

# MPEG Standards Enabling Universal Multimedia Access

## MPEG-21 Multimedia Framework – Overview

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1<sup>st</sup> Int'l. Conf. on  
Automated Production of Cross Media Content for Multi-channel Distribution  
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Acknowledgements:

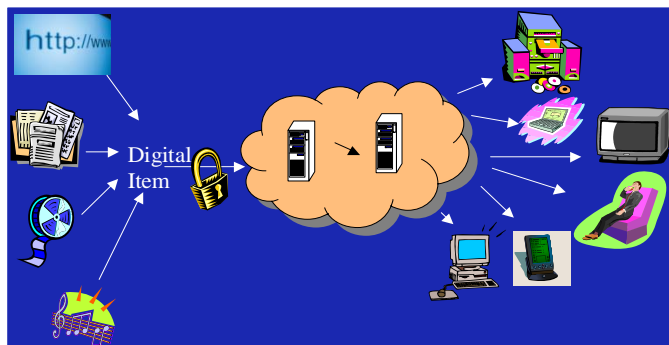
Ian Burnett, Fernando Pereira, Rik Van de Walle

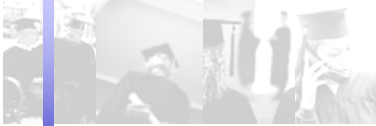


## MPEG-21 Vision

To enable **transparent and augmented use** of multimedia resources across a wide range of **networks, devices, user preferences, and communities**, notably for trading (of bits).

- Assumption: every human is potentially a node of a network involving billions of ...
  - content providers
  - value adders
  - packagers
  - service providers
  - consumers
  - resellers





## MPEG-21 Integration Goals

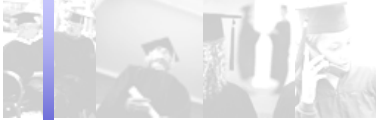
MPEG-21's goal is to create an **interoperable and integrated multimedia framework** in three steps:

- **Develop "big picture"**: understand how the components of the framework are related and identify where gaps in the framework exist
- **Fill the gaps**: develop new standard specifications where needed
- **Integrate**: achieve the integration of standards to support harmonized technologies for the management of multimedia content



## Functions to Support

- Content creation
- Content production
- Content distribution
- Content adaptation
- Content consumption and usage
- Content packaging
- Digital rights management
- Content identification and description
- Financial management
- User privacy
- Terminals and network resource abstraction
- Content representation
- Event reporting



## Why an Open Standard, not a “Walled Garden” ?

- Technology usable by everybody on **fair and reasonable terms**
- Stimulates **competition and technological evolution** in the non-normative areas
- Consumers will have access to a large variety of **complex content** in an interoperable way, including rights management
- Content providers and consumers will have access to a large variety of **interoperable products** from different companies
- Competition in the context of the standard will improve the performance while decreasing the costs, facilitating **rich multimedia applications**



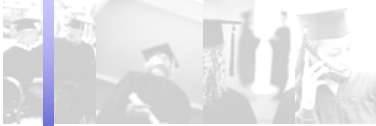
## MPEG-21 Basic Concepts

### What ? – Digital Items (DIs)

- A **Digital Item (DI)** is a structured digital object with a standard representation, identification, and metadata (e.g., digital rights) within the MPEG-21 framework. Digital Items are “the content”.

### Who ? – Users

- A **User** is any entity that interacts in the MPEG-21 environment or makes use of a Digital Item. Users will assume rights and responsibilities according to their interaction with other Users.



## What is a Digital Item ?

**Digital Item = Resources + Metadata + Structure**

**Resources:** individual assets, (distributed) content

**Metadata:** (distributed) data about or pertaining to the DI or its resources

**Structure:** relationships among the parts of the DI

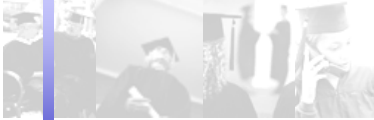
- **Tangibility:** content is more than "files on a disk"
- **Configurability:** can express options/augmentations for specific users, groups, locales, prices
- **Deliverability:** more automated, less end-user involvement



