DASH-IF Implementation Guidelines: Content Protection Information Exchange Format (CPIX) Version 2.3

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1. Scope§

The scope of this document is to define a Content Protection Information Exchange Format (CPIX). A CPIX document contains keys and DRM information used for encrypting and protecting content and can be used for exchanging this information among entities needing it in many possibly different workflows for preparing, for example, DASH or HLS content. The CPIX document itself can be encrypted, signed and authenticated so that its receivers can be sure that its confidentiality, source and integrity are also protected.

This specification describes version 2.3 of the CPIX document format. Detailed changes with respect to version 2.2 are tracked on GitHub. Highlighted changes are:

- Addition of the `commonEncryptionScheme` element with the CENC protection scheme value
- Addition of the `version` element
- Addition of a section on using the same content key with different encryption schemes
- Clarification on the `explicitIV` element encoding

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3. Introduction§

This document defines a container allowing the exchange between entities of content protection information typically made of keys used for encrypting content and any associated DRM specific information. There may be one or several keys and these keys may be protected by one or several DRMs, hence there may be one or several DRM specific information. There is no assumption on the entities exchanging this information but it is not expected that a client device will use this exchange format. The goal is to allow entities involved in the content preparation workflow to get the content protection information so that, for example a DASH MPD can be generated with all content protection information.

Because the defined container is not made for a specifically defined content preparation workflow but is generic, conformance is not considered to be a critical part of CPIX. As a consequence, no conformance is defined for this specification.

3.1. Normative Language§

See [DASHIFIOP] section 2.3.

3.2. Terms & Definitions§

Content
: One or more audio-visual elementary streams and the associated MPD if in DASH format.

Content Key
: A cryptographic key used for encrypting part of the Content.

Content Protection

The mechanism ensuring that only authorized devices get access to Content.

DRM Signaling

The DRM specific information to be added in Content for proper operation of the DRM system when authorizing a device for this Content. It is made of proprietary information for licensing and key retrieval.

Document Key

A cryptographic key used for encrypting the Content Key(s) in the CPIX document.

PSSH

Protection System Specific Header box that is part of an ISOBMFF file. This box contains DRM Signaling.

Content Key Context

The portion of a media stream which is encrypted with a specific Content Key.

4. Use Cases and Requirements§

Content Keys and DRM Signaling, a.k.a. content protection information need to be created and exchanged between some system entities when preparing Content. The flows of information are of very different nature depending on where Content Keys are created and also depending on the type of Content that can be either On-Demand or Live.

This section presents different use cases where such exchanges are required. § 4.1 Overview of the End to End Architecture is an overview of the general context in which exchange of content protection information is happening, § 4.2 Use Cases for the Preparation of Content describes some workflows for content creation and § 4.3 Exchange over an Interface goes in the details of how content protection information can be exchanged over an interface between two entities.

4.1. Overview of the End to End Architecture§

This informative section gives a general overview of the context in which content protection information need to be exchanged between entities in the backend. It completes section 7.5 of [DASHIFIOP] by putting more emphasis on the backend aspects.

This informative section takes DASH content as an example for providing more specific and clear understanding, but this can be generalized to other streaming formats, such as HLS.

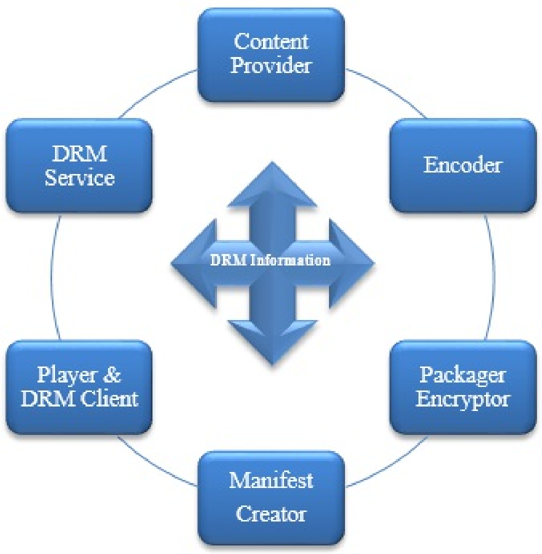


Figure 1 *Logical roles that exchange DRM information and media.*

The figure above shows logical entities that may send or receive DRM information such as media keys, asset identifiers, licenses, and license acquisition information. A physical entity may combine multiple logical roles, and the point of origin for information, such as media keys and asset identifiers, can differ; so various information flows are possible. This is an informative example of how the roles are distributed to facilitate the description of workflow and use cases. Alternative roles and functions can be applied to create conformant content. The different roles are:

Content Provider - A publisher who provides the rights and rules for delivering protected media, also possibly source media (mezzanine format, for transcoding), asset identifiers, key identifiers (KID), key values, encoding instructions, and content description metadata.

Encoder - A service provider who encodes media in a specified set of formats with different bitrates and resolutions etc., possibly determined by the publisher.

Packager / Encryptor - A service provider who encrypts and packages media, inserting DRM Signaling and metadata into the media files. In the case of DASH packaging, this consists of adding the default_KID in the file header `tenc` box, initialization vectors and subsample byte ranges in track fragments indexed by `saio` and `saiz` boxes, and possibly one or more PSSH boxes containing license acquisition information (from the DRM Service). Tracks that are partially encrypted or encrypted with multiple keys require sample to group boxes and sample group description boxes in each track fragment to associate different KIDs to groups of samples. The Packager could originate values for KIDs, Content Keys, encryption layout, etc., then send that information to other entities that need it, including the DRM Service and Streamer, and probably the Content Provider. However, the Packager could receive that information from a different point of origin, such as the Content Provider or DRM Service.

Manifest Creator - A service provider which generates the media manifests which group the various media files into a coherent presentation. These manifest files may contain DRM Signaling information. For DASH, the MPD Creator is assumed to create one or more types of DASH MPD files, and provide indexing of Segments and/or sidx indexes for download so that players can byte range index Subsegments. The MPD must include descriptors for Common Encryption and DRM key management systems, and should include identification of the default_KID for each AdaptationSet element, and sufficient information in UUID ContentProtection elements to acquire a DRM license. The default_KID is available from the Packager and any other role that created it, and the DRM specific information is available from the DRM Service.

DRM Client - It gets information from different sources: media manifest files, media files, and DRM licenses.

DRM Service - The DRM Service creates licenses containing a protected Content Key that can only be decrypted by a trusted DRM Client.

The DRM Service needs to know the default_KID and DRM SystemID and possibly other information like asset ID and player domain ID in order to create and download one or more licenses required for a Presentation on a particular device. Each DRM system has different license acquisition information, a slightly different license acquisition protocol, and a different license format with different playback rules, output rules, revocation and renewal system, etc. For DASH, the DRM Service typically must supply the Streamer and the Packager license acquisition information for each UUID ContentProtection element or PSSH box, respectively.

The DRM Service may also provide logic to manage key rotation, DRM domain management, revocation and renewal and other Content Protection related features.

4.2. Use Cases for the Preparation of Content§

This informative section describes some workflows for content preparation where content protection information is exchanged between or carried through some entities.

As for the previous section, this informative section takes DASH content as an example for providing more specific and clear understanding, but this can be generalized to other streaming formats, such as HLS.

4.2.1. On-Demand Content§

The flow for preparing On-Demand Content requires that a media asset is available non-encrypted, ideally in the maximum resolution so that an adaptive streaming presentation can be prepared.

One possible flow is that a Content Management System (CMS) creates a workflow ensuring that DASH Content is prepared. The CMS makes the file available to a transcoder. The transcoder outputs the segmented files that can be encrypted. The encryption engine either generates the Content Keys or requests them from a DRM system. The DRM system also provides PSSH boxes to be added to the media files, as well as ContentProtection elements to be added to the MPD file. When the encrypted DASH Content is ready, the MPD is generated by a MPD Generator It asks the DRM system the required DRM Signaling to be added in the MPD. DASH content is then uploaded by the CMS on a CDN making it available to users. In parallel, editorial metadata is exported to the Portal, enabling access to users. DRM systems receive relevant metadata information that needs to be included in the license (output controls) when creating a license.

This flow is summarized in the figure below where arrows show the flow of information.

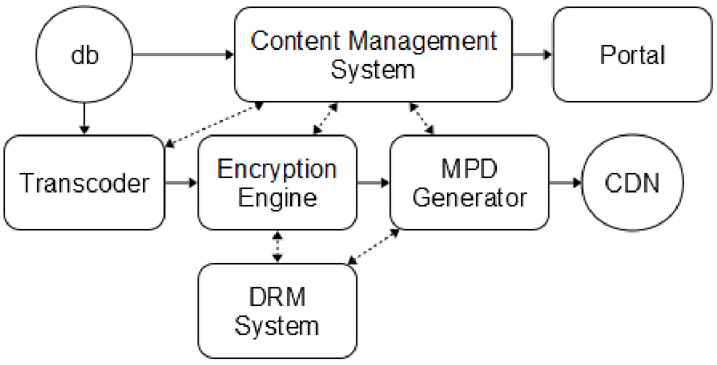


Figure 2 *Example of workflow for On-Demand Content preparation.*

4.2.2. Live Content§

Metadata is regularly imported with new or updated information. Metadata can include different type of information on the EPG events such as the duration of the event, the list of actors, the output controls usage rules, a purchase window, etc.

Content is continuously received, transcoded in the desired format and encrypted if any type of entitlement is required.

One or many Content Keys can be used if key rotation is used or not. Such setting is static and configuration is hard-coded in the relevant equipment, hence a Content Management System is not required for this workflow to operate. As for Content on-Demand, keys are generated by the encryption engine or the DRM system and are available to all DRM systems and the encryption engine at the right moment depending on how these keys are used. The encoder requests to the DRM systems their specific signaling, if any, to be added in the MPD.

Encrypted segments and the media manifest are uploaded on a CDN making it available to users.

Metadata is exported to the Portal, enabling access to users. DRM systems receive relevant metadata information that needs to be included in the license (output controls).

This flow is summarized in the figure below where arrows show the flow of information.

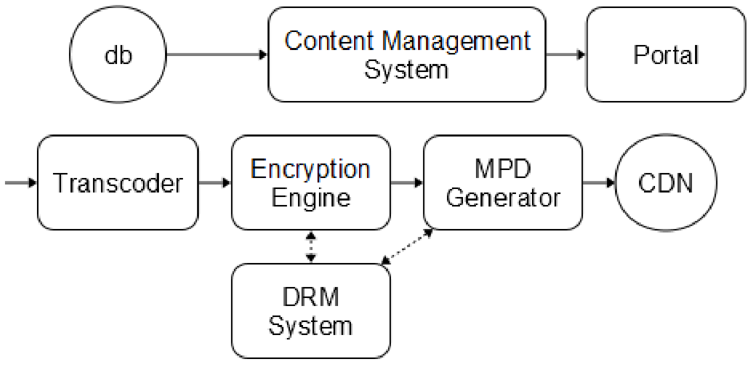


Figure 3 *Example of workflow for Live Content preparation.*

4.2.3. Catch-up§

Live Content has already been encoded and encrypted (if required) for Live unicast. All DRM systems have access to the keys.

Additional metadata may be required for ensuring that events are effectively available in catch-up. These are made available to the Portal and some Live events are identified as being able to be replayed as On-demand. Optionally, the operator may choose to replace the advertising content with targeted ads.

4.2.4. Electronic Sell Through§

In order to make available its Content in a defined and controlled quality, a content owner is preparing it. Preparation includes transcoding to the desired format and encryption of the resulting segments. The content owner is generating also the Content Key(s). At the end of the process, Content is ready and stored along with the Content Key(s).

Later the content owner distributes the prepared Content to multiple locations, in addition metadata describing it is also made available to retail platforms so that it becomes salable on multiples Portals. In parallel, the content owner distributes the Content Key(s) to any authorized DRM system. A DRM system is authorized if it is one used by one of the Portal that has this Content for sale.

