

Multimedia Content Management (4)

Prof. Ralf Möller, TUHH, STS

■ Previous lecture:

- Classification of base data formats
- Graphics (single medium):
 - | GIF
 - | JPEG

■ Contents today:

- Video (two media):
 - | MPEG-1, MPEG-2
- Multimedia:
 - | MPEG-4, SMIL
- Audio:
 - | MPEG Audio layer 3
- Metadata
 - | MPEG-7
 - | Resource Description Framework, Dublin Core
- MMCMS-related standards
 - | MPEG 21

Session overview

■ Base Data

- Classification of base data formats

- Graphics (single medium):

 - GIF

 - JPEG

- Video (two media):

 - MPEG-1, MPEG-2

- Multimedia:

 - MPEG-4, SMIL

- Audio:

 - MPEG Audio layer 3

■ Metadata

- MPEG-7

- Resource Description Framework, Dublin Core

■ MMCMS-related standards

- MPEG 21

Digital Video

■ Basic idea:

- Recording: Take sample images of real world motion in short time intervals, e.g. 25 images per second.
- Replay: Show the sample images in the same temporal order, fast enough to create an impression of motion.

■ Problem:

- Even if the single images are compressed, the amount of data is still too large for distribution, e.g. for broadcast over the internet.

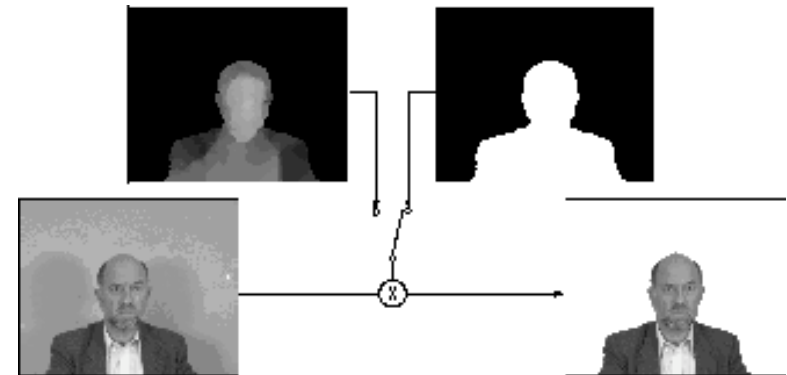
■ Example:

$$50 \text{ KB/pic} * 25 \text{ pics/sec} \\ = 1250 \text{ KB/sec}$$

Properties	
time dependent	yes
description of base data	discrete samples
decoding style	stream oriented
compression	yes
compression scope	local
lossy compression	yes

