Bitstream Syntax Description Language: Application of XML-Schema to Multimedia Content Adaptation

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Presentation Plan

- Content Adaptation
- Scalable Coding formats
- XML description of a multimedia bitstream
- Bitstream Syntax Description Language (BSDL)
- XMLtoBin
- System approach / Demo
- Conclusion and future works

Content adaptation: system features

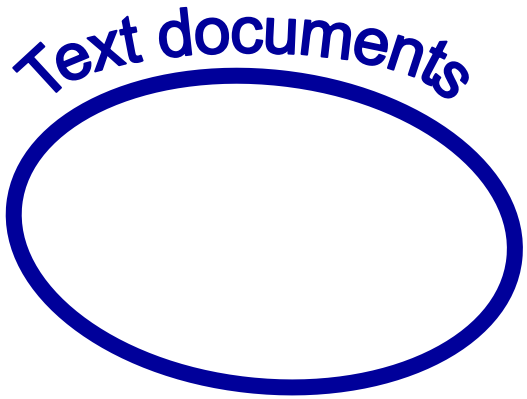
Content servers:
audio, video, MPEG, JPEG2000, H263, proprietary formats

Device capabilities:
display, CPU, memory

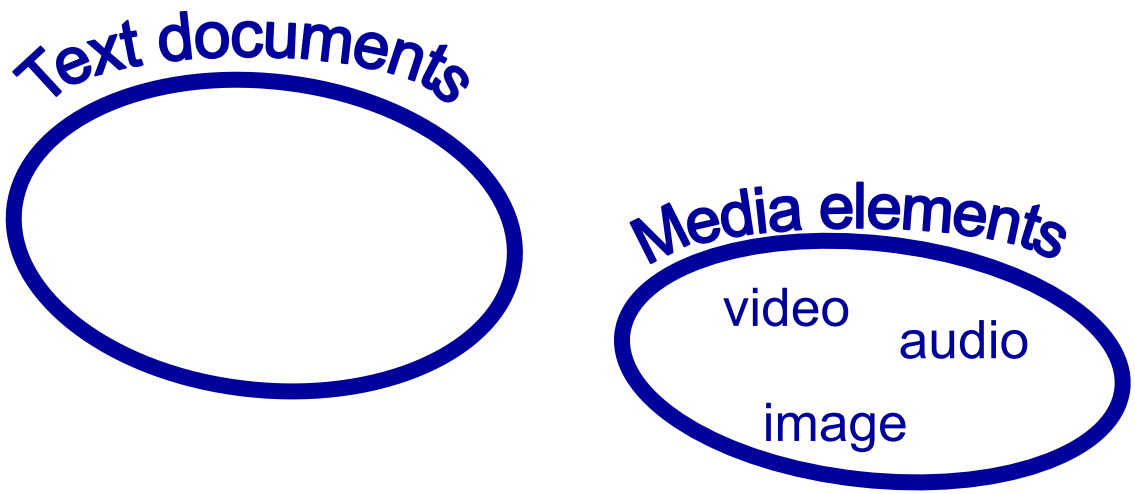
Wireless networks

Content adaptation: content types

Content adaptation: content types



Content adaptation: content types



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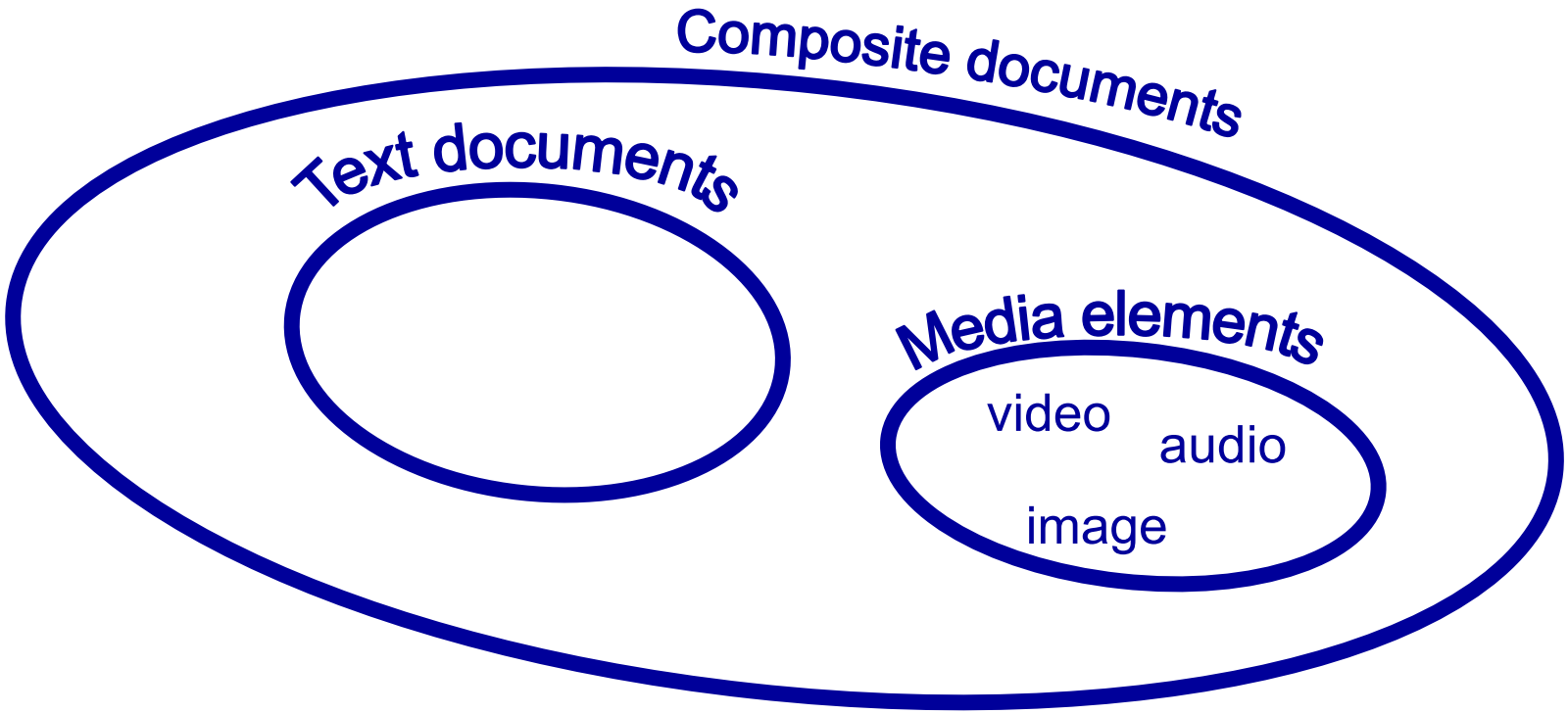

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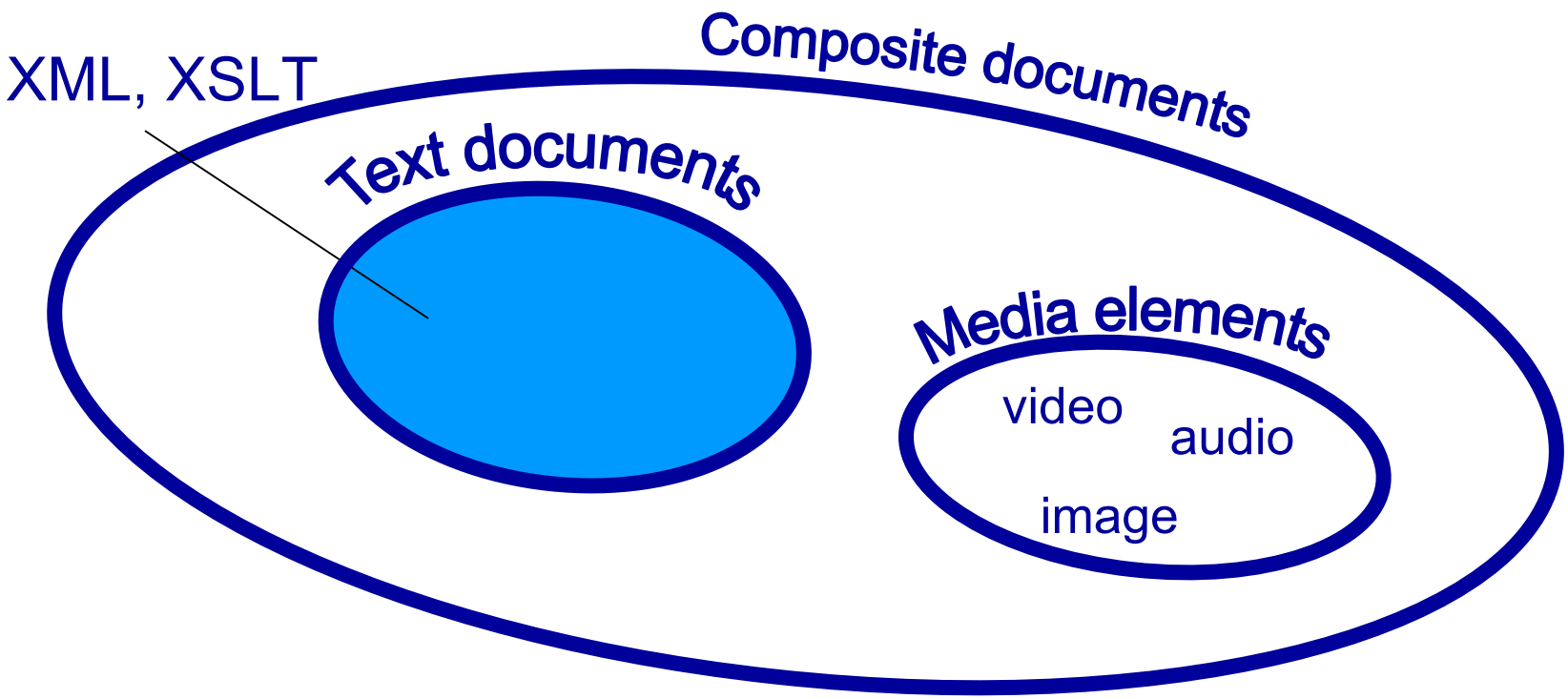

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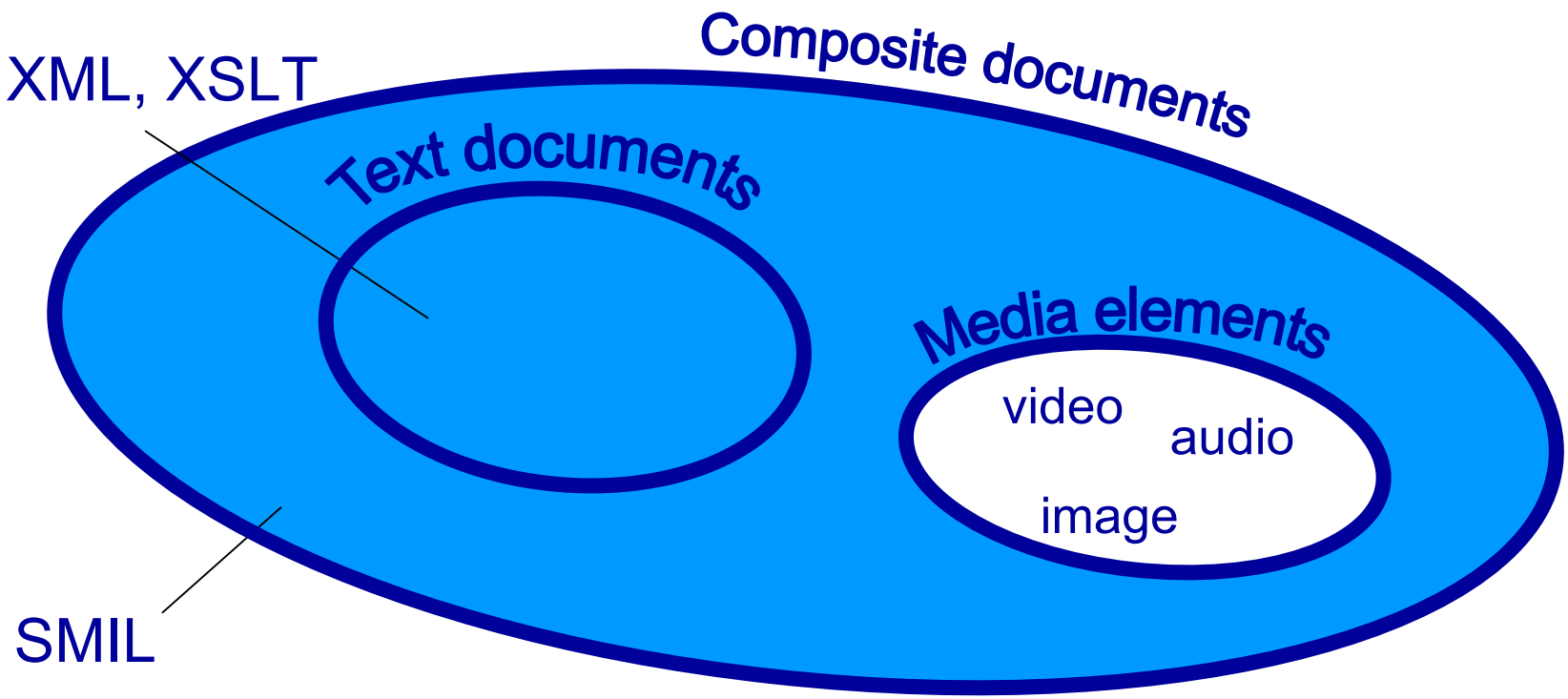
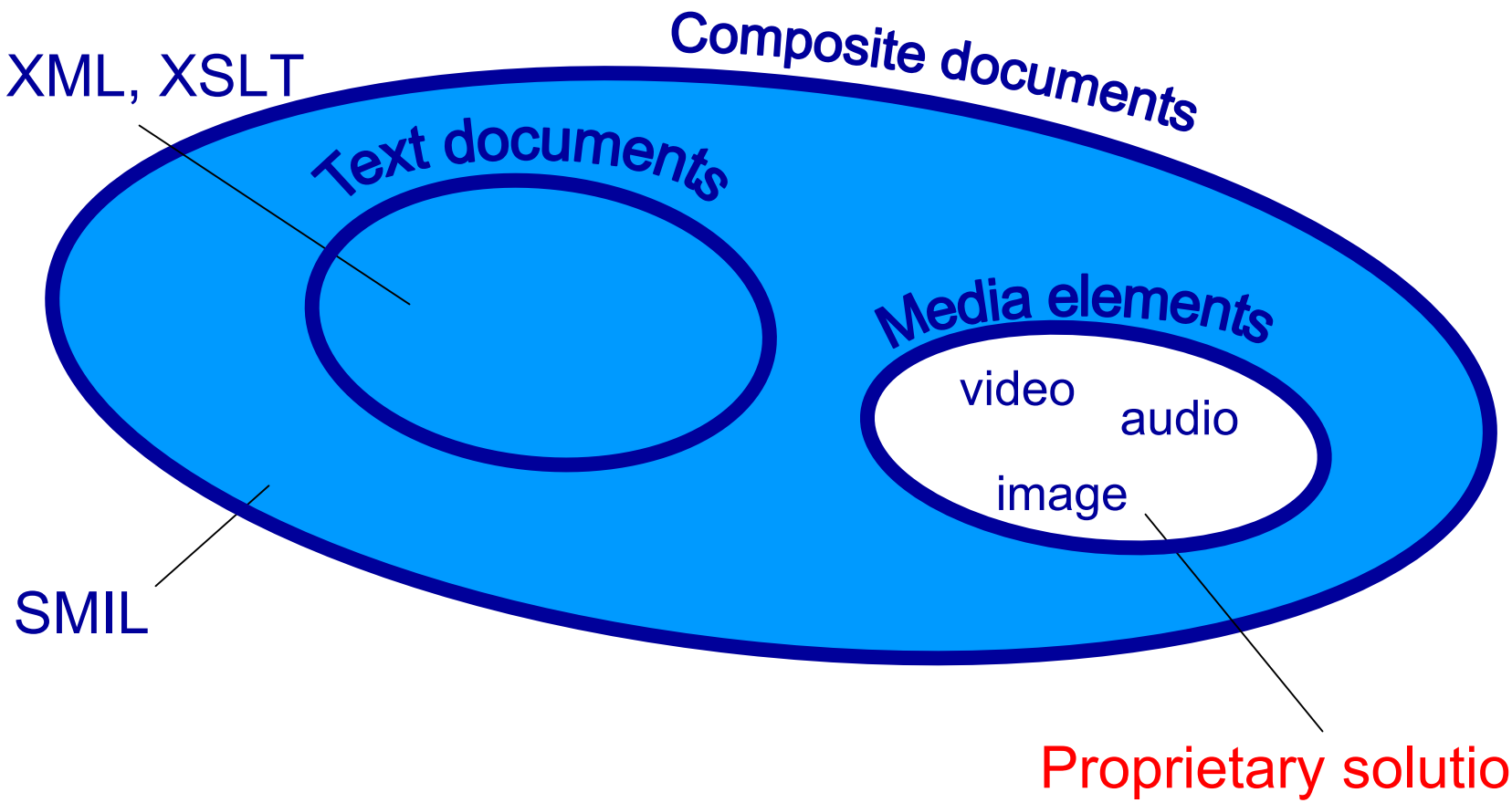


Content adaptation: content types



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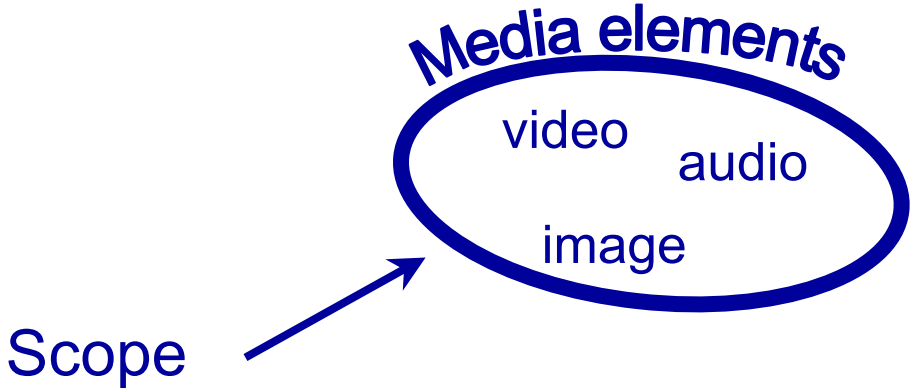
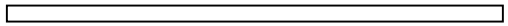
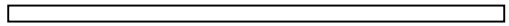


Scalable Coding formats

Scalability by quality (SNR)

