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# An incentive-based electronic payment scheme for digital content transactions over the Internet

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## ABSTRACT

Digital content transactions through e-commerce will grow tremendous in the coming years. Well-designed electronic payment schemes and high-quality digital contents are two critical successful factors. This paper proposes an incentive-based electronic payment scheme, which can ensure both important properties of fair exchange and customer anonymity in e-commerce transactions and enhance authors' motivation to create digital contents. The proposed payment scheme is based on cryptographic techniques. Besides, it adopts a mechanism called "the apportionment contract of sales revenue", which records payees' apportionment amount. The bank can immediately apportion the sales revenue according to this contract when customers complete payments. By scrupulous analyses, the proposed payment scheme can achieve fair exchange, customer anonymity, and payment security. This paper also compares the proposed payment scheme to related schemes. The comparison result shows that the proposed payment scheme has the best characteristics on the following viewpoints: incentive-based payment, fair exchange, customer anonymity, the denomination of payment token, and the number of payment token for a transaction.

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## 1. Introduction

Digital contents are commercial products that are available in digital form and can be transmitted over the Internet. Because more and more people purchase digital contents through e-commerce transactions, we believe that the number of digital content transactions through e-commerce will grow tremendously. Under this circumstance, well-designed electronic payment schemes and high-quality digital contents are two critical successful factors for digital content transactions through the Internet.

The well-designed electronic payment scheme can be constructed by cryptographic techniques to ensure fair exchange and customer anonymity. Fair exchange and customer anonymity are two important properties of e-commerce transactions (Ray et al., 2005; Zhang et al., 2003, 2006). Fair exchange ensures that either both or neither a customer or a merchant involved in an e-commerce transaction obtain the other's item. In the electronic environment a participant does not always has a physically identifiable location. After treating another party unfairly, a participant can simply vanish without trace. Consequently, participants are reluctant to trust each other. Because of this lack

of trust, electronic payment schemes should be carefully designed to prevent unfair dealings. Customer anonymity ensures that the real identity of any customer is not revealed during transactions. Anonymity is essential to protect personal information. A research report conducted by eMarketer pointed out that approximately one-third of US Internet users over 14 years old were unwilling to adopt online transaction in 2005. They were concerned about the payment security and their personal information (Grau, 2006).

High-quality digital contents need a lot of authors having motivation to create. The authors' motivation will be weakened because of customers' misbehaviors. Therefore, an appropriate method that can keep or enhance authors' motivation to create high-quality digital contents is needful. Motivation is a process of seeking a goal and by moving toward that goal adjusting authors' mental and physical activities. Motivation results from incentives. An incentive is an external stimulus that interacts with authors' internal needs and potential interests to motivate seeking (McMahon and McMahon, 1986). Pay is frequently used as a motivator as it can easily be differentiated and computed, linked clearly and visibly to desired performance and is generally a valued reward (Beardwell and Holden, 1997). Further, reward is time-sensitive for authors. Motivational value will increase when the timing of the delivery of the rewards closely approximates the demonstration of behavior, the completion of an assignment, or the achievement of a result (Henderson, 1994). Advocates of reinforcement theory also believe that the magnitude of the

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subject's motivation to response can be shaped by manipulating reinforcement schedules, e.g. fixed interval, fixed ratio, variable interval or variable ratio (Muchinsky, 1993). Yukl and Latham (1975) and Yukl et al. (1976) compare the effectiveness of various schedules of reinforcement. They found that employees paid on a "ratio schedule" were significantly more productive. Later, Pritchard et al. (1980) confirmed that ratio schedules were more effective than interval schedules. Reinforcement theory is premised on rewarding desired behavior. The stronger is the link between the behavior and the reward, the greater is the probability of behavior (Muchinsky, 1993). According to above literatures, we can conclude that the shorter is the settlement of payment in digital content transactions, the higher is the incentive to authors of digital contents. Authors will obtain more incentive to improve their motivation on creating digital contents by means of shortening the time period of apportioning sales revenue, even immediate apportionment according to the ratio decided beforehand by all payees including authors and merchants. This is a new thinking in e-payment schemes.

Traditionally, the apportionment of sales revenue among payees including sellers, publishers, and authors, is a long process in publishing. The author can obtain deserved profits after a period of time, e.g. 1 month or longer. Certainly, it is infeasible to apportion sales revenue immediately when customers pay the money in traditional payment scheme because this method increases a lot of processing costs. However, when physical products are digitized, e.g. images, audios, and videos, and sold by e-commerce transaction and electronic payment, it is feasible to apportion sales revenue immediately due to the processing capability of information systems. Besides, because these digital contents are created by one or more authors, sales revenues should be apportioned among multiple payees including authors and merchants. Therefore, an electronic payment scheme should support the apportionment of sales revenue directly to authors for incentive purpose, without the intermediaries such as the merchant. Actually, this is a kind of multiple payees' electronic payment scheme, but to our knowledge it has seldom been proposed in the literature.

