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Information technology — ASN.1 encoding rules

Part 4: XML Encoding Rules (XER)

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ISO/IEC 8825-4

Fourth edition
2021-06

Information technology — ASN.1 encoding rules —

Part 4: XML Encoding Rules (XER)

Technologies de l'information — Règles de codage ASN.1 — Partie 4: Règles de codage XML (XER)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs)

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A list of all parts in the ISO/IEC 8825 series can be found on the ISO and IEC websites.

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Introduction

Rec. ITU-T X.680 | ISO/IEC 8824-1, Rec. ITU-T X.681 | ISO/IEC 8824-2, Rec. ITU-T X.682 | ISO/IEC 8824-3, Rec. ITU-T X.683 | ISO/IEC 8824-4 together describe Abstract Syntax Notation One (ASN.1), a notation for the definition of messages to be exchanged between peer applications.

This Recommendation | International Standard defines encoding rules that may be applied to values of ASN.1 types defined using the notation specified in Rec. ITU-T X.680 | ISO/IEC 8824-1 and Rec. ITU-T X.681 | ISO/IEC 8824-2. Application of these encoding rules produces a transfer syntax for such values. It is implicit in the specification of these encoding rules that they are also to be used for decoding.

There is more than one set of encoding rules that can be applied to values of ASN.1 types. This Recommendation | International Standard defines three sets of encoding rules that use the Extensible Markup Language (XML). These encoding rules all produce an XML document compliant to W3C XML 1.0. The first set is called the Basic XML Encoding Rules (BASIC-XER). The second set is called the Canonical XML Encoding Rules (CANONICAL-XER, or CXER) because there is only one way of encoding an ASN.1 value using these encoding rules. (Canonical encoding rules are generally used for applications using security-related features such as digital signatures.) The third set is called the extended XML Encoding Rules (EXTENDED-XER). The extended XML Encoding Rules allow additional encoders options, and take account of encoding instructions that specify variations of the BASIC-XER encodings in order to support specific styles of XML documents (see below). The extended XML Encoding Rules are not canonical, and there is no canonical form for these rules defined in this Recommendation | International Standard.

There are many aspects of an XML representation of data (such as the use of XML attributes instead of child elements, or the use of white-space delimited lists) whose use is a matter of style and XML designer choice. If a type defined in an ASN.1 specification is encoded by BASIC-XER or by CXER, then there is a single fixed style used for the XML representation, with no user control of stylistic features. This Recommendation | International Standard specifies the syntax and semantics of XER encoding instructions which specify the stylistic features of the XML in an EXTENDED-XER encoding. XER encoding instructions can also be used to determine the possible insertion of XML processing instructions in an EXTENDED-XER encoding. XER encoding instructions are ignored by BASIC-XER and by CXER, but are used by EXTENDED-XER.

NOTE – "Stylistic features", such as use of attributes or white-space delimited lists, can also affect the size of an encoding and the ease with which it can be processed, so use of such features is not just a matter of style. Where such issues are important, EXTENDED-XER with encoding instructions may be preferred over BASIC-XER or CXER.

Clause 8 specifies the BASIC-XER encoding of ASN.1 types.

Clause 9 specifies the CXER encoding of ASN.1 types.

Clause 10 specifies the EXTENDED-XER encoding of ASN.1 types, referencing later clauses which define the XER encoding instructions.

Clauses 11 to 14 list and categorize the XER encoding instructions and specify the syntax for their assignment to an ASN.1 type or component using either an XER type prefix (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 31.3) or an XER encoding control section (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 54).

Clause 15 defines the order of precedence if XER encoding instructions are present in both an XER type prefix and in an XER encoding control section.

Clause 16 specifies the XER encoding instruction support for XML namespaces when using EXTENDED-XER.

Clause 17 specifies EXTENDED-XER encodings.

Clauses 18 to 39 specify:

a) the syntax of each XER encoding instruction used in a type prefix or an XER encoding control section;

b) restrictions on the XER encoding instructions that can be associated with a particular ASN.1 type (resulting from inheritance and multiple assignments);

c) modifications to the XER encoding rules that are required in an EXTENDED-XER encoding when an XER encoding instruction is applied.

Annex A is informative and contains examples of BASIC-XER and CXER encodings.

Annex B is informative and contains a description of the partial XML content that is produced when constructions such as sequence and sequence-of have their surrounding tags removed, together with restrictions on EXTENDED-XER specifications that enable easy determination of the ASN.1 component that an XML element is associated with.

Annex C is informative and contains examples of XER encoding instructions and of the corresponding EXTENDED-XER encodings.

