A Provider Base Accounting Architecture

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***Abstract*—This paper presents a novel content accounting architecture. Content accounting is becoming increasingly important since it is anticipated that in the near future more billable content on the Internet will be published. The architecture presented in this paper has a distributed functionality and an innovative view with respect to the payment system that is incorporated. The architecture enables outsourcing of the accounting functions. In particular it is shown how Internet Service Providers can be involved in the billing function. The proposed payment system is worldwide applicable and allows online, instant and small payments to be made for a number of content types and units. An important characteristic of this payment system is that customers can always use the same payment mechanism regardless the expectations and requirements of the other (paid) party.**

***Keywords*—content accounting, outsourcing, accounting architecture, micropayments**

I. Introduction

Nowadays the Internet has reached a considerable penetration in our daily life. The recent years have shown an exponential growth in the number of people using it. Moreover, the bandwidth supported by the Internet and the processing power of computers have increased considerably.

The above-mentioned observations form enabling factors for Content Providers (CPs), e.g., Springer Verlag, Reed Elsevier, Inc., Elektra Records, CinemaNow or Inside.com, to publish and sell content on the Internet. In spite of what many believe, not all content will be for free [1]. CPs want to exploit these new opportunities to make a successful business on the Internet. The diversity and quantity of content is already growing. CPs require content accounting systems to be able to sell their content online.

A content accounting system is responsible for carrying out several functions: metering, data collection, pricing, charging and billing.

Metering is the measurement of content[1] consumption. The consumption can be expressed in different units of content: e.g., the number of bytes or files, or the transmission period. Data collection consists of the transport and storage of metering data. This is necessary because data may be needed for a longer period and meters may not have enough storage capacity. Pricing sets a tariff to a unit of content. Charging is the calculation of costs for content usage based on collected metering data and pricing information. The billing function consists of a few sub-functions: the transformation of charging information into bills, the sending of this information to the customers and the collection of payments from customers.

Most CPs carry out themselves the accounting functions (we call this "server based accounting" - SBA) [2]. Such CPs define and implement the accounting functions in a particular way to fulfill their best interests. For example, different CPs may apply different definitions of content units, different metering strategies, or different formats to store metering data. In the collection of payments even a bigger diversity can be noticed. Although there are some widely accepted payment systems on the Internet (e.g., credit cards), many proprietary payment mechanisms have been developed and introduced.

The majority of current content accounting systems fall under the SBA category. Usually SBA systems require customers to register and payments to be completed before accessing any content. It is quite common that content is sold in atomic pieces, and smaller parts cannot be bought separately. The applied payment systems generally use credit cards, checks or other proprietary solutions (e.g., electronic wallets). There are many situations in which these payment instruments are not available for customers or not suitable. E.g., credit cards are not suitable for paying small amounts like a few cents because a credit card transaction costs about 25 cents.

The facts listed above and the lack of content accounting standards on the Internet has led to thousands of content accounting possibilities. As a consequence, the customers must deal with accounting systems, which have various payment systems, incorporated. They may be confused and discouraged when facing difficulties of understanding and using many proprietary systems. This way the selling of content is indirectly hindered.

[1] Only non-tangible content is considered, such as online articles, streaming data, dictionary entries and search query results. Tangible content, such as books or CDs, are not considered.

This paper is based on the work performed in within Work Unit 5 of the Internet Next Generation [7] project. The project is part of the Dutch Gigaport programme, and sponsored by the Telematica Instituut [8].

The problems, drawbacks and limits of current content accounting systems require a different approach to this subject. One aspect that can be improved is the payment sub-function. This paper proposes a content accounting architecture that is flexible with respect to the payment system. The smooth selling of content on the Internet requires an appropriate payment system. The proposed payment system allows small payments of a few cents and allows the incorporation of different payment mechanisms. Additionally, it is a customer friendly payment system, i.e., it allows customers to use a single payment system when paying different CPs.