On the basis of above discussions, the objective and contribution of this paper is to propose a new electronic payment scheme that fulfills fair exchange and customer anonymity for participants of e-commerce and incentive purpose for authors. Through this new payment scheme, customers can purchase digital contents under the fair and secure e-commerce platform, and authors can obtain deserved profits immediately when customers purchase digital contents. Thus, the proposed payment scheme can promote customers' desires to purchase digital contents and enhance authors' motivation to create high-quality products.

The remainder of this paper is organized as follows. Section 2 reviews literatures related to multiple payees' electronic payment schemes and cryptographic techniques. Section 3 describes the details of the proposed payment scheme including system framework and system processes. Section 4 evaluates the proposed payment scheme through three viewpoints: fair exchange, customer anonymity and payment security. This paper also compares the proposed payment scheme to related schemes in order to find out its advantages and disadvantages; and further, it analyzes the efficiency of the proposed payment scheme. Finally, conclusions and future works are given in Section 5.

## 2. Related works

### 2.1. Multiple payees' electronic payment schemes

The multiple payees' electronic payment scheme has seldom been proposed in the literature. To our knowledge, four papers have discussed the similar concept.

Huang et al. (2000) proposed a generic electronic payment model supporting multiple-merchant transactions. When merchants want to sell digital contents, they must apply for selling license (SL) from a content provider. A SL consists of the proportion of apportionment. The payment gateway (PG) separates the sales revenue into multiple items after a customer purchases digital contents according to the proportion of apportionment. The PG then sends out the clearing message, and requests payment for the transaction from the customer's bank. Payees in this model are merchants, not the authors of digital contents.

Tewari and O'Mahony (2003) proposed a multiparty micro-payment for ad hoc networks. Upon arrival in a new city a user finds a route through an ad hoc network to a node that has the capability to relay packets into the fixed network using existing ad hoc routing protocols. Each of the nodes in the path from the user to the fixed network must be actively involved in relaying the packets toward the destination. This protocol has been designed to address the issue of payment for forwarding of packets by nodes in an ad hoc network. This scheme allows each of the nodes involved in the relaying of the packets to be paid as they provide the service. Payees in this protocol are nodes that help forwarding packets.

Zhu et al. (2004) proposed a micro-payment scheme for multiple vendors in mobile e-commerce. They thought that future mobile systems will involve different public and private network operators (NOs), through which users will access a variety of online services provided by a large number of competing value-added service providers (VASPs). However, mobile users can only select a single NO that provides connectivity and charges for usage. To permit users to roam and use the services of a foreign mobile network, the payment protocol should be utilized to pay all of the vendors involved in providing services to a mobile user. When a mobile user requests a service from a VASP, a signed pricing contract will be generated by all service providers (SPs) involved in this service. The user releases payment hashes at regular intervals during the payment process. The SPs continue to provide the service they agreed in the pricing contract in return for a valid payment. At the end of the day, each SP redeems the highest-spent payment hash from the visit with its preferred broker. The broker knows how much to pay each SP based on the contents of the pricing contract. Payees in this payment scheme are NOs, SPs, and VASPs.

Weyland et al. (2006) proposed a hybrid motivation-based cooperation mechanism called CASHnet. This scheme is applied to multi-hop cellular networks. Every time a node wants to transmit a self-generated packet or received a packet addressed to it, the node has to pay with traffic credits. Every time a node forwards a packet, it gets helper credits. Traffic credits can be bought for real money or traded for helper credits at service stations. This mechanism encouraged nodes to share their network resources via the distribution of some financial incentive. Payees in this mechanism are nodes that help forwarding packets.

Aforementioned four schemes can apportion payments directly to payees for incentive purpose, but payees in these schemes are merchants, network operators, content providers or device owners, not authors of digital contents. In addition, these schemes do not emphasize fair exchange and customer anonymity, which are essential properties for e-commerce transactions. In Huang et al.'s (2000) scheme and Zhu et al.'s (2004) scheme, payments are apportioned among payees directly, but not immediately. Therefore, these schemes are unsuitable for digital content transactions discussed in this paper.

However, Huang et al.'s (2000) scheme and Zhu et al.'s (2004) scheme proposed a common feature that can be regarded as a reference for this paper. They indicate that a multiple-payee

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