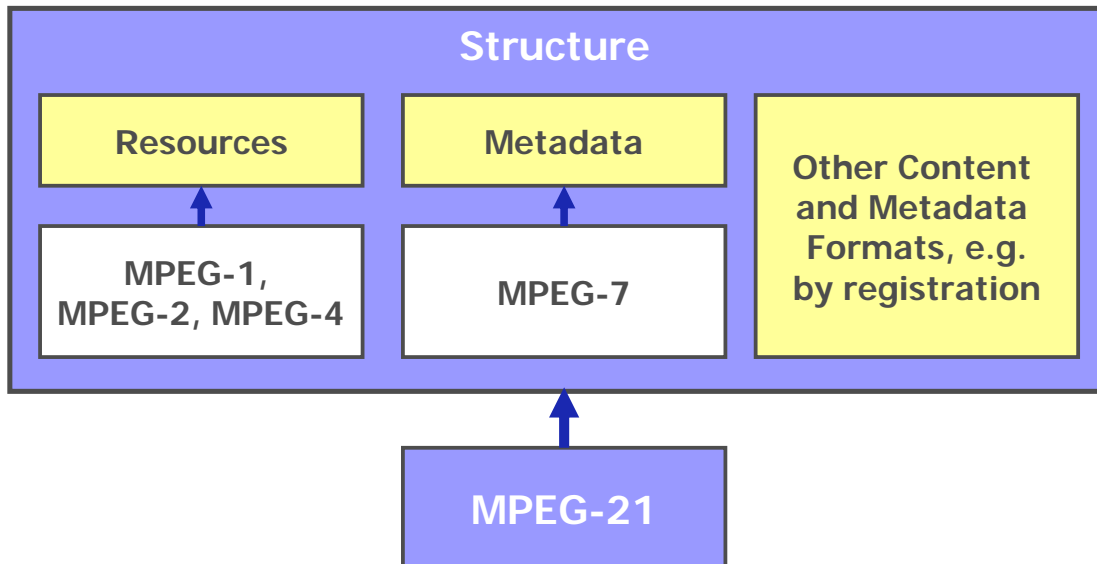
## Digital Item: a Real Example



The DI is the **fundamental unit for distribution and transaction** within the MPEG-21 framework.



## Digital Item: MPEG-based or not ...



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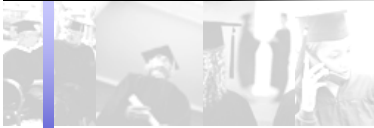
## MPEG-21 Users

- MPEG-21 considers **all Users** of the multimedia infrastructure
- A User is **any entity** that interacts in the MPEG-21 environment or makes use of a **Digital Item**
  - Includes individuals, consumers, communities, organisations, corporations, consortia, governments and other standards bodies and initiatives around the world
  - Roles including creators, consumers, rights holders, content providers, distributors, etc; there is no technical distinction between providers and consumers
- All Users need to be able to express and manage their **interests** in Digital Items.

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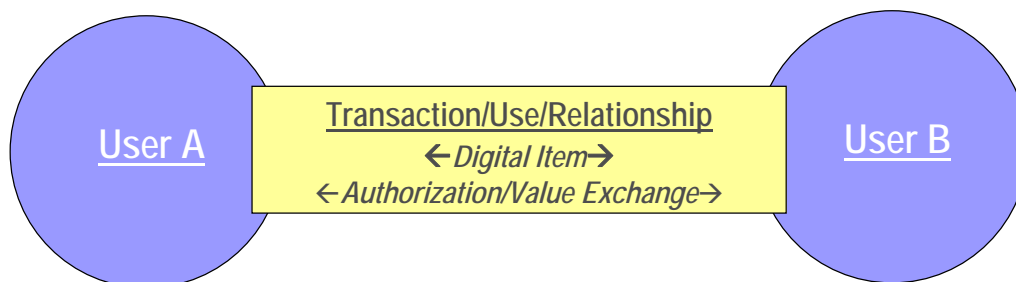
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## User Interaction

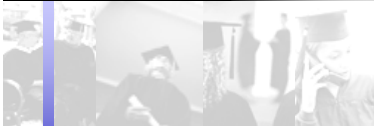
- MPEG-21 provides a framework in which **Users interact** and the object of the interaction is a **Digital Item**
- All parties that have a **requirement** within MPEG-21 to interact are categorized equally as Users
- Each User will assume specific **rights and responsibilities** according to their interaction with other Users



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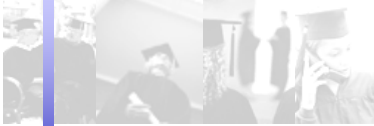
## What Users Need to Do

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Create content</li> <li>• Provide content</li> <li>• Archive content</li> <li>• Rate content</li> <li>• Enhance/adapt content</li> <li>• Deliver content</li> <li>• Aggregate content</li> <li>• Syndicate content</li> <li>• Retail sale of content</li> </ul> | <ul style="list-style-type: none"> <li>• Consume content</li> <li>• Subscribe to content</li> <li>• Regulate content</li> <li>• Facilitate transactions that occur from any of the above</li> <li>• Regulate transactions that occur from any of the above</li> </ul> |
|--|---|

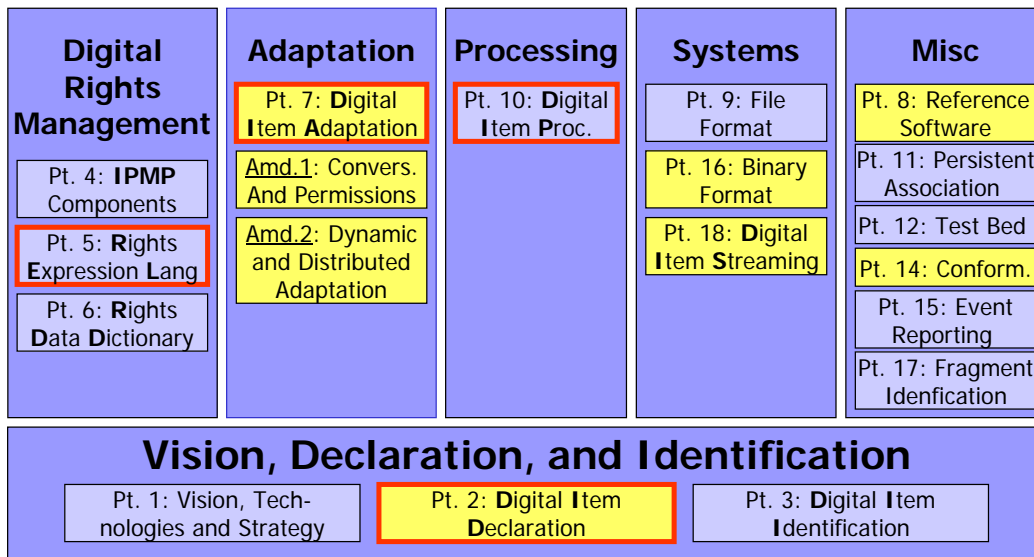
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## MPEG-21 organization (parts)