In our new architecture the billing function that includes the payment collection will no longer be a task of the CP (like in SBA); it is outsourced to potential billing providers (Fig. 1). For this purpose, the direct customer-CP payment chain is broken into several payment links. The amounts of money paid by a customer will be transferred via a number of billing providers to the CP. First, the customer pays to a billing provider with which he/she has a contract, and then the payment will be transferred further to the billing provider who has a contract with the CP and notifies it about the incoming payments. This may be a cost-effective solution for CPs; it supports different business models and allows a worldwide applicability.

The remainder of this paper is structured as follows. Section 2 presents our content accounting architecture. Section 3 presents an accounting scenario. Section 4 describes related work. Section 5 presents the conclusions and further work.

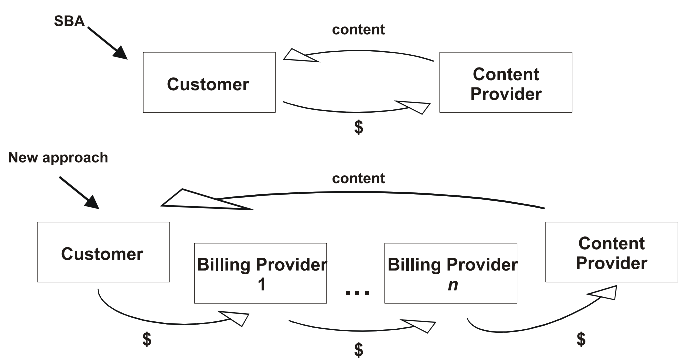

Figure 1. Different payment possibilities

II. A Provider Based Accounting Architecture

A. Requirements

The development of the new content accounting architecture was driven by a number of requirements. The architecture should provide the following features:

- Customers should always be able to use the same payment mechanism, irrespective the CP they communicate with;
- Customers should have a trust relationship with the organization providing the billing function;
- Organizations providing the billing functions must have trust relations with each other to assure their financial collaboration;
- The architecture should be able to cope with small amounts of money, which are processed online, instantly and anonymously.

B. Approach

Accounting functions can be outsourced or handled by the CP itself.

In this research we propose that the ISP organizations of customers and CPs provide the billing function. The name of our architecture, provider[2] based accounting (PBA) architecture, reflects the role of the ISPs. The other accounting functions are performed by the CPs.

There are non-technical and technical reasons to motivate the choice of ISPs to provide the billing function. The results of a survey shows that almost one third of the adults willing to pay for content would like to pay their ISPs [3].

From another perspective, ISPs can use their market position to generate extra revenues. ISPs have a large trusted customer base and can offer a new value added service. Customers and CPs have (probably) durable agreements with ISPs for Internet access and data transport. Such agreements can be extended to include content-related billing.

The situation presented resembles the case of telephone operators and their customers. Customers are allowed to make phone calls, even receive “content” from various information or service providers (e.g. 0900 numbers). Customers pay a single bill to their carrier at the end of a billing period. In general, this bill includes a subscription fee, costs of local and interurban calls and additional costs if services of certain service or content providers were used.

This research focuses on content types and units that have no standardized accounting solution or for which current solutions are not suitable. For instance, the following content types are considered: streaming video, voice over IP (VoIP), Internet radio, online games, and atomic content (e.g., files, articles, dictionary entries). It is assumed that content is offered in small units. This means, for instance, that a video stream is offered in units that are 5 minutes or 5 MB long.

Such content types and units need small and micro sized payments. Small payments are considered to be in the $0.10-5.00 range, while micropayments are up to $0.10. Micropayment systems satisfy the listed requirements, but there is no consensus among CPs to use a single system.

C. Basic Content Accounting Architecture

The PBA architecture is illustrated in Fig. 2. The basic architecture consists of a customer and a CP, which are connected via to two different ISPs. Different cases, such as multiple customers and CPs, or customers and CPs connected to the same ISP, are not considered. However, the ideas presented in this paper also apply to these cases.

[2] In this paper the term provider will exclusively be used for ISPs.