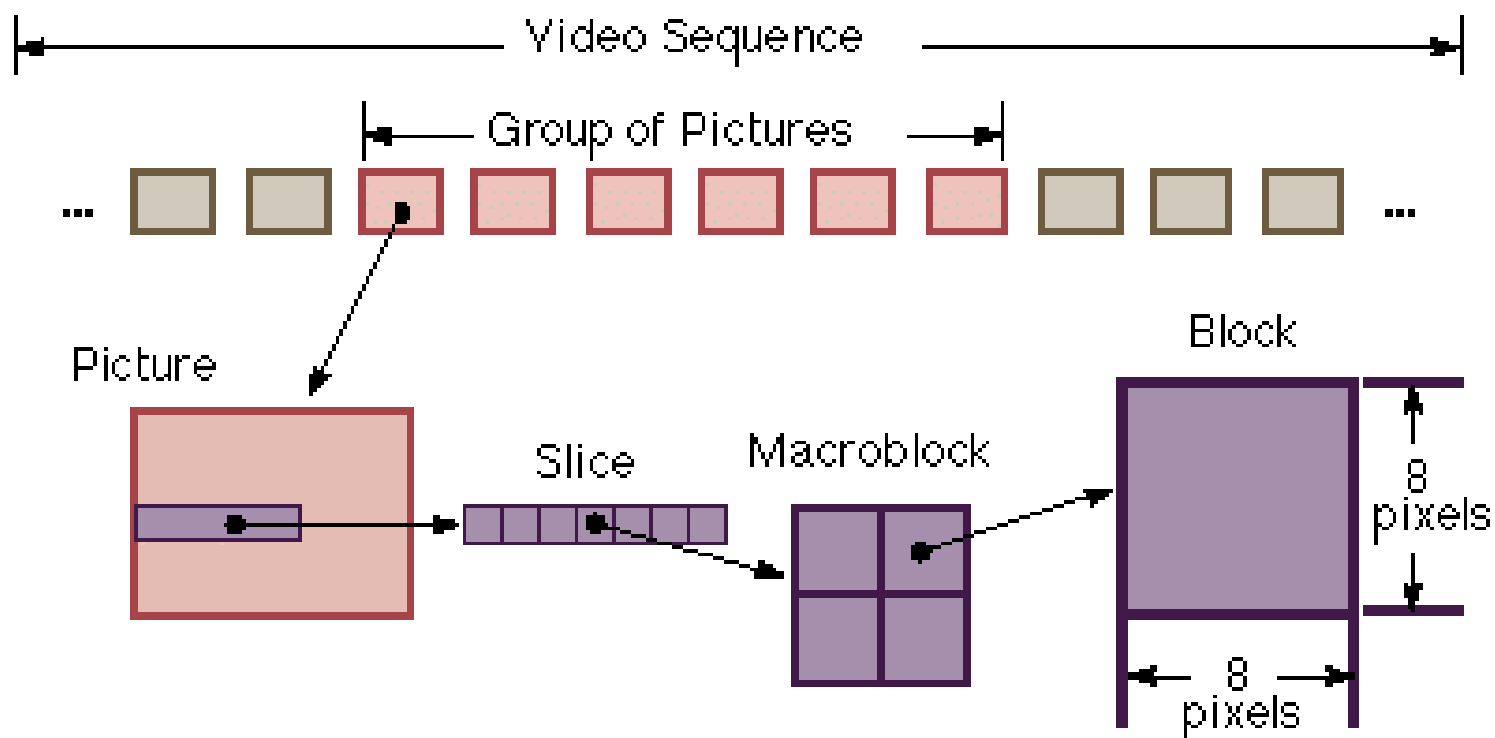
MPEG

- Family of standards created by the **M**oving **P**icture **E**xperts **G**roup
- Applies techniques similar to those of the JPEG still image encoding to audio and video data
- Basic idea: Like JPEG removes spatial redundancy from pictures, MPEG removes temporal redundancies from movies.



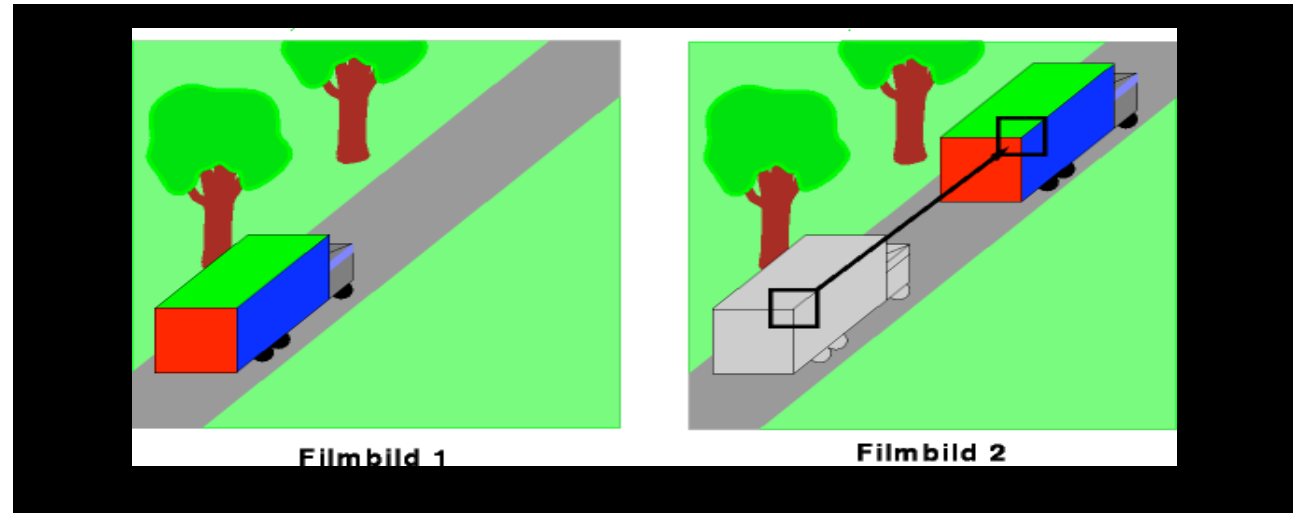
Basic principle

- Not each image of the video sequence that is seen by the human viewer is stored as a whole, pixel by pixel.
- Only the differences to some previous (or future) reference images are encoded.
- From one sample image of the video to the next sample image there are usually only little changes.
- Parts that do not change between two adjacent frames, only have to be encoded once.



Translation Vectors

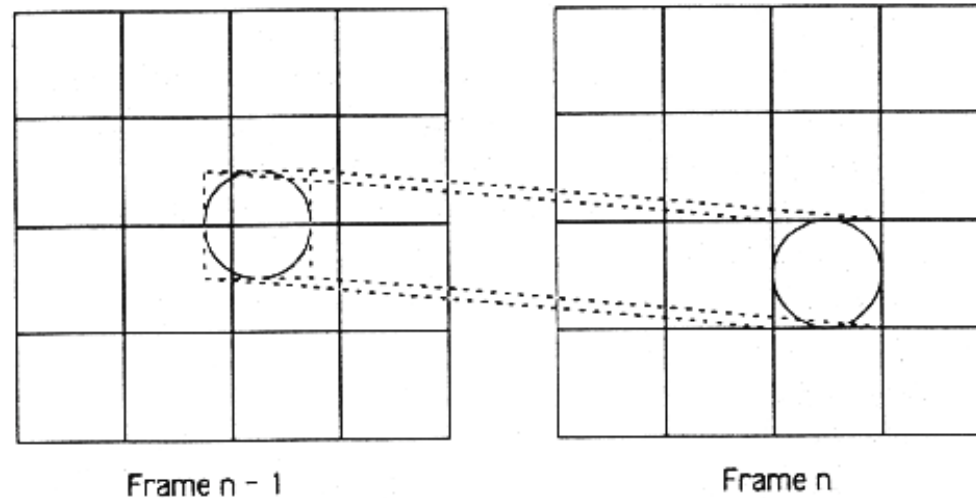
Fixed background and moving foreground => compression



Frame subdivided into
macro blocks.

