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To

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Reply to Call for Participation in W3C Workshop on Binary Interchange of XML Information Item Sets

Dear Mr. Liam Quin,

as representative of SIEMENS AG and active contributor to the ISO/IEC 15938-1 standardisation activities also known as MPEG-7 Binary Format Jörg Heuer wishes to participate in the workshop on Binary Interchange of XML Information Item Sets. The position with respect to the activity on Binary Interchange of XML Information Item Sets stated in this letter is our answer on the call for participation of the W3C [1].

Interest of Siemens

Within Siemens the Binary Interchange of XML Information Item Sets is of interest in departments which have to support the delivery of XML based Information Sets to wireless connected Terminals. On one hand these are departments in our division Information and Communication Mobile (ICM). One of the focuses in these departments is to extend the scope of web based information technology to wireless, embedded devices and to the infrastructure to serve these devices. To ensure interoperability Siemens is participating in the standardisation efforts for mobile communication in the 3rd Generation Partnership Project (3GPP [2]). Also in this body the applicability of web technologies for mobile devices is addressed for instance for multimedia presentations based on Scalable Vector Graphics (Mobile SVG Profiles [3]). Another focus is to support the presentation of multimedia information on mobile devices. To support this functionality multimedia information is adapted based on XML formatted metadata to network conditions, device constrains and user preferences. To support an interoperable exchange format Siemens Corporate Technology (CT) contributed to the ISO/IEC 15938 standardisation activities especially to the MPEG-7 Binary Format activities [4].

Secondly also the departments providing business solutions in the division of Siemens Business Services (SBS) develop and distribute B2B solutions which also serve mobile devices based on XML technologies. To serve a wide range of different infrastructure installed at customers, these departments are interested in a Binary Interchange of XML which is efficient with respect to bandwidth consumption and parsing complexity so that XML based technology can be applied to a wide range of constrained devices.

Siemens Activities

Back in 1999 Siemens CT has started to investigate solutions for binary interchange formats of XML Information Item Sets. At the beginning existing solutions based on text compression (ZIP, Lempel-Ziv), specific proprietary solutions like XMill [5], Milleau [6] and already applied solutions such as WBXML [7] have been investigated. Due to the lack of support for several required functionalities (see also section on

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requirements) none of these approaches were selected. Instead Siemens CT joined and contributed to the effort in the ISO/IEC 15938 standardization to specify a generic XML Schema based binary representation of XML information item sets.

Requirements on Binary Representation of XML Information Item Sets

In the specification for Siemens application as well as in the requirements discussion of the MPEG-7 standardisation the following requirements have been identified:

- Coding Efficiency: the binary representation shall allow an efficient representation of XML Information Item Sets with respect to size.
- Low Complexity: the binary representation shall allow the generation and consumption of binary representations of XML Information Item Sets on computational constrained devices.
- Streaming: the binary representation shall enable the continuous decoding of XML Information Item Sets being transmitted
- Arbitrary Order: the binary representation shall allow transmitting XML Information Item Sets in an arbitrary order, e.g. sorted with respect to certain criteria such as the importance of XML information items.
- Random Access: the binary representation shall allow fast random access to XML information items in the binary representation e.g. steered by indexing mechanisms.
- Robust Representation: the binary representation shall be robust with respect to errors such as packet loss i.e. the received information shall be impaired by packet loss as little as possible.
- Dynamic Update: the binary representation shall allow partly updating XML information items at certain points in time.
- Lossy Representation: the binary representation shall allow representing XML information items approximately for efficiency reasons, e.g. by quantizing integer values.

Importance of required Functionality in Siemens Applications

In mobile multimedia applications based on XML formatted metadata as well as in B2B applications one of the main goals for Siemens is to enable low complexity for the implementation on constrained devices. To a certain extent this can be achieved by an efficient binary representation of XML information item sets which reduces the complexity of parsing. On the other hand in these applications to a certain point in time only a small fraction of information of the whole XML information item set is of interest. According to this observation the parsing complexity can be significantly reduced if

- random access to these fractions and
- identification of relevant fractions is supported in the binary representation.

Similarly the redundancy reduced binary representation of XML information item sets allows the efficient transmission via wireless networks to mobile devices. However in multimedia applications metadata such as user preference descriptions are dynamically changing. Also in B2B applications descriptions of application states are dynamically changing. Based on this observation the bandwidth can significantly be increased if

- the binary representation supports the dynamic update of already transmitted XML information item sets.

Beside these functionalities, which are motivated by bandwidth and computational efficiency of the binary representation also the robustness of the binary representation with respect to packet loss is in our view of high importance. Mobile IP channels are known to provide on one hand very limited capacity and on the other hand can not guarantee undisturbed transmission. Due to this fact a robust transmission over these mobile IP channels can be provided if

- the binary representation supports scalable packetisation
- where the packets can be parsed consecutively and
- where the packets bear a minimum of interdependency.

Overview on MPEG-7 BiM:

The binary representation MPEG-7 BiM of XML information item sets is composed of three major components: .

- the context path specification used for addressing

- the fragment payload for the representation of a sub-tree of an XML information item and
- commands that allow the dynamic manipulation of the already transmitted XML information item sets

With these components, XML information item sets can be compiled step by step in a description composer at the receiver side.

The XML information item structure is represented as a data-tree: the properties of each node are broken down by its children in more details. The structure of the tree symbolizes the context in which every node is instantiated in the XML information item. The leaves of this tree contain the information payload. For instance in the case of MPEG-7 these are the actual values of the descriptors.

