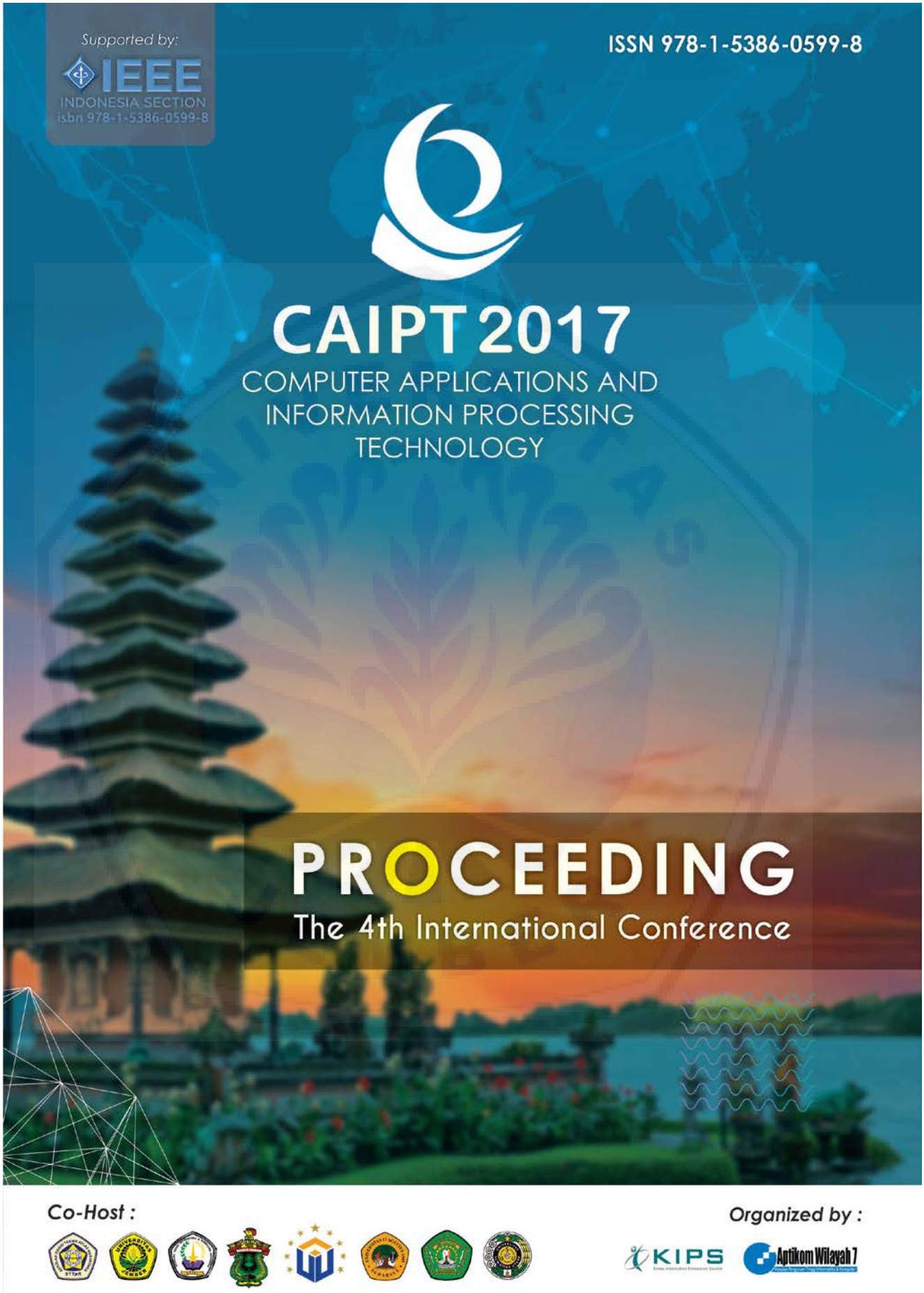

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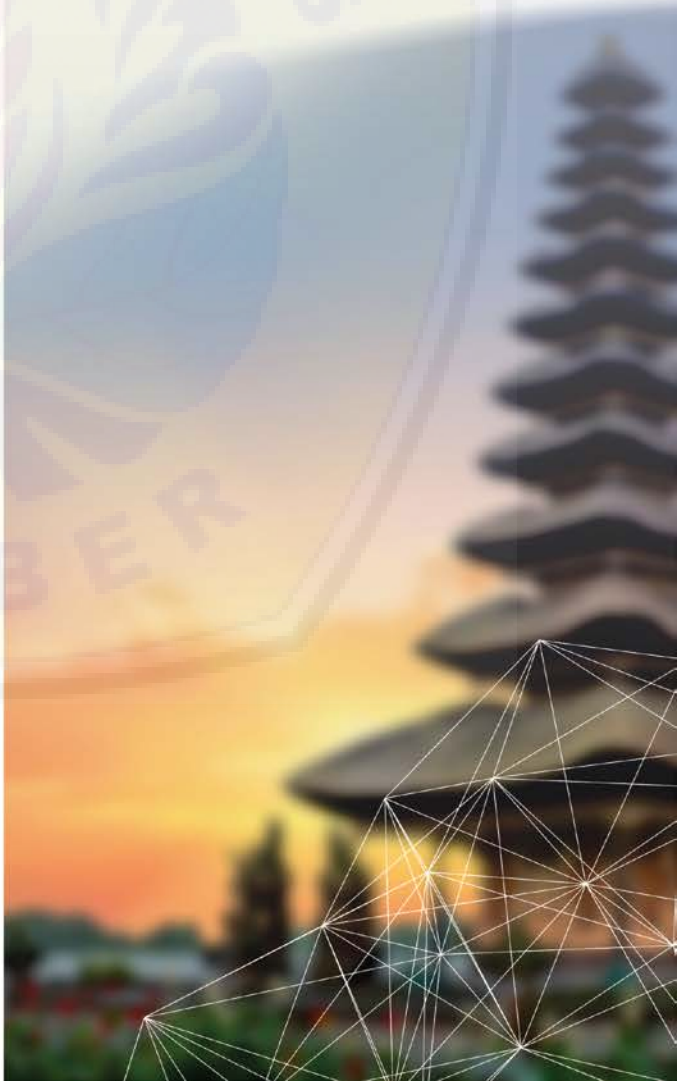

Welcome Message from CAIPT 2017 Honorary Chair

It is our great pleasure to welcome you to the 4th International Conference on Computer Applications and Information Processing Technology(CAIPT 2017), which is held in the historically rich and naturally beautiful city, Bali, Indonesia on August, 8-10, 2017.

CAIPT 2017 is Organized by Korea Information Processing Society (KIPS) and Hosted by Association of Higher Education in Informatics and Computer (APTIKOM).

CAIPT 2017 will focus on various important aspects of advances in ubiquitous information technologies and applications and will provide an opportunity for researchers and practitioners in academia and industry to discuss the state-of-art issues, research results, and progress in ubiquitous information technologies and applications. We expect that the conference and its publications will stimulate related research and technology improvements on this important subject.

We would like to thank the Program Committee members for their contributions to build up an excellent technical program.

We would like to sincerely thank the following speakers who kindly accepted our invitations, and, in this way, helped to meet the objectives of the conference: Prof. Dr.,Ricardus Eko Indrajit (ABFI Institute Perbanas, Indonesia).

The coordination with the General Co-Chairs (Sang Hoon Kim, Teddy Mantoro, Eva Handriyantini), the Steering Co-Chairs(Jin Kwak, Joko Lianto), the Program Co-Chairs(Kyung Oh Lee, Media A. Ayu),the Organization Chair (Betty Dewi Puspasari), the Publication Chair (Mukhlis Amien), the Publicity Co - Chairs (Eun Young Cho, Rangga Firdaus,Nurul Hidayat), was essential for the success of the final program. We sincerely appreciate their constant support and guidance.

