

The MPEG-21 Rights Expression Language and Rights Data Dictionary

Xin Wang, Thomas DeMartini, Barney Wragg, M. Paramasivam and Chris Barlas

Abstract— The MPEG-21 Rights Expression Language (REL) is an XML-based language for digital rights management (DRM), providing a universal method for specifying rights and conditions associated with the distribution and use of assets like content, resources and services. Evolved from the eXtensible rights Markup language (XrML), the REL facilitates the creation of an open DRM architecture for managing and protecting these assets. As a general-purpose rights expression language, the REL is agnostic to types of assets, platforms and media, and expressive enough to support applications that can be even beyond DRM, including protecting privacy. It also contains additional capabilities in the areas of extensibility, security, trust management, and life cycle management of rights. This article provides an overview of the REL in terms of its data model, expressiveness, authorization model, structure for extensibility and profiling, and usages in digital media, trust management, and web services. To support the REL and provide extensive semantics for the management of rights, MPEG-21 also defined a Rights Data Dictionary (RDD). Based on original work conducted by <indecs>, the MPEG-21 RDD specifies a methodology and structure for the RDD dictionary. The specification defines a core set of terms and provides a mechanism for the introduction of further terms through a registration authority. The RDD also supports the mapping of terms from different namespaces.

Index Terms— Authorization, digital rights management, protection, rights, and trust management.

I. INTRODUCTION

THE Internet has spawned a revolution in how content is distributed and services are accessed. This reality, coupled with the increasing availability of broadband networks and improving capability and portability of computing and consumer electronic devices, has fueled the development of technologies to automate, manage and secure the flow of content and the access to services over the Internet. Many business models in electronic commerce and enterprise management have been developed to establish cost effective, reliable, flexible, highly available, and secure means of

managing the supply, delivery, consumption and sharing of these content and services.

One of the key technologies in digital rights management (DRM) is a rights expression language (REL). DRM [10][11][14] refers to the collection of hardware, software, services, and technologies for persistently governing authorized distribution and use of content and services according to their associated rights and managing consequences of that distribution and use throughout their entire life cycle or workflow. For DRM, content can be in the form of audio, video, text, image, software or others, and a service can be any local or remote, centralized or distributed resource that provides a set of functionality to its clients. In order to develop effective and efficient DRM systems, the capability of specifying and communicating rights information among the participants is certainly required at each step of the lifecycle or in the workflow. For example, backward along the supply-distribution-consumption value chain, content users need to know what rights are associated with content and granted to them, content distributors and retailers need not only to communicate the rights that are available for consuming the content but also to understand the rights that pertain for distributing the content, and content providers in the upstream of the value chain need to ensure that both usage and distribution rights are granted precisely as intended for each participant in the end-to-end value chain. Clearly, these rights can be simple or very complex. For example, a user may obtain the rights for unlimited play for a music file, and a corporate document may have the usage right restricted to certain management levels and business divisions. Rights expressions get more complex when one tries to model the use and distribution of content in the physical world. For example, specifying the rights that govern the lending of a digital book or the giving-away of an article in an electronic magazine could be fairly complex.

Thus, a common REL that can be shared among the participants in the workflow and lifecycle is essential. Not only from an obvious interoperability point of view, but more so to comprehend that rights will be manipulated and changed during the workflow and lifecycle as content moves from the creator, aggregator, distributor, retailer, and finally to consumer, and to comprehend system issues such as security and trust needed to preserve the authenticity, integrity, confidentiality and trustworthiness of rights expressions.

Beyond the content industries, other sectors will almost certainly require the functionality provided by a common

Manuscript received May 9, 2004.

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REL. Almost all business communities have a requirement for authorizing access to and governing use of their resources and services. In the case of business, a company may wish to restrict certain documents to certain employees or to communicate with third parties on the basis of certain conditions. The adoption of a common REL beyond the content industries will have advantages in addition to those that accrue to any individual sector. The obvious advantage is that it will be possible to communicate content, share resources, and exchange services, all governed by rights expressions, beyond the boundaries of a particular sector. This could be particularly useful in certain types of corporate publishing, such as the exploitation of data in the financial services industry, where a standard shared with commercial publishing may produce new business opportunities. However, an equally important advantage for consumers is likely to flow from the existence of a common REL standard for implementers of rights management as well as technologies for conditional access and traditional access control and authorization. Such a standard will produce greater competition among implementers. Users will be able to choose “best of breed” based on a single standard, which will lead to lower prices and larger markets with more affordable and accessible content and services for more customers.

