Collaborative Micropayment Systems

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Abstract - Around the world many different micropayment systems are in use. Because of this variety, content providers and customers may rely on different systems. As a result, customers may be unable to buy content from providers using a different system. This paper proposes a novel approach that allows existing micropayment systems to collaborate. This collaboration is realized by introducing an intermediate system, called Payment Gateway, that interconnects different payment systems. This payment gateway enables content providers and customer to use their micropayment system of choice.

Keywords - *micropayment system, payment gateway, Internet service provider*

1. INTRODUCTION

Nowadays online content is predominantly for free. However, the trend is that a growing number of content providers start charging for content. Market research companies (e.g., Forrester Research) expect that for future content providers online content will become an important source of revenues [1][2]. Digital music, for example, is forecasted to be one of these new markets where revenues may become quite high. These revenues will mostly come from payments for individual downloads, rather than subscriptions. Content providers such as Apple iTunes or MusicNet already have an overwhelming success in selling digital music at low prices (e.g., US$0.79-1.14).

These expectations are sustained by the increasing willingness of customers to pay for online content. A recent German study, for example, revealed that 51,3% of the customers are willing to pay small amounts of money for such content [2]. Additionally, the preferred method would be “pay-per-use”. Among the systems that support such payments, micropayment systems are accounting for an increasing share [3]. This paper therefore focuses on micropayment systems; subscription based payments are outside the scope of this paper.

Many micropayments systems have already been proposed for the Internet. However, until now, no micropayment system managed to reach a dominant position among customers and content providers [4]. Most systems are nowadays used within restricted communities, often within national borders. Nevertheless, in the light of globalization, the demand for cross-border payments is growing [4][8]. Future micropayment systems should therefore be useable across country borders, preferably at a world-wide scale.

As a consequence of the fact that different providers use different payment systems [2], customers who want to buy from multiple providers are forced to use multiple payment systems. Also the opposite is true; providers who want to sell to different customers are also forced to use multiple systems. Figure 1 illustrates this problem for two customers and two content providers, each using a different micropayment system.

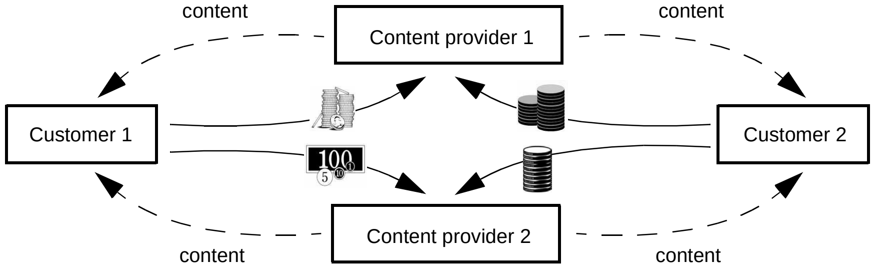

Figure 1: Current micropayments for content on the Internet

Both content providers and customers may encounter problems when they use multiple micropayment systems concurrently. Examples of such problems are: they must trust the various organizations that operate these systems (payment system operators, PSOs), manage multiple accounts and e-wallets, register on PSO web sites and remember passwords, obtain and install multiple software packages and (sometimes) hardware devices, pay for using the various payment systems, and contact multiple helpdesks in case of difficulties. On the long run the effect of these problems could be that customers will turn away, and will not use micropayment systems frequently. Low value content that needs to be sold in large quantities (because of the very low profit obtained per unit of content) will suffer from such problems.

The purpose of this paper is to discuss whether it is possible to solve these problems by proposing a micropayment system that allows both customers and providers to use their micropayment system of choice, regardless of the system used by the other party.

The paper starts with identifying three fundamental approaches to solve the problem (Section 2). One of these approaches involves the introduction of a Payment Gateway; the functionality of this gateway will be presented in Section 3. This functionality may be implemented by different parties; Section 4 therefore discusses two likely candidates: banks and ISPs. The conclusions are presented in Section 5.

2. APPROACHES

We consider the following approaches to support micropayments between any customer and any content provider:

- agree on a single existing micropayment system and introduce it world-wide;
- create a new micropayment system and introduce it world-wide;
- keep existing micropayment systems in place and make them collaborate with each other.

