

# An Analysis and Comparison of Different Types of Electronic Payment Systems

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**Abstract-** Two parties that conduct a business transaction through the Internet do not see each other face-to-face; nor do they exchange any document or currency hand-to-hand. When electronic money is transferred from a buyer to a seller over telecommunications networks, accuracy and security is critical. This paper explores the advantages and limitations of four types of electronic payment systems; namely, the online credit card payment system, the electronic-cash payment system, the electronic-check payment system, and the smart-card-based electronic-cash payment system. Each payment system was assessed from four perspectives: the technological aspect, the economic aspect, the social aspect, and the regulatory aspect. The requirements of merchants and consumers, the appropriate business environments for each of them to function, and the potential for future expandability were analyzed. The findings of this research could be useful for companies who are planning to adopt or to devote R & D into an electronic payment system.

## I. INTRODUCTION

Worldwide proliferation of the Internet led to the birth of electronic commerce, a business environment that allows the transfer of electronic payments as well as transactional information via the Internet. Electronic commerce flourishes based upon the openness, speed, anonymity, digitization, and global accessibility characteristics of the Internet. It facilitates real-time, on line business activities, such as: advertising, querying, sourcing, negotiating, auctioning, ordering, or paying for merchandise.

The main concern with electronic payment is the level of security in each step of the transaction because money and merchandise are transferred without direct contact between parties involved in the transaction. If even the slightest possibility exists that electronic payment system may be insecure, consumers', merchants', and bankers' confidence in this system might erode and, consequently, destroy the foundation of electronic commerce.

There are four major categories of electronic payment systems: online credit card, on line electronic-cash, electronic-check and smart-card-based electronic-cash<sup>[20]</sup>. Each system has its advantages and disadvantages for merchants and consumers. This paper will explore the requirements of merchants and consumers, the appropriate business environments for each of them to function, and the potential for future expandability.

This research was based on extensive literature reviews and experts' opinions. Information from market surveys, technical journals, company reports, product catalogs, research reports, newspapers, and magazines were analyzed.

## II. ASSESSMENT CRITERIA FOR ELECTRONIC PAYMENT SYSTEMS

An electronic payment system may be assessed from four dimensions: the technological aspect, the economic aspect, the social aspect, and the regulatory aspect<sup>[9,12]</sup> in the following.

### A. Technological Aspect

The technological aspect of an electronic payment system includes the system's expandability, its efficiency and security in handling each transaction, its compatibility with other payment systems, and its level of complexity for consumers to adapt to the system. Above all, security is an utmost technical concern.

Business and financial activities require secure deposit and withdrawal of money to and from bank accounts; secure data, application programs, and databases; secure transactions and payments; secure communication networks and computer systems; and secure facility maintenance and network management. Among these, the security in business transactions and payments is of utmost concern for companies and consumers. They must satisfy the following requirements:

- a. Authenticity (Also referred to as validity): The purpose is to verify the claimed identities of all parties involved in the transaction in order to prevent from malicious misrepresentation, sabotaging information, making unauthorized transfers or false transactions.
- b. Privacy: The purpose is to protect the anonymity of the purchaser in a transaction, and to prevent unauthorized personnel or even merchant's employees from accessing information with respect to the transaction.
- c. Integrity (Also referred to as accuracy): The purpose is to prevent tampering with any data in the transaction process, sending more or less than the actual information involved in a transaction, as well as to avoid transmission errors,
- d. Non-repudiation: The purpose is to prevent consumers and/or merchants from denying the commitments they made in a transaction, or from altering the information in the transaction. Therefore, records of detailed transactional information, such as the time of the transaction, the quantity of purchase, and the agreements, etc., must be recorded and verified.