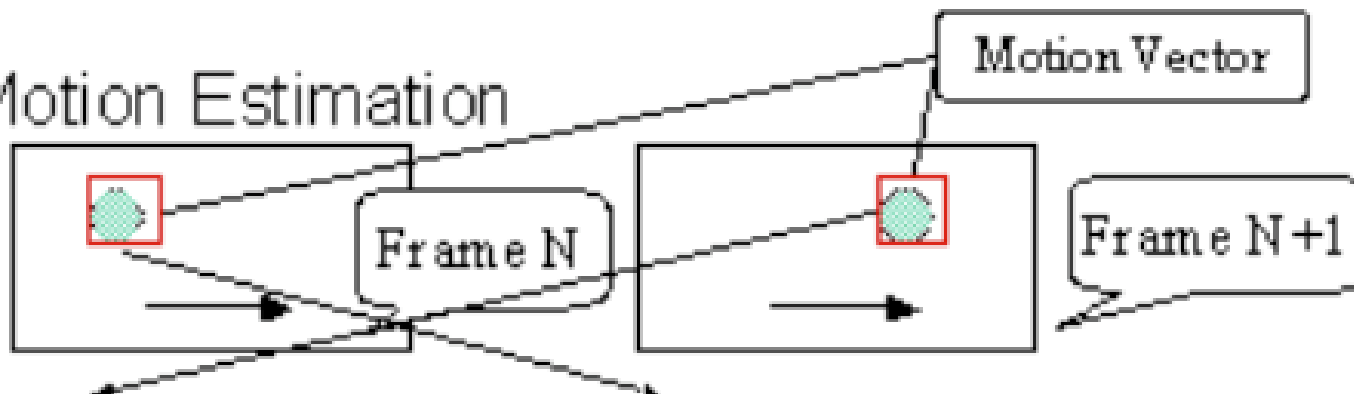
Transmission of
translation vectors

(and difference blocks)



Motion Estimation

- Motion Estimation

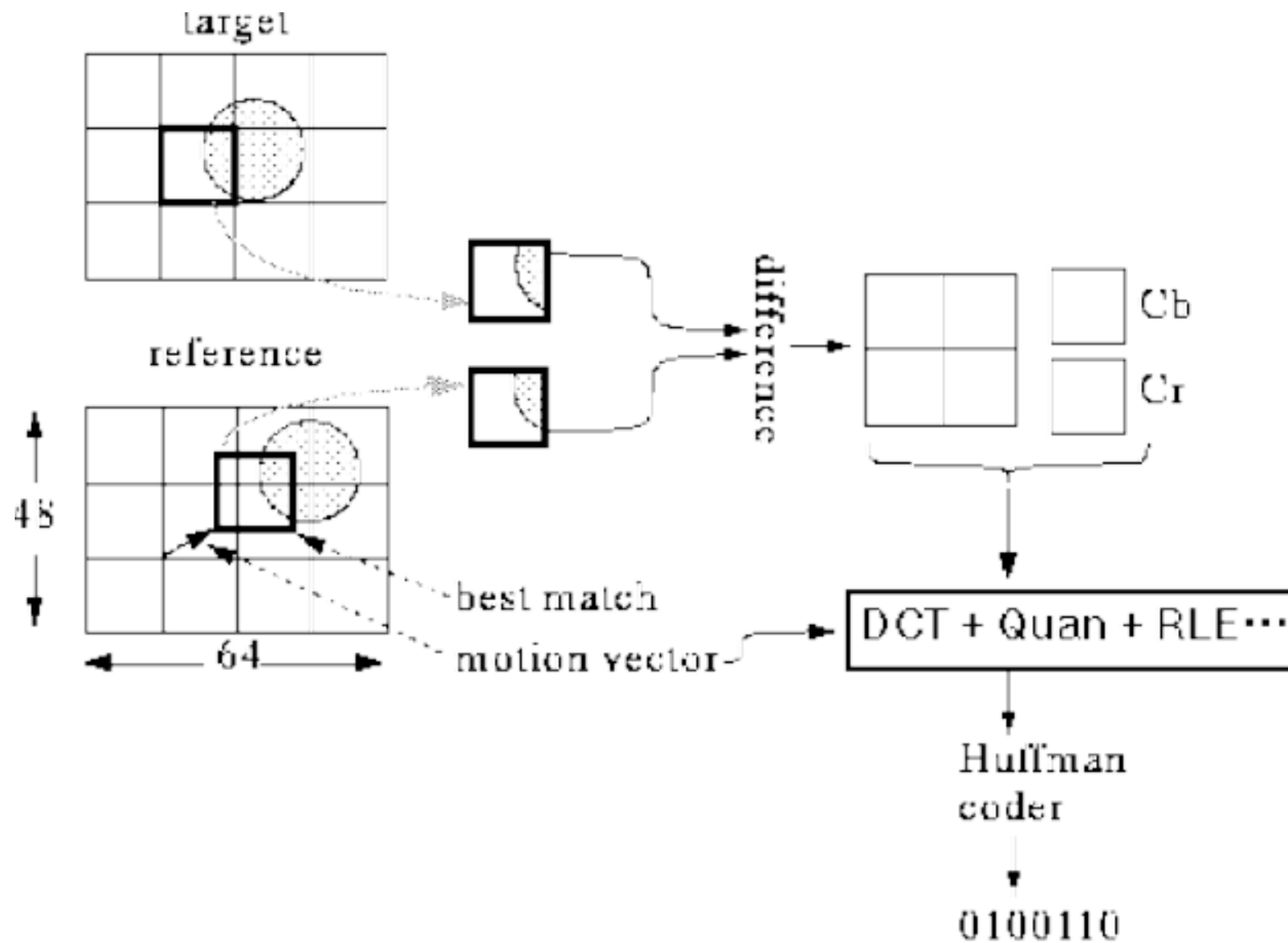


88 84 83 84 85 86 83 82	84 82 83 81 85 86 83 81	-4 -2 0 -3 0 0 0 -1
86 82 82 83 82 83 83 81	82 82 81 83 82 83 83 81	-4 0 -1 0 0 0 0 0
82 82 84 87 87 87 81 84	83 82 84 87 87 87 81 88	1 0 0 0 0 0 0 4
81 86 87 89 82 82 84 87	81 85 86 88 82 82 84 87	0 -1 -1 -1 0 0 0 0
81 84 83 87 85 89 80 81	81 84 85 87 85 89 84 81	0 0 2 0 0 0 4 0
81 85 85 86 81 89 81 85	82 85 81 84 81 89 81 83	1 0 -4 -2 0 0 0 -2
82 81 86 83 86 89 81 84	81 87 86 83 86 89 81 84	-1 6 0 0 0 0 0 0
88 88 90 84 85 88 88 81	88 82 87 84 87 89 84 81	0 -6 -3 0 2 1 -4 0