This article provides an overview of the International Standard ISO/IEC 21000-5:2004, the MPEG-21 Rights Expression Language [8] (or thereafter the MPEG REL for short), and the International Standard ISO/IEC 21000-6:2004, the MPEG-21 Rights Data Dictionary [9] (or thereafter the MPEG RDD for short). The Moving Picture Experts Group (MPEG) started the development process for the MPEG REL in 2001 with a Call for Proposals and an evaluation process in which XrML 2.0 from ContentGuard [3][19] was selected as the core architecture and base technology. The publication of the MPEG REL as an International Standard [8] culminates more than two years of work by representatives from technology companies, consumer electronics companies, content owners, and creators that have taken part in this open development process. The development of the MPEG RDD advanced in parallel with the MPEG REL, the submission from the <indec>2 Consortium [15] having been selected as the baseline technology at the same time. The parallel development was essential as the two specifications have a semantic dependency, though they can be used independently of one another.

The rest of this article first presents an overview of the MPEG REL in terms of its objectives, data model, expressiveness, authorization model, structure for extensibility, and profiling; then describes the relationship the REL has with the other parts of MPEG-21 [1][2] and its adoption in other industry standards; and finally provides three illustrative applications on digital media, trust management, and distributed authorization for multi-tier web services. The article ends with an overview of the MPEG RDD.

II. THE MPEG REL LANGUAGE

A. Objectives

The MPEG REL is an XML-based declarative language used to specify rights and conditions for the authorized distribution and use of any content as well as resources and services. Its goals are: (1) to define syntax and semantics of a machine interpretable language that can be used to specify rights unambiguously; (2) to provide an authorization model to determine if an authorization or access control request can be granted according to a set of rights expressions in the language; and (3) to support many usage models in the end-to-end distribution value chain.

The MPEG REL is intended to provide flexible, interoperable mechanisms to support transparent and augmented use of digital resources in publishing, distributing, and consuming of digital content (including movies, digital music, electronic books, broadcasting, interactive games, computer software, and other creations in digital form) in a way that protects the content and honors the rights, conditions, and fees specified for the content. It is also intended to support specification of access and use controls for digital content in cases where financial exchange is not part of the terms of use, and to support exchange of sensitive or private digital content. It is thus critical that the language has well defined syntax and unambiguous semantics.

This language can be used, not only in the entertainment industry but also by enterprises and individuals, to enable the authorized distribution and persistent protection of valuable data, content, and resources in accordance with privacy and confidentiality requirements. This includes that, when used for protecting consumer privacy [18], the MPEG REL provides a flexible interoperable mechanism to ensure personal data is processed in accordance with individual rights and to meet the requirement for consumers to be able to express their rights and interests in a way that addresses issues of privacy and use of personal data. Therefore, it is essential that the language provides a formal model on how authorization can be granted according to rights expressed in the language.

As an important technology for the development of interoperability across DRM systems as well as content management and digital asset management systems, the MPEG REL must be rich enough to express a wide variety of usage models and enable multi-tier distribution and usage of all types of digital content, resources and services in closed and centralized as well as open and distributed environments.

B. Data Model

The primary function of the MPEG REL is to specify rights relating to digital resources (such as content, services, or software applications). Using this language, anyone owning or distributing digital resources can identify principals (such as users, groups, devices, and systems) authorized to use those resources, the specific rights accorded to those principals, and the terms and conditions under which those rights may be exercised.

For example, consider a song “When the Thistle Blooms”, distributed by a label “PDQ Records”, to the owner of an MP3 player – call her Alice. A typical REL expression might make the statement, “under the authority of PDQ Records, Alice is granted the right to play ‘When the Thistle Blooms’ for 3 weeks.” Fig. 1 shows this simple REL expression in its structural form:

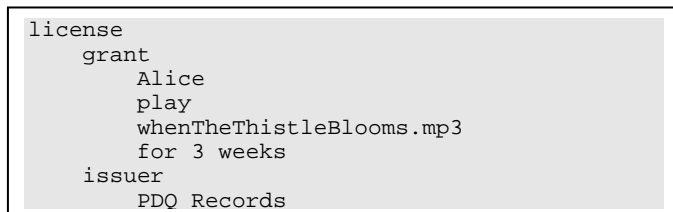


Figure 1. An Example REL Expression

With this expression, Alice has been issued the right to play the song whenTheThistleBlooms.mp3 under the condition that she can only play it for 3 weeks.

In the MPEG REL terminology, Alice is considered as a *principal*; play, a *right*; “When the Thistle Blooms”, a *resource*; for 3 weeks, a *condition*; and PDQ Records, an *issuer* of the right. The simple example above captures the essence of an MPEG REL expression; that is, it conveys a statement of the following form: An issuer states that a *principal* has some *right* to a *resource* under some *condition*. The right-granting portion of this statement (e.g., “Alice is granted with the right to play ‘When the Thistle Blooms’ for 3 weeks”) is called a *grant* and the entire statement is called a *license*, which in this case consists of the grant and the issuer, PDQ Records.