### *B. Economic Aspect*

Any electronic payment system must make economical sense with respect to designing it, building it, running it, maintaining it, and upgrading it. Besides, its acceptance and widespread use by the consumers is the critical factor affecting its economical feasibility. The economic needs are summarized in the following:

- a. **Cost of Transactions:** This refers to the costs incurred by the seller and buyer in a transaction. The costs include both direct costs and indirect costs. The fixed cost in a transaction is the most critical consideration of a micro-payment system.
- b. **Atomic Exchange:** This means that an electronic payment system must involve consumers paying money or something equivalent in value in a transaction.
- c. **User Reach:** This refers to the range of users to whom an electronic payment system is accessible. This attribute characterizes whether a system is accessible in all countries of the world, or the population of all ages.
- d. **Value Mobility:** An electronic payment system's token of purchasing power may be circulated only within the community authorized by the issuing company. On the other hand, the token may be valued by a large number of parties at different places, may be passed along as a gift, or exchanged for currency in equal value.
- e. **Financial Risk:** Consumers are concerned about the level of security involved in online transactions. The potential damages or financial losses that consumers and/or merchants may incur are another important economic characteristics of an electronic payment system.

### *C. Social Aspect*

In addition to satisfying the needs associated with the technical and economic aspects, an electronic payment system still needs to address social needs before it can win consumers' trust and acceptance. The social needs include:

- a. **Anonymity:** To protect the privacy of consumers and to prevent companies or financial institutions from tracing users' purchasing preferences or behaviors.
- b. **User friendliness:** An electronic payment system should be simple and easy to use. The degree of user friendliness is a factor when consumers choose which payment system to use, especially for micro payments.
- c. **Mobility:** Users do not always use a PC to access the Internet and to make online purchases. Besides, it is not uncommon that family members may share the same PC at home. Therefore, it is inconvenient if a payment system is tied up with the hardware of a PC. Electronic payment systems should provide mobility, i.e. can be used anywhere.

### *D. Regulatory Aspects*

In addition to the technical, economic, and social needs, a payment system must abide by all government regulations with respect to on-line business transactions. Some of the

concerns associated with such regulations include: digital signatures, digital fund transfers, electronic commerce contracts, technical standards, customs and taxation, and international agreements, etc. Because each district or nation has its own set of policies, an electronic payment system must conform to the respective regulations of the countries in which it plans to operate.

## III. ELECTRONIC PAYMENT SYSTEM OVERVIEW

In the growing B2C electronic commerce market, electronic payment systems must be secure, popular, and work well with existing business practices. This paper aims to assess the characteristics of different kinds of electronic payment systems, and to analyze the business environments that each electronic payment system is appropriate to operate in. The following electronic payment systems have either started commercial operation or have received support from W3C or other conglomerates, including: VCC, SSL, cybercast, SET, Ecash, Mondex, Visa Cash, FSTC, Millicent, MPTP, and IBM small payments etc.<sup>[6,11,13,17,19]</sup>

The Secure Electronic Transaction (SET) is a protocol co-developed by MasterCard and Visa for secure bankcard transactions<sup>[8,14,18]</sup>. The Secure Socket Layer (SSL) is a session layer protocol proposed by Netscape for secure information exchanges between a client and a server<sup>[3-4]</sup>. Other payment systems such as NetBill<sup>[7,15,16]</sup> and Millicent<sup>[2,5,10]</sup> are more appropriate for micro-payments, i.e., payments of trivial amounts for which the use of credit cards is uneconomical.

### *A. General Comparison of Electronic Payment System Types*

Electronic payment systems can be divided into four general types: online credit card payment systems, online electronic-cash systems, electronic-check systems, and smart-card-based electronic-cash systems<sup>[1]</sup>. Note that the micro-payment system is characterized by the amount of the payment and not by the type of transaction.

It's worth noting that Ecash and Mondex/Visa Cash systems are very different in function. For example, Ecash uses blind signatures and relies on online checking of database to ensure that the amount of the transaction is deducted immediately after it is used. On the other hand, Mondex and Visa Cash store the amount of the transaction in the buyer's and the seller's smart cards. The funds will be transferred offline from the buyer's bank account into the seller's bank account. Not only does it not use the blind signature technology, it doesn't have to maintain a real-time database. Therefore, the Mondex and Visa Cash systems are classified in the smart-card based electronic-cash system instead of the online credit card system or the online electronic-cash system. The characteristics of online credit card payment systems, electronic-cash systems, electronic-check systems, and smart-card based electronic-cash systems are compared in Table 1.

