Micropayment in the Context of Distributed Digital Libraries

WOLFGANG KIENREICH
KLAUS TOCHTERMANN
Know-Center, Competence Center for Knowledge-Based Applications and Systems
Inffeldgasse 21a, 8010 Graz
Austria
http://www.know-center.at

ELISABETH OSWALD
IAIK, Institute for Applied Information Processing and Communications
Graz University of Technology
Inffeldgasse 16a, 8010 Graz
Austria
http://www.iaik.tugraz.at

Abstract: - Distributed digital libraries provide access to multiple sources of information not necessarily located within their physical, legal or commercial sphere through a single point of entry. Charging and billing users for content consumed in such an environment could be a prototypical field of application for micropayment solutions, which instantly collect small amounts of money for services provided. This publication defines requirements for payment methods in the context of distributed digital libraries and examines micropayment schemes for compliance.

Key-Words: - E-Commerce, Digital Libraries, Micropayment, Educational Context, Legal Issues

1 Introduction

Digital Libraries have been a major trend in recent efforts to organize, index and make accessible the rapidly growing amount of global knowledge. As a consequence of widely varying technical and methodological environments, the concept of distributed digital libraries has formed: Such libraries provide access to multiple sources of information not necessarily located within their physical, legal or commercial sphere through a single point of entry and strive to present users with a unified view on these sources. Distributed digital libraries are especially important in the academic domain, where researchers and students have to locate and access relevant material quickly and efficiently, regardless of physical separation or varying means of presentation [1].

Similarities and potential synergies between digital libraries and e-commerce in general have been recognized quite early. E-commerce and digital libraries share infrastructure requirements in the areas of networking, security, searching and advertising, negotiating and matchmaking, contracting and ordering, billing, payment, production, distribution, accounting, and customer service mechanisms [2]. However, only a subset of e-commerce methods and approaches is suitable for the digital library sector. For example, users and librarians alike would be greatly disturbed in their work if they would have to follow proper billing procedures for every single source of information they access. After all, a central aspect of distributed digital libraries is to provide unification of access across information sources. Consequentially, payment procedures have to be unified, in a context where access patterns range from downloading a publication as a whole to referencing a paragraph or chapter of a book. Micropayment methodologies and techniques, which instantly collect potentially very small amounts of money for services provided online, are promising candidates for charging and billing under such circumstances.

This publication briefly introduces the topic of distributed digital libraries and micropayment. An example scenario of a distributed digital library requiring unified charging and billing for consumed content is presented. Requirements for payment procedures are derived from the example scenarios and similar projects. Found requirements are then matched against known capabilities of existing micropayment systems, and conclusions are drawn towards the feasibility of using micropayment as a payment scheme in dynamical digital libraries.

2 Digital Libraries

Definitions for distributed digital libraries are quite heterogeneous across domains of applications. In addition, terms such as "electronic library" and "virtual library" are often used synonymously. However, elements common to most definitions can be identified: Distributed digital libraries are not formed by a single entity, they use technological means to link resources, present such links to the end user in a transparent way

and are not limited, in type or format of content, to text document but may also include, for example, multimedia content not directly representable in textual form [3].

The academic and educational context chosen for this publication emphasizes specific elements of the definition given in contrast to, for example, a public digital library of literature. Resource diversity is very high, with only a tiny percentage of documents available actually residing in the domain of the library service provider. Transparent resource linkage is important because the source of a piece of information is often used to determine its quality. Finally, user access must be controlled on a very fine level because many documents require commercial access privileges which have to be covered by the library and, ultimately, by the user or the educational or academic facility.

2.1 Current Trends

The first generations of digital libraries simply transferred the concept of physically locating books or other forms of documents in a library to the virtual library space they created. However, work on digital libraries has been emphasizing annotation and personalisation recently: Documents are being extensively supplemented with meta data which enables users to identify relevant content, on a sub-document level, without having to access the document as a whole. Tools and techniques are being devised which allow personalisation and customisation of access to digital libraries, invalidating the traditional concept of accessing documents [4].

In another development, content stored in digital libraries is becoming increasingly cross-media in nature. It is estimated that there will be nearly 300 million digital image capture devices in use worldwide through 2004, capturing about 29 billion digital pictures, most of which will be organised in some kind of multimedia repository and available via the world wide web or other means of sharing data [5]. As a consequence, today's focus on textual documents is likely to change towards image and video libraries in the near future.