2.1. Agree on a single existing micropayment system

The first approach is that everyone agrees on one existing micropayment system, which will then be introduced world-wide. This approach will be difficult to realize, however. The first obstacle is that the PSOs do no want to give up their market position in favour of another system [4]. They already operate proprietary systems, which meet local (national) needs and regulations (e.g., Micromoney in Germany, Wallie in The Netherlands). These existing systems function already cost-efficient on a national scale or even in broader geographical regions, so any alternative system will face serious competition [5]. The second obstacle is formed by legislative and regulatory differences, which are likely when an existing micropayment system is introduced in new countries. The third obstacle is that customers may be unwilling to switch to another system, because they are acquainted to and trust their current system(s). Customers must therefore be persuaded to adopt the new system, which may involve substantial introduction costs. Hence, the world-wide introduction of one existing micropayment system has a significant chance of failure. This is also shown by history: many micropayment systems aimed at global acceptance and domination, but none succeeded.

2.2. Create a new micropayment system

The second approach is to create a new micropayment system and introduce it world wide. The first step in this process is to develop a new standard for micropayments. In addition to the difficulties listed in the previous section, new obstacles arise. One of these is the standardization process. In case of technical standards, like those of the IETF, the standardization process can easily take four to six years. Standards for payment systems, however, also require involvement from financial and legal authorities. This involvement will likely result in a further delay of the development. Additionally, it is not even sure that all legal and regulatory issues can be solved, due to the different laws and rules imposed by the financial authorities.

For example, there is no agreement on the type of organizations that are allowed to issue electronic money; in the Netherlands, for example, electronic money (e-money) is exclusively issued by credit institutions or banks, while in Denmark non-banks are allowed to issue smart cards, although under special conditions [6].

2.3. Make existing micropayment systems collaborate

The third approach is to keep current micropayment systems in place and make them collaborate. This can be achieved by introducing a Payment Gateway (PG), which interconnects the various existing systems. The introduction of a PG in fact creates a hybrid micropayment system that comprises existing micropayment systems.

Figure 2 illustrates the interconnection of four payment systems. Customer 1, Customer 2, Content provider 1 and Content provider 2 may all use different micropayment systems. The functionality of the PG consists of receiving payments from customers, then initiating payments, which are sent to the content providers.

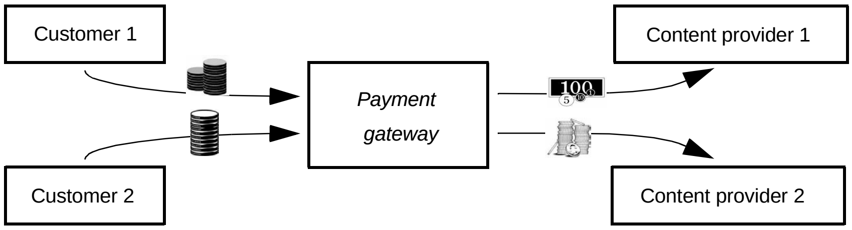

Figure 2: Interconnection of payment systems

The interconnection should be based on rules, which define the complete mapping between two micropayment systems, i.e., between the original payment of a customer and the initiated payment. The initiated payment should contain the information of the original one (e.g., value, addressee, content identification information).

This approach solves the problems of content providers and customers discussed in Section 1. In this case they need to trust only one PSO, select and use one payment system provided by that trusted PSO, obtain and install software and hardware components of just one payment system, and then learn its usage, etc. Furthermore, this approach does not suffer from the drawbacks of the other two. As a consequence, PSOs present on the market can keep their positions and proprietary systems, investment costs are reduced compared to the other two approaches, the hybrid system can start functioning as soon as the PG is in place, and most legal and regulatory issues are addressed, since the comprised systems already function.

Because this approach is more likely to succeed, the following sections will analyse what functionality is required from a PG.

3. PAYMENT GATEWAY

In general, each payment system consists of four entities: a payer, a payee, an issuer and an acquirer [7]. Figure 3 depicts a basic interconnection scenario, in which a PG is interconnecting two different micropayment systems. The Customer and Content provider each interact with their payment system through entities Payer 1 and Payee 2, respectively. Payer 1 sends payments when requested by the Customer. Payee 2 indicates payments to the Content pro-