These basic elements and their inter-relationships constitute the MPEG REL data model, as shown in Fig. 2.

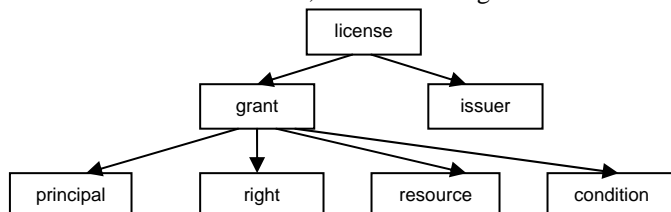


Figure 2. Data Model of Licenses

In this data model, a license contains one or more grants and an issuer, whereas a grant contains principal, a right, a resource, and a condition. More specifically, the roles of these elements can be explained as follows:

license – A license is a container of grants, issuers, and some other related information. It is the central construct of the MPEG REL. Conceptually, a license is a collection of grants issued by one or more issuers.

issuer – An issuer is an element within the license that identifies a principal who issues the license. The issuer can also contain a digital signature of the license signed by the principal to signify that the principal does indeed bestow the grants contained in the license, and to facilitate reliable establishment of trustworthiness of the license by others.

grant – A grant is the element within the license that essentially grants a principal with a right over a resource, possibly subject to a condition.

principal – A principal within a grant encapsulates the identification of a party to whom a right is granted. A principal denotes the party that it identifies by information unique to that party. Usefully, this is information that has some associated authentication mechanism by which the principal can prove its identity. For example, the MPEG REL supports the concept of a keyHolder, meaning someone identified as possessing a secret key, such as the private key of a public/private key pair.

right – A right is the “verb” that a principal can be granted to exercise against some resource under some condition. Typically, a right specifies an act (or activity) or a class of acts that a principal may perform on or using the associated resource. The MPEG REL provides a set of commonly used, specific rights, such as play, print and adapt, as well as rights relating to other rights, such as obtain, issue, and revoke.

resource – A resource is the “object” to which a principal can be granted a right. A resource can be a digital work (such as an eBook, an audio or video file, or an image), a service (such as an email service, or B2B transaction service), or even a piece of information that can be owned by a principal (such as a name, an email address, a role, or any other property or attribute). A resource can also be a grant, and in this case a right about that grant (as a meta right) would be specified within its parent grant. The MPEG REL provides mechanisms to encapsulate the information necessary to identify a particular resource or a collection of resources with some common characteristics.

condition – A condition specifies the terms, conditions, and obligations under which rights can be exercised. For example, a simple condition is a time interval within which a right can be exercised, and a slightly more complicated condition may require the existence of a valid, prerequisite right that has been issued by some trusted entity. Moreover, a condition can be the conjunction of several other conditions. Note that, in case the disjunction of several other conditions needs to be specified for a grant, the same grant can be specified several times in a license with each having a different condition.

The data model above describes the basic elements of an MPEG REL expression. For many additional elements related to, for example, variable declaration and reference, delegation control, and revocation, see the specification [8].

C. Extensibility and Profiling

The MPEG REL is designed to be extensible and is itself specified in extensions. Its syntax is defined using the XML Schema and Namespace Recommendations by W3C [14][17]. This enables the MPEG REL to offer a high degree of flexibility in its extensibility. The MPEG REL is organized into several architectural parts as shown in Fig. 3.

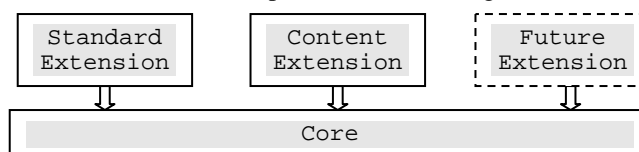


Figure 3. Extensibility Structure

- Core: definitions of general constructs that are domain agnostic and form the architectural basis for the language.
- Standard extension: definitions of concepts that are generally and broadly useful and applicable to DRM usage scenarios.
- Multimedia extension: definitions of DRM concepts (e.g., rights, resources, and conditions) specifically related to multimedia content such as books, music, and video.

Each of these architectural parts is a normative aspect of the overall MPEG REL specification. Other parties may, if they wish, define their own, possibly domain-specific, extensions to the MPEG REL and its future extensions. This is accomplished using the existing, standard XML Schema and XML Namespace mechanisms [16][17]. More specifically, extensions to the MPEG REL could define principals, rights, resources, and conditions appropriate to specific usage models and technical applications. For example, the MPEG REL multimedia extension defines rights appropriate to using digital resources such as play and print, and conditions to using digital resources, such as those for specifying watermarks, destinations, and rendering applications.