2.2 Technical Aspects

Early work on technical aspects of distributed digital libraries focused on means of transportation and delivery of library content across network and system barriers. Before the advent of database-backed web servers and secure browser-based client interfaces, proprietary systems had to be designed and implemented to provide baseline functionality like content delivery or user rights management. With the maturing of web-based applications, the focus of interest has shifted towards standardisation of approaches and interoperability of available systems.

An in-depth examination of technical standards and implementation practices for digital libraries is beyond the scope of this publication. A comprehensive overview on predominant approaches is provided by [6]. The implementation of digital libraries in the form of web-based information systems using browser-based client interfaces constitutes a major trend. Resulting systems rely on secure http for communication security, implement digital rights management through the use of OpenDRM, MPEG21[7] or similar standards and recognize the portable document format PDF[8] as a major format for text-and image-based documents. Digital libraries have become increasingly rich in meta data, which is attached to content in formats like the venerable Dublin Core standard or its domain-specific, xml-based successors. Finally, standards are being introduces which aim at unifying technical properties of digital libraries on a system and architectural level (e.g. [9]).

2.3 Commercial Aspects

While digital libraries have historically focused on free and unified access to information sources, many document collections, publishers and portals do not provide their services and content for free. Consequentially, possible charging and billing scenarios for digital content constitute a major requirement aspect for digital libraries. In an educational context, three scenarios can be distinguished by domain:

- Documents in the public domain - Such documents usually include material made accessible to the public by individuals or institutions at specific terms. While access to such documents is not subject to immediate charge, restrictions may apply to further usage, like copying, printing or citations. Most often, authors provide material for free non-commercial use, with varying definitions of the term non-commercial.
- Documents in the commercial domain of a third party - Publications provided by commercial publishers or accessible through commercial portal services like ACM fall into this category. Concrete charges amount for accessing of documents, and rights for all forms of further distribution are severely restricted.
- Documents in the commercial domain of the library - This category could include tutorials or internal publications created by employees of the institution running the library. Access charges for such content are fully under control of the institution. In many situations, large user groups (i.e. students or employees of the institution) will not be charged for using such material. However, copyright restrictions may still apply to further distribution.

A digital library system must be able to handle these charging an billing scenarios in accordance with the status of customer accounts. Classical, consumer-oriented customer-to-business applications focus on individual customers. However, in an educational context there is an emphasis on customer groups. A simple example is constituted by a group of students registered for a course: Each student could be granted access to a range of documents relevant for the course with charges being collected from a grouped account managed by the course administrator. In another case, all members of an organisational unit may share an account to certain sources of information, with a collective charge being applied based on access count per time frame. More complex scenarios, like access charges to a portal being charged to a group account but individual document charges being charged to individual customers, may also arise. Commercial requirements for digital libraries in educational context must reflect these peculiarities, providing transparent charging and billing to users while preserving maximum financial and legal coverage for the library institution.

3   Micropayment

Generally speaking, micropayment schemes can be defined by an emphasis on the ability to make payments of small amounts. However, most definitions imply a more specialized view: Common assumptions are for micropayment schemes to be implemented in an electronic form, to aggregate many small virtual transactions into fewer, larger actual transfers of money and to implement, or rely on, sophisticated security mechanisms for verification of identity and solvency of both customer and merchant [10].

3.1 Commercial Aspects

In a classical business transaction, customer and merchant exchange money via a bank, which charges transaction fees to cover its expenses. Such fees are usually fixed in amount and, in the context of micropayment, can be expected to be many times larger than the sum actually transferred in the payment transaction. Consequentially, a micropayment scheme cannot be implemented by simply exchanging electronic checks -payments must be aggregated and presented to the bank as a single, larger transaction covering a specified merchant, customer and time range. Micropayment schemes can be classified, in a commercial sense, by the presence or absence of a direct communication between merchant and customer. In the case of indirect communication, an intermediate (usually a bank of some kind) is employed and only the customer needs to be concerned with the payment. However, most current digital payment systems implement direct payments, with the merchant and the customer

immediately interacting to complete a desired transaction [11]. This strategy mostly avoids the transaction costs mentioned above, but introduces new problems in the areas of identification, security and, ultimately, trust.

3.2 Technical Aspects

A wide variety of technological approaches to micropayment systems has been proposed. While most of these approaches are quite domain-specific or of a rather theoretical nature, several common schemes of possible relevance for the digital library context can be identified.