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INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – ASN.1 encoding rules: XML Encoding Rules (XER)

1 Scope

This Recommendation | International Standard specifies a set of basic XML Encoding Rules (BASIC-XER) that may be used to derive a transfer syntax for values of types defined in Rec. ITU-T X.680 | ISO/IEC 8824-1 and Rec. ITU-T X.681 | ISO/IEC 8824-2. This Recommendation | International Standard also specifies a set of Canonical XML Encoding Rules (CXER) which provide constraints on the basic XML Encoding Rules and produce a unique encoding for any given ASN.1 value. This Recommendation | International Standard further specifies a set of extended XML Encoding Rules (EXTENDED-XER) which adds further encoders options, and also allows the ASN.1 specifier to vary the encoding that would be produced by BASIC-XER. It is implicit in the specification of these encoding rules that they are also used for decoding.

The encoding rules specified in this Recommendation | International Standard:

- are used at the time of communication;
- are intended for use in circumstances where displaying of values and/or processing them using commonly available XML tools (such as browsers) is the major concern in the choice of encoding rules;
- allow the extension of an abstract syntax by addition of extra values for all forms of extensibility described in Rec. ITU-T X.680 | ISO/IEC 8824-1.

This Recommendation | International Standard also specifies the syntax and semantics of XER encoding instructions, and the rules for their assignment and combination. XER encoding instructions can be used to control the EXTENDED-XER encoding for specific ASN.1 types.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

NOTE – This Recommendation | International Standard is based on ISO/IEC 10646:2003 and the Unicode standard version 3.2.0:2002. It cannot be applied using later versions of these two standards.

2.1 Identical Recommendations | International Standards

- Recommendation ITU-T X.680 (2021) | ISO/IEC 8824-1:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.
- Recommendation ITU-T X.681 (2021) | ISO/IEC 8824-2:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification*.
- Recommendation ITU-T X.682 (2021) | ISO/IEC 8824-3:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification.*
- Recommendation ITU-T X.683 (2021) | ISO/IEC 8824-4:2021, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications*.
- Recommendation ITU-T X.690 (2021) | ISO/IEC 8825-1:2021, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER).*

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– Recommendation ITU-T X.691 (2021) | ISO/IEC 8825-2:2021, *Information technology – ASN.1 encoding rules: Specification of Packed Encoding Rules (PER).*

– Recommendation ITU-T X.692 (2021) | ISO/IEC 8825-3:2021, *Information technology – ASN.1 encoding rules: Specification of Encoding Control Notation (ECN).*

– Recommendation ITU-T X.891 (2005) | ISO/IEC 24824-1:2007, *Information technology – Generic applications of ASN.1: Fast infoset*.

NOTE – The references above shall be interpreted as references to the identified Recommendations | International Standards together with all their published amendments and technical corrigenda.

2.2 Additional references

– IETF RFC 2045 (1996), *Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies.*

– IETF RFC 2141 (1997), *URN Syntax.*

– IETF RFC 2396 (1998), *Uniform Resource Identifiers (URI): Generic Syntax.*

– IETF RFC 3061 (2001), *A URN Namespace of Object Identifiers.*

– ISO/IEC 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS).*

– The Unicode Standard, Version 3.2.0, The Unicode Consortium. (Reading, MA, Addison-Wesley)

NOTE 1 – The graphics characters (and their encodings) defined by the above reference are identical to those defined by ISO/IEC 10646, but the above reference is included because it also specifies the names of control characters.

– W3C XML 1.0:2008, *Extensible Markup Language (XML) 1.0 (Fifth Edition), W3C Recommendation, Copyright ©2008 W3C® (MIT, ERCIM, Keio),* https://www.w3.org/TR/2008/REC-xml-20081126/ .

– W3C XML Namespaces:1999, *Namespaces in XML, W3C Recommendation, Copyright © 1999 W3C (MIT, INRIA, Keio), http://www.w3.org/TR/1999/REC-xml-names-19990114.*

NOTE – The reference to a document within this Recommendation | International Standard does not give it, as a stand-alone document, the status of a Recommendation or International Standard.

3 Definitions

For the purposes of this Recommendation | International Standard, the definitions of Rec. ITU-T X.680 | ISO/IEC 8824-1 and the following definitions apply.

3.1 ASN.1 Basic Encoding Rules (BER)

This Recommendation | International Standard makes use of the following terms defined in Rec. ITU-T X.690 | ISO/IEC 8825-1:

a) data value;

b) dynamic conformance;

c) encoding (of a data value);

d) receiver;

e) sender;

f) static conformance.

3.2 Additional definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.2.1 ASN.1 schema: The definition of the content and structure of data using an ASN.1 type definition.