4.3. Exchange over an Interface§

This informative section gives details on how content protection information is exchanged or transferred over an interface between two or more entities.

4.3.1. Content Key Delivery to One Entity§

In the simplest use case, content protection information is made of a Content Key. One entity sends a Content Key to the other entity.

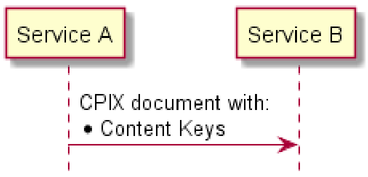


Figure 4 *Content Key delivery to one entity.*

The primary data model carried by content protection information document is made of one to many Content Keys with their associated KIDs. Any context or meaning is attributed externally. The document simply serves as a standard way to serialize Content Keys for delivery.

4.3.2. Secure Content Key Delivery to Several Entities§

This use case is an extension of § 4.3.1 Content Key Delivery to One Entity and is compatible with the use cases presented in the following sections.

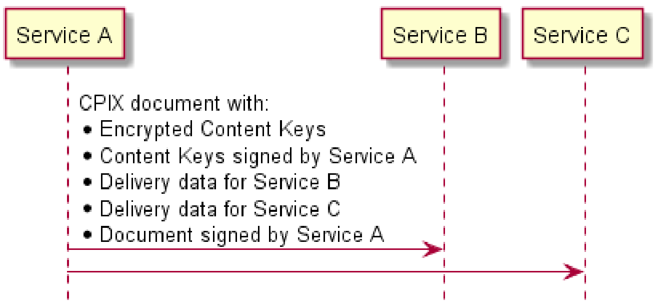

Service A
Service B
Service C
CPIX document with:
• Encrypted Content Keys
• Content Keys signed by Service A
• Delivery data for Service B
• Delivery data for Service C
• Document signed by Service A

Figure 5 *Secure Content Key delivery to several entities.*

The entities exchanging Content Keys may want to rely upon a trust relationship that ensures authentication and privacy of communications. Such a mechanism can be provided by the communication protocol used to deliver the document but the document can also be self-protected. CPIX documents can deliver Content Keys in encrypted and digitally signed form, enabling confidentiality, authentication and nonrepudiation.

In situations with more than one recipient, the document allows each one to decrypt the Content Keys using its own private key.

4.3.3. Content Key Delivery with Usage Rules§

These use cases are extension of § 4.3.1 Content Key Delivery to One Entity and present different rules that can be applied on a Content Key when delivered to an entity. Each usage rule defines a set of filters that are used to define a Content Key Context. If a rule match is found, the Content Key referenced by the usage rule is to be used to encrypt the Content Key Context defined by the rule.

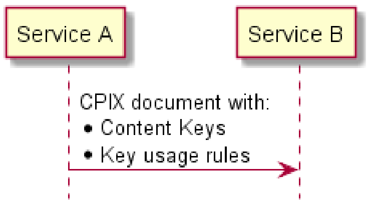


Figure 6 *Content Key delivery with key usage rules.*

4.3.3.1. Label Filter§

This use case adds information to Content Keys that specifies how they are to be mapped to labelled Content Key Contexts, where the labeling system has been pre-agreed between the producer and consumer of the CPIX document.

For example, labels might be the IDs of DASH adaptation sets or, for more compatibility with formats other than DASH, names of media files/directories or input values for arbitrary custom logic.

The recipient will use the added information to map Content Keys to Content Key Contexts defined by labels.

4.3.3.2. Key Period Filter§

This use case adds information to Content Keys that specifies how they are to be mapped to key periods, a.k.a. crypto-periods for Content Key rotation. The mapping is accomplished by defining key periods and mapping Content Keys to any number of key periods.

The recipient will use the added information to map Content Keys to time periods.

4.3.3.3. Policy-based Filters§

This use case associates policy-based information with Content Keys, constraining how they define Content Key Contexts. Policy based filters are, for example, video or audio stream attributes and bitrate ranges.

The recipient will use the added information to map Content Keys to Content Key Contexts according to the defined policy.

Having no policy in some dimension means that the Content Key Context is not constrained in that dimension. For example, if the HDR policy is not specified, the Content Key Context may include both HDR and non-HDR media.

4.3.4. Content Key Delivery with DRM Signaling§

This use case is an extension of § 4.3.1 Content Key Delivery to One Entity and is compatible with § 4.3.3 Content Key Delivery with Usage Rules.

This use case adds DRM Signaling information to each Content Key. The recipient may embed this signaling into the data streams it generates.

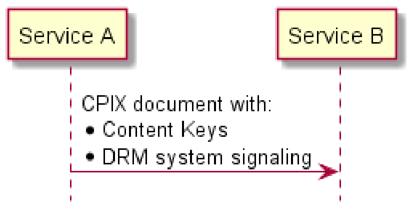


Figure 7 *Content Key Delivery with DRM Signaling.*

The primary data model carried by content protection information document needs then to include zero to many DRM system signaling elements, each element consisting of a DRM system ID, some signaling information such as for example signaling data for a DASH manifest or a HLS playlist or signaling data for an ISOBMFF file.

The use of 3rd party extensions enable the inclusion of DRM system signaling in forms suitable for other media delivery technologies.

The recipient may use the part of signaling data that it understands and knows how to embed into its output, ignoring signaling data that targets other media delivery technologies.

4.3.5. Incremental Update and Extension of the Document§

This use case illustrates the usage of the content protection information document in a realistic workflow comprising multiple cooperating components that require a standardized data format for content protection information exchange.

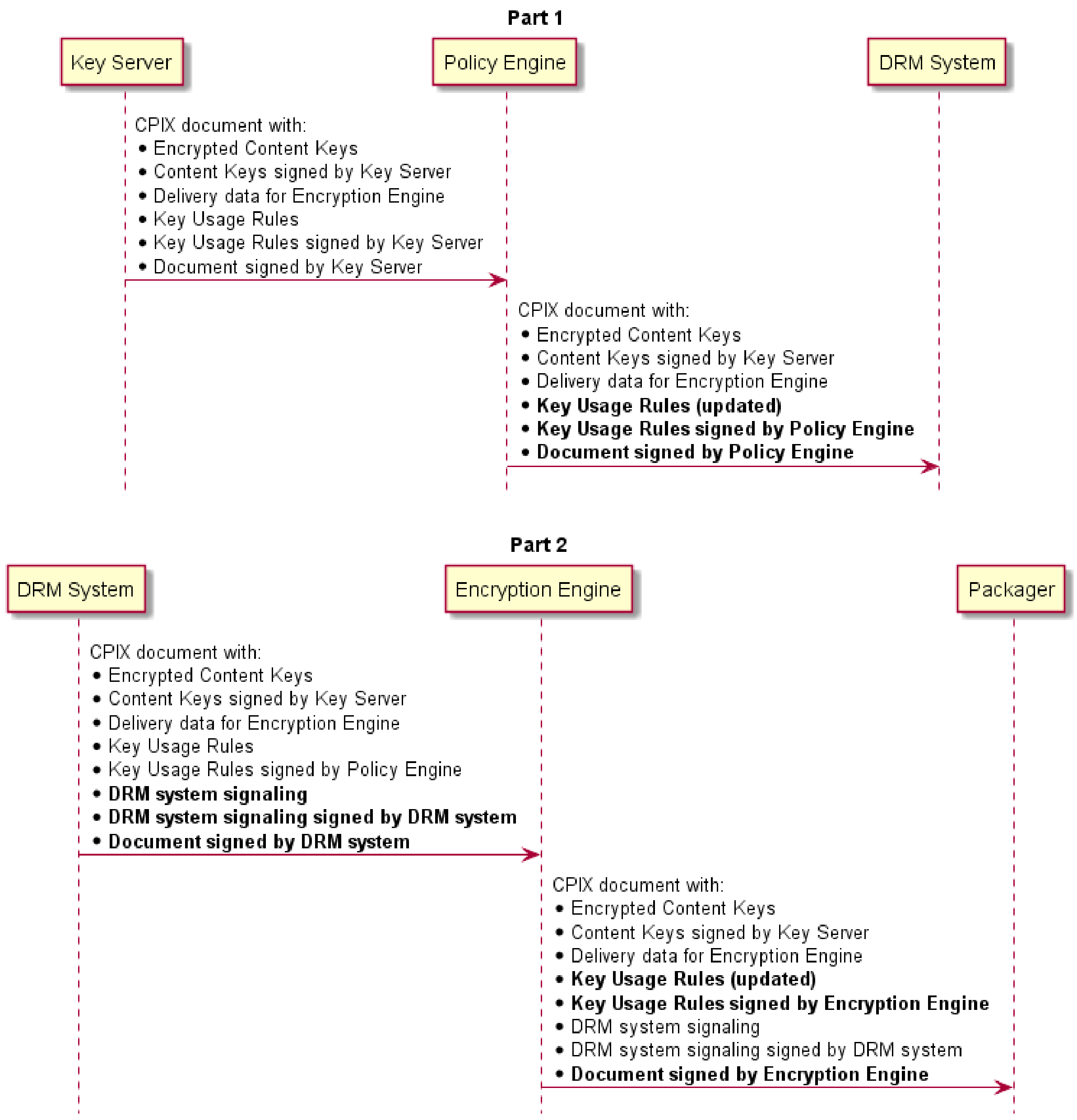

Part 1
Key Server
Policy Engine
DRM System
CPIX document with:
• Encrypted Content Keys
• Content Keys signed by Key Server
• Delivery data for Encryption Engine
• Key Usage Rules
• Key Usage Rules signed by Key Server
• Document signed by Key Server
CPIX document with:
• Encrypted Content Keys
• Content Keys signed by Key Server
• Delivery data for Encryption Engine
• **Key Usage Rules (updated)**
• **Key Usage Rules signed by Policy Engine**
• **Document signed by Policy Engine**
Part 2
DRM System
Encryption Engine
Packager
CPIX document with:
• Encrypted Content Keys
• Content Keys signed by Key Server
• Delivery data for Encryption Engine
• Key Usage Rules
• Key Usage Rules signed by Policy Engine
• **DRM system signaling**
• **DRM system signaling signed by DRM system**
• **Document signed by DRM system**
CPIX document with:
• Encrypted Content Keys
• Content Keys signed by Key Server
• Delivery data for Encryption Engine
• **Key Usage Rules (updated)**
• **Key Usage Rules signed by Encryption Engine**
• DRM system signaling
• DRM system signaling signed by DRM system
• **Document signed by Encryption Engine**

Figure 8 *Incremental update and extension of the document.*

Each component participating in such a workflow is the authority on a particular aspect. For example, the Key Server manages Content Keys and usage rules and may define the key periods, the DRM System knows how to define the correct DRM Signaling and the Encryption Engine might want to inform the Packager what representations the Content Keys actually got mapped to (the Packager might not have enough information to resolve usage rules based on detailed metadata, so the Encryption Engine could define a new set of usage rules that are simple enough for the Packager to understand, e.g. by making use of label filters).

As the document travels in the workflow, each component adds the elements containing the content protection items it generates (key periods, usage rules, Content Keys, DRM Signaling, etc), making it suitable for the next component that will make use of it. After each modification, the added elements may be signed to maintain a chain of trust on each set of elements individually. The document in its entirety may also be signed to authenticate the document as a whole.

Note that in the above example, the Content Key material itself is encrypted for the Encryption Engine. Despite the fact that many other components participate in the workflow, they do not have access to Content Keys.

4.3.6. Content Key Hierarchy Delivery for Content Packaging§

Some DRM systems enable the use of hierarchy of keys, where the set of keys delivered to clients (root keys) within licenses differs from the set of keys used to encrypt Content (leaf keys). Doing so enable DRM systems to separate content encryption and commercial offer management.