Finally, we would like to thank the Korea Information Processing Society and Asosiasi Pendidikan Tinggi Ilmu Komputer Indonesia for providing valuable assistance to the conference.

We hope you will find the conference very productive and enjoyable.

CAIPT 2017 Honorary Chair
Seok-Cheon Park
Chairman of KIPS IT Convergence Society

Prof. Dr. Lee Kyeong Oh

The Fourth Industrial Revolution is a very hot topic in Korea and I want to share the notion of it with Indonesia educators and researchers.
The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres.
Previous industrial revolutions liberated humankind from animal power, made mass production possible and brought digital capabilities to billions of people. This Fourth Industrial Revolution is, however, fundamentally different. It is characterized by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human.
The resulting shifts and disruptions mean that we live in a time of great promise and great peril. The world has the potential to connect billions more people to digital networks, dramatically improve the efficiency of organizations and even manage assets in ways that can help regenerate the natural environment, potentially undoing the damage of previous industrial revolutions.
The Fourth Industrial Revolution builds on the Digital Revolution, representing new ways in which technology becomes embedded within societies and even the human body. The Fourth Industrial Revolution is marked by emerging technology breakthroughs in a number of fields, including robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology, The Internet of Things, 3D printing and autonomous vehicles. These technologies have great potential to continue to connect billions more people to the web, drastically improve the efficiency of business and organizations and help regenerate the natural environment through better asset management.[9]

Prof. Dr. Ir. R. Eko Indrajit, M.Sc., MBA., Mphil., MA

Utilizing Big Data to Gain Competitive Advantage: Hypothetical Cases of Indonesia

Many modern companies are flooded with data and information gleaned from their day-to-day business activities. However, there are very few of them who can turn it into a precious asset and provide benefits to the company. Lack of knowledge and competence in the field of data science became one of the causes.
Competition in the 21st century lies in how far the company can learn and master knowledge - where the main source is data and information. Initially, Big data is merely a supporting technology, but has now become a very powerful competing weapon for those who successfully utilize it effectively.
This session provides an overview of how strategic and technical big data use can improve business competitiveness during its significant utilization.

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Oblivious content distribution system to advantage digital rights management

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Abstract:
This research aims to construct a content distribution protocol that preserves the content provider's security and users' privacy. The protocol can improve Digital Rights Management (DRM) that is required to provide balanced protection for the content provider and the users in a content distribution system. The concept of oblivious transfer (OT) is utilized to fulfill the DRM requirement. The OT concept allows a sender to securely send a set of information to a receiver in such a way that, at the end of the protocol, the receiver cannot learn more than he was supposed to learn while the sender cannot determine what the receiver has learned. Assuming that tamper-proof device exists, the constructed protocol achieves perfect security for the content provider and privacy for the users. This oblivious content distribution ultimately enables DRM to be a privacy-aware protection system. The system does not merely focus on content providers' rights, but also seriously considers users' privacy protection.

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I. Introduction
Digital Rights Management (DRM) is a popular approach to achieve security required in digital content distribution systems. Under DRM protection, dig content is usually encrypted before distributed. To strengthen security, the implementation of the encryption algorithms needs to be modified, so that th algorithms are unintelligible to adversaries. Some methods, such as code obfuscation [1] and white-box cryptography [2]–[5], have been proposed to undertake such modifications. These methods ultimately aim to keep the decryption key secret, so that only authorized users can access protected co In addition, traitor tracing schemes [6], [7] have also been implemented to trace nasty users that redistribute the content illegally.