TABLE 1: COMPARISON OF ELECTRONIC PAYMENT SYSTEMS

	Online Credit Card Payment	Electronic Cash	Electronic Checks	Smart Cards
Actual Payment Time	Paid later	Prepaid	Paid later	Prepaid
Transaction information transfer	The store and bank checks the status of the credit card	Free transfer. No need to leave the name of parties involved	Electronic checks or payment indication must be endorsed	The smart card of both parties make the transfer
Online and offline transactions	Online transactions	Online transactions	Offline transfers are allowed	Offline transfers are allowed
Bank account involvement	Credit card account makes the payment	No involvement	The bank account makes the payment	The smart card account makes the payment
Users	Any legitimate credit card users	Anyone	Anyone with a bank account	Anyone with a bank or credit card account
Party to which payment is made out	Distributing Bank	Store	Store	Store
Consumer's transaction risk	Most of the risk is borne by the distributing bank, consumers only have to bear part of the risk	Consumer is at risk of the electronic cash getting stolen, lost, or misused.	Consumer bears most of the risk, but the consumer can stop check payments at any time.	Consumer is at risk of the smart card getting stolen, lost or misused.
Current degree of popularity	Credit card organizations check for certification then total the purchases. Therefore, it can be used internationally, and is the most popular payment type	Unable to meet financial internet standards in the areas of expansion potential and internationalism.	Cannot meet international standards, therefore its not very popular	Credit card organizations check for certification then total the purchases. Therefore, it can be used internationally, and is becoming more widely used.
Anonymity	Partially or entirely anonymous	Entirely anonymous	No anonymity	Entirely anonymous, but if needed, the central processing agency can ask stores to provide information about a consumer
Small payments	Transaction costs are high. Not suitable for small payments	Transaction costs are low, suitable for small payments	Allows stores to accumulate debts until it reaches a limit before paying for it. Suitable for small payments	Transaction costs are low. Allows stores to accumulate debts until it reaches a limit before paying for it. Therefore, it is suitable for small payments.
Database safeguarding	Safeguards regular credit card account information	Needs to safeguard a large database, and maintain records of the serial numbers of used electronic cash.	Safeguards regular account information	Safeguards regular account information
Transaction information face value	Can be signed and issued freely in compliance with the limit	Face value is often set, and cannot give change	Can be signed and issued freely in compliance with the limit	Can be deducted freely in compliance with the limit
Real/Virtual world	Can be partially used in real world	Can only be used in the virtual world	Limited to virtual world, but can share a checking account in the real world.	Can be used in real or virtual worlds.
Limit on transfer amounts	Dependent on the limit of the credit card	Dependent on how much is prepaid	No limit	Dependent on how much money is saved.
Mobility	Yes	No	No	Yes

*B. Comparison of Electronic Payment Systems in Each Type*

Even within the same type of electronic payment system, the encryption/decryption mechanisms of each individual payment system still differ. This section of the paper will analyze the differences of each electronic payment system, evaluate their characteristics, and assess the applicability of each system.

1. Online Credit Card Payment Systems

Currently, commercially available online credit card payment systems include: VCC, SSL, InstaBuy, and SET<sup>[14]</sup>.

Table 2 lists the pros and cons of the above four systems measured against users' requirements described in Section 2.

2. Electronic Cash Payment Systems

Currently, commercially available electronic cash payment systems include the online Ecash system and the offline smart card based Mondex and Visa Cash systems. Table 3 lists the pros and cons of the above three electronic cash payment systems measured against users' requirements described in Section 2.