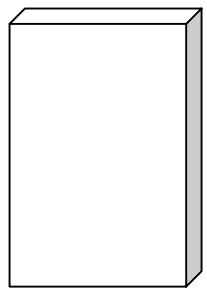


Spatial scalability



Temporal scalability

3D scalable scenes



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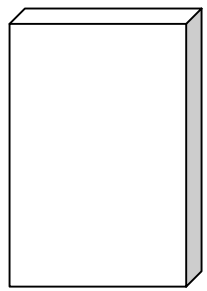

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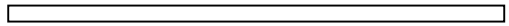

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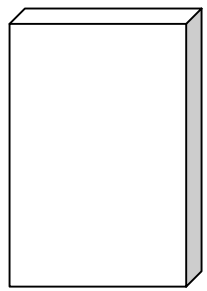

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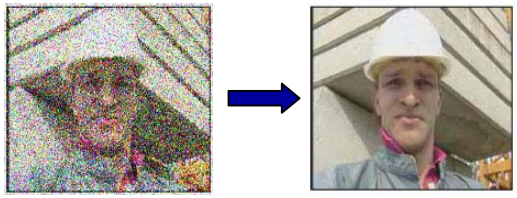

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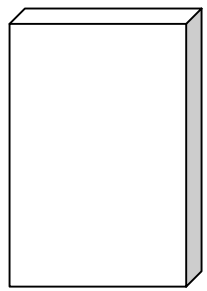

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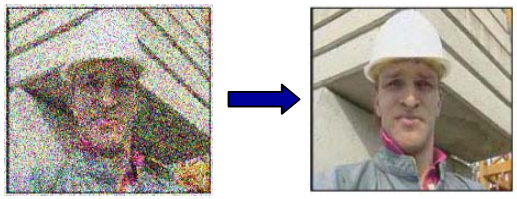

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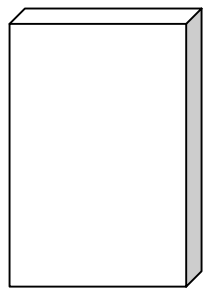

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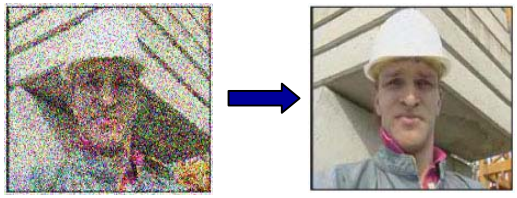

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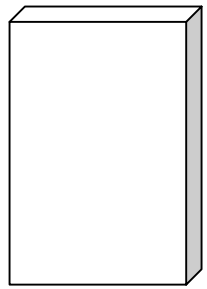

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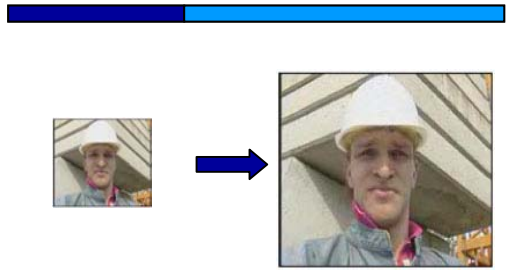

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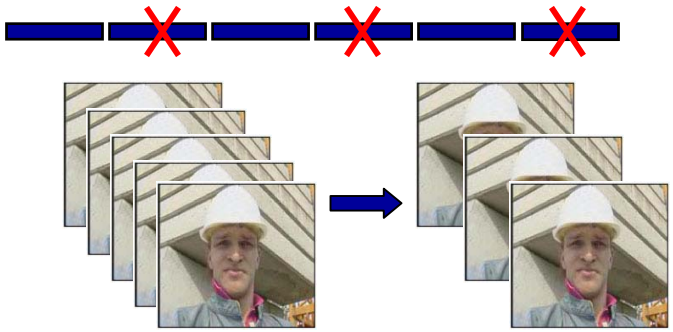

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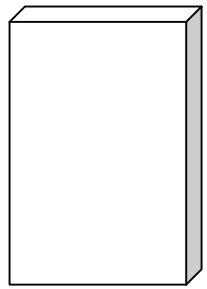

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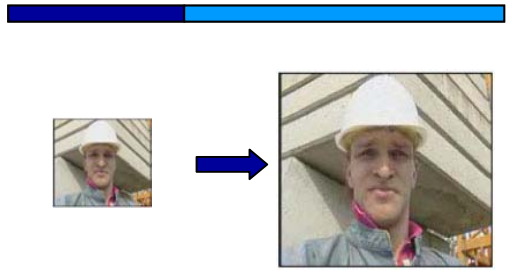

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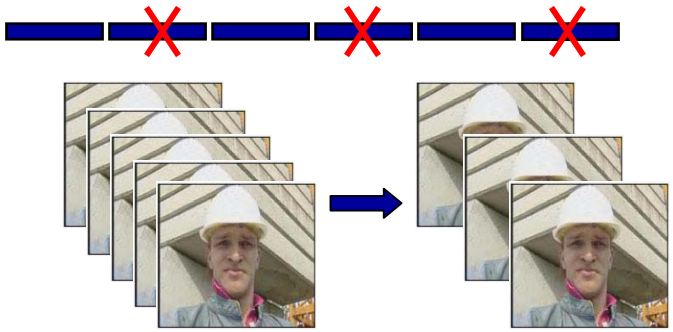

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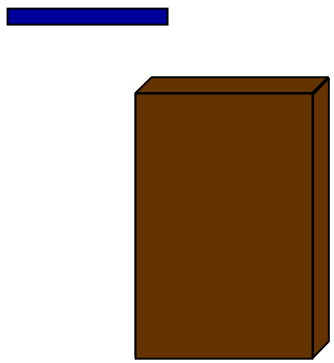

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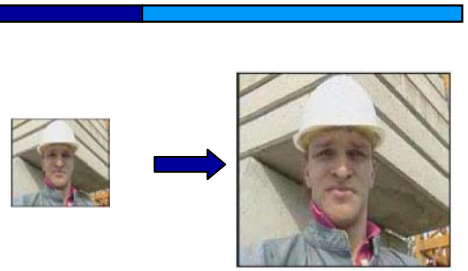

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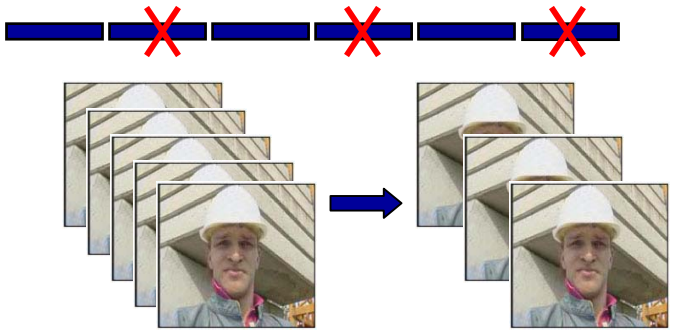

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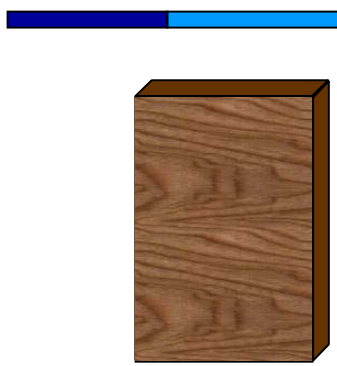

Dynamic Content Adaptation

- Issue: how to fully exploit scalability for content adaptation ?
- In a client-server application:
  - The client requests a scalable content available on a server
  - The server establishes a content negotiation stage
  - The server edits the bitstream, and sends it to the client

⇨ Need of a software to parse and edit the bitstream

- Issue: each coding format has its own data structure
  - one software per available format
  - update the software if new version

⇨ Generic approach: use a common structuring language to describe the bitstream syntax

➡ Use XML !

XML Description of a Multimedia Bitstream

- *Not* an alternative format, but additional layer describing the high-level structure (i.e. in packets or layers)
- May be stored / transmitted along with content
- Data may be
  - embedded in the XML description
    - in a readable format
    - in binary format (hexadecimal or base64)
  - in an external entity (pointed by the XML description)