While it is expected that many communities will create extensions to the baseline MPEG REL, it is also possible to profile the language according to the flexibility of its definition (e.g., many MPEG REL elements and attributes are optional, and their occurrences can be included or omitted in a profile). This involves the creation of a subset of the language for a specific purpose. This will become extremely important as content moves through the value chain down to many different devices. For instance, for a mobile phone the full power of the language as required by a PC will not be needed and a slimmed down version – a profile – can be used to express usage rights. By this means, the MPEG REL can be exploited both for demanding applications on powerful equipment and for simple applications on lightweight consumer devices.

D. Expressiveness

The MPEG REL has very rich expressiveness in terms of usage models and potential applications it supports. Some commonly used types of licenses that the MPEG REL can express for the end-to-end, multi-tier distribution value chain of digital content are: *usage*, *distribution*, *offer*, *certificate*, and *revocation*. These types of licenses are briefly explained here, and uses of these licenses will be demonstrated in Section II for some example applications.

A *usage license* certifies that the issuer authorizes the principal the right to exercise the specified usage right on a resource if the stated condition is met. A usage license contains rights such as “play” and “edit” for content usage. For example, the usage license in Fig. 1 grants a principal, Alice, the right to play an MP3 song for three weeks.

An *offer license* expresses the fact that a certain principal has the right to “obtain” other rights (in the form of grants) by meeting any listed condition. The offer license uses “obtain” as the right and places the other rights that are being offered in

the form of grants as the resource. For example, the license in Fig. 4 gives Alice an offer to obtain the usage right to play an MP3 song for three weeks if she pays a fee of \$4.

```

license
  grant
    Alice
    obtain
    grant
      Alice
      play
      whenTheThistleBlooms.mp3
      for 3 weeks
    fee $4
  issuer
    PDQ Records

```

Figure 4. An Example Offer License

A *distribution license* expresses that a certain principal has the right to issue particular other rights to other principals if abiding by a set of conditions. Distribution licenses can be used within the distribution value chain for content owners to allow distributors to distribute content and for distributors to permit retailers to sell content. For example, the distribution license in Fig.5 shows that a company ACMEmusicwarehouse is granted with the right to issue to any other principal the right to play an MP3 song for three weeks if the company pays a fee of \$3 for every such issuance.

```

license
  grant
    ACMEmusicwarehouse
    issue
    grant
      anyone
      play
      whenTheThistleBlooms.mp3
      for 3 weeks
    fee $3
  issuer
    PDQ Records

```

Figure 5. An Example Distribution License

A *certificate license* represents an assertion by the issuer that some principal possesses some properties (especially in the forms of roles and attributes). A certificate license is characterized by the “possessProperty” right. In many cases, this kind of license is required before granting a principal other rights. The example in Fig. 6 is that the issuer certifies that the principal Alice is a member of a certain music club.

```

license
  grant
    Alice
    possessProperty
    musicClubMembership
  issuer
    PDQ Records

```

Figure 6. An Example Certificate License

A *revocation license* allows the issuer to grant the right to “revoke” the licenses it has issued. At any time after issuing a license, the issuer may revoke that issuance. In this way, that particular issuer no longer authorizes the grants that the license contains. Using the revoke right, issuers may grant revocation authority to other principals. A grant containing the revoke right must identify the revocable that may be revoked

as its resource. The revocation license in Fig. 7 allows Alice to revoke another license issued by PDQ Records having the specified signature value.

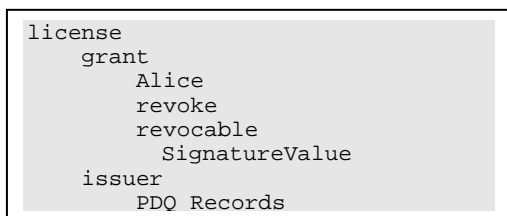


Figure 7. An Example Revocation License

E. Authorization Model

In order to provide a formal semantics of a license and its elements, the MPEG REL defines an authorization model as shown in Fig. 8 for determining if a request for exercising a right is permitted or not according to a set of licenses.