Packaging content that uses a key hierarchy requires the Packager to know:

- The leaf keys.
- The KIDs of the root keys (but not the root keys themselves).
- DRM system signaling data for both root and leaf keys.

To fulfill this use case, CPIX enables the above data to be exchanged.

4.3.7. Root Key Delivery for License Server Operation§

Some DRM systems enable the use of hierarchical keys, where the set of keys delivered to clients (root keys) differs from the set of keys used to encrypt Content (leaf keys).

When, for example, key creation is not a function of the license server, creating licenses in scenarios that use hierarchical keys requires the license server to know the root keys. CPIX enables root keys to be delivered to license servers.

The exchange of root keys is technically identical to the exchange of non-hierarchical Content Keys as described in § 4.3.1 Content Key Delivery to One Entity. It is expected that the recipient of a CPIX document in this use case is already aware of the hierarchical nature of the keys within, without any signaling in the CPIX document.

4.4. Workflow Examples§

4.4.1. Encryptor Producer and Encryptor Consumer§

There are many workflows that are possible, depending on which entities provide information in the CPIX document, and which entities consume that information. Two simple single-producer, single-consumer examples are illustrated below:

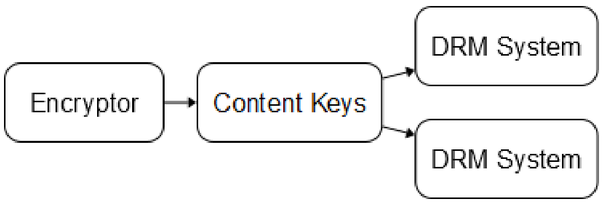


Figure 9 *Encryptor Producer.*

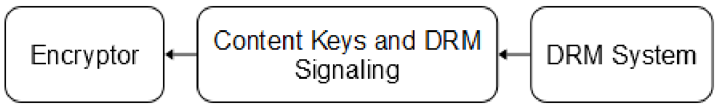


Figure 10 *Encryptor Consumer.*

All workflows require that content protection information and Content Keys be exchanged between two or more entities. In the examples above the entities are the Encryptor and DRM System:

- The Encryptor Producer example allows, in this case, the Encryptor to generate Content Keys and to push them to one or many DRM systems. The Encryptor could expect to receive from the DRM systems some DRM Signaling.

- The Encryptor Consumer example allows the Encryptor to pull Content Keys and DRM Signaling from a DRM system. In this case, Content Keys are generated by the DRM System.

The document allows supporting both workflows above in addition to other workflows not explicitly described here.

Before exchanging key information in a secure manner, the entities which exchange key material must know about each other and share public keys so that one entity could encrypt data and the other entity could decrypt it. This important step of Trust establishment is out of the scope of this document.

4.4.1.1. Encryptor Producer§

This informative section shows a possible workflow for securing the exchange of the key information between entities when the Encryptor generates the Content Keys. In this example, the Encryptor is the entity which is taking responsibility for generating the Content Keys, protecting them and pushing them to the DRM Systems.

- The first step is the Trust establishment. Public keys must be exchanged between two or more entities (the Encryptors and the DRM Systems) prior exchanges.
- Once the Trust is established and the necessary associated key material is shared between entities, Content Keys can be exchanged. The Encryptor is encrypting these keys using DRM Systems public keys. The DRM Systems can decrypt using their own private key.
- The Encryptor provides crypto material required to uniquely identify the entity capable of decrypting the media.

All these steps are summarized in the figure below.

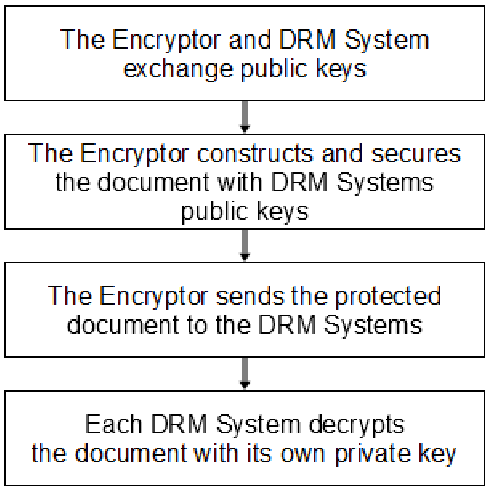

The Encryptor and DRM System exchange public keys
The Encryptor constructs and secures the document with DRM Systems public keys
The Encryptor sends the protected document to the DRM Systems
Each DRM System decrypts the document with its own private key

Figure 11 *Encryptor Producer example steps.*

4.4.1.2. Encryptor Consumer§

This informative section shows a possible workflow for securing the exchange of the key information between entities when the DRM System generates the Content Keys. In this model, the Encryptor can pull documents directly from a DRM System. In this case, the DRM System is generating Content Keys and is encrypting them for a secure delivery to the Encryptor.

- As in the case of the Encryptor Producer model, the first step is the Trust establishment. Public keys must be exchanged between two or more entities (the Encryptors and the DRM System) prior exchanges.
- The DRM System will use the public key of the Encryptor to encrypt keys to be inserted in the document and will send it to Encryptor.
- The Encryptor can decrypt the Content Keys using its private key.

All these steps are summarized in the figure below.

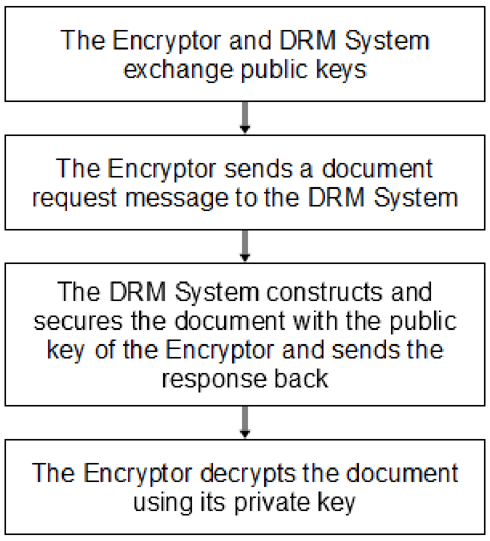

The Encryptor and DRM System exchange public keys
The Encryptor sends a document request message to the DRM System
The DRM System constructs and secures the document with the public key of the Encryptor and sends the response back
The Encryptor decrypts the document using its private key

Figure 12 *Encryptor Consumer example steps.*

4.4.1.3. Multiple Producers§

This informative section illustrates that it is possible to have more complex workflows than those previously illustrated. In one such example, for DASH content, a media packager might define the types of streams in the presentation, an Encryptor might generate the Content Keys, a DRM System might generate other DRM Signaling, An Encryptor and an MPD Generator might be the consumers of the final document. In such workflows, the document gets passed from entity to entity in sequence, with each entity adding top-level elements, and recording the update.

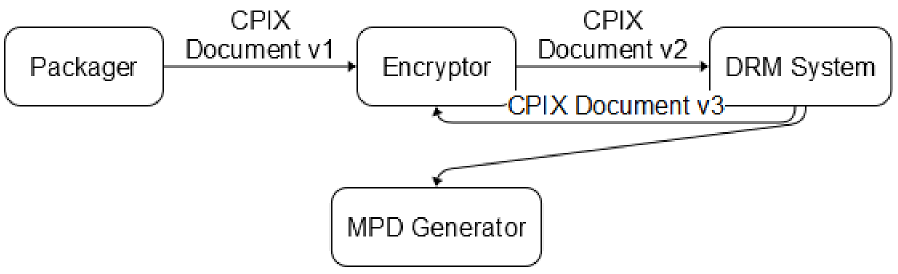


Figure 13 *Multiple Producers example.*

- The first step is the Trust establishment. Public keys must be exchanged between two or more entities prior to exchanges.
- Once the Trust is established and the necessary associated key material is shared between entities, Content Keys can be exchanged.
- The Packager provides identification of the receivers and the various stream encoding criteria (usage rules) in version 1 of the document.
- The Encryptor adds key information in version 2 of the document. These elements only contain Keys and no DRM information.
- The DRM System imports the Content Keys stored in the document, and adds its own information in version 3 of the document, which is the finalized version.
- The Encryptor extracts content protection information from the document to be embedded in the media (e.g. PSSH boxes).

- The MPD Generator also extracts content protection related information from the document to be embedded in the MPD document (e.g. PSSH boxes, key IDs).

All these steps are summarized in the figure below.

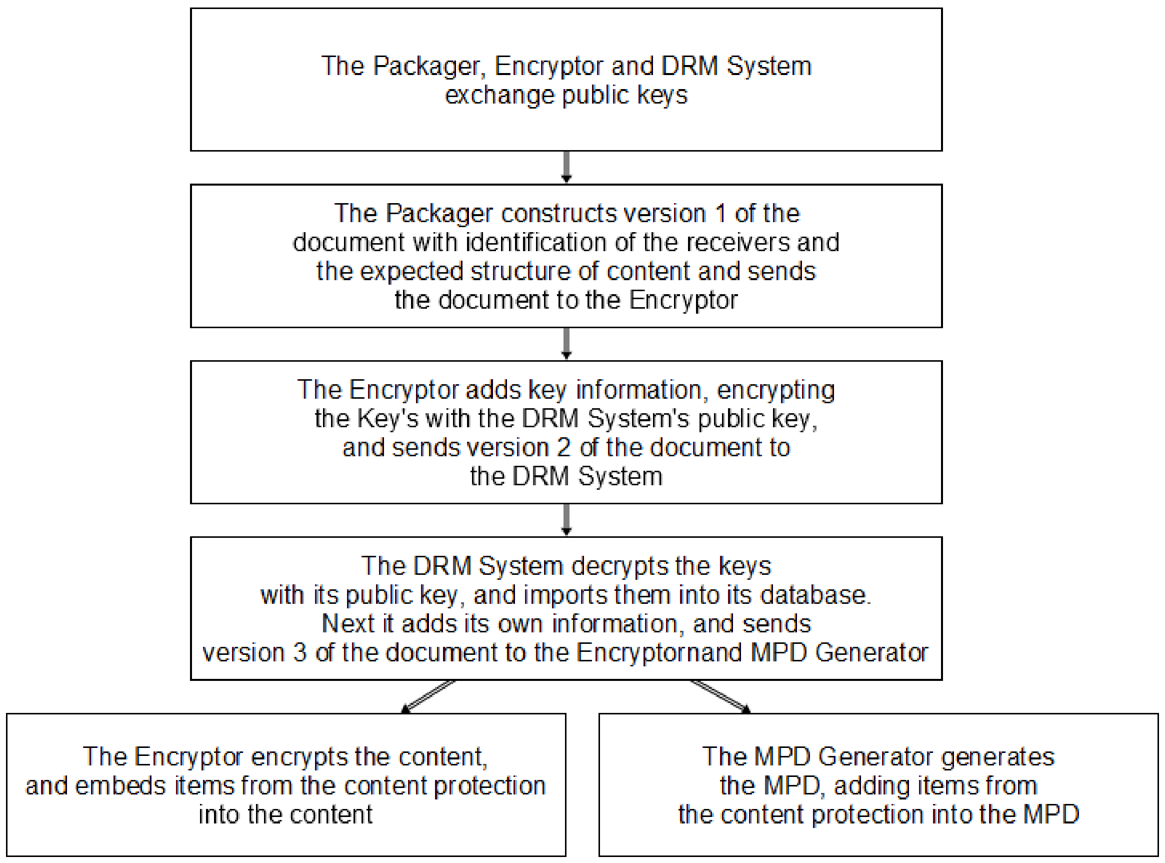

The Packager, Encryptor and DRM System exchange public keys
The Packager constructs version 1 of the document with identification of the receivers and the expected structure of content and sends the document to the Encryptor
The Encryptor adds key information, encrypting the Key's with the DRM System's public key, and sends version 2 of the document to the DRM System
The DRM System decrypts the keys with its public key, and imports them into its database. Next it adds its own information, and sends version 3 of the document to the Encryptornand MPD Generator
The Encryptor encrypts the content, and embeds items from the content protection into the content
The MPD Generator generates the MPD, adding items from the content protection into the MPD

Figure 14 *Multiple Producers example steps.*

4.5. Requirements§

It shall be possible to exchange Content Key(s) and DRM Signaling between entities involved in Content preparation workflows, an example of such interface where the exchange shall be possible is between a DRM system and the encryption engine.