XML description

```
<Bitstream
  xml:base="http://www.example.com/akiyo.mpg4">
  <Header>0-17</Header>
  <frame>18-4658</frame>
  <frame>4659-4756</frame>
  <frame>4757-4772</frame>
  <frame>4773-4795</frame>
  <frame>4796-4973</frame>
  <frame>4974-5026</frame>
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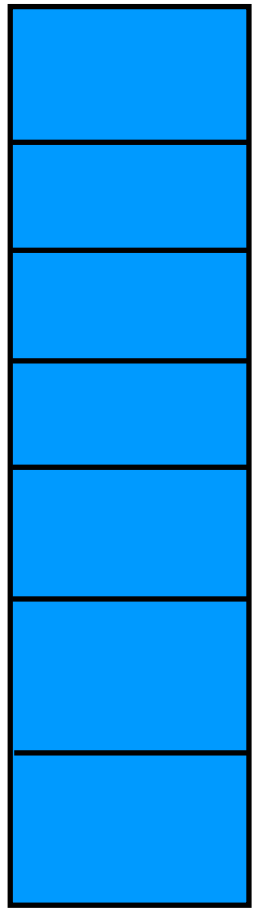

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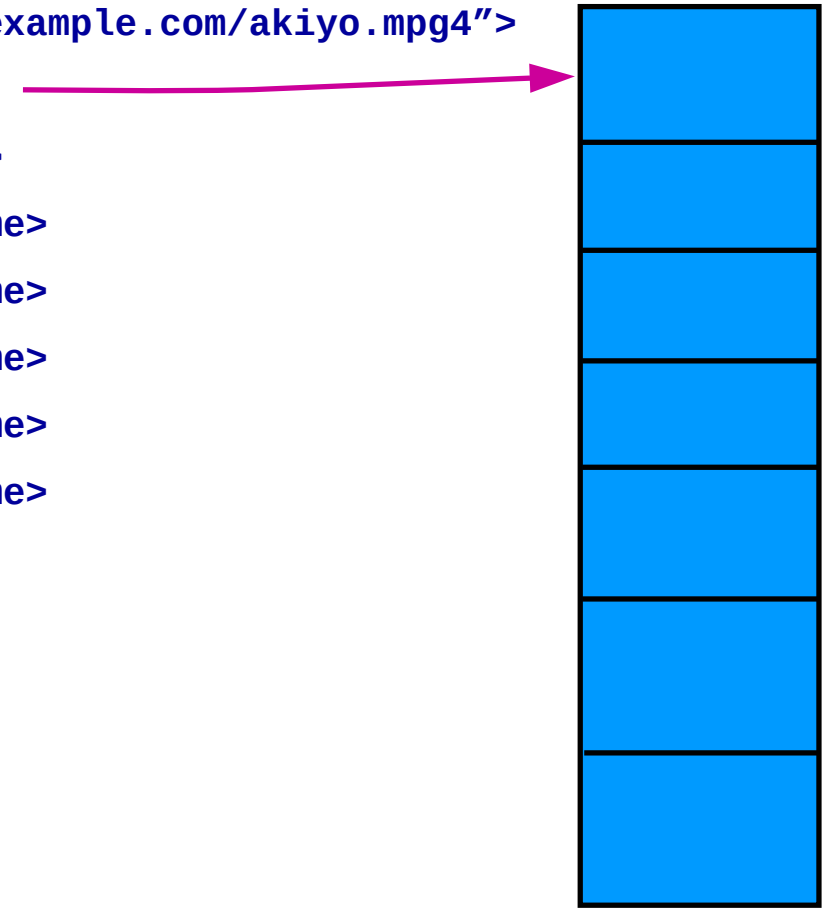

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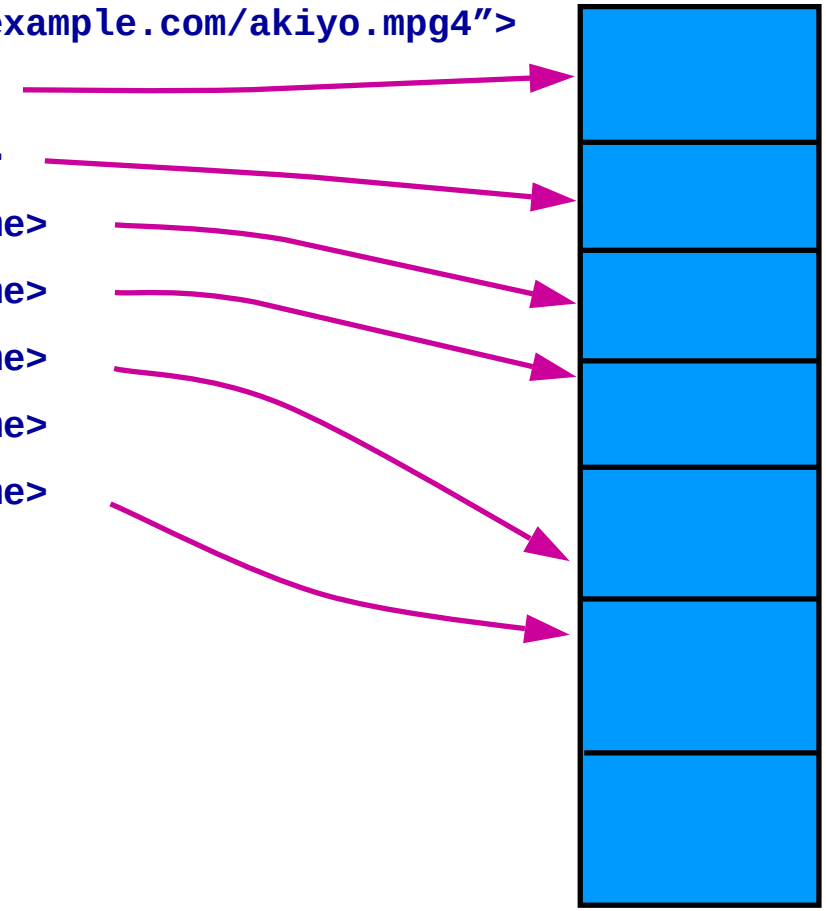

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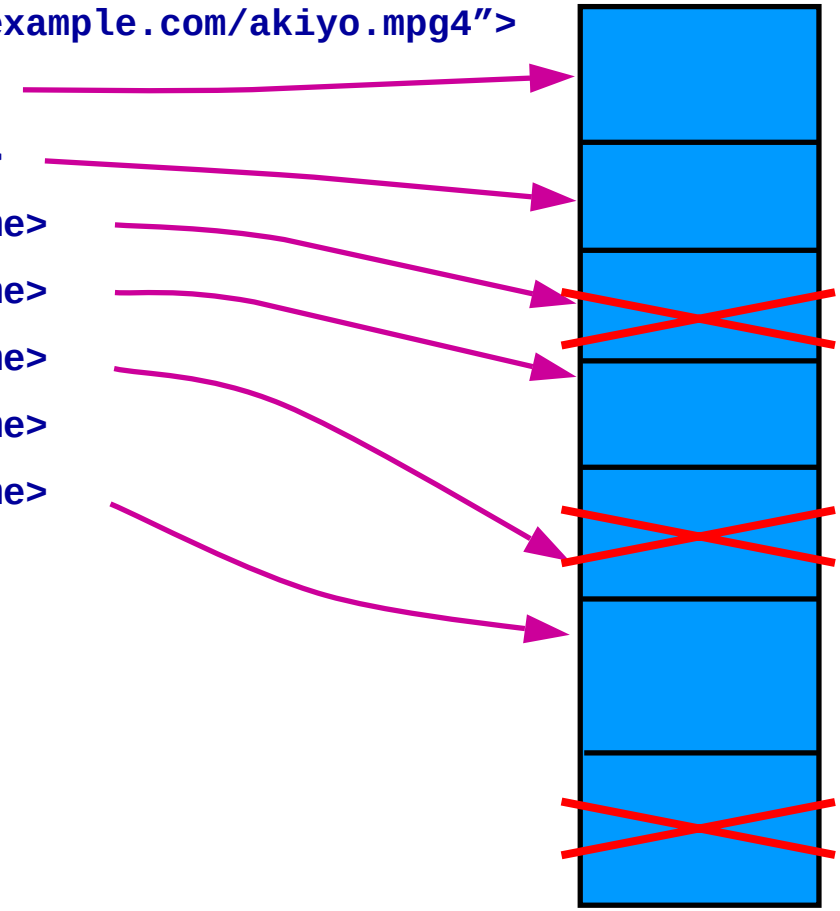

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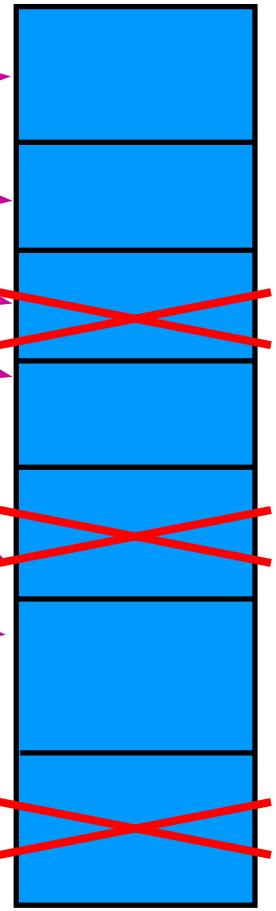
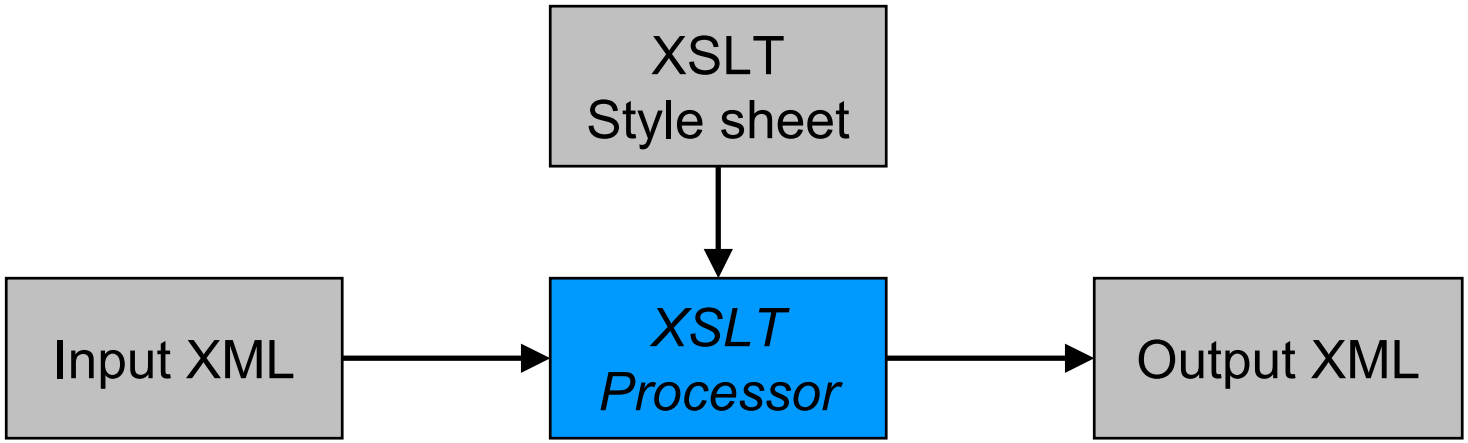


Image Transformation with XSLT

- eXtensible Stylesheet Language Transformations (XSLT): W3C language specifying XML-to-XML transformations



Scalable Content Adaptation with XML

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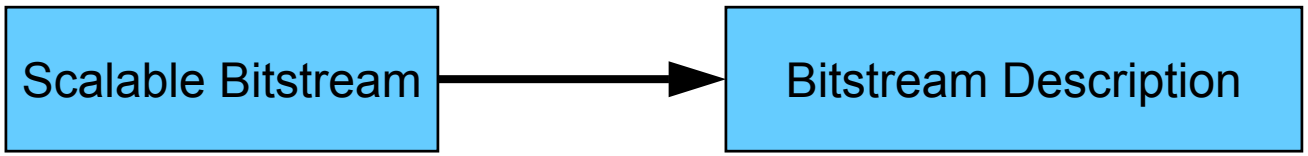

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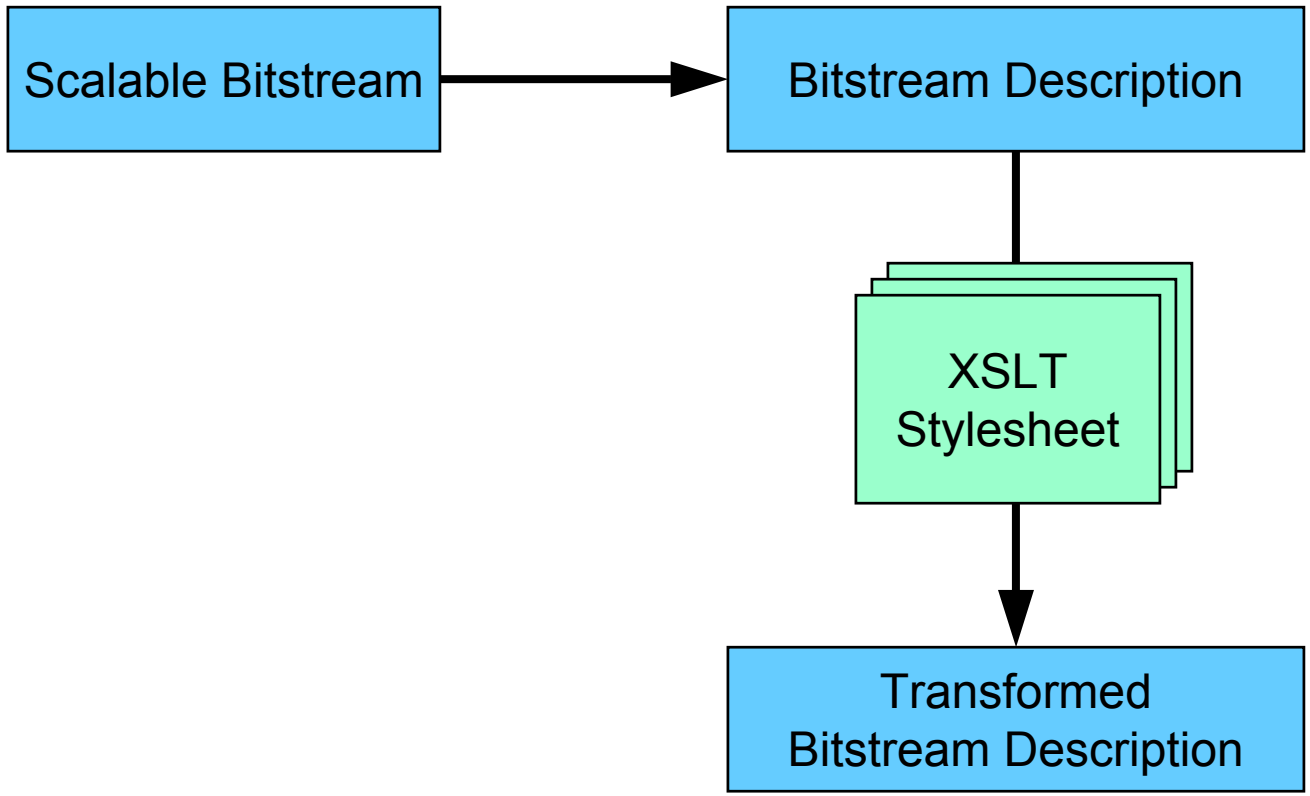

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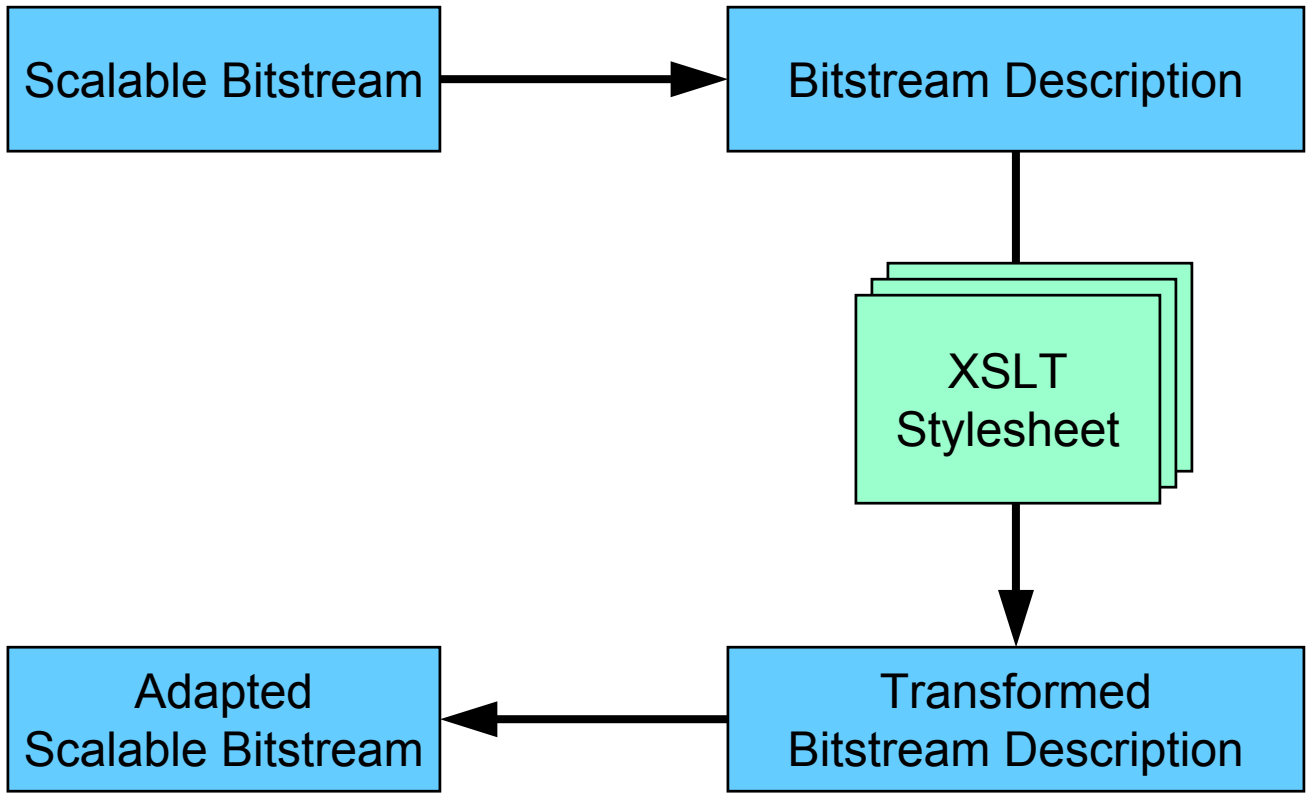

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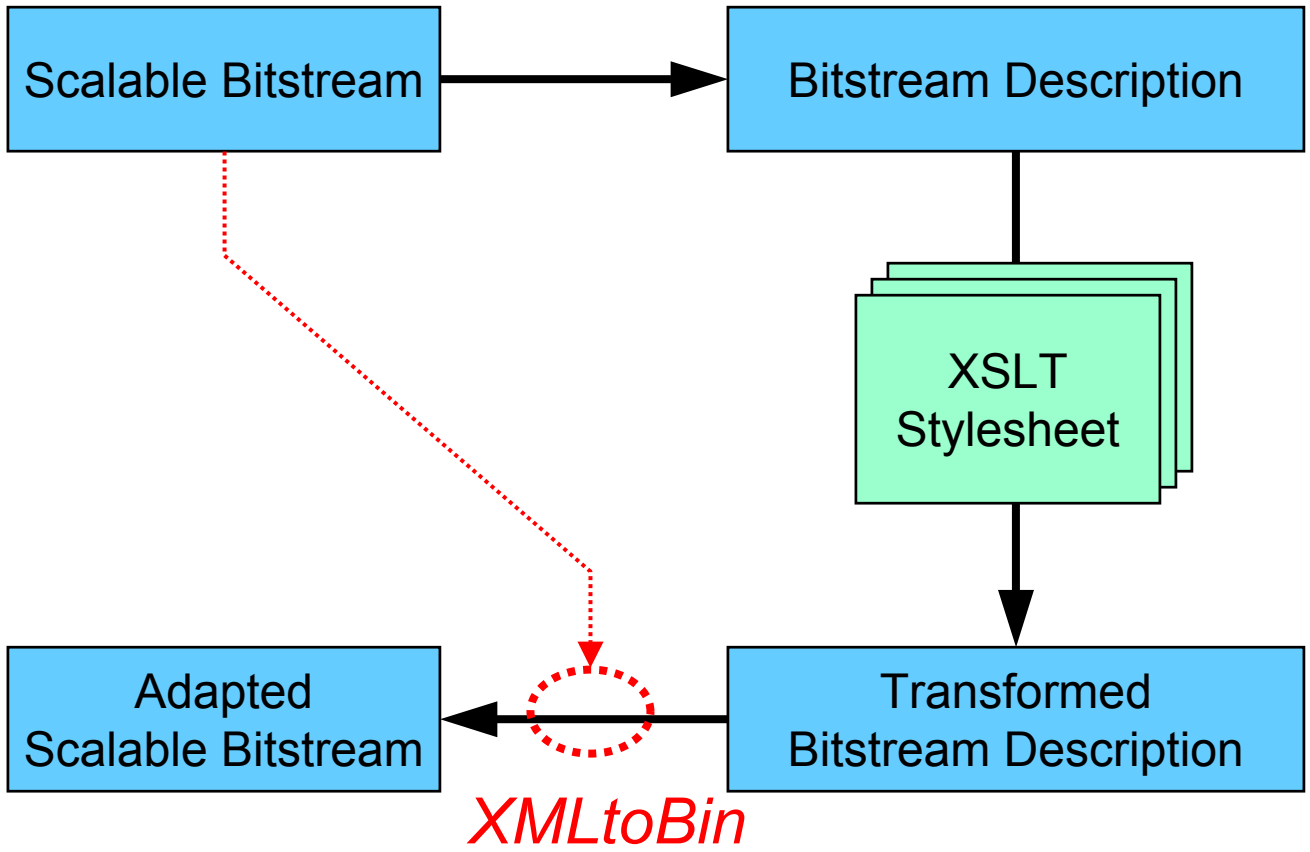

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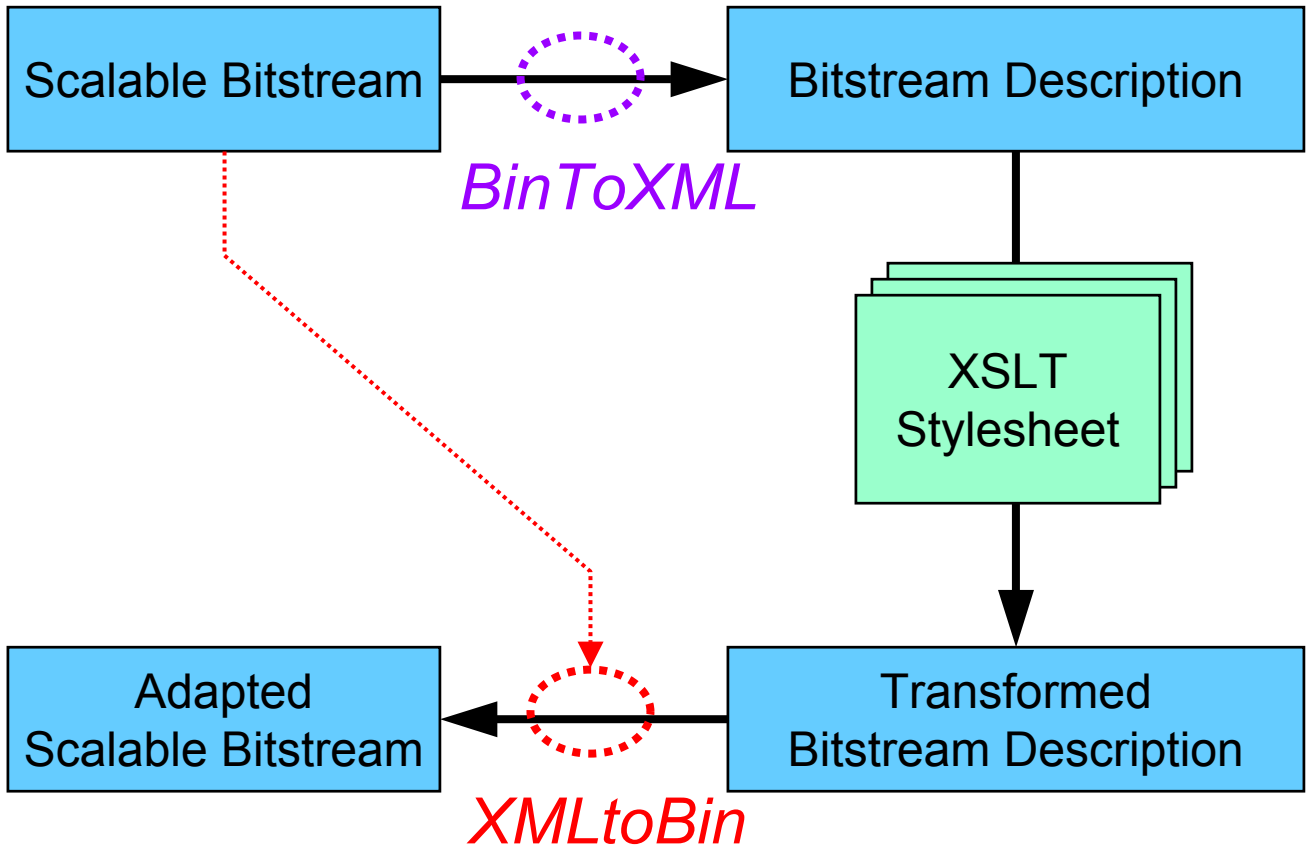

Need for a document model

XML Bitstream Description

```
<Codestream>
  <MainHeader>
    <SOC>
      <Marker>ff4f</Marker>
    </SOC>
    <SIZ>
      <Marker>ff51</Marker>
      <Lsiz>47</Lsiz>
      <Xsiz>512</Xsiz>
    </SIZ>
  </MainHeader>
</Codestream>
```

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How many bits in the bitstream ?

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- How to binarize these values ?

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→ Need for a document model

→ Efficient for data type specification

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How many bits in the bitstream ?

- Some parameters need to be written in a readable format (for XSLT transformations)
- How to binarize these values ?

→ Need for a document model

→ Efficient for data type specification

→ XML-schema

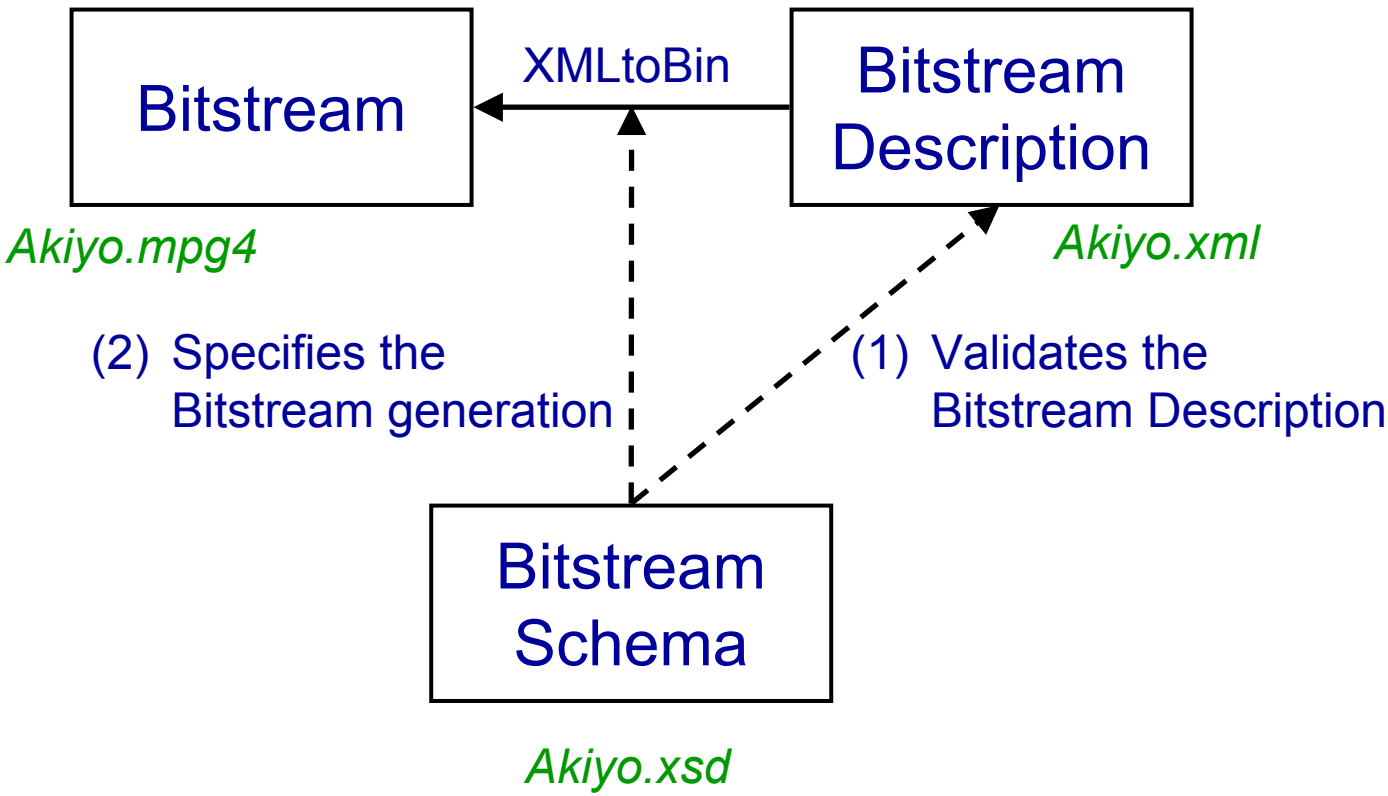
Bitstream Syntax Description Language

To design a new technical framework based on XML for describing the structure of bitstreams,

we define a “schema language”:
“Bitstream Syntax Description Language”,

based on W3C XML-Schema (restrictions + extensions)

BSDL Functionality



BSDL: Embedded Data

Input BSDL Description

