

Advanced Access Content System (AACCS)

Pre-recorded Video Book

Intel Corporation
International Business Machines Corporation
Microsoft Corporation
Panasonic Corporation
Sony Corporation
Toshiba Corporation
The Walt Disney Company
Warner Bros.

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Preface

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Contact Information

Please address inquiries, feedback, and licensing requests to AACS LA LLC:

- Licensing inquiries and requests should be addressed to licensing@aacsla.com.
- Feedback on this specification should be addressed to comment@aacsla.com.

The URL for the AACS LA LLC web site is <http://www.aacsla.com>.

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Table of Contents

Notice	iii
Intellectual Property.....	iii
Contact Information.....	iii
CHAPTER 1 INTRODUCTION	1
1 INTRODUCTION.....	1
1.1 Purpose and Scope.....	1
1.2 Overview.....	1
1.3 Organization of this Document.....	3
1.4 References	3
1.5 Document History.....	3
1.6 Future Directions.....	4
1.7 Notation	4
1.8 Terminology	4
1.9 Abbreviations and Acronyms	4
CHAPTER 2 CONTENT REVOCATION.....	5
2 INTRODUCTION.....	5
2.1 Scope.....	6
2.2 Content Signing infrastructure	6
2.3 Content Hash Table.....	6
2.4 Content Certificate	7
2.5 Creating Content Certificate	10
2.6 Verifying Content Certificate	11
2.7 Content Revocation List (CRL).....	12

CHAPTER 3 CONTENT ENCRYPTION AND DECRYPTION	17
3 INTRODUCTION.....	17
3.1 Content Encryption (General).....	17
3.2 Content Decryption (General)	18
3.3 Calculating the Volume Unique Keys	19
3.4 AACS Encryption on Pre-Recorded Media	19
3.5 AACS Decryption on Pre-Recorded Media.....	20
CHAPTER 4 SEQUENCE KEY BLOCK.....	21
4 INTRODUCTION.....	21
4.1 Sequence Key Block Principles.....	21
4.2 Calculation of the Media Key Variant Data.....	23
4.2.1 Sequence Keys.....	23
4.2.2 Sequence Key Block (SKB)	23
4.2.2.1 Verify Media Key Record.....	24
4.2.2.2 Nonce Record	24
4.2.2.3 Calculate Variant Data Record	25
4.2.2.4 Conditionally Calculate Variant Data Record.....	26
4.2.2.5 End of Sequence Key Block Record.....	27
4.3 Calculation of the Media Key Variant from the Variant Data	28
CHAPTER 5 MANAGED COPY OF PRE-RECORDED CONTENT	29
5 INTRODUCTION.....	29
5.1 Managed Copy Machine Initiation	36
5.2 Connection Protocol	37
5.3 Managed Copy Account Transactions.....	37
5.3.1 Encapsulated Web Service Clients	37
5.3.2 Links to a Transaction Web Page	38
5.3.3 Use of AACS Object for Financial Transaction	38
5.3.4 Accessing the AACS Object.....	39
5.4 MCS Certificate.....	41
5.5 Managed Copy Messages	41
5.5.1 Perform Read Drive.....	42
5.5.2 Perform Read Drive Response.....	43
5.5.3 Request Offer.....	44

5.5.4	Offer Response Creation.....	45
5.5.4.1	Creation of Cryptographic Signature of Managed Copy Offer Response.....	45
5.5.4.2	Offer Details	46
5.5.4.3	Deal Manifest.....	48
5.5.5	Offer Response Verification and Interpretation.....	48
5.5.5.1	Verification of Cryptographic Signature of Managed Copy Offer Response	48
5.5.5.2	Display of Managed Copy Offers	48
5.5.5.3	Returning Control to the MCM.....	50
5.5.6	Check Serial Number.....	51
5.5.7	Check Serial Number Response.....	51
5.5.8	Request Permission.....	51
5.5.9	Request Permission Response Creation.....	52
5.5.9.1	Request Permission Response Validation.....	53
5.6	Making a Managed Copy.....	53
5.7	Managed Copy Server.....	53
5.8	Informative Section: Components of a Managed Copy Architecture.....	54
5.8.1	The AACCS Compliant Disc	54
5.8.2	The AACCS Compliant Player.....	54
5.8.3	The Managed Copy Machine.....	54
5.8.3.1	The Application Layer of the Managed Copy Machine.....	55
5.8.3.2	The AACCS Layer of the Managed Copy Machine.....	55
5.8.4	MCOT ID Considerations.....	55
5.8.5	The MCOT Transcryptor.....	56
A	APPENDIX MANAGED COPY OFFER XML SCHEMA	57
B	APPENDIX MANAGED COPY PERMISSION XML SCHEMA	63
C	APPENDIX MANAGED COPY WEB SERVICE DESCRIPTION	65
D	DRIVE AUTHENTICATION SCHEMA	71
E	DRIVE AUTHENTICATION WEB SERVICE DESCRIPTION (WSDL)	73

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List of Figures

Figure 1-1 – System Overview (Informative).....	2
Figure 2-1 – Content Validation and Revocation Overview.....	5
Figure 2-2 – Content Signing Process	11
Figure 3-1 – Encryption and Decryption Overview.....	17
Figure 4-1 – Example Sequence Key Block.....	22
Figure 5-1 – Managed Copy Overview	33
Figure 5-2 – Example of Managed Copy Message Flow.....	35
Figure 5-3 –Example Use of performReadDrive Messages	42

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List of Tables

Table 2-1 – Content Certificate for Pre-recorded Video.....	8
Table 2-2 – Content Revocation List for Pre-recorded Video	12
Table 2-3 – Revocation Record for Content Certificate ID	14
Table 2-4 – Revocation Record for Managed Copy Server Certificate ID	15
Table 2-5 – Recordable Media Revocation Record	15
Table 4-1 – <i>Verify Media Key</i> Record Format.....	24
Table 4-2 – <i>Nonce</i> Record Format.....	24
Table 4-3 – <i>Calculate Variant Data</i> Record Format	25
Table 4-4 – <i>Conditionally Calculate Variant Data</i> Record Format	26
Table 4-5 – <i>End of Sequence Key Block</i> Record Format	27
Table 5-1 –Managed Copy - Setting Data Elements.....	35
Table 5-2 –Managed Copy Server Certificate	41

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Chapter 1

Introduction

1 Introduction

1.1 Purpose and Scope

The Advanced Access Content System (AACCS) specification defines an advanced, robust and renewable method for protecting entertainment content, including high-definition audiovisual content. The specification is organized into several “books”. The *Introduction and Common Cryptographic Elements* book defines cryptographic procedures that are common among the various defined uses of the protection system. This document (the *Pre-recorded Video Book*) specifies additional details for using the system to protect audiovisual content distributed on pre-recorded (read-only) storage media. Specifications covering other storage types, transmission media and formats are expected to be available in the future (see Section 1.6 below).

The use of this specification and access to the intellectual property and cryptographic materials required to implement it will be the subject of a license. A license authority referred to as AACCS LA LLC (hereafter referred to as AACCS LA) is responsible for establishing and administering the content protection system based, in part, on this specification.

1.2 Overview

In addition to the general objectives described in the *Introduction and Common Cryptographic Elements* book of this specification, the use of AACCS for protecting Pre-recorded Video Content was designed to meet the following specific criteria:

- Provide robust protection for both off-line playback and optional enhanced uses enabled via on-line connection.

Provide for extended and extensible usage (e.g. jukebox storage, pay for copy).

Independent of physical storage format to the degree possible.

Compliant players can authenticate that content came from an authorized, Licensed Replicator.

Figure 1-1 presents an informative overview of the system, as used for protecting Pre-recorded high-definition Video Content. Actual details and requirements of system operation are described in subsequent chapters.

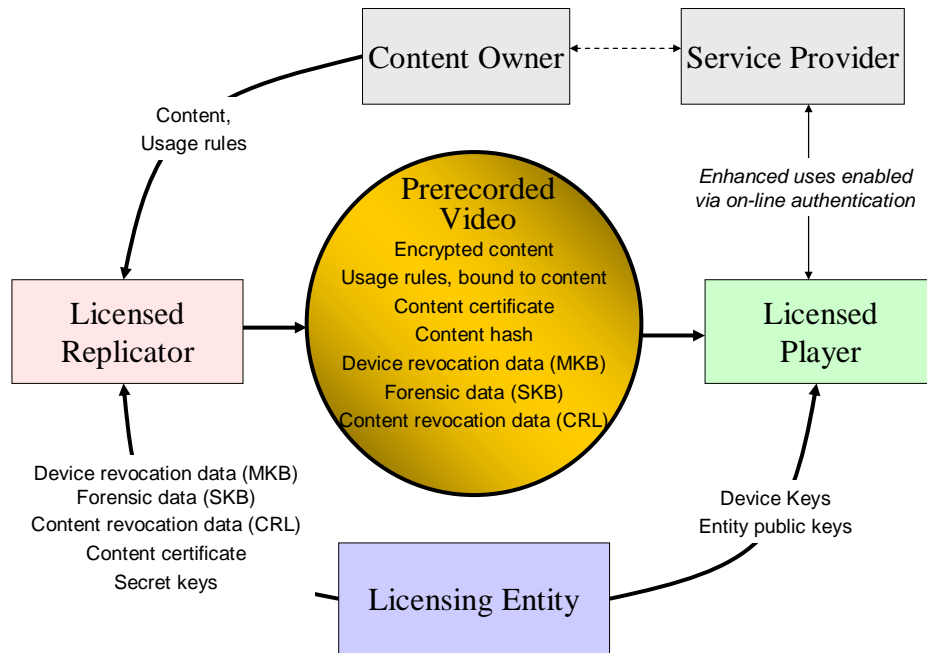


Figure 1-1 – System Overview (Informative)

The owner of audiovisual content that is to be protected provides that content and an associated set of usage rules to a Licensed Replicator.

The licensing entity provides to the Licensed Replicator device revocation data in the form of a Media Key Block (MKB). As described in the *Introduction and Common Cryptographic Elements* book of this specification, the MKB will enable players, each using its set of device keys, to calculate the Media Key. If a set of device keys is compromised in a way that threatens the integrity of the system, an updated MKB can be provided by the Licensing Entity that will cause a device with the compromised set of device keys to calculate a different key than is computed by devices containing unrevoked device keys. In this way, the compromised device keys are “revoked” by the new MKB.

The licensing entity also provides to the Licensed Replicator content revocation data in the form of a Content Revocation List (CRL), and a Content Certificate, both cryptographically signed by AACS LA. The Certificate identifies the content and includes a cryptographic hash thereof (based on a series of hashes), which the licensing entity receives from the replicator prior to signing the Certificate. The CRL identifies content that has been signed and contains a valid certificate but has since been revoked and therefore shall not be accessed by a compliant player.

The licensing entity also provides to the Licensed Replicator device variation data in the form of a Sequence Key Block (SKB), and secret keys, called Media Key Variants, based on both the device variation data and Media Key.

The Licensed Replicator encrypts the AACS Content to be protected, using one or more secret keys of its own choosing, called Title Keys. The replicator encrypts the Title Keys in one or more keys derived from the Media Key. For usage rules that can be modified by a Compliant Recorder, the replicator denotes one of the Title Keys as the primary Title Key and cryptographically binds that Title Key to those usage rules to prevent any malicious alteration of those usage rules. The AACS Content, usage rules, MKB, SKB, CRL and Content Certificate are all pre-recorded onto the storage medium.

AACS LA provides secret Device Keys and Sequence Keys to licensed manufacturers for inclusion in compliant playback devices/applications (Device Key sets and Sequence Key sets are typically unique per device/application). When a storage medium with AACS Content is placed in a compliant player, the player uses its Device Keys to process the MKB and calculate the corresponding Media Key. Using the Media Key

and its Sequence Keys to process the SKB, the device will calculate a particular Media Key Variant. Assuming the given set of Device Keys has not been revoked, the calculated key will be one of the keys used by the Licensed Replicator. The player uses an inverse procedure to that used by the Licensed Replicator to derive a Title Key. The player also uses the Title Key to provide access to the AACS Content in a compliant manner.

AACS LA also provides its Entity Public Keys (i.e., its AACS LA Public Key and AACS LA Content Certificate Public Key) to Licensed Manufacturers for inclusion in compliant devices/applications. Prior to accessing content that has been signed as described in this book, a Compliant Player reads the Content Certificate and CRL from the pre-recorded medium, and uses the Entity Public Keys to verify their integrity. If either verification fails, access is aborted.

The compliant player keeps the CRL in non-volatile storage, unless it already has a more up-to-date list. Using the most up-to-date CRL, the player checks to see if the content is revoked, and if it is, access is aborted. During playback, the compliant player calculates a series of content hashes using the same method used by the replicator. If the player's calculated hash values differ at any point from the replicator-stored values, access is aborted.

The system enables certain enhanced uses of Pre-recorded Video Content, at the election of the Content Owner, through the use of a robust on-line connection. For example, a home video server might connect with a service provider to obtain authorization to make a protected local copy of a given pre-recorded Title for "jukebox" purposes. Such authorization might be provided free-of-charge to the owner of the optical media, with any additional authorized copies incurring a charge. Thus, this and other enhanced uses may entail business interaction between Content Owners and Service Providers, as indicated by the dashed line in the figure above.

1.3 Organization of this Document

This document is organized as follows:

- Chapter 1 provides an introduction and overview.
- Chapter 2 describes procedures related to the authentication and revocation of pre-recorded content.
- Chapter 3 describes procedures for the production (encryption) and off-line playback (decryption) of protected pre-recorded content.
- Chapter 4 describes the Sequence Key Block.
- Chapter 5 describes how devices can perform a Managed Copy of content protected by AACS.

1.4 References

This specification shall be used in conjunction with the following publications. When the publications are superseded by an approved revision, the revision shall apply.

- AACS LA, *License agreement*
- *Introduction and Common Cryptographic Elements* book
- *Specification of Exclusive XML Canonicalization*, <http://www.w3.org/TR/xml-exc-c14n/#sec-Specification>
- *Objects, Images and Applets in HTML Documents. Generic inclusion: the OBJECT element*, <http://www.w3.org/TR/html4/struct/objects.html#edef-OBJECT>
- *Mt. Fuji Commands for Multimedia Devices Version 7 Revision 0.9* or later

1.5 Document History

This document version 0.951 adds corrections for editorial errata to version 0.95, which superseded version 0.92 dated November 29, 2007. It contained editorial improvements since the 0.92 version, plus the following changes:

- Modifications to the Content Certificate for Bus Encryption
- Changes to Managed Copy protocols described in Chapter 5 and the Appendices to support recovery from interrupted transactions and provide significant clarifications.
- Updated description and integrity protocol PMSN

- Addition of the Recordable Media Revocation Record Type
- Addition of Content Certificate ID to Request Offers

1.6 Future Directions

With its advanced, robust cryptography, key management and renewal mechanisms, it is expected that this technology will develop and expand, through additions to this specification, to address content protection for additional storage types, application formats and usage models, as authorized by AACSLA.

1.7 Notation

Except where specifically noted otherwise, this document uses the same notations and conventions for numerical values, operations, and bit/byte ordering as described in the *Introduction and Common Cryptographic Elements* book of this specification.

1.8 Terminology

Except where specifically noted otherwise, this document uses the same terminology as described in the *Introduction and Common Cryptographic Elements* book of this specification.

1.9 Abbreviations and Acronyms

Except where specifically noted otherwise, this document uses the same abbreviations and Acronyms as described in the *Introduction and Common Cryptographic Elements* book of this specification.

Chapter 2 Content Revocation

2 Introduction

This chapter describes a robust mechanism whereby content on individual media can be revoked to prevent playback of unauthorized content. This is accomplished by applying cryptographic signatures to authorized content and storing those signatures on the media with the content. The signature is validated before allowing playback. A Content Revocation List (CRL) is also embedded onto media and then stored in non-volatile memory by players and contains a list of content that contains a valid signature but has since been revoked. The License Agreement describes the conditions under which such revocation can occur. Figure 2-1 presents an overview of the approach, and details are provided in subsequent sections.

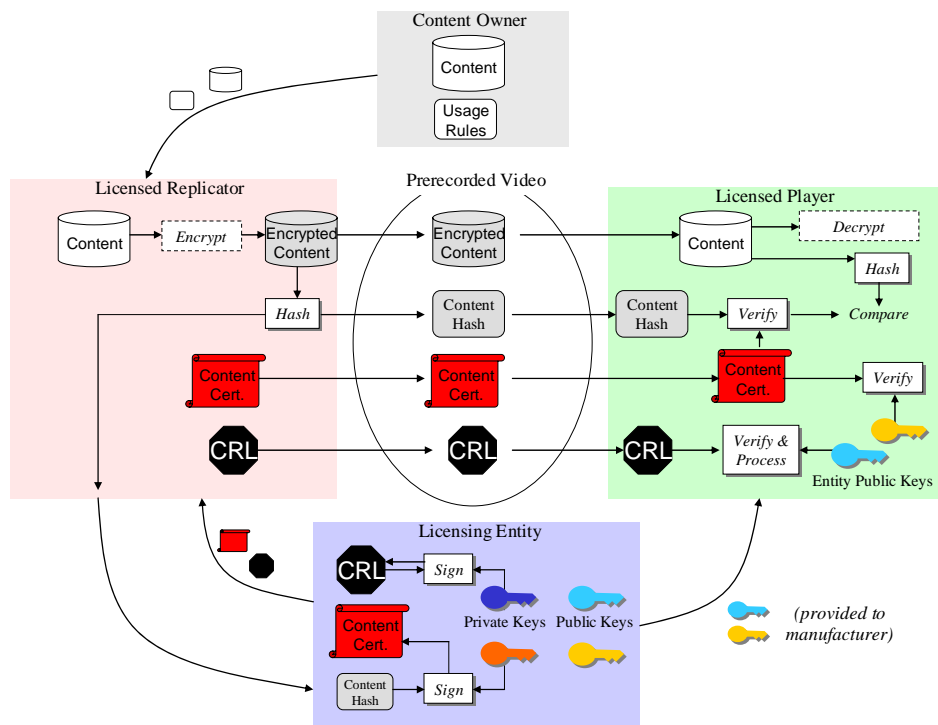


Figure 2-1 – Content Validation and Revocation Overview

2.1 Scope

The content verification and revocation scheme described in this chapter can be applied to both AACCS Encrypted and Unencrypted data. In this chapter, AACCS Encrypted shall mean encrypted as described in this specification and as applied to content formatted as defined in the format specific books of this specification. Unencrypted shall mean content which could have been AACCS Encrypted but was not, and is completely unprotected, i.e., in the clear. Any content to which the AACCS content verification rules can apply, whether AACCS Encrypted or Unencrypted, is referred to in this chapter as Certifiable Content. Content that conforms to this scheme is referred to as Certified. The format specific books of this specification shall define requirements, if any, for verifying the content signature that are not provided in this specification book.

- Certifiable Content that is AACCS Encrypted shall conform to this scheme.
- Certifiable Content that is Unencrypted but on the same media as AACCS Content shall also conform to this scheme.
- Certifiable Content that is completely Unencrypted is not required under this license to conform to this scheme.

AACCS Licensed Players shall verify that the signature is correct as defined in Section 2.6 before providing access to all content (AACCS Encrypted or Unencrypted) which has been signed as described in this chapter, including signed content that is completely Unencrypted. It is anticipated that format specific books will be added to this specification which will define how to apply this scheme to other pre-recorded video formats which do not utilize AACCS encryption as it is defined in this specification.

2.2 Content Signing infrastructure

Licensed Players will contain the Entity Public Keys that will be used as the root of trust for validating content signatures. Media containing content signed in accordance with this scheme will contain the following items:

- Content Certificate
- Content Hash Table
- Content Revocation List

The Content Certificate and Content Hash Table are together used to validate the authenticity of the content and prevent playback of that content if the signature is not valid. The Content Revocation List is a mechanism to prevent playback of content that contains a valid signature but is not valid content.

The Content Certificate, Content Hash Table, and Content Revocation List shall be stored on the pre-recorded media with the signed content. The details and file formats for storing this information are contained in the format specific books of this specification.

2.3 Content Hash Table

Replicators shall include with each *Certified Content* (i.e., content signed with an AACCS Content Certificate), that they produce a Content Hash Table (CHT). The CHT consists of a series of cryptographic hash values calculated by the replicator, which cover the complete content, including any unencrypted content included on the same media with AACCS Content. For storage media that contain more than one physical layer, the storage medium may contain a separate Content Hash Table for each layer. Details of CHT format, calculation and storage are specific to each supported format, and are provided in the format-specific books of this specification.

The inclusion of a Content Hash Table, together with the use of its digest in signing the Content Certificate, enables Licensed Products to verify a correspondence between the Content Certificate and the pre-recorded content with which it is used. If this verification fails, access to such content shall be aborted. When providing access to Certified Content, the Licensed Product shall calculate the series of content hash values using the same algorithm used by the replicator, and shall abort such access if at any time a calculated hash value does not match the corresponding hash value provided by the replicator in the CHT. Unless the Licensed Product has a robust means of detecting a change of the pre-recorded storage medium, it shall re-verify that the hash of the CHT is the same as the Content Hash Table Digest contained in the Content Certificate whenever a CHT is re-read from the medium.