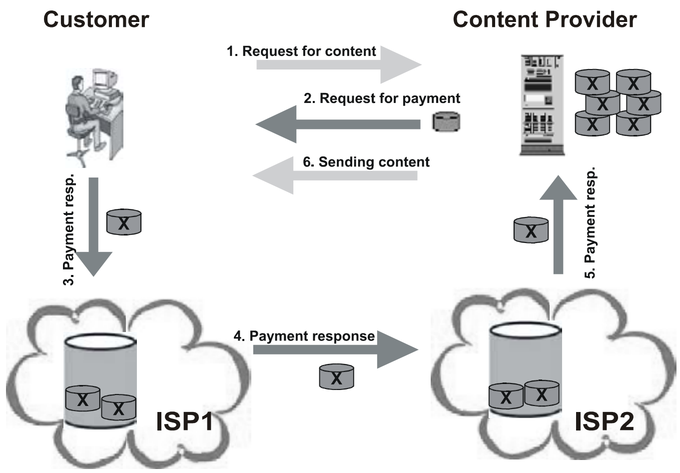

Figure 2. Basic PBA Architecture

Let us suppose that a customer surfs to the web site of a CP on which chargeable content is offered. After selecting a certain piece of content the customer receives the necessary pricing information. The customer decides to request for this piece of content, which is followed by a payment request from the CP. The customer issues the subsequent payment response to its own ISP that in turn will transfer it to the ISP of the CP. After the CP receives the payment response from its ISP the content is sent to the customer.

Payment responses are collected within the ISPs. This is necessary because customers may only send payment acknowledgements in their responses instead of actual electronic money. With acknowledgements customers pledge that the costs made will be paid later. Periodically the ISPs present an overview of the payments to the customers. This can be an informational overview of costs for a certain period or an invoice.

The ISPs allow their customers and CPs to use only one payment system. In this way, the customer has to learn only once the usage of a payment system. The two payment systems used by the customer and CP could be different. Due to this (likely) difference and existence of many currencies interoperability issues may arise. ISPs must provide a solution to cope with these problems. This means the currencies must be changed and mapping between different payment systems must be defined. It is unlikely that it is possible to define a mapping between each pair of payment system. This implies that not all-existing combination of two payment system may be useful.

D. PBA Entities

This section describes the functionality of and the relations between the entities illustrated in Fig. 2:

- Content Provider,
- Customer,
- ISPs.

The CP offers chargeable content in different units. The CP has a contract with ISP2 for Internet access. This contract will be extended to include a content related billing function. Whenever a customer sends a request for chargeable content, the CP responds with a payment request. According to the agreement ISP2 will receive and collect payments coming from customers of the CP. The payments can be transferred immediately or periodically to the CP. In all cases, the CP will be notified immediately after a payment response has arrived. Subsequently, the CP will send the paid content to its customers. There is a cheating possibility for CPs. After the payment was completed the customer expects the content but nothing arrives. This is not a worrying situation because the content involved may be worth a small amount of money. On the other hand, the CP's reputation and ability to run a successful business are worth much more.

The customer plays the role of a content consumer. It has a contract with ISP1 for Internet access. This contract will also be extended with a billing clause. Surfing around on the web, the customer requests content. In case of chargeable content the customer will receive payment requests. Based on the agreement, the customer can send payment responses to its ISP to be forwarded to the CPs. The customer is informed periodically (e.g., with the monthly bill) about the costs for chargeable content. No personal information of the customer need to be transferred to the CP together with a payment response.

Different ISPs connect customers and CPs around the world. All entities must obey various financial legislations and use an appropriate payment system that is available. ISPs handle conversions between different currencies and between different payment systems if necessary or required by the other party. The presence and collaboration of ISPs is necessary to achieve the financial cooperation between customers and CPs. The customer-CP direct payment link is broken into three payment links that are easier to build up and exploit: customer-ISP1, ISP1-ISP2 and ISP2-CP. In this manner customers and CPs will always be able to use a single payment system.