NOTE – This enables encoding rules to produce binary encodings of the values of an ASN.1 type, or encodings using XML.

3.2.2 associated empty-element tag: The XML empty-element tag that can replace an associated preceding tag and an associated following tag, when present.

NOTE – Some encoding instructions remove the associated tags of an "XMLValue".

3.2.3 associated encoding instructions (for a type): A set of XER encoding instructions associated with a type.

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3.2.4 associated following tag: The XML end-tag following the "XMLValue" of a type in the absence of encoding instructions that remove the associated tags.

3.2.5 associated preceding tag: The XML start-tag preceding the "XMLValue" of a type in the absence of encoding instructions that remove the associated tags.

3.2.6 canonical encoding: A complete encoding of an abstract value obtained by the application of encoding rules that have no implementation-dependent options. Such rules result in the definition of a 1-1 mapping between unambiguous and unique encodings and values in the abstract syntax.

3.2.7 canonical valid XML document (for an ASN.1 schema): An XML document which is well-formed (see W3C XML 1.0) and whose content conforms to the CXER specification for the encoding of an ASN.1 type specified by an ASN.1 schema.

3.2.8 character-encodable type: An ASN.1 type to which an **ATTRIBUTE** encoding instruction can be applied (see 20.2.1).

3.2.9 control namespace: A namespace that is used to identify attributes that perform functions or carry values that control an EXTENDED-XER encoding.

NOTE 1 – An example would be a type identification attribute. The control namespace defaults to the ASN.1 namespace specified in 16.9, but can be changed by the **GLOBAL-DEFAULTS** encoding instruction.

NOTE 2 – The control namespace may also contain names for attributes that may be present, but which are ignored by EXTENDED-XER decoders (see 10.2.10). An example of such an attribute name could be **schemaLocation**.

3.2.10 enclosed (ASN.1) type: An ASN.1 type whose "XMLValue" in a BASIC-XER encoding is enclosed directly within the "XMLValue" of an ASN.1 type (the enclosing type).

NOTE – All types in a BASIC-XER or EXTENDED-XER encoding are enclosed types unless they are used as the root type (see 10.3.1 b) in an encoding.

3.2.11 enclosing element (of an ASN.1 type): An "ExtendedXMLTypedValue", "ExtendedXMLChoiceValue", "ExtendedXMLNamedValue" or "ExtendedXMLDelimitedItem" that has as its "ExtendedXMLValue" the "ExtendedXMLValue" encoding of the type (see 17.1, 17.5, 17.6 and 17.7).

3.2.12 enclosing type (of an ASN.1 type): An ASN.1 type whose "XMLValue" in a BASIC-XER encoding directly encloses the "XMLValue" of an ASN.1 type (an enclosed type).

NOTE – The enclosing type can be a sequence type, a set type, a choice type, a sequence-of type, a set-of type, an open type, or an octetstring or bitstring type (with a **CONTAINING** and without an **ENCODED BY**).

3.2.13 final encoding instructions (for a type): The set of XER encoding instructions associated with a type as a result of the complete ASN.1 specification, and which are applied in producing encodings of that type.

3.2.14 inherited encoding instructions: XER encoding instructions that are associated with the type identified by a type reference.

3.2.15 namespace-qualified name: A name in an XML document that has an XML namespace prefix or is an XML element name in the scope of an XML default namespace declaration.

NOTE – XML default namespace declarations affect only XML element names, not the names of attributes. A namespace prefix can be applied to either.

3.2.16 nil identification attribute: An XML attribute that can appear on any element to identify whether the content has a **nil** value (see clause 33).

3.2.17 partial XML element content: XML child elements defined by an ASN.1 type which is **UNTAGGED**, and which provides part of the XML element content generated by the enclosing type.

NOTE – If the enclosing type is itself **UNTAGGED**, then that enclosing type may also be generating only partial XML element content.

3.2.18 prefixed encoding instructions: XER encoding instructions that are assigned using a type prefix.

NOTE – Prefixed encoding instructions can delete, replace, or add to the associated encoding instructions of a type.

3.2.19 qualifying information: Information supplied as part of the specification of a target for the assignment of an encoding instruction that identifies specific values of the target type.

3.2.20 targeted encoding instructions: XER encoding instructions that are assigned using a target list in an XER encoding control section.

NOTE – Targeted encoding instructions can delete, replace, or add to the associated encoding instructions of a type.

3.2.21 type identification attribute: An XML attribute that can appear on any element to identify the type of that element (see clause 37).