TABLE 2: AN EVALUATION OF THE ONLINE CREDIT CARD PAYMENT SYSTEMS

	VCC	SLL	InstaBuy	SET
Authenticity	Good: VCC card number and PIN is used to check identity	Fair: Uses only the consumer's account information to establish identity	Good: InstaBuy account number and PIN is used to establish identity	Good: Uses SET certification and consumer's account information to check identity
Privacy	Good: Actual card number is not sent through the internet. The VCC card number is limited to internet use.	Fair: Uses actual card number to make transaction. At risk of information being stolen	Fair: Uses actual card number to make transaction. At risk of information being stolen	Fair: Uses actual card number to make transaction. At risk of information being stolen
Integrity	Yes: Uses Hash function to ensure integrity.	Yes: Uses Hash function to ensure integrity.	Yes: Uses digital signatures to ensure integrity	Yes: Uses digital signatures to ensure integrity
Non-repudiation	None	None	Yes: Uses digital signatures to ensure integrity	Yes: Uses digital signatures to ensure integrity
Expansion	Good	Good	Fair: When the number of users increases, to ensure that the server's gold key won't be easily extracted, the gold key needs to be lengthened. Because of this, the length of time needed to complete security measures.	Fair: Because the process is complex, this uses asymmetric golden keys. Therefore when the number of users increases, the processing time increases accordingly.
Transaction efficiency	Good	Good	Fair: Using public golden key added security would increase the time needed to complete transaction.	Fair: Using public golden key added security would increase the time needed to complete transaction.
Compatibility	Good: Compatible with all types of browsers	Good: Compatible with all types of browsers	Good: Compatible with all types of browsers	Good: Compatible with all types of browsers
Acceptability	Good	Good	Good	Poor: Needs to construct entirely open golden key structure. (PKI)
Transaction cost	About the same as regular credit card transaction costs	About the same as regular credit card transaction costs	A bit higher than credit card transactions: Besides regular credit card transfer costs, there is still the fixed cost of the public golden key patent.	A bit higher than credit card transactions: Besides regular credit card transfer costs, there is still the fixed costs of applying for certification and the public golden key patent.
Atomic Exchange	None: Consume first, payment later	None: Consume first, payment later	None: Consume first, payment later	None: Consume first, payment later
User Range	Fair: Limited to people who have a credit card	Fair: Limited to people who have a credit card	Fair: Limited to people who have a credit card	Fair: Limited to people who have a credit card
Value Mobility	None: Cannot be transferred among parties.	None: Cannot be transferred among parties.	None: Cannot be transferred among parties.	None: Cannot be transferred among parties.
Financial Risk	Low: Most of the risk is borne by the credit card industry	Low: Most of the risk is borne by the credit card industry	Low: Most of the risk is borne by the credit card industry	Low: Most of the risk is borne by the credit card industry
Anonymity	Good: Companies are unable to attain information about the consumer's VCC account, and distributors are unable to attain details about the spending habits of the consumer.	Fair: Companies are able to attain information about the consumer's credit card account, but the distributor is unable to attain details about the spending habits of the consumer.	Fair: Companies are able to attain information about the consumer's credit card account, but the distributor is unable to attain details about the spending habits of the consumer.	Good: Companies are unable to attain information about the consumer's VCC account, and distributors are unable to attain details about the spending habits of the consumer.
Convenience	Fair: Besides needing to have a credit card account, consumers must apply for a VCC account	Good: As long as the consumer has a credit card, it's convenient to make transactions.	Fair: Besides needing to have a credit card account, consumers need to apply for and install InstaBuy electronic purse	Fair: Consumers need to apply for SET certification from the certification center
Mobility	Good: There is no limit on where it can be used.	Good: There is no limit on where it can be used.	Good: There is no limit on where it can be used.	Poor: Restricted to computers that have the consumer's SET certification installed.