2.4 Content Certificate

Licensed Replicators shall include with any Certified Content that they produce, a signed Content Certificate covering that content. The Content Certificate is stored as unencrypted data on the same storage medium as the Certified Content, as described for each supported content format elsewhere in this specification. For storage media that contain more than one physical layer, the storage medium may contain a separate Content Certificate for each layer. Where a storage medium contains Certified Content in more than one content format, a Content Certificate shall be included for each format. Table 2-1 shows the format of the Content Certificate.

Table 2-1 – Content Certificate for Pre-recorded Video

Byte	Bit	7	6	5	4	3	2	1	0
0	Certificate Type: 00 ₁₆								
1	BEE	Reserved							
2	Total_Number_of_HashUnits								
...									
5									
6	Total_Number_of_Layers								
7	Layer_Number								
8	Number_of_HashUnits								
...									
11									
12	Number_of_Digests								
13									
14	Applicant ID								
15									
16	(msb)	CCSS ID					(lsb)	Sequence Number 1	
17	Sequence Number 1		(msb)						
18	Timestamp								
19	(lsb)	Sequence Number 2							
20	Minimum CRL Version								
21									
22	Reserved								
23									
24	Length_Format_Specific_Section								
25									
26	Format_Specific_Section Reserved for definition and possible extension in Adaptation books								
...									
26+L-1									
26+L	Content Hash Table Digest #1								
:									
33+L									
...	...								
26+L+(N-1)*8	Content Hash Table Digest #N								
...									
33+L+(N-1)*8									
34+L+(N-1)*8	Signature Data								
:									
73+L+(N-1)*8									

Note: L is the length determined by Length_Format_Specific_Section. See the description below.

Each Content Certificate includes:

- A 1-byte Certificate Type value, where 00_{16} shall be used to indicate a first-generation AACCS Content Certificate
- A 1-bit Bus Encryption Enabled (BEE) flag, where 0_2 means that bus encryption is not enabled for the content covered by this Content Certificate, and 1_2 means that bus encryption is enabled for that content.
- A 4-byte Total_Number_of_HashUnits field indicates the total number of Hash Unites on the optical media.
- A 1-byte Total_Number_of_Layers field indicates the total number of layers on the optical media.
- A 1-byte Layer_Number field indicates the layer of the optical media for which this Content Certificate is created. NOTE: This field may not be used by every Format. Additional details on the meaning and use of this field may be provided in the Format specific books of this specification.
- A 4-byte Number_of_HashUnits field indicates the number of Hash Units on the layer for which this Content Certificate is created. NOTE: This field may not be used by every Format. Additional details on the meaning and use of this field may be provided in the Format specific books of this specification.
- A 2-byte Number_of_Digests field indicates the number of Content Hash Table Digests contained within the Content Certificate. NOTE: Additional details on the meaning and use of this field may be provided in the Format specific books of this specification.
- A 2-byte Applicant ID, assigned by the AACCS LA. Each adopter that will be submitting requests to AACCS LA to create Content Certificates will be assigned a unique Applicant ID.
- A 4-byte Content Sequence Number consists of 6-bit Content Certificate Signing Server ID (CCSS ID), 15-bit Timestamp, and 11-bit Sequence Number that is a concatenation of 4-bit Sequence Number 1 and 7-bit Sequence Number 2, and is assigned by the AACCS LA to uniquely identify the Certified Content amongst that applicant's content. The combination of the Applicant ID and the Content Sequence Number is referred to as the *Content Certificate ID*. In other words, the Content Certificate ID is a 6-byte number. Timestamp indicates the date (referenced to UTC) when a Content Certificate is signed, and contains a value for the elapsed days from 1st January 2008 with the value 0 representing 1st January 2008. Timestamp values predating 2 February 2008 are reserved, and shall not be used as a timestamp.
- A 2-byte Minimum CRL Version value, assigned by the AACCS LA to indicate the minimum Content Revocation List Version number that shall accompany the Certified Content.
- A 2-byte Length_Format_Specific_Section that specifies the length of the subsequent Format_Specific_Section section. If this value is zero, then the length of Format_Specific_Section is 2 to maintain byte alignment and the 2 bytes shall be treated as Reserved.
- A Format_Specific_Section. The length of this section and the fields contained within it are defined separately in the adaptation books for each Format utilizing AACCS. The combination of the Length_Format_Specific_Section field and the Format_Specific_Section field shall always be a multiple of 4 bytes.
- A series of 8-byte Content Hash Table Digests, containing the digests of the Content Hash Tables. The digest consists of the least significant 64 bits of the resulting digest from SHA-1 as described in the *Introduction and Common Cryptographic Elements* book of this specification.
- A 40 byte Signature Data, calculated using the Entity Private Key, over the entire data up to and including Content_Hash_Table_Digest#N .

The Licensed Replicator shall obtain a signed Content Certificate from AACCS LA for the content to be stored on the medium, and where appropriate with a separate Content Certificate for each layer. The resulting Content Certificate(s) and Content Hash Table(s) will be included with the content on the pre-recorded medium. Section 2.5 contains additional details on what content shall be included in the creation of the Content Certificate. The AACCS LA will provide to the Licensed Replicator a current version of the Content Revocation List which will also be included on the pre-recorded medium. The creation of the Content Certificate is performed by the Licensed Replicator. The signing of the certificate is performed by a secure facility operated

by AACS LA. The Licensed Replicator will submit the certificate to the secure facility and receive the signed certificate back from that facility.

The AACS LA provides its Entity Public Keys (which corresponds to the Entity Private Keys) to each licensed manufacturer for inclusion in each licensed device or application produced. Licensed Products shall treat the Entity Public Keys as Integrity Required, as defined in the AACS Compliance Rules. Prior to providing access to Certified Content, Licensed Products shall verify the signature of the Content Certificate. If at any point in the process the verification fails, such access shall be aborted. Unless the Licensed Product has a robust means of detecting change of the pre-recorded storage medium, it shall, whenever a Content Certificate is re-read from the medium, either re-verify the signature of the Certificate or robustly verify that the Certificate is the same as one whose signature it already verified, before using the Content Hash Table Digest contained therein for comparisons with the CHT.

Prior to providing access to Certified Content, Licensed Products shall also read and process a Content Revocation List having a List Version value equal to or greater than the Minimum CRL Version value, as described below.

2.5 Creating Content Certificate

A Licensed Replicator shall create the Content Certificate by the following procedure.

1. The digests of the individual units of content are computed as follows:

$$C_d = [\text{SHA-1}(\text{Hash_Unit})]_{\text{lsb}_{64}}$$

Where Hash_Unit is defined in the format specific Pre-recorded books of this specification and SHA-1 is the SHA hashing function as defined in *Introduction and Common Cryptographic Elements* book.

All Hash_Units on the media shall be included in this computation. In the case where some of the Hash_Units on the media are encrypted and others are not encrypted, the digest of the unencrypted Hash_Units shall also be included in the CHT. For Hash_Units that are encrypted, C_d shall be calculated after encryption of those Hash_Units.

2. Each instance of C_d is stored in one or more Content Hash Tables (CHT) as defined in the format specific Pre-recorded books of this specification.
3. The digest of each Content Hash Table is computed as follows:

$$\text{CHT}_d = [\text{SHA-1}(\text{CHT})]_{\text{lsb}_{64}}$$

4. Each instance of CHT_d is stored in a Content Certificate (CC) and the Content Certificate is cryptographically signed as follows:

$$\text{CC}_{\text{sig}} = \text{AACS_Sign}(\text{AACS_CC}_{\text{priv}}, \text{CC})$$

With AACS_Sign as defined in *Introduction and Common Cryptographic Elements* book and the format and layout of the Content Certificate as defined in Section 2.4. The private key, denoted $\text{AACS_CC}_{\text{priv}}$, is an additional private key of the AACS LA that is used only for the purpose of signing the Content Certificate.

This step will be performed at a secure facility operated by the AACS LA where $\text{AACS_CC}_{\text{priv}}$ is securely stored. The previous steps are all performed by the Licensed Replicator. This process is demonstrated in Figure 2-2.

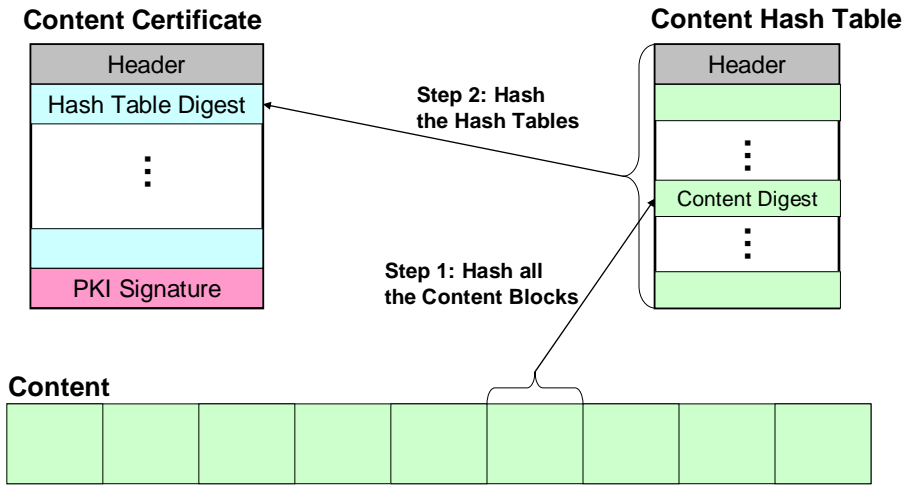


Figure 2-2 – Content Signing Process

2.6 Verifying Content Certificate

As a condition of playing, copying or other use of content stored on a pre-recorded media as defined in the relevant format specific books of this specification, a Licensed Product shall verify the integrity of that content by the following procedure, once for each starting use of that content.

1. Selects a subset of hash units randomly from all content hash units, from which the content hash value is calculated. The Licensed Product shall select the subset of hash units using one of the following two procedures:
 - a) Selects 7 hash units randomly from all content hash units
 - b) Selects the first hash unit and additionally selects at least 1% of the remaining content hash units from the position where playback begins until the end of the Title, where the hash units are randomly selected and evenly distributed throughout all content hash units. As an example, the Licensed Product could use a pseudo randomly generated value modulo 100 to determine which one of the next 100 hash units to verify.

All digests in the CHT shall be included in this selection process.

2. Calculates hash value for each of the selected content hash units.

$$C_d = [\text{SHA-1}(\text{Hash_Unit})]_{\text{lsb}_{64}}$$

Where Hash_Unit is defined in the Format-specific Pre-Recorded books of this specification and SHA-1 is the SHA hashing function as defined in *Introduction and Common Cryptographic Elements* book.

3. Reads Content Hash Table (or tables), which includes the content hash values corresponding to the selected content hash units and calculates the Content Hash Table digest.

$$\text{CHT}_d = [\text{SHA-1}(\text{CHT})]_{\text{lsb}_{64}}$$

4. Reads Content Certificate, which includes the Content Hash Table digest (or digests) that should match the digests calculated in step 3. If they do not match, the Licensed Product shall not proceed with content playback.

- Verifies the Signature of the Content Certificate, where the Content Hash Table digest (or digests) has been replaced with the digests calculated in step 3.

$$\text{AACs_Verify}(\text{AACs_CC}_{\text{pub}}, \text{CC}_{\text{sig}}, \text{CC})$$

With AACs_Verify as defined in *Introduction and Common Cryptographic Elements* book. The public key, denoted AACs_CC_{pub}, is an additional public key of the AACs LA that is used only for the purpose of verifying the Content Certificate. All Licensed Players are required to store this AACs LA's additional public key in a way that resists malicious modification.

- The Licensed Product will not proceed with content playback if the signature fails to correctly verify.
- For each selected hash unit, verifies that the calculated C_d from step 2 is equal to the corresponding C_d that was contained in the selected Content Hash Tables. The Licensed Product will not proceed with content playback if the digest of any of the selected hash units fails to match the expected digest value.

In addition, the player computes the cryptographic hash of the usage rules stored on the media, C_{ur}. The Licensed Product will not proceed with content playback if C_{ur} is not equal to the associated usage rules hash value present in the content certificate.

$$C_{ur} = \text{SHA-1}(\text{Usage_Rules})$$

This procedure is performed either before or after playback begins. If it is performed after playback begins and the selection process described in step 1.a is utilized, steps 1 through 7 shall be completed within the first 300 seconds of playback. If it is performed after playback begins and the selection process described in step 1.b is utilized, steps 3 through 6 shall be completed within the first 30 seconds of playback.

2.7 Content Revocation List (CRL)

Under certain circumstances described in the License Agreement, a variety of revocation actions may be accomplished using the CRL. These actions include revocation of Certified Content (i.e., content signed with an AACs Content Certificate), AACs Recordable Media used for Prepared Video, or Managed Copy Servers. When this occurs, corresponding revocation records are added to the Content Revocation List. The Content Revocation List is signed by AACs LA using its Entity Private Key and provided to all Licensed Replicators. Licensed Replicators shall include the most recent CRL on each pre-recorded medium that they produce containing Certified Content, in a manner consistent with normal production cycles as described in the License Agreement, and as described for each supported content format elsewhere in this specification. The CRL is also included as part of any AACs Prepared Video disk image, as described in the in the *AACs Prepared Video Book*. Table 2-2 shows the format of the CRL.

Table 2-2 – Content Revocation List for Pre-recorded Video

Byte	Bit	7	6	5	4	3	2	1	0	
0		List Type: 0000 ₂				Reserved				CRL Header
1		List Version								
2										
3		Number of Segments (N)								CRL Segment #1
4		Segment Size #1 (S ₁)								
:										
7										
8		Revocation Record Set #1								
:										
4+S ₁ -41										

4+S ₁ -40 : 4+S ₁ -1	Entity Signature #1	
...
X : X+3	Segment Size #N (S _N)	CRL Segment #N
X+4 : X+S _N -41	Revocation Record Set #N	
X+S _N -40 : X+S _N -1	Entity Signature #N	

A CRL shall consist of:

- A 4-bit List Type value, where 0₁₆ shall be used to indicate a first-generation AACCS Content Revocation List
- A 2-byte List Version value, which is assigned by the AACCS LA to identify the version number of the CRL, and shall start at 0000₁₆ and increase by an increment of one with each new version
- A 1-byte Number of Segments field, which indicates the number of CRL Segments that follow, and shall be at least 1.
- One or more variable-size CRL Segments, each consisting of the following:
 - A 4-byte Segment Size field, which indicates the size of the CRL Segment in bytes, starting with the Segment Size field itself, and ending with the Entity Signature field of that CRL Segment. The Segment Size value for the first segment (CRL Segment #1) shall be no more than 128K bytes less the CRL Header.
 - A variable-size Revocation Record Set field, which consists of zero or more Revocation Records, as described below.
 - A 40-byte Signature field, which contains the result of the AACCS LA signing all fields above the Signature field, including the CRL Header and previous CRL Segments, using the Entity Private Key

Prior to providing access to Certified Content, Licensed Products shall read at least the CRL Header and CRL Segment #1 of the CRL provided on the pre-recorded medium with that content, and use the Entity Public Key to verify the Entity Signature found in that first segment. Licensed Products that allocate more than the minimum non-volatile storage for the CRL shall also read subsequent CRL Segments, up to the amount of storage provided, if present, and verify their corresponding Entity Signature. NOTE: when reading more than one CRL Segment, only the signature of the last Segment shall be checked since that signature includes all previous fields including previous Segments and the CRL Header. Licensed Products shall verify that the CRL's List Version value is equal to or greater than the Minimum CRL Version value of the Content Certificate. If any of the above-mentioned verifications fails, such access shall be aborted.

The signature of a CRL segment is verified as follows:

$$\text{AACCS_Verify}(\text{AACCS_LA}_{\text{pub}}, \text{CRL_Seg}_{\text{sig}}, \text{CRL_Seg})$$

With AACCS_Verify and AACCS_LA_{pub} as defined in *Introduction and Common Cryptographic Elements* book.

A Licensed Product shall retain in non-volatile storage, at least the List Version and the Revocation Record Set #1 of the CRL data with the highest valued List version which it encounters and has verified. Therefore, when a CRL (or a portion thereof) is successfully verified as described above, the Licensed Product shall compare its List Version value to the List Version value of its persistently stored CRL data, if any. If

- no CRL data was previously stored, or
- if the List Version value of the previously stored CRL data is lower than that of the newly read CRL, or
- if the List Version values are the same but the newly read CRL data is larger (more complete) than the previously stored CRL data and the product is able to store more CRL data than it previously stored,

then the Licensed Product shall replace the previously stored CRL data, if any, with the newly read CRL data. Then, using its persistently stored CRL data, the Licensed Product shall examine the list to see if the Content Certificate ID to be accessed is revoked and if so, such access shall be aborted.

When persistently storing CRL data, Licensed Products shall have at least 128K bytes of non-volatile storage for that purpose. That size is sufficient to store the List Version field of the CRL and the Revocation Record Set field of CRL Segment #1. Licensed Products that allocate more than 128K bytes of non-volatile storage shall store other fields of the CRL which fit in the additional storage, including the Revocation Record Set fields of other CRL Segments, if present. Where a Licensed Product persistently stores some but not all Revocation Record Set fields of a CRL, it shall give priority to storing the Revocation Record Set fields of the lowest-numbered CRL Segments. In all cases, Licensed Products shall treat CRL List Version and Revocation Record Set fields as Integrity Required, as defined in the license agreement. Table 2-3 shows the format of a Revocation Record for Content Certificate ID.

Table 2-3 – Revocation Record for Content Certificate ID

Bit	7	6	5	4	3	2	1	0
Byte 0	Record_Type: 0000 ₂				Range (bits 11-8)			
1	Range (bits 7-0)							
2 : 7	Content Certificate ID							

A Revocation Record for Content Certificate ID shall consist of:

- A 4-bit Record Type value, where 0₁₆ shall be used to indicate a Revocation Record for Content Certificate ID.
- A 12-bit Range value indicates the range of revoked Content Certificate ID's starting from the ID contained in the record. A value of zero in the Range field indicates that only one ID is being revoked.
- A 6-byte Content Certificate ID value (the concatenation of the 2-byte Applicant ID and the 4-byte Content Sequence Number) indicating the lowest numbered Content Certificate ID to be revoked.

The CRL is also used to contain revocation information for Managed Copy Servers. A Licensed Product that supports the client-side Managed Copy features described in Chapter 5 shall check the persistently stored CRL for revocation entries that correspond to the Managed Copy Server Certificate that they received during communication with the Managed Copy Server as defined in Chapter 5 when requesting authorization to make a Managed Copy. Table 2-4 shows the format of a Revocation Record for Managed Copy Server Certificate ID.

Table 2-4 – Revocation Record for Managed Copy Server Certificate ID

Byte	Bit	7	6	5	4	3	2	1	0
0		Record_Type: 0001 ₂				Range (bits 11-8)			
1		Range (bits 7-0)							
2		Managed Copy Server Certificate ID							
:									
:									
7									

A Revocation Record for Managed Copy Server Certificate ID shall consist of:

- A 4-bit Record Type value, where 01₁₆ shall be used to indicate a Revocation Record for Managed Copy Server Certificate ID.
- A 12-bit Range value indicates the range of revoked Managed Copy Server Certificate ID's starting from the ID contained in the record. A value of zero in the Range field indicates that only one ID is being revoked.
- A 6-byte Managed Copy Server Certificate ID value indicating the lowest numbered ID to be revoked.

The CRL can also include revocation information for AACS Recordable Media via the Recordable Media Revocation Record (RMRR). This record's use is described in the AACS *Prepared Video Book*, and it is only used for Prepared Video on AACS Recordable Media. Table 2-5 – Recordable Media Revocation Record Table 2-5 shows the format of the Recordable Media Revocation Record. Note that the payload of this record does not fit in a single 8 byte Revocation Record, so three contiguous Revocation Records are used. These contiguous records will always occur in the order described below and shall not cross a CRL Segment boundary.