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3.2.22 uniform resource identifier (URI): A globally unambiguous identifier, assigned according to any one of a number of URI schemes, used to provide identification of namespaces in EXTENDED-XER encodings.

NOTE – The URI scheme used by default for ASN.1 enables an ASN.1 object identifier value to be used to identify namespaces (see 16.9 and 29.1.5).

3.2.23 valid XML document (for an ASN.1 schema): An XML document which is well-formed (see W3C XML 1.0) and whose content conforms to the BASIC-XER, CXER or EXTENDED-XER specification for the encoding of an ASN.1 type specified by an ASN.1 schema, possibly including XER encoding instructions.

3.2.24 XER encoding instructions: Notation used to change the EXTENDED-XER encoding of a type (or of a component of a type).

NOTE – XER encoding instructions are included in either an XER type prefix (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 31.3) or an XER encoding control section (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 54).

3.2.25 XML attribute: Part of an EXTENDED-XER encoding consisting of an "XMLValue" enclosed in quotation marks or apostrophes, preceded by an (attribute) name and an equals sign.

3.2.26 XML element: Part of an XML document specified in W3C XML 1.0.

NOTE – An XML element is either an empty-element tag or starts with a start-tag and ends with an end-tag. Both the start-tag and the empty-element tag can contain attribute encodings.

3.2.27 XML element name: The lexical item following a "<" or "</" lexical item in the associated tags.

3.2.28 XML document: A sequence of characters which conforms to the W3C XML 1.0 definition of document.

3.2.29 XML processing instruction: Part of an XML document which carries information concerning the processing of some or all of that document (see W3C XML 1.0).

NOTE – The processing instruction identifies the type of processing for which it is applicable, and is ignored in other processing. It could be used to identify a style-sheet that is to be applied if the document is presented for human viewing.

3.2.30 XML prolog: The initial part of an XML document (which does not carry information about the value of the ASN.1 type that has been encoded).

4 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

ASN.1	Abstract Syntax Notation One
CXER	Canonical XML Encoding Rules
PDU	Protocol Data Unit
UCS	Universal Multiple-Octet Coded Character Set
URI	Uniform Resource Identifier
UTC	Coordinated Universal Time
UTF-8	UCS Transformation Format, 8-bit form
XER	XML Encoding Rules
XML	Extensible Markup Language

5 Encodings specified by this Recommendation | International Standard

5.1 This Recommendation | International Standard specifies three sets of encoding rules:

– Basic XML Encoding Rules (BASIC-XER);

– Canonical XML Encoding Rules (CXER);

– Extended XML Encoding Rules (EXTENDED-XER).

5.2 The basic set of encoding rules specified in this Recommendation | International Standard is BASIC-XER, which does not in general produce a canonical encoding, and which does not provide any user control over the style of XML which is produced.

5.3 A second set of encoding rules specified in this Recommendation | International Standard is CXER, which produces encodings that are canonical. This is defined as a restriction of implementation-dependent choices in the BASIC-XER encoding.

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NOTE 1 – Any implementation conforming to CXER for encoding is conformant to BASIC-XER for encoding. Any implementation conforming to BASIC-XER for decoding is conformant to CXER for decoding. Thus, encodings made according to CXER are encodings that are permitted by BASIC-XER.

NOTE 2 – CXER produces encodings that have applications when authenticators need to be applied to abstract values.

5.4 The third set of encoding rules specified in this Recommendation | International Standard is EXTENDED-XER. This is defined as variations of the BASIC-XER encodings specified by XER encoding instructions (see 6) associated with an ASN.1 type. In the absence of XER encoding instructions, an EXTENDED-XER encoding differs from a BASIC-XER encoding only because it provides more encoders options.

5.5 If a type encoded with CXER contains **`EMBEDDED PDV`**, **`EXTERNAL`** or **`CHARACTER STRING`** types, then the outer encoding ceases to be canonical unless the encoding used for all the **`EMBEDDED PDV`**, **`EXTERNAL`** and **`CHARACTER STRING`** types is canonical.

6 Encoding instructions specified by this Recommendation | International Standard

6.1 This Recommendation | International Standard specifies the syntax and semantics of XER encoding instructions (see clauses 11 to 39). XER encoding instructions only affect EXTENDED-XER encodings.

6.2 ASN.1 forms a basic XML schema notation. The ASN.1 schema is used to define the content and structure of data using ASN.1 and the BASIC-XER (and CXER) encoding rules. It can be used without XER encoding instructions.