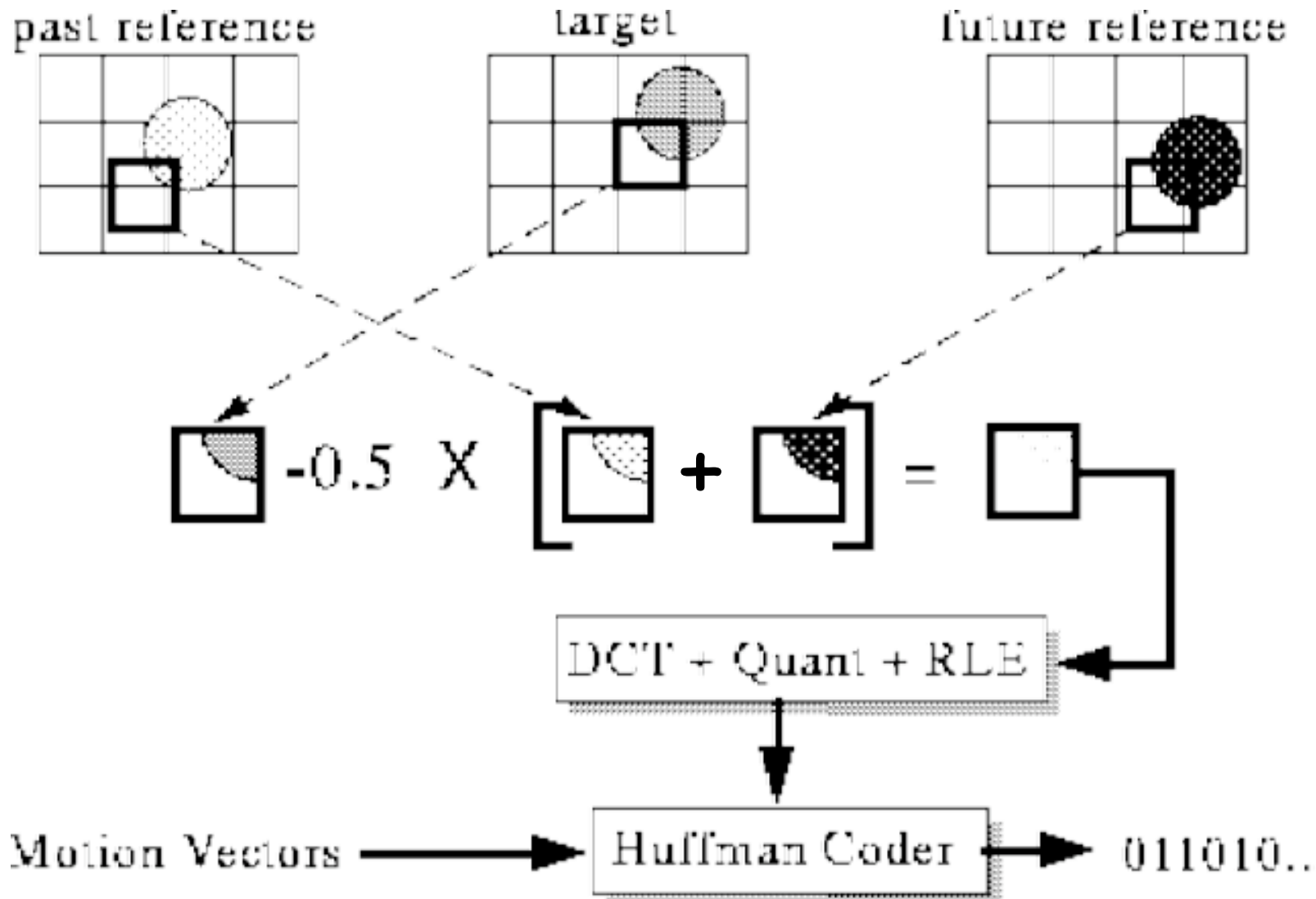
Frame types in MPEG

- I-frames or intrapictures: Complete images containing data about each visible point of a picture. Encoded with a technique similar to that of the JPEG.
- P-frames or predicted pictures: Encode the differences to a previous I- or P-frame only.
- B-frames or interpolated pictures: Describe differences with reference to a past and a future picture (**bidirectional prediction**)
- Typical sequence of frames in an MPEG video:
I B B P B B P BB I ...