Table 2-5 – Recordable Media Revocation Record

Byte	Bit	7	6	5	4	3	2	1	0
0		Record_Type: 0010 ₂				ICCID	Recordable Media Type		
1		Content Certificate ID							
:									
:									
6									
7		Media ID (bits 127-120)							
8		Record_Type: 0011 ₂				Media ID (bits 119-116)			
9		Media ID (bits 111-56)							
.									
.									
15									
16		Record_Type: 0100 ₂				Media ID (bits 115-112)			
17		Media ID (bits 55-0)							
.									
.									
23									

A Recordable Media Revocation Record consists of

- A 4-bit Record Type value of 2_{16} which indicates a Recordable Media Revocation Record (RMRR)
- A 1 bit Ignore Content Certificate ID flag. When this flag is set (1) only the content of the Media ID field is relevant for revocation.
- A 3 bit Recordable Media Type field where, 0=BD-R/RE, 1=HD DVD-R/RW/RAM, 2=DVD-R/RW/RAM, 3=R/+RW.
- A 6-byte Content Certificate ID value (the concatenation of the 2-byte Applicant ID and the 4-byte Content Sequence Number) indicating the Content Certificate ID to be revoked. The purpose of the Content Certificate ID field here is to reference valid content that has been cloned using cloned media IDs.
- A 16 byte (128 bits) Media ID value indicating the AACS Recordable Media identifier (as defined in the AACS *Recordable Video Book*) to be revoked. For Media Types that use fewer than 128 bits then the most significant bits shall be set to zero (0). Note: the Media ID spans all three Revocation Records that in aggregate make up the Recordable Media Revocation Record as described in Table 2-5 above.
- A 4-bit Record Type of 3_{16} which indicates the 2nd of three Revocation Records associated with the RMRR
- A 4-bit Record Type of 4_{16} which indicates the 3rd of three Revocation Records associated with the RMRR

If a Licensed Product encounters a Revocation Record with a Record_Type value it does not recognize, the record shall be ignored. Other valid records in the CRL shall still be processed, however. Revocation Records within a CRL will not necessarily occur in order of their Content Certificate ID field values.

Chapter 3

Content Encryption and Decryption

3 Introduction

This chapter specifies the procedures for encryption and decryption of pre-recorded video content protected by AACS. Figure 3-1 presents a simplified overview (also see Chapter 3 of the *Introduction and Common Cryptographic Elements* book for an explanation of KCD in this figure). The remainder of the chapter describes the encryption and decryption processes in detail.

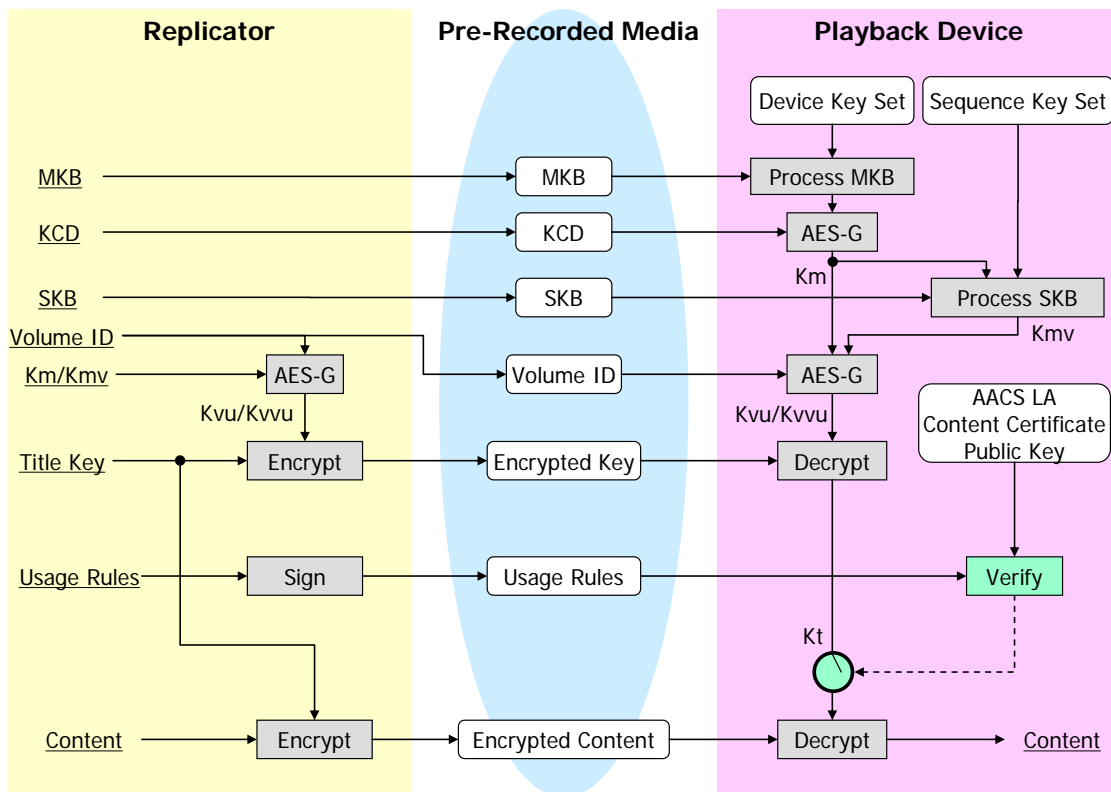


Figure 3-1 – Encryption and Decryption Overview

3.1 Content Encryption (General)

The owner of content that is to be protected provides the content in the form of one or more Titles, and their associated Usage Rules, to the Licensed Replicator.

The Licensed Replicator shall select a secret, random Title Key for each Title to be protected. Each Title Key shall be used to encrypt the content of its corresponding Title, as specified for each supported content format elsewhere in this specification. At the replicator’s discretion, a given Title may be encrypted using the same Title Key for all instances of pre-recorded media, or different Title Keys may be used for different instances.

The Licensed Replicator shall also assign an unpredictable (e.g., random) identifier to the protected Title or set of protected Titles to be included together on a pre-recorded medium. This identifier, referred to as the Volume ID, is used as a safeguard against “bit-by-bit copying” of AACS Content, and is therefore stored on the pre-recorded medium in a manner that cannot be duplicated by consumer recorders, as specified for each supported storage format elsewhere in this specification. At the Licensed Replicator’s discretion, the same Volume ID

may be used for all instances of pre-recorded media containing a given protected Title or set of protected Titles, or different values may be assigned for different instances. Note: The use of different Volume IDs for the same set of protected Titles in combination with downloaded content that is bound using the Content Binding method as described in Section 5.5 of the *Introduction and Common Cryptographic Elements* book of this specification will limit the downloaded content to use with media which share the same Volume ID.

For each protected Title or set of protected Titles to be included together on a pre-recorded medium, the AACSLA provides to the Licensed Replicator a Media Key Block (MKB), a secret Media Key, a Sequence Key Block (SKB), and a corresponding set of secret Media Key Variants. The Media Key Block will enable all compliant devices, each using their set of secret Device Keys, to calculate the same Media Key as described in the *Introduction and Common Cryptographic Elements* book of this specification. If a set of Device Keys is compromised in a way that threatens the integrity of the system, an updated MKB can be released that will cause a device with the compromised set of Device Keys to calculate a different Media Key than is computed by the remaining compliant devices. In this way, the compromised Device Keys are “revoked” by the new MKB.

For each protected Title, the Licensed Replicator calculates a cryptographic hash of the Media Key and/or the Media Key Variants and the Volume ID, and uses the result to encrypt the Title’s Title Key. The AACSLA Content, Encrypted Title Keys, signed Usage Rules and MKB are stored on the pre-recorded medium as specified for each supported storage/content format elsewhere in this specification.

3.2 Content Decryption (General)

The AACSLA provides a set of 253 secret Device Keys, denoted $K_{d,0}, K_{d,1}, \dots, K_{d,n-1}$, to the licensed manufacturer for inclusion into each compliant device or application produced. Device Key sets are either unique per Licensed Product, or are used commonly by multiple products; the license agreement describes the details and requirements associated with these two alternatives. A Licensed Product shall treat its Device Keys as highly confidential, as defined in the license agreement.

The Licensed Product reads the MKB from the pre-recorded medium, and uses its Device Keys to process the MKB and thereby calculate the Media Key, as described in the *Introduction and Common Cryptographic Elements* book of this specification. If the given set of Device Keys has not been revoked, then the calculated Media Key will be the same Media Key that was used by the Licensed Replicator as described above.

The AACSLA also provides a set of 256 Sequence Keys to the licensed manufacturer for inclusion in each compliant device or application produced. Like Device Keys, Sequence Keys are either unique per Licensed Product, or are used in common by multiple products. If a product’s Device Keys are unique, then its Sequence Keys will also be unique; if a product’s Device Keys are in common, then its Sequence Keys will also be in common. In either event, the Licensed Product reads the SKB from the pre-recorded medium and uses its Sequence Keys and its previously calculated Media Key to calculate its Media Key Variant.

For each protected Title the Licensed Product then calculates a cryptographic hash of the calculated Media Key and/or the Media Key Variants and the Volume ID, and uses the result to decrypt the Title’s Encrypted Title Key. The result is then used to decrypt the Title, as specified for each supported format elsewhere in this specification.

The Licensed Product verifies that the Content Certificate ID has not been included on a revocation list before allowing playback of that Title.

Playback of AACSLA Content shall only be performed using the Title Keys and Volume ID which are read from the media as defined in the applicable adaptation book. Except where otherwise provided for in these specifications, the values used to enable playback of AACSLA Content (e.g. Title Keys and Volume ID) shall be discarded upon removal of the instance of media from which they were retrieved. Any derived or intermediate cryptographic values shall also be discarded.

3.3 Calculating the Volume Unique Keys

The Volume Unique Key (K_{vu}) and/or the Volume Variant Unique Keys (K_{vvu}) are used to encrypt and decrypt the Title Keys stored on the pre-recorded media, in a manner that is described in the given Format-specific book of this specification.

The Volume Unique Key is calculated as follows:

1. Calculate the Media Key (K_m):

The K_m , and the Media Key Block are delivered directly to Licensed Replicators. The Licensed Replicator embeds the MKB onto the media to enable Licensed Players to derive K_m .

2. Calculate the Volume Unique Key (K_{vu}):

The Licensed Replicator chooses a Volume ID (ID_v) to be placed on the pre-recorded media and calculates a Volume Unique Key (K_{vu}) as follows:

$$K_{vu} = \text{AES-G}(K_m, ID_v)$$

where AES-G represents the AES-based one-way function defined in the *Introduction and Common Cryptographic Elements* book.

The Volume Variant Unique Key is calculated as follows:

1. Calculate the Media Key Variant (K_{mv}):

The K_{mv} 's, and the Sequence Key Block are delivered directly to Licensed Replicators. The Licensed Replicator embeds SKB onto the media to enable Licensed Players to derive its particular K_{mv} , as described in Chapter 4

2. Calculate the Volume Variant Unique Key (K_{vvu}):

The Licensed Replicator calculates a Volume Variant Unique Key (K_{vvu}) as follows:

$$K_{vvu} = \text{AES-G}(K_{mv}, ID_v).$$

3.4 AACs Encryption on Pre-Recorded Media

The following steps detail the minimum procedures for encrypting AACs Content on pre-recorded media as illustrated in Figure 3-1 above.

1. Generate the Title Key

The Licensed Replicator generates a statistically unique 128-bit Title Key (K_t).

2. Encrypt the content

The Title Key is used to encrypt the Content (C) as follows:

$$C_e = \text{AES-128CBCE}(K_t, C)$$

where AES-128CBCE represents encryption by the AES algorithm in CBC mode as defined in the *Introduction and Common Cryptographic Elements* book.

3. Sign the content

The AACs Content is signed using the procedure defined in Section 2.5.

4. Encrypt the Title Key(s)

The Title Key(s) is encrypted (K_{te}) as follows:

$$K_{te} = \text{AES-128E}(K_u, K_t)$$

where AES-128E represents encryption by the AES algorithm in ECB mode as defined in the *Introduction and Common Cryptographic Elements* book and the K_u 's is one of the Volume Unique Keys defined in Section 3.3. There may be more than one encryption at this step, if a Title Key is encrypted in all of the Volume Variant Unique Keys.

5. Transfer the data

The Licensed Replicator stores the encrypted Title Keys (K_{te}), Usage Rules, Content Certificate, and the encrypted AACs Content to the pre-recorded media in the location and manner as specified for each supported Format elsewhere in this specification.

3.5 AACCS Decryption on Pre-Recorded Media

The following steps detail the minimum procedures for decrypting AACCS Content on pre-recorded media as illustrated in Figure 3-1 above.

1. Decrypt the Title Key(s)

The Title Key(s) is decrypted (K_t) as follows:

$$K_t = \text{AES-128D}(K_u, K_{te})$$

where AES-128D represents decryption by the AES algorithm in ECB mode as defined in the *Introduction and Common Cryptographic Elements* book and K_u is one of the Volume Unique Keys defined in Section 3.3.

2. Verify content is not revoked

The Content Certificate ID is checked for revocation status as defined in Section 2.7. If the content has been revoked, the content shall not be decrypted nor played.

3. Verify content signature

The AACCS Content is verified as defined in Section 2.6. If the verification fails, the content shall not be further decrypted nor played.

4. Decrypt the content

The Title Key is used to decrypt the Content (C) as follows:

$$C = \text{AES-128CBCD}(K_t, C_e)$$

where AES-128CBCD represents decryption by the AES algorithm in CBC mode as defined in the *Introduction and Common Cryptographic Elements* book.

Steps 3 and 4 can be performed in parallel as defined in Section 2.6.

Chapter 4

Sequence Key Block

4 Introduction

This chapter describes the use of device Sequence Keys and the Sequence Key Block (SKB) on pre-recorded media. This chapter applies only to Class I Licensed Products. Class II Licensed Products process unified (Type 10) MKBs to achieve the same function, as described in the AACS *Introduction and Common Cryptographic Elements Book*.

Fundamentally, AACS protection depends on Device Keys and the tree-based Media Key Block, which allows unlimited, precise revocation without danger of collateral damage to innocent devices. Because of the inherent power of the revocation of the AACS system, it is possible that attackers may forgo building clones or non-compliant devices and instead devote themselves to attacks where they try to hide the underlying compromised device(s). These attacks are both more expensive and more legally risky for the attackers, because the attacks require them to have an active server serving either content keys or the content itself, on an instance-by-instance basis.

It is possible that non-technical means could stop these “anonymous attack” servers. Nonetheless, AACS has developed a technology to accurately determine the underlying compromised devices that these servers are using, so the AACS revocation mechanism can be brought to bear. The technology is called Sequence Keys and the Sequence Key Block.

Sets of Sequence Keys are assigned to individual devices by the AACS LA out of a matrix of keys. The AACS LA also assigns the Sequence Key Blocks to be used on the pre-recorded media. In this respect, the key management aspects of Sequence Keys are identical to the technology developed by 4C Entity, LLC, called Content Protection for Recordable Media (CPRM). Sequence Key Blocks are very similar to CPRM Media Key Blocks; the only differences arise from the different ciphers used (AES instead of C2). However, unlike CPRM MKBs, the AACS SKBs are not part of the fundamental cryptographic protection of the content. The fundamental protection of AACS is the Media Key; the SKB merely allows different variants of the Media Key to be calculated by different devices.

The remainder of this section describes the Sequence Key Block in detail.

4.1 Sequence Key Block Principles

This is an informative section intended to give an overview of how Sequence Key Blocks work.

The AACS licensing agency will generate Sequence Keys organized in a large matrix. The matrix has 256 columns and not more than 65,536 rows. Each cell is a different Sequence Key. A single device has one key in each column. Thus, each device has 256 Sequence Keys.

Attackers would prefer to use already-compromised Sequence Keys if they could, so that no new forensic information could be deduced by the licensing agency. Therefore, it is important that compromised keys are no longer usable by the attackers. The problem is that many thousands of devices might share a single compromised key. Therefore, revocation of a single key is impossible. On the other hand, revocation of a unique *set* of keys is very possible; in fact, that is precisely what the SKB achieves. The fundamental principle is that no two devices have many keys in common, so even if the system has been heavily attacked and a significant fraction of the Sequence Keys is compromised, all innocent devices will have many columns in which they have uncompromised keys. The purpose of the Sequence Key Block is to give all innocent devices a column they can use to calculate the correct answer, while at the same time preventing compromised devices (who have compromised keys in all columns) from getting to the same answer.

In an SKB there are actually many correct answers, one for each variation in the content. For the purpose of explanation, however, it is helpful to imagine that a single SKB is producing a single answer. We will call that answer the *output key*. Then the SKB mechanism is completely identical to the CPRM/CPPM mechanism.

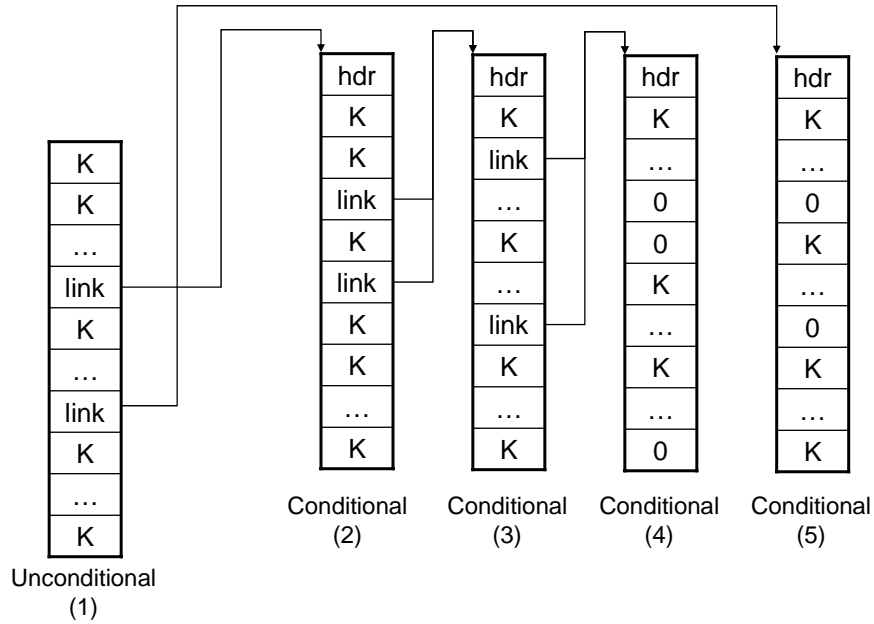


Figure 4-1 – Example Sequence Key Block

As shown in Figure 4-1 above, the SKB begins with a first column, called the “unconditional” column. By “column”, we mean a column of Sequence Keys in the matrix will be used to encrypt. (To be precise, the key used to encrypt is derived from the Sequence Key, not the Sequence Key itself.) The first column will have an encryption of the output key (denoted ‘K’ in the figure) in every uncompromised Sequence Key’s cell. Devices that do not have compromised keys in that column immediately decrypt the output key. Devices, both innocent and otherwise, that do have compromised keys instead decrypt a key called a *link key* that allows them to process a further column in the SKB. To process the further column they need both the link key and their Sequence Key in that column. Thus the subsequent columns are called “conditional” columns because they can only be processed by the device if it were given the necessary link key in a previous column.

The subsequent additional conditional columns are produced the same way as the first column: They will have an encryption of the output key in every uncompromised Sequence Key’s cell. Devices with a compromised key will get a further link key to another column instead of the output key. However, after some number of columns depending on the actual number of compromised keys, the AACSS licensing agency will know that only compromised devices would be getting the link key—all innocent devices would have found the output key in this column or in a previous column. At this point, rather than encrypting a link key, the agency encrypts a 0, and the SKB is complete. All innocent devices will have decrypted the output key, and all compromised devices have ended up decrypting 0.

How do the devices know they have a link key versus the output key? The short answer is they do not, at least not at first. Each conditional column has a header of known data ($DEADBEEF_{16}$) encrypted in the link key for that column. The device decrypts the header with the key it currently has. If the header decrypts correctly, the device knows it has a link key and processes the column. If it does not decrypt correctly, the device knows it has either the output key or a link key for a different column. When the device reaches the end of the SKB without decrypting 0, it knows it shall have an output key. Note that this device logic allows the licensing agency to send different populations of devices to different columns by having more than one link key output from a single column. For example, in the figure, column (1) links to both column (2) and column (5). This flexibility can help against certain types of attacks.

The preceding description is equally accurate for an AACSS SKB as it is for a CPRM/CPM Media Key Block, with the exception that in the AACSS SKB there is not a single output key, but multiple output keys called *Variant Data*.

4.2 Calculation of the Media Key Variant Data

4.2.1 Sequence Keys

Each AACS compliant device capable of playing pre-recorded content is given a set of secret Sequence Keys when manufactured. These are in addition to the Device Keys that all AACS devices require. These Sequence Keys are provided by the AACS LA and are for use in processing the Sequence Key Block. The result of the calculation is Variant Data which is then combined with the Media Key from the Media Key Block to generate the Media Key Variant, as explained in Section 4.3. Key sets are either unique per device, or are used commonly by multiple devices. The AACS license agreement describes the details and requirements associated with these two options.

Each device receives 256 64-bit Sequence Keys, which are referred to as K_{s_i} ($i=0,1,\dots,255$). For each Sequence Key there is an associated Column and Row value, referred to as C_{s_i} ($i=0,1,\dots,n-1$) and R_{s_i} ($j=0,1,\dots,m-1$) respectively. Column and Row values start at 0. For a given device, no two Sequence Keys will have the same associated Column value (in other words, a device will have at most one Sequence Key per Column). It is possible for a device to have some Sequence Keys with the same associated Row values.

A device uses a Sequence Key K_{s_i} together with the Media Key K_m to calculate the Media Sequence Key K_{ms_i} as follows:

$$K_{ms_i} = \text{AES-G}(K_m, K_{s_i} \parallel 0302153EE3EC7524_{16})$$

The Media Sequence Keys serve the role that the device keys in CPRM. In other words, the device does not use its Sequence Key directly to decrypt; instead, it combines it with the Media Key first as shown above. That means that a given SKB is associated with a given MKB (because the SKB depends on the Media Key for correct processing).