6.3 XER encoding instructions provide wider flexibility in the XML documents that can be specified.

6.4 XER encoding instructions are assigned to ASN.1 type definitions or to type references using either or both of XER type prefixes (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 31.3) and an XER encoding control section (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 54). If encoding instructions are associated with a type definition, they are carried with the ASN.1 type (through its type reference) into other type definitions and other ASN.1 modules. When EXTENDED-XER encodes a type that has XER encoding instructions associated with some or all of its parts, those final encoding instructions are applied and modify the EXTENDED-XER encodings that are produced.

NOTE – The final encoding instructions are also used when performing validation and/or decoding of an EXTENDED-XER encoding.

7 Conformance

7.1 Dynamic conformance for the basic XML Encoding Rules is specified by clause 8, and dynamic conformance for the Canonical XML Encoding Rules is specified by clause 9, and dynamic conformance for the extended XML Encoding Rules is specified by clause 10.

7.2 Static conformance is specified by those standards which specify the application of one or more of these encoding rules.

7.3 Alternative encodings are permitted by the basic XML Encoding Rules and by the extended XML Encoding Rules as an encoder's option. Decoders that claim conformance to BASIC-XER shall support all BASIC-XER alternatives. Decoders that claim conformance to EXTENDED-XER shall support all EXTENDED-XER encoding alternatives.

NOTE – This clause applies whether or not there are any final encoding instructions.

7.4 No alternative encodings are permitted by the Canonical XML Encoding Rules for the encoding of an ASN.1 value.

8 Basic XML encoding rules

8.1 Production of a complete BASIC-XER encoding

8.1.1 A conforming BASIC-XER encoding is a valid XML document which shall consist of:

a) an XML prolog (which may be empty) as specified in 8.2;

b) an XML document element which is the complete encoding of a value of a single ASN.1 type as specified in 8.3.

8.1.2 The specification in 8.2 to 8.6 completely defines the BASIC-XER encoding.

NOTE – Other constructs of W3C XML 1.0, such as XML processing instructions, are not allowed by those subclauses, and are never produced by a conforming BASIC-XER encoder.

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8.1.3 The XML document shall be encoded using UTF-8 to produce a string of octets which forms the encoding specified in this Recommendation | International Standard. The ASN.1 object identifier for these encoding rules is specified in clause 40.

8.1.4 Where this Recommendation | International Standard uses the term "white-space", this means one or more of the following characters of the Unicode Standard: HORIZONTAL TABULATION (9), LINE FEED (10), CARRIAGE RETURN (13), SPACE (32). The numbers in parentheses are the decimal value of the characters of the Unicode Standard. The number and choice of characters that constitutes "white-space" is an encoder's option.

8.1.5 Where this Recommendation | International Standard uses the term "white-space with escapes", this means one or more of the characters listed in 8.1.4, with an encoder's option to represent any of these characters with an escape sequence of the form "**&#*n*;**" or "**&#x*n*;**" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.15.8).

8.2 The XML prolog

8.2.1 The XML prolog shall either:

a) be empty; or

b) shall consist of the following character sequences in order, and as an encoder's option the last character sequence may be followed by "white-space" (see 8.1.4):

```
<?xml
version="1.0"
encoding="UTF-8"?>
```

8.2.2 The character sequences listed in 8.2.1 shall not contain "white-space", but shall be separated by a single SPACE (32) character.

8.3 The XML document element

8.3.1 The XML document element shall be an "XMLTypedValue" as specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 16.2, with the changes and restrictions specified in the following subclauses of this clause 8.3.

8.3.2 All occurrences of "ExternalTypeReference" within the "XMLTypedValue" shall be replaced by the "typereference" in that "ExternalTypeReference".

8.3.3 The ASN.1 "comment" lexical item (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.6) shall not be present. If an XER encoding contains a pair of adjacent hyphens, or "/*", or "*/", these shall be treated as part of the data, and not as ASN.1 comment delimiters.

8.3.4 Where Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.1.4, 12.11 and 12.13, permits the use of ASN.1 white-space between lexical items or in "xmlbstring" or in "xmlhstring", the characters used shall be restricted to the "white-space" specified in 8.1.4.

8.3.5 The "XMLBooleanValue" specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 18.3, shall only be "EmptyElementBoolean" and the "XMLSequenceOfValue" and "XMLSetOfValue" with a component that is a boolean type shall be "XMLValueList".

8.3.6 The "XMLIntegerValue" specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 19.9, shall only be "XMLSignedNumber".

8.3.7 The "XMLEnumeratedValue" specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 20.8, shall only be "EmptyElementEnumerated" and the "XMLSequenceOfValue" and "XMLSetOfValue" with a component that is an enumerated type shall be "XMLValueList".

8.3.8 The "XMLSpecialRealValue" specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 21.6, shall only be "EmptyElementReal".