ISPs have no notion of any content that they are transporting. In the PBA architecture their role is to provide the billing function including the transferring of payments from customers to CPs.

Other ISPs, network operators or backbone providers can be between the ISPs of customers and CPs. These providers are not involved in the content accounting process.

Since money is involved, ISPs need certain trust agreements to be able to collaborate financially. To keep the number of bilateral agreements scalable, an ISP should not have to conclude a contract with all other ISPs. Trusted Third Parties (TTP) can assist ISPs realizing these agreements by issuing them trust certificates [4].

Depending on the nature of the ISP-ISP agreements, the financial settlements between two ISPs can be arranged in different ways. One possibility could be to transfer the amount mentioned by the customer whenever a payment response arrives. Micropayment systems are a good method to implement such payments. Another approach could be the periodical (e.g. monthly) wholesale billing. In this case, ISPs sum up the payment responses at the end of the billing period and transfer the amounts due to the other party.

ISPs taking part in the PBA architecture must perform certain operations when payment responses arrive. One of the most important tasks is to check the sender's identity, i.e., authentication. Together with the sender's authentication its credit may be verified as well. ISPs may set up spending (credit) limits for their customers or other ISPs as protection measures for customers or themselves. If there is such a limit, first the credit must be checked before the response can be accepted. The accepted payment must be recorded. If necessary, other actions can be carried out as well, such as the conversions between different currencies and/or payment systems. Subsequently, the payment response can be sent to the next entity in the architecture.

E. Handling Error Situations in PBA

Several errors may occur during a transaction. These can be grouped in hardware failures (billing entities of ISPs or network breakdowns), software failures and denial of service errors (invalid or expired transactions, accounting errors). In either of these errors, payments cannot be completed and customers should be notified regarding the nature of the error and refunded (if possible) since they will not receive any content.

In case of hardware or software failure, customers cannot do much to recover them (unless it is their system). When a payment response is rejected the sender should be notified. A rejection may occur when the credit of the sender is exceeded. The rejecting entity decides what will happen with the included payment. One solution is to discard or delete it. The sender may also receive it back. However, the customer bears all risks when a payment is rejected and it may not be able to recover it. This design decision is due to the need to keep the architecture efficient. Since the architecture supports small amounts of money, it must be a trade off between the costs involved in losing a payment response and the costs of having heavy recovery mechanisms.

In real life losing very small amounts of money is acceptable. For instance, losing a few cents in a telephone booth when the connection breaks right after it was established seems to be acceptable for most of us. Losing a payment response due to an error in the PBA architecture is very similar. The costs of implementing heavy recovery mechanisms to provide increased reliability must be in balance with the amounts of money that may be lost.

F. Security and Feasibility Issues in PBA

Security threats on the Internet always appear, especially when valuable information is transmitted. Secure payment systems are needed to assist the commercial activities on the Internet. Since payments and electronic money is involved it is very important to protect these messages against different forms of fraud. Some of the most important security problems are destruction or modification of information, masquerading of messages and repudiation. A study concerning the security threats and their countermeasures (e.g., digital signatures, certificates) in the PBA architecture was performed as part of the Internet Next Generation (ING) project [7].

A prototype of the PBA architecture has been implemented to investigate and evaluate its feasibility. Although, the testing was effectuated with a single customer and CP, many scenarios were created (using various transport protocols, network conditions etc.). The response-time it the time period while a payment response of the customer arrives to the CP. The implementation measured the response-times as well and the conclusion was that the protocol is reasonably fast. Results of this investigation can also be found on the web site of the ING project [7].

III. PBA Scenario For Streaming Video

During the development of the accounting architecture, a streaming video on demand (SVoD) system was used as working environment.

An SVoD is an interactive system, where a customer can select and watch video content from a database [5]. In the SVoD system the content is provided as a continuous data stream and it is rendered as it arrives. A customer of an SVoD system is not waiting to download large files before viewing the video or hearing sound.