A device shall treat its Sequence Keys as highly confidential, and their associated Row values as confidential, as defined in the AACS license agreement.

4.2.2 Sequence Key Block (SKB)

The SKB is generated by the AACS LA and allows all compliant devices, each using their set of secret Sequence Keys and the Media Key, to calculate the Variant Data, D_v , which in turn allows them to calculate the Media Key Variant. If a set of Sequence Keys is compromised in a way that threatens the integrity of the system, an updated SKB can be released that causes a device with one or more compromised sets of Sequence Keys to calculate invalid Variant Data. In this way, the compromised Sequence Keys are “revoked” by the new SKB.

An SKB is formatted as a sequence of contiguous Records. Each Record begins with a one-byte Record Type field, followed by a three-byte Record Length field. The Record Type field value indicates the type of the Record, and the Record Length field value indicates the number of bytes in the Record, including the Record Type and the Record Length fields themselves. Record lengths are always multiples of 4 bytes. The Record Type and Record Length fields are never encrypted. Subsequent fields in a Record may be encrypted (by the AES cipher in ECB mode), depending on the Record Type.

Using its Sequence Keys, a device calculates D_v by processing Records of the SKB one-by-one, in order, from first to last. Except where explicitly noted otherwise, a device shall process every Record of the SKB. The device shall not make any assumptions about the length of Records, and shall instead use the Record Length field value to go from one Record to the next. If a device encounters a Record with a Record Type field value it does not recognize, it ignores that Record and skips to the next. For some Records, processing will result in the calculation of a D_v value. Processing of subsequent Records may update the D_v value that was calculated previously. After processing of the SKB is completed, the device uses the most recently calculated D_v value as the final value for D_v .

If a device correctly processes an SKB using Sequence Keys that are revoked by that SKB, the resulting final D_v will have the special value 0000000000000000_{16} . This special value will never be an SKB’s correct final D_v value, and can therefore always be taken as an indication that the device’s Sequence Keys are revoked. Device behavior in this situation is implementation defined. As an example, a device could exhibit a special

diagnostic code, as information to a service technician. If at any point, a device calculates a D_v value of zero, it shall discontinue processing of the SKB and may conclude that it has been revoked.

The following subsections describe the currently defined Record types, and how a device processes each.

4.2.2.1 Verify Media Key Record

Table 4-1 – Verify Media Key Record Format

Byte	Bit	7	6	5	4	3	2	1	0
0	Record Type: 81_{16}								
1	Record Length: 000014_{16}								
2									
3									
4	Verification Data (D_x)								
...									
19									

A properly formatted SKB shall have exactly one *Verify Media Key Record* as its first Record. Bytes 4 through 19 of the Record contain the ciphertext value

$$D_x = \text{AES-128E}(K_m, 0123456789\text{ABCDEF}_{16} \parallel \text{XXXXXXXXXXXXXXXX}_{16})$$

where $\text{XXXXXXXXXXXXXXXX}_{16}$ is an arbitrary 8-byte value, and K_m is the correct final Media Key value.

The presence of the *Verify Media Key Record* in an SKB is mandatory, but the use of the Record by a device is not mandatory. The device may use the *Verify Media Key Record* to make sure that it has the correct Media Key for processing the SKB. The Media Key comes from calculation based on the separate Media Key Block. Since MKBs and SKBs are associated, the device can, in effect, verify it has the correct MKB/SKB pair. The device action in the case of a mismatched MKB/SKB pair is manufacturer-specific. In any event, the device will not be able to process the content correctly.

If everything is correct, the device observes the condition:

$$[\text{AES}_{128}\text{D}(K_m, D_x)]_{\text{msb}_{64}} == 0123456789\text{ABCDEF}_{16}$$

where K_m is the Media Key value.

4.2.2.2 Nonce Record

Table 4-2 – Nonce Record Format

Byte	Bit	7	6	5	4	3	2	1	0
0	Record Type: 03_{16}								
1	Record Length: 000014_{16}								
2									
3									
4	Nonce number (X)								
...									

19	
----	--

A properly formatted SKB shall have exactly one *Nonce* Record. The nonce number *X* is used in the Variant Data calculation as described below. The Nonce Record will always precede the Calculate Variant Data Record and the Conditionally Calculate Variant Data Records in the SKB, although it may not immediately precede them.

4.2.2.3 Calculate Variant Data Record

Table 4-3 shows the format of a *Calculate Variant Data* Record.

Table 4-3 – Calculate Variant Data Record Format

	Bit	7	6	5	4	3	2	1	0
	0	Record Type: 01 ₁₆							
	1	Record Length							
	2								
	3								
	4								
	...	Reserved							
	7	Column							
	8								
	9								
	10	Generation: 0001 ₁₆							
	11	Reserved							
	12								
	...								
	19								
Encrypted Key Data	20	Encrypted Variant Data for Row 0 (D _{ke_0})							
	...								
	29								
	30	Encrypted Variant Data for Row 1 (D _{ke_1})							
	...								
	39								
	40	⋮							
...									
Length-1									

A properly formatted SKB shall have exactly one *Calculate Variant Data* Record. Devices shall ignore any *Calculate Variant Data* Records encountered after the first one in an SKB. The use of the Reserved fields is currently undefined, and they shall be ignored. The Generation field shall contain 0001₁₆ for the first generation. The Column field indicates the associated Column value for the Sequence Key to be used with this Record, as described below. Bytes 20 and higher contain Encrypted Key Data (possibly followed by some padding bytes at the end of the Record, not shown in Table 4-3). The first ten bytes of the Encrypted Key Data correspond to Sequence Key Row 0; the next ten bytes correspond to Sequence Key Row 1; and so forth.

Before processing the Record, the device checks that both of the following conditions are true:

Generation == 0001₁₆

and

the device has a Sequence Key with associated Column value $C_{d,i} == \text{Column}$, for some i .

If either of these conditions is false, the device ignores the rest of the Record.

Otherwise, using the value i from the condition above, the value X from the Nonce Record, and $r = R_{d,i}$, $c = C_{d,i}$, the device calculates:

$$D_v = [\text{AES-G}(K_{ms,i}, X \oplus f(c,r))]_{msb_{80}} \oplus D_{ke,r}$$

where $K_{ms,i}$ is the device's i -th Media Sequence Key's value and $D_{ke,r}$ is the 80-bit value starting at byte offset $r \times 10$ within the Record's Encrypted Key Data. $f(c,r)$ represents the 128-bit value:

$$f(c,r) = 0000_{16} \parallel c \parallel 0000_{16} \parallel r \parallel 0000000000000000_{16}$$

where c and r are left-padded to lengths 16 bits, by appending zero-valued bits to each as needed. The resulting D_v becomes the current Variant Data value.

It is not necessary for a first generation device to verify that Record Length is sufficient to index into the Encrypted Key Data. First generation devices are assured that the Encrypted Key Data contains a value corresponding to their Device Key's associated Row value.

4.2.2.4 Conditionally Calculate Variant Data Record

Table 4-4 shows the format of a *Conditionally Calculate Variant Data* Record.

Table 4-4 – Conditionally Calculate Variant Data Record Format

Byte	Bit	7	6	5	4	3	2	1	0
0	Record Type: 82 ₁₆								
1	Record Length								
2									
3									
4									
...	DEADBEEF ₁₆ (encrypted)								
7	Column (encrypted)								
8									
9	Generation: 0001 ₁₆ (encrypted)								
10	Reserved								
11									
12									
...									
19	Doubly Encrypted Variant Data for Row 0 (D_{kde_0})								
20									
...									
29	Doubly Encrypted Variant Data for Row 1 (D_{kde_1})								
30									
...									
39	.								
40									
...	.								

	Length-1	
--	----------	--

A properly formatted SKB may have zero or more *Conditionally Calculate Media Key* Records. Bytes 4 through 19 of the Record contain Encrypted Conditional Data (D_{ce}). If decrypted successfully, as described below, bytes 4 through 7 contain the value $DEADBEEF_{16}$, bytes 8-9 contains the associated Column value for the Sequence Key to be used with this Record, and bytes 10-11 contain a Generation value of 0001_{16} for the first generation. Bytes 20 and higher contain Doubly Encrypted Variant Data (possibly followed by some padding bytes at the end of the Record, not shown in Table 4-4). The first ten bytes of the Doubly Encrypted Key Data correspond to Sequence Key Row 0, the next ten bytes correspond to Sequence Key Row 1, and so forth.

Upon encountering a Conditionally Calculate Variant Data Record, the device first calculates its current Media Key Variant, as follows:

$$K_{mv} = \text{AES-G}(K_m, D_v \parallel 041826fa7749_{16})$$

Where D_v is its current Variant Data calculated from a previous Calculate Variant Data Record or Conditionally Calculate Variant Data Record.

Using its current K_{mv} value, the device calculates Conditional Data (D_c) as:

$$D_c = \text{AES-128D}(K_{mv}, D_{ce}).$$

Before continuing to process the Record, the device checks that all of the following conditions are true:

$$[D_c]_{\text{msb}_{32}} == \text{DEADBEEF}_{16}$$

and

$$[D_c]_{79:64} == 0001_{16}$$

and

$$\text{the device has a Sequence Key with associated Column value } C_{d,i} == [D_c]_{95:80} \text{ for some } i.$$

If any of these conditions is false, the device ignores the rest of the Record.

Otherwise, using the value i from the condition above, X from the Nonce Record, the device's current Variant Data D_{vold} , and $r = R_{d,i}$, $c = C_{d,i}$, the device calculates:

$$D_{\text{vnew}} = [\text{AES-G}(K_{\text{ms}_i}, X \oplus f(c,r))]_{\text{msb}_{80}} \oplus D_{\text{vold}} \oplus D_{\text{kde}_r}$$

where D_{kde_r} is the 80-bit value starting at byte offset $r \times 10$ within the Record's Doubly Encrypted Key Data, $f(c,r)$ represents the 128-bit value:

$$f(c,r) = 0000_{16} \parallel c \parallel 0000_{16} \parallel r \parallel 0000000000000000_{16}$$

where c and r are left-padded to lengths 16 bits, by prepending zero-valued bits to each as needed. The resulting D_{vnew} becomes the current Variant Data value.

This Record is always a multiple of 4 bytes.

4.2.2.5 End of Sequence Key Block Record

Table 4-5 – End of Sequence Key Block Record Format

Bit	7	6	5	4	3	2	1	0
Byte 0	Record Type: 02_{16}							
1	Record Length							
2								
3								
4	Signature Data							
...								
Length-1								

A properly formatted SKB shall contain an *End of Sequence Key Block* Record. When a device encounters this Record it stops processing the SKB, using whatever D_v value it has calculated up to that point as the final D_v for that SKB.

The End of Sequence Key Block Record contains the AACSLA's signature on the data in the Sequence Key Block up to, but not including, this Record. Devices may ignore the signature data. However, if any device checks the signatures and determines that the signature does not verify or is omitted, it shall refuse to use the Variant Data.

The length of this Record is always a multiple of 4 bytes.

4.3 Calculation of the Media Key Variant from the Variant Data

When the device has finished processing the SKB, and if it has not been revoked, it will have an 80-bit valid Variant Data D_v . The device calculates the Media Key Variant from the Variant Data as follows:

$$K_{mv} = \text{AES-G}(K_m, D_v \parallel 041826fa7749_{16})$$

In addition, the low-order 10 bits of the Variant Data identify the Variant Number for the device to use in playing the content, from 0 to 1023. This number usually denotes the particular Title Key file the device uses to decrypt the content, although the meaning and use of the Variant Number is format-specific.

Chapter 5

Managed Copy of Pre-recorded Content

5 Introduction

Content protected by AACS includes an offer for the consumer to make at least one additional copy of that content after receiving appropriate authorization. That copy can be up to a full resolution “bit for bit” copy of the original content and can also include other offers where only certain portions of the original content is included in the copy. With some exceptions, all content protected by AACS includes this offer. Additional details on those exceptions are documented in the license agreement. There may be additional offers available and for the purposes of this chapter, the term “Managed Copy” means a copy of the content that has been made subject to external authorization using the process defined in this chapter.

For the sake of clarity in this section, the precise definition of relevant terms is given as follows:

Client-side Binding	In a transaction using Client-side Binding, the MCM will contain the cryptographic keys to rebind the content to the destination (MCOT).
Content ID	Defined in Chapter 5 of the <i>Introduction and Common Cryptographic Elements</i> book
Content Certificate ID	The concatenation of the Applicant ID and the Content Sequence Number as defined in Section 2.4. The Content Certificate ID is a 6-byte value.
Default URL	A URL provided by AACS LA to be used for locating a Managed Copy Server for media which does not contain a valid Managed Copy URL. The Default URL is embedded into Managed Copy Machines for this purpose. The actual Default URL to be embedded into a Managed Copy Machine is available on the AACS LA website. NOTE to Adopters: It may be advisable to support the ability to update the embedded URL in the Managed Copy Machine. Note that the Default URL stored in the MCM identifies the Default Managed Copy Server
Format Specific Application	Refers to an application type specific to a format supported by this specification (i.e., HDEX or BD-J).
Managed Copy Output Technology or (MCOT)	As defined in the Compliance Rules
Managed Copy Machine	or (MCM) is the consumer software or hardware which performs a Managed Copy. It is either tied to a Licensed Player, or it exists as a stand-alone application – e.g. as part of a home media server
Managed Copy Server	or (MCS) is the remote computer that provides authorization to MCM’s to make Managed Copies. The appropriate MCS for a particular Title will be identified by a URL that will be contained on the media to be copied. Note that the “default” Managed Copy Server is the server instance operated on behalf of AACS LA.

Managed Copy Unit or (MCU) is a particular offer that is made available as a part of the offers retrieved from the MCS or which reside on the media

PMSN Defined in Chapter 1 of the *Introduction and Common Cryptographic Elements* book as the Pre-recorded Media Serial Number

Secretless Client An MCM client which is not running under an AACS Licensed Product. These clients do not have access to an AACS Host Private Key, and must use Server-side Binding. These clients typically run in a PC-like environment.

Serial Number This is a value provided to the Managed Copy Server to identify the particular disc being copied.

The Serial Number is either:

1. The PMSN included on pre-recorded media
2. Provided separately from the physical media (e.g., a sticker in the packaging)
3. Not provided

It is required that a Licensed Replicator use a Serial Number that is not easily guessed by the end user. If Managed Copy offers are dependent on the Serial Number, then Content Owners using the default Managed Copy Server either shall identify a list of valid values for the Serial Number, or these values shall conform to the constraints described below.

If the Content Owner plans on using the default Managed Copy Server, then that Serial Number shall conform to the following format. This format shall contain the following two fields:

1. One field is a sequence of 32 bits that encode a counter. The counter contains either (a) a value from 1 to N, where N is the total number of discs of that movie that have been released, or (b) a value which alone, or when combined with other fields of the Serial Number, ensures that the Serial Number is globally unique. The counter is in Big Endian (most significant byte first) format.
2. One field is a sequence of Y check bits. The number Y is different, depending on the type of Serial Number. The check bits are the most significant Y bits of the following value:

$$\text{AES-128E}(K_{\text{sn}}, 5c65148db53e47d920119f90_{16} \parallel D_{\text{counter}})$$

Where K_{sn} is a secret picked by the Content Owner or the replicator, and D_{counter} is the counter value for the particular Serial Number. It is strongly recommended that K_{sn} be a movie-by-movie secret, especially for the case of 1 (a) above. If the same K_{sn} is used for two or more movies, there might be a risk that the Serial Numbers generated for one movie would be used for another movie.

The order of fields is such that check bits come first and the counter field comes second.

In the case the Serial Number is a PMSN which is compatible with the default Managed Copy Server, then the number Y is format specific; some formats have defined fields in the PMSN so the 128-bit PMSN cannot be completely arbitrary.

In the case that the Content Owner plans on using the default Managed Copy Server but is using a different algorithm to produce the unguessable PMSN, then they shall provide a list of the valid Serial Numbers to the default Managed Copy Server.

In the case that the Serial Number is a sticker inside the disc packaging, and the Content Owner plans on using the default Managed Copy Server, the sticker shall be unguessable and shall be of the following form:

XXXX-XXXX-XXXX-XXXX-XXXX

Where x's are alphanumeric characters from the set
234679BCFGHJKLMQTVWXY

with 2 being 0₁₀, 3 being 1₁₀, ..., and Y being 19₁₀.

The 20 alphanumeric characters are treated as a base-20 positive integer, which in turn encodes an 86-bit string. This means that the first 54 (Y) bits are the check bits, and the last 32 bits encode the counter. To improve the user experience, the default server settings will convert the following invalid alphanumeric characters before converting the Serial Number from alphanumeric to binary:

8 --> Auto-map to "B"

D --> Auto-map to "B"

L --> Auto-map to "J"

N --> Auto-map to "M"

P --> Auto-map to "B"

R --> Auto-map to "B"

Z --> Auto-map to "2"

The remaining characters of 015AEIOSU remain invalid characters.

Note: Since the Serial Number type can be either a binary number or a string, the data type used is base64Binary in the wsdl message declaration to insure its integrity during processing.

Informative Note: The use of a Serial Number (whether provided as a PMSN or as a Sticker Code) can affect the offers available for that disc. The MCS tracks the use of the Serial Numbers as offers are redeemed. Offers presented after the initial use of the Serial Number could, for example, be priced differently, etc.

Server-side Binding

In a transaction using Server-side Binding, the MCM counts on the Managed Copy Server to bind the content to the destination.

Session ID

A unique (string) value created by the Managed Copy Server (MCS) when offers are requested by the Managed Copy Machine (MCM). This value is cached by the MCS and is used to maintain idempotency through the rest of the transaction. Note that there is also a sessionID argument associated with the PerformReadDrive API. It is also set by the MCS, but it is only used during that API. It is distinct from the Session ID value described here. It is recommended that the value used for a Session ID be the string representation of a Universally Unique Identifier (UUID)¹.

Sticker Code

Any non-PMSN-based Serial Number that is entered by the end user. A typical example is a sticker associated with the packaging of the media.

¹ A Universally Unique Identifier (UUID) is a 128-bit identifier described in Internet Engineering Task Force RFC 4122: [A Universally Unique Identifier \(UUID\) URN Namespace](#).

Figure 5-1 presents an overview of the Managed Copy process and the remainder of this chapter describes this process in detail.

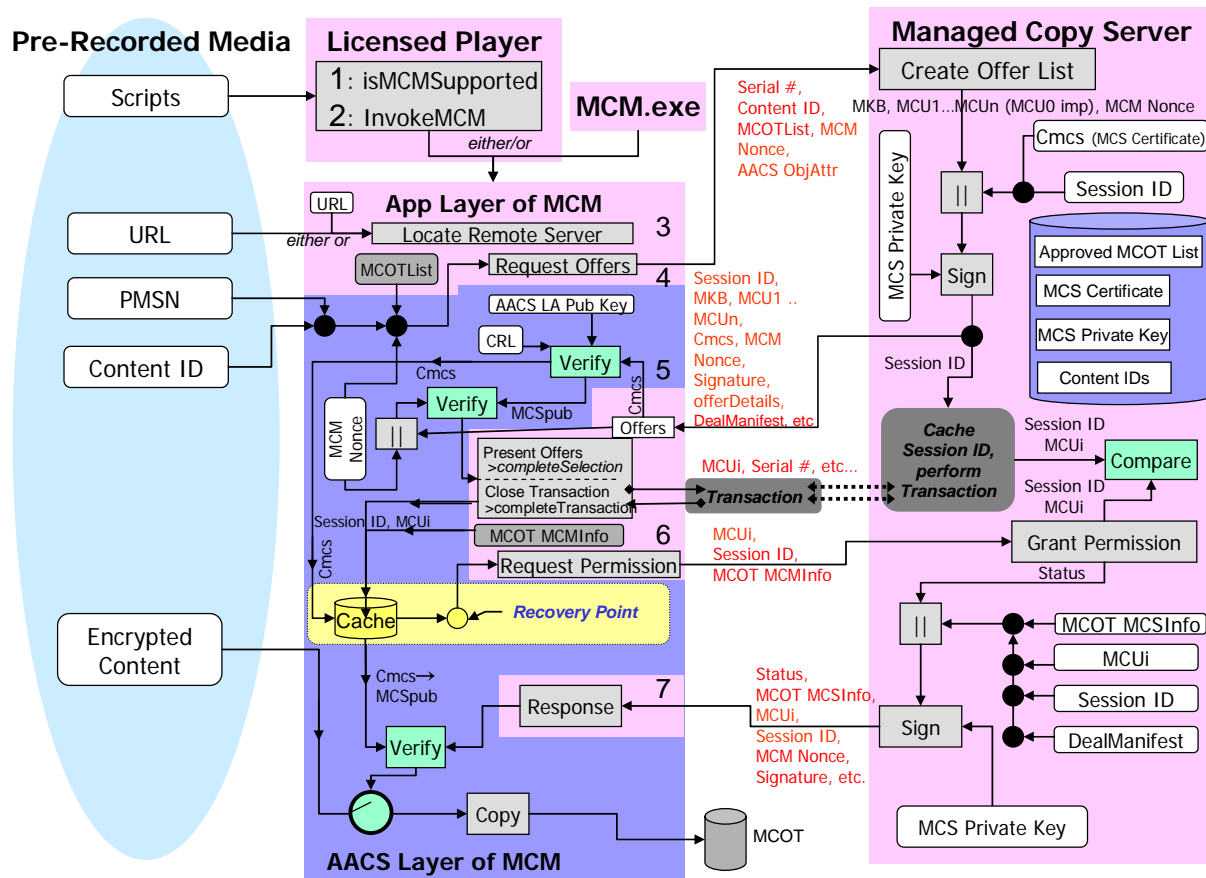


Figure 5-1 – Managed Copy Overview

When making a Managed Copy, the MCM shall first connect to a MCS to obtain authorization. The URL contained on the media identifies the MCS to be used for obtaining this authorization. In the event that no Managed Copy URL is contained on the media, the MCM uses the Default URL to locate the MCS to be used. The MCM shall provide to the MCS both the Content ID and the Content Certificate ID contained on the media. The Content Owner shall direct the MCS on which of the two IDs to use for the Managed Copy operation. The Format specific books of this specification define where these items are contained on the media.