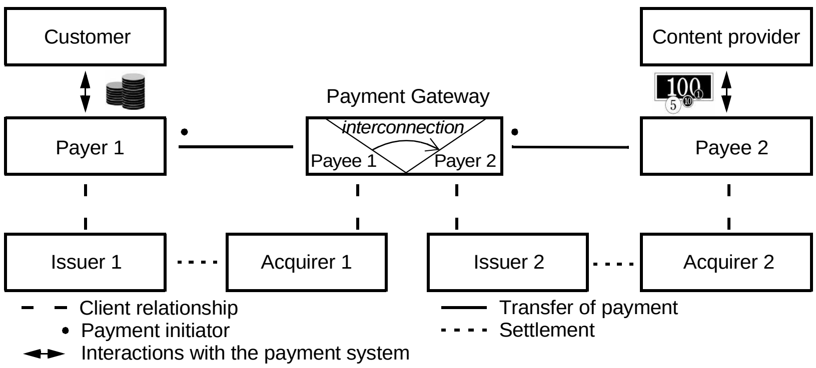

Figure 3: Basic interconnection scenario

vider, which will send the paid content to the Customer. The PG combines entities Payee 1 and Payer 2. Payer 2 initiates and sends a new payment to Payee 2 for each payment received by Payee 1. Issuer X (X = 1, 2) provides electronic money to Payer X for making payments. Acquirer X holds an account for Payee X, and settles in cooperation with Issuer X payments received from Payee X. Examples of organizations that may act as issuer and/or acquirer are banks, financial institutions, or independent organizations (e.g., Bibit). Note that an issuer and acquirer are often combined for efficiency reasons.

3.1. Differences between micropayment systems

In order to establish the functional requirements and assess the feasibility of a PG, we studied several micropayment systems to find out their differences. In this paper, we focus on the following main differences in:

- the type of electronic money: token-based vs. notational (or pre-paid vs. post-paid);
- the applied payment transaction models;
- the size of payments;
- the validation mechanisms used to guarantee the settlement of payments.

Additional differences that need to be considered are, e.g., the applied security mechanisms, currencies, transaction costs, trust and business agreements between PSOs. These differences are however beyond the scope of this paper.

3.1.1 Type of electronic money

Two types of e-money can be distinguished: token-based and notational. A token has a predetermined (fixed) value, which is carried by itself, just like coins. A notation can have an arbitrary value and has an owner identifier that indicates to whom the notation belongs (e.g., an account number from which this e-money will be deducted). For instance, Payer 1 buys tokens from Issuer 1, or Issuer 1 creates an account for Payer 1 (see Figure 3). In case of a debit account, Payer 1 needs to deposit money into that account before making payments. In case of a credit account, Payer 1 deposits money after making payments. The interconnection of systems using different types of e-money is possible under the condition that the PG knows what type of e-money Payer 1 and Payee 2 use. Thus, Payer 1 and Payee 2 need to inform the PG about the type of e-money they use. Based on the information received from Payee 2, the PG obtains the necessary e-money for sending payments to Payee 2. In general, the PG should be able to interconnect many payment systems. Consequently, a PG may need to invest considerably in (pre-paid) e-money.

3.1.2 Applied payment transaction models

Micropayment systems may function according to four distinct payment transaction models: direct cash-like, direct account-based, indirect pull account-based, and indirect push-account based [7]. The main differences between these models are (i) token-based vs. notational e-money; see section 3.1.1, (ii) the initiator of a payment, and (iii) the presence of direct interactions between Payer X and Payee X (see Figure 3). Most micropayment systems function according to the direct cash-like and direct account-based payment transaction models. This means that Payer 1 is the initiator, and the payment is directly sent to Payee 1. The interconnection of such systems is possible since they only differ w.r.t. (i). In our study we found no micropayment system that functions according to the indirect push-account based model; hence such systems are not considered. In case of micropayment systems that function according to the indirect pull account-based model, Payee X initiates the payment. This means interoperability with systems using the direct cash-like or account-based transaction model is a problem. However, because we know of only one payment system (Cartio) that uses the indirect pull-account model, we chose not to consider this type of system either (at least for now).

3.1.3 Size of payments

A micropayment system may enforce a minimum and a maximum value on a payment. The interconnection of various systems is only possible if the value of that payment is allowed by each of the involved payment systems. Nevertheless, most micropayment systems allow payments within approximately the same minimum and maximum value range.

3.1.4 Validation mechanisms

Micropayment systems use online or offline validation mechanisms [7]. In case of online validation, a third party (e.g., Acquirer X, see Figure 3) is involved to validate every payment. If the PG receives a payment that requires online validation, the PG deposits that payment at Acquirer 1 and receives a validation indication. In case of offline validation, no third party is required, and the PG can validate the received payments itself. For this purpose, the PG needs to obtain the payment validation criteria from Issuer 1 based on payment information initially received from Payer 1. Regardless of the used validation mechanism, a new payment is only initiated after the original one has been proven valid. Subsequently, the same process is repeated for the second payment system, where Payee 2 or Acquirer 2 may perform the validation. Since validation is performed per payment system, the use of different validation mechanisms poses no additional requirements on the PG.