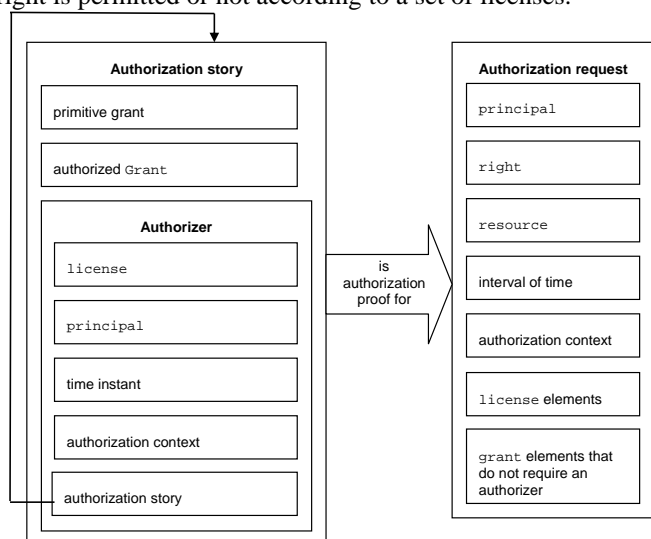


Figure 8. Authorization Model

The authorization model consists of two components called “authorization request” and “authorization story”, and a relationship between them called “authorization proof”. In essence, the model says that an authorization request is permitted if there is an authorization story that provides an authorization proof for the request. An authorization request holds the information necessary to ask the following question:

“Is a given principal permitted to perform a given right upon a given resource during a given time interval based on a given authorization context, a given set of licenses, and a given trust root?”

and an authorization story holds all the information necessary to state the following fact:

“A given primitive grant (i.e., a grant with no variables) may be derived from a given grant authorized by a given authorizer, which identifies a principal from a license at a time instant based on an authorization context and supported (recursively) by an (additional) authorization story.”

Here, the authorization context is a subordinate component that provides name-value pairs representing a list of context attributes used to evaluate conditions and verify the issuance

of licenses. An authorization story is said to be an authorization proof for an authorization request if the following are true:

- the primitive grant in the story matches the principal, right, and resource in the request and its condition is satisfied within the authorization context in the request,
- the primitive grant indeed is derived from the grant,
- the issuance of the grant in the first authorization story is recursively authorized via the additional authorization story in the authorizer in the first authorization story, and
- the recursive authorization eventually terminates in one of the trust roots given in the authorization request.

When the question represented by the authorization request is answered “yes,” the authorization model requires that there shall be at least one authorization story that is an authorization proof for the authorization request. According to this, the semantics of licenses is that the licenses permit an authorization request if there is an authorization story that is an authorization proof for the authorization request.

III. THE ROLE OF REL IN MPEG-21 AND OTHER STANDARDS

Within MPEG-21 [1][2], the MPEG REL [8] is closely related to the RDD (Rights Data Dictionary) [9] which specifies a dictionary of terms that can be used by the REL to describe rights. The RDD specification also provides a methodology for extending the dictionary to include new terms. The MPEG REL can also use the identification mechanism defined in the DII (Digital Item Identification) [7] to identify digital items described in the language defined by the DID (Digital Item Declaration) [6] and hence specify rights over those digital items. Rights expressions can also be included in digital item declarations.

Outside MPEG, the MPEG REL has started to receive a lot of attention. It has been selected as the basis for the Rights Expression Language standard of the Open eBook Forum [13]. It is also under consideration for adoption by a number of other standards bodies due to its nature of being domain agnostic. For instance, the OASIS Web Services Security Technical Committee [12] has approved the use of the MPEG REL with respect to the WSS specification for building secure Web services to implement message level integrity and confidentiality. In addition, there is now an on-going liaison between the Learning Technologies Sub-committee of the IEEE [5] and MPEG, specifically on adopting the MPEG REL for the delivery of distance teaching and learning.

IV. EXAMPLE APPLICATIONS

This section illustrates how the MPEG REL can be used in the following three example applications:

- On-line movie rental,
- Restriction of content usage on trusted devices, and
- Distributed authorization in multi-tier Web services.

For more example applications of the MPEG REL, see [4].

A. On-line Movie Rental

An online movie company, Internet Film, allows consumers to play any film in its library for a \$2 fee. Consumer licenses are valid for 30 days before they expire. Once a consumer has viewed the video file, they may replay it any number of times within the next 24 hours, at which time the license expires.

To address this case, two licenses are required:

- an offer license that allows anyone to play any video file if that person pays the \$2 fee.
- a usage license that specifies the time limits for a specific consumer's use of a particular video file.