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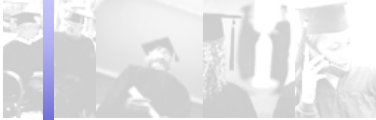
## Digital Item Declaration (DID)

- ISO/IEC 21000-2
- Why ?
- MPEG-21 solution: DID Language

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## Why Declare DIs ?

Currently, multimedia applications are based on transfer/processing/presentation/... of:

- **Different media types, with different representations**
  - Still images (JPEG2000, GIF, PNG, ...)
  - Video (MPEG-4, QuickTime, ...) and audio (WAV, MP3, ...)
  - Text (txt, doc, ...)
  - ...
- **Metadata**
  - Descriptive information about actual data (MPEG-7, ...)
  - DRM information (e.g., copyright statement)
  - Configuration information
  - ...

But how do these elements relate to each other ? ⇒ **Structure**



## Structure in Digital Media: Example

**aria title: Nessun Dorma**  
**track number: 04**

nessunDorma.txt type: lyrics composer: Giacomo Puccini opera: Turandot copyright: Ricordi & co ...	nessunDorma.mp3 type: audio format: mp3 duration: 200 s bitrate: 192 kbps copyright: EMI ...
---	--

.....

ACA01039.jpg  
 type: album cover art  
 format: image/jpeg  
 size: 300x400  
 copyright: EMI  
 ...

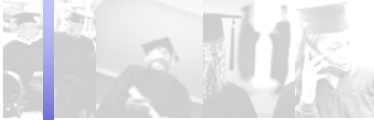
**aria title: O mio babbino caro**  
**track number: 07**

babbinoCaro.doc type: lyrics composer: Giacomo Puccini opera: Gianni Schicci copyright: DECCA ...	babbinoCaro.wav type: audio format: wav duration: 170 s bitrate: 128 kbps copyright: DECCA ...
--	--

.....

**title: concert recording**  
**date: July 2003**  
**location: Covent Garden**  
 ...

concert.mov  
 type: concert video  
 format: video/mov  
 duration: 4500 s  
 bitrate: 500 kbps  
 size: 320x240  
 copyright: DECCA  
 ...



# MPEG-21 Solution: DID Language

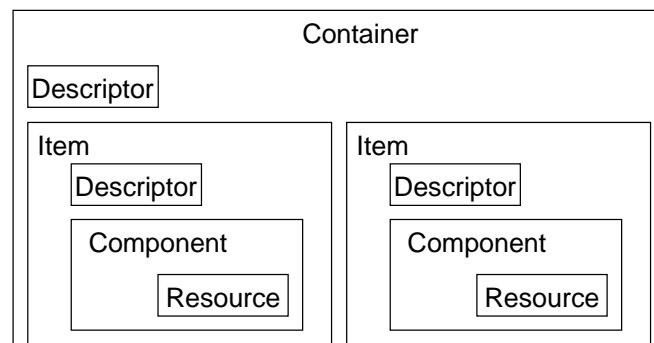
A Digital Item is ...

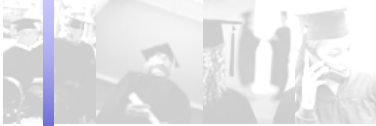
- **structured**, with a standard representation, identification, and metadata
  - Structure
    - Resources (e.g., MPEG-4, other/new formats)
    - Metadata (e.g., MPEG-7, other/new formats)
- the **fundamental unit of distribution and transaction** in the multimedia framework
- expressed by the **Digital Item Declaration Language (DIDL)**, based on XML schema



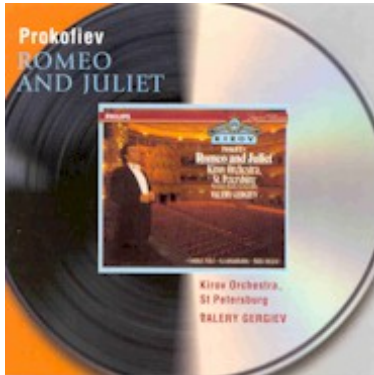
# DID Language (DIDL)

- **Generic container structure**
- Set of **building blocks**
- Expressed in **XML**
- Allows declaration of **any** Digital Item