8.3.9 The "XMLBitStringValue" specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 22.9, shall not be "XMLIdentifierList".

8.3.10 The "XMLExternalValue" specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 37, shall be replaced by the "XMLExternalValue" specified in 8.4.

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8.4 Encoding of the EXTERNAL type

8.4.1 The "XMLExternalValue" production used for an XER encoding of an "EXTERNAL" type shall be the "XMLValue" for the encoding of the sequence type specified in Rec. ITU-T X.691 | ISO/IEC 8825-2, 29.1, with a value as specified in 29.2 to 29.4 of that Recommendation | International Standard.

NOTE – For historical reasons, the XER encoding of an "EXTERNAL" type is not the same as the XML value notation specified in Rec. ITU-T X.680 | ISO/IEC 8824-1.

8.4.2 Rec. ITU-T X.691 | ISO/IEC 8825-2, 29.5 to 29.8 shall apply, except that the provisions of 29.6 shall be replaced by 8.4.3 of this Recommendation | International Standard.

8.4.3 If the data value is the value of a single ASN.1 type, and if the encoding rules for this data value are those specified in this (XER) Recommendation | International Standard, then the sending implementation shall use the "single-ASN1-type" alternative.

8.4.4 Rec. ITU-T X.691 | ISO/IEC 8825-2, 29.9 to 29.11 shall apply, except that the provisions of 29.9 shall be replaced by 8.4.5 of this Recommendation | International Standard. The Note in Rec. ITU-T X.691 | ISO/IEC 8825-2, 29.9 applies.

8.4.5 If the "encoding" choice is "single-ASN1-type", then the ASN.1 type shall be the "XMLTypedValue" of the type encoded in the "EXTERNAL", with a value equal to the data value to be encoded.

8.5 Encoding of the open type

Both alternatives of "XMLOpenTypeFieldVal" (see Rec. ITU-T X.681 | ISO/IEC 8824-2, 14.6) can be used.

NOTE – The use of the "xmlhstring" alternative of "XMLOpenTypeFieldVal" is not recommended in general, as there are no mechanisms to identify the encoding rules being used to produce the "xmlhstring" in an instance of an encoding. Cases where this alternative may be convenient are when the message being encoded in XER (e.g. for display purposes) is the result of a previous binary encoding and has not been completely decoded, or when there are bilateral agreements.

8.6 Decoding of types with extension markers

8.6.1 A BASIC-XER decoder shall accept as a valid XML document BASIC-XER encodings of types with extension markers in which unknown extensions are present.

8.6.2 Unknown extensions in a sequence or set type result in unexpected XML elements with names distinct from any of the names of the next expected XML element.

NOTE – There may be multiple names for a known following XML element when optionality is present, but the extension additions will always have names that differ from all of these.

8.6.3 Unknown extensions in a choice type result in a single unexpected XML element in place of an element corresponding to one of the known choices. It will always have a different XML element name from that of any XML element that encodes a known alternative of the choice type.

8.6.4 Unknown extensions in an enumerated type result in an XML element with an unexpected content, but with no unexpected XML elements.

8.6.5 Unknown extensions arising from relaxation of a subtype constraint result in an encoding that can be a valid encoding of any value of the unconstrained type. Such encodings can produce unexpected content, but no unexpected XML elements.

9 Canonical XML encoding rules

Where "XMLTypedValue" contains options, this clause specifies precisely one of those options in order to produce a unique encoding. The provisions of this clause determine the canonical XML encoding rules.

9.1 General rules for canonical XER

9.1.1 The XML prolog shall be empty (see 8.2.1).

9.1.2 All lexical items forming the "XMLTypedValue" shall have no "white-space" between them (see 8.3.4).

NOTE – This ensures that the digital signature of a document can be easily generated without considering any possible insertion of "white-space" between the lexical items of the "XMLTypedValue".

9.1.3 The escape sequences specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.15.8, shall not be used.

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9.1.4 If the XML value notation permits the use of an XML empty-element tag (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 16.5 and 17.8), then this empty-element tag shall be used.

9.2 Real values

9.2.1 The real value zero shall be encoded as "0".

9.2.2 For all other values, the following subclauses specify restrictions that apply to "realnumber" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.9).

9.2.3 The "realnumber" shall be normalized so that the integer part consists of a single, non-zero digit. The decimal point shall be present and shall be followed by a fractional part containing at least one digit (which may be zero). The fractional part shall not contain any trailing zeros after the first digit.

9.2.4 The fractional part shall be followed by an "E" (not an "e") and by an exponent (which may be zero).

NOTE – Leading zeros in the exponent are already forbidden by Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.9.