1) Offering Movie Rentals

The offer that Internet Film makes to its rental customers is shown structurally in Fig. 9.

```

license
  grant
    Anyone
    obtain
    grant
      Anyone
      play
      AnyMovie
      allConditions
        ThirtyDays
        validityIntervalFloating
        serviceReference
        duration: 24 hours
    fee per use: $2

```

Figure 9. Offer License for Movie Rental

This offer enables any principal who pays a \$2 fee to obtain the usage right, which allows that principal to play a movie subject to the specified time limits. This offer license uses the following variables:

- **Anyone:** the principal in both grants. When a consumer exercises the obtain right, this variable in the inner grant is replaced by that consumer's identity.
- **AnyMovie:** any movie in Internet Film's library. When a consumer exercises the obtain right, this variable is replaced by a resource representing a particular movie the consumer wants to rent.
- **ThirtyDays:** a validity interval of 30-days duration. When a consumer exercises the obtain right, this variable is replaced by a specific 30 day interval.

The condition `validityIntervalFloating` specifies a floating interval of 24 hours during which the consumer may play the movie he rents. This floating interval begins when the consumer first exercises the play right. This condition uses a service reference to record the first exercise of the play right and determine whether replays fall within the stipulated 24-hour interval. In conjunction with the `ThirtyDays` condition, it ensures that the movie play, once it starts, is restricted to a 24-hour interval within some fixed 30 day rental period.

2) Licensing Movie Rentals

When a consumer pays the \$2 fee and exercises the obtain right, Internet Film issues that consumer a usage license. Fig. 10 illustrates the structure of the usage license that Internet Film issues to Alice when she pays the \$2 fee to rent a big blockbuster movie:

```

license
  grant
    Alice
    play
    big blockbuster movie
    allConditions
      validityInterval
        notBefore: March 1
        notAfter: March 30
      validityIntervalFloating
      serviceReference
      duration: 24 hours

```

Figure 10. Usage License for Movie Rental

Note that the grant in this license matches the grant in the offer, except that all the variables are now replaced as follows:

- Alice's identity replaces the `Anyone` variable.
- The `big blockbuster movie` replaces the `AnyMovie` variable.
- A specific 30-day interval (March 1-30) replaces the `ThirtyDays` variable.

It should be pointed out that, in this license, elements representing Alice and the big blockbuster movie should be referenced in the `serviceReference` of the `validityIntervalFloating` condition, so that this use of the movie rental service can be tracked separately from uses by other consumers or Alice's rental of other films. However, this detail has been omitted from the figure for clarity and brevity. Similar kinds of tracking details have also been omitted from all the `serviceReference` elements in all the licenses throughout the rest of Section II.

B. Content Usage on Trusted Devices

This application describes how to grant rights to consumers to play music on trusted devices, in order to show a use of certificate licenses in trust management of devices. In this case, Music Label A offers consumers the right to obtain the right to play a specific album on any device that Music Label A trusts for a fee of \$10. Fig. 11 illustrates the structure of this offer license.

```

license
  grant
    Consumer
    obtain
    grant
      Consumer
      play
      Album
      renderer
        TrustedDevice
          Music Label A
    feeFlat: $10

```

Figure 11. Offer License for a Trusted Device

This license uses the following variables:

- **Consumer:** any consumer who may obtain the right to play an album.
- **Album:** any album in Music Label A's catalog.
- **TrustedDevice:** a device trusted by Music Label A; that is, it specifies that any device substituted for this variable must possess the property of being trusted by Music Label A. The consumer grant references this

variable in a renderer condition, which stipulates that the right (play in this case) must be exercised using a trusted device.

If Alice chooses this offer and exercises the obtain right, she pays the \$10.00 fee and receives a license to play a particular album in Music Label A's library.

When issuing Alice's usage license as shown in Fig 12, Music Label A replaces two of the variables in the license with specific information, as follows:

- Alice's identity replaces the variable Consumer.
- A reference to a particular album, Jazz Top Hits, replaces the variable Album.

```
license
grant
  Alice
  play
  JazzTopHits
  renderer
    TrustedDevice
    Music Label A
```

Figure 12. Usage License for a Trusted Device

The renderer condition stipulates that the album may only be played on a device that matches the TrustedDevice variable.

To satisfy the renderer condition, Alice must have a certificate license specifying that the particular device she wants to use to play the album is trusted by Music Label A. Fig. 13 illustrates the structure of one such license:

```
license
grant
  Alice's device
  possessesproperty
  trustedDevice
  Music Label A
```

Figure 13. Certificate License for a Trusted Device

In this certificate license, Alice's device is granted the possessProperty right. The possessProperty right enables the device to claim ownership of the characteristics listed as resources in the grant. The resource for the grant is the property of being a device trusted by Music Label A.

C. Distributed Authorization in Multi-Tier Web services

This example application describes a series of scenarios based on a multi-tier commerce model using web services. It shows how rights depend on existence and validity of other rights, and how various kinds of licenses are used in web services for multi-tier distribution. In this case, the following institutes offer services to their respective clients:

1. Financial Research provides financial research reports, which consumers may view online.
2. ABC Financial is one of Financial Research's clients. In addition to financial planning services, it provides its clients with access to the financial research reports. ABC Financial's clients fall into two categories:
 - a. End consumers, such as Fred. The fees these consumers pay to view financial research reports are split between ABC Financial and Financial Research, Inc.

b. Other financial firms that have an alliance with ABC Financial, such as XYZ Financial, who provide their own clients with access to the financial reports.