## DID Example



```

<DIDL>
  <Item>
    <Descriptor>
      <Statement mimeType="text/plain">
        Prokofiev: Romeo and Juliet
      </Statement>
    </Descriptor>
    <Item>
      <Descriptor>
        <Statement mimeType="text/plain">
          Valery Gergiev
        </Statement>
      </Descriptor>
      <Component>
        <Resource
          ref="Prokofiev_RnJ.mp3"
          type="audio/mp3"/>
        </Component>
      </Item>
    ...
  </Item>
</DIDL>

```

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## DID Building Blocks

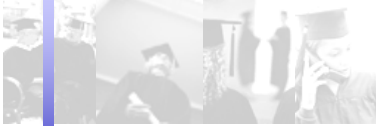
DID described in three normative sections:

- **Model**
  - Describes set of abstract terms and concepts
  - Digital Item is the digital representation of "a work"
  - DI is the thing that is acted upon within the model
  - DIs are managed/handled/processed, described, exchanged, collected, ...
- **Representation**
  - DID elements are represented in XML
  - Normative description of their syntax and semantics
- **Schema**
  - Normative XML schema
  - Comprising entire grammar of the DID

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## DIDL Building Blocks

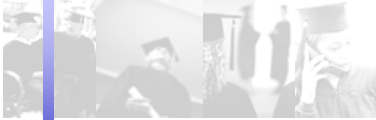
Variety of **elements** with different semantics and use:

- Container
- Descriptor
- Item
- Component
- Resource
- Fragment
- Anchor
- Condition
- Choice
- Selection
- Predicate
- Assertion
- Annotation
- Statement



## DIDL Building Blocks

- **Container**
  - Structure allowing *items* and/or *containers* to be **grouped**
  - Groupings of *items* and/or *containers* can be used to form
    - logical **packages** (for transport or exchange)
    - logical **shelves** (for organization)
- **Descriptor**
  - Allows for "**labeling**" of *containers*
  - With information that is appropriate for the grouping (e.g., delivery instructions for a *package*, or category information for a *shelf*)



## DIDL Building Blocks (cont'd)

### • Item

- **Grouping** of sub-*items* and/or *components* that are bound to relevant *descriptors*
- *Descriptors* contain information about the *item*
- May contain *choices*
  - Allow *items* to be customized or configured
- May be **conditional**

### Notes:

- *Item* **without** sub-*items* can be considered a **logically indivisible work**
- *Item* that **does contain** sub-*items* can be considered a **compilation**

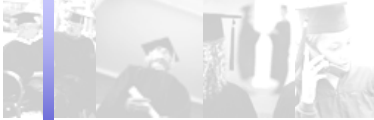


## DIDL Building Blocks: Example

```

<DIDL xmlns="urn:mpeg:mpeg21:2002:01-DIDL-NS ">
  <Container>
    <Item>
      <Item>
        .
        .
        .
      </Item>
      <Item>
        .
        .
        .
      </Item>
    </Item>
  </Container>
</DIDL>

```



## DIDL Building Blocks (cont'd)

### • Component

- Binding of a *resource* to its *descriptors*
- *Descriptors* will typically contain *control* or *structural information* about the *resource*
  - Bit rate
  - Character set
  - Start points
  - Encryption information
  - ...

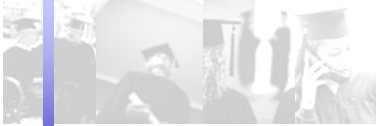
### Notes:

- A *component* itself is not an *item*
- *Components* are building blocks of *items*



```

<DIDL xmlns="urn:mpeg:mpeg21:2002:01-DIDL-NS">
  <Container>
    <Item>
      <Item>
        <Component>
          <Descriptor>
            <Statement mimeType="text/plain">
              Video
            </Statement>
          </Descriptor>
          <Resource ref="myFirstPicture.jpg" mimeType="image/jpg" />
        </Component>
      </Item>
      <Item>
        <Component>
          <Resource ref="mySecondPic.bmp" mimeType="image/bmp" />
        </Component>
      </Item>
    </Item>
  </Container>
</DIDL>
  
```



## DIDL Building Blocks (cont'd)

- **Resource**

- Individually identifiable **asset**
- Examples: video or audio clip, image, textual asset
- Must be locatable via an **unambiguous address**

- **Fragment**

- Corresponds to a **specific location or range** within a *resource*
- May be *resource* type specific

- **Anchor**

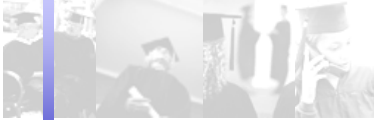
- **Binding** of *descriptors* to a *fragment*



```

<DIDL xmlns="urn:mpeg:mpeg21:2002:01-DIDL-NS">
  <Item>
    <Component>
      <Resource ref="JimsGarageBand.mp3" mimeType="audio/mp3" />
      <Anchor precedence="200">
        <Descriptor>
          <Statement mimeType="text/plain">
            The whole session
          </Statement>
        </Descriptor>
      </Anchor>
      <Anchor precedence="100" fragment="media_time(17:30)">
        <Descriptor>
          <Statement mimeType="text/plain">
            Jim's killer drum solo
          </Statement>
        </Descriptor>
      </Anchor>
    </Component>
  </Item>
</DIDL>

