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相互運用性と、応用毎の最適化を両立させる国際標準 MPEG-21 の最適化バイナリー符号化手法

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［要旨］相互運用性と、応用毎の最適化を両立させる国際標準 MPEG-21 の最適化バイナリー符号化手法を提案する。MPEG-21 (ISO/IEC 21000 シリーズ) は現在 MPEG が活発に標準化を進めている複合ネットワークマルチメディアサービスのための標準集合である。MPEG-21 は著作権管理などの属性情報の記述に XML 言語の利用し、高い拡張性と柔軟性を確保したが、低ビットレートやストリーミングにおける効率性が懸念されている。著者等はこの問題を解決するためのバイナリー符号化方法を提案している。この方法によれば MPEG-21 の拡張性や機器間の互換性を失わせることなく、様々な応用毎に最適化されたバイナリー符号を用いることが可能できる。

Application specific binary coding of MPEG-21 descriptions maintaining interoperability and optimized binary coding

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Abstract:

In this paper, we propose application specific binary coding of MPEG-21 description that maintaining interoperability and optimized binary coding. MPEG-21 (ISO/IEC 21000 series), a set of the standard for multimedia services on heterogeneous network, is currently under development by MPEG. MPEG-21 uses XML for description of various properties such as those for copyright management. XML is noted for it's extensibility and flexibility, however, it is questionable that use of XML fulfills requirements for low bitrate and streaming. Authors proposes binary coding to solve such problem. Using this method, it becomes possible to use various optimized binary coding of XML for different applications while maintaining extensibility and interoperability of MPEG-21 standard.

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1. Introduction

In this paper, we describe a binary coding method of MPEG-21 content descriptors, called ASBC (Application Specific Binary Coding). ASBC is designed to exploit coding gain from application dependent statistical characteristics of Digital Item Declaration (DID) to achieve higher compression ratio.

ASBC maintains full interoperability between any ASBC-encoded bitstreams for different applications and generic MPEG-21 terminals, using dynamic translation techniques.

In the following sections, we describe the encoding and decoding process of ASBC and experimental result using example data, which is designed to emulate a real business circumstances and is currently used for core experiment within MPEG-21 standardization process. Experimental result shows superior additional coding gain derived from ASBC, up to a factor of 10.

2. Challenges in binary coding of MPEG-21

Within the development of MPEG-21 Multimedia Framework, in MPEG submissions, m10646[1], Kaneko & Neergard et al proposed the use of an ASBC that can be transformed to MPEG-21 DID/REL to allow for:

- Use of MPEG-21 standard in highly resource constrained devices.
- Bridging existing systems for multimedia service, which use application specific central databases, to systems supporting MPEG-21 based service for heterogeneous network services.
- Full interoperability of any ASBC encoded content to generic MPEG-21 based terminal using dynamic translation.

3. Processing method

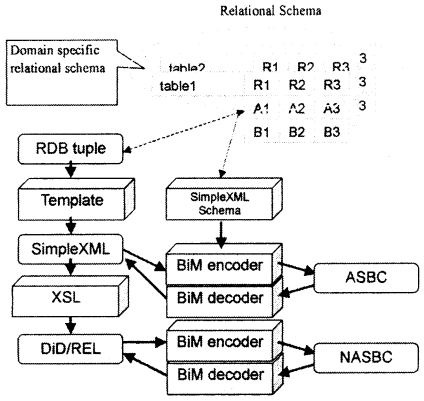

Figure 1 Block diagram of conversion process for ASBC

Figure 1 shows conversion process for ASBC.

- Source data for ASBC may have any form but typically the data is stored in a relational database which is designed for a specific application.
- SimpleXML schema is XML schema optimized for each of given applications.
- Using SimpleXML schema, one RDB tuble (one record in RDB) can be represented as one SimpleXML document. All records in this database can be described using SimpleXML schema.
- Using knowledge of SimpleXML schema, BiM (MPEG-7 tool to encode XML document) may encode SimpleXML to ASBC at superior compression ratio.
- ASBC can be decoded using BiM and same SimpleXML schema.
- Using SXLT translation template, SimpleXML document can be translated to regular form (non application specific form) of MPEG-21 descriptor.

4. Interoperability evaluations

The following 2 tables show interoperability of bitstream and terminal, in both constrained and unconstrained environments. Table 1 shows interoperability without ASBC. Table 2 shows interoperability in the case when using ASBC.