Wallets provide customers with the electronic equivalent of a wallet full of cash. The wallet is loaded with electronic cash units at the wallet provider, who consequentially has to handle all the personal and financial data of each customer. Cash units can be expended for the purchase of items at vendors supporting a specific brand of wallet. Dedicated secure software for managing wallets is required on the client and vendor side. An example for such a system is provided by CyberCoin, a company recently purchased by VeriSign [12].

Single-use token systems employ public key cryptography to let users generate blinded electronic cheques, which are then signed by the bank and verified by a receiving vendor using the banks public key. Such systems emphasize the privacy of the customer. An example is the eCash concept initially provided by DigiCash, a company with a lively history of changing owners and commercial success and failure [13]. In contrast to the wallet concept, the tokens themselves are secure and do not rely on an encapsuling, secure environment.

Broker-based systems like the venerable Millicent architecture [14] introduce three instances required for micropayment transactions. A broker instance mediates between vendor and customer, by providing electronic currency for the micropayment to the customer and offering validation and macro payment summary transaction services to the vendor.
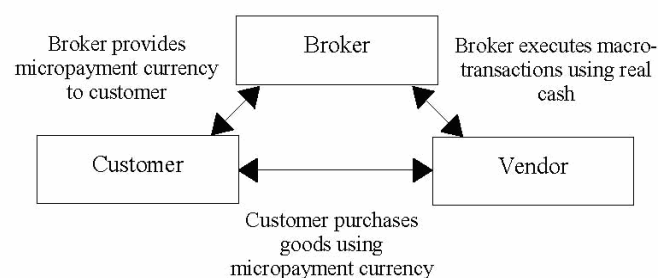
(Figure 1: The Millicent micropayment architecture)

3.3 Current Trends

Recent studies list a large number of micropayment schemes proposed by researchers and implemented by companies [15], providing a sound technological and theoretical foundation for micropayment solutions. Micropayment systems have yet to demonstrate sufficient market penetration to rival traditional methods of online charging like credit card transactions [16]. However, the advent of mobile commerce and the according demand for appropriate mobile payment systems may finally provide enough commercial incentives for micropayment to become one of the major technologies in the e-commerce sector [17].

4   Micropayment and Digital Libraries

This section defines requirements for payment solutions in the context of distributed digital libraries. In the CHABLIS project, a survey of payment solutions has been done and requirements for charging and billing in the context of digital libraries have been formulated, including unobtrusiveness, reliability, a high degree of automation, handling of very small payments and handling of casual short term and anonymous users [18].

While the CHABLIS survey is quite dated and many of the payment solution providers examined are no longer offering their services, formulated requirements are still valid. Drawing from the presented example case, these requirements will be extended and adapted. To provide a clear view on the issue, this section lists requirements separated by defining domain: User requirements describe needs of librarians and library users, technical requirements deal with underlying hardware and software requirements while commercial and legal requirements state the needs of content and library providers.
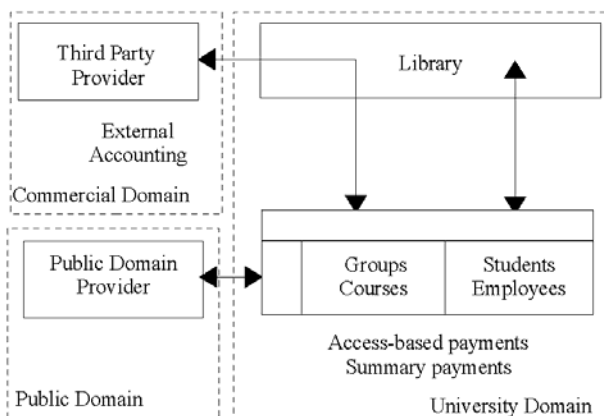
(Figure 2: Digital Library payment scenario)

4.1 Example Scenario

The example scenario is that of a university-based digital library providing access to documents within its own domain as well as documents served by third-party portals. Both the library itself and the third party portals may charge fees based on access or on content consumed, as depicted in figure 2. Users access documents in the domain of the library directly. External documents are accessed through the library which serves as an intermediate portal unifying access to third party resources. Finally, public domain documents are left aside, as they are directly accessed by users (though they may be indexed by the library).