It shall be possible that the manifest generator receives DRM Signaling for several DRM systems and/or content formats

Update of Content Key(s) shall be possible at periodic time or based on events. Some period of time could be in the clear (no encryption).

It shall allow generating MPD conformant to [DASHIFIOP].

Content Key(s) shall be secured over the interface.

Entities exchanging content protection information should be authenticated.

5. XSD Schema Definition§

This section describes the Content Protection Information eXchange (CPIX) format to provide a framework to securely exchange Content Key(s) and DRM Signaling between different system entities (see § 4 Use Cases and Requirements). This is an XML file that is described by the XSD provided in [CPIX-XSD]. This section describes in details elements part of the schema.

5.1. Structure Overview§

The structure is articulated around Content Keys and the accompanying material. The document contains all the information required for allowing any entitled entity to get access to or add in the Content Keys and either consume or add material, such as time constraint, DRM information to the CPIX document. The same XML file can be shared between several receiving entities. Hence, each one must be able to decrypt keys and must be properly identified.

Taking this into account, the CPIX document contains lists of elements:

- DeliveryDataList: This list contains instances of DeliveryData, each of which describes an entity entitled to decrypt Content Keys contained in the CPIX document.
- ContentKeyList: This list contains instances of ContentKey, each of which contains a Content Key used for encrypting media.
- DRMSystemList: This list contains instances of DRMSystem, each of which contains the signaling data to associate one DRM system with one Content Key.
- ContentKeyPeriodList: This list contains instances of ContentKeyPeriod, each of which defines a time period that may be referenced by the key period filters included in Content Key usage rules.
- ContentKeyUsageRuleList: This list contains instances of ContentKeyUsageRule, which maps a Content Key to one or more Content Key Contexts.
- UpdateHistoryItemList: This list contains instances of UpdateHistoryItem, each of which contains an update version number and an identifier of the entity which produced the update. Other elements in the document are linked to a specific update by update version number (via the `updateVersion` attribute).
- Signature: Each instance of this element contains a digital signature [XMLDSIG-CORE] over either the entire document or a subset of XML elements.

The Content Keys can be encrypted inside the XML file using the public keys of the recipients, identified in the DeliveryData elements. The XML file also allows storing the Content Keys in the clear, in which case the security of the Content Keys is contingent on the security of the communication channel used to deliver the CPIX document to the recipients.

The figure below shows the first elements and a high-level view of the structure. Detailed description of the structure is given in the following sections.

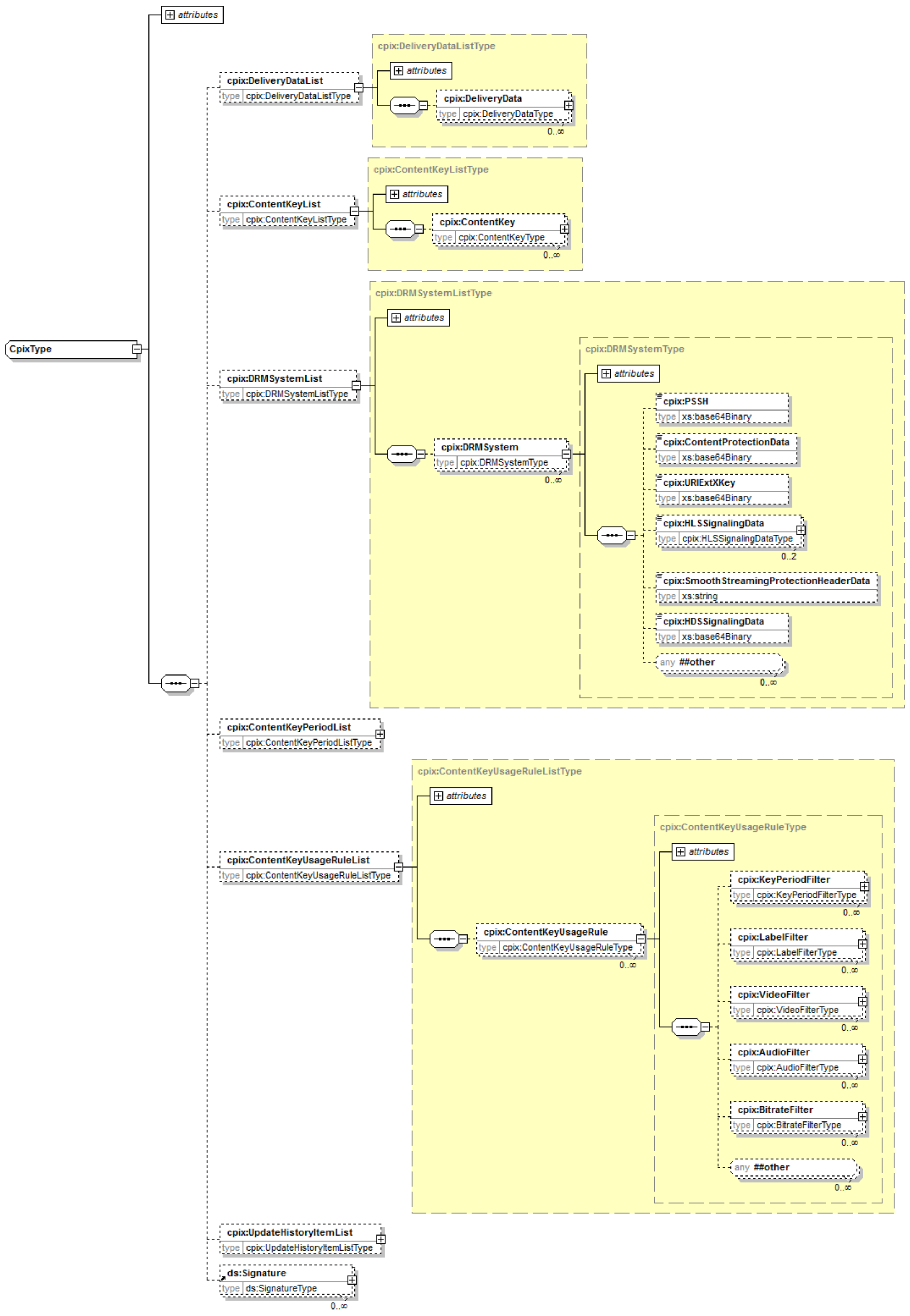


Figure 15 *Content Protection Information Exchange Format high level view.*

5.2. Hierarchical Data Model§

In this section the following conventions are used:

- Element names are in `PascalCase` and attribute names are in `camelCase`.
- Each type member is suffixed with its use requirements and its data type.
- Child element use requirements specify the number of elements allowed (`min...max`) where N means unbounded.
- Attribute use requirements indicate M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory.

Child elements shall be in the order specified here. Attributes may be in any order.

The XSD schema for this model is provided in [CPIX-XSD]. In addition to types defined in this document, the CPIX data model references types defined in [XMLSCHEMA11-2], [RFC6030], [XMLDSIG-CORE] and [XMLENC-CORE]. External data types are prefixed with `xs:`, `pskc:`, `ds:` and `xenc:` respectively.

5.2.1. `CPIX` Element§

The root element that carries the Content Protection Information for a set of media assets.

`id` (O, xs:ID)
An identifier for the CPIX document. It is recommended to use an identifier that is unique within the scope in which this file is published.

`contentId` (O, xs:string)
An identifier for the asset or content that is been protected by the keys carried in this CPIX document. It is recommended to use an identifier that is unique within the scope in which this file is published.

`name` (O, xs:string)
A name for the presentation.

`version` (O, xs:string)
A version for the CPIX document. The value shall reference a published version of the CPIX Guidelines and be structured as majorVersion.minorVersion (Example: '2.3').

If the CPIX client knows that it doesn’t support all the features of a given CPIX version, it needs to behave according to the recommendations of the API used to exchange the CPIX document.

`DeliveryDataList` (0...1, `<DeliveryDataList>`)
A container for `<DeliveryData>` elements. If not present, Content Keys in the document are delivered in the clear, without encryption.

`ContentKeyList` (0...1, `<ContentKeyList>`)
A container for `<ContentKey>` elements.

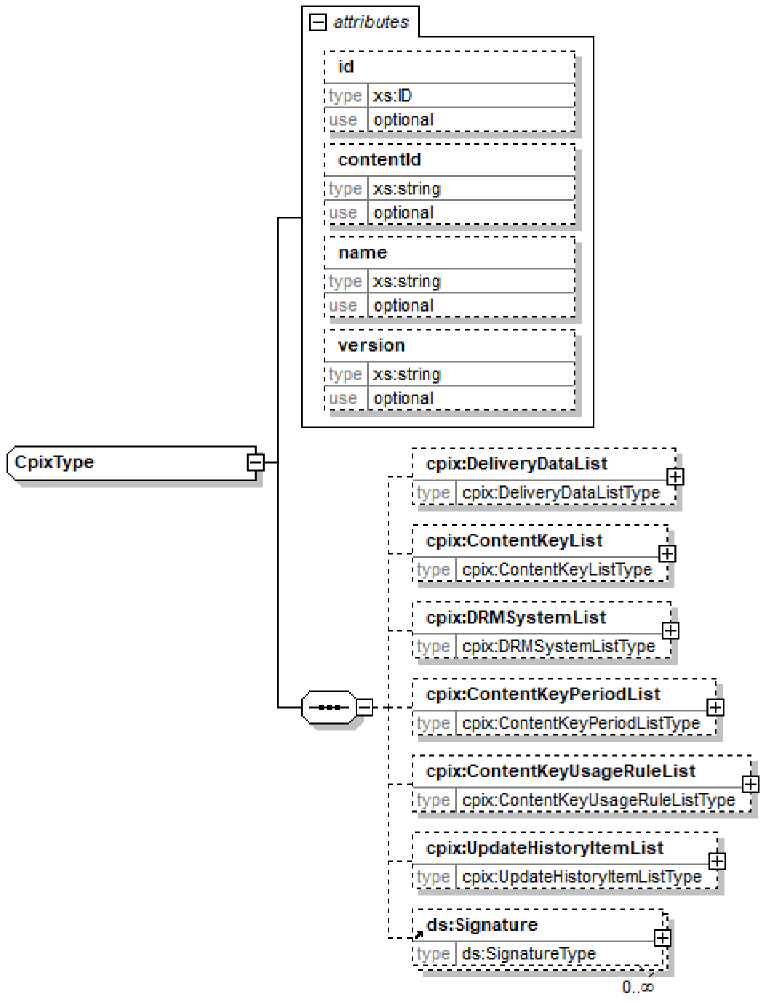
`DRMSystemList` (0...1, `<DRMSystemList>`)
A container for `<DRMSystem>` elements. If not present, the document does not contain any DRM system signaling data.

`ContentKeyPeriodList` (0...1, `<ContentKeyPeriodList>`)
A container for `<ContentKeyPeriod>` elements.

`ContentKeyUsageRuleList` (0...1, `<ContentKeyUsageRuleList>`)
A container for `<ContentKeyUsageRule>` elements. If not present, the document does not define Content Key Contexts and an external mechanism is required for synchronizing the content creation workflow.

`UpdateHistoryItemList` (0...1, `<UpdateHistoryItemList>`)
A container for `<UpdateHistoryItem>` elements.