9.2.5 No "+" sign shall be present either before the integer part or before the exponent.

9.3 Bitstring value

9.3.1 If the "XMLTypedValue" alternative of "XMLBitStringValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 22.9) can be used (as specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 22.11), then it shall be used. Otherwise, the "xmlbstring" alternative shall be used with all "white-space" removed (see 8.3.4).

9.3.2 If the bitstring type has a "NamedBitList", there shall be no trailing zero bits (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 22.7).

9.4 Octetstring value

If the "XMLTypedValue" alternative of "XMLOctetStringValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 23.3) can be used (as specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 23.4), then it shall be used. Otherwise, the "xmlhstring" alternative shall be used with all "white-space" removed (see 8.3.4), and all letters in upper-case.

9.5 Sequence value

All components of a sequence which have default values, and which have an abstract value set to those default values, shall have the encoding of the default value textually present. There shall always be an encoding for those components.

9.6 Set value

9.6.1 The set type shall have the elements in its "RootComponentTypeList" sorted into the canonical order specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 8.6, and additionally for the purposes of determining the order in which components are encoded when one or more component is a choice type with no ASN.1 tag, each such choice type is ordered as though it has a tag equal to that of the smallest tag in the "RootAlternativeTypeList" of that choice type or any such choice types nested within it.

9.6.2 The set elements that occur in the "RootComponentTypeList" shall then be encoded in the resulting sorted order. After the elements in the "RootComponentTypeList", if any, have been encoded, the set elements that occur in the "ExtensionAdditionList" shall be encoded in the order in which they are defined. (An example of this ordering of elements is provided in Rec. ITU-T X.691 | ISO/IEC 8825-2, clause 21.)

9.6.3 All components of a set which have default values, and which have an abstract value set to those default values, shall have the encoding of the default value textually present. There shall always be an encoding for those components.

9.7 Set-of value

9.7.1 The order of the elements of an "XMLSetOfValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 28.3) shall be determined by sorting the character strings which represent the CXER encoding for each element as specifed in 9.7.2 and 9.7.3.

9.7.2 The sort order for the character strings is determined using the 32-bit value of characters specified in ISO/IEC 10646, with lower numbered characters preceding higher numbered characters.

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9.7.3 A conceptual "pad" character is used in specifying the sort order. This character precedes all other characters. When determining whether a string "A" sorts before a string "B", the shorter string has conceptual "pad" characters added at its end if necessary. String "A" sorts before string "B" if and only if the character in string "A" precedes the corresponding character in string "B" in the first character position in which they have different characters.

9.8 Object identifier value

The "XMLObjIdComponent" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 32.3) shall be "XMLNumberForm".

9.9 Relative object identifier value

The "XMLRelativeOIDComponent" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 33.3) shall be "XMLNumberForm".

9.10 GeneralizedTime

9.10.1 The encoding of a value of type "GeneralizedTime" shall terminate with the character "Z" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 46.3).

9.10.2 The string representing the seconds shall always be present.

9.10.3 The string representing fractions of seconds, if present, shall omit all trailing zeros. If the fractional part corresponds to 0, this string shall be wholly omitted together with the decimal point.

EXAMPLE

Seconds represented with the string "26.000" shall be encoded as "26". Seconds represented with the string "26.5200" shall be encoded as "26.52".

9.10.4 The decimal point, if present, shall be ".".

9.10.5 Midnight (GMT) shall be encoded as a string of the form:

"YYYYMMDD000000Z"

where "YYYYMMDD" represents the day following the midnight in question.

EXAMPLE

The followings encodings are valid:

"19920521000000Z"

"19920622123421Z"

"19920722132100.3Z"

The following encodings are invalid:

"19920520240000Z" (midnight represented incorrectly)

"19920622123421.0Z" (spurious trailing zeros)

"19920722132100.30Z" (spurious trailing zeros)

9.11 UTCTime

9.11.1 The encoding of a value of type "UTCTime" shall terminate with the character "Z" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 47.3).

9.11.2 The string representing the seconds shall always be present.

9.11.3 Midnight (GMT) shall be encoded as a string of the form:

"YYMMDD000000Z"

where "YYMMDD" represents the day following the midnight in question.

EXAMPLE

The following encodings are valid:

"920521000000Z"

"920622123421Z"

"920722132100Z"

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The following encodings are invalid:

"920520240000Z" (midnight represented incorrectly)

"9207221321Z" (seconds of "00" omitted)

9.12 Open type value

The "xmlhstring" alternative of "XMLOpenTypeFieldVal" shall not be used (see 8.5).