However, due to the introduction of an intermediate system, the situation may occur that Payer 1 sent a valid payment, but the payment initiated by the PG is considered invalid. As a result, the Customer receives no content although he has paid for it. The general rule is that Payer 1 bears the loss of money in such a case, but only up to a certain limit [8]. The probability of this occurring is however low. The main causes for invalid payments are communication or system failure, and fraud. A well-designed and implemented PG does not really add to the first cause. The second cause is unlikely because the PG falls under the supervision of financial authorities, and should generate and store audit information about its interconnection activity [8]. Furthermore, in case of repeated invalid payments, Issuer 2 may choose to expel Payer 2 from the payment system. Because audit information exists at the PG, payments of Payer 1 can be investigated, and refunds should be possible.

3.2. Performance and scalability

Because it is expected that the volume of payments will be huge, the use of a PG may introduce a bottleneck in a hybrid micropayment system. To enhance performance, parallel PGs can be introduced. In this way, the interconnection load can be balanced.

The complexity of the PG increases with the number of micropayment systems, which may cause scalability problems. For example, in case there are m different payment systems, the PG should know $m \times (m-1)$ interconnection rules. Moreover, if a new payment system is being introduced, then $2m$ new interconnection rules must be defined and implemented by the PG.

This complexity can be decreased by performing the interconnection in two (or more) steps (see Figure 4). The first step interconnects an existing payment system and an intermediate one. And the second step interconnects the intermediate system and an existing system. In this way the number of interconnection rules is reduced to $2m$. In case one of the existing systems can be used as intermediate, the number of rules can even be reduced to $2(m-1)$. In case of stepwise interconnection, the addition of a new system requires only 2 additional rules.

A suitable intermediate micropayment system could be chosen from existing systems that support cross-border micropayments (e.g., NewGenPay, Paynova).

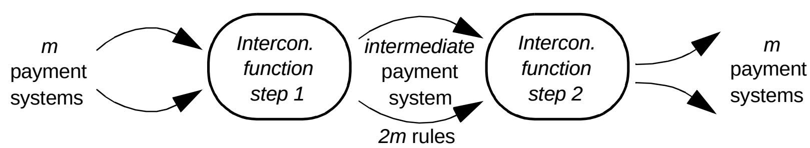

Figure 4: Interconnection in two steps

4. PAYMENT GATEWAY PROVIDERS: BANKS VS. ISPS

The functionality of the PG can be implemented by different parties. Two interesting candidates are banks and ISPs. Both have already large user bases (i.e., customers and content providers) and, in general, users trust them. Although banks have a strong expertise in payments and may already act as issuer and/or acquirer, ISPs have other qualities.

A strong point for ISPs is that the communication channel, which is used to exchange the online content between the customer and providers, is controlled by them. Because the content and payments are transferred over the same communication channel, it is relatively easy to couple payments with content delivery. In case of failures, for example, the delivery of content and payments can be stopped in parallel. Also it may be relatively easy to implement schemes in which the customer has to pay for the time a content service has been used; examples of such services are Internet radio broadcasts and streaming videos. The usage metering needed for such service can be easily performed by ISPs; banks can hardly perform such measurements. An additional argument in favour of ISPs, is that customers have more trust in their ISPs then in the remote content providers [10]. This can be explained by the fact that ISPs usually have a (durable) billing and financial relationship with their customers. Compared to banks, ISPs are also more open to introduce the new information technologies needed to overcome some weaknesses of current payment systems [9].

5. CONCLUSIONS

In the next years the market for low value online content, like music and videos, is expected to grow substantially. To allow “pay-per-use” of such content, micropayment systems will play an important role. Although many micropayment systems already exist, none has obtained a dominant market position. Customers and providers are therefore faced with the situation that they have to install and use multiple systems. This is not a desirable situation.

This paper proposed a hybrid micropayment system that guarantees interoperability but still allows customers and content providers to use their payment system of choice. The core component of our hybrid system is a Payment Gateway (PG), which interconnects the various existing systems. To improve performance, scalability and to facilitate cross-border payments, multiple PGs may be used. ISPs can play an important role in the operation of the hybrid micropayment system; they control the communication channel over which content and payments are transferred and they have already a strong relationship with customers.

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