`Signature` (0...N, ds:Signature)
Digital signatures as defined in [XMLDSIG-CORE]. Each signature signs either the full document or any set of elements within the CPIX document. Every digital signature shall contain an X.509 certificate identifying the signer and the associated public key.


attributes
id
type xs:ID
use optional
contentId
type xs:string
use optional
name
type xs:string
use optional
version
type xs:string
use optional
CpixType
cpix:DeliveryDataList
type cpix:DeliveryDataListType
cpix:ContentKeyList
type cpix:ContentKeyListType
cpix:DRMSystemList
type cpix:DRMSystemListType
cpix:ContentKeyPeriodList
type cpix:ContentKeyPeriodListType
cpix:ContentKeyUsageRuleList
type cpix:ContentKeyUsageRuleListType
cpix:UpdateHistoryItemList
type cpix:UpdateHistoryItemListType
ds:Signature
type ds:SignatureType
0..∞

5.2.2. `DeliveryDataList` Element§

`id` **(O, xs:ID)**

An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

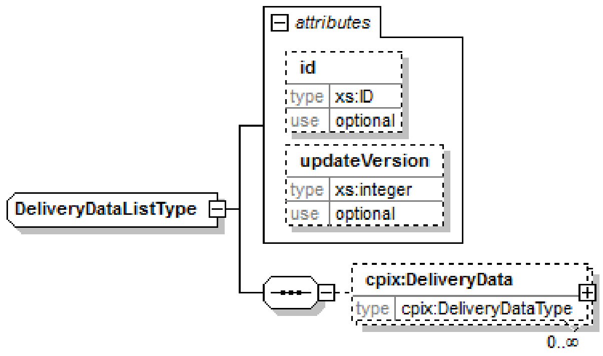
`updateVersion` **(O, xs:integer)**

Matches the `updateVersion` attribute of the `<UpdateHistoryItem>` element providing details on when this element was added or updated.

`DeliveryData` **(0...N, `<DeliveryData>`)**

Contains the required information allowing defining which entities can get access to the Content Keys delivered in this document.

There is one `<DeliveryData>` element per entity capable of accessing encrypted Content Keys stored in this document. If this element is not present, then the Content Keys are in the clear in the file.



5.2.3. `DeliveryData` Element§

`id` (O, xs:ID)
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`updateVersion` (O, xs:integer)
: Matches the `updateVersion` attribute of the `<UpdateHistoryItem>` element providing details on when this element was added or updated.

`name` (O, xs:string)
: Name of the Delivery Data.

`DeliveryKey` (1, ds:KeyInfoType)
: Contains an X.509 certificate that identifies the intended recipient and the public key that was used to encrypt the Document Key.

  Refer to § 6.1 Key Encryption in the CPIX Document for a description of the key management within the CPIX document.

`DocumentKey` (1, cpix:KeyType)
: Contains the key that was used for encrypting the Content Key stored in each `<ContentKey>` element. The Document Key is encrypted using the public key listed in the recipient's X.509 certificate.

  This is an extension of `KeyType` defined in [RFC6030]. The attributes `id` and `Algorithm` are optional in this extension.

  Refer to § 6.1 Key Encryption in the CPIX Document for a description of the key management within the CPIX document.

`MACMethod` (0...1, pskc:MACMethodType)
: Identifies the MAC algorithm and contains the MAC key used to implement authenticated encryption of Content Keys. The MAC key is encrypted using the public key listed in the recipient's X.509 certificate.

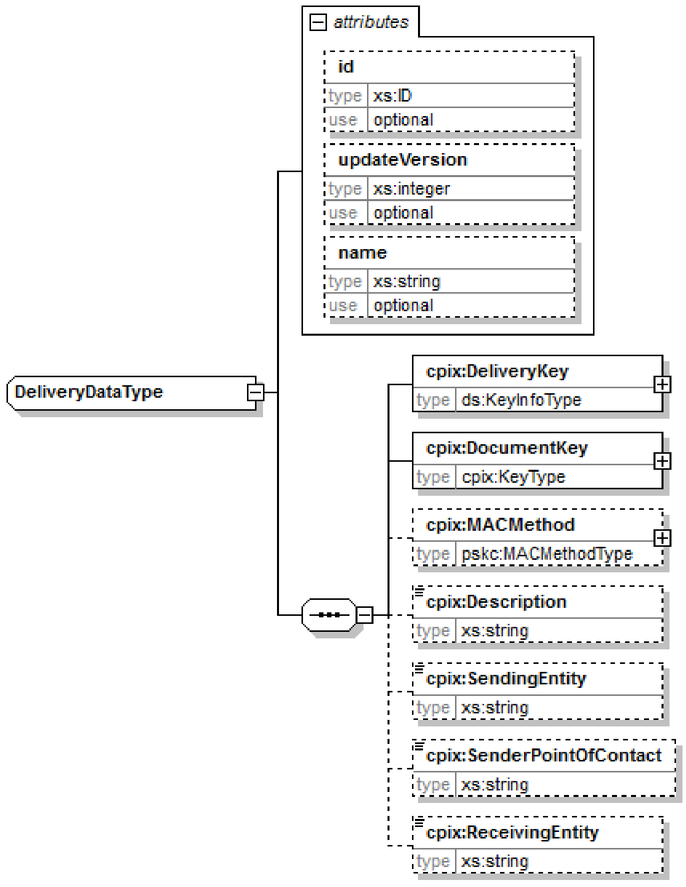
  Refer to § 6.1 Key Encryption in the CPIX Document for a description of the key management within the CPIX document.

`Description` (0...1, xs:string)
: A description of the element.

`SendingEntity` (0...1, xs:string)
: The name of the entity generating this CPIX document.

`SenderPointOfContact` (0...1, xs:string)
: The contact information, such as an email address, of the entity generating this CPIX document.

`ReceivingEntity` (0...1, xs:string)
: The name of the entity capable of decrypting Content Keys in this CPIX document.

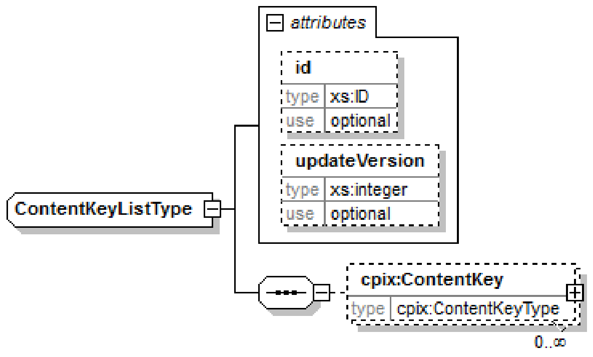


5.2.4. `ContentKeyList` Element§

`id` (O, xs:ID)
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`updateVersion` (O, xs:integer)
: Matches the `updateVersion` attribute of the `<UpdateHistoryItem>` element providing details on when this element was added or updated.

`ContentKey` (0...N, `<ContentKey>`)
: Contains all information on a Content Key used to encrypt one or more Content Key Contexts.



5.2.5. `ContentKey` Element§

This is an extension of `KeyType` defined in [RFC6030]. The attributes `id` and `Algorithm` are optional in this extension.

The key this element contains can be encrypted. If it is encrypted, it is encrypted with the key that is under the `DocumentKey` element part of the `<DeliveryData>`. Refer to § 6.1 Key Encryption in the CPIX Document for a description of the key management within the CPIX document.

`id` **(O, xs:ID)**
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`Algorithm` **(O, xs:ID)**
: This is an attribute inherited from [RFC6030] and made optional in this specification.

`kid` **(M, cpix:KeyIdType)**
: The unique identifier of the Content Key. It shall be formatted as defined in [MPEGCENC], section 11.2.

`explicitIV` **(O, xs:base64binary)**
: The IV to use when solution-specific logic requires a single explicit IV to be associated with a Content Key. The value consists of a 128-bit IV in binary format, base64-encoded.

  The primary use case is to enable the use of DRM systems that associate a single IV with each Content Key and whose DRM client implementations are unable to extract the IV from the content, requiring the license server to deliver the IV together with the Content Key upon request. A CPIX document can be used to supply the Content Key and IV together to the license server.

  Use of this attribute is not recommended except for compatibility with such DRM systems. Even if present in a CPIX document, the attribute should be ignored if solution-specific logic does not require it to be used.

`dependsOnKey` **(O, xs:string)**
: This attribute signals that the Content Key is a leaf key in a key hierarchy. It references the `kid` attribute of another `<ContentKey>` element describing the root key.

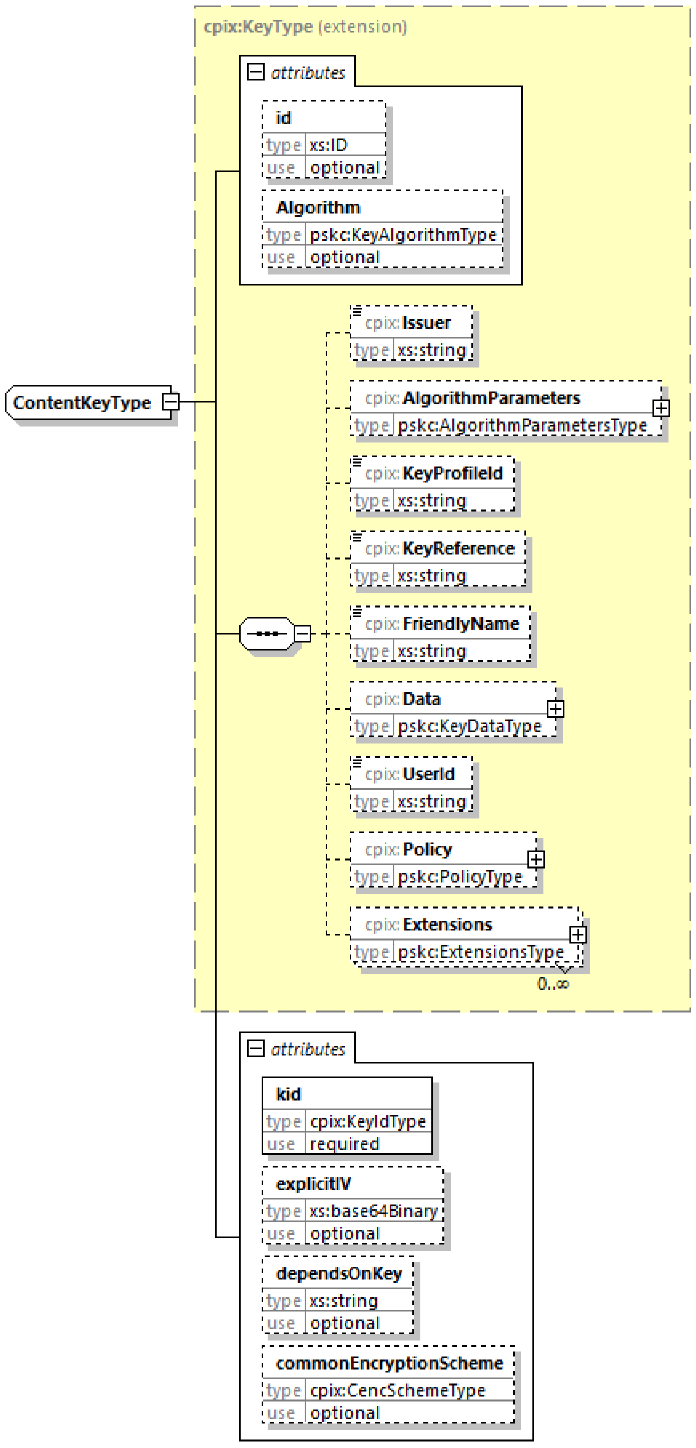
  The referenced key shall not be a leaf key.

  If this attribute is not specified, the Content Key is either a root key or does not participate in a key hierarchy. The CPIX document format does not make a distinction between these two cases.

`commonEncryptionScheme` **(O, xs:string with length=4)**
: This attribute shall not be used if the `dependsOnKey` attribute is present. In a key hierarchy, the root key defines the Common Encryption protection scheme to use with all keys in the hierarchy.