Let us suppose that a customer is surfing on the Web when it remarks a collection of multimedia content (e.g., video and movie files) stored by a video server of a CP. The video files are considered big (e.g., a couple of hundred MBs large or a few hours long) and the CP offers them in 10 minutes long units for a $0.05/unit price.

The customer sends a request for content to the video server (Fig. 3). The video server replies with a payment request message. The customer issues the payment response (acknowledgement) and sends it to ISP1. Actually, both ISP1 and ISP2 have a billing entity for handling payment responses. The ISPs will process the response before the response will arrive at the video server. Upon reception of the response, the video server starts sending the video stream.

At a certain moment before the paid unit is completely sent, the video server issues a new payment request to continue the streaming. It is up to the customer whether it would like to continue watching the video or not. If yes, it will issue a new payment response. This may continue in a cyclic way. If the customer refuses to respond to further requests the video server will stop at the end of the last paid unit.

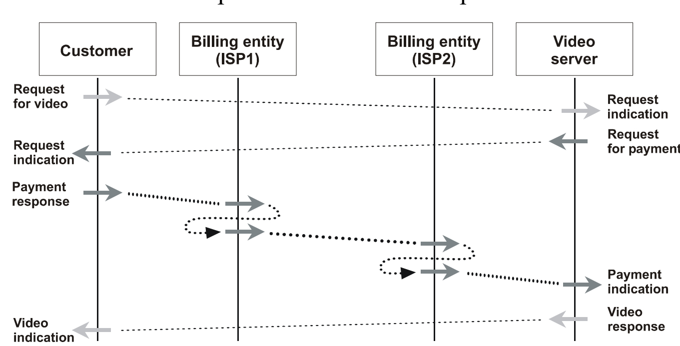

Figure 3. Message exchange between the entities

In case of streaming data (SVoD, VoIP etc.), the customers have the freedom to respond with bigger amounts than the ones requested. The CPs will notice this and consequentially will issue new payment requests only when the extra paid piece of content is reaching the end.

In many cases (e.g., streaming video) payment responses should occur automatically, but with the possibility for the customers to limit their losses. At the customer's side an intelligent client can be installed to allow the automatic generation of payment responses. This avoids that every payment request must be explicitly acknowledged with a keystroke or mouse-click.

IV. Related Work

Although currently SBA is the dominant accounting solution, there are already PBA-like solutions in practice.

NTT DoCoMo is a major ISP that provides Internet access and services using a technology called iMode. iMode is a PBA-like system with a single access provider, a very large customer base and many CPs. A central billing relationship exists among provider, CPs and clients. According to this relationship, content related flat-rate payments (besides subscription and amount per packet fees) are collected by the provider and distributed to CPs [1].

Enition proposes an accounting system that allows ISPs to pay CPs for content on behalf of their clients. Clients of ISPs can ask for content from CPs while their ISPs will pay the CPs (by placing payment tokens in the IP layer). At a later moment they will charge the clients based on special data records (toll detail records) [6].

V. Conclusions and Further Work

In this paper a new content accounting architecture is proposed. The outsourcing of the billing function to ISPs and the financial interoperability characteristic of the PBA architecture makes it applicable world-wide in different technical and legal situations. The PBA architecture introduces a hybrid payment system, which may consist of different payment systems. Values of one payment system can be converted into values represented by another system. Existing contracts between customers or CPs and ISPs will be extended to include content related billing. ISP-ISP trust relationships can be established using TTPs.

The PBA architecture proposes a flexible payment system that facilitates small, online and anonymous payments. CPs are paid indirectly for their content by introducing three payment links instead of a direct link. On each payment link a suitable micropayment system can be selected. Although in real life payments are often bidirectional, in the basic PBA system's current design the payments flow only in a single direction.

Further work is performed following a cyclic approach. The next steps will study the robustness and reliability of the architecture, add security mechanisms, select suitable payment systems and define their mapping.

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