```
<Codestream>
  <MainHeader>
    <SOC>
      <Marker>ff4f</Marker>
    </SOC>
    <SIZ>
      <Marker>ff51</Marker>
      <Lsiz>47</Lsiz>
      <Xsiz>512</Xsiz>
    </SIZ>
  </MainHeader>
</Codestream>
```

BSDL Schema

```
<xsd:complexType name="SOCType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd:short"/>
  </xsd:sequence>
</xsd:complexType>
<xsd:complexType name="SIZType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd: short "/>
    <xsd:element name="Lsiz"
      type="xsd:unsignedShort"/>
    <xsd:element name="Xsiz"
      type="xsd:unsignedInt"/>
  </xsd:sequence>
</xsd:complexType>
```

Output bitstream: `ff4f ff51 002f 00000200 ...`

BSDL: Embedded Data

Input BSDL Description

```
<Codestream>
  <MainHeader>
    <SOC>
      <Marker>ff4f</Marker>
    </SOC>
    <SIZ>
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  </xsd:sequence>
</xsd:complexType>
<xsd:complexType name="SIZType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd: short "/>
    <xsd:element name="Lsiz"
      type="xsd:unsignedShort"/>
    <xsd:element name="Xsiz"
      type="xsd:unsignedInt"/>
  </xsd:sequence>
</xsd:complexType>
```

Output bitstream: ff4f ff51 002f 00000200 ...

BSDL: Embedded Data

Input BSDL Description

```
<Codestream>
  <MainHeader>
    <SOC>
      <Marker>ff4f</Marker>
    </SOC>
    <SIZ>
      <Marker>ff51</Marker>
      <Lsiz>47</Lsiz>
      <Xsiz>512</Xsiz>
    </SIZ>
  </MainHeader>
</Codestream>
```

BSDL Schema

```
<xsd:complexType name="SOCType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd:short"/>
  </xsd:sequence>
</xsd:complexType>
<xsd:complexType name="SIZType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd: short "/>
    <xsd:element name="Lsiz"
      type="xsd:unsignedShort"/>
    <xsd:element name="Xsiz"
      type="xsd:unsignedInt"/>
  </xsd:sequence>
</xsd:complexType>
```

Output bitstream: `ff4f ff51 002f 00000200 ...`

BSDL: Embedded Data

Input BSDL Description

```
<Codestream>
  <MainHeader>
    <SOC>
      <Marker>ff4f</Marker>
    </SOC>
    <SIZ>
      <Marker>ff51</Marker>
      <Lsiz>47</Lsiz>
      <Xsiz>512</Xsiz>
    </SIZ>
  </MainHeader>
</Codestream>
```

BSDL Schema

```
<xsd:complexType name="SOCType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd:short"/>
  </xsd:sequence>
</xsd:complexType>
<xsd:complexType name="SIZType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd: short "/>
    <xsd:element name="Lsiz"
      type="xsd:unsignedShort"/>
    <xsd:element name="Xsiz"
      type="xsd:unsignedInt"/>
  </xsd:sequence>
</xsd:complexType>
```

Output bitstream: `ff4f ff51 002f 00000200 ...`

BSDL: Embedded Data

Input BSDL Description

```
<Codestream>
  <MainHeader>
    <SOC>
      <Marker>ff4f</Marker>
    </SOC>
    <SIZ>
      <Marker>ff51</Marker>
      <Lsiz>47</Lsiz>
      <Xsiz>512</Xsiz>
    </SIZ>
  </MainHeader>
</Codestream>
```

BSDL Schema

```
<xsd:complexType name="SOCType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd:short"/>
  </xsd:sequence>
</xsd:complexType>
<xsd:complexType name="SIZType">
  <xsd:sequence>
    <xsd:element name="Marker"
      type="xsd: short "/>
    <xsd:element name="Lsiz"
      type="xsd:unsignedShort"/>
    <xsd:element name="Xsiz"
      type="xsd:unsignedInt"/>
  </xsd:sequence>
</xsd:complexType>
```

Output bitstream: `ff4f ff51 002f 00000200 ...`

BSDL: External Entity

Input BSDL Description

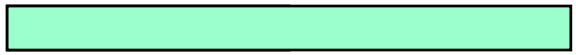
```
<Bitstream xml:base="myImage.jp2">
<PacketData>122-363</PacketData>
<PacketData>370-861</PacketData>
```

BSDL Schema

```
<xsd:element name="PacketData"
     type="bsdl:byteRange"/>
```

Input bitstream:

Output bitstream:



BSDL: External Entity

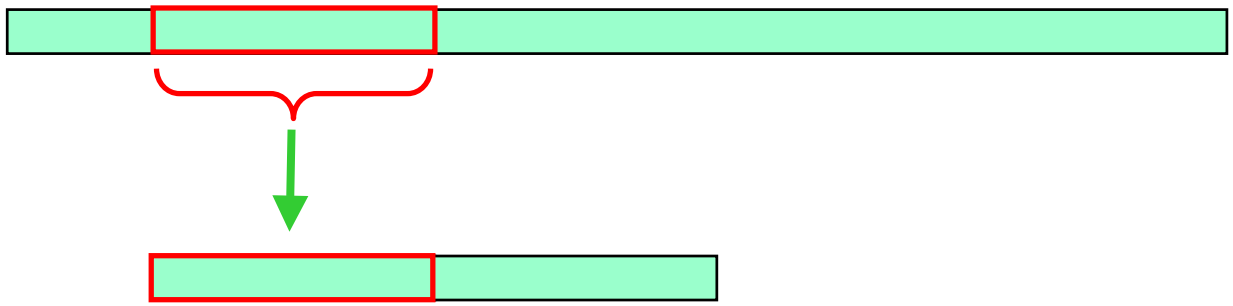
Input BSDL Description

```
<Bitstream xml:base="myImage.jp2">
<PacketData>122-363</PacketData>
<PacketData>370-861</PacketData>
```

BSDL Schema

```
<xsd:element name="PacketData"
     type="bsdl:byteRange"/>
```

Input bitstream:



Output bitstream:

BSDL: External Entity

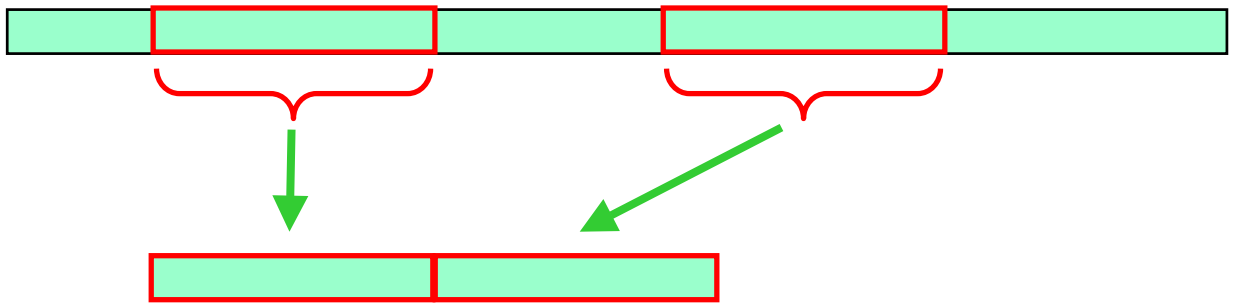
Input BSDL Description

```
<Bitstream xml:base="myImage.jp2">
<PacketData>122-363</PacketData>
<PacketData>370-861</PacketData>
```

BSDL Schema

```
<xsd:element name="PacketData"
     type="bsdl:byteRange"/>
```

Input bitstream:



Output bitstream:

BSDL: Restrictions on Structures

- Data shall be embedded in elements (and not in attributes)
- A type must be assigned to each element of the instance

BSDL: Restrictions on Datatypes

- Use only XML-Schema datatypes having an implicit binary representation.

  `xsd:integer` = unbounded integer
  ➔ excluded

  `xsd:int` = bounded integer
  ➔ included, binary representation on 4 bytes

BSDL: Extensions on Datatypes

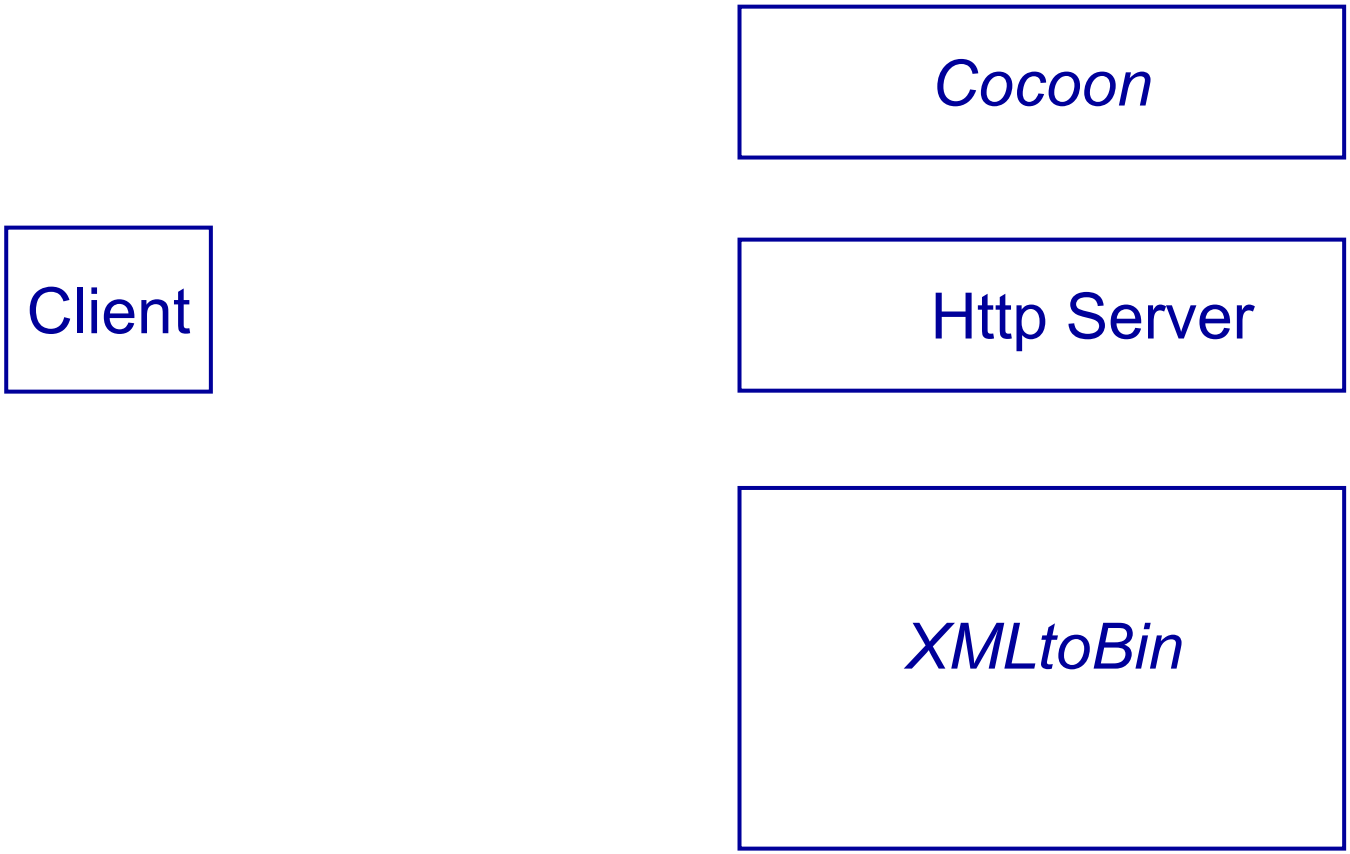
- BSDL Pseudo-facets

  bsdl:bitsLength = indicates the number of bits on which the element should be encoded

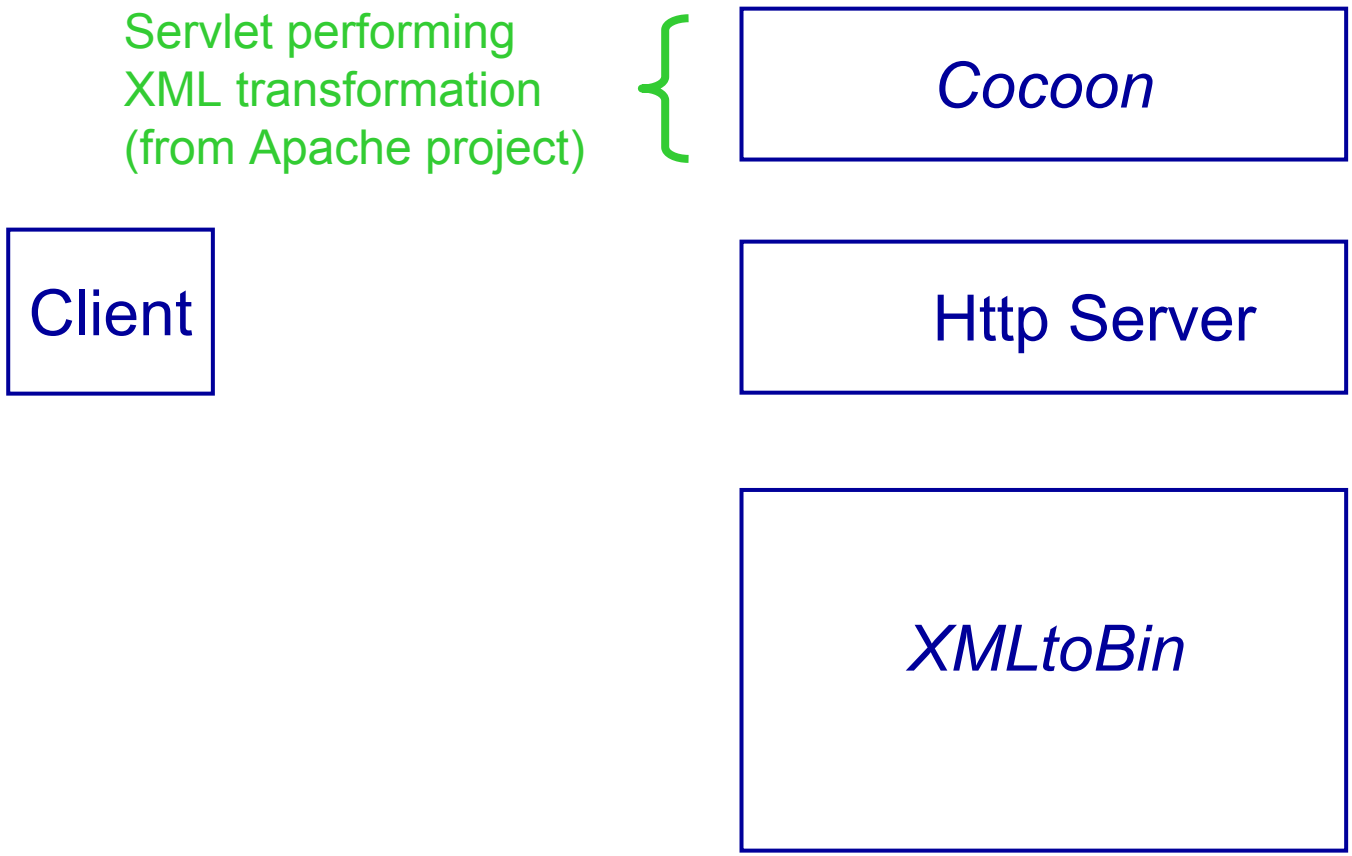
- XML-Schema extension mechanism