```



## DIDL Building Blocks (cont'd)

- **Descriptor**

- Associates **information** with the enclosing element
- Can be
  - a *component* (thumbnail of an image, textual *component*)
  - a textual *statement*

- **Condition**

- Describes the enclosing element as being **optional**
- Links it to the *selection(s)* that affect its inclusion

- **Choice**

- Describes **set of related selections**
- *Selections* can affect the **configuration** of an *item*



## DIDL Building Blocks (cont'd)

- **Selection**

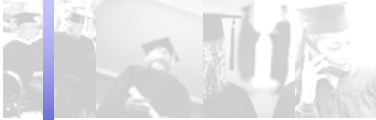
- Describes **specific decision** that will affect one or more *conditions* somewhere within an item
- If chosen, its *predicate* becomes true
- If not chosen, its *predicate* becomes false
- If it is left unresolved, its *predicate* is undecided

- **Predicate**

- Three obvious possible "values": true – false – undecided

- **Assertion**

- Defines a full or partially configured **state of a choice**
- By asserting true, false or undecided values
- For *predicates* associated with the *selections* for that *choice*



## DIDL Building Blocks (cont'd)

- **Annotation**

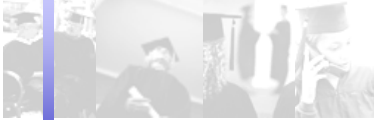
- Describes **set of information** about another identified element
- Without altering or adding to that element
- Information can take the form of *assertions, descriptors, anchors*

- **Statement**

- Literal textual value
- Contains **information**, but not an asset
- Examples: descriptive info, control info, revision tracking info



```
<DIDL xmlns="urn:mpeg:mpeg21:2002:01-DIDL-NS">
  <Item>
    <Item id="PHOTO_1">
      <Component>
        <Resource ref="myFirstPicture.jpg" mimeType="image/jpg" />
      </Component>
    </Item>
    <Item>
      <Component>
        <Resource ref="mySecondPic.bmp" mimeType="image/bmp" />
      </Component>
    </Item>
    <Annotation target="PHOTO_1">
      <Descriptor>
        <Statement mimeType="text/plain">This photo is really cool!</Statement>
      </Descriptor>
    </Annotation>
  </Item>
</DIDL>
```

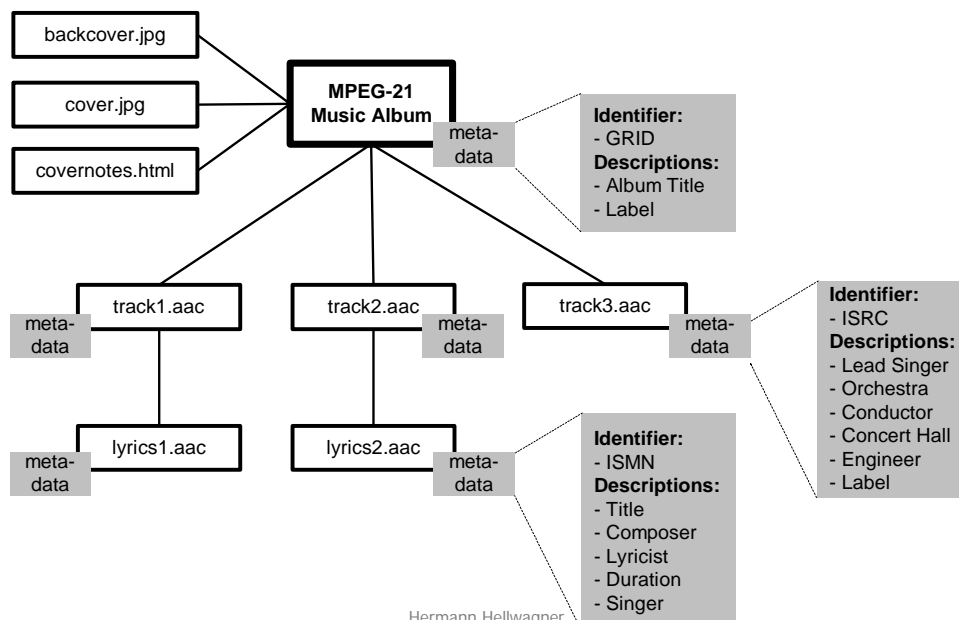


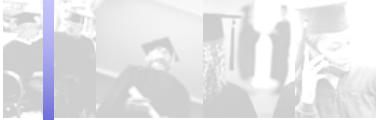
# Digital Item Identification (DII)

- ISO/IEC 21000-3
- Scope: How to ...
  - uniquely identify DIs and parts thereof (including resources)
  - uniquely identify IP related to the DIs and parts thereof (e.g., abstractions)
  - uniquely identify Description Schemes
  - use identifiers to link DIs with related information such as descriptive metadata
  - identify different types of DIs
- Identifiers can be associated with DIs by including them in a *statement* element

