anonymously) paying contribution to the fear generated by the underlying privacy issue.

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