The term "constraints" used in these 2 tables refers to constraints other than those from ASBC such as screen

size, memory or CPU and constraints for same application.

Table 1 shows interoperability in the case without using ASBC. When the bitstream and the terminal have corresponding constraints, decoding of the content is possible. If they do not have matching constraints, even if MPEG-21 binary could be decoded, content cannot be played.

Table 1 Interoperability of constrained bitstream and decoder without use of ASBC

Bitstream	Player	Decoding	Decoding of MPEG-21 binary
Within Constraints	Constrained	Possible	Binary->BiM ->MPEG-21
Within Constraints	Unconstrained	Possible	Binary->BiM-> MPEG-21
Exceed Constraints	Constrained	Impossible	Binary->BiM ->MPEG-21
Exceed Constraints	Unconstrained	Possible	Binary->BiM ->MPEG-21

Table 2 shows interoperability potentials using ASBC.

With the use of ASBC, binary coding is tailored to match the constraints of the player. ASBC is not available for unconstrained bitstreams. Unconstrained bitstream cannot be played on the constrained terminal.

Table 2 Interoperability while bitstream and terminal support ASBC

Bitstream	Player	Decoding	Decoding of MPEG-21 binary
Within Constraints	Constrained	Possible	Binary-> iM->XSLT ->MPEG-21
Within Constraints	Unconstrained	Possible	Binary->BiM->XSLT ->MPEG-21
Exceed Constraints	Constrained	Impossible	Binary->Bim ->MPEG-21
Exceed Constraints	Unconstrained	Possible	Binary->BiM ->MPEG-21

Overall, the ability to use the contents on specific terminal is only determined by the restriction of the player itself. Thus, we may conclude that use of ASBC does not introduce any disadvantage with regards to interoperability.

5. Experimental design

5.1. Experimental data

An experiment was carried out to evaluate the proposed processing method.

Experimental data is provided to the MPEG working group for the purpose of core experiment for XML binarization and streaming. The data consists of about 100 records provided in two form. One form is CSV (comma separated variable length) text file which maps directly to the application specific database. The 2nd form is MPEG-21 DID which is the application specific database mapped onto generic form of MPEG-21 descriptors.

5.2. System environment

We used Oracle 9i server and client running on Linux.

5.3. Encoding process

CSV file is first extracted from the Oracle database. Each record is converted to SimpleXML document. Then SimpleXML documents are encoded using BiM encoder and SimpleXML schema to generate ASBC encoded data.

5.4. Decoding process

ASBC encoded data is first converted to SimpleXML using BiM and the same SimpleXML schema that was used in encoding. SimpleXML document is translated to MPEG-21 descriptor in regular form using XSLT translation template.

6. Experimental Result

Table 3: Experimental result of binary coding using with ASBC

	Min	Compression Ratio
	byte	
XML	2926	1.0
SimpleXML	1177	0.4
ASBC/BIM	175	0.05
ASBC/ZIP	686	0.23

Table 3: Experimental result of binary coding using with ASBC

	Min	Max	Avg.	S.div.	Var.	Compression Ratio
	byte	byte	byte	byte	byte	
XML	5271	6258	5965			1.00
SimpleXML	943	1337	1186			0.20
ASBC/BIM	96	133	122	16.14	260.5	0.020
ASBC/ZIP	642	805	738	48.41	2344	0.12
XML/ZIP	1104	1349	1260	78.39	6145	0.21

Table 3 shows experimental result comparing various binary coding methods. First column, titled "XML", shows size of MPEG-21 XML-based descriptors. Second row, titled "SimpleXML" shows size of descriptor in application specific XML schema. "ASBC/BIM" shows size of binary data in ASBC encoded form. "ASBC/ZIP" show size when ZIP compression is used instead of BiM. "XML/ZIP"shows sizes for MPEG-21 descriptor in generic form simply compressed by ZIP.

Min, Max, Avg., S.div. and Var. represent Minimum, Maximum, Average, Standard Deviation and Variance respectively. Compression ratios show average ratios of compressions compared to regular textual form of MPEG-21 descriptors.

7. Conclusion and Further Work

We have shown that ASBC (Application Specific Binary Coding) can be used:

- To establish interoperability of applications specific schema with applications using MPEG-21 DID
- To minimize resource requirements on constrained devices without imposing constraints on DID/REL.
- To bridge existing non-MPEG-21-based content with MPEG-21 based general-purpose descriptions.