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Oblivious Content Distribution System to Advantage Digital Rights Management

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***Abstract*— This research aims to construct a content distribution protocol that preserves the content provider's security and users' privacy. The protocol can improve Digital Rights Management (DRM) that is required to provide balanced protection for the content provider and the users in a content distribution system. The concept of oblivious transfer (*OT*) is utilized to fulfill the DRM requirement. The *OT* concept allows a sender to securely send a set of information to a receiver in such a way that, at the end of the protocol, the receiver cannot learn more than he was supposed to learn, while the sender cannot determine what the receiver has learned. Assuming that tamper-proof device exists, the constructed protocol achieves perfect security for the content provider and privacy for the users. This oblivious content distribution ultimately enables DRM to be a privacy-aware protection system. The system does not merely focus on content providers' rights, but also seriously considers users' privacy protection.**

Keywords—component; digital rights management, content distribution system, oblivious transfer, security, privacy

I. INTRODUCTION

Digital Rights Management (DRM) is a popular approach to achieve security required in digital content distribution systems. Under DRM protection, digital content is usually encrypted before distributed. To strengthen security, the implementation of the encryption algorithms needs to be modified, so that the algorithms are unintelligible to adversaries. Some methods, such as code obfuscation [1] and white-box cryptography [2-5], have been proposed to undertake such modifications. These methods ultimately aim to keep the decryption key secret, so that only authorized users can access protected content. In addition, traitor tracing schemes [6, 7] have also been implemented to trace nasty users that redistribute the content illegally.

Focusing on the security aspect, however, DRM systems often neglect users' privacy. The systems usually collect users' data to allocate appropriate usage rights. This data acquisition is also useful to view users' buying patterns. The provider may use the data for marketing purposes without users' permission. This situation increasingly invades users' privacy and, thus, reduces users' satisfaction. Therefore, DRM systems need to provide balanced protection for content providers' security and users' privacy [8].

A typical DRM for content distribution consists of four parties: content provider, distributor, clearing house and consumer (user) [9]. First of all, the content provider delivers encrypted content to the distributor and corresponding usage rules to the clearinghouse. The distributor makes the protected content available on a web server that enables users to download it. A consumer then retrieves the content through the distribution channel and requests a license from the clearinghouse. Downloading content from the distributor's web does not seriously threaten the content provider's security neither the users' privacy. While the users can download content anonymously, they cannot unlock the content, unless having the proper decryption key. In contrast, acquiring a license from the clearinghouse creates a concern over security and privacy. If an eavesdropper steals the license when a user requests it from the clearinghouse, revenue will be lost, and thus threaten the provider's security. Moreover, personal information submitted by a user to the clearinghouse is not guaranteed to be kept secret, thus potentially threat the user's privacy.

To overcome the problem, we construct a content distribution protocol by utilizing the oblivious transfer concept. Oblivious Transfer (OT) is a cryptographic protocol that allows two parties to privately exchange one or more secret messages. An OT protocol has to be set up in such a way that it will achieve security for the sender and privacy for the receiver [10]. The former means that the receiver will not be able to learn more than he was supposed to learn. The latter means that the sender will not know what the receiver has learned. The first OT protocol, introduced by Rabin [11], was intended to overcome the exchange of secrets (EOS) problem. This protocol enables a sender to deliver a message to a receiver in such a way that the receiver can access the message with probability $1/2$ and the sender will not know whether the message was received. Rabin's protocol was then generalized to the OT_1^2 [12] . In the OT_1^2 protocol, the sender has two secret messages and the receiver wishes to learn one of them. This scheme has been studied extensively and

generalized to a wide variety of models including OT_1^N [13-15] and OT_K^N [16, 17]. The security of the OT protocols has been intensively studied [18-21]. The OT protocols are also aimed at overcoming the restriction in the availability of the secret message.

II. The Proposed Protocol and Implementation

To provide a solution for the identified DRM problem, we undertake four stages: (1) constructing an oblivious content distribution protocol; (2) implementing the protocol to improve the DRM model for content distribution; (3) analyzing the security and privacy aspects of the improved DRM; and (4) extending the protocol to cover more variables.