3. XYZ Financial's clients, like Alice, can also purchase rights to view the financial reports. The fees these consumers pay are split three ways between XYZ Financial, ABC Financial, and Financial Research, Inc.

For the brevity sake, this example limits the distribution to a few tiers. Clearly it can be expanded to allow more tiers to split the fees that are paid for the financial reports.

1) Granting View and Issue Rights

In this scenario, Financial Research, Inc. issues two licenses to its clients:

- A usage license enabling the client to play (view) any of Financial Research's reports for a fee.
- A distribution license that enables anyone to issue a license that enables someone else to play (view) the financial reports for a fee. The right to issue is predicated on that person also having their own license to play (view) Financial Research's reports for a fee.

Fig. 14 illustrates the structure of the first of these licenses:

```
license
grant
  ABC Financial
  play
  AnyReport
  feeFlat
    serviceReference
    rate $12
    to: Financial Research
  issuer
    Financial Research's signature
```

Figure 14. License issued to ABC Financial

This license enables ABC Financial to view any of Financial Research's reports, provided that they pay a flat fee to Financial Research. In this case, a variable, AnyReport, is used to identify the report that ABC Financial can view.

```
license
grant
  Anyone
  issue
  grant
    SomeoneElse
    play
    AnyReport
    feeFlat
      serviceReference
      rate $12
      to: allPrincipals
      feeRecipient
      Anyone
  existRight
  Anyone
  play
  AnyReport
  feeFlat
    serviceReference
    rate $12
    to: feeRecipient
  issuer
    Financial Research's signature
```

Figure 15. Distribution and Usage License

Fig. 15 illustrates the structure of a distribution license that allows anyone to issue a license to someone else that enables them to view financial reports for a fee. The right to issue is predicated on the issuer also having its own license to view Financial Research's reports for a fee.

2) *Issuing Licenses to ABC Financial's Clients*

At the next tier of distribution, ABC Financial issues licenses to an end consumer Fred and XYZ Financial enabling them to view any of Financial Research's reports, provided that they pay a fee that is split equally between Financial Research and ABC Financial. ABC Financial can issue these licenses because its license to view Financial Research reports satisfies the existsRight condition in the license that Financial Research, Inc. issued above in Fig. 15.

Figures 16 and 17 illustrate the licenses that ABC Financial issues to Fred and XYZ Financial, respectively:

```
license
  grant
    Fred
    play
    AnyReport
    feeFlat
    serviceReference
    rate $12
    to: allPrincipals
      Financial Research
      ABC Financial
  issuer
    ABC Financial's signature
```

Figure 16. License issued to Fred by ABC Financial

```
license
  grant
    XYZ Financial
    play
    AnyReport
    feeFlat
    serviceReference
    rate $12
    to: allPrincipals
      Financial Research
      ABC Financial
  issuer
    ABC Financial's signature
```

Figure 17. License issued to XYZ Financial by ABC Financial

3) *Issuing Licenses to XYZ Financial's Clients*

At this tier of distribution, XYZ Financial issues a license as shown in Fig. 18 to Alice.

```
license
  grant
    Alice
    play
    AnyReport
    feeFlat
    serviceReference
    rate $12
    to: allPrincipals
      allPrincipals
      Financial Research
      ABC Financial
      XYZ Financial
  issuer
    XYZ Financial's signature
```

Figure 18. License issued to Alice by XYZ Financial

This license enables her to play (view) any of Financial Research's reports, provided that she pays a fee that is split equally between Financial Research, ABC Financial, and XYZ Financial. XYZ Financial can issue this license because its license to view Financial Research reports satisfies the existsRight condition in the license that Financial Research, Inc. issued in Fig. 15.

V. THE MPEG RDD

The MPEG RDD is based on the work undertaken in the original <indec> project [15], which set out an event based approach to the interoperability of metadata. Building on this approach, the MPEG RDD is based on a logical structure, referred to as the Context Model, which is used to construct a natural language ontology for Terms used in rights management. The MPEG RDD supports a range of common ontological axioms such as type inheritance and disjunction, but enhances them with an additional core structure. Terms are organized into Families according to the roles they play in Contexts. Contexts come in two varieties – Events (through which change happens) and Situations (which are unchanging) - which conform to the rules of the MPEG RDD Context Model. This model (see diagram below) defines a group of five Terms which form the “BasicTermSet” – Context, Agent, Resource, Time and Place. These terms and their associated Classes and Relators form the core semantic architecture of the MPEG RDD – that is, the mechanisms by which meanings are derived from one another.