The use of ASBC allows constrained devices to reduce storage requirements through more compact data representation and to reduce CPU computation requirements through simplified schema processing. As can be seen above, the compression ratios achieved through ASBC are significantly better than those achievable through normal compression such as ZIP.

References:

1) Itaru Kaneko (Waseda University), Yasuhiro Nakanishi (MMG), Nobuyuki Kinoshita (MMG), Mika Onishi Neergaard (MMG), MPEG m10646, "MMG-Waseda proposal on MPEG-21 DID binary coding (binarization)", 2004
2) Mika Onishi Neergaard, Itaru Kaneko,MPEG m9698, "MMG MPEG-21 IPMP Use Case / Walkthrough", 2003
3) Mika Onishi Neergaard, Itaru Kaneko, "Mika Onishi Neergaard, Itaru Kaneko,m10009, "Technical analysis of Use Cases – m9698", 2003
4) Mika Onishi Neergaard, Itaru Kaneko,m10313, "Optimization of DID in MPEG-21 architecture", 2003

Figure 2 Experimental data

Code 1: Data in SimpleXML form

```
<?xml version="1.0" encoding="UTF-8" ?>
<Rights id="PermissionsForItem1"
        xmlns="http://www.m-m-g.net/2004/SXML"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://www.m-m-g.net/2004/SXML
        SimpleXML.xsd">
  <ContentID>SMJP010000001101</ContentID>
  <FromID>HJPO010000002023</FromID>
  <ToID>DJPC010000003234</ToID>
  <Version>1.0.0</Version>
  <Record>1</Record>
  <PublicClass>Closed</PublicClass>
  <PurposeClass>Promotion</PurposeClass>
  <ChargeClass>
    <Charge-free/>
  </ChargeClass>
  <BillingClass>BlanketBilling</BillingClass>
  <ApplicationClass>BlanketPermission</ApplicationClass>
  <TerritoryClass>JP</TerritoryClass>
  <UsageClass>
    <Fixation>
      <Physical>
        <Shared/>
      </Physical>
    </Fixation>
  </UsageClass>
  <ID>729988</ID>
  <CompressionMethod>WMA</CompressionMethod>
  <RecordingMedia>MemoryStick</RecordingMedia>
  <SecurityParam>Watermark</SecurityParam>
  <TransferParam>Wireless</TransferParam>
  <CharacterParam>ByAlbum</CharacterParam>
  <PlayCount>1</PlayCount>
  <DurationStart>2003-07-03</DurationStart>
  <DurationEnd>2004-08-01</DurationEnd>
  <Period>2004-10-01</Period>
  <LastCapture>Mobile</LastCapture>
</Rights>
```