The MCM can either be activated directly as a stand-alone application or it can be invoked via the menuing system contained within the scripts on the media to be copied. Assuming the MCM is activated via the menuing system, the MCM will follow the steps outlined below. If it is being activated as a stand-alone application, then the MCM will begin at step 3.

The details appearing in both the figure above as well as the descriptive steps below illustrate the Managed Copy protocol; some of the steps do not apply in the case where Server-side Binding is used. For simplicity, the optional “Perform Read Drive” message (Section 5.5.1) and the optional “Check Serial Number” message (Section 5.5.6) are omitted in this figure.

1. The menuing system calls the API “IsMCMSupported” to determine if the Licensed Player contains the ability to make a Managed Copy. If the response is false, then the process is terminated.
2. The menuing system calls the API “InvokeMCM” which will transfer control to the MCM.

3. The MCM uses the URL contained on the media to identify which MCS will be used to obtain authorization to make the Managed Copy. Note: A Secretless-Client would execute the PerformReadDrive message at this point (not shown).
4. The MCM formulates a “Request Offer” message as described in Section 5.5.3 below, to be sent to the MCS as a means to request what Managed Copy offers are available. This message includes a nonce to prevent replay attacks or modification of session information in the offers response.
5. The MCS formulates the list of Managed Copy offers that are available and sends them to the MCM using the AACS defined Web service. This session information and the nonce received from the MCM in step 4 are signed by the MCS.
6. After verifying the status of the MCS and the integrity of the message, the MCM may filter the results returned based upon offers that it can support:
 - a. It then presents the Managed Copy offers to the user, using either
 - i. a Content Owner provided Format Specific Application,
 - ii. an (XSLT generated) HTML page, or
 - iii. at a minimum, its own custom display of the XML data returned.Note: Use of the Check Serial Number message (not shown) would occur here if the offer selected requires use of a Sticker Code.
 - b. After an Offer is selected (or cancelled), the *completeSelection* API may optionally be invoked at this point if the presentation of offers is to be invoked separately from the financial transaction. This returns control to the MCM.
 - c. The MCM can then launch either the
 - i. *financialApplicationURI* or
 - ii. *financialHTMLURL*,as available, to complete the financial transaction.
 - d. The subsequent interactions between the financial transaction (application or HTML) and the MCS to exchange such items as the specific offer chosen, the sessionID, account information and the performance of any financial transactions, are outside the scope of the AACS Specification. The MCS shall expose a protocol for the financial transaction to provide this information to the MCS, but this protocol is outside the scope of the AACS Specification.
 - e. If the offer presentation and financial transaction steps are combined, then another alternative for performing the financial transaction step is to do so inline, without returning control to the MCM. In the ladder diagram below, the columns labeled “UI Appl” and “Financial Appl” which are shown as separate, would then be combined into one application.
 - f. In either event, after the financial transaction is completed, the *completeTransaction* API is called and control is returned to the MCM.

Note: Verification of the MCS message by the MCM is not required when using Server-side Binding. See Section 5.3 below.

7. Once the user has selected an offer and completed any required transactions with the MCS, the MCM sends the “Request Permission” message as described in Section 5.5.8 below.

Note that since the AACS Managed Copy Protocol is idempotent, caching of the Session ID, the MCUi on the MCS, and the MCS Certificate cached on the MCM provides the MCM with a recovery mechanism (Recovery Point in Figure 5.1).
8. The MCS verifies the correctness of the values contained in the Request Permission message by comparing them to the values contained in previous transactions and if they are correct and all conditions have been met, then the MCS formulates a cryptographically secure response to the MCM that will indicate authorization to make the Managed Copy as described in Section 5.5.9 below.
9. An MCM using Client-side Binding will verify the integrity of the response message.
10. If all the conditions described in Section 5.5.9.1 below are met, then the MCM will initiate the Managed Copy.

For sake of clarification, the following ladder diagram in Figure 5-2 is provided as an example to show the flow of control for when Format Specific Applications are used to present offers and perform the financial transaction. The numbers correlate to the steps above.

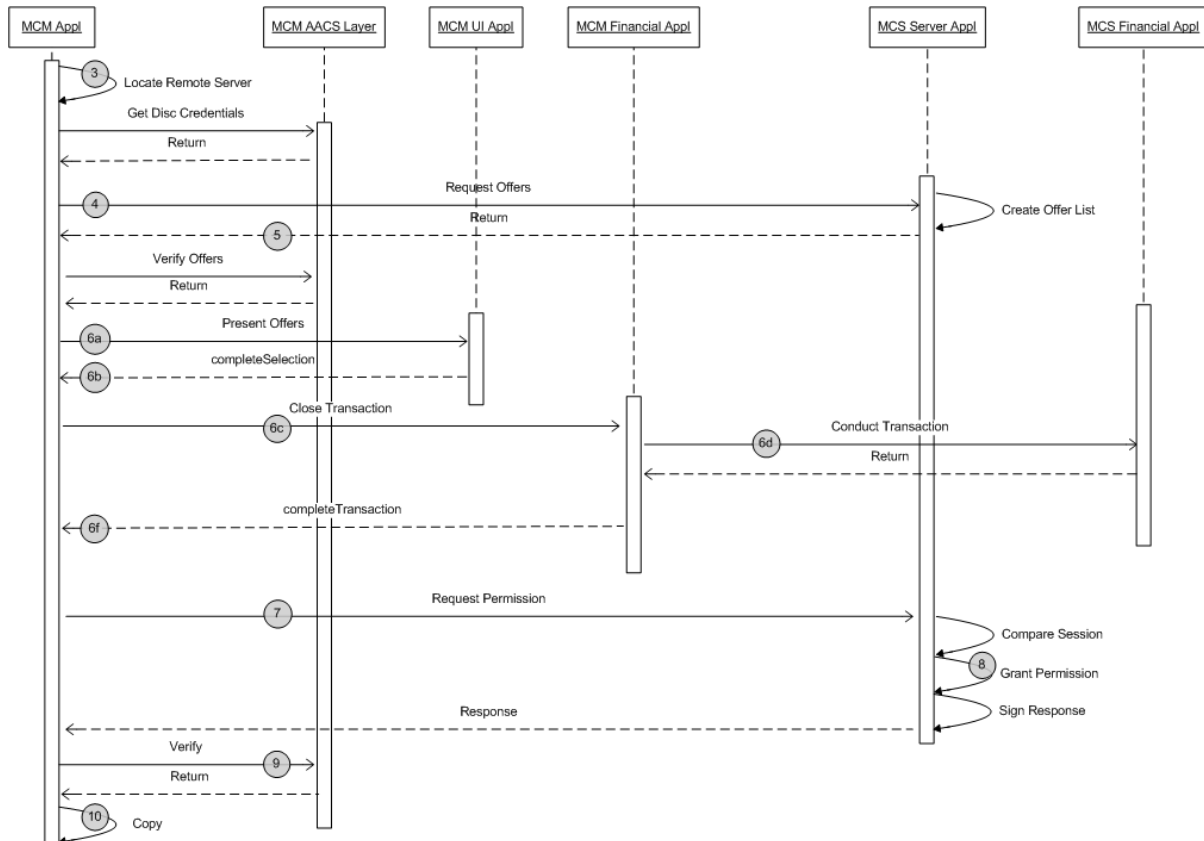


Figure 5-2 – Example of Managed Copy Message Flow

The following table lists pertinent data values and when in the timeline they are set for this example. It is important to note that once the “Session ID” is set by the server, it becomes a key element to tie the complete process together. Additionally, the MCMUI is set at time of offer selection and along with the Session ID, become the primary data elements used to maintain consistency through the entire process. The “SET” values in the table should be interpreted to mean that once a data element is set, it remains set.

Table 5-1 –Managed Copy - Setting Data Elements

	4	5	6a	6b	6c	6d	6f	7
Session ID		SET						
Coupon							SET ²	
MCOT				SET				
MCOTList	SET ¹	SET ¹						

MCUi				<i>SET</i>			<i>(SET³)</i>	
------	--	--	--	------------	--	--	--------------------------	--

SET¹: MCOTList is optional – see Section 5.5.3

SET²: Only set when the financial transaction is successfully completed.

SET³: In this example, completeSelection is used, and that is when the MCUi is set. If it had not been used, then it would be set during completeTransaction.

Sections 5.1 to 5.7 provide additional details on the process of making a Managed Copy and are normative unless otherwise specified.

Section 5.8 describes an implementation example and is informative unless otherwise specified. This section is included to provide sufficient background and description to enable implementation of a Managed Copy infrastructure but is not meant to dictate a particular implementation.

5.1 Managed Copy Machine Initiation

AACS does not specify whether or not the MCM is integrated with the AACS Licensed Player and does not require that all Licensed Players support making a Managed Copy. AACS does define two normative API's to facilitate the initiation of a Managed Copy as a part of the menuing system of the disc.

IsMCMSupported A Boolean function which returns true if the player can invoke a Managed Copy Machine, otherwise it shall return false. If the player is designed to support a Managed Copy Machine, but none is available, it shall return false.

InvokeMCM A function which invokes a Managed Copy Machine, if one is supported by the player.

The precise syntax of these APIs is format specific and will be defined in the format specific books of this specification. The general functions are as listed here. All AACS Licensed Players shall support the equivalent of the IsMCMSupported call. Support for the InvokeMCM call is only required for Licensed Players that also contain an MCM. The menuing system is format specific and is defined in the format specific books of the specification. The scripts that implement the menuing system shall not call the InvokeMCM function if the IsMCMSupported call returns false.

The MCM may also be activated as a stand-alone application and is not required to be integrated with the menuing system on the media.

5.2 Connection Protocol

All of the normative communication between the MCM and the MCS are performed using the AACS defined Web services interface as presented (see Appendix C).

Figure 5-1 shows the interface between the AACS Layer and the not necessarily secure Internet Application Layer in the MCM. Applications not using Server-side Binding shall conform to that interface.

5.3 Managed Copy Account Transactions

A Managed Copy may involve a financial and/or account setup transaction. The protocol used to exchange any such information is outside of the scope of this specification. However, two hooks are provided within the Managed Copy Web services to enable the Content Owner to insert methods for collecting this information from the consumer.

These methods are roughly equivalent, since they both involve execution of a program defined by the MCS on the MCM, within a standard execution environment (i.e, HDEX, BD-J or browser), and communicating transaction results to the MCM through an AACS defined API.

If the MCM is using a standard execution environment (as described above) to render the offers, that environment would naturally continue to perform the financial transaction. See section 5.5.5.2. However, the MCM may render the offers itself. In this case, the MCM refers to one of two elements in the Managed Copy Offer XML Schema (see Appendix A) to perform the financial transaction. They are:

- `<financialApplication>` which provides one or more URIs where a Format Specific (financial) Application associated with each offer can be downloaded.
- `<financialHTMLURL>` which is a link to a financial transaction web page.

Each offer shall contain both a `financialHTMLURL` element and a `financialApplication` element for the MCM. Offers shall provide a valid (non-empty string) value for at least the `financialHTMLURL`. Note, that the Session ID and `MCUi` shall be cached in the MCM after the financial transaction has been completed (*completeTransaction*) to facilitate a recovery point between the close of the financial transaction and prior to granting permission.

In both cases the Session ID in the Managed Copy Offer XML Schema (see Appendix A) shall be used by the MCS and financial application to correctly associate each financial and/or account transaction with the correct AACS-specified Managed Copy message. In the case of Server-side Binding, the financial transaction may also convey the destination (binding) information.

As described in the text accompanying Figure 5-1, the financial transaction provides an opportunity to collect additional information needed to complete the transaction.

5.3.1 Encapsulated Web Service Clients

A set of URIs are included in the Managed Copy Offer XML Schema (see Appendix A) which may be used by the MCM. A given URI encapsulates the required account or financial transactions for the specified offer. A “`financialApplicationURI`” shall point to a client application. This client application would know how to engage the MCS-specific Web service for these transactions. Content Owners can include multiple `financialApplication` elements with their `financialApplicationURI` values, associating each with a particular type of MCM. A `financialApplicationType` field is associated with each URI to allow the MCM to differentiate among financial applications. As documented in the schema, each `financialApplication` element contains URI and type pairs as follows:

- `financialApplicationType` – which is a value from a list of types which the MCM can use to identify the appropriate application. Predefined values for this field are “BD-J” and “HDEX”. Other values can be added by Content Owners working with MCM providers.
- `financialApplicationURI` – which identifies the URI of a financial application for the offer

The MCM retrieves the file referenced by the URI and executes the enclosed application. At a minimum, the following data values from the AACS Object must be provided:

- Session ID (already included in *offers*)
- MCUi (if already populated via prior callback *completeSelection*)

Once this application has finished, the last action it takes is to execute the required *completeTransaction* method as described in Section 5.3.3 below. This provides the MCM with the information needed to complete the Managed Copy operation.

This method enables the MCM to be implemented without specific knowledge of the Web service framework required for the MCS encountered.

The *financialApplicationURI* normally references an application hosted by the MCS, but it could also indicate a 3rd party application which provides its own means of interaction with the MCM to verify completion of the financial transaction. In the case of 3rd party applications, the MCS shall use technical and/or contractual means to confirm the completion of the financial transaction before granting permission in its response to the Request Permission message for the offer.

5.3.2 Links to a Transaction Web Page

In addition to the *financialApplicationURI* values described in Section 5.3.1, the Managed Copy Offer XML schema associates with each offer a *financialHTMLURL*. Regardless of how the offers are rendered for the user, the MCM can choose to consummate financial and/or account transactions using the page pointed to by this link.

The MCM launches a component browser passing to it the *financialHTMLURL*. When the transaction is complete, the last action the HTML shall instruct the browser to do is to execute the *completeTransaction* method as described in Section 5.3.3 below. This allows the MCM to continue with the Managed Copy operation.

The *financialHTMLURL* normally references a web page hosted by the MCS, but it could also indicate a 3rd party web site which provides its own means of interaction with the MCM to verify completion of the financial transaction. In the case of 3rd party applications, the MCS shall use technical and/or contractual means to confirm the completion of the financial transaction before granting permission in its response to the Request Permission message for the offer.

5.3.3 Use of AACS Object for Financial Transaction

The financial and/or account transactions required to acquire a Managed Copy approval are not normative to AACS. For this reason, they are executed within either a client application or a browser.

In order for these hosted components described in 5.3.1 and 5.3.2 to provide the MCM with the status of their actions, the MCM shall expose to the selected component the *completeTransaction* method. This method can be implemented in a variety of ways:

- If the encapsulated Web service client is used, then the method shall be implemented as part of a client application method appropriate to the format (e.g. HDEX or BD-J);
- If links to a transaction web page are used, then a method of an embedded HTML Object (e.g., a Java applet, a plug in, or an ActiveX control) shall be used.

The *completeTransaction* method is an exit function used to return control back to the MCM after completion of the financial transaction. Data returned through this API will be used in the subsequent Request Permission step. The MCM shall provide support for the *completeSelection* API, although it may or may not be used when an offer is selected (i.e., the offer presentation application or HTML could also perform the financial transaction then call *completeTransaction*).

In order for the interactive layer scripts to have access to the XML *offers* property, the MCM shall load the contents of the received XML offers into a Managed Copy *offers* property in the AACS Object. Note that the MCM may further filter the offers returned by the MCS according to its capabilities, prior to their presentation.

A Managed Copy Machine shall include a *completeTransaction* method and these properties in the AACS Object:

Properties: String *Offers*, *MCUi*, *majorMcotID*, *minorMcotID*, *mcotOfferInfo*

Where:

Offers	Contains the XML object “Offers” returned from the Managed Copy Server using the RequestOffer message (see 5.5.1 and Appendix C).
MCUi	Managed Copy Unit. A string containing the ID of the particular offer that was selected as a part of the transaction. Note that this property is only set (into the AACS Object) when the <i>completeSelection</i> method is used.
majorMcotID	A string identifier of the major ID of Managed Copy Output Technology selected for the Managed Copy, as defined in the AACS License. Note that this property is only set (into the AACS Object) when the <i>completeSelection</i> method is used.
minorMcotID	A string identifier of the minor ID of the Managed Copy Output Technology selected for the Managed Copy, as defined in the AACS License. If there is no minor code, this will be an empty string. Note that this property is only set (into the AACS Object) when the <i>completeSelection</i> method is used.
mcotOfferInfo	A base64Binary encoded string which provides MCOT specific information. If there is no value, this will be an empty string. Note that this property is only set (into the AACS Object) when the <i>completeSelection</i> method is used.

Functional Property: void *completeTransaction*

Syntax:

```
void completeTransaction( Coupon, majorMcotID, minorMcotID,
mcotOfferInfo, MCUi, Status, MCOTParams );
```

Where:

Coupon	A string uniquely identifying the financial or account transaction. If no financial or account transaction has been completed, Coupon shall be an empty string.
majorMcotID	A string identifier of the major ID of Managed Copy Output Technology selected for the Managed Copy, as defined in the AACS License.
minorMcotID	A string identifier of the minor ID of the Managed Copy Output Technology selected for the Managed Copy, as defined in the AACS License. If there is no minor code, this will be an empty string.
mcotOfferInfo	A base64Binary encoded string which provides MCOT specific information. If there is no value, this will be an empty string.
MCUi	Managed Copy Unit. A string containing the ID of the particular offer that was selected as a part of the transaction. If no offer was selected, the MCUi shall be an empty string.
Status	A string containing further information on the transaction. Informative: For example, if the transaction failed, Status may contain information about why that transaction failed. At minimum, it must contain an empty string.
MCOTParams	A string value with additional information specific to the Managed Copy Output Technology to be used in customization of MCM_MCOTInfo to be sent in the Request Permission message. This string is optional in the case of Client-side Binding. In the case of Server-side Binding, it contains the necessary binding information (the ID of the destination). If not provided, this shall be an empty string.

5.3.4 Accessing the AACS Object

The AACS Object can be referenced directly by Format Specific Applications. When offers are rendered using a Format Specific Application, that application requires offers data returned by the MCS. This data is held in

the *offers* property of the AACCS Object. Format Specific Applications performing the financial transaction step of the Managed Copy operation also require the *completeTransaction* method from the AACCS Object. See individual Adaptation books for details.

The AACCS Object is also the mechanism by which several other properties are communicated between the MCM and the financial application (or HTML). Specifically, when offer selection is performed prior to invocation of the financial transaction (application or HTML), then items such as the MCUI and other MCOT specific data, will already be known by the MCM, and be available in the AACCS Object for use by the financial transaction (application or HTML).

When the financial transaction of a Managed Copy operation is performed using HTML, the MCM will need to provide access to the *completeTransaction* method of the AACCS Object within the HTML context. This is accomplished through an embedded HTML Object.² The data needed to embed the HTML Object was passed to the MCS by the MCM in the AACCSObjectAttributes during the Request Offers message (see Section 5.5.3). The MCS then added the AACCSObjectAttributes to each financialHTMLURL element value as a query parameter before returning them in the Request Offers response.

When an HTML Object is used to initiate the completeTransaction API, a value of “application/x-aacs-completetransaction” shall be set in the type attribute of the object. Similarly, when the HTML Object is used to initiate the completeSelection API, a value of “application/x-aacs-completeselection” shall be set in the type attribute of the object.