  The Common Encryption protection scheme that the content key is intended to be used with. When present, the value shall be a 4-character protection scheme name as defined by [MPEGCENC]. If the attribute is omitted then content may be encrypted using any Common Encryption protection scheme.

The DRM system signaling data in `<DRMSystem>` elements often contains the Common Encryption protection scheme identifier in a DRM system specific format. Ensure that the values in `<DRMSystem>` elements are aligned with the values in `commonEncryptionScheme` attributes.



5.2.6. `DRMSystemList` Element§

`id` (O, xs:ID)

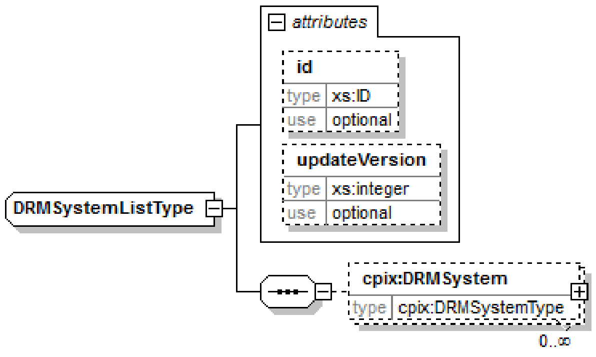
An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`updateVersion` (O, xs:integer)

Matches the `updateVersion` attribute of the `<UpdateHistoryItem>` element providing details on when this element was added or updated.

`DRMSystem` (0…N, `<DRMSystem>`)

DRM Signaling of a DRM system associated with a Content Key.



5.2.7. `DRMSystem` Element§

The `<DRMSystem>` element contains all information on a DRM system that can be used for retrieving licenses for getting access to content. This specification defines elements for DRM system signaling in DASH, ISOBMFF, Smooth Streaming, HLS and HDS formats. Implementations may extend CPIX documents with additional elements to provide DRM system signaling information for other formats.

`id` (O, xs:ID)
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`updateVersion` (O, xs:integer)
: Matches the `updateVersion` attribute of the `<UpdateHistoryItem>` element providing details on when this element was added or updated.

`systemId` (M, xs:string)
: This is the unique identifier of the DRM system. Values are avaialble on dashif.org.

`kid` (M, xs:string)
: Matches the `kid` attribute of the `<ContentKey>` this element references.

`name` (O, xs:string)
: This is a human-readable name and version of the DRM system. This can be used in DASH MPD as the value for the `@value` attribute of the `ContentProtection` element.

`PSSH` (0...1, xs:base64binary)
: This is the full PSSH box that should be added to ISOBMFF files encrypted with the referenced Content Key.

  When the key is a leaf key in a key hierarchy, the value is inserted under the `moof` boxes.

  This element should not be used when the key is not part of a key hierarchy or is a root key in a key hierarchy. Instead, the DRM system signaling should be carried by the format-specific data structures such `ContentProtectionData`. See [DASHIFIOP] section 7.7.1. If this element is used in the above circumstances, the value is inserted under the `moov` box.

  This element has meaning only when the media content is in the ISOBMFF format. In such a case, this is a mandatory attribute.

`ContentProtectionData` (0...1, xs:base64binary)
: This is the full well-formed standalone XML fragment to be added to the DASH manifest under the ContentProtection element for this DRM system. This is UTF-8 text without a byte order mark. An example of such data is the W3C signaling defined in [DASHIFIOP], in this case, all `dashif:xxx` elements are children of the `ContentProtection` element and are therefore be signaled in this element.

  This element shall not be used if the referenced Content Key is a leaf key in a key hierarchy.

  This element has meaning only when a DASH manifest is created for the media content.

`URIExtXKey` (0...1, xs:base64binary)
: This is the full data to be added in the URI parameter of the EXT-X-KEY tag of a HLS playlist. This is UTF-8 text without a byte order mark.

  This element is present only when the content is in the HLS format.

The use of this element is deprecated. Using `HLSSignalingData` is recommended.

`HLSSignalingData` (0...2, `<HLSSignalingData>`)

This is the full data including the #EXT-X-KEY or #EXT-X-SESSION-KEY tag of a HLS playlist depending on the destination of the data (see § 5.2.8 HLSSignalingData Element). This may contain multiple lines allowing to add lines with proprietary tags and values. This is UTF-8 text without a byte order mark.

This element shall not be used if the referenced Content Key is a leaf key in a key hierarchy.

This element has meaning only when a HLS playlist is created for the media content.

`SmoothStreamingProtectionHeaderData` (0...1, xs:string)

This is the inner text of the ProtectionHeader XML element to be added to the Smooth Streaming manifest for this DRM system. This is UTF-8 text without a byte order mark.

This element shall not be used if the referenced Content Key is a leaf key in a key hierarchy.

This element has meaning only when a Smooth Streaming manifest is created for the media content.

`HDSSignalingData` (0...1, xs:base64binary)

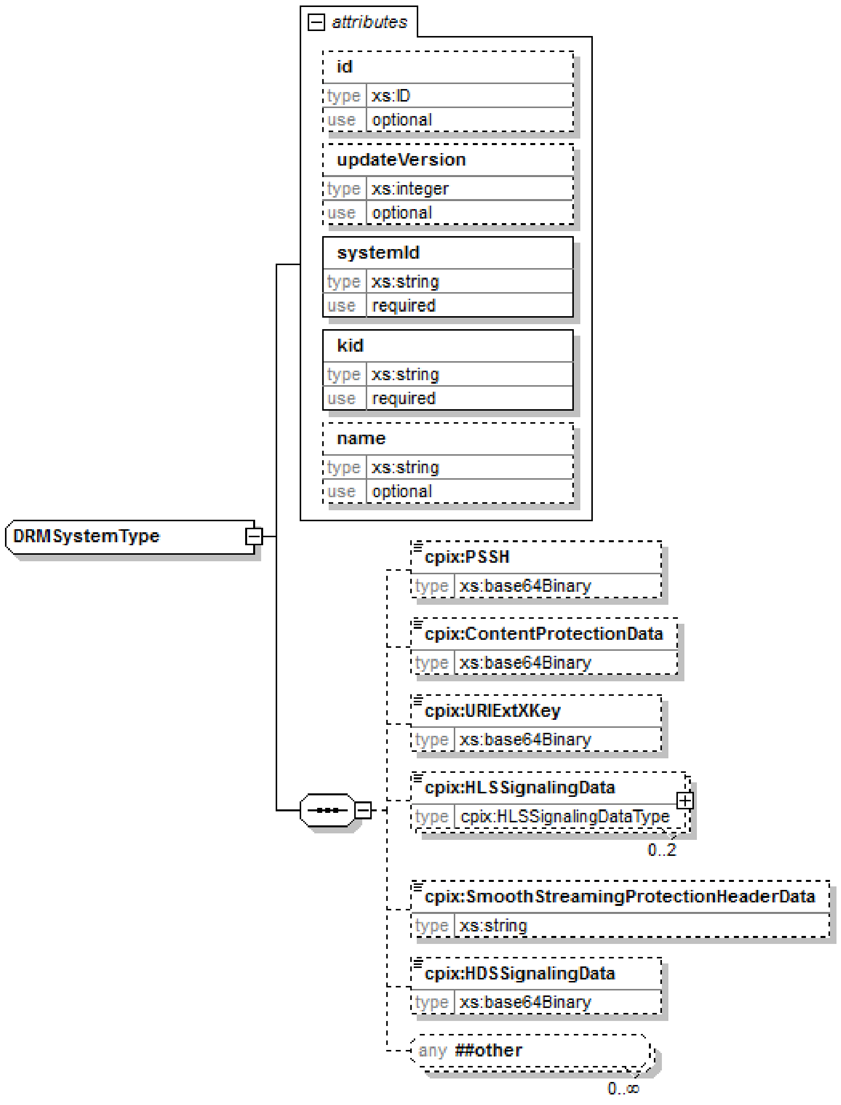
This is the full drmAdditionalHeader element to be added to the HDS playlist (including the beginning and ending tags). This is UTF-8 text without a byte order mark.

This element shall not be used if the referenced Content Key is a leaf key in a key hierarchy.

This element has meaning only when a Flash media manifest is created for the media content.

The DRM system signaling data in `<DRMSystem>` elements often contains the Common Encryption protection scheme identifier in a DRM system specific format. Ensure that the values in `<DRMSystem>` elements are aligned with the values in `commonEncryptionScheme` attributes.

Additional child elements not defined by DASH-IF may be present containing signaling data for other media formats. Such elements must appear after any elements defined here.

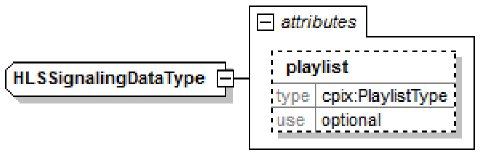


5.2.8. `HLSSignalingData` Element§

The HLSSignalingData allows carrying base64 encoded text. It has an optional attribute allowing to define where this data is to be placed, either in the master playlist or in the media playlist. It allows having different proprietary signaling in these locations. In a `<DRMSystem>` element, every `<HLSSignalingData>` SHALL have a different `playlist` value if present. If `playlist` is not present then the HLSSignalingData goes in the media playlist and there is no signaling in the master playlist (in this case, there is only one HLSSignalingData element in the `<DRMSystem>` element).

`playlist` (O, restricted xs:string)

Specifies the destination of the data carried by this element. It can only have two values `master` and `media`. There is a uniqueness rule for this attribute. If two elements are added under a `<DRMSystem>` element, they SHALL not have the same `playlist` value.



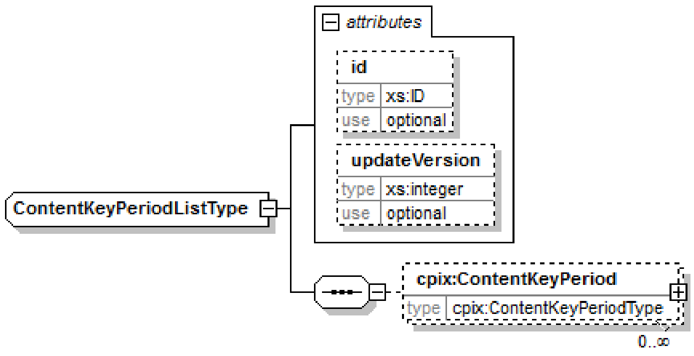
5.2.9. `ContentKeyPeriodList` Element§

`id` (O, xs:ID)

An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`updateVersion` (O, xs:integer)
: Matches the `updateVersion` attribute of the `<UpdateHistoryItem>` element providing details on when this element was added or updated.

`ContentKeyPeriod` (0...N, `<ContentKeyPeriod>`)
: A list of ContentKeyPeriod element. For every Content Key, ContentKeyPeriod elements cover non ovelapping periods of time. The concatenation of all period of times may not fully cover the Content as some parts may be in the clear.



5.2.10. `ContentKeyPeriod` Element§

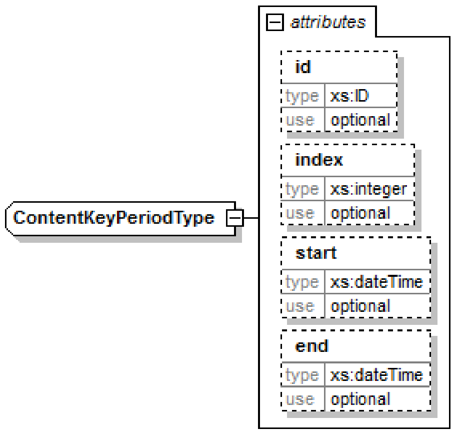
When `start` and `end` are present, the interval is defined by [`start`, `end`), meaning that the key is in use at the start time but not at the end time. If neither are specified, then it is assumed that the encryptor is determining the key period boundaries internally, and other components do not need to be aware of them. In this case, the key periods are referenced simply by a sequence number (`index`). An example of this would be an encryptor which rotates the keys once an hour, and not necessarily at specific times.