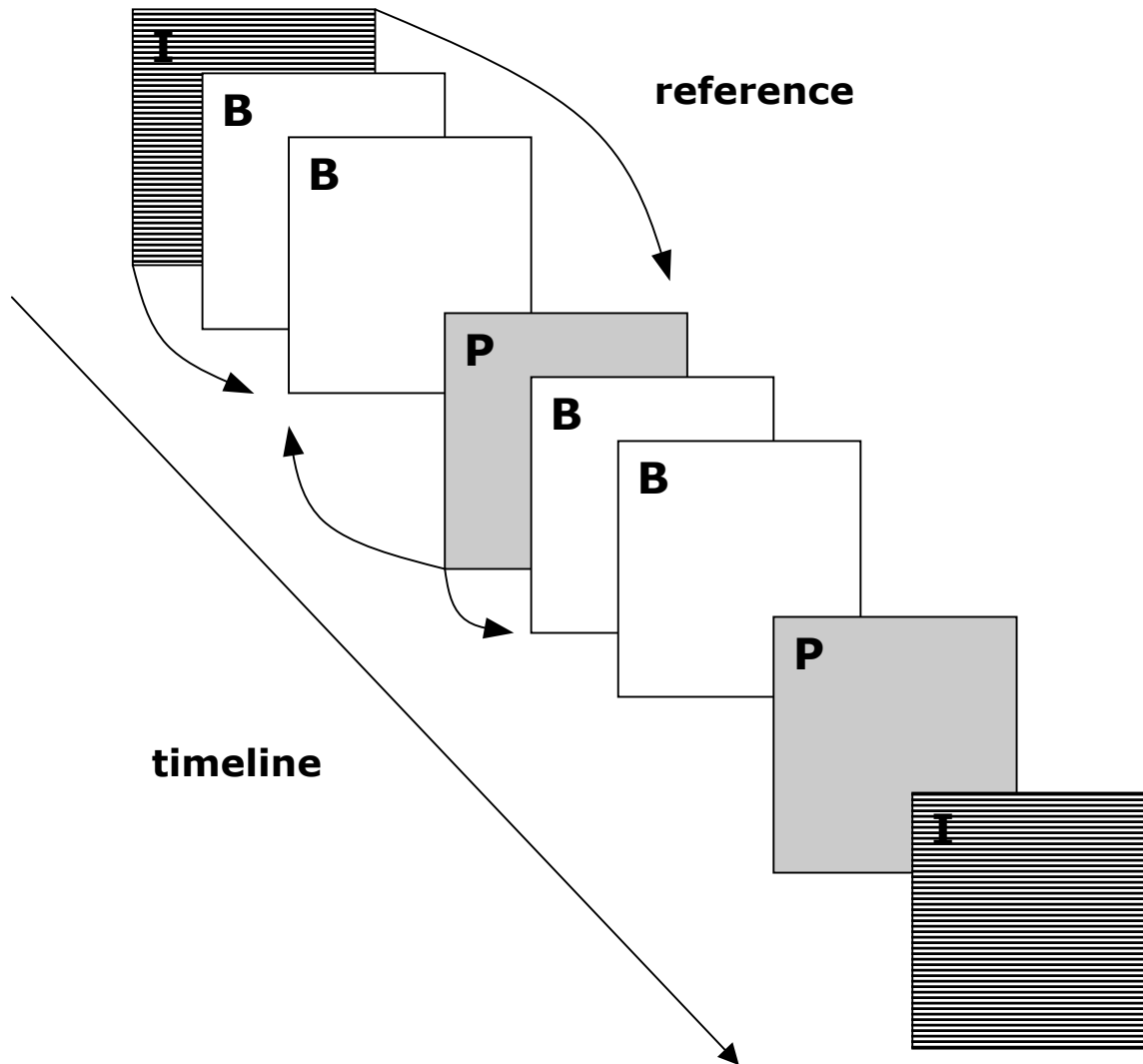
P-Frames



B-Frames



Frame types in MPEG video



**types of single frames in MPEG:
I-, B- and P-frame**

source:
R. Steinmetz
„Multimedia-Technologie“
Springer Verlag, 3. Aufl.
page 152, fig. 7-21

Video Compression: Codecs and Formats

Codec

= **C**ompressor**D**ecompressor
Includes algorithms to decrease
filesize with preferably less quality loss

Video-Codecs:

indeo, sorenson, divx, mpeg-4, cinepak, ...

Audio Codecs:

pcm, wrpr, mp3, CCITT

Graphic Codecs:

jpg, lzw, fax g4

Format

= a standard for storage and transfer
of media files

VideoFormats:

avi, mpg, mov (Quicktime), ...

Audio Formats:

wav, mp3, aiff, ...

Graphic Formats:

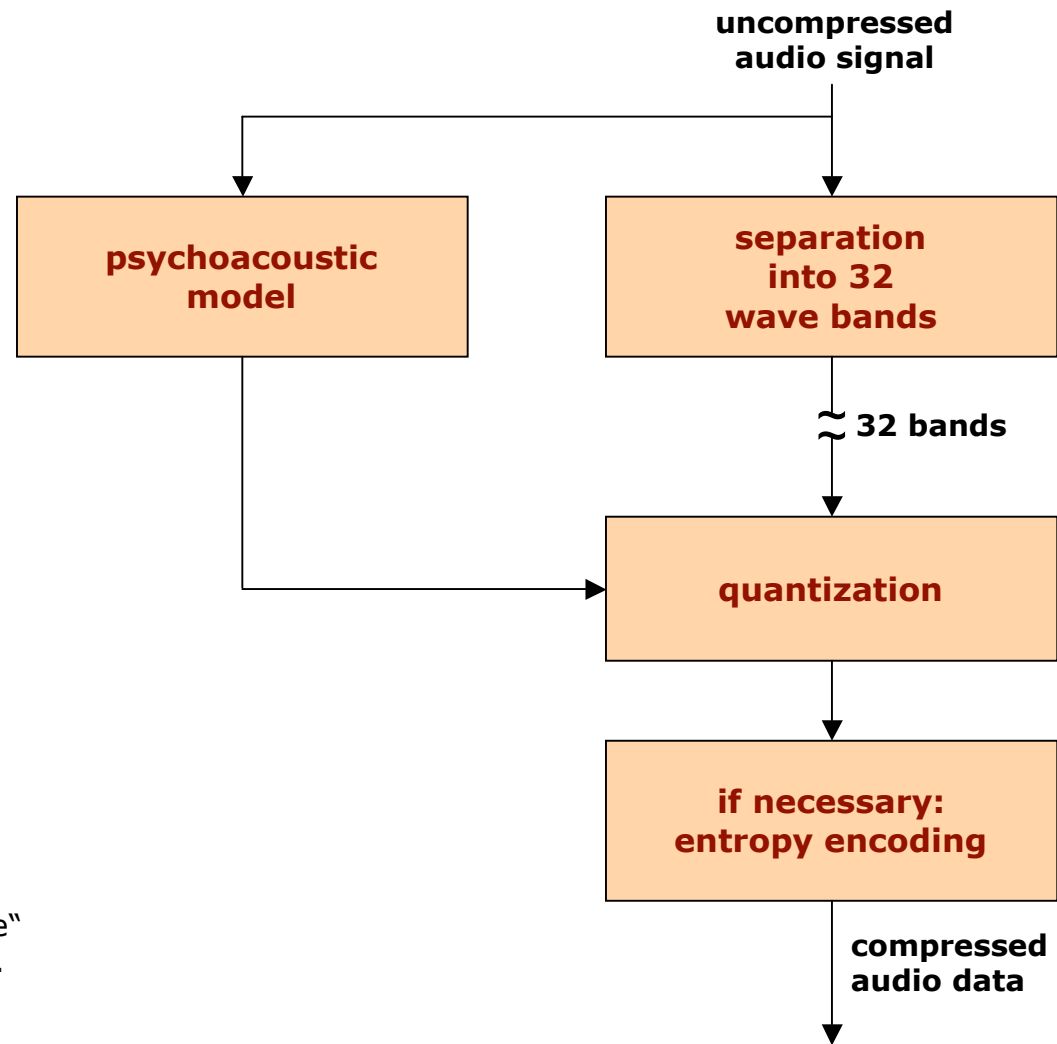
psd, bmp, gif, jpg, tiff

Confusion: Some graphic formats have the same name as their codec equivalents

MPEG Audio

- Audio standard separated into three layers
- The layers differ in compression rate and encoding complexity
- Most common format today: layer 3 (mp3)
- Encoding procedure:
 1. Transformation into frequency spectrum (Fourier Transformation)
 2. Separation into wave bands
 3. Quantization
 4. Entropy-Encoding (Huffmann)

MPEG Audio Encoding



Source:
R. Steinmetz
„Multimedia-Technologie“
Springer Verlag, 3. Aufl.
page 156, fig. 7-22

Integrating vs. integrated data formats

- Integrating formats (e.g. SMIL)
 - Do not encode media data themselves but
 - Describe how to mix and synchronize media from different sources
- Integrated formats (e.g. MPEG-4)
 - Single file or stream which transports an already synchronized mixture of different media types

MPEG-4

- Integrated format which supports
 - digital video,
 - digital audio,
 - 3D scenes,
 - object-based scene composition,
 - user interaction,
 - multiple presentation scenarios
 - interactive television,
 - multimedia presentations,
 - mobile devices.
- Complete standard, software available (Windows Media; plugin for RealPlayer; Quicktime 6), but licensing problems

The MPEG family of standards

- MPEG or MPEG-1:
 - integrated audio/video format, e.g. for CD Video
 - Important substandard: Audio Layer 3 (mp3)
- MPEG-2:
 - Extension of MPEG-1 for high-resolution video
 - Sample applications: Digital Television, DVD
- MPEG-4:
 - Scalable integrated media format including concepts for mobile applications, scene modeling and interaction
- MPEG-7:
 - Multimedia Content Description Interface
 - Proposed metadata format

Metadata

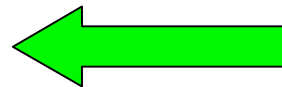
- Data *about* data
- Describe properties of resources (documents, files, multimedia presentations etc.) and their content, e.g.
 - Format information required for interpreting/processing base data
 - Condensed information (overview)
 - additional contextual information (relations to external resources, creation context)
- Can be interpreted by persons
- Can be processed by machines
- Can be interpreted by machines, e.g. for
 - Automatic classification of resources or
 - In catalog systems
- Distinction between data and metadata depends on application's context, e.g.
 - From a file system's perspective a list of keywords in an HTML file is simply data
 - From a search engine perspective the same list of words may be interpreted as describing the body of the HTML file, so the keywords are treated as metadata

Languages for Metadata

- Interpretation / processing requires common syntax & semantics
- Metadata language may be tailored to specific application domain
- Simple case: fixed structure
 - Positionally identified fields with primitive values (number, string)
 - Esp. for low level meta data (e.g. network packet header vs. payload)
- More complex: structural variation
 - varying cardinality (optional and repeated parts)
 - Vocabulary (tags, markers) – e.g. JPEG, TIFF
 - Aggregation (possibly hierarchical), specialization and choice, association
- Metadata language definition languages
- Advanced: Combination of metadata from multiple application domains
e.g. XML namespaces

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- MPEG-7:
 - Multimedia Content Description Interface
 - Extensible set of metadata languages for media