The following informative example describes this interaction:

If the AACCSObjectAttributes value included in the Request Offers request contains:

```
<OBJECT
classID="clsid:12345678-1234-1234-123456789ABC" type=application/x-aacs-
completetransaction width="0" height="0" >
```

then the URL encoded financialHTMLURL value returned in the Request Offers response might be:

```
https://TakeMyMoney.com?miscParam1=foo&miscParam2=bar&AACCSObjectAttributes=cla
ssID%3D%22clsid%3A12345678-1234-1234-123456789ABC%22+
type%3Dapplication%2Fx%2Daacs%2Dcompletetransaction+width%3D%220%22+height%
3D%220%22
```

and the resulting financial transaction web page would instantiate an HTML OBJECT of the form:

```
<OBJECT
id="AACCS"
classID="clsid:12345678-1234-1234-123456789ABC"
type="application/x-aacs-completetransaction" width="0" height="0">
</OBJECT>
```

Note: the id of the resulting AACCS Object can be any desired string, and can be generated by the financial transaction entity.

Upon completion of the financial transaction, the browser would invoke the *completeTransaction* method of the AACCS object:

```
AACCS.completeTransaction (“myPurchase107”, “CPRM”, “”, “7”, “Successful”, “”)
```

² The W3C has standardized the mechanism for creating objects in HTML via the OBJECT element (for details, see “Objects, Images and Applets in HTML Documents, Generic inclusion: the OBJECT element”, <http://www.w3.org/TR/html4/struct/objects.html#edef-OBJECT>).

5.4 MCS Certificate

The Managed Copy Server shall have an MCS Certificate (MCS_{cert}) which is used by MCMs to validate responses signed with the corresponding private key of the MCS. Table 5-2 shows the format of the MCS Certificate.

Table 5-2 –Managed Copy Server Certificate

Byte	Bit	7	6	5	4	3	2	1	0
0	Certificate Type: 03 ₁₆								
1	Reserved								
2	Length: 005C ₁₆								
3									
4	MCS ID								
...									
9									
10	Reserved								
...									
11									
12	MCS Public Key								
:									
51									
:									
52	Signature Data								
:									
91									

Each MCS Certificate includes:

- A 1-byte Certificate Type value, where 03₁₆ shall be used to indicate a first-generation AACCS MCS Certificate
- A 2-byte Length field which indicates in bytes, the length of the MCS Certificate including the signature data.
- A 6-byte MCS ID field which will be a unique identifier for each Managed Copy Server and will be assigned by AACCS LA.
- A 40 byte Managed Copy Server Public Key.
- A 40 byte Signature Data, calculated using the Entity Private Key, over the entire data up to and including MCS Public Key.

For future compatibility, when verifying the signature of the MCS Certificate, the Length field shall be used to locate the Signature Data field, rather than a fixed offset.

5.5 Managed Copy Messages

An important component for both the request and response messages associated with the communication of the available offers for Managed Copy operations is the Managed Copy Output Technology identifier (MCOT ID). The MCOT ID is actually represented in a structured data element called mcotInfo, which includes a major ID

(MCOT) and zero or more minor IDs (mcotMinorCode) values. Additional informative discussion on this topic relevant to MCOT providers can be found in Section 5.8.4.

5.5.1 Perform Read Drive

The purpose of this message is to allow the MCS to remotely read the PMSN on the media, in order to determine that it is authentic, and to verify the presence of AACS media in the Licensed Drive. When a Secretless Client MCM is seeking to make a Managed Copy, the “performReadDrive” API shall be the first message sent to the MCS. Other MCMs are not required to use this API.

This message begins a remote drive authentication process with the drive in the MCM. (When an MCM is not otherwise associated with a drive which contains a Drive Certificate to meet other obligations in the specifications, it shall simulate this authentication by having its own Drive Certificate; see Section 5.7). The authentication protocol (defined in Chapter 4 of the *Introduction and Common Cryptographic Elements* book) requires several steps, which are accomplished by the MCM sending successive “performReadDrive” messages to the MCS. As long as the returned status to a “performReadDrive” message is “CONTINUE”, then the protocol is not finished, and the MCM needs to send a further “performReadDrive” message as described below, or abort the protocol by simply not sending any further “performReadDrive” messages. The example figure below illustrates the process.

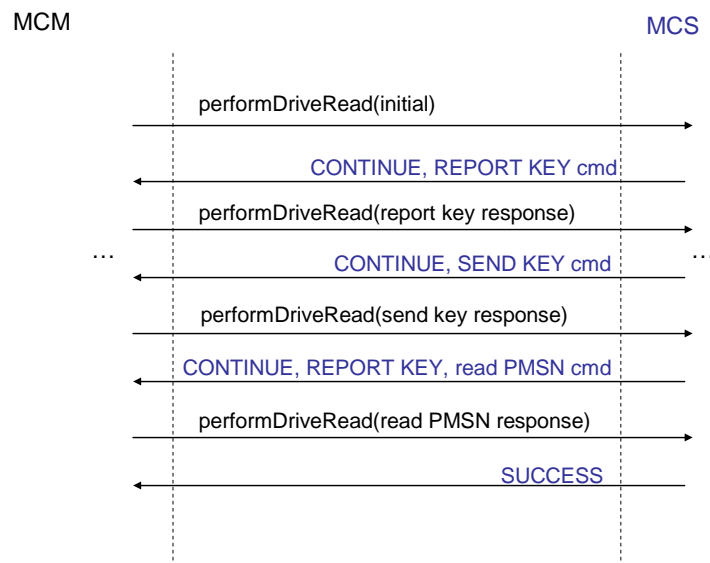


Figure 5-3 –Example Use of performReadDrive Messages

In effect, the MCM acts as a proxy which allows the MCS to direct its interaction with the drive. Each successive response from the MCS provides status information on the process as well as information needed to execute a Mt. Fuji command with the drive. After receiving the message response from the MCS, the client proxy uses the information returned to perform a Mt. Fuji command against the drive. The response from the drive is then used as an argument for the next invocation of the “performReadDrive” message with the MCS, and so on. The process continues until the MCS indicates the process is completed or has failed. The client proxy checks for these conditions after each response from the MCS.

The “performReadDrive” message is a Web service message. The schema and associated WSDL definitions which define this Web service are available in Appendix D and Appendix E of this document, respectively. The request message contains the following information:

sessionId	A text string received from the server in the previous response. In the special case where this is the start of the drive authentication process being requested by the client proxy, this argument shall contain the empty string (“”). If the server receives an invalid sessionId, it shall return “FAILURE” in the message response.
driveData	<p>This contains a generic binary argument which is primarily used to carry the response data returned from execution of a Mt. Fuji command with the drive. As such, the XML schema validation steps performed by the MCS on this Web service request do not accomplish any automatic checking on content validity. The MCS shall be able to parse this argument and perform validation of its content based upon the context of which step of the drive authentication process it is acting upon.</p> <p>The actual drive command that corresponds to the driveData is generated by the proxy based on the response of the <i>previous</i> performReadDrive message, described below.</p> <p>In the special case where this is the start of the drive authentication process being requested by the client proxy, this argument will contain a binary value of 10101010₂ which signals the MCS that the process is being initiated.</p>
driveMessage	This field indicates success with a value of 00 ₁₆ or failure via an error code from the drive, returned from execution of the Mt. Fuji command, or zero length field if the process is being initiated.

5.5.2 Perform Read Drive Response

The response by the MCS from the drive verification request is an XML object containing arguments needed by the invoking client proxy to execute a Mt. Fuji command and continue the drive verification process. The response message contains the following items:

Status	<p>This is a flag indicating the current status of this remote drive authentication process. It has legal values of: “CONTINUE”, “FAILURE” and “SUCCESS”.</p> <ul style="list-style-type: none"> • If the value is “CONTINUE”, the proxy will use the “driveCommand” to execute a Mt. Fuji command with the drive • If the value is “SUCCESS” then the drive verification process has completed successfully, and the MCM shall perform the next message in the Managed Copy process (the requestOffers message defined in Section 5.5.3). • If the value is “FAILURE”, the MCM shall also perform the next message, but assume that the original disc does not have a PMSN. Alternatively, if the MCM has a reason to believe the original disc actually <i>has</i> a PMSN, it shall abort the protocol or restart it from the beginning. Note that an optional text string describing the reason for the failure may be available in the “serverMessage” response argument as below.
sessionId	This is a text string generated by the MCS so that it can distinguish multiple concurrent drive authentication sequences. The client shall pass it unmodified and unchecked as an argument to the subsequent performReadDrive messages. sessionId is only valid if the Status is CONTINUE; if the Status is FAILURE or SUCCESS, the MCS shall set sessionId to be the empty string (“”).

driveCommand	<p>Binary data containing a valid Mt. Fuji command and associated arguments which the MCS is requesting the client proxy to execute against the drive. It is not checked by the schema validation processor. This response argument will be empty when the status indicates the process has completed in either “SUCCESS” or “FAILURE”.</p> <p>In general, the client proxy is not required to check the data for validity; however, if the response is a response to the “Read PMSN” subcommand, it may be useful for the client to remember the PMSN value for future messages.</p>
serverMessage	<p>This is an optional text string message which shall be used to provide additional information related to the failure of the drive authentication process to complete properly.</p>

For a detailed definition of this Web service’s request and response syntax, please refer to Appendix E.

5.5.3 Request Offer

The Request Offer message is the second message in the Managed Copy protocol. It is a Web service message as given in Appendix C, which uses the offer schema described in Appendix A. It contains the following information:

cid	<p>Content ID. This shall be provided to the MCS since it is needed to identify the content, and therefore the offers which are available. If the Content ID is not available on the disc, this field shall be zero. Note that for discs which do not have a Content ID, the Managed Copy process can still be performed because the ccid (next field) will be available in such cases.</p>
ccid	<p>Content Certificate ID. This shall be provided to the MCS to uniquely identify the content. For multi-layer discs, this shall be the CC ID for Layer 0. Note that if the ccid sent to the MCS has been revoked by AACS, then the offers returned by the MCS shall either be marked with the “withheld” tag, or the MCS can prevent the offers from being returned to the MCM. Either is sufficient.</p>
mcmNonce	<p>Managed Copy Machine generated 16-byte nonce (or 0 if the MCM is using Server-side Binding). This will be used in processing the Offer Response message to prevent replay attacks when the MCM is using Client-side Binding. Such an MCM shall retain a cached copy of the mcmNonce for comparison with the nonce value received back from the MCS in the Offer Response message.</p>
serialNumber	<p>The Serial Number may be sent to the MCS to identify the specific instance of media for which the copy is being requested. The MCS shall use the Serial Number to determine what offers remain available for this media.</p> <p>The Serial Number may be part of the physical media (i.e., a PMSN) or it may be provided separately from the physical media (i.e., a sticker in the packaging).</p> <ul style="list-style-type: none"> • If the Serial Number is provided separately from the physical media, it is not required to be passed to the MCS as part of the Request Offer Message. • If the Serial Number is included as part of the source media, then it shall be sent to the MCS as part of the Request Offer message. <p>This is the PMSN value acquired by the MCM from reading the media, or in the case of a Secret-less Client it is the value returned from the drive during the performReadDrive protocol.</p>

Managed Copy Servers shall not accept PMSNs that are invalid.

Note: Since the Serial Number type can be either a binary number or a string, the data type used is base64Binary in the wsdl message declaration to insure its integrity during processing.

Note: For Secret-less Clients, this value is the only connection in the Managed Copy Server between the performReadDrive protocol and the rest of the Managed Copy protocol.

LanguageCode	This optional argument is one or more ISO 639-2 compliant (alpha-3) Language Code values which allows the MCM to communicate its locale specific language preference(s) information to the MCS. When provided, the MCS shall only return offers which correspond to the language(s) requested. If this argument is omitted, this means offers in all available languages are being requested.
AACSOBJECTAttributes	This optional argument contains a string which the MCS URL encodes and adds to the financialHTMLURL as a query string. It provides data necessary to instantiate an HTML Object in the browser, which in turn allows access to the AACSOBJECT (See Section 5.3.4).
MCOTList	<p>This is an optional array of Managed Copy Output Technology IDs (MCOT IDs) that the MCM uses to identify to the MCS the set of MCOTs for which it would like to receive applicable offers. If the request only identifies an MCOT major ID value, the MCS will return all the offers which are valid for that MCOT major ID, regardless of its knowledge of any minor codes.</p> <p>When the MCOT minor ID codes are also provided, the MCS will filter the offers returned based upon its knowledge of the available MCOT ID minor codes to just those which are valid for the requested major and minor MCOT ID code pair(s) requested.</p> <p>When no MCOT ID is supplied by the MCM, the MCS will treat the request as a “wild card,” and shall return all available valid offers without any filtering. For example, an MCOT with a major ID of “XYZ” and minor codes of “A”, “B” and “C”, for which the MCOTList only identified the major code of “XYZ”, would return offers applicable to any of these minor codes.</p> <p>Each of the formulated offers (or MCUi’s) that are returned will specify which MCOT(s) can be used as the output technology for that offer. The MCM will likely want to filter out unusable offers prior to display to users, but such behavior is not required.</p>

5.5.4 Offer Response Creation

The response from the offer request is an XML object containing the offers available for this particular disc. The contents of that XML object are described in Appendix A. Items of particular interest are described in the following sections.

5.5.4.1 Creation of Cryptographic Signature of Managed Copy Offer Response

The MCS Certificate is sent to the MCM and after it has been validated by the MCM, the MCM shall use the public key contained within the MCS Certificate to verify the signature of the Request Offer response (see Section 5.5.4.3). It is also used to verify the Request Permission response (see Section 5.5.9.1). In a transaction using Server-side Binding, an MCM is allowed to ignore the MCS Certificate and the signatures.

The Managed Copy Server (MCS) shall apply a cryptographic signature to the offers, Session ID and mcmNonce. In the case of Client-side Binding, the MCM’s AACSOBJECT Layer’s verification of this signature is used to prevent replay attacks or attempts to modify the offers, Session ID or MCUi on the wire. This signature shall be computed in the following manner:

AACSOBJECT_Sign(MCS_{pub}, offersSignedContent)

With AACS_Sign as defined in *Introduction and Common Cryptographic Elements* book and where MCS_{pri} is a Elliptic Curve Digital Signature Algorithm (ECDSA) Private Key that has been provided by AACS LA to the MCS and where the data being signed consists only of the bytestream of the canonical serialization of the Managed Copy Offer XML Schema element **offersSignedContent** (see Appendix A).

In order to produce the contents of the **offersSignedContent** element as a byte array for the AACS_Sign method, the canonical form of **offersSignedContent** will be produced as UTF-8 bytes according to the Exclusive XML Canonicalization specification (<http://www.w3.org/TR/xml-exc-c14n/#sec-Specification>)³.

5.5.4.2 Offer Details

Individual offer objects may include a set of offer details which, when present provide programmatically accessible information about that Managed Copy offer. These details provide information which the MCM may use to determine whether it is capable of fulfilling the offer and to present the offers in a more intelligent way, such as filtering out offers which could not be satisfied by the MCM. It also functions to express the performance and quality levels applicable to the copy which can be made for a given offer which the MCM should observe when executing that particular Managed Copy offer. Rules pertaining to how an MCM is to use this offer detail information are provided in the AACS Compliance Rules. The information provided by offerDetails is organized into sections on video, audio and miscellaneous information as follows:

Video Codec Specific Information:

videoParametersName	This is an optional name tag which can be useful in describing the overall video attributes of the offer (e.g., “High Quality Video”).
minimumHorizontalResolution and maximumHorizontalResolution	These optional values characterize the range of horizontal resolution values (in pixels) intended for the offer. The aspect ratio is assumed to be maintained, so only the horizontal resolution can be specified.
minimumFrameRate	This optional value identifies the minimum frame rate (in frames/sec) for the offer.
videoBitrateInfo	This is an optional set of information which can include a list of video codec names (valid values for these names may be found at http://www.aacsla.com/managedcopy/AACS_Video_Codecs.pdf), as well as an optional minimum video bit rate (in Mbits/sec) applicable to the offer. Multiple codecs might share the same bitrate constraint so any number of them can be associated with a given minimum bit rate. Not specifying any codec name is interpreted as a wild card, implying all valid video codec names. An offer can have at most one minimum video bit rate which is not associated with a specifically identified codec, and that minimum bit rate then applies to all codecs which do not have specifically identified bit rates.
videoCodecName	This is a list of zero or more video codec names.
minimumBitRate	This is the minimum bit rate intended for using the offer with which it is associated.

Audio Codec Specific Information:

audioParametersName	This is an optional name tag which can be useful in describing the overall audio attributes of the offer (e.g., “High Quality Audio”).
---------------------	--

³ Informative Note: The Exclusive XML Canonicalization specification allows canonicalization of the subdocument in a way that is substantially independent of its XML context. This procedure does not strip tags from the resultant canonicalized result, except where it has been removed from an enveloped context. See the specification for more information.

audioCodecName	This is an optional list of audio codec names (valid values for these names may be found at http://www.aacsla.com/managedcopy/AACS_Audio_Codecs.pdf). Not specifying any codec name is interpreted as a wild card, implying all valid audio codec names.
minimumBitRate	This is an optional lower bound on the minimum bit rate (in kbits/sec) under which the referenced offer is intended to apply.
maximumBitRate	This is an optional upper bound on the maximum bit rate (in kbits/sec) over which the referenced offer is intended to apply.
minimumChannels	This is an optional count of the minimum number of audio channels applicable to the referenced offer.

Miscellaneous Information:

mcotInfo	<p>This is a list of one or more sets of parameters, where each set includes an MCOT ID and optionally an mcotOfferInfo parameter whose binary content is beyond the scope of this specification.</p> <p>When the MCOT ID in the offer includes only the major code component, the offer applies to all minor ID codes.</p> <p>If one or more MCOT minor ID codes is returned, then the offer applies only to those MCOT major and minor ID code combinations.</p> <p>For example, for an MCOT ID which has a major code of “XYZ” and three possible minor codes of “A”, “B” and “C”, the MCS might return “XYZ” as the MCOT ID major code together with “B” and “C” as minor codes. This means that this particular offer only applies to “XYZ” with either the “B” or “C” minor codes.</p> <p>The mcotOfferInfo may contain MCOT specific information which permits the MCM to make the best decision possible in presenting and processing the offer for a particular MCOT. The valid MCOT major ID values are found in Tables C-1 and C-2 of the AACS License.</p>
sourceURI	This is an optional means of specifying a file or network location where prepared content which corresponds specifically with the offer can be found by the MCM. For example, this might correspond to a reduced resolution version of the content prepared specifically for a class of target devices.
hint	This optional list of strings which allows the offer to provide useful information to an MCM concerning the applicability of that offer for a given device. It is intended to be used by the MCM to perform more intelligent filtering of the available offers it presents to the user based upon the capabilities of the device. The format and content of the hints are beyond the scope of this specification, but an example of its use might be to identify which offer is best suited to a particular device.

If a minimum range value is omitted, it is assumed to be zero. If a maximum range value is omitted, then no upper limit is intended.

5.5.4.3 Deal Manifest

A deal manifest can optionally be returned as part of the response to the Request Offers message. The deal manifest shall contain format specific information that corresponds to specific offers, allowing the MCM to determine exactly what needs to be copied when performing the copy to the destination. This information may also be used by the MCM to estimate the space requirements required by the copy operation.

5.5.5 Offer Response Verification and Interpretation

The following sections describe topics specific to the interpretation and verification of the Managed Copy offer response returned by the MCS.

5.5.5.1 Verification of Cryptographic Signature of Managed Copy Offer Response

When an MCM using Client-side Binding receives the Offer Response message from the MCS, it shall verify the message using the process outlined below (For transactions that utilize Server-side Binding, MCMs may ignore this section):

1. Verify the integrity of the MCS Certificate using the following procedure and shall abort the Managed Copy process if the signature fails to verify.

AACS_Verify(AACS_LA_{pub}, Signature Data, MCS_{cert})

With AACS_Verify as defined in *Introduction and Common Cryptographic Elements* book.

2. Verify the MCS Certificate has not been revoked using the procedure described in Section 2.7 above. If the MCS Certificate has been revoked, the MCM shall abort the Managed Copy process.
3. Verify the integrity of the Offer Response Message using the following procedure and shall refuse to allow the Managed Copy process to continue if the signature fails to verify.

AACS_Verify(MCS_{pub}, Signature Data, **offersSignedContent**)

With AACS_Verify as defined in *Introduction and Common Cryptographic Elements* book and where MCS_{pub} is contained in the MCS_{cert} and where the data which was signed consists only of the bytestream of the canonical serialization of the Managed Copy Offer XML Schema element **offersSignedContent** (see Appendix A).

In order to produce the contents of the **offersSignedContent** element as a byte array for the AACS_Sign method, the canonical form of **offersSignedContent** will be produced as UTF-8 bytes according to the Exclusive XML Canonicalization specification (<http://www.w3.org/TR/xml-exc-c14n/#sec-Specification>)⁴.

4. Verify that the mcmNonce is the same nonce value that was transmitted to the MCS in the Request Offer message and shall abort the Managed Copy process if the nonce values are not the same.

5.5.5.2 Display of Managed Copy Offers

The Managed Copy Machine can display the *offers* in multiple ways.

1. Content Owner provided Format Specific Application (i.e., BD-J or HDEX).

This option is available if an optional list of *render* elements is returned in the *offers* data provided in the response to the getOffers message. Content Owners may identify one or more rendering applications for presenting the offers. Each element of the *render* list contains the following items:

⁴ Informative Note: The Exclusive XML Canonicalization specification allows canonicalization of the subdocument in a way that is substantially independent of its XML context. This procedure does not strip tags from the resultant canonicalized result, except where it has been removed from an enveloped context. See the specification for more information.