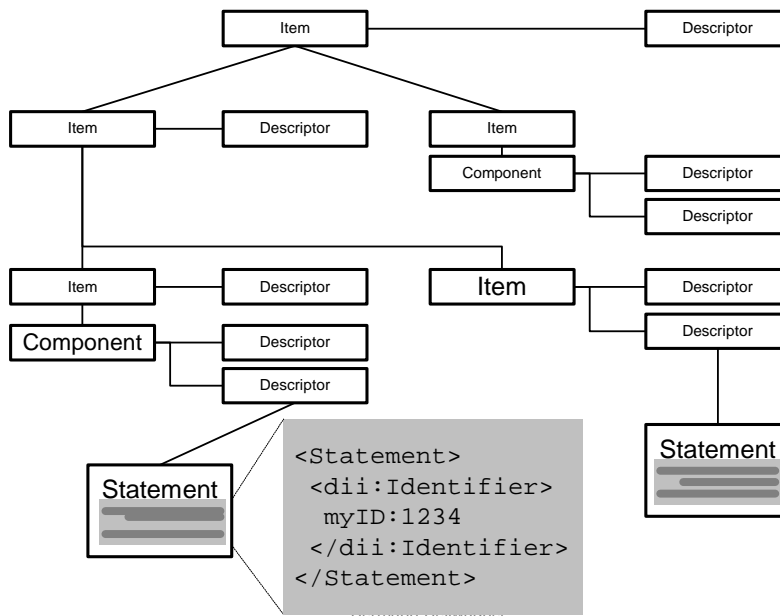


## DII: Example





## Relationship DID – DII



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## Digital Rights Mgmt. in MPEG-21

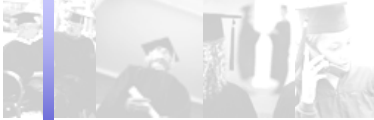
- **Rights Expression Language (REL)**  
ISO/IEC FDIS 21000-5
- **Rights Data Dictionary (RDD)**  
ISO/IEC FDIS 21000-6
- **Intellectual Property Management and Protection (IPMP)**  
ISO/IEC 21000-4

**A flavor only** – the specifications run to hundreds of pages of definitions ...

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## REL

**REL** := machine-readable language that can declare rights and permissions on digital resources

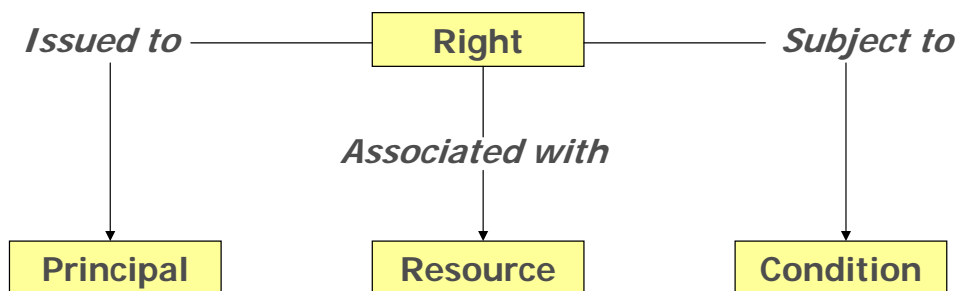
### Goals:

- Provide a standard way to express **rights/interests**
  - For protection of digital contents
  - For privacy and use of personal data
- Provide a standard way to express **grants of rights**
  - Specify access and use of controls for digital content
  - Honor the rights, conditions, and fees specified
- Support guaranteed end-to-end **interoperability**



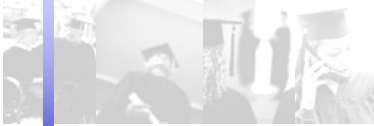
## REL Data Model

- **Grant**: four basic entities and their relationship



Using this model, flexible rights expressions can be generated

- **License**: grant and issuer



## REL Example

Grant: "John may play DI in 2003"

```

<license>
  <grant>
    <keyHolder licensePartId="John">...</keyHolder>
    <mx:play/>
    <mx:diReference>
      <mx:identifier>urn:grid:a1-abcde-1234567890-f</mx:identifier>
    </mx:diReference>
    <validityInterval>
      <notBefore>2003-01-01T00:00:00</notBefore>
      <notAfter>2003-12-31T23:59:59</notAfter>
    </validityInterval>
  </grant>
  <issuer>
    <keyHolder licensePartId="Xin">...</keyHolder>
  </issuer>
</license>
  
```

Principal  
Right  
Resource

Condition

Issuer

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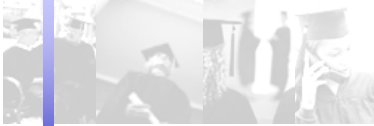
## REL Basic Entities (1)

- **Principal:**
  - Party identified by unique information
  - E.g., **keyHolder**: someone possessing the private key corresponding to the public key specified
- **Right:**
  - Action (or activity) or a class of actions that a principal may perform on or using the associated resource
  - **Multimedia rights**: e.g., play, print, adapt digital media
  - **Meta-rights** (rights relating to other rights): e.g., issue, obtain, revoke rights
  - **PossessProperty**: claiming ownership of a property
  - .....