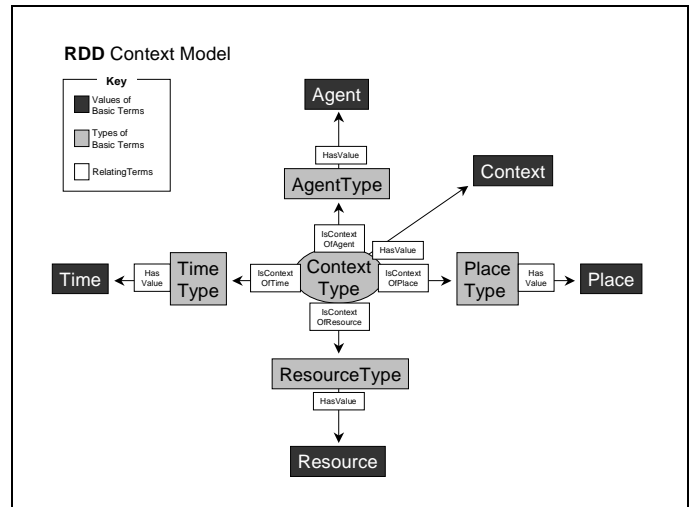


Figure 19, The MPEG RDD Context Model

Using the Context Model, Terms can be introduced in a logical manner, ensuring that the structure of the dictionary is not broken. For instance, when a new Act (say, Modify) is defined, a full range of related Terms embodying some aspect of the Act can also be defined, and each new Term placed in its logical node of the Dictionary. This Modify “Begets” the Terms Modifier, Modification, TimeOfModification and PlaceOfModification. The Model also provides all the specific Relationship Types which exist between any two elements of a Context (for example, IsModifierOf or HasPlaceOfModification). This ready proliferation of derived

Terms creates mapping points for potentially any Term in any Schema.

The baseline dictionary contained in the specification contains approximately 2000 Terms, providing the basis for the introduction of new Terms, in accordance with the methodology based on the Context Model.

As the primary purpose of the MPEG RDD is to support the MPEG REL there are fourteen RDD ActTypes which are normatively referenced by the MPEG REL specification. These “rights verbs” – defined as ActTypes by the MPEG RDD – are the baseline actions that can be used in REL grants. The fourteen ActTypes, with their supporting ontology are the result of a very careful analysis and cover the most common expected actions a user might wish to undertake with respect to digital content. They are presented in the table below.

ActType	Definition
Adapt	To ChangeTransiently an existing Resource to Derive a new Resource.
Delete	To Destroy a DigitalResource.
Diminish	To Derive a new Resource which is smaller than its Source.
Embed	To put a Resource into another Resource.
Enhance	To Derive a new Resource which is larger than its Source.
Enlarge	To Modify a Resource by adding to it.
Execute	To execute a DigitalResource.
Install	To follow the instructions provided by an InstallingResource.
Modify	To Change a Resource, preserving the alterations made.
Move	To relocate a Resource from one Place to another.
Play	To Derive a Transient and directly Perceivable representation of a Resource.
Print	To Derive a Fixed and directly Perceivable representation of a Resource.
Reduce	To Modify a Resource by taking away from it.
Uninstall	To follow the instructions provided by an UninstallingResource.

Table 1. The Fourteen RDD ActTypes

It is recognized that in future, as more complex rights expressions are created, more granular definitions may be required and this is managed through the process of specialization, whereby a Term can be created, using the methodology of the Context Model, to suit a particular circumstance.

The MPEG RDD has also been designed to deal with many different metadata schemes which already exist and supports the mapping of Terms from different namespaces. Such mapping will enable the transformation of metadata from the terminology of one namespace (or Authority) into that of another namespace (or Authority). This is an essential prerequisite to semantic interoperability of rights expressions.

The mapping will be the responsibility of the Registration Authority, which will be established under JTC1 Directives.

VI. CONCLUDING REMARKS

The MPEG REL is the international standard rights expression language approved by the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC). Supported by the MPEG RDD and due to its precision, flexibility, extensibility, and richness in expressing rights, conditions, and obligations, the international standard REL is able to support end-to-end interoperability, consistency, and reliability between different devices, systems, and services in a wide variety of usage models in applications ranging from simple single-tier distribution to complex multi-tier distribution of content and resources.

For the complete and precise descriptions of the MPEG REL and RDD, see [8] and [9], respectively. For more information on examples and applications of the MPEG REL, see [4].

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