- `renderType` – which is a value from a list of types which the MCM can use to identify the appropriate application. Predefined values for this field are “BD-J” and “HDEX”. Other values can be added by Content Owners working with MCM providers.
- `renderURI` – which identifies where to obtain the downloadable application to execute.

The MCM examines the application(s) referenced in the list of *render* elements as part of the process of presenting offers and shall select the first one that it can support.

2. Content Owner provided XSLT for generating HTML

If the MCM is not capable of supporting any of the Format Specific Applications described in option (1) above, and it is capable of supporting XSLT, then it shall display the offers using XSLT. If the Content Owner chooses to offer XSLT as an option, then the MCS returns it in the `getOffers` response as an `xml-stylesheet Processing Instruction` (see <http://www.w3.org/TR/xml-stylesheet/>). The MCM can then use this instruction to invoke an XSL processor to generate the HTML document.

3. MCM presentation of *offers* data using its own UI

When the MCM is not capable of supporting either options (1) or (2) above, then the MCM shall display the *offers* in a manufacturer specific way using its own UI.

The MCM is deemed capable of supporting an offer presentation type based upon the following criteria:

- For Format Applications (e.g., BD-J or HDEX):
 - The MCM is designed to interact with the applicable application layer engine, or
 - The MCM is part of a Licensed Player which supports processing such applications
- For XSLT generated HTML:
 - The MCM is designed to use a browser for the presentation of *offers*, and
 - The browser can support at least XSL Transformations (XSLT) Version 1.0 W3C Recommendation 16 November 1999.
- For Presentation of XML *offers* data using MCM’s UI:
 - The MCM shall always support this option.

If the MCM renders offers using a Format Specific Application, the financial transaction may be performed in the same application, or alternatively the *completeSelection* API may be used to return control to the MCM where the MCM would launch the financial transaction.

Likewise, if the MCM renders offers with HTML, that application can either perform the financial transaction or return control to the MCM in the same manner (using *completeSelection*).

Each offer returned by the MCS optionally includes an ISO 639-2 compliant Language Code value. These values are available for use by the MCM to adjust the display of data for localization purposes. The MCM may also filter the offers returned based upon those which it can support.

Note that in addition to the offers, this XML object includes an optional updated MKB which shall be used by the MCS in the case that the Managed Copy destination is an AACS recordable disc for Prepared Video. This MKB is ignored by the MCM.

The Request Offers response message can include a *withheld* attribute which functions as a flag that may be associated with each offer. When the *withheld* flag is present and set to 1 for a given offer (which does not affect whether the offer is displayed), the MCM shall not permit that offer to be selectable for purchase. This is useful, for example, when it is desired to prevent the offer from being purchased, but still inform the consumer of its existence.

Each offer contains a Boolean flag called *serialNumberRequired*. If this flag is set to 1, then a Serial Number is required in order to purchase the offer. If offers are being presented by the MCM as described in option (3) above, then the MCM shall indicate to the user that the offer requires a Serial Number for purchase.

Note that an application that supports Managed Copy Machine functionality could be configured to allow automated selection of *offers* based on some user input criteria and MCM capabilities. If this results in only one remaining offer, then the MCM may bypass the rendering of the *offers* data. Otherwise, the MCM shall display *offers* according to the rules described in this section.

5.5.5.3 Returning Control to the MCM

In order for the Content Owner provided format-specific application or (XSLT generated) HTML page based rendering options described in section 5.5.5.2 to provide the MCM with the status of their actions, the MCM shall expose to the selected component the *completeSelection* method. This method can be implemented in a variety of ways:

- If the encapsulated Web service client (i.e., a Content Owner provided format-specific application) is used for rendering of the offers, then the *completeSelection* method shall be implemented as part of a client application method appropriate to the format (e.g. HDEX or BD-J);
- If links to an offer rendering web page are used, then a method of an embedded HTML Object shall be used. See Section 5.3.4 for an example illustrating how HTML <OBJECT> can be used to similarly provide access to the *completeSelection* API and *offers* property of the AACCS Object.

The *completeSelection* method is an optional exit function used to return control back to the MCM after completion of the offer selection. Data returned through this API will be used in the subsequent financial transaction step.

As described in Section 5.3.3, in order for the interactive layer scripts to have access to the XML offers object, the MCM shall load the contents of the received XML offers object into a Managed Copy *offers* property. The MCM may further filter the offers returned by the MCS according to its capabilities, prior to their presentation.

As with the *completeTransaction* method used for returning control from the financial transaction step described in Section 5.3.3, the Managed Copy Machine shall include the following additions to the AACCS Object – a *completeSelection* method and these properties (same as described in Section 5.3.3):

Property: String Offers, MCUi

Where:

Offers	Contains the XML object “Offers” returned from the Managed Copy Server using the RequestOffer message (see 5.5.1 and Appendix C).
MCUi	Managed Copy Unit. A string containing the ID of the particular offer that was selected as a part of the transaction. Note that the <i>completeSelection</i> method will populate this property using the value passed.

Functional Property: void *completeSelection*

Syntax:

```
void completeSelection( majorMcotID, minorMcotID, mcotOfferInfo,
MCUi, status );
```

Where:

majorMcotID	A string identifier of the major ID of Managed Copy Output Technology selected for the Managed Copy, as defined in the AACCS License.
minorMcotID	A string identifier of the minor ID of the Managed Copy Output Technology selected for the Managed Copy, as defined in the AACCS License. If there is no minor code, this will be an empty string.
mcotOfferInfo	A base64Binary encoded string which provides MCOT specific information. If there is no value, this will be an empty string.
MCUi	Managed Copy Unit. A string containing the ID of the particular offer that was selected as a part of the transaction. If no offer was selected, the MCUi shall be an empty string.
status	A string containing further information on the selection. If the selection failed or was cancelled; status may contain information indicating why. At minimum, it must contain an empty string.

5.5.6 Check Serial Number

The Check Serial Number message shall be supported by the default Managed Copy Server, and by any other MCS which supports Sticker Codes. If the user has selected an offer that requires a Serial Number and the disc does not have a PMSN, then the Check Serial Number message shall be used to establish that 1) the Serial Number is valid, and 2) it is still available to be used for the selected offer.

Check Serial Number is a Web service message as given in Appendix C, which uses the check serial number schema described in Appendix A. It contains the following information:

serialNumber	Serial Number. This string is the Sticker Code entered by the user.
MCUi	Managed Copy Unit. A string containing the ID of the particular offer that was selected.
sessionId	Contains the Session ID that was returned in the XML object in response to the Request Offers message. This sessionId is used by the MCS to correlate the Check Serial Number message to any transactions that will occur as a result of selecting a particular offer, as described in Section 5.3. It is recommended that the value of the sessionId be the string representation of a Universal Unique Identifier (UUID) ⁵ . As noted previously, this sessionId may be different than the Session ID in the Perform Read Drive message; this is a design choice of the MCS.

5.5.7 Check Serial Number Response

The MCS returns the status of the Serial Number. The Check Serial Number message is a Web service message as given in Appendix C, using the serialNumberStatus described in the Appendix A schema. It contains the following information:

serialNumberStatus	Indicates one of three values: <ol style="list-style-type: none"> 1. “valid”. The Serial Number is valid and available for use with the selected offer. 2. “invalid”. The Serial Number is not valid for the selected offer. 3. “used”. The Serial Number is valid but is not available for use with the selected offer.
--------------------	---

If the MCS returns “valid” and the Session ID is valid and active, this means the MCS has now associated the Serial Number with the Session ID. This Serial Number, in all respects, acts like a Serial Number entered in the Request Offers message. In other words, if the MCM successfully completes the protocol with the Request Permission message (section 5.5.8), the MCS shall record the use of the Serial Number for the selected offer.

5.5.8 Request Permission

Once the appropriate offer has been selected, the MCM sends a Request Permission message to the MCS. The Request Permission message is a Web service message as given in Appendix C, which uses the permission schema described in Appendix B. The Request Permission message is executed synchronously with the Request Permission response returned as described in Section 5.5.9.1. It contains the following information:

⁵ A Universally Unique Identifier (UUID) is a 128-bit identifier described in Internet Engineering Task Force [RFC 4122: A Universally Unique Identifier \(UUID\) URN Namespace](#).

MCUi	Managed Copy Unit. A string containing the ID of the particular offer that was selected as a part of the transaction.
sessionId	Contains the sessionId that was returned in the XML object in response to the Request Offers message.
MCM_MCOTInfo	Information sent to the MCS which is MCOT specific. It is optional in the case of Client-side Binding; in the case of Server-side Binding, it is recommended to contain the binding information. For example, it might contain the media ID if the MCOT protects content on a recordable disc.

5.5.9 Request Permission Response Creation

When the MCS receives a Request Permission message, the contents of the message are compared to the information received in the initial Request Offer message and any subsequent transactions that occurred. If all the information is correct and the conditions have been satisfactorily met, the MCS will provide its permission via its Request Permission response sent to the MCM. The Request Permission response message is a Web service message as given in Appendix C, using the permission schema described in Appendix B. It contains the following information:

status	Indicates whether or not permission has been granted to make the copy. In an MCM using Client-side Binding, this Status field shall only be used by the AACS Layer after all message integrity checks have been completed. This Status field can also be used to facilitate the Application Layer's ability to determine the authorization status. A value of zero indicates success.
statusMessage	This is an optional text message suitable for end users, which may contain a reason for a non-zero status code.
MCS_MCOTInfo	Information sent to the MCM which is output technology specific. It is optional in the case of Client-side Binding. In the case of Server-side Binding, it is recommended to contain the license from the server. In a transaction using Server-side Binding, the MCM may use the MCS_MCOTInfo in the response message to extract the binding information to use with the copy. In such a case, the MCM is not required to verify the integrity of the response.
Signature	The Managed Copy Server (MCS) shall apply a cryptographic signature to the message which in the case of Client-side Binding can be used by the AACS Layer to determine if the copy has or has not been authorized. This value shall be computed in the following manner:

$AACS_Sign(MCS_{pri}, permissionSignedContent)$

With $AACS_Sign$ as defined in *Introduction and Common Cryptographic Elements* book and where MCS_{pri} is a ECDSA Private Key that has been provided by AACS LA to the MCS and where the data being signed consists only of the bytestream of the canonical serialization of the Managed Copy Permission XML Schema element `permissionSignedContent` and its direct descendants and does not include the associated tags from the Web service message (see Appendix B).

In order to produce the contents of the `permissionSignedContent` element as a byte array for the $AACS_Sign$ method, the canonical form of `permissionSignedContent` will be produced as UTF-8 bytes according to the Exclusive XML Canonicalization specification (<http://www.w3.org/TR/xml-exc-c14n/#sec-Specification>).

5.5.9.1 Request Permission Response Validation

During a transaction using Client-side Binding, an MCM receiving the Request Permission response from the MCS shall determine if the requested copy has been authorized. This is done using the process outlined below (in a transaction using Server-side Binding, the MCM is not required to perform these steps):

1. Verify the integrity of the Request Permission Response message using the following procedure and shall refuse to allow the Managed Copy process to continue if the signature fails to verify.

AACS_Verify(MCS_{pub}, Signature Data, permissionSignedContent)

With AACS_Verify as defined in *Introduction and Common Cryptographic Elements* book and where MCS_{pub} is contained in the MCS_{cert} received in the Request Offer Response and stored in the MCM Cache and where the data which was signed consists only of the bytestream of the canonical serialization of the Managed Copy Permission XML Schema element permissionSignedContent and its direct descendants and does not include the associated tags from the web service message (see Appendix B).

In order to produce the contents of the permissionSignedContent element as a byte array for the AACS_Sign method, the canonical form of permissionSignedContent will be produced as UTF-8 bytes according to the Exclusive XML Canonicalization specification (<http://www.w3.org/TR/xml-exc-c14n/#sec-Specification>).

2. Verify that the Session ID contained within the permissionSignedContent element matches the Session ID stored in the local MCM cache. If it does not, the MCM shall abort the Managed Copy process.
3. Verify that the MCUI contained within the permissionSignedContent element matches the MCUI stored in the local MCM cache. If it does not, the MCM shall abort the Managed Copy process.
4. Verify that the mcmNonce value contained within the permissionSignedContent element matches the mcmNonce stored in the local MCM cache. If it does not, the MCM shall abort the Managed Copy process.
5. Determine if authorization to make the Managed Copy has been granted by verifying that the status field of the Request Permission response is zero, indicating that the copy is authorized.

5.6 Making a Managed Copy

Once an MCM has validated the Request Permission response, or a Server-side Binding MCM has obtained the license (e.g., from the MCS_MCOTInfo), the copy can be made to the selected MCOT. The copy shall be bound to the destination media using a binding method defined by the MCOT.

The MCS_MCOTInfo that is returned by the MCS in the Request Permission response will contain any MCOT specific information required by the selected MCOT to successfully bind the content to the destination media.

5.7 Managed Copy Server

A Managed Copy Server (MCS) is required to verify the authenticity of a PMSN, by carrying out a drive authentication protocol with the drive local to the MCM. When an MCM is not otherwise associated with a drive containing a Drive Certificate to meet other obligations in the specifications, the MCM itself shall have a Drive Certificate and shall simulate the drive authentication with the MCS. All of the drive requirements in the *Introduction and Common Cryptographic Elements* book Chapter 4 apply to such an MCM, including the requirement to save the most recent Host Revocation List it has seen.

In normal operation, a PMSN read by the MCS will promptly be used in a “Request Offers” message from the MCM. In the case that it is not, the MCS shall forget the PMSN after a reasonable amount of time has elapsed. The amount of time that a validated PMSN lives in the MCS cache is a design choice of the MCS, but it shall not exceed one hour.

The MCS shall have a Host Certificate and its associated private key, as described in Chapter 4 of the *Introduction and Common Cryptographic Elements* book. In general, the Managed Copy Server shall follow the protocols defined in that chapter; with the exception that it shall receive the latest Drive Revocation List from AACS LA.

Note that the MCS performs some preliminary steps associated with bus decryption, although it shall not perform the actual bus decryption procedure. To prevent the MCS from being used as part of a prohibited remote playback operation, it is restricted to use of the following drive commands:

1. The READ DISC STRUCTURE command
2. The REPORT KEY command
3. The SEND KEY command
4. The SEND DISC STRUCTURE command

5.8 Informative Section: Components of a Managed Copy Architecture

This informative section is provided as a technical context for the requirements outlined in the normative sections, above. It describes some assumptions about the kind of architecture which may evolve around Managed Copy and the likely role of the normative Managed Copy components in that architecture.

For example,

- It is assumed that there will not be one monolithic Managed Copy Server. Content Owners will engage a variety of Managed Copy service providers - different service providers for different titles, for different titles at different times, or for the same title at the same time.
- Since permission granting for a Managed Copy is a more security sensitive operation, we have assumed that such permission granting servers might not be collocated with the 'store front' service server.
- It is further assumed that users will want to use a single account for multiple services, rather than having to set up a credit card or debit account with each and every Managed Copy service. For that reason, we consider it likely that the account manager will be a separate server, with multiple service servers accessing that same account.

What follows is an informative description of each component in this architecture.

5.8.1 The AACS Compliant Disc

An AACS compliant disc may contain the URL to identify the Managed Copy Server. As noted above, the MCM also contains a Default URL to be used for any disc that does not contain this URL. The storage location and encoding of this URL can be format specific, but it shall be available through an API to the AACS layer of the Managed Copy Machine.

Inasmuch as AACS compliant discs have appeared on the market prior to Managed Copy services becoming available, the URL stored on the AACS compliant disc may be set to a Content Owner owned URL which will redirect to the Managed Copy Server chosen by the Content Owner for that disc. In this way, changing the Managed Copy Server for a particular disc can easily be done from a single point.

5.8.2 The AACS Compliant Player

There are two ways that a Managed Copy can be initiated: as part of the consumer's interactive experience with the menuing system of the disc, or performed from a stand-alone application.

Although it is optional for an AACS compliant player to enable a Managed Copy, it shall expose the AACS specified API for determining if Managed Copy can be initiated from the player.

5.8.3 The Managed Copy Machine

This component is required because all products which support Managed Copy shall, at a minimum, support the communication between the Managed Copy Machine and the Managed Copy Server which makes rendering of Managed Copy offers possible.

The Managed Copy Machine (MCM) is the consumer software which initiates a Managed Copy. It is either tied to a player, or it exists as a stand-alone application – e.g., as part of a home media server which includes an AACS-compliant drive.

Since AACS will support a wide variety of future Managed Copy scenarios, we make some rather limited assumptions about the nature of the target Managed Copy Output Technologies (MCOTs): other than they are AACS approved MCOTs, as listed in the AACS license agreement.

5.8.3.1 The Application Layer of the Managed Copy Machine

The application layer of the Managed Copy Machine manages the communication with the Managed Copy Server, providing that server with the required information in the AACS specified format so that the server can return the Managed Copy offers to the consumer. For this reason, the application layer shall be provided in all products which support AACS Managed Copy.

This application layer of the Managed Copy Machine is what is optionally launched by an AACS-compliant player.

5.8.3.2 The AACS Layer of the Managed Copy Machine

This component of the Managed Copy Machine is required if binding of the content to the media takes place in the consumer product. Otherwise, it is not required.

If binding of the content is performed on separate machine from where the permission is granted, then a secure means of communication shall be established between these two entities. This communication is described in detail in Section 5.7.

5.8.4 MCOT ID Considerations

As discussed above, the MCOT ID can possess both a major and multiple minor components. AACS assigns the major part of the ID to the MCOT. The MCOT provider is free to define minor codes associated with its major ID. These minor ID codes need not be communicated to AACS except under conditions where at least one major/minor MCOT ID code combination is for some reason no longer required to be included in any offer. This could occur in cases where the ID is being suspended, de-listed, or for some other reason the MCOT provider wanted to discontinue service. Note that Bound Copy Methods share a common major ID, and AACS LA will assign the corresponding minor-IDs.

An MCOT provider may choose to have a single major ID and a single minor ID code. There are, however, two reasons why they might consider defining more than one minor ID:

1. If the MCOT is expressed in different product types with very different functional characteristics, there is no chance of confusion--in fact, it might even be clearer--if those different product types use different MCOT minor ID codes. For example, CPRM for DVD and CPRM for SD Card are sufficiently different that they might choose to use different MCOT minor IDs.
2. Even if one has functionally equivalent products, if they are provided on different platforms with different implementations, one might consider using a separate MCOT minor ID for each implementation. For example, one might have a DRM client with both a Windows and a Linux implementation. The important consideration is how likely it is for a break in one implementation to lead immediately to a break in the other implementation. If such a cascade of breaks is unlikely, one could get into a situation where the implementation on one platform is still valid, but the implementation on the other platform has to be temporarily suspended from the mandatory MCOT list. If the two platforms were not differentiated with separate MCOT minor IDs, then a temporary suspension of the major MCOT ID would suspend all uses of the MCOT on all platforms for that MCOT, and the MCOT provider would need to request a new major MCOT ID from AACS in order to continue operations on the unbroken platform. If the platforms had different MCOT minor IDs from the start, this step could be avoided. (Observe that the guidelines for two platforms having different MCOT minor IDs are very similar to the guidelines for an AACS player implemented on two platforms to have different sets of proactive renewal device keys.)

If a particular MCOT major/minor ID combination is no longer required to be included in an offer, then it is necessary for the MCOT provider to identify to AACS the entire list of minor ID codes used. This allows offers to be adjusted if necessary, and for Managed Copy Servers to perform filtering of affected offers appropriately. For additional information, please refer to Appendices A and C and Section 5.5.2.

5.8.5 The MCOT Transcryptor

Once permission has been granted to perform a Managed Copy, a rebinding operation can take place. If this transcription and rebinding occurs on the target device, an MCOT transcryptor is required. This is a software component which knows how to take decrypted AACS Content and re-encrypt it in the approved MCOT, mapping rights correctly, according to the AACS Compliance Rules.

AACS places no requirements on how players, Managed Copy Machines and MCOT transcryptors interoperate. However, it is assumed that a consumer may have multiple MCOTs on their Licensed Product. This leads to two general architectures:

- An optional player tied to a single Managed Copy Machine, which in turn is tied to a single MCOT transcryptor.
- An optional player tied to a single Managed Copy Machine, which in turn supports multiple MCOT transcryptors.

The second model would appear to be more consumer friendly, but we have defined an architecture which supports both models.