```
<xsd:simpleType>
  <xsd:restriction base="xsd:unsignedByte">
     <xsd:annotation><xsd:appinfo>
        <bsdl:bitsLength>
     </xsd:appinfo></xsd:annotation>
  </xsd:restriction>
</xsd:simpleType>
```

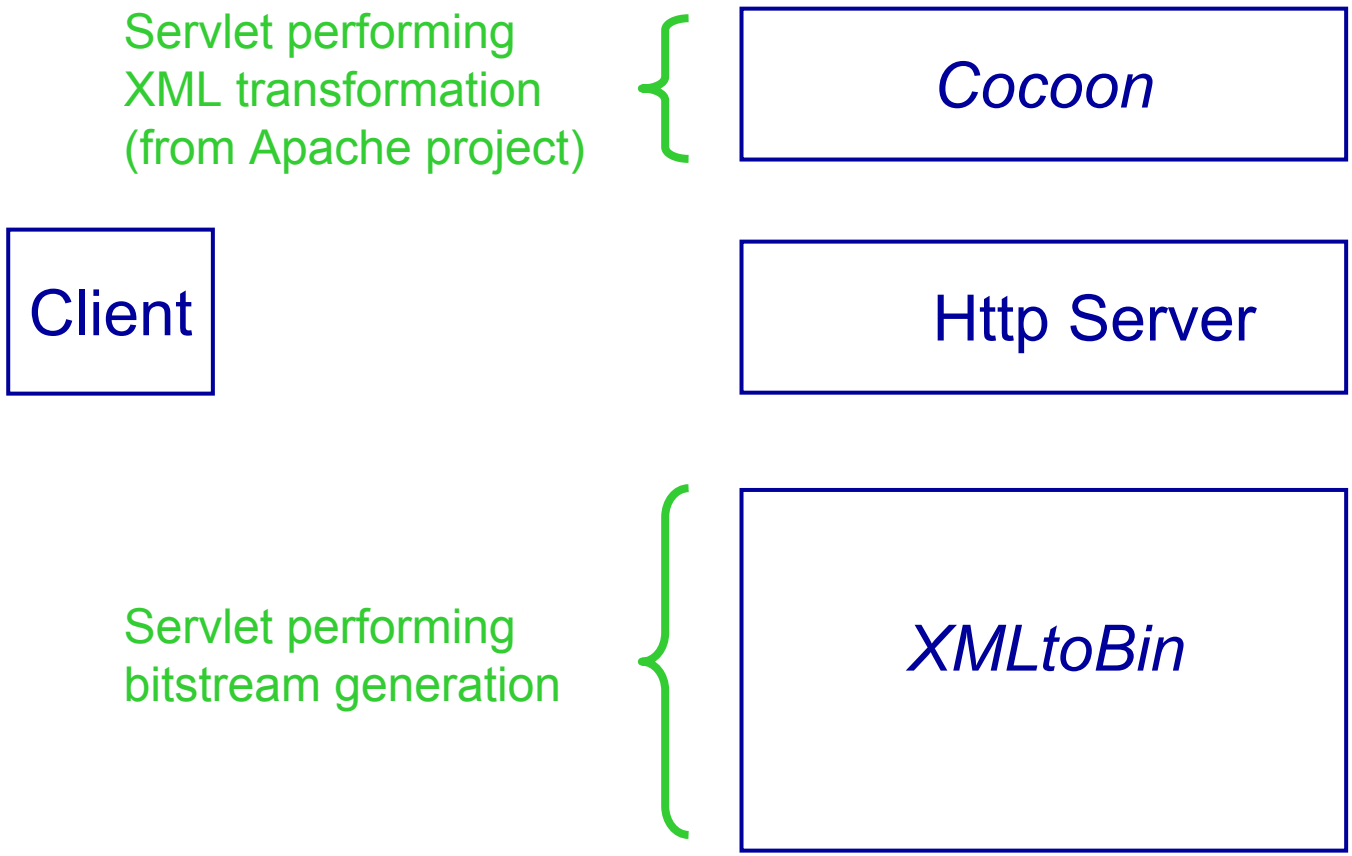
Demo: Implementation on a Web Architecture



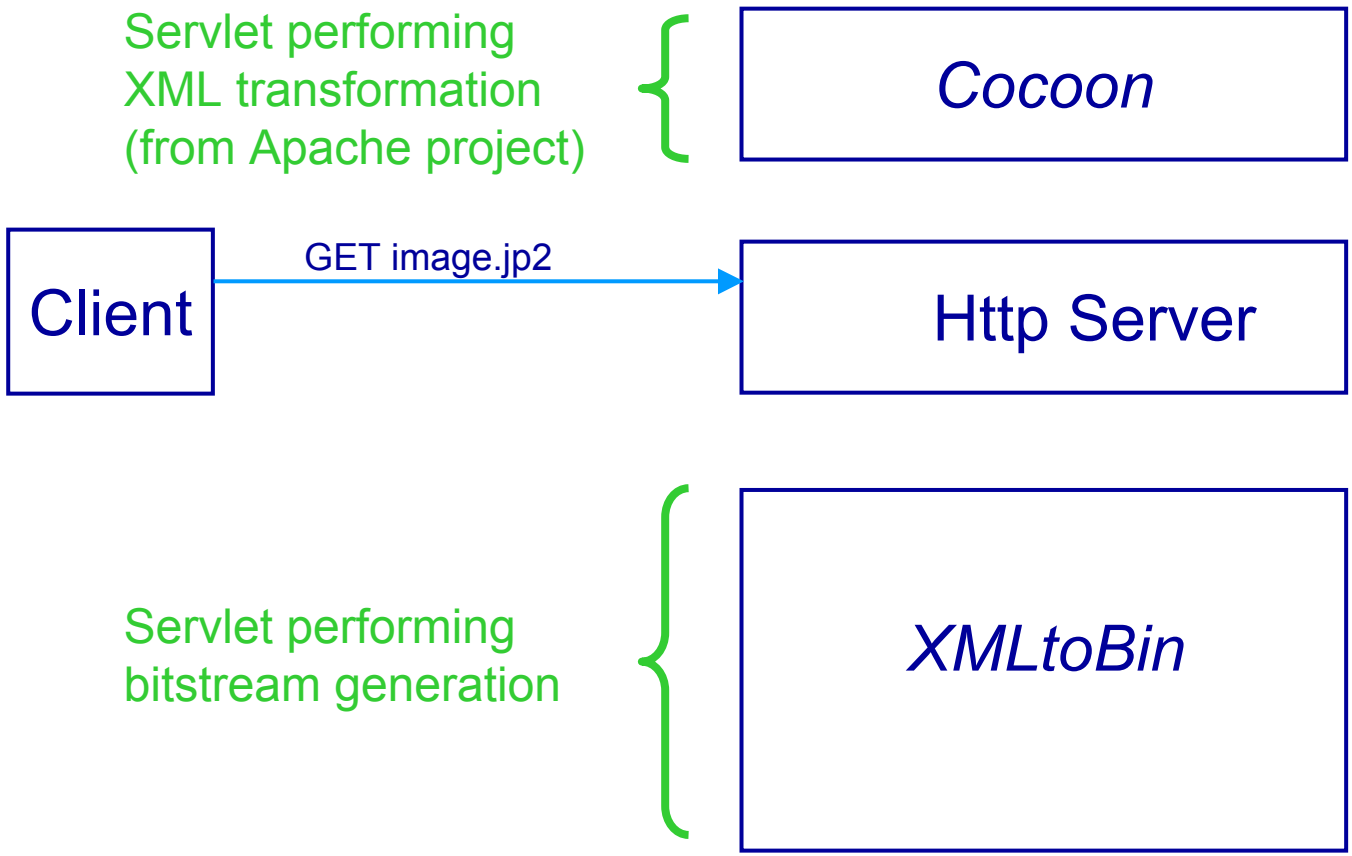
Demo: Implementation on a Web Architecture



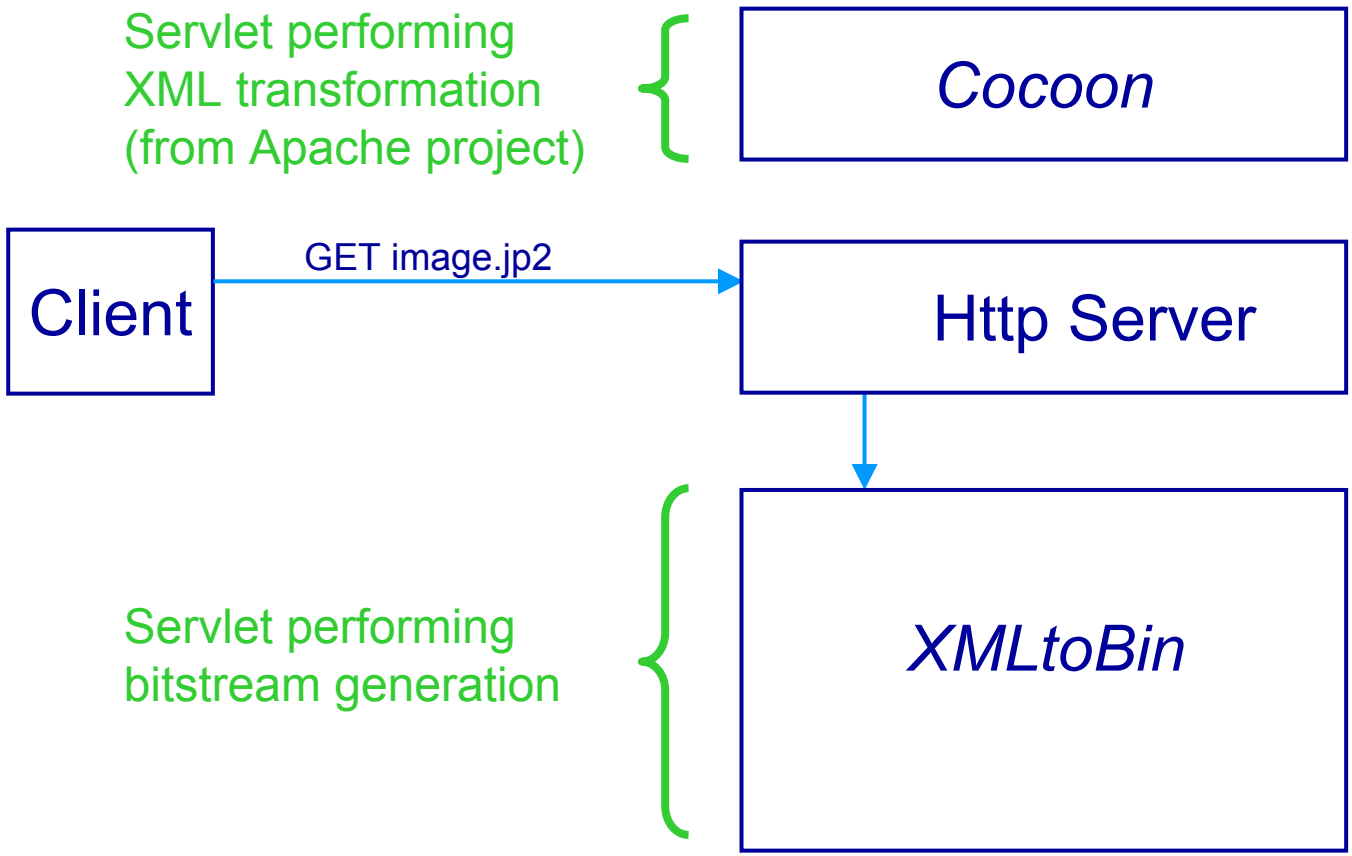
Demo: Implementation on a Web Architecture



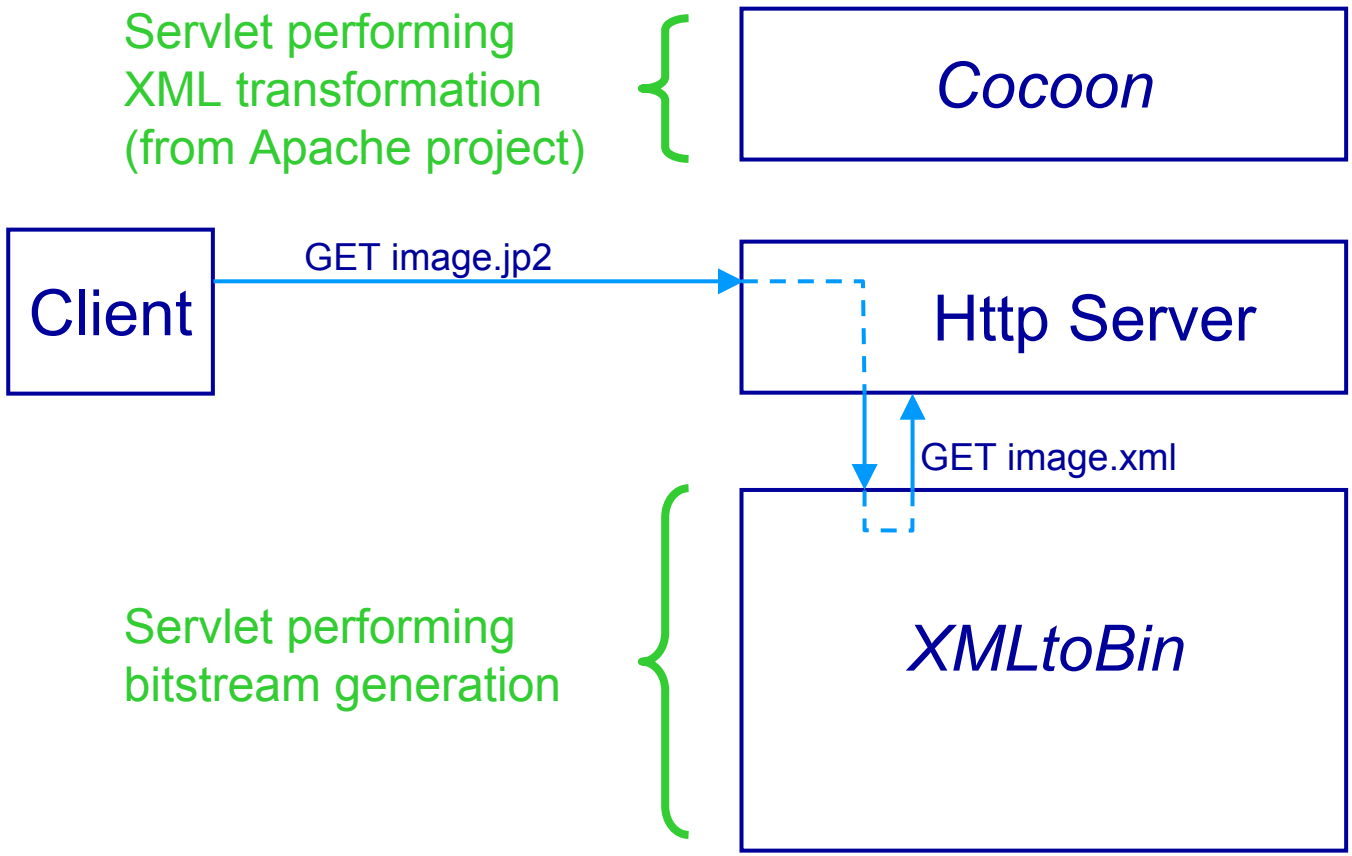
Demo: Implementation on a Web Architecture



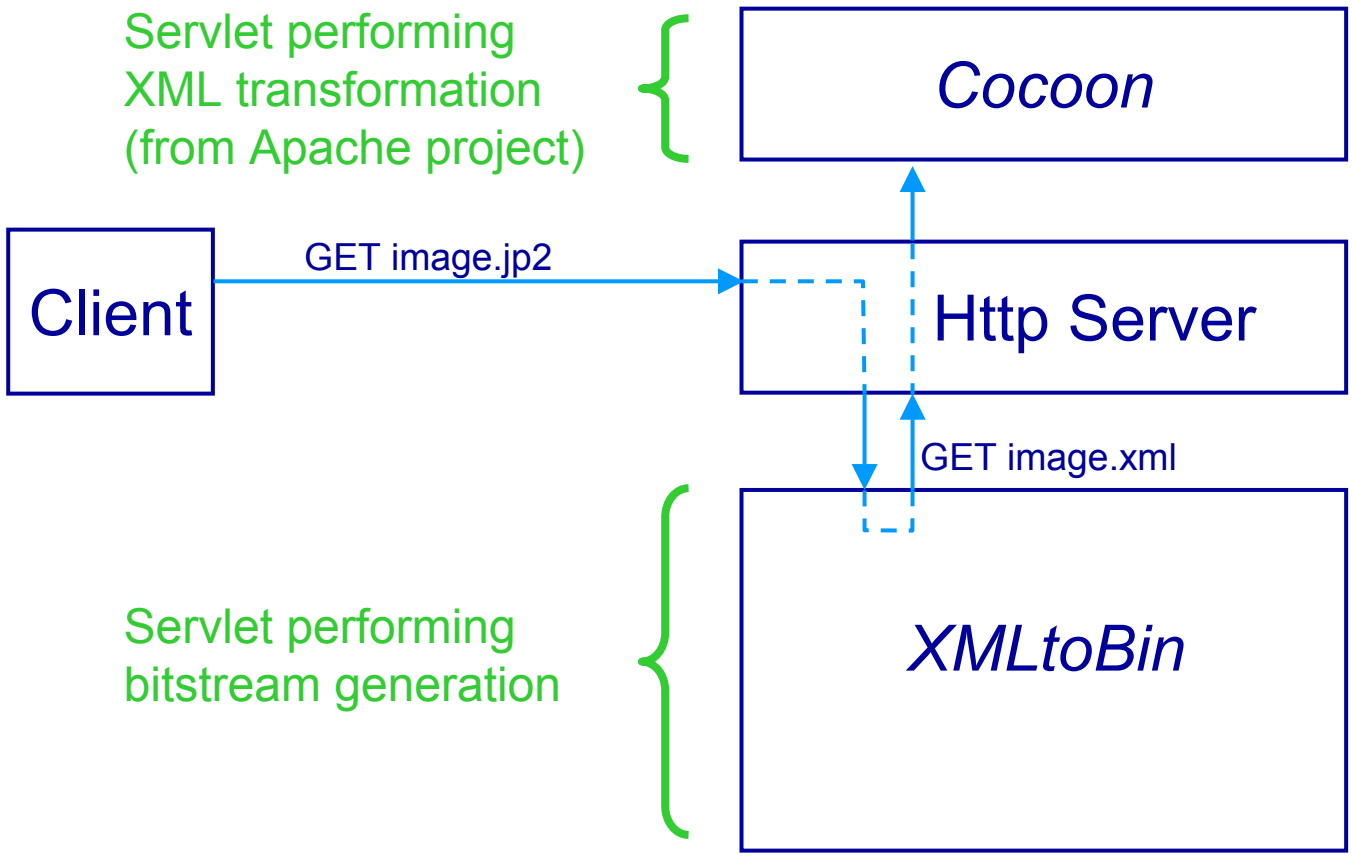
Demo: Implementation on a Web Architecture



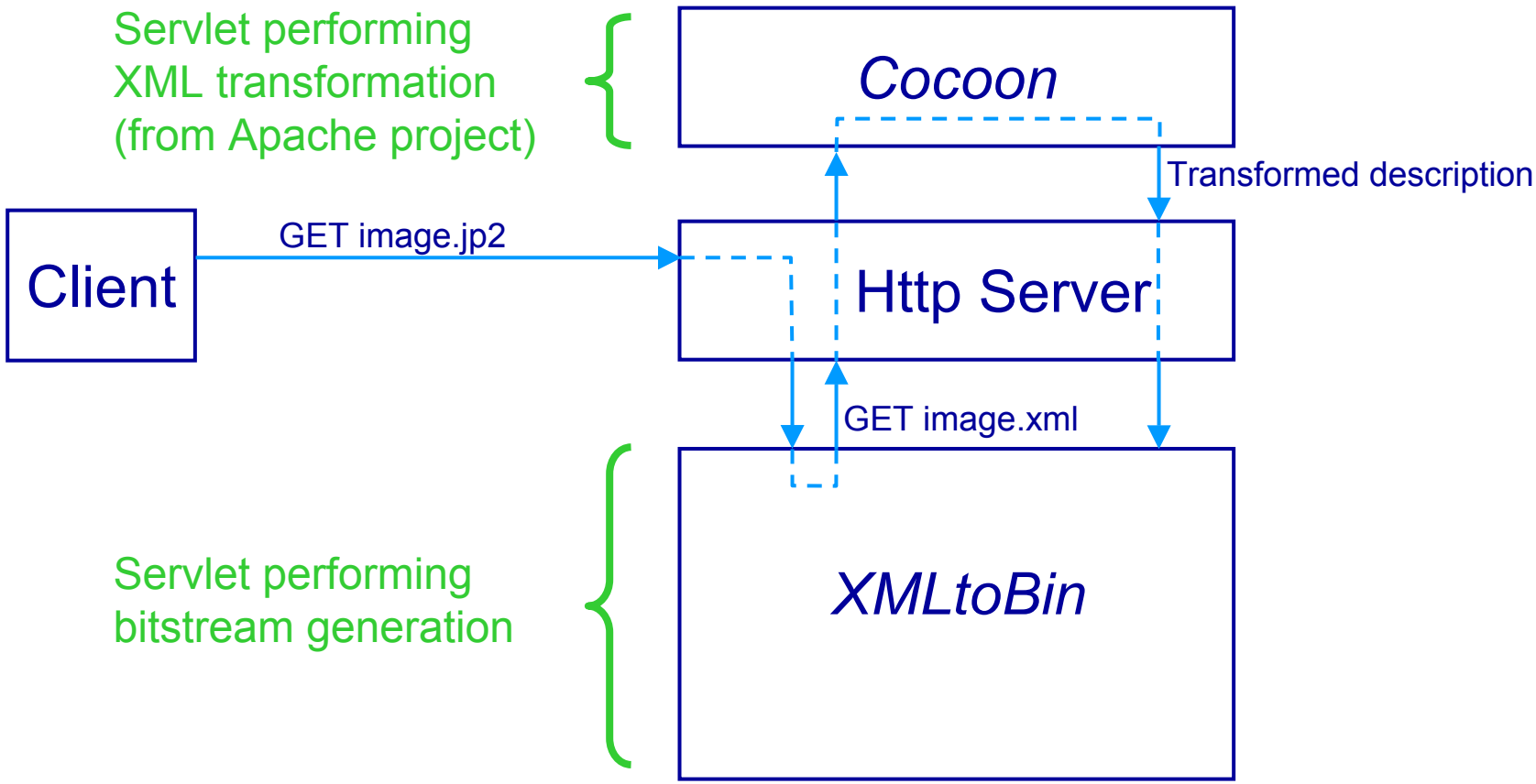
Demo: Implementation on a Web Architecture



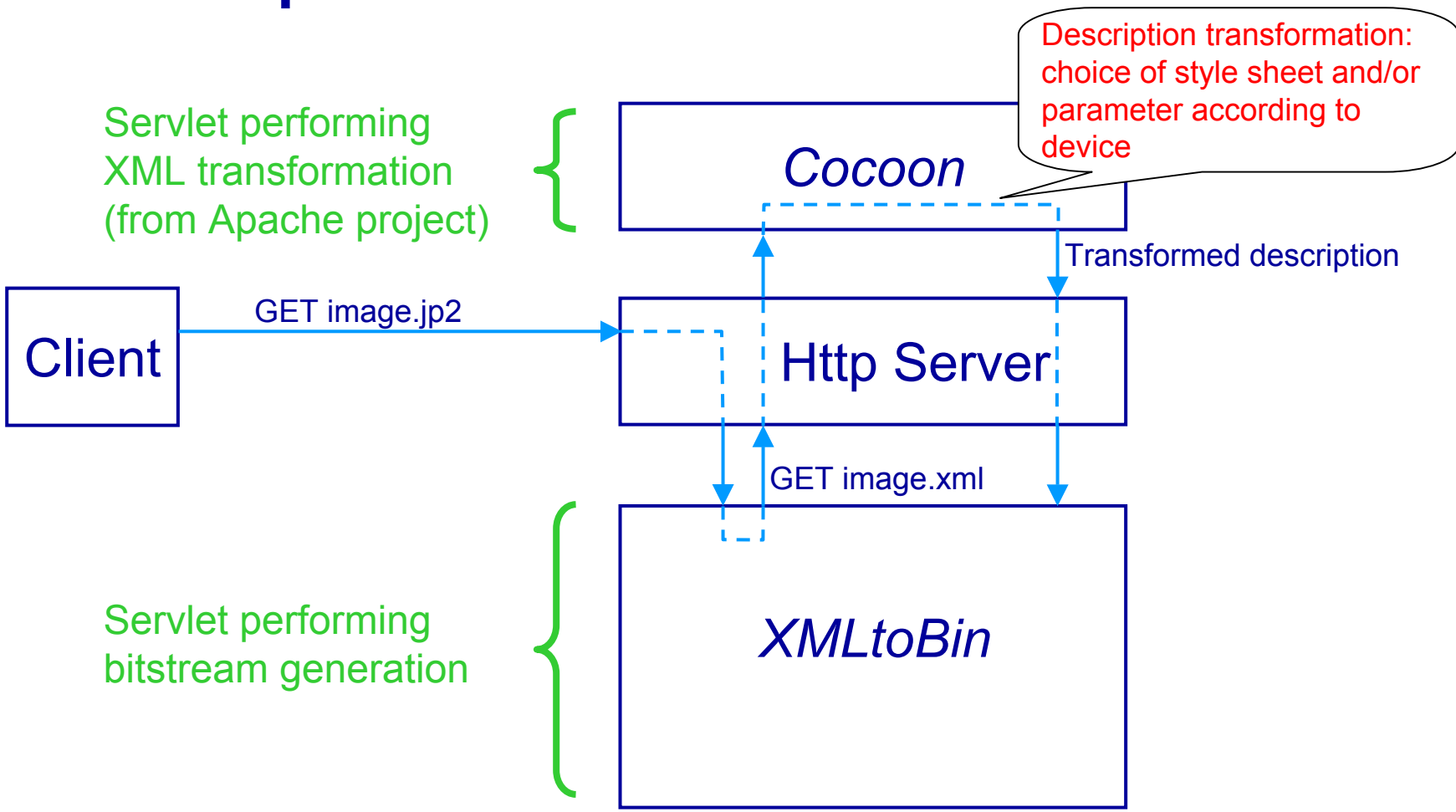
Demo: Implementation on a Web Architecture



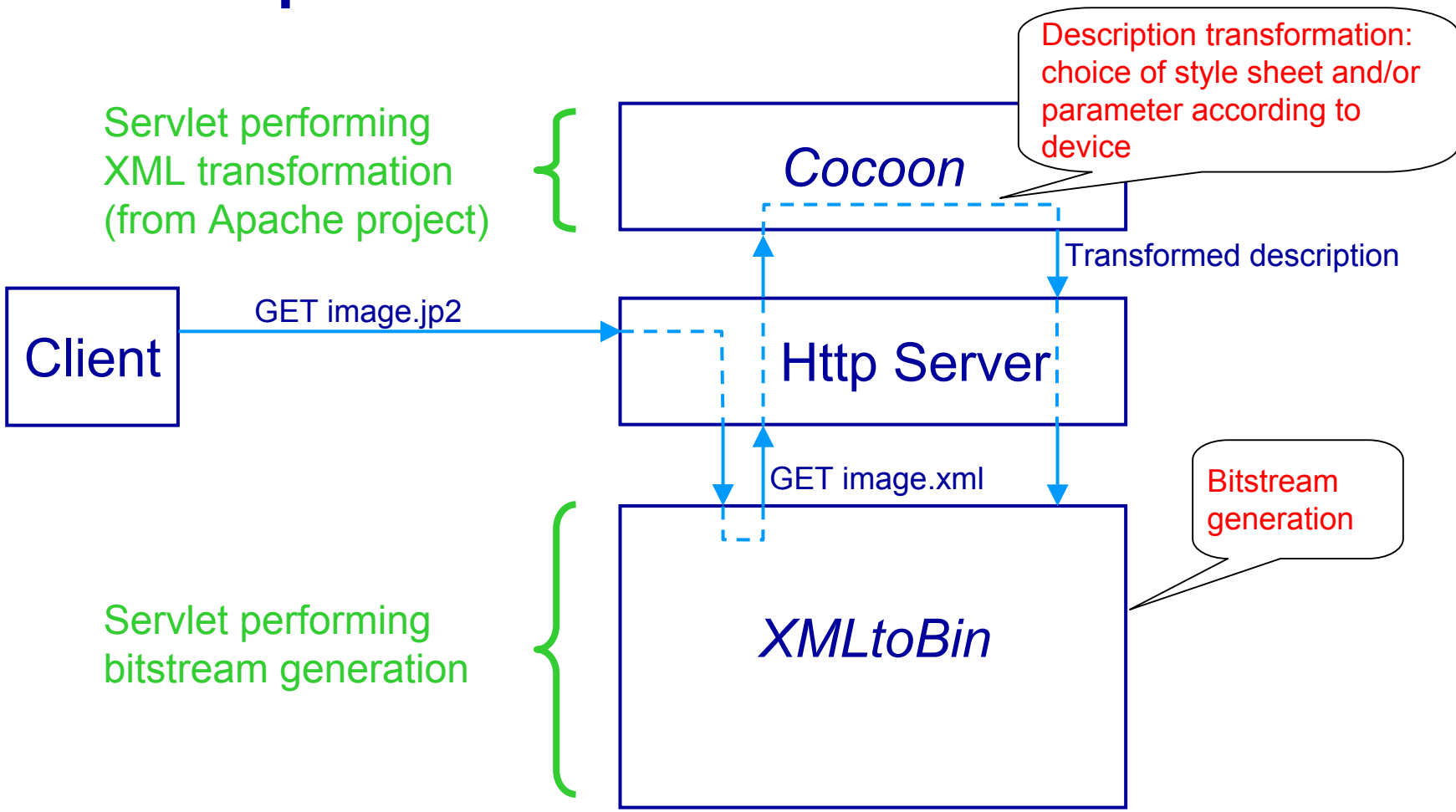
Demo: Implementation on a Web Architecture



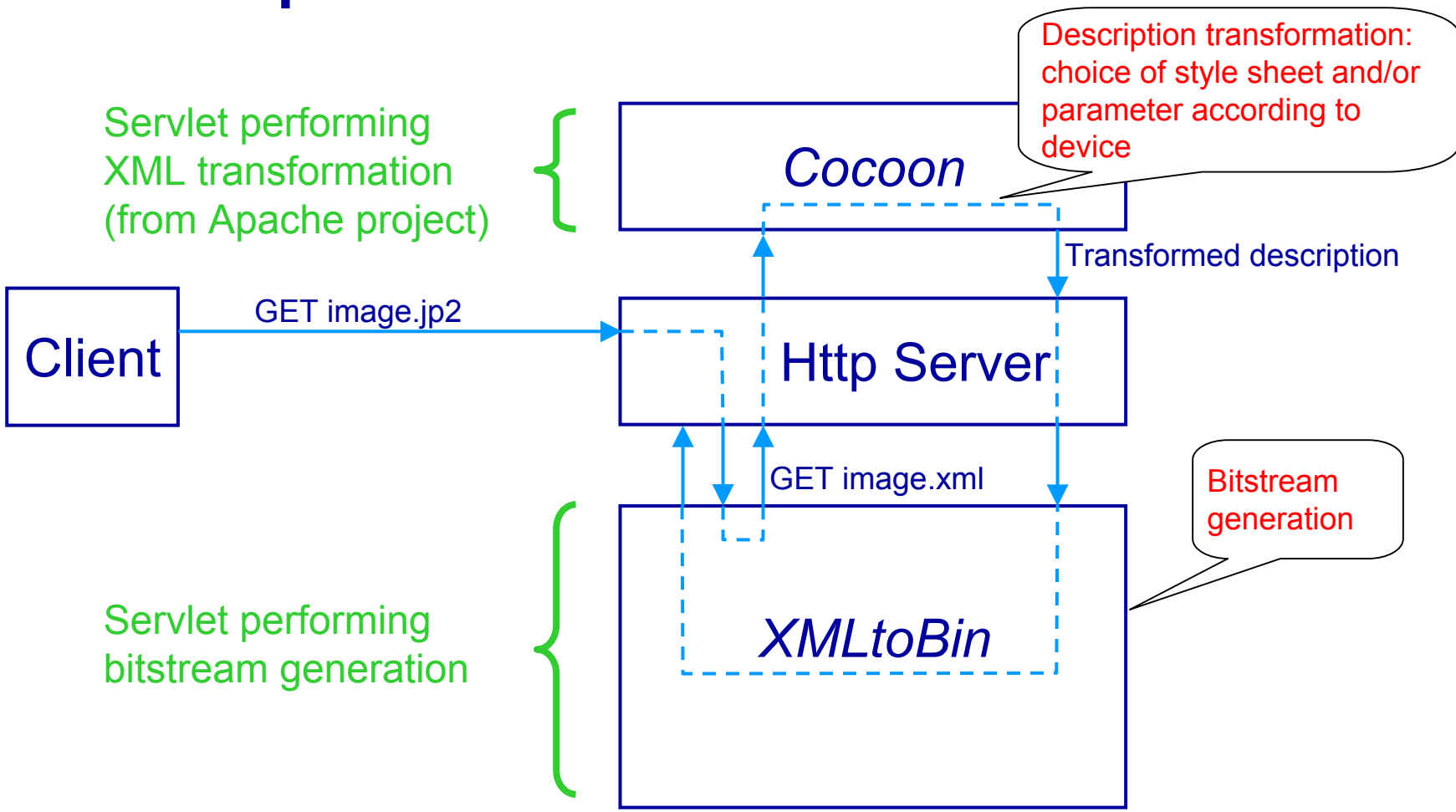
Demo: Implementation on a Web Architecture



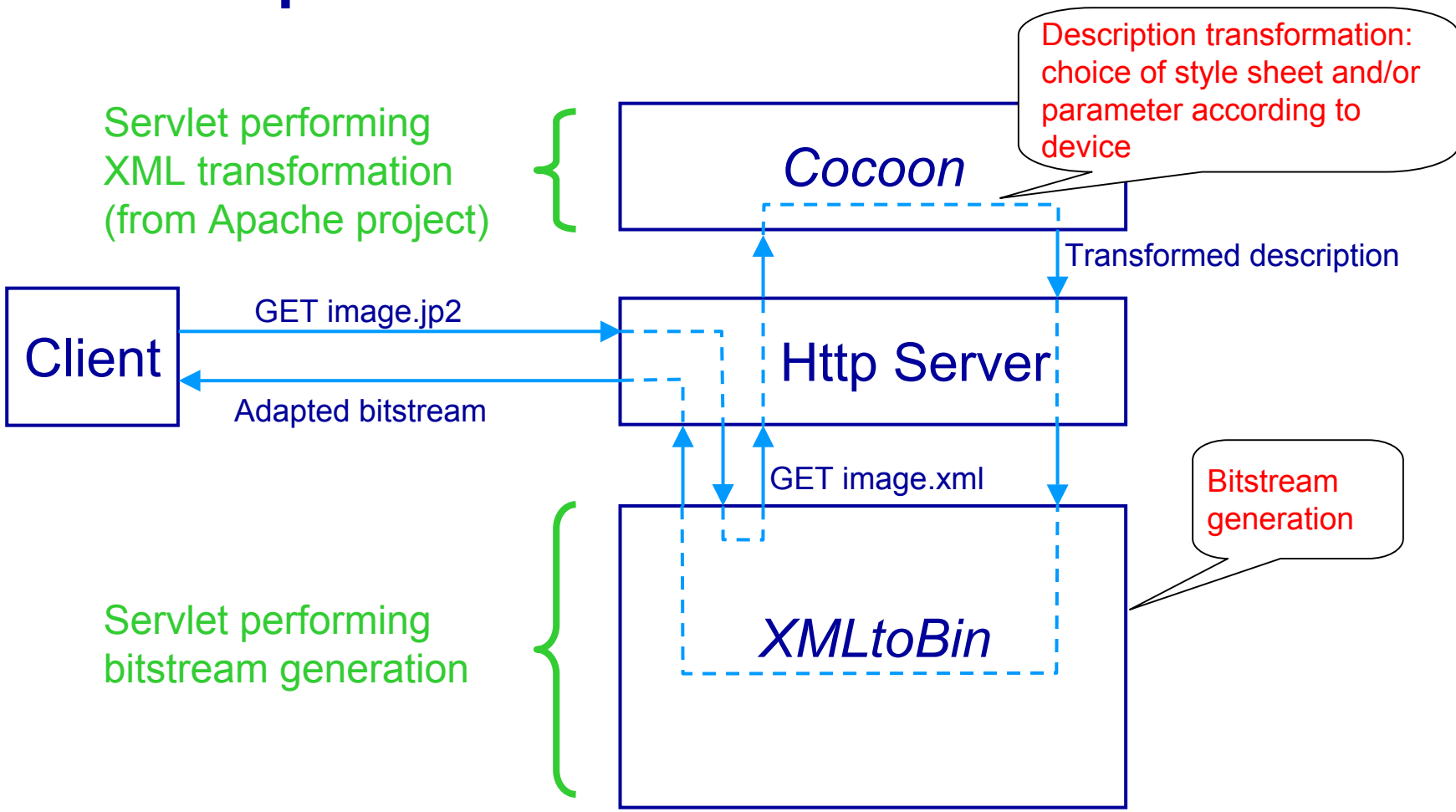
