The MPEG-21 Multimedia Framework for Integrated Management of Environments enabling Quality of Service

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Outline

• UMA: Universal Multimedia Access
• MPEG-21 Overview
  – Concept and MPEG-21 Parts
  – Digital Item Declaration
  – Rights Expression Language
  – Digital Item Adaptation
• End-to-end management enabling UMA: the ENTHRONE solution based on MPEG-21
• Conclusions
UMA Challenge and Concept

Universal Multimedia Access := any content should be available anytime, anywhere
Universal Multimedia Experiences := User should have worthwhile, informative experience anytime, anywhere

Content Adaptation for Universal Access

Heterogeneous Networks, Dynamic Conditions

Rich Multimedia Content

Growing mismatch

Need for scalable content, descriptions, negotiation, adaptation

Diverse Set of Terminal Devices, User Preferences
Introduction to 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: Basic Concepts

What ? – Digital Items (DIs)

• A **Digital Item (DI)** is a structured digital object with a standard representation, identification, and metadata 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
• All parties that have a **requirement** within MPEG-21 to interact are categorized equally as Users
MPEG-21: Basic Concepts

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

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
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MPEG-21 Organisation – Parts

Digital Rights Management
- Pt. 4: IPMP Components
- Pt. 5: Rights Expression Lang
- Pt. 6: Rights Data Dictionary
  - Amd.1: DII relationship types

Adaptation
- Pt. 7: Digital Item Adaptation
- Amd.1: Convers. And Permissions
- Amd.2: Dynamic and Distributed Adaptation

Processing
- Pt. 10: Digital Item Processing
  - Amd.1: Add’l C++ bindings

Systems
- Pt. 9: File Format
- Pt. 16: Binary Format
- Pt. 18: Digital Item Streaming

Misc
- Pt. 8: Reference Software
- Pt. 11: Persistent Association
- Pt. 12: Test Bed
- Pt. 14: Conform.
- Pt. 15: Event Reporting
- Pt. 17: Fragment Identification

Vision, Declaration, and Identification
- Pt. 1: Vision, Technologies and Strategy
- Pt. 2: Digital Item Declaration
- Pt. 3: Digital Item Identification
Digital Item Declaration

Why declare Digital Items?
Currently, multimedia applications are based on transfer / processing / presentation / ... of:

• Different **media resources/types**, with different representations
  – Still images (JPEG, JPEG2000, GIF, PNG, ...)
  – Video (MPEG-4, QuickTime, ...) and audio (WAV, MP3, ...)
  – Text (txt, doc, pdf, ...)

  **Resources (e.g., MPEG-4, other/new formats)**

  **Structure**

• **Metadata**
  – Descriptive information about actual data (MPEG-7, ...)
  – DRM information (rights expressions, IPMP, ...)
  – Configuration information (usage environment descriptions, ...)

  **Metadata (e.g., MPEG-7, other/new formats)**

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

⇒ **MPEG-21 Solution:** **Digital Item Declaration Language (DIDL)**  
Digital Item Declaration (DID) – instance conforming to DIDL
IPMPDIDL: how to include IPMP information and protected parts of DIs in a DID
DID Example

<DiDi>
  <Item>
    <Descriptor>
      <Statement mimeType="text/plain">Best of Mozart</Statement>
    </Descriptor>
    <Descriptor>
      <Component><Resource mimeType="image/jpg" ref="cover.jpg"/></Component>
    </Descriptor>
    <Item>
      <Descriptor>
        <Statement mimeType="text/plain">Le nozze di Figaro KV 492, Overture, 4:08</Statement>
      </Descriptor>
      <Component>
        <Descriptor>
          <Statement mimeType="text/plain">Bitrate 192kbps</Statement>
        </Descriptor>
        <Resource mimeType="audio/m4a" ref="track01.m4a"/>
      </Component>
    </Item>
  </Item>
</DiDi>
Rights Expression Language

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

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

  - **Issued to**
  - **Right**
  - **Subject to**
  - **Associated with**

  - **Principal**
  - **Resource**
  - **Condition**

  ⇒ Using this model, flexible rights expressions can be generated

• **License**: grant and issuer
Grant: “John may play DI in 2008”

<license>
  <grant>
    <keyHolder licensePartId="John">…</keyHolder>  
    <mx:play/>
    <mx:diReference>
      <mx:identifier>urn:grid:a1-abcd-e-1234567890-f</mx:identifier>
    </mx:diReference>
    <validityInterval>
      <notBefore>2008-01-01T00:00:00</notBefore>
      <notAfter>2008-12-31T23:59:59</notAfter>
    </validityInterval>
  </grant>
  <issuer>
    <keyHolder licensePartId="Xin">…</keyHolder>
  </issuer>
</license>
Digital Item Adaptation

DIA := syntax and semantics of tools that assist in the adaptation of Digital Items

Goals:

- Satisfy transmission, storage and consumption constraints as well as Quality of Service (QoS) management
- Enable transparent access to (distributed) advanced multimedia content by shielding users from network and terminal installation issues
- Codec Format-independent mechanisms that provide support for Digital Item Adaptation in terms of:
  - Resource adaptation
  - Description adaptation
  - Quality of Service management
- The adaptation engines themselves are non-normative tools
Context-related metadata describes the usage environment in terms of terminal capabilities; network characteristics; user characteristics; natural environment characteristics;

e.g., codec capabilities = mp2, ML@MP; available bandwidth=1500kbps; visually impaired; high-level ambient noise;
AdaptationQoS and Universal Constraints Description

- **Content-related metadata** – *AdaptationQoS* – describes the relationship between constraints; feasible adaptation operations satisfying these constraints; associated utilities (qualities);

  e.g., available bandwidth is 384kbps, terminal display is CIF; reduce bit-rate; quality at QCIF/30fps/QP=10 versus CIF/10fps/QP=15
  e.g., bit-rate = 256kbps, frame-rate=30fps, resolution=CIF, etc.

- **Universal Constraints Description (UCD):** mathematical approach based on an optimization problem
  - find values for the variables representing adaptation parameters that do not violate the limitation constraints (feasibility) and maximize the optimization constraint (optimality, objective function)
End-to-End QoS through Integrated Management of Content, Networks and Terminals

1. Integrated Management of Services
2. Content Provider
3. Service Provider
4. Network Provider(s)
5. Content Consumer

- Integrated Management of Content (Digital Items)
- Content- and Context-aware Digital Item Service Management
- Integrated Management of Connectivity Services of Heterogeneous Networks
- Integrated Management of Heterogeneous Terminals
ENTHRONE System Architecture

ENTHRONE Integrated Management Supervisor

- Quality of Service and Adaptation
- Metadata Management and Search (MATool)
- Enhanced Features

Metadata Management Model

Adapters
- Producer Front End
- Server TVM
- IPMP
- Adaptation TVM @ CP/SP
- Network Management
- QoS Monitoring
- Adaptation TVM @ ANP
- End User Terminal
- Consumer Front End

Interfaces

Business Actors
- Content Provider
- Adapation Provider
- Network Provider
- Content Consumer
- Licence Authority

Service Provider

Supervision layer

Delivery layer

Business level (simplified)

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ENTHRONE System Architecture

ENTHRONE Integrated Management Supervisor

- Quality of Service and Adaptation
- Metadata Management and Search (MATool)
- Enhanced Features

- Adaptation management

And extended functionalities:
- End to end (QoS) management
- Service management (SM)
- Terminal Device Management (TDM)

Adapters

EIMS

Supervision layer

Delivery layer

Business level (simplified)

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ENTHRONE System Architecture

Generic model for
- Metadata management
- Metadata storage

MAtool implementation using MPEG-7/-21, TV-anytime, ...
ENTHRONE System Architecture

ENTHRONE Integrated Management Supervisor

- Quality of Service and Adaptation
- Metadata Management and Search (MATool)
- Enhanced Features

Supervision layer

Metadata Management Model Interfaces

- Multicast management
- Content caching and CDN management

Delivery layer

Adapters
- Producer Front End
- Server TVM
- IPMP
- Adaptation TVM @ CP/SP
- Network Management
- QoS Monitoring
- AT

Business level (simplified)

Business Actors
- Content Provider
- Adaptation Provider
- Network Provider
- Content Consumer
- Licence Authority
- Service Provider

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ENTHRONE System Architecture

- **ENTHRONE Integrated Management Supervisor**
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- **Interfaces**
  - Producer Front End
  - Server TVM
  - IPMP
  - Adaptation TVM @ CP/SP
  - Network Management
  - QoS Monitoring
  - Adaptation TVM @ ANP
  - End User Terminal
  - Consumer Front End

- **Adapters**
  - Content Provider
  - Network Provider
  - Consumer
  - Adaptation Provider
  - Licence Authority

- **Business Actors**
  - New entity.
  - More open business models

- **Supervision layer**
- **Delivery layer**
- **Business level (simplified)**

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MPEG-21 for End-to-End QoS Management enabling UMA

Enhance with DIA AdaptationQoS/UCD according to E2E QoS Model
Add’l Rights Expression, License
Service-related Metadata
Capabilities of Adaptation Engines

UED: User Characteristics and Terminal Capabilities
Event Reporting: req./conf.
Monitoring System

DI Model/Declaration/Identification
Rights Expression
Basic Content Descr.

Adaptation Decision-Taking Engine: exploit Content- and Context-related Metadata

Signaling of Characteristics and Conditions using UED
Request and configure monitoring system through Event Reporting
Conclusions

• MPEG-21 Multimedia Framework
  – 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

• ENTHRONE
  – Integrated end-to-end management enabling QoS
  – Heterogeneous contents, networks, and terminals
  – Subsystems with well-defined functionality and interfaces
  – Service-enabling technology
Thank you for your attention

... questions, comments, etc. are welcome ...

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