A Appendix

Managed Copy Offer XML Schema

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="http://www.aacsla.com/2006/02/managedOffer"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:tns="http://www.aacsla.com/2006/02/managedOffer"
  elementFormDefault="qualified">
  <xs:element name="offers">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="offersSignedContent">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="tns:offer"
                minOccurs="1" maxOccurs="256" />
              <xs:element ref="tns:render"
                minOccurs="0" />
              <xs:element ref="tns:sessionId"
                minOccurs="1" maxOccurs="1" />
              <xs:element ref="tns:mcmNonce"
                minOccurs="1" maxOccurs="1" />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element ref="tns:MCScert" minOccurs="1"
          maxOccurs="1" />
        <xs:element ref="tns:signature" minOccurs="1"
          maxOccurs="1" />
      </xs:sequence>
      <xs:attribute name="MKB" use="optional" type="xs:string" />
      <xs:attribute name="version" use="required"
        type="xs:decimal" />
    </xs:complexType>
  </xs:element>

  <xs:element name="offer">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="tns:MCUi" minOccurs="1"
          maxOccurs="1" />
        <xs:element ref="tns:title" minOccurs="1"
          maxOccurs="1" />
        <xs:element ref="tns:abstract" minOccurs="1"
          maxOccurs="1" />
        <xs:element ref="tns:description" minOccurs="1"
          maxOccurs="1" />
        <xs:element ref="tns:image" minOccurs="0"
          maxOccurs="1" />
        <xs:element ref="tns:ISO639LanguageCode" minOccurs="0"
          maxOccurs="1" />
        <xs:element ref="tns:price" minOccurs="0"
          maxOccurs="1" />
        <xs:element ref="tns:serialNumberRequired"
          minOccurs="1" maxOccurs="1" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```

```

        <xs:element ref="tns:financialApplication"
            minOccurs="1" maxOccurs="unbounded" />
        <xs:element ref="tns:financialHTMLURL" minOccurs="1"
            maxOccurs="1" />
        <xs:element ref="tns:dealManifest"
            minOccurs="0" maxOccurs="1" />
        <xs:element ref="tns:offerDetails" />
    </xs:sequence>
    <xs:attribute name="withheld" use="optional"
        type="xs:boolean" />
</xs:complexType>
</xs:element>

<xs:element name="serialNumberStatus">
    <xs:simpleType>
        <xs:restriction base="xs:string">
            <xs:enumeration value="valid" />
            <xs:enumeration value="invalid" />
            <xs:enumeration value="used" />
        </xs:restriction>
    </xs:simpleType>
</xs:element>

<xs:element name="dealManifest">
    <xs:complexType>
        <xs:sequence>
            <xs:any namespace="##other" processContents="lax" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="MCUi" type="xs:string" />
<xs:element name="image">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="tns:url" minOccurs="1"
                maxOccurs="1" />
            <xs:element ref="tns:title" minOccurs="1"
                maxOccurs="1" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="url" type="xs:anyURI" />
<xs:element name="title" final="restriction">
    <xs:simpleType>
        <xs:restriction base="xs:string">
            <xs:maxLength value="1024" />
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="description" final="restriction">
    <xs:simpleType>
        <xs:restriction base="xs:string">
            <xs:maxLength value="65536" />
        </xs:restriction>
    </xs:simpleType>
</xs:element>
<xs:element name="abstract" final="restriction">

```

```

<xs:simpleType>
  <xs:restriction base="xs:string">
    <xs:maxLength value="4096" />
  </xs:restriction>
</xs:simpleType>
</xs:element>

<xs:element name="offerDetails">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="tns:videoParameters"
        minOccurs="0" maxOccurs="1" />
      <xs:element ref="tns:audioParameters" minOccurs="0"
        maxOccurs="1" />
      <xs:element name="sourceURI" type="xs:anyURI"
        minOccurs="0" maxOccurs="1" />
      <xs:element ref="tns:mcotInfo" minOccurs="1" />
      <xs:element ref="tns:hint" minOccurs="0" />
    </xs:sequence>
  </xs:complexType>
</xs:element>

<xs:element name="videoParameters">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="videoParametersName"
        type="xs:string" minOccurs="0" maxOccurs="1" />
      <xs:element ref="tns:minimumHorizontalResolution"
        minOccurs="0" maxOccurs="1" />
      <xs:element ref="tns:maximumHorizontalResolution"
        minOccurs="0" maxOccurs="1" />
      <xs:element ref="tns:minimumFrameRate" minOccurs="0"
        maxOccurs="1" />
      <xs:element ref="tns:videoBitrateInfo"
        minOccurs="0" />
    </xs:sequence>
  </xs:complexType>
</xs:element>

<xs:element name="videoBitrateInfo">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="tns:videoCodecName"
        minOccurs="0" />
      <xs:element ref="tns:minimumBitRate" minOccurs="0"
        maxOccurs="1" />
    </xs:sequence>
  </xs:complexType>
</xs:element>

<xs:element name="audioParameters">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="audioParametersName"
        type="xs:string" minOccurs="0" maxOccurs="1" />
      <xs:element ref="tns:audioCodecName"
        minOccurs="0" />
      <xs:element ref="tns:minimumBitRate" minOccurs="0"
        maxOccurs="1" />
      <xs:element ref="tns:maximumBitRate" minOccurs="0"

```

```

        maxOccurs="1" />
        <xs:element ref="tns:minimumChannels" minOccurs="0"
            maxOccurs="1" />
    </xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="mcotInfo">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="tns:MCOT" />
            <xs:element ref="tns:mcotMinorCode" minOccurs="0" />
            <xs:element name="mcotOfferInfo"
                type="xs:base64Binary" minOccurs="0"
                maxOccurs="1" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="render">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="tns:renderURI" minOccurs="1"
                maxOccurs="1" />
            <xs:element ref="tns:renderType" minOccurs="1"
                maxOccurs="1" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="financialApplication">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="tns:financialApplicationURI"
                minOccurs="1" maxOccurs="1" />
            <xs:element ref="tns:fiancialApplicationType"
                minOccurs="1" maxOccurs="1" />
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="renderURI" type="xs:anyURI" />
<xs:element name="renderType" type="xs:string" />
<xs:element name="videoCodecName" type="xs:string" />
<xs:element name="audioCodecName" type="xs:string" />
<xs:element name="minimumBitRate" type="xs:decimal" />
<xs:element name="maximumBitRate" type="xs:decimal" />
<xs:element name="minimumHorizontalResolution" type="xs:decimal" />
<xs:element name="maximumHorizontalResolution" type="xs:decimal" />
<xs:element name="minimumFrameRate" type="xs:decimal" />
<xs:element name="minimumChannels" type="xs:decimal" />
<xs:element name="price" type="xs:string" />
<xs:element name="financialApplicationURI" type="xs:anyURI" />
<xs:element name="fiancialApplicationType" type="xs:string" />
<xs:element name="financialHTMLURL" type="xs:anyURI" />
<xs:element name="mcmNonce" type="xs:base64Binary" />
<xs:element name="MCScert" type="xs:base64Binary" />
<xs:element name="sessionId" type="xs:string" />
<xs:element name="signature" type="xs:base64Binary" />
<xs:element name="hint" type="xs:string" />
<xs:element name="MCOT" type="xs:string" />

```

Advanced Access Content System: Pre-recorded Video Book

```
<xs:element name="mcotMinorCode" type="xs:string" />  
<xs:element name="ISO639LanguageCode" type="xs:language" />  
<xs:element name="serialNumberRequired" type="xs:boolean" />  
</xs:schema>
```


B Appendix

Managed Copy Permission XML Schema

```

<?xml version="1.0"?>
<xs:schema
  targetNamespace="http://www.aacsla.com/2006/02/managedPermission"
  xmlns:tns="http://www.aacsla.com/2006/02/managedPermission"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:element name="permission">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="permissionSignedContent">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="tns:status"
                minOccurs="1" maxOccurs="1" />
              <xs:element ref="tns:statusMessage"
                minOccurs="0" maxOccurs="1" />
              <xs:element ref="tns:MCS_MCOTInfo"
                minOccurs="0" maxOccurs="1" />
              <xs:element ref="tns:mcmNonce"
                minOccurs="1" maxOccurs="1" />
              <xs:element ref="tns:MCUi"
                minOccurs="1" maxOccurs="1" />
              <xs:element ref="tns:sessionId"
                minOccurs="1" maxOccurs="1" />
            </xs:sequence>
          </xs:complexType>
        </xs:element>
        <xs:element ref="tns:signature" minOccurs="1"
          maxOccurs="1" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="status" type="xs:nonNegativeInteger" />
  <xs:element name="statusMessage" type="xs:string" />
  <xs:element name="signature" type="xs:base64Binary" />
  <xs:element name="MCS_MCOTInfo" type="xs:base64Binary" />
  <xs:element name="mcmNonce" type="xs:base64Binary" />
  <xs:element name="MCUi" type="xs:string" />
  <xs:element name="sessionId" type="xs:string" />
</xs:schema>

```

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C Appendix

Managed Copy Web Service Description

```

<?xml version="1.0" encoding="utf-8"?>
<wsdl:definitions
  targetNamespace="http://www.aacsla.com/2006/02/managedCopyService"
  xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
  xmlns:soap12="http://schemas.xmlsoap.org/wsdl/soap12/"
  xmlns:tns="http://www.aacsla.com/2006/02/managedCopyService"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:aacsmmp="http://www.aacsla.com/2006/02/managedPermission"
  xmlns:aacsoffer="http://www.aacsla.com/2006/02/managedOffer"
  xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
  xmlns:xsd="http://www.aacsla.com/2006/02/managedOffer"
  xmlns:xsd1="http://www.aacsla.com/2006/02/managedPermission">

  <wsdl:documentation>Managed Copy Web Service</wsdl:documentation>
  <wsdl:types>
    <xs:schema elementFormDefault="qualified"

targetNamespace="http://www.aacsla.com/2006/02/managedCopyService">
  <xs:import

namespace="http://www.aacsla.com/2006/02/managedPermission"
  schemaLocation="aacs_managed_permission.xsd" />
  <xs:import
    namespace="http://www.aacsla.com/2006/02/managedOffer"
    schemaLocation="aacs_copy_offer.xsd" />

  <xs:element name="RequestOffers">
    <xs:complexType>
      <xs:sequence>
        <xs:element minOccurs="1" maxOccurs="1"
          name="cid" type="xs:string" />
        <xs:element minOccurs="1" maxOccurs="1"
          name="ccid" type="xs:base64Binary" />
        <xs:element minOccurs="0" maxOccurs="8192"
          name="mcotList"
          type="tns:ArrayOfMCOTs" />
        <xs:element minOccurs="0"
          maxOccurs="1"
          name="SerialNumber"
          type="xs:base64Binary" />
        <xs:element minOccurs="1" maxOccurs="1"
          name="mcmNonce"
          type="xs:base64Binary" />
        <xs:element minOccurs="0" maxOccurs="128"
          name="LanguageCode"
          type="xs:language" />
        <xs:element minOccurs="0" maxOccurs="1"
          name="AACSOBJECTAttributes"
          type="xs:string" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```

```

<xs:complexType name="ArrayOfMCOTs">
  <xs:sequence>
    <xs:element minOccurs="1" maxOccurs="1"
      name="mcotID" nillable="true"
      type="xs:string" />
    <xs:element minOccurs="0"
      maxOccurs="8192"
      name="mcotMinorIDList"
      type="tns:ArrayOfString" />
  </xs:sequence>
</xs:complexType>

<xs:complexType name="ArrayOfString">
  <xs:sequence>
    <xs:element minOccurs="0" maxOccurs="unbounded"
      name="string" nillable="true"
      type="xs:string" />
  </xs:sequence>
</xs:complexType>
<xs:element name="RequestOffersResponse">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" maxOccurs="1"
        ref="aacsoffer:offers" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="RequestPermission">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="1" maxOccurs="1"
        name="MCUi" type="xs:string" />
      <xs:element minOccurs="1" maxOccurs="1"
        name="sessionId" type="xs:string" />
      <xs:element minOccurs="0" maxOccurs="1"
        name="MCM_MCOTInfo"
        type="xs:base64Binary" />
      <xs:element minOccurs="1" maxOccurs="1"
        name="mcmNonce" type="xs:base64Binary" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="RequestPermissionResponse">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="0" maxOccurs="1"
        ref='aacsmp:permission' />
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="CheckSerialNumber">
  <xs:complexType>
    <xs:sequence>
      <xs:element minOccurs="1" maxOccurs="1"
        name="serialNumber" type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>

```

```

        <xs:element minOccurs="1" maxOccurs="1"
            name="MCUi" type="xs:string" />
        <xs:element minOccurs="1" maxOccurs="1"
            name="sessionId"
            type="xs:string" />
    </xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="CheckSerialNumberResponse">
    <xs:complexType>
        <xs:sequence>
            <xs:element minOccurs="1" maxOccurs="1"
                ref='aacsoffer:serialNumberStatus' />
        </xs:sequence>
    </xs:complexType>
</xs:element>

</xs:schema>
</wsdl:types>
<wsdl:message name="RequestOffersSoapIn">
    <wsdl:part name="parameters" element="tns:RequestOffers" />
</wsdl:message>
<wsdl:message name="RequestOffersSoapOut">
    <wsdl:part name="parameters"
        element="tns:RequestOffersResponse" />
</wsdl:message>
<wsdl:message name="RequestPermissionSoapIn">
    <wsdl:part name="parameters" element="tns:RequestPermission" />
</wsdl:message>
<wsdl:message name="RequestPermissionSoapOut">
    <wsdl:part name="parameters"
        element="tns:RequestPermissionResponse" />
</wsdl:message>
<wsdl:message name="CheckSerialNumberSoapIn">
    <wsdl:part name="parameters" element="tns:CheckSerialNumber" />
</wsdl:message>
<wsdl:message name="CheckSerialNumberSoapOut">
    <wsdl:part name="parameters"
        element="tns:CheckSerialNumberResponse" />
</wsdl:message>

<wsdl:portType name="ServiceSoap">
    <wsdl:operation name="RequestOffers">
        <wsdl:input message="tns:RequestOffersSoapIn" />
        <wsdl:output message="tns:RequestOffersSoapOut" />
    </wsdl:operation>
    <wsdl:operation name="RequestPermission">
        <wsdl:input message="tns:RequestPermissionSoapIn" />
        <wsdl:output message="tns:RequestPermissionSoapOut" />
    </wsdl:operation>
    <wsdl:operation name="CheckSerialNumber">
        <wsdl:input message="tns:CheckSerialNumberSoapIn" />
        <wsdl:output message="tns:CheckSerialNumberSoapOut" />
    </wsdl:operation>
</wsdl:portType>
<wsdl:binding name="ServiceSoap" type="tns:ServiceSoap">

```

```

        <soap:binding transport="http://schemas.xmlsoap.org/soap/http"
/>
        <wsdl:operation name="RequestOffers">
            <soap:operation
soapAction="http://www.aacsla.com/2006/02/managedCopyService/RequestOffers"
" style="document" />
                <wsdl:input>
                    <soap:body use="literal" />
                </wsdl:input>
                <wsdl:output>
                    <soap:body use="literal" />
                </wsdl:output>
            </wsdl:operation>
            <wsdl:operation name="RequestPermission">
                <soap:operation
soapAction="http://www.aacsla.com/2006/02/managedCopyService/RequestPermis
sion" style="document" />
                    <wsdl:input>
                        <soap:body use="literal" />
                    </wsdl:input>
                    <wsdl:output>
                        <soap:body use="literal" />
                    </wsdl:output>
                </wsdl:operation>
                <wsdl:operation name="CheckSerialNumber">
                    <soap:operation
soapAction="http://www.aacsla.com/2006/02/managedCopyService/CheckSerialNu
mber" style="document" />
                        <wsdl:input>
                            <soap:body use="literal" />
                        </wsdl:input>
                        <wsdl:output>
                            <soap:body use="literal" />
                        </wsdl:output>
                    </wsdl:operation>
                </wsdl:binding>
                <wsdl:binding name="ServiceSoap12" type="tns:ServiceSoap">
                    <soap12:binding
transport="http://schemas.xmlsoap.org/soap/http" />
                    <wsdl:operation name="RequestOffers">
                        <soap12:operation
soapAction="http://www.aacsla.com/2006/02/managedCopyService/RequestOffers"
" style="document" />
                            <wsdl:input>
                                <soap12:body use="literal" />
                            </wsdl:input>
                            <wsdl:output>
                                <soap12:body use="literal" />
                            </wsdl:output>
                        </wsdl:operation>
                        <wsdl:operation name="RequestPermission">
                            <soap12:operation

```

```
soapAction="http://www.aacsla.com/2006/02/managedCopyService/RequestPermis  
sion" style="document" />  
    <wsdl:input>  
        <soap12:body use="literal" />  
    </wsdl:input>  
    <wsdl:output>  
        <soap12:body use="literal" />  
    </wsdl:output>  
</wsdl:operation>  
<wsdl:operation name="CheckSerialNumber">  
    <soap12:operation  
  
soapAction="http://www.aacsla.com/2006/02/managedCopyService/CheckSerialNu  
mber" style="document" />  
    <wsdl:input>  
        <soap12:body use="literal" />  
    </wsdl:input>  
    <wsdl:output>  
        <soap12:body use="literal" />  
    </wsdl:output>  
</wsdl:operation>  
</wsdl:binding>  
</wsdl:definitions>
```


D Drive Authentication Schema

```

<?xml version="1.0"?>
<xs:schema
  targetNamespace="http://www.aacsla.com/2006/02/performReadDrive"
  xmlns:tns="http://www.aacsla.com/2006/02/performReadDrive"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:element name="readDrive">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="tns:driveCommand"
          minOccurs="1" maxOccurs="1" />
        <xs:element ref="tns:sessionId"
          minOccurs="1" maxOccurs="1" />
        <xs:element ref="tns:status"
          minOccurs="1" maxOccurs="1" />
        <xs:element ref="tns:serverMessage"
          minOccurs="0" maxOccurs="1" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <xs:element name="driveCommand" type="xs:base64Binary" />
  <xs:element name="sessionId" type="xs:string" />
  <xs:element name="status" type="xs:string" />
  <xs:element name="serverMessage" type="xs:base64Binary" />
</xs:schema>

```

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E Drive Authentication Web Service Description (WSDL)

```

<?xml version="1.0" encoding="utf-8"?>
<wsdl:definitions
  targetNamespace="http://www.aacsla.com/2006/02/readDriveService"
  xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
  xmlns:soap12="http://schemas.xmlsoap.org/wsdl/soap12/"
  xmlns:tns="http://www.aacsla.com/2006/02/readDriveService"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:aacsrld="http://www.aacsla.com/2006/02/performReadDrive"
  xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/" >
  <wsdl:documentation>Read Drive Web Service</wsdl:documentation>
  <wsdl:types>
    <xs:schema elementFormDefault="qualified"

targetNamespace="http://www.aacsla.com/2006/02/readDriveService">
    <xs:import

namespace="http://www.aacsla.com/2006/02/performReadDrive"
    schemaLocation="aacs_read_drive.xsd" />

    <xs:element name="performReadDrive">
      <xs:complexType>
        <xs:sequence>
          <xs:element minOccurs="1" maxOccurs="1"
            name="sessionId" type="xs:string" />
          <xs:element minOccurs="1" maxOccurs="1"
            name="driveData" type="xs:base64Binary"
/>>
          <xs:element minOccurs="1" maxOccurs="1"
            name="driveMessage"
type="xs:base64Binary" />
        </xs:sequence>
      </xs:complexType>
    </xs:element>

    <xs:element name="performReadDriveResponse">
      <xs:complexType>
        <xs:sequence>
          <xs:element minOccurs="1" maxOccurs="1"
            ref="aacsrld:readDrive" />
        </xs:sequence>
      </xs:complexType>
    </xs:element>
  </xs:schema>
</wsdl:types>
<wsdl:message name="performReadDriveSoapIn">
  <wsdl:part name="parameters" element="tns:performReadDrive" />
</wsdl:message>
<wsdl:message name="performReadDriveSoapOut">
  <wsdl:part name="parameters"
    element="tns:performReadDriveResponse" />
</wsdl:message>
<wsdl:portType name="ServiceSoap">
  <wsdl:operation name="performReadDrive">
    <wsdl:input message="tns:performReadDriveSoapIn" />

```

```

        <wsdl:output message="tns:performReadDriveSoapOut" />
    </wsdl:operation>
</wsdl:portType>
<wsdl:binding name="ServiceSoap" type="tns:ServiceSoap">
    <soap:binding transport="http://schemas.xmlsoap.org/soap/http"
/>
    <wsdl:operation name="performReadDrive">
        <soap:operation
soapAction="http://www.aacsla.com/2006/02/managedCopyService/RequestOffers
" style="document" />
        <wsdl:input>
            <soap:body use="literal" />
        </wsdl:input>
        <wsdl:output>
            <soap:body use="literal" />
        </wsdl:output>
    </wsdl:operation>
</wsdl:binding>
<wsdl:binding name="ServiceSoap12" type="tns:ServiceSoap">
    <soap12:binding
        transport="http://schemas.xmlsoap.org/soap/http" />
    <wsdl:operation name="performReadDrive">
        <soap12:operation
soapAction="http://www.aacsla.com/2006/02/managedCopyService/RequestOffers
" style="document" />
        <wsdl:input>
            <soap12:body use="literal" />
        </wsdl:input>
        <wsdl:output>
            <soap12:body use="literal" />
        </wsdl:output>
    </wsdl:operation>
</wsdl:binding>
</wsdl:definitions>

```