Demo: Implementation on a Web Architecture



Demo: Implementation on a Web Architecture



Demo: Implementation on a Web Architecture



Conclusion and future works

- Cross-standard and flexible approach to handle scalable content
- Generic software XMLtoBin
- Scenario for a Client/Server system
- Further steps for BSDL: provide a grammar to parse a bitstream and to generate an XML description

Thank you for your attention

Philips Research France

Appendix

Bitstream Syntax Description Language

- New language based on W3C XML-Schema (restrictions + extensions)
- Allows to:
  - Validate (in the XML-Schema meaning) the instance (Bitstream Description) against its schema (Bitstream Schema)

    Level 0
  - Parse a Description and generate the Bitstream (XML to Bin)

    Level 1
  - Parse a Bitstream and generate its Description (Bin to XML)

    Level 2

BSDL level 2: Extensions on Structures

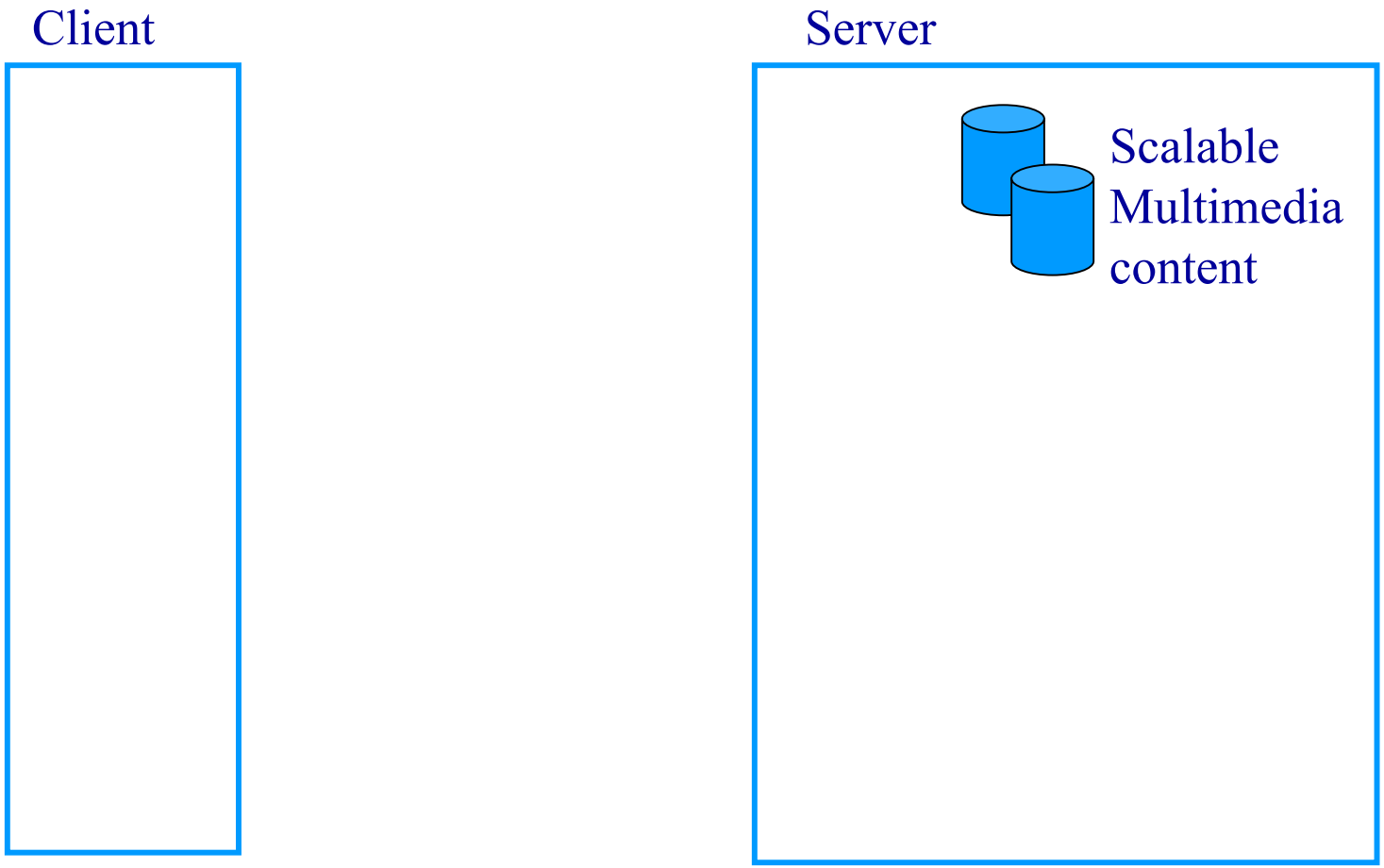
- Variables, to specify the occurrence number of a particle