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## REL Basic Entities (2)

- **Resource:**

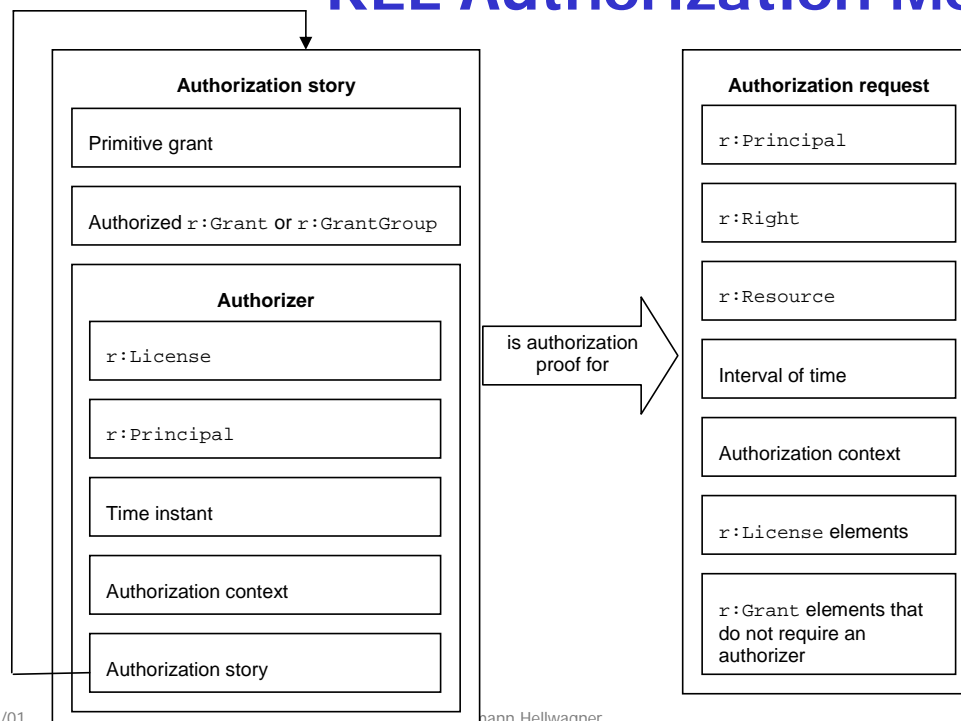
- **Digital resource (work):** e.g., music file, e-book
- **Service:** e.g., e-mail or B2B transaction service
- **DI reference:** to Container, Descriptor, Item, ... of a DI
- **Piece of information, property, collection** of resources
- .....

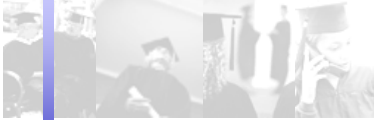
- **Condition:**

- **Time, fee, count, territory, freshness, integrity, marking, signed-by, ... conditions**
- **Existence is valid prerequisite rights, resource attribute specific conditions, ...**



## REL Authorization Model





## RDD

**RDD** := set of clear, consistent, structured, integrated, uniquely identified terms to support REL

### Goals:

- Provide a standard way to describe the semantics of terms based on their relations to other terms
- Support mapping/transformation of metadata from the terminology of one namespace (or authority) into that of another namespace (or authority)

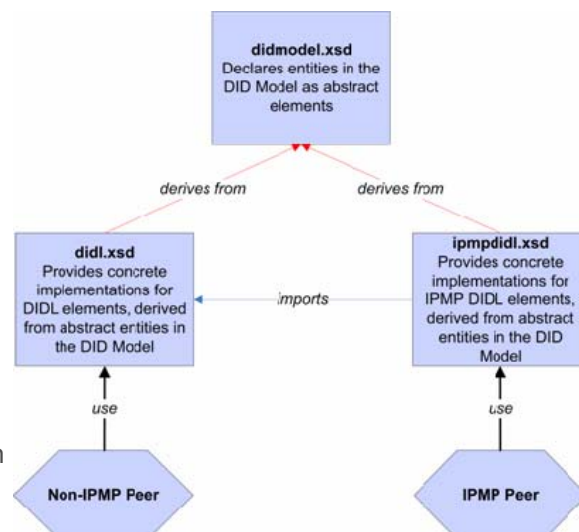


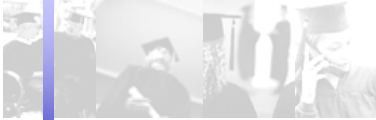
## IPMP

**IPMP** := MPEG-21 DRM System

### Goals:

- Extend beyond MPEG-4 IPMP "hooks" to provide more interoperable and concrete IPMP system and tools
- Provide standardized ways for
  - Protected representation of the DID model (encrypted, digitally signed, or otherwise governed)
  - Defining structures for expressing information relating to the protection of content, including tools, mechanisms, and licenses
- Provide for integration of REL/RDD rights expressions

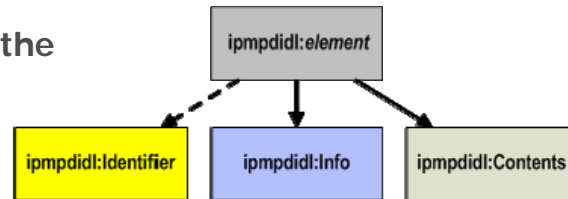




## IPMP Elements

- **ipmp:Identifier**

- Appropriate identifier for the protected representation
- E.g., dii:Identifier



- **ipmp:Info**

- Information about the governance
- E.g., IPMP tools, rights expressions, signature

- **ipmp:Contents**

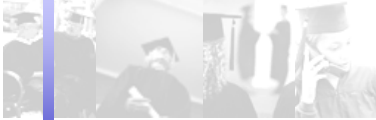
- The governed content
- E.g., did:Item, did:Component, ...