MPEG-7

- | Metadata format released by the MPEG
- | “Multimedia Content Description Interface”
- | Main elements:
 - | Descriptors (D): representations of features, that define the syntax and the semantics of each feature representation, e.g. “color space” or “expiration time”
 - | Description Schemes (DS), that specify the structure and semantics of the relationships between their components (Descriptors and Description Schemes),
 - | A Description Definition Language (DDL) to allow the definition of new and extension of existing Description Schemes and Descriptors (“metadata language definition language”)
 - | System tools, to support
 - multiplexing of descriptions,
 - synchronization of descriptions with content, transmission mechanisms etc.
 - management and protection of intellectual property

Parts of the MPEG-7-Standard

1. *Systems* - the tools that are needed to prepare MPEG-7 Descriptions for efficient transport and storage, and to allow synchronization between content and descriptions. Tools related to managing and protecting intellectual property.
2. *Description Definition Language* - the language for defining new Description Schemes and perhaps eventually also for new Descriptors.
3. *Audio* – the Descriptors and Description Schemes dealing with (monomedia) Audio descriptions
4. *Visual* – the Descriptors and Description Schemes dealing with (monomedia) Visual descriptions
5. *Multimedia Description Schemes* - the Descriptors and Description Schemes dealing with generic features and multimedia descriptions
6. *Reference Software* - a software implementation of relevant parts of the MPEG-7 Standard
7. *Conformance* - guidelines and procedures for testing conformance of MPEG-7 implementations.

Resource Description Framework

- Recommendation by the World Wide Web Consortium (W3C)
<http://www.w3.org/RDF/>
- Application areas:
 - Resource discovery,
 - Cataloging,
 - Content rating,
 - Property rights management.
- Goal: Turn the data in the World Wide Web from *machine-readable* data into *machine-understandable* data
- Standard includes experience from the fields of
 - Library science,
 - Structured document management (SGML, XML),
 - Knowledge representation.

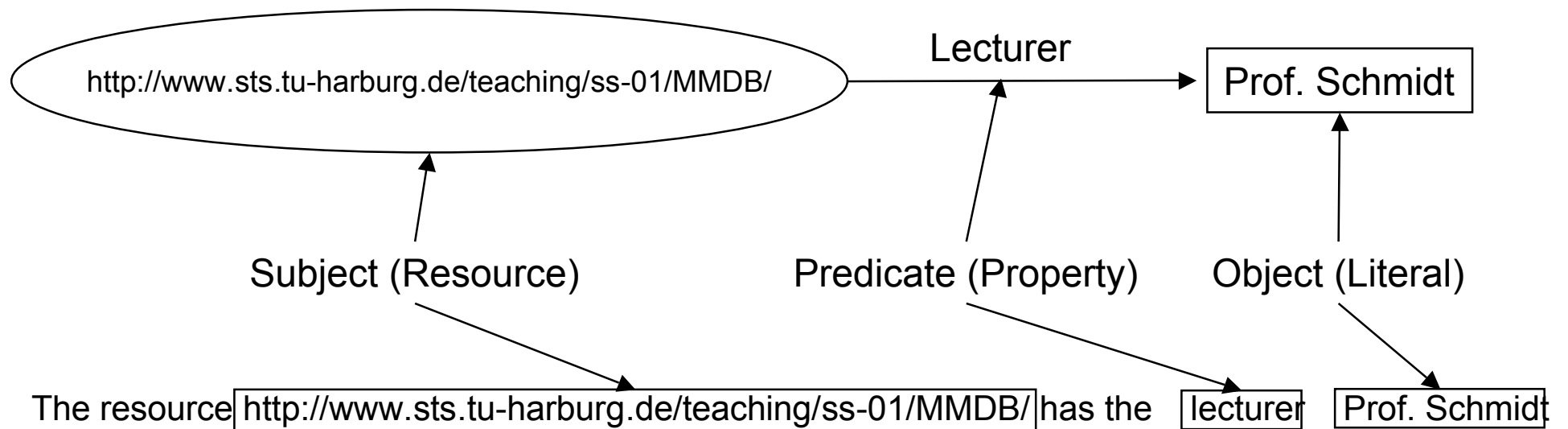
RDF Elements

- Resource:
 - the entity being described
 - examples: electronic documents, parts of them, a complete website or even non-electronic entities like books.
 - identified by Uniform Resource Identifiers (URIs)
- Property:
 - aspect, characteristic, attribute or relation used to describe a resource
 - characteristics of properties (described by RDF schema):
 - permitted values,
 - relationship with other properties,
 - applicability,
 - (Meaning).
- Statement, a triple of
 - a resource,
 - a named property and
 - a value of that property for the given resource

Simple RDF example

Colloquial description: Prof. Schmidt is the lecturer of <http://www.sts.tu-harburg.de/teaching/ss-01/MMDB/>

RDF “node and arc diagram”



RDF statements in XML

```
<?xml version="1.0"?>
<rdf:RDF      xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
              xmlns:sts="http://www.sts.tu-harburg.de/schema/">
  <rdf:Description about="http://www.sts.tu-harburg.de/teaching/ss-01/MMDB/">
    <sts:Lecturer>Prof. Schmidt</sts:Lecturer>
  </rdf:Description>
</rdf:RDF>
```

Alternative:
Single-valued
property as
XML attribute

```
<?xml version="1.0"?>
<rdf:RDF      xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
              xmlns:sts="http://www.sts.tu-harburg.de/schema/">
  <rdf:Description      about="http://www.sts.tu-harburg.de/teaching/ss-01/MMDB/"
                        sts:Lecturer="Prof. Schmidt"/>
</rdf:RDF>
```

RDF schema

■ Basic RDF:

- Properties are modeled by simple name/value pairs
- Definition of properties and dependencies among them are not considered.