MPEG-7 BiM basically consists of two parts: the Context Path and the Fragment Payload representation. Both parts use a schema-aware approach: a schema definition, which is instantiated by the XML information item, is used to assign codes to the individual children of an XML element. These codes are signalled in the binary format to select nodes in the XML description tree. To signal the code assignment the schema definition is referenced or encoded (option in version 2) at the beginning of the binary representation. By the use of schema knowledge it is possible to exploit the structural redundancy of an XML information item to achieve a good compression of the XML information item structure.

The Context Path is used to address nodes of the XML information item, where an operation on the tree shall take place. The Context Path is essential for the support of the advanced coding options of the binary format such as the transmission of description tree nodes and sub-trees in arbitrary order or fast filtering.

The fragment payload represents the information contained in a node or sub-tree, which has been addressed with the Context Path. It gains a very high compression for the structure, and also encodes the content of the description nodes (i.e. the descriptor values).

Measurements based on MPEG-7 BiM v.2

Within the MPEG-7 standardisation process Siemens CT was working on the investigation and test of appropriate technology for a binary interchange format which fulfils the above listed requirements. Furthermore, parallel to this task Siemens CT contributed to the reference implementation of the MPEG-7 BiM standard. Based on this reference implementation several experiments were conducted to compare the standardized approach to alternative approaches such as GZIP mentioned above with respect to compression efficiency and functionality.

Beside this, Siemens CT developed an optimised implementation of the MPEG-7 BiM codec for embedded devices to evaluate the computational complexity and the required memory footprint.

We will present here results on version 2 of MPEG-7 BiM [8] which is going to be standardized at the end of the year. For the evaluation the following data sets have been used:

- XML based MPEG-7 description examples [9] valid with respect to urn:mpeg:mpeg7:schema:2001
- XML based MPEG-21 gBSDL bitstream descriptions
- SVG examples
- XML Schema examples

For instance the MPEG-7 description example descriptionExample000.xml [9] represented in one Fragment by MPEG-7 BiM in 8542 Bytes while GZIP requires 12479 Bytes (gzip 1.3, highest compression).

Note: More complete results could not be generated due to lack of time but will be contributed to the workshop as soon as possible.

Comparison of MPEG-7 BiM v.2 vs. GZIP

Applying text compression mechanisms based on the Lempel-Ziv algorithms such as GZIP to raw XML information items can achieve up to similar results with respect to a compact representation compared to the representation in the MPEG-7 BiM v.2 format. However, the computational complexity in parsing the XML information item represented with GZIP is increased due to the fact that additionally to textual parsing the information has to be decompressed from beginning first. Contrary the representation in MPEG-7 BiM can be

understood as a pre-parsed and pre-validated format of the XML information item which can be consumed incrementally, by random access (if configured accordingly), without textual parsing respectively string comparison on the receiver side. Textual parsing is one of the most time consuming processes when consuming XML. Measurements of the optimised MPEG-7 BiM encoder based on MPEG-7 description examples [9] have shown that the textual parsing in the encoder requires 30-60% of the encoding time. Accordingly using pre-parsed binary representations of XML information items such as MPEG-7 BiM reduces the computational complexity on the receiver side significantly.

Note: More detailed results will be contributed to the workshop as soon as possible.

In addition to a pure efficiency consideration, contrary to the GZIP representation the MPEG-7 BiM format fully supports the above listed and in the targeted applications required functionality. In the envisaged applications this further enhances the efficiency on size and computational efficiency.

Internationalisation and Accessibility of MPEG-7 BiM v.2 binary representations

Internationalisation is supported in MPEG-7 BiM with respect to the representation of strings in Unicode with UTF-8. On the other hand it is also possible to generate mappings between internationalised and localized schema definitions based on the binary representation of an XML information item set in MPEG-7 BiM. This is possible if the localized schema definition generates the corresponding code tables with respect to other localized schema definitions. However, an explicit identification of a set of localized schema definitions which fulfils this aspect is not yet supported in MPEG-7 BiM.

In version 2 of MPEG-7 BiM the binary representation of XML Schema definitions as well as its XML instances are supported. Similarly to generic algorithms such as GZIP this allows any device to access the contained information without particular knowledge of the contained XML dialect. Additionally this supports an efficient representation of XML Schema definitions in means of size and complexity.

Generality of MPEG-7 BiM v.2

The fundamental principle of the MPEG-7 BiM v.2 representation is to generate binary representation of XML information item sets based on XML Schema definitions. Based on this principle XML information item sets valid with respect to an XML Schema definition can be represented in MPEG-7 BiM v.2.

From Siemens point of perspective XML information item sets based on XML Schema definitions are of highest relevance in the market place due to the capabilities of the XML Schema language and the large acceptance. To support other Schema languages such as DTD two different approaches are applicable:

- a) translation of schema definitions into XML Schema for generation and parsing of binary representations or
- b) translation of the rule set for XML schema for generation and parsing of binary representations to apply them to other schema definitions.

Conclusion

In this position paper we presented our work carried out so far on the binary representation of XML information item sets. Many aspects of this work have also been contributed to the MPEG-7 BiM (ISO/IEC 15938-1) standardization activity. The listed application areas within Siemens business units lead to a set of (generic but also demanding) requirements that cannot be fulfilled by generic text compression algorithms like ZIP. The MPEG-7 BiM algorithm (in its second version) fully supports these requirements. Being an open standard the MPEG-7 BiM algorithm is a publicly available specification that is accompanied by reference implementation that is also available in source code.

We are looking forward to fruitful discussions in the workshop.

Best regards,

Jörg Heuer
and
Andreas Hutter

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