## Digital Item Adaptation (DIA)

- ISO/IEC FDIS 21000-7

→ Christian



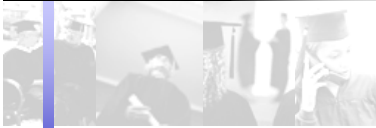
# Digital Item Processing (DIP)

- ISO/IEC CD 21000-10
- Why ?
- Idea/concepts



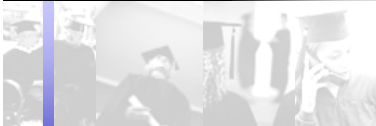
## DIP: Motivation

- Declaration of a Digital Item ...
  - defines “structure” of the DI
  - is static
- What happens when a DI arrives at a terminal ?  
So far – **nothing !**
- Digital Item Processing/Methods allow Users to add **functionality** to a DI Declaration
- On receipt of a DID, ...
  - list of **DI Methods** that can be applied to the Digital Item is presented to the User
  - User chooses a Method which is then **executed**

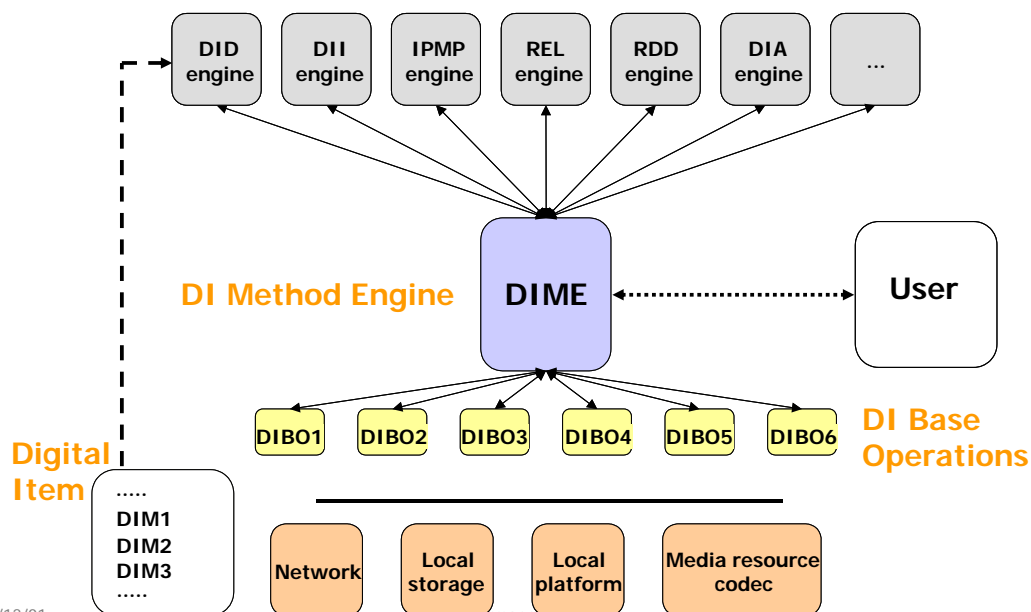


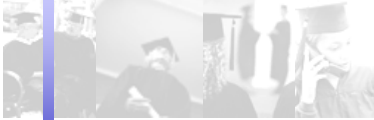
## DIP: Scope

- **DI Methods provide a way for Users of the DI ...**
  - to select preferred procedures by which the DI should be handled
  - at the level of the DI itself
- **Example:**
  - Music Album DI
  - “AddTrack” DIM
- **NOT intended to be utilized for implementing the processing of media resources themselves !**



## DIP: Current Model





## DIMs and DIBOs and ...

**Digital Item Methods (DIMs) := “a list of operations”**

- Specified in normative language: **DIM Language (DIML)**
- One DIML has been chosen: ECMAScript

**Digital Item Base Operations (DIBOs) :=**

**set of normative basic operations on which DIMs are built**

- Analogous to standard library of functions of a prog. language
- Atomic operations
- Normative, high-level interface
- Implemented in any language
- Access to Multimedia Middleware API

**Digital Item eXtension Operations (DIXOs)**



## References

- **Adopted MPEG standards → ISO/IEC**  
<http://www.iso.org>
- **MPEG standards under development and working documents**  
**→ MPEG Website**  
<http://www.chiariglione.org/mpeg/index.htm>
- **I. Burnett, R. Koenen, F. Pereira, R. Van de Walle (eds.),**  
***The MPEG-21 Book*, Wiley, 2006 (to appear)**