A. Oblivious Content Distribution Protocol

Our oblivious content distribution protocol, described in our previous paper [22], utilizes tamper-proof devices. A tamper-proof device means any device that can be used only in a particular way, otherwise the device will be corrupted and its content will no longer be accessible. Utilizing tamper-proof devices in this protocol is less expensive. The device contains only two types of functions, `GetKey` and `GetContent`. `GetKey` function allows the user to ask for the key; that is, the input parameter to the `GetContent` function. `GetContent`, on the other hand, requires an authorized key to reveal the message stored in it. With this characteristic, the device can be mass produced at a low cost. Creating a single device containing all pairs of functions (`GetKey`,`GetContent`) may be reasonable and more efficient. However, for the sake of clarity in this sub section, we assume that one device contains a pair of functions (`GetKey`,`GetContent`).

The protocol allows content provider to deliver contents to user in such a way that at the end of the protocol the user cannot access contents more than he is supposed to access and the content provider will not know which contents are accessed by the user. Suppose the content provider (say, Alice) provides N contents (e.g. movies), (M_1, ..., M_N), and the user (say, Bob) wishes to access K, where $K < N$, of these contents. Alice has a secret code S to access the contents, and utilizes Shamir's secret sharing scheme [23], with the threshold parameter N-K, to share the secret. That is, she splits the secret into N pieces such that any set of at least N-K shares can reconstruct the secret.

The detail protocol is as follows. To share the secret and send the contents, Alice performs the following steps:

1. She secretly chooses random N-K-1 elements of Z_p, denoted a_1, ..., a_{N-K-1} and forms the polynomial $f(x) = S + a_1 x^1 + ... + a_{N-K-1} x^{N-K-1}$. Note that p is a prime and $p > N$.
2. For $i = 1, ..., N$, she computes s_i, where $s_i = f(i) \bmod p$
3. She loads device d_i with s_i as the key value, and M_i as the content value.
4. She gives all devices to Bob.

After delivering the devices there is no subsequent communication between Alice and Bob. Bob can access K contents if he accepts sacrificing N-K contents that are not supposed to be accessed. This condition is applied with assumption that once a device is executed, it will be corrupted or will destroy itself. To obtain K contents, Bob performs the following steps (see also Figure 1 for a clear illustration).

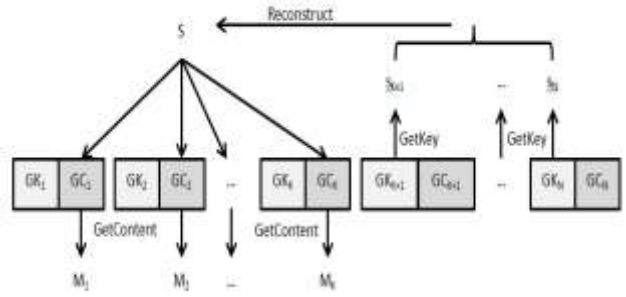

Figure 1. Process for obtaining K out of N contents

1. For simplicity, assume that K contents Bob want to access are M_1, ..., M_K. Bob performs the `GetKey` function on the devices d_{K+1},...,d_N (namely GK_{K+1},...,GK_N), to obtain N-K shares.
2. With the N-K shares, s_{K+1},...,s_N, Bob can reconstruct the polynomial, e.g. using the Lagrange interpolation, and learn the secret S.
3. Using the access code S, Bob performances the `GetContent` function on devices d_1, ..., d_K (namely GC_1,...,GC_K) to obtain the contents M_1, ..., M_K.

B. Implementation to Improve DRM

To implement the constructed protocol in the DRM applications, we employ smart cards. A smart card contains an embedded microprocessor so that it can be used not only to store data, but also to process the data [24]. The microprocessor is also used for security purposes. Data are never directly available to the external applications as the microprocessor controls data handling and memory access according to a given set of conditions.

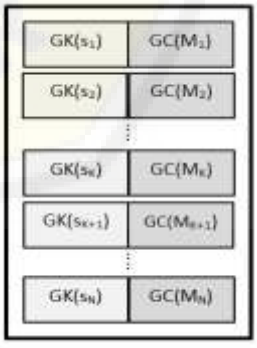

Figure 2. Smart card model; *GK* and *GC* stand for `GetKey` and `GetContent`, respectively.