`id` (O, xs:ID)
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`index` (O, xs:integer)
: Numerical index for the key period. Mutually exclusive with `start` and `end`.

`start` (O, xs:dateTime)
: Wall clock (Live) or media time (VOD) for the start time for the period. Mutually inclusive with `end`, and mutually exclusive with `index`.

`end` (O, xs:dateTime)
: Wall clock (Live) or media time (VOD) for the end time for the period. Mutually inclusive with `start`, and mutually exclusive with `index`.

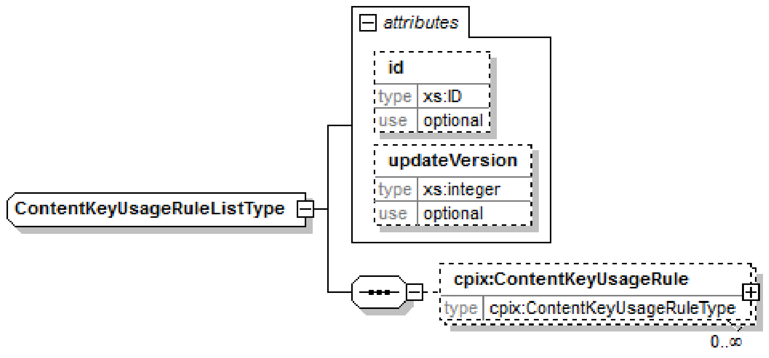


5.2.11. `ContentKeyUsageRuleList` Element§

`id` **(O, xs:ID)**
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`updateVersion` **(O, xs:integer)**
: Matches the `updateVersion` attribute of the `<UpdateHistoryItem>` element providing details on when this element was added or updated.

`ContentKeyUsageRule` **(0…N, `<ContentKeyUsageRule>`)**
: A rule which defines a Content Key Context.



5.2.12. `ContentKeyUsageRule` Element§

`id` **(O, xs:ID)**
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`kid` **(M, xs:string)**
: Matches the `kid` attribute of the `<ContentKey>` this element references.

  In hierarchical key scenarios, this shall reference a leaf key, not a root key.

`intendedTrackType` **(O, xs:string)**
: Specifies the type of media track which corresponds to the streams which match the rules defined in this `<ContentKeyUsageRule>` element.

  Examples of types for the media track might be UHD, UHD+HFR. See § 5.2.13.3 LabelFilter Element for more details.

`KeyPeriodFilter` **(0…N, `<KeyPeriodFilter>`)**
: Defines a period of time constraints for the Content Key Context.

  This filter links `<ContentKey>` and `<ContentKeyPeriod>` elements.

`LabelFilter` **(0…N, `<LabelFilter>`)**
: Defines a label association for the Content Key Context.

`VideoFilter` **(0…N, `<VideoFilter>`)**
: Defines video constraints to be associated with the Content Key Context.

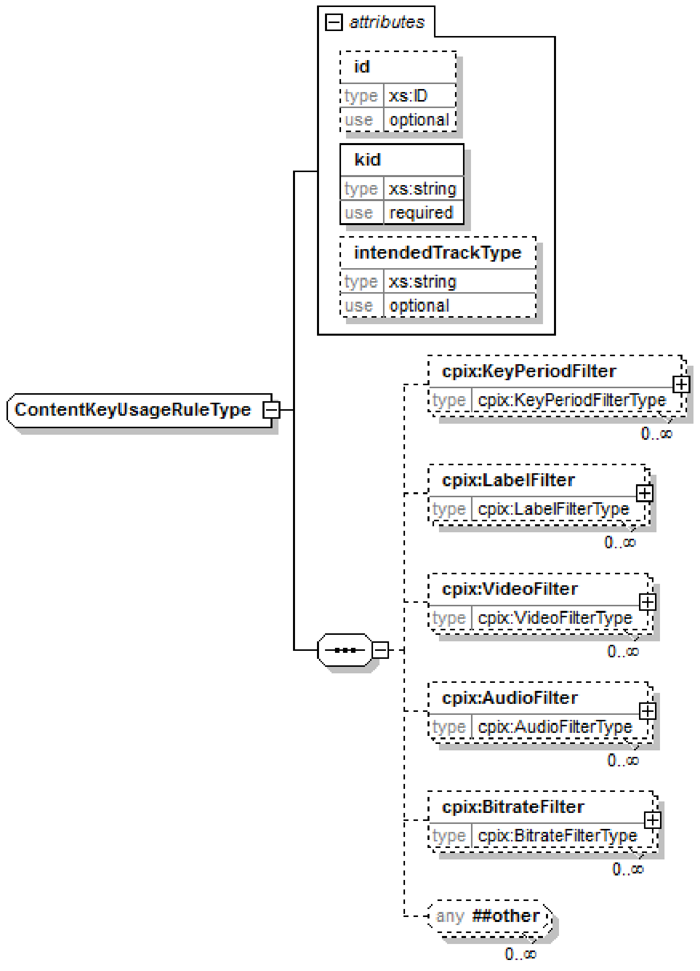
  This filter can only be used on media content of type video.

`AudioFilter` **(0…N, `<AudioFilter>`)**
: Defines audio constraints to be associated with the Content Key Context.

  This filter can only be used on media content of type audio.

`BitrateFilter` **(0…N, `<BitrateFilter>`)**
: Defines bitrate constraints to be associated with the Content Key Context.

Additional child elements not defined by DASH-IF may be present containing proprietary filters. Such elements must appear after any elements defined here.



5.2.13. `Usage Rules Filters`§

5.2.13.1. `Introduction`§

There can be several filters defined within a single `<ContentKeyUsageRule>`. In this case, all rules apply identically, the entity generating the `<ContentKeyUsageRule>` element or adding a new rule is responsible for ensuring that they do not contradict each other. A set of rules that would match multiple Content Keys to a single Content Key Context is invalid.

If more than one of a particular type of filter (e.g. `<KeyPeriodFilter>`) is present within a `<ContentKeyUsageRule>`, then they are first aggregated with a logical OR operator. After that, different types of filters are aggregated with a logical AND operator. For example, a rule that defines a label filter for stream-1, a label filter for steam-2 and a video filter would be matched as (stream-1 OR stream-2) AND video.

A scenario where multiple Content Keys can be mapped to a single Content Key Context shall be considered invalid. A CPIX document must always match exactly zero or one Content Keys to any Content Key Context.

A usage rule shall be considered unusable if it contains a child element whose meaning is unknown (i.e. a filter of an unknown type) or which cannot be processed for any other reason (e.g. `minPixels` is defined but the implementation does not know the pixel count of the video samples). An entity interpreting the `<ContentKeyUsageRule>` element shall not perform Content Key(s) mapping to Content Key Contexts if any unusable usage rules exist. An entity that is not interpreting the `<ContentKeyUsageRule>` element (doing, for example, only storage of the CPIX document for latter distribution to another entity) can perform any processing on the document.

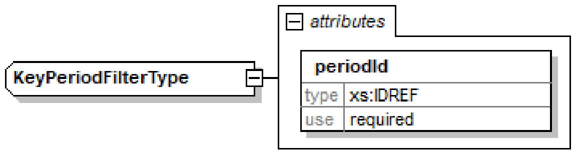
Processing of the Content Key(s) referenced by any unusable usage rules must not be performed. The usable part of the document can be processed normally.

There can be many different sources for defining usage rules, for example, they can be the result of a right holder requirement or a decision to encrypt separately SD, HD and UHD tracks. The CPIX document does not keep track of the source of these rules, it only defines how to maps Content Keys to tracks.

5.2.13.2. `KeyPeriodFilter` Element§

`periodId` (M, xs:IDREF)

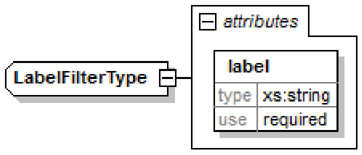
This references a `<ContentKeyPeriod>` element by `id`. The filter will only match samples that belong to the referenced key period.



5.2.13.3. `LabelFilter` Element§

`label` (M, xs:string)

The filter will only match samples that carry a matching label. The exact meaning of labels is implementation-defined and must be agreed upon in advance by the producer and consumer of the CPIX document.



The `label` attribute is meant for triggering a particular `<ContentKeyUsageRule>` by using pre-agreed upon label strings. Its value may or may not correspond to media track types. One example is a label such as UHD that can be used to match the corresponding `<ContentKeyUsageRule>` element when used as an input or selector for a content encryptor, media packager, MPD generator or license service to select a specific Content Key, populate the ContentProtection element, or include the corresponding key in a content license. Another example is if there is a previous agreement defined outside of a CPIX document that "blue tracks" are encrypted with the Content Key 1234 and "green tracks" are encrypted with the Content Key 5678. The labels can be used in this case to identify the suitable tracks (without expressing the specifics of the agreement itself).

In contrast, the `intendedTrackType` attribute of `<ContentKeyUsageRule>` is used to assign a track type to the media streams which match the filters. The value of the string may not be pre-agreed between the various entities making use of the CPIX document. Said differently, the `intendedTrackType` attribute is a metadata that states business logic. For example, a rule can be that all low resolutions streams are encrypted with the same Content Key. The value lowRes matches this rule. It has no function in defining what Content Key are matched to what tracks, it simply acts as a label to allow business logic to say authorize the use of lowRes Content Key and then a CPIX processor can find the rules that matches the right Content Keys for lowRes and thereby associated with low resolution tracks.

Note: If a specific key is to be used for more than one type of track (this is not recommended), then there ought to be multiple `<ContentKeyUsageRule>` elements, one for each track type, even if they all reference the same Content Key with the same `kid`.

5.2.13.4. `VideoFilter` Element§

If present, even without any attributes, the filter will only match video samples.

`minPixels` (OD, xs:integer)

The filter will only match video samples that contain at least this number of pixels (encoded width x height before considering pixel/sample aspect ratio). The default value is 0 (zero).

`maxPixels` **(OD, xs:integer)**
: The filter will not match video samples that contain more than this number of pixels (encoded width x height before considering pixel/sample aspect ratio). The default value is MAX_UINT32.

`hdr` **(O, xs:boolean)**
: Boolean value indicating whether the matching video stream is encoded in HDR.

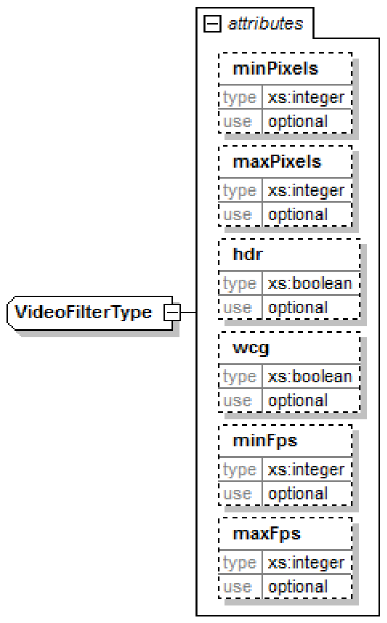
`wcg` **(O, xs:boolean)**
: Boolean value indicating whether the matching video stream is encoded in WCG.

`minFps` **(O, xs:integer)**
: Minimum nominal number of frames per second for the video stream. For interlaced video, this is half the number of fields per second.

`maxFps` **(O, xs:integer)**
: Maximum nominal number of frames per second for the video stream. For interlaced video, this is half the number of fields per second.

When `minPixels` and `maxPixels` are present, the interval is defined by [`minPixels`, `maxPixels`], meaning that the filter is used for content with video samples that contain `minPixels` pixels and is used for content with video samples that contain `maxPixels` pixels.

When `minFps` and `maxFps` are present, the interval is defined by (`minFps`, `maxFps`], meaning that the filter is not used for content with nominal FPS equal to `minFps` but is used for content with nominal FPS equal to `maxFps`.