4.2 User Requirements

In the example scenario, users are subscribers to the university library. All account management and handling of sensitive data is done by the already established library administration. Users may be assigned temporary valid accounts, i.e. limited to course duration or duration of employment. Accounts issued to users may grant access to subsets of documents in the library domain and/or may map to third party portal accounts in the commercial domain. A special case arises when users have individual accounts with selected third party providers in the commercial domain. Such accounts may feature payment policies and access rights differing from summary accounts available to the library itself. The following requirements for a payment scheme can be derived:

- To keep the payment process simple and to minimize the amount of sensitive data which has to be distributed, payment transactions for any material accessed through the library account should be handled with the library as the sole transaction partner for customers.
- To keep transactions transparent and thus enhance user acceptance, users of library resources or external resources provided through the library should be able to access their account status (i.e. costs amounted) at any time.
- To allow for real time monitoring of spendings, the library should be able to access the account status (i.e. amount of information transferred, costs amounted) of all users at any time. Furthermore, administrators of user groups should be able to access summary reports for spendings of their groups at any time.
- To keep administrative overhead at a minimum, existing authentications schemes of the library should be used (if their security level suffices) to validate payment account identities.
- The library should be able to make summarized macro payments to third-party providers to cover

expenses produces by micro-access of users to content owned by such providers.

- Users should be able to bypass library accounts for third-party providers employing individual custom accounts owned by themselves.

4.3 Technical Requirements

Virtually all third party providers of the commercial domain offer access to their content via web-based interfaces. In addition, most implemented digital library systems in educational environments are web-based. Consequentially, the paramount requirement for any payment solution in the chosen scenario is that it requires only a web-based client interface, no additional software and that it relies on security and authentication standards common on the Internet. Existing digital library systems for the educational context already fulfill these requirements: It should be possible to extend such systems to include payment methods without adding layers of software.

4.4 Legal Requirements

To implement any payment scheme involving the library provider as a financial transactor, the legal status of the library provider must be secured in regard to the financial operations executed. For Europe, the EU Directive on e-Money formalised in 2000 enables none-banking organisations to become regulated issuers of e-Money. E-Money is defined by the EU as "an electronic surrogate of cash (coins and banknotes) which is stored on an electronic device. It enables cashless payment of smaller amounts in diverse environments such as points of sale or through mobile or intranet communication."[19] Many other countries have implemented similar directives and legislations. While detailed legal examination is highly case-and location-dependent, no fundamental legal obstructions exist for digital library providers in the (often non¬commercial) educational domain to act as collectors and mediators of payments in electronic form.

4.5 Micropayment Solutions

The wallet approach to micropayment could be advantageous in the described environment if the issuing of appropriate wallet software is feasible for all users. As the technical requirements formulated demand a web-based system, any wallet solution would have to be solely web-based. Such a system could be implemented using existing library accounts and extending them with the necessary wallet information. Similar work has been done in a less sensible area, for example covering low-level services like copy card payments, in the educational context.

Single-use token systems could only be employed with the library taking the role of the bank. As this would impose a high administrative overhead on the library, and raise several legal issues, contradicting the requirements formulated, single-use tokens do not seem to be a valid approach in context of the example scenario.

Broker-based systems seem to be a promising alternative in the digital library context. Based on existing user accounts, libraries could easily issue a micropayment-capable version of electronic cash expendable only in the context of the library itself. Such electronic cash could be coupled to the user account, which would then serve as a kind of wallet as described above. Resulting modifications to existing library administrative structures would likely be minimal, mostly including the adaption of summary macro transactions with third-party providers. However, authentication and communication security measures would have to be re-evaluated to ensure that a level of security suitable for the processing of financial transactions can be obtained.

4.6 Existing Systems

No concrete micropayment solution targets digital libraries in an educational context. While the Millicent scheme and the PayPal system are likely candidates which could server at least as examples for a solution in the chosen context, no applicable implementation of Millicent is available and PayPal is a highly proprietary, commercial system not easily adaptable to a customized digital library architecture.

Research has been done into payment systems for publisher-subscriber networks, a rather similar environment. To be commercially viable, such systems need mechanisms for collecting payments from subscribers and distributing them fairly to publishers. Systems have been proposed which fulfill many requirements for this sector [20], however, the context of research has focused on small business applications and on cases where subscribers wish to keep their identity secret from publishers. While work in the sector is clearly relevant to digital libraries, requirements will have to be revised to make it applicable to the domain.