```
<xsd:element name="NrOfPackets" type="xsd:short"/>
<xsd:element name="Packet" type="packetType"
        bsdl:nOccurs="NrOfPackets"/>
```

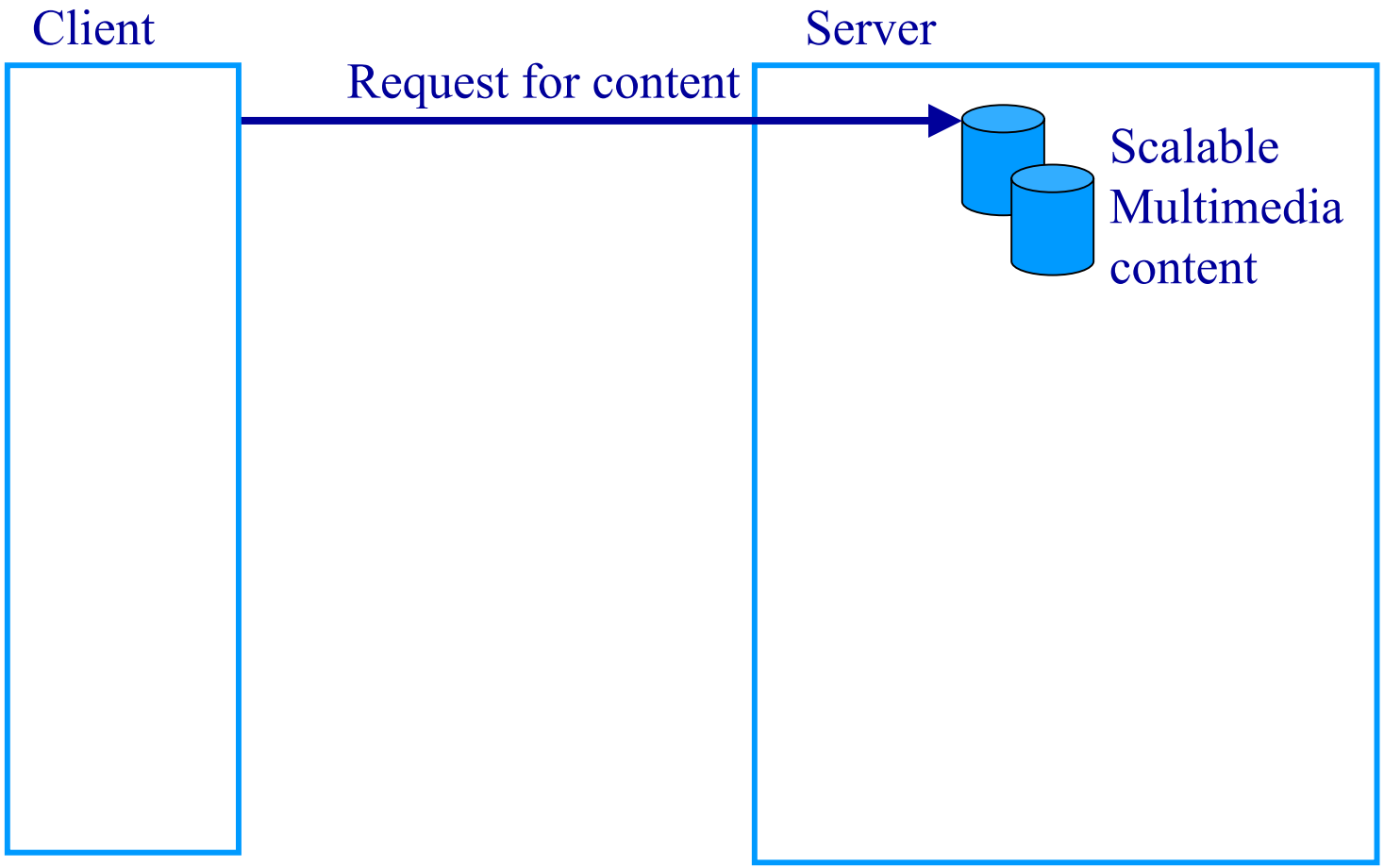
- Conditional statements