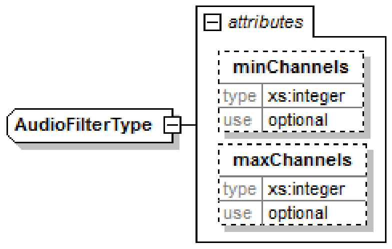
5.2.13.5. `AudioFilter` *Element*§

If present, even without any attributes, the filter will only match audio samples.

`minChannels` **(OD, xs:integer)**
: The filter will only match audio samples that contain at least this number of channels. The default value is 0 (zero).

`maxChannels` **(OD, xs:integer)**
: The filter will not match audio samples that contain more than this number of channels. The default value is MAX_UINT32.

When `minChannels` and `maxChannels` are present, the interval is defined by [`minChannels`, `maxChannels`], meaning that the filter is used for content with audio samples that have `minChannels` audio channels and is used for content with audio samples that have `maxChannels` audio channels.



5.2.13.6. `BitrateFilter` Element§

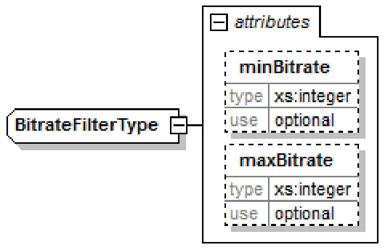
`minBitrate` (OD, xs:integer)
: The filter will only match samples from streams with a nominal bitrate in b/s of at least this value. The default value is 0 (zero).

  At least one of `minBitrate` and `maxBitrate` must be specified.

`maxBitrate` (OD, xs:integer)
: The filter will not match samples from streams with a nominal bitrate in b/s that exceeds this value. The default value is MAX_UINT32.

  At least one of `minBitrate` and `maxBitrate` must be specified.

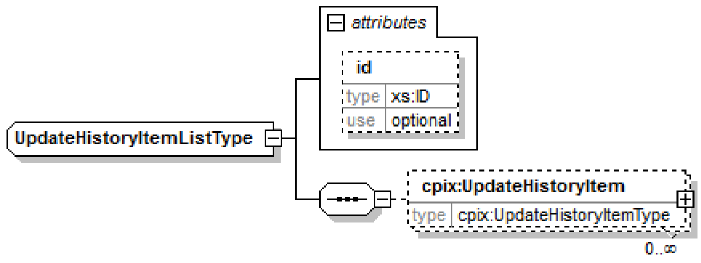
When `minBitrate` and `maxBitrate` are present, the interval is defined by [`minBitrate`, `maxBitrate`], meaning that the filter is used for content with bitrate of `minBitrate` and is used for content with bitrate of `maxBitrate`.



5.2.14. `UpdateHistoryItemList` Element§

`id` (O, xs:ID)
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`UpdateHistoryItem` (0...N, `<UpdateHistoryItem>`)
: It contains metadata about an update made to the CPIX document. There should be one entry for each instance in which an entity updated the document.



5.2.15. `UpdateHistoryItem` Element§

`id` (O, xs:ID)
: An identifier for the element. It is recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`updateVersion` **(M, xs:integer)**

The is the ID referenced by other elements in the document. It is strongly recommended to use an identifier that is unique within the scope in which this CPIX document is published.

`index` **(M, xs:string)**

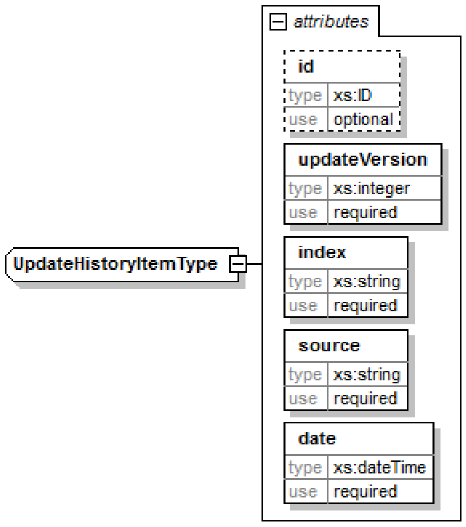
This is the version number for the document update. Each `<UpdateHistoryItem>` element contains a unique value for this attribute. It is a monotonically increasing number, starting at value 1.

`source` **(M, xs:string)**

This is the identifier for the entity which performed the document update.

`date` **(M, xs:dateTime)**

This is the date and time when the document update was performed.



6. Key Management§

6.1. Key Encryption in the CPIX Document§

The CPIX document allows exchanging Content Keys in the clear but this is not a recommended method as it relies on the security of the communication mechanism used to deliver the CPIX document to the recipients, which may not be sufficient to adequately protect the Content Keys.

Content Keys can be delivered encrypted within the document itself and in this case, a multi-level structure of encryption keys is used for an efficient encryption avoiding duplication of encrypted content and expensive encryption methods. This section describes the mechanism that shall be used when encryption of the Content Keys in the document is used.

6.1.1. Keys Used to Secure the CPIX Document§

The document contains the following keys:

Content Keys

Each `<ContentKey>` element contains one Content Key that is used for encrypting an asset or crypto period of an asset or that acts as a dependency for the use of other Content Keys (when a key hierarchy is used). Typically, for Common Encryption as supported in [DASHIFIOP], these keys are 128-bit keys used with the AES cipher.

Document Key

For every CPIX document, a Document Key is created. It is used for encrypting every Content Key. The Document Key is a 256-bit key and the encryption algorithm used for encrypting every Content Key is AES. The Document Key is part of each `<DeliveryData>` element. It is itself encrypted in the document, using the public key of each recipient.

Delivery Keys

Each `<DeliveryData>` element identifies a Delivery Key, which is a public key from a key pair owned by the intended recipient. The Delivery Key is identified in the `<DeliveryData>` element by including the X.509 certificate of the intended recipient. The Delivery Key is used for encrypting the Document Key using an algorithm that is described within the CPIX document, according to [XMLENC-CORE].

The below figure gives the schema of encryption of the different keys when there are several `<DeliveryData>` elements and several `<ContentKey>` elements. The Document Key allows reducing the numbers of `<ContentKey>` elements as the Content Key they contain are all encrypted by the same Document Key.

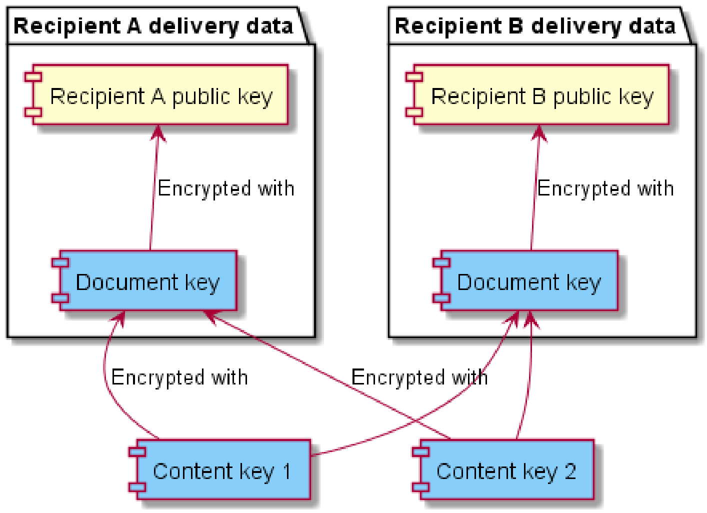


Figure 16 *Encryption relationships within the CPIX document. Blue indicates encrypted data.*

6.1.2. Authenticated Encryption§

MAC Key

For every CPIX document, a MAC Key is created. It is used to calculate the MAC of every encrypted Content Key. The `<DeliveryData>` element identifies the MAC algorithm and provides the MAC Key, encrypted with the Delivery Key, for each recipient.

Authenticated Encryption of Content Keys

Implementations shall provide a MAC for every encrypted Content Key and shall verify the MAC before attempting to decrypt any encrypted Content Key. The purpose of the MAC is to protect against cryptographic vulnerabilities in the receiving application; it is not used as a general purpose authentication mechanism.

The MAC is calculated over the data in the `CipherValue` element (the concatenated IV and encrypted Content Key) and stored in the `ValueMac` element under the Secret element for each encrypted Content Key.

6.1.3. Digital Signature§

Every element in the document that has an @id attribute can be signed according to [XMLDSIG-CORE]. Furthermore, the document (including any other signatures) can be signed as a whole.

Upon loading a CPIX document, implementations should verify that signatures are present on entities that are expected to be signed and verify all digital signatures that are present. Implementations should refuse to process a document if expected signatures are missing or if the signatures cannot be verified or if the signers are not trusted as authoritative sources for the signed data.

Implementations should sign any elements that recipients wish to authenticate. Note that modifying any signed data will require any signatures on the data to be removed and/or re-applied. This requires the appropriate consideration and trust model design in content processing workflow creation (out of scope of this specification).

6.1.4. Mandatory Algorithms§

The following table gives the identification of the algorithms that shall be used for encryption, signature, MAC creation.

Usage	*Algorithm*
Content Key wrapping	AES256-CBC, PKCS #7 padding
Encrypted key MAC	HMAC-SHA512
Document Key wrapping	RSA-OAEP-MGF1-SHA1
Digital signature	RSASSA-PKCS1-v1_5
Digital signature digest	SHA-512
Digital signature canonicalization	Canonimal XML 1.0 (omits comments)

For RSA, the recommended minimum key size is 3072 bits and is it not recommended to use certificates that are signed using SHA-1.

6.2. Key Rotation Support§

A CPIX document can contain content protection information for multiple crypto-periods, or period of time for content encrypted using key rotation. In this case, the document shall contain one or more `<ContentKey>` elements, one per crypto-period which the document covers. Each `<ContentKey>` element contains the key material for a single crypto-period. The crypto-period itself is identified by the `<ContentKeyPeriod>` element, that includes `start`/`end` or `index` attributes.

Key rotation may be supported in complex workflows, with one entity requesting DRM Signaling for multiple crypto periods, and another entity providing the requested information (keys, DRM system-specific information for the crypto period, etc).

Content encrypted using key rotation may also have periods in the clear that are not encrypted. In this case, there is no Content Key for these periods. A CPIX document will carry no specific information allowing to know that some periods are not encrypted. The information that content is encrypted or not would be known by either looking at the playlist/manifest or any other specific deployment source of data (such as EPG, a metadata server).

6.3. Hierarchical Keys§

Some DRM systems support the use of hierarchical keys, where the keys used to encrypt media samples (leaf keys) are not usable without a second set of keys (root keys). The mechanism by which root keys are used to protect leaf keys is DRM system specific.

CPIX supports expressing two-level key hierarchies, where each leaf key has exactly one root key that is required in order to use the leaf key. Both root keys and leaf keys are represented using `<ContentKey>` elements, with leaf keys indicated by the presence of a `dependsOnKey` reference to the root key as described in § 5.2.5 ContentKey Element.

When using hierarchical keys, only the leaf keys shall be used to encrypt media content. Therefore, root keys must not be referenced by any `<ContentKeyUsageRule>` elements.

The usage of DRM system signaling data is different when hierarchical keys are used. The differences are described in § 5.2.7 DRMSystem Element.

Any DRM system specific functionality associated with key hierarchies exists on the DRM layer. It may affect the DRM system signaling data but not the keys themselves.

6.4. Content Keys with Several Protection Encryption Schemes§

[MPEGCENC] defines several protection schemes that are not interoperable. This means that several encrypted versions for the same content in the clear are created if the targeted devices support one or another protection scheme. While it may not be recommended, it is possible to use the same Content Keys when encrypting these different versions. In term of CPIX document, this means that several documents need to be created, these documents will differ on the `commonEncryptionScheme` which will take a different value depending on the protection schemes. Note that depending on the DRM, some elements under the `<DRMSystem>` element may also be different.

7. Examples§

Example CPIX documents are available on GitHub.

The examples contain valid data unless explicitly noted otherwise. Their contents are described on the referenced page.

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