■ RDF-Schema:

- Defines a schema language based on RDF primitives,
- Can be treated as a simple type system,
- Can be used to define properties, their characteristics (e.g. domain/range) and relationships to other properties (e.g. subPropertyOf).

- Notation: Concepts of RDF and RDF-schema were designed language-independently, but are often expressed in terms of XML.

Dublin Core

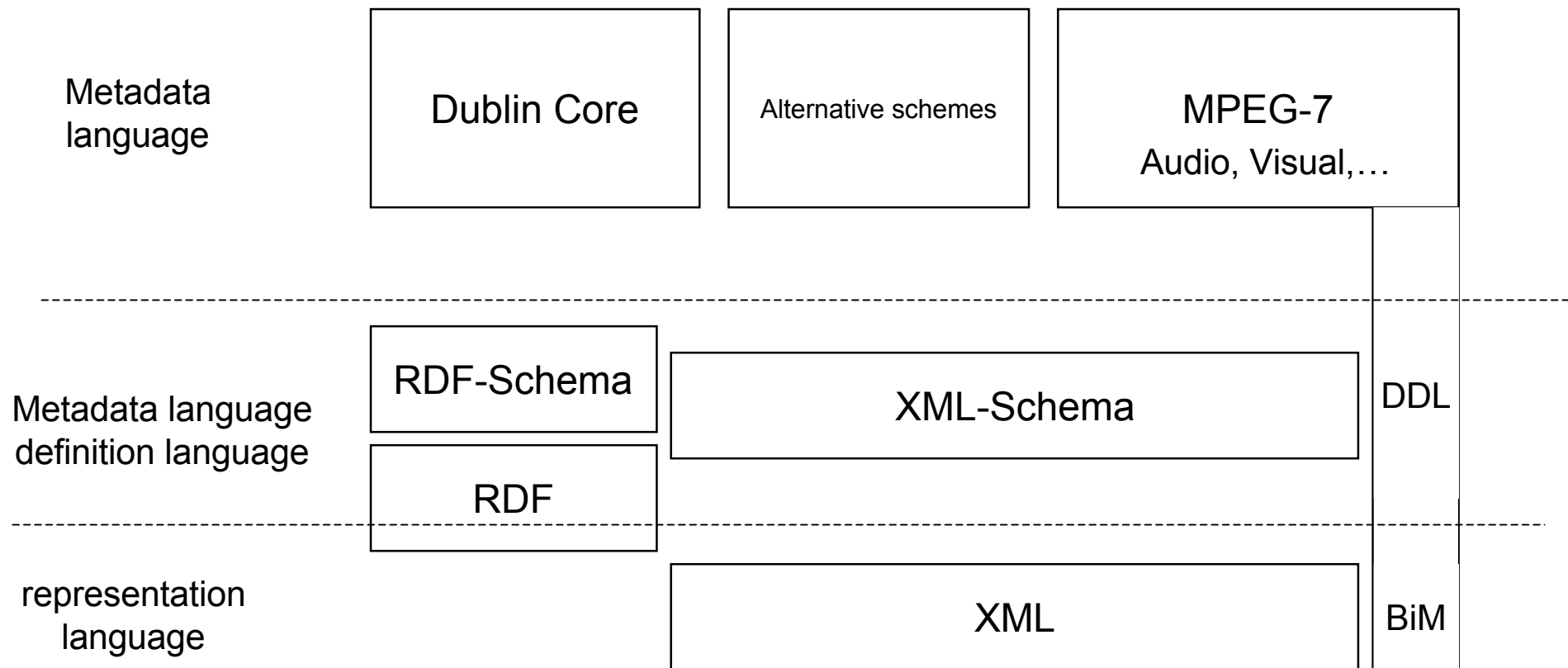
- <http://dublincore.org/>
- Standard for metadata developed by the Dublin Core Metadata Initiative (DCMI), founded on a workshop in Dublin, Ohio in 1995
- Joint standardization activity conducted by experts from various groups including
 - Archives and Museum Information Systems
 - Digital Information Management
 - Digital Libraries
 - Educational Institutions
 - Electronic Collections
 - Knowledge Management
 - Library Technology Services
 - Resource Discovery
- Small set of elements useful even for inexperienced users for the description of arbitrary resources



Dublin Core (2)

- Well defined semantics for all elements understandable in all communities involved in the standardization.
- Guidelines for the usage of each element and the extensibility of the element set.
- Examples:
 - Content: Coverage, Subject, Title, Source
 - Intellectual Property: Creator, Publisher, Rights
 - Instantiation: Date, Format, Language
- Dublin Core can be expressed as a concrete RDF schema

Relationships between metadata standards

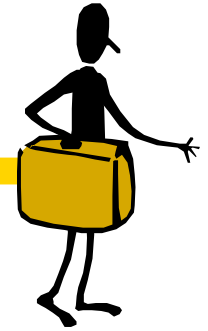


BiM = Binary format for Multimedia data

MPEG-21 (not yet complete)

- Effort to develop the architecture of a multimedia framework covering the complete multimedia delivery chain which includes:
 - content creation,
 - production,
 - delivery and
 - consumption.
- MPEG-21 is expected to address the following issues:
 - digital item declaration,
 - digital item identification and description,
 - content handling and usage,
 - intellectual property management and protection,
 - interoperability across different terminals and networks,
 - event reporting.

Summary: Data Encoding



■ Base Data

- Classification of base data formats
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 - JPEG
- Video (two media):
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- Multimedia:
 - MPEG-4, SMIL
- Audio:
 - MPEG Audio layer 3

■ Metadata

- MPEG-7
- Resource Description Framework, Dublin Core

■ MMCMS-related standards

- MPEG 21

What comes next?