Suppose the content provider provides N contents, M_1, ..., M_N. First of all, the content provider encrypts all contents using a secret key S. For a particular value K, $1 \leq K \leq N-1$, S is split into N shares, $s_1,\ldots,s_N$, using Shamir's scheme with the threshold parameter $N-K$. The content provider then passes the protected contents to the distributor and the key's shares to the smart card (SC) manufacturer.

The SC manufacturer creates smart cards and sends them to the distributor. The smart card model (see Figure 2) has the following characteristics.

1. For a particular K, a smart card contains N pairs of functions (`GetKey(s_i)`, `GetContent(M_i)`), where $i = 1,2,\ldots,N$.
2. Only one function can be executed from each pair. That is, executing the function `GetKey(s_i)` will disable the associated function `GetContent(M_i)` and, thus, will deny access to the associated content M_i. Conversely, executing the function `GetContent(M_i)` will disable `GetKey(s_i)`.
3. In concrete terms, the smart card executes N-K `GetKey` functions associated with N-K unselected contents. The shares revealed by these functions are then combined to construct the key S that be used to unlock K selected contents

A user can download the protected contents from the distributor's channel and purchases an appropriate smart card. To access the downloaded contents, the user's player must be connected to a compatible smart card reader. A K-valued smart card can be used to unlock K selected contents and denies access to N-K unselected contents.

C. Security and Privacy Analysis

The improved DRM model for content distribution provides an efficient mechanism. Instead of a clearing house, the system employs a smart card manufacturer. Users obtain the content and the corresponding license (provided by an appropriate smart card) from one party, that is, the distributor. This mechanism makes the process more efficient. Furthermore, the improved system also achieves security and privacy for the content provider and the users, respectively. An analysis of both characteristics follows.

Assuming that the smart card is a tamper-proof device, the proposed oblivious content distribution protocol achieves perfect security for the content provider. In the proposed protocol, the shares of the secret key and the function for accessing content are stored in tamper-proof devices. The user cannot access content without obtaining the secret key. The key, however, is split into several pieces of shares and distributed among the pairs of functions (`GetKey`,`GetContent`) inside the device, using Shamir's secret sharing scheme [23]. This scheme is secure because knowing less than a predetermined number of shares gives the user no way to reconstruct the secret. As a result, the user can only obtain the secret key if (and only if) he sacrifices all contents that he is not supposed to access. This means that the user is not able to access anything other than the contents that are supposed to be accessed. Additionally, the smart card is only allocated to the user who has made the payment for it. A particular smart card allows the user to access a limited number of contents as determined in it. Therefore, the proposed protocol achieves perfect security for the content provider.

By the same assumption, the proposed oblivious content distribution protocol preserves high privacy for the users. In the proposed protocol, there is no interaction between content provider and user after the content provider gives all devices to the user. There is no way for the content provider to determine which devices the user has used. As all pairs of functions (`GetKey`,`GetContent`) are corrupted at the end of the protocol, the content provider has no knowledge about which content that has been accessed by the user. Additionally, in the protocol implementation, to unlock the content, a user does not need to provide his personal data for the license. Instead, he purchases the corresponding smart card anonymously. The content and its associated smart card will not be connected to the user's identity. Therefore, the user's privacy is protected.

III. Extended Protocol

In the basic protocol described previously, a user can decrypt a set of contents no more than he was supposed to access. However, once the content has been decrypted, the user can play it without limit. If the restriction of the number of plays is also considered in a business scheme, then an extra variable must be added to the content distribution protocol.

This section describes how the proposed protocol can be enlarged to cover more variables of the usage rules. That is, how we can combine the variable *number_of_items* and *number_of_plays* in one scheme. For example, a user may purchase 5 items, namely content M_1,M_2,M_3,M_4,M_5, and 20 plays. In this case, the user can play all items, but no more than 20 times overall. He may play M_1 for 3 times, M_2 for 4 times, M_3 for 7 times, M_4 for 4 times and M_5 twice. However, he cannot play M_2 for 10 times and M_5 for 11 times.