5 Future Work

Few micropayment solutions are available on the market, and implementations of digital libraries as described in the example case are usually highly customized, proprietary solutions. Much work remains to be done in analyzing requirements in more detail and in evaluating concrete products which could be applied to the domain discussed. An in-depth survey of existing systems could narrow down a list of candidates of micropayment schemes and of commercially available solutions.

6 Concluding Remarks

This publication discussed the feasibility of micropayment schemes as a payment mechanism for digital libraries in an educational context. While the current absence of economically successful and technologically mature micropayment systems does not allow the use of out-of-the-box solutions in digital library projects, several features of proposed micropayment systems match requirements of the domain and open up interesting possibilities for future digital library projects.

References:

[1] Duval, E., Forte, E., Cardinaels, K., Verhoeven, B., Van Durm, R., Hendrikx, K., Wentland Forte, M., Ebelm N., Macowicz, M., Warkentyne, K., Haenni, F.: The ARIADNE Knowledge Pool System: a Distributed Digital Library for Education. *Communications of the ACM*, Bd. 44, Nr. 5, 2001. http://www.ariadne-eu.org

[2] Schutzer, D.: A Need For A Common Infrastructure: Digital Libraries and Electronic Commerce. *D-Lib Magazine*, April 1996. http://www.dlib.org/dlib/april96/04schutzer.html

[3] Drabenstott, K.M. Analytical review of the library of the future, *Washington, DC: Council Library Resources*, 1994.

[4] Hicks, D., Tochtermann, K.: Towards Support for Personalization in Distributed Digital Library Settings. *Proceedings of the Joint DELOS-NSF Workshop on Personalisation and Recommender Systems in Digital Libraries*, Ireland, 2001

[5] Infotrend Research Group, Inc. Internet 2004 http://www.infotrends-rgi.com

[6] Fox, E.A.: Practical Digital Libraries Overview. *ACM Multimedia'2000 Tutorial*, Los Angeles, 2000. http://ei.cs.vt.edu/~dlib/tut/mm00print.pdf

[7] Burnett, I., Van de Walle, R., Hill, K., Bormans, J., Pereira, F.: MPEG21-Goals and Achievements. *IEEE Multimedia*, 2004. http://www.chiariglione.org/mpeg/events&tutorials/MM paper.pdf

[8] Adobe, Inc.: The PDF standard. Internet 2004 http://www.adobe.com/products/acrobat/adobepdf.html

[9] Gonçalves, M.A., Panchanathan G., Ravindranathan, U., Krowne, A., Fox, E.A., Jagodzinski, F., Cassel, L.: The XML Log Standard for Digital Libraries: Analysis, Evolution, and Deployment. *Third Joint Conference in Digital Libraries*, Houston, Texas, May, 2003

[10] O'Mahony, D., Peirce, M.: Electronic Payment Systems. Artech House Inc., 1997.

[11] Weber, R.: Market analysis of digital payment systems. *Technical Report TUM-I9819*, TU München, 1998

[12] VeriSign, Inc., Internet, 2004. http://www.verisign.com/products-services/payment-processing/index.html

[13] ECash Technologies, Inc., Internet, 2004. http://www.ecash.net

[14] Glassman, S., Manasse, M., Abadi, M. , Gauthier, P., Sobalvarro P.: The millicent protocol for inexpensive electronic commerce. *4th WWW Conference Proceedings*, O'Reilly, New York, 1995.

[15] Micali, S. and Rivest, R: Micropayments revisited. In: Preneel, B. (ed.): Progress in
.Cryptology, *Lecture Notes in Computer Science #2272*, Springer, 2002.

[16] Odlyzko, A.M.: The Case Against Micropayment. In *Financial Cryptography: 7th International Conference, FC 2003, R. N. Wright (ed.), Lecture Notes in Computer Science #2742*, Springer, 2003.

[17] Mobile Commerce and Micropayment Strategies. Juniper Research, Internet, 2004. http://www.researchandmarkets.com/reportinfo.asp?report_id=220686

[18] Brüggemann-Klein1, A., Endres, A., Jessen, E., Weber1, R., Werner, H.: Chablis - Accounting and Payment Concepts for Digital Library Services, TU Munich, 1998.

[19] EU Directive 2000/46/EC on the taking up, pursuit of and prudential supervision of the business of electronic money institutions, 2000. http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_275/l_27520001027en00390043.pdf

[20] Wang, C., Carzaniga, A., Evans, D, Wolf, A.L: A Payment Mechanism for Publish-Subscribe Systems. *Hawaii International Conference on System Sciences*, 2002.