TABLE 3: AN EVALUATION OF THE ELECTRONIC CASH SYSTEMS

	Ecash	Mondex	Visa Cash
Authenticity	Fair: Uses PIN to establish identity	Fair: Uses PIN to establish identity	Fair: Uses PIN to establish identity
Privacy	Good: The store or third parties online have no way of attaining the consumers bank account information	Good: The store or third parties online have no way of attaining the consumers bank account information	Good: The store or third parties online have no way of attaining the consumers bank account information
Integrity	Yes: Uses blind signatures to ensure integrity	Yes: Uses signatures to ensure integrity	Yes: Uses signatures to ensure integrity
Non-repudiation	None: Stores have no way of knowing who is on the other side of the transaction	Yes: Uses signatures to ensure non-repudiation	Yes: Uses signatures to ensure non-repudiation
Expansion	Poor: As the number of users increases, the size of the databank that needs to be protected will increase as well, thereby lengthening the time needed to complete a transaction.	Good	Good
Transaction efficiency	Poor: Needs to enter a large database to make comparisons.	Good	Good
Compatibility	Poor: Is incompatible with other financial systems or electronic payment systems.	Fair: Currently, the magnetic strip readers for Mondex and Visa Cash are incompatible.	Fair: Currently, the magnetic strip readers for Mondex and Visa Cash are incompatible.
Acceptability	Good	Poor: Companies and consumers both need to install smart card magnetic strip readers.	Poor: Companies and consumers both need to install smart card magnetic strip readers.
Transaction cost	Low	The cost of regular transactions is relatively low, but one needs to account for the fixed costs of smart cards and magnetic strip readers	The cost of regular transactions is relatively low, but there is the fixed costs of smart cards and magnetic strip readers
Atomic Exchange	Yes: Payment first, consume later	Yes: Payment first, consume later	Yes: Payment first, consume later
User Range	Good: Consumers do not need to have a bank account or credit card	Fair: Users are limited to those who have a bank account or credit card	Fair: Users are limited to those who have a bank account or credit card
Value Mobility	Yes: Can be transferred among parties	Yes: Can be transferred among parties	Yes: Can be transferred among parties
Financial Risk	High: People are solely responsible if it is lost or stolen.	High: People are solely responsible if the smart card is lost or stolen.	High: People are solely responsible if the smart card is lost or stolen.
Anonymity	Good: Companies have no way of finding out the consumer's account information, and the distributors of Ecash have no way of finding out how the consumer spent the Ecash.	Good: But if necessary, the Central Processing Unit can ask stores to provide consumers transaction records.	Good: But if necessary, the Central Processing Unit can ask stores to provide consumers transaction records.
Convenience	Fair: Consumer must first install Ecash cash purse	Fair: Consumer must apply for the smart card	Fair: Consumer must apply for the smart card
Mobility	Poor: Consumers can only use computers that have the Ecash cash purse installed	Fair: Can only be used with a smart card magnetic strip reader.	Fair: Can only be used with a smart card magnetic strip reader.

TABLE 4: AN EVALUATION OF THE ELECTRONIC CHECK SYSTEM

	FSTC
Authenticity	Good: Uses digital signatures and digital certification to check identity
Privacy	Fair: Although it uses asymmetrical golden keys to calculate and send information, but consumer's payment account information is at risk of being stolen.
Integrity	Good: Uses information certification number and asymmetrical golden keys for increased security, to ensure the integrity of transaction information.
Non-repudiation	Good: Uses digital signatures and digital checks to ensure non-repudiation.
Expansion	Good: The consumer and store's electronic checkbook complete the transaction. Financial systems only provide check certification and exchanges.
Transaction efficiency	Good: But if the transaction is offline, the transaction efficiency will decrease.
Compatibility	Good: Is compatible with an actual check account and traditional financial organizations.
Acceptability	Poor: Company and consumers must both install a smart card reader
Transaction cost	Normal transaction costs are low, but it must be responsible for electronic checkbook (smart cards) and digital certification and other fixed costs.
Atomic Exchange	None: Use check first, pay later
User Range	Fair: Limited to those who have a check account
Value Mobility	Yes: Uses endorsement limit. Can be transferred among parties.
Financial Risk	Fair: Consumers can stop check payments for questionable transactions.
Anonymity	None: Everyone who writes out and transfers a check need to sign their names.
Convenience	Fair: Consumers need to apply for an electronic checkbook from a bank.
Mobility	Good: Includes signing, certification, and signing temporary saving checks, checking the check's legitimacy and uniqueness.