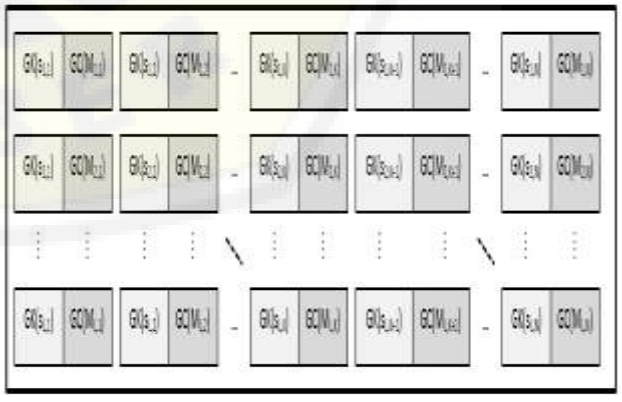

Figure 3. Extended smart card model for the extended protocol

Generally, suppose content provider has N items and a user purchases K items and L plays. An extended smart card utilized to fulfill this need is called (L,K)-smart card. In the (L,K)-smart card model, we place $L \times N$ pairs of functions $(\texttt{GetKey}(s_{i,j}), \texttt{GetContent}(M_{i,j}))$ in a $L \times N$ matrix. For a particular j and $1 \leq i \leq L$, all $s_{i,j}$ and $M_{i,j}$ associate with the key share s_j and the item M_j, respectively. The extended smart card (see Figure 3) has following characteristics:

a. As the previous model, only one function can be executed from each pair.
b. The secret decryption key S can be obtained by executing some `GetKey` functions at the first play (i.e at the first row of the matrix). Once S is reconstructed, it can be used to decrypt other selected items at subsequent plays.
c. Executing $\texttt{GetKey}(s_{1,j})$ functions will disable associated $\texttt{GetContent}(M_{i,j})$ functions for all $1 \leq i \leq L$, and thus, unable user to access item M_j in all plays.
d. For each i, executing a $\texttt{GetContent}(M_{i,j})$ function, will disable all $\texttt{GetContent}(M_{i,h})$ functions, for $h \neq j$. This means that for each play user can only access one item.

To access K items and L plays, Bob has to perform the following protocol.

1. Bob determines K items he wants to access. For simplicity, without lost of generalization, assume that K items Bob chooses are $M_1, ..., M_K$.
2. Smart card then executes $\texttt{GetKey}(s_{1,K+1}), \ldots, \texttt{GetKey}(s_{1,N})$ functions to obtain shares $s_{K+1}, \ldots, s_N$ and reconstruct the secret key S. The key is then be used for all plays. These executions disable all $\texttt{GetContent}(M_{i,j})$ functions, for $1 \leq i \leq L$ and $K+1 \leq j \leq N$.
3. For each i, where $1 \leq i \leq L$, smart card can only execute one of K $\texttt{GetContent}(M_{i,j})$ functions, for $1 \leq j \leq K$

The characteristics of (L,K)-smart card and the protocol it performs guarantee that the user can play all K items, but no more than L times overall. This advanced scenario provides a flexible content distribution system that still preserves security and privacy.

IV. Conclusion

The oblivious content distribution protocol developed in this research provides balanced protection for the content provider and the users in a content distribution system. To strengthen security of the distributed content, the decryption key is split into a number of shares. Decrypting the protected content requires adequate shares to reconstruct the key. It means that a user can only access content that he has paid for. On the other hand, utilizing tamper-proof devices in the protocol guarantees that the users' privacy is protected.

The proposed protocol can also be enlarged to cover more variables. Despite providing flexibility, the system still preserves security and privacy. The implementation of the protocol can potentially improved DRM to be a privacy-aware rights protection system – providing balanced achievement on content provider's security and users' privacy.

Acknowledgment

This paper is an extended version of our paper titled *Secure and Private Content Distribution in the DRM* Environment that was presented at Information System International Conference (ISICO) 2013[22]

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