```
<xsd:element name="param" type="xsd:short"/>
<xsd:element name="elt"
        bsdl:if="param=3" minOccurs="0">
```

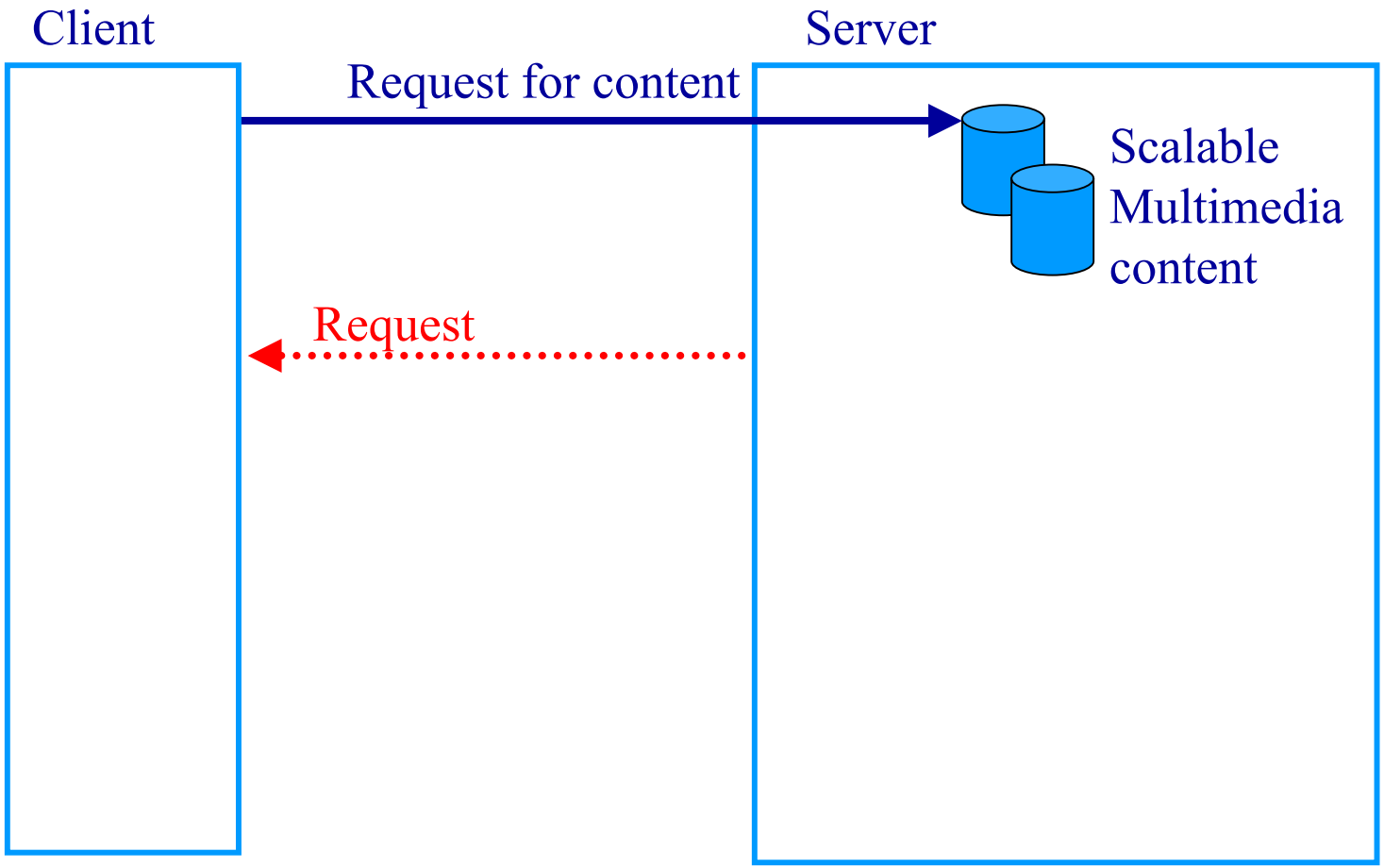
System Approach: a complete scenario



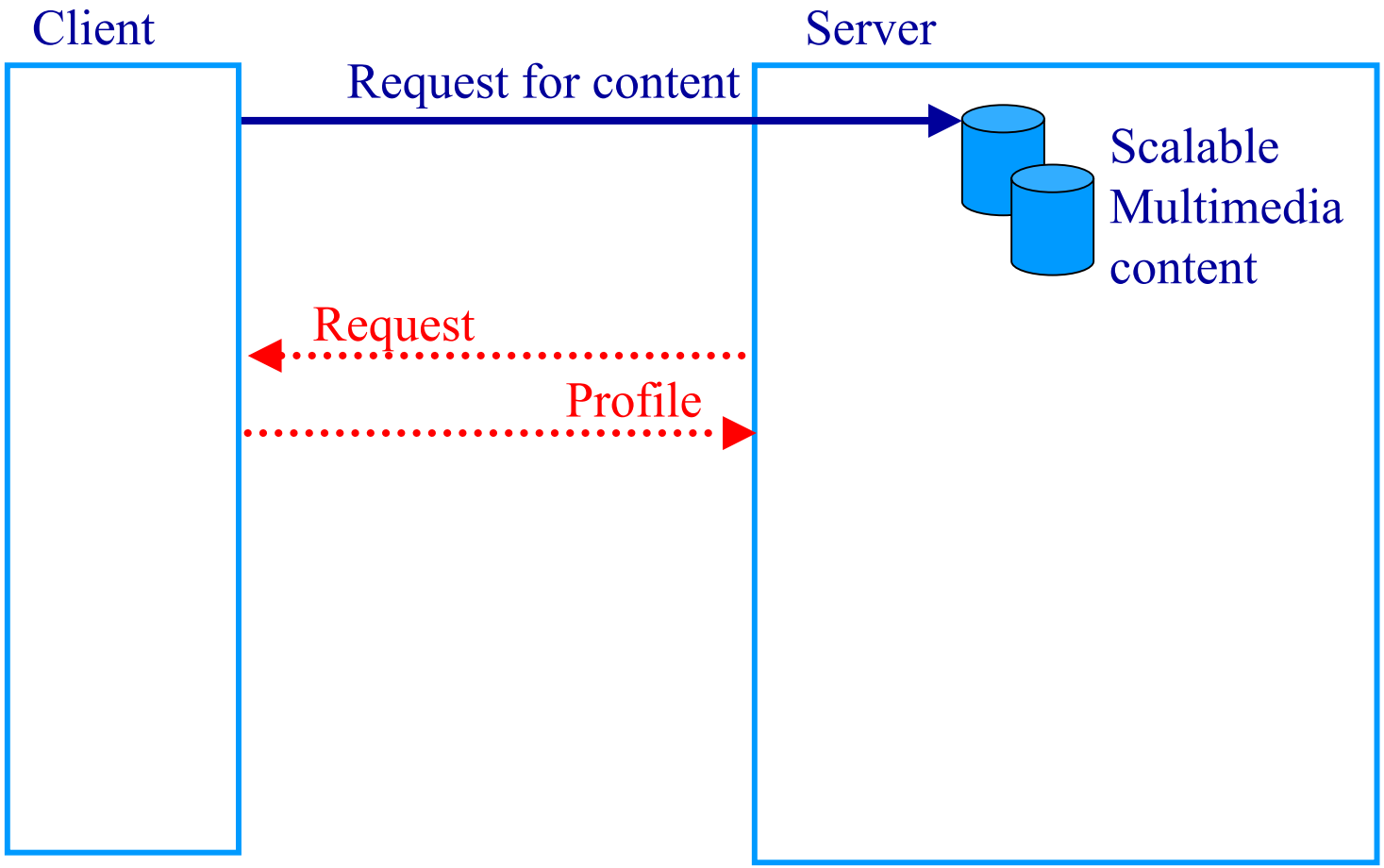
System Approach: a complete scenario



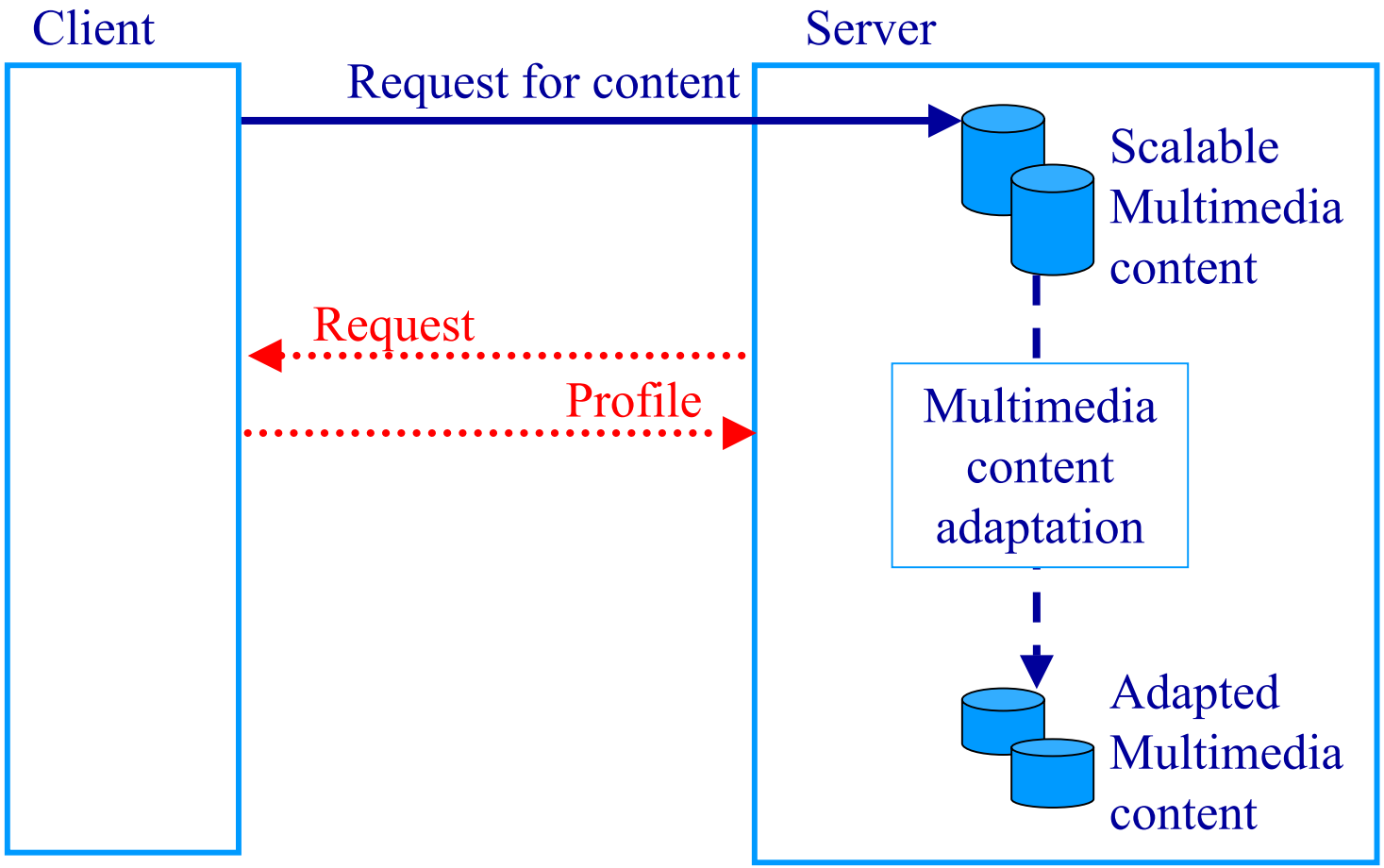
System Approach: a complete scenario



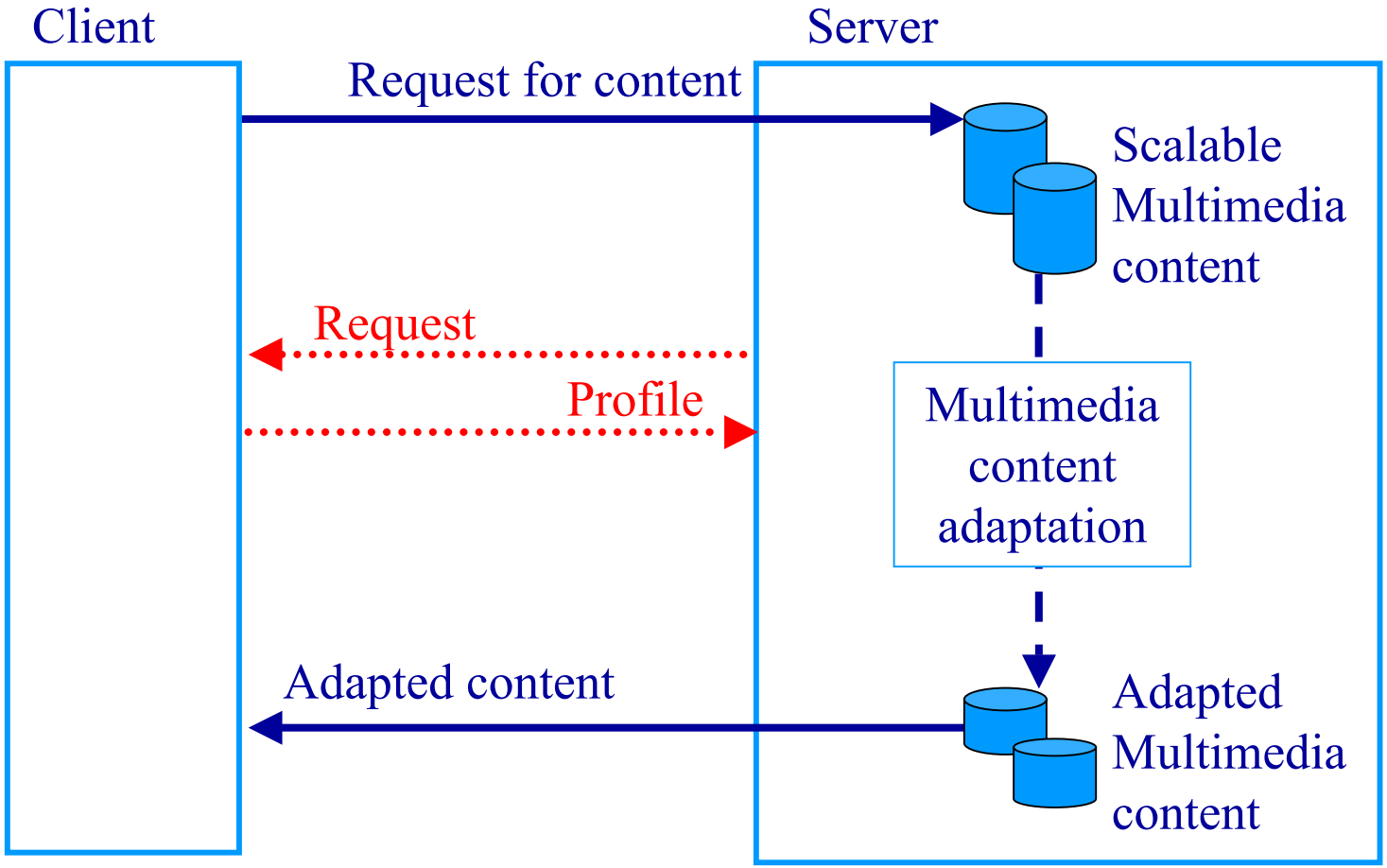
System Approach: a complete scenario



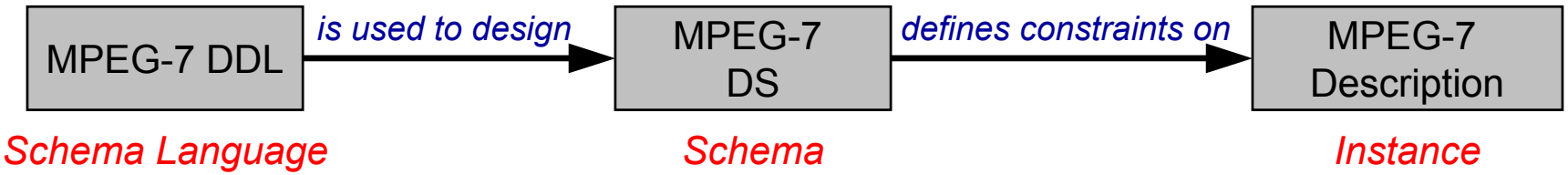
System Approach: a complete scenario



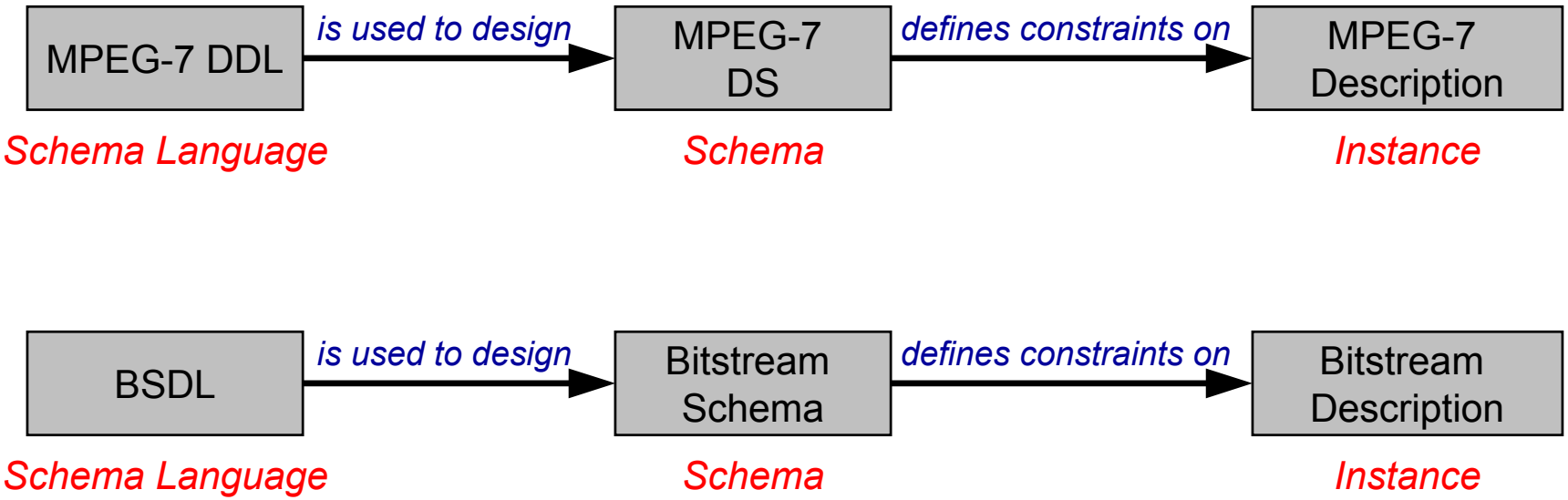
System Approach: a complete scenario



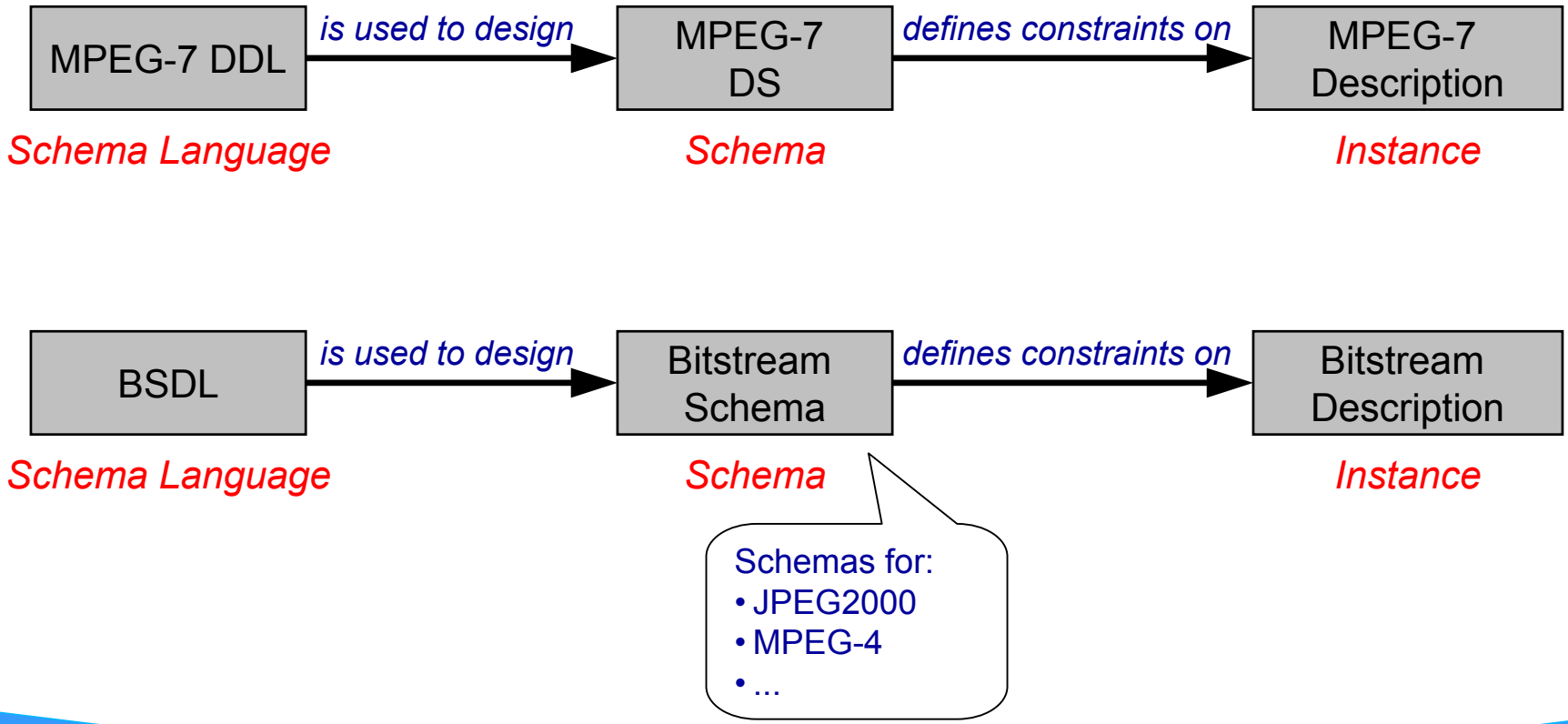
Analogy with MPEG-7



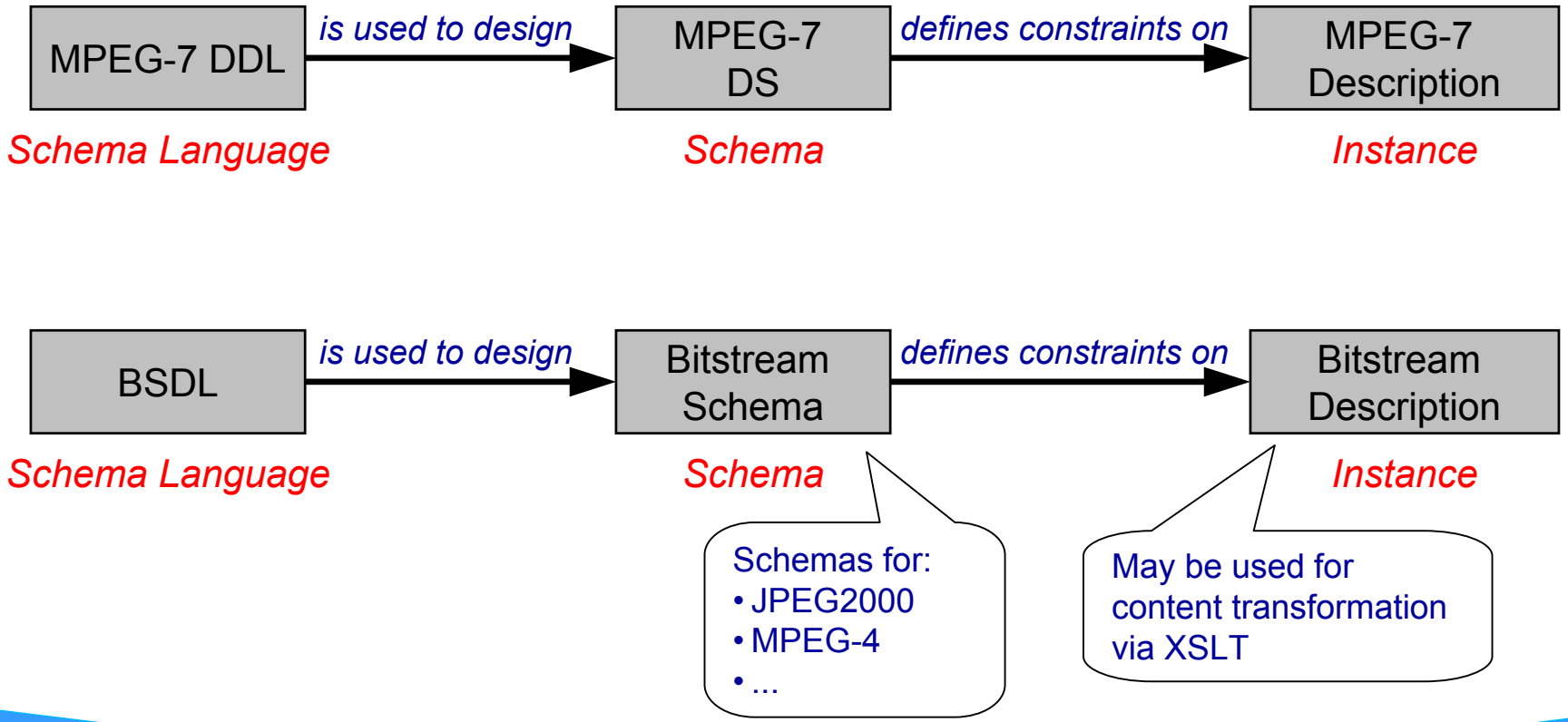
Analogy with MPEG-7



Analogy with MPEG-7



Analogy with MPEG-7



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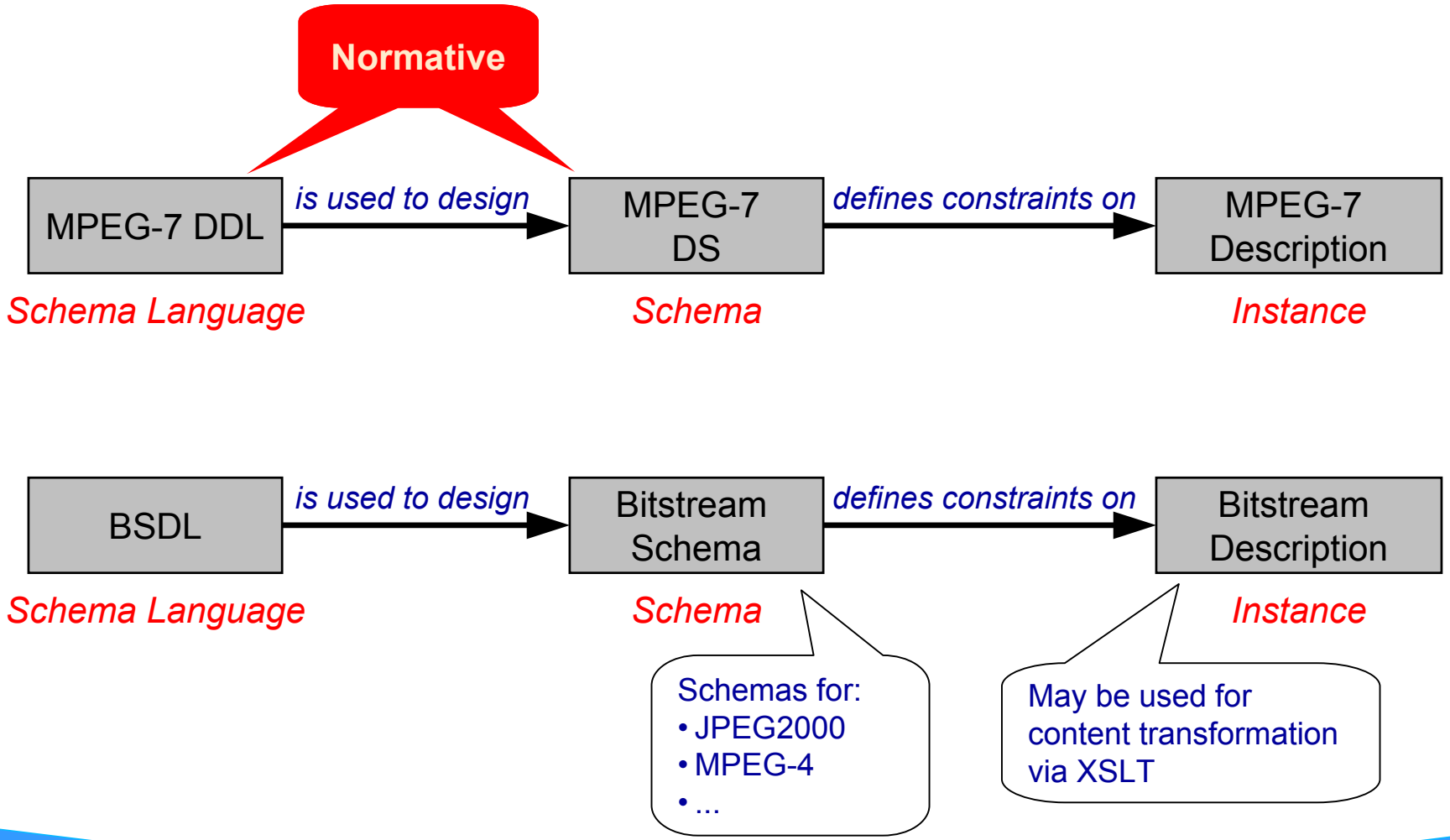

Analogy with MPEG-7