Code 2: Reproduced MPEG-21 DID with REL

```
<?xml version="1.0" encoding="utf-8"?>
<didl:DIDL xmlns:didl="urn:mpeg:mpeg21:2002:02-DIDL-NS"
           xmlns:sxml="http://www.m-m-g.net/2004/SXML"

        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

        xsi:schemaLocation="http://www.m-m-g.net/2004/SXML
        SimpleXML.xsd       urn:mpeg:mpeg21:2002:02-DIDL-NS
        didl.xsd">

  <didl:Item id="id729988">
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement
      mimeType="text/plain">Record</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">1</didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement
      mimeType="text/plain">PublicClass</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">Closed</didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement
      mimeType="text/plain">PurposeClass</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">Promotion</didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement
      mimeType="text/plain">BillingClass</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">BlanketBilling</didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement
      mimeType="text/plain">ApplicationClass</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">BlanketPermission</didl:Statement
      >
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Statement mimeType="text/xml">
        <sxml:ChargeClass>
          <sxml:Charge-free/>
        </sxml:ChargeClass>
      </didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Statement mimeType="text/xml">
        <sxml:UsageClass>
          <sxml:Fixation>
            <sxml:Physical>
              <sxml:Shared/>
            </sxml:Physical>
          </sxml:Fixation>
        </sxml:UsageClass>
      </didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement mimeType="text/plain">
        CompressionMethod</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">WMA</didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement
      mimeType="text/plain">RecordingMedia</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">MemoryStick</didl:Statement>
    </didl:Descriptor>
    <didl:Descriptor>
      <didl:Descriptor>
        <didl:Statement
      mimeType="text/plain">SecurityParam</didl:Statement>
      </didl:Descriptor>
      <didl:Statement
      mimeType="text/plain">Watermark</didl:Statement>
```

```
      </didl:Descriptor>
      <didl:Descriptor>
        <didl:Descriptor>
          <didl:Statement
        mimeType="text/plain">TransferParam</didl:Statement>
        </didl:Descriptor>
        <didl:Statement
        mimeType="text/plain">Wireless</didl:Statement>
      </didl:Descriptor>
      <didl:Descriptor>
        <didl:Descriptor>
          <didl:Statement
        mimeType="text/plain">CharacterParam</didl:Statement>
        </didl:Descriptor>
        <didl:Statement
        mimeType="text/plain">ByAlbum</didl:Statement>
      </didl:Descriptor>
      <didl:Descriptor>
        <didl:Descriptor>
          <didl:Statement
        mimeType="text/plain">Period</didl:Statement>
        </didl:Descriptor>
        <didl:Statement
        mimeType="text/plain">2004-10-01</didl:Statement>
      </didl:Descriptor>
      <didl:Descriptor>
        <didl:Descriptor>
          <didl:Statement
        mimeType="text/plain">LastCapture</didl:Statement>
        </didl:Descriptor>
        <didl:Statement
        mimeType="text/plain">Mobile</didl:Statement>
      </didl:Descriptor>
      <didl:Component>
        <didl:Resource mimeType="text/xml">
          <r:license
        xmlns:r="urn:mpeg:mpeg21:2003:01-REL-R-NS"
          xmlns:mmg="http://profiles.m-m-g.net/rel"
          xmlns:dsig="http://www.w3.org/2000/09/xmldsig#"
          xmlns:mx="urn:mpeg:mpeg21:2003:01-REL-MX-NS"
          xmlns:sx="urn:mpeg:mpeg21:2003:01-REL-SX-NS"
          sx:profileCompliance="mmg:v1.0.0"

        xsi:schemaLocation="urn:mpeg:mpeg21:2003:01-REL-MX-
        NS    rel-mx.xsd    urn:mpeg:mpeg21:2003:01-REL-R-NS
        rel-r.xsd              urn:mpeg:mpeg21:2003:01-REL-SX-NS
        rel-sx.xsd">

            <r:title>PermissionsForItem1</r:title>
            <r:grant>
              <r:keyHolder licensePartId="mmg-KeyHolder">
                <r:info>

        <dsig:KeyName>DJPC010000003234</dsig:KeyName>
                </r:info>
              </r:keyHolder>
              <sx:rightUri definition="urn:m-m-g:fixate" />
              <mx:diReference
        licensePartId="mmg-diReference">
                <mx:identifier>

        http://ContentID.m-m-g.net/SMJP010000001101</mx:identi
        fier>
              </mx:diReference>
              <r:allConditions
        licensePartId="mmg-allConditions">
                <r:validityInterval>

        <r:notBefore>2003-07-03T00:00:00</r:notBefore>

        <r:notAfter>2004-08-01T00:00:00</r:notAfter>
```

```
                </r:validityInterval>
                <sx:territory>
                  <sx:location>
                    <sx:country
        xmlns:iso="urn:mpeg:mpeg21:2003:01-REL-SX-NS:country
        ">
                      iso:JP</sx:country>
                  </sx:location>
                </sx:territory>
                <sx:trackReport />
                <sx:exerciseLimit>
                  <sx:count>1</sx:count>
                </sx:exerciseLimit>
              </r:allConditions>
            </r:grant>
            <r:grant>
              <r:keyHolder   licensePartIdRef="mmg-KeyHolder"
        />
              <sx:rightUri definition="urn:m-m-g:shared" />
              <mx:diReference
        licensePartIdRef="mmg-diReference" />
              <r:allConditions
        licensePartIdRef="mmg-allConditions" />
            </r:grant>
            <r:issuer>
              <r:keyHolder>
                <r:info>

        <dsig:KeyName>HJPO010000002023</dsig:KeyName>
                </r:info>
              </r:keyHolder>
            </r:issuer>
          </r:license>
        </didl:Resource>
      </didl:Component>
    </didl:Item>
  </didl:DIDL>
```