### 3. Electronic Check System

Currently, FSTC is the major commercially available electronic check system. Table 4 lists the pros and cons of this electronic check payment system measured against users' requirements described in Section 2.

### 4. Micro Payment Systems

This section explores electronic payment mechanisms designed for transaction amounts under \$10 US or under \$0.25 US. The currently available micro payment systems include: Millicent, MPTP, and IBM Small Payments. Millicent system deducts from a prepaid amount, while IBM Small Payments delays payment until after the transaction. Table 5 lists the pros and cons of micro payment systems measured against users' requirements described in Section 2.

## IV. CONCLUSIONS AND RECOMMENDATIONS

After analyzing and comparing the above different types of electronic payment systems, we come to the following conclusions:

### A. Online Credit Card Payment Systems

Credit cards have been widely accepted by consumers and merchants throughout the world, and by far the most popular method of payment in the retail market. Among the different online credit cards, VCC is secure, protects the user's privacy, and is not limited to use at a fixed location. The above characteristics can support next generation mobile phones to offer wireless Internet and mobile commerce applications.

Considering these advantages, the Virtual Credit Card is in a good position to flourish in the future.

### B. Electronic Cash Systems

Compared with traditional electronic-cash systems, smart card based electronic-cash systems do not need to maintain a large real time database. They also have advantages, such as anonymity, transfer payment between individual parties, and low transaction handling fees. Therefore, in the future, smart card based electronic cash will eventually replace traditional electronic cash in the market. If a smart card is lost, the electronic cash stored inside of it is not replaceable. The situation is the same as when a person keeps cash in his/her wallet/purse. It should be the user's decision as to how much electronic cash he/she carries in the smart card.

Currently, the two major smart card based electronic-cash systems – Mondex and Visa Cash are incompatible in smart card and card reader specifications. Not knowing which smart card system will become the market leader; banks around the world are unwilling to adopt either system, let alone other smart card systems. Therefore, establishing a standard smart-card system, or making different systems interoperable with one another is critical success factors for smart-card based electronic-cash systems. Smart-card organizations around the world must establish a smart-card interface standard and a conformance testing organization to make all smart-card systems compatible, otherwise smart-card related products will not develop.

TABLE 5: AN EVALUATION OF THE MICRO PAYMENT SYSTEMS

	Millicent	MPTP	IBM small payments
Authenticity	Good: Uses the serial number of temporary currency and certification to check identity.	Good: Uses "consumer's identification certificate" to check identity.	Good: Uses "Day's electronic certification" to check identity.
Privacy	Good: Uses consumer's serial number to complete transaction, account information is not sent through the Internet.	Good: All sent information passes through DSS and El Gamal and other offline added security measures	Good: Personal account information is not sending through the internet.
Integrity	None: Doesn't use signatures or the Hash function to compare information stored in the database.	Good: At the same time, all sent information passes through DSS and El Gamal and other offline added security measures.	None: Doesn't use signatures or the Hash function to compare information stored in the database.
Non-repudiation	None: Does not use signatures, certification or other security measures.	Yes: Uses signatures and digital certification to ensure non-repudiation.	None: Does not use signatures, certification or other security measures.
Expansion	Good	Good	Good
Transaction efficiency	Good	Good	Good
Compatibility	Good: Can share a bill with banks, ISP, water fee, electricity fee and other fees.	Good: Financial organization can assume the role of the broker.	Good: Is compatible with ISP, banks, telecommunication users, and websites.
Acceptability	Good	Good	Good
Transaction cost	Low	Low	Low
Atomic Exchange	Yes: Pay first, consume later.	None: Consume first, pay later.	None: Consume first, pay later.
User Range	Fair: Is limited to consumers who have a credit card or bank account.	Fair: Is limited to consumers who have a credit card account.	Good: Can accept ISP, banks, and telecommunication and website customers.
Value Mobility	None: Cannot be transferred among parties.	None: Cannot be transferred among parties.	None: Cannot be transferred among parties.
Financial Risk	Low: Because transferred amount is low, financial risk is also low.	Low: The store has control of its financial risk.	Low: The electronic certification is only valid for one day. There is also a limit of the amount for offline use.
Anonymity	Good: Can use the user's serial number to replace user's name.	Good: Can use MPTP account number to replace the real account number and user's name.	Good: Can use blind signatures to ensure anonymity of stores and account server.
Convenience	Poor: Consumers must apply for a special certificate from a broker each time a transaction is made; to preserve the temporary currency different stores might give out. When the certificate expires, the consumer must apply for another one.	Fair: Consumers must attain identity certification from a broker.	Poor: Consumers must extract the "Day's electronic certification" from the IBM small payment account server every time a transaction is about to be made.
Mobility	Poor: Can only be used with computers that have the Millicent cash purse installed.	Poor: Can only be used with computers that support the MPTP agreement.	Poor: Can only be used with computers that have IBM small payment cash purse installed.

*C. Electronic Check Systems*

The disadvantages of electronic-checks include their relatively high fixed cost, their limited use only in a virtual world, and the fact that they cannot protect the users' anonymity. Therefore, it is not suitable for retail transactions by consumers, although useful for government and B2B operations because the latter transactions do not require anonymity, and the amount of the transactions is generally large enough to cover the fixed processing cost.

Currently, the United States FTSC system's participants mostly consist of American financial organizations, research organizations, and government agencies. FTSC lacks participants from other countries' government and commercial organizations. FSTC should cooperate with other countries' commercial institutions and regulators (for example, W3C), in order to evolve into a globally accepted E-Check system.

#### D. Micro-Payment Systems

Consumers will gradually accept the concept that information is valuable, and will become willing to pay a reasonable price for it. Usage-sensitive information charges based upon the value and amount of information content retrieved is more reasonable than a usage-insensitive flat membership charge. Therefore, pay-per-click or per-fee-links will soon become popular for online transactions.

The existing micro-payment systems are not established by any of the international financial organizations; neither does it use existing financial systems or tools in its infrastructure. In order for the micro-payment system to work, alliances with banks, Internet portals, ISPs, telecommunications service operators, content providers, and customer services providers are essential. Some of them control the marketing channel, some have customer base, and others could integrate micro-payments into their existing bills. An ideal micro-payment system must be accepted by a large number of websites, and interoperable with other electronic payment systems. It would be inconvenient for consumers to use a micro-payment system for micro transactions, but have to switch to a different payment system when making larger amount transactions.

#### E. Recommendations

Wireless and broadband communications are the two major trends in future telecommunications development. WAP mobile handsets and interactive digital TVs shall be able to access the Internet. Consumers will no longer be limited to using their personal computers to access the Internet or purchase merchandise online. Therefore, future electronic payment systems must work well with personal computers, as well as mobile phones, digital TVs, and personal digital assistants.

Secondly, there will be multiple electronic payment systems competing in the market. In order to increase the penetration and popularity of an electronic payment system, alliances with other industries such as telecommunications, utility, cable television, publishing, entertainment, financial and retail, will be synergistic. Each of the above industries collects bills from consumers and gives coupons /discounts to consumers regularly. These processes could evolve into a digital format eventually. They may become the killer application of the electronic payment systems.

Finally, the Internet globalizes business transactions. Consumers in one country may make purchases from merchants in any country of the world. Therefore, electronic payment systems in one country must provide currency exchange for electronic payment systems in other countries. This process will require agreements among electronic

payment system providers before electronic payments can become a common business practice in the global digital economy.

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