9.13 The `TIME` type and the useful time types

The "XMLTimeValue" for these types shall be modified as follows:

a) all commas used as decimal signs shall be converted to full stop;

b) the minutes digits for all time difference components that are an integral number of hours shall be removed;

c) if an interval or recurring interval contains a start point and an end point, and the end point contains the same time difference component as the start point, the time difference component of the end point shall be removed;

d) for a duration, and for a duration in an interval (or in an interval in a recurring interval) expressed with a start point and a duration or with a duration and an end point, the value notation shall be modified to remove all zero time components except the least significant time component that is present in the instance of the value notation.

10 Extended XML encoding rules

10.1 General

10.1.1 The extended XML encoding rules (EXTENDED-XER) augment and modify BASIC-XER. They enable ASN.1 to define the form and content of a much wider range of XML documents.

10.1.2 EXTENDED-XER extends BASIC-XER in three main ways.

a) It provides additional encoder's options (for example, for the insertion of XML Processing Instructions or XML Comment, and for the use of identifiers for named bits in a bitstring value);

b) It specifies a set of encoding instructions that can be used to specify modification of the BASIC-XER encoding of an ASN.1 type, including an encoding instruction to use simple text rather than empty-element tags for boolean, integer (with named numbers), enumerated, special values of real, and bitstring (with named bits) types;

c) It requires decoders to ignore (in the absence of encoding instructions) attributes from the control namespace that are unknown (for example, a **schemaLocation** attribute), and some known attributes that other XML tools may insert which may have different values from those that a conforming encoder can insert (for example, use of a type identification attribute). (See 10.2.10.)

10.1.3 If an ASN.1 specification does not contain any XER encoding instructions, then every BASIC-XER encoding of any abstract value of an ASN.1 type is also an EXTENDED-XER encoding of the same abstract value of that type.

NOTE – The opposite is not true. Even in the absence of XER encoding instructions, there are EXTENDED-XER encodings that are not conforming to BASIC-XER encodings (see 10.1.2 a and 10.1.2 c).

10.1.4 All occurrences of ASN.1 "Type" notation have an associated set (possibly empty) of XER encoding instructions (the final associated encoding instructions). Encoding instructions are associated with a "Type" through:

a) (Inherited encoding instructions) the presence of associated encoding instructions on the "Type" used in the definition of a "typereference" used as a "Type"; and

b) (Targeted encoding instruction) assignment of one or more XER encoding instructions to an occurrence of "Type" using an XER encoding control section (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 54); and

NOTE – An ASN.1 module can contain only one XER encoding control section, and hence only one XER "EncodingInstructionAssignmentList" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 54.2)

c) (Prefixed encoding instructions) assignment of one or more XER encoding instructions to an occurrence of "Type" using XER type prefixes (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 31.3); and

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d) (Import-list encoding instructions) assignment of one or more encoding instructions to all type references imported from an identified ASN.1 module.

10.1.5 The effect of assigning an XER encoding instruction is to add, delete, or replace associated encoding instructions (see clause 15 for the rules that apply for multiple assignments of XER encoding instructions).

10.1.6 The order (or manner) in which encoding instructions become part of (or are removed from) the set of associated encoding instructions is not significant in the application of the final encoding instructions.

10.1.7 The final encoding instructions affect the EXTENDED-XER encoding of types. They have no other impact, and in particular are not associated with any value reference defined using the type, nor do they affect value mappings, nor do they affect other encoding rules.

NOTE – There are, however, requirements on the unambiguity of names that are affected by the presence of a final **NAME**, **NAMESPACE**, or **UNTAGGED** encoding instruction. These requirements can be interpreted either as restrictions on the way in which types with such final encoding instructions can be used, or as restrictions on the use of these encoding instructions.

10.2 EXTENDED-XER conformance

10.2.1 If an ASN.1 specification assigns XER encoding instructions in accordance with clauses 11 to 17 such that an ASN.1 type or component has final encoding instructions that violate the restrictions specified in clauses 18 onwards, then that ASN.1 specification is not in conformity with this Recommendation | International Standard, even if (without the XER encoding instructions) it would conform to all the requirements of Rec. ITU-T X.680 | ISO/IEC 8824-1.

NOTE – It is only occasionally illegal to assign an encoding instruction to a "Type", as it can be negated (removed from the set of associated encoding instructions) by a further assignment. It is the final encoding instructions that normally determine conformity of the specification. In some (but not all) cases, a final encoding instruction that is not applicable to the type to which it is being applied is ignored. If the clauses specifying the syntax and application of encoding instructions identify circumstances where an encoding instruction is ignored in the application of the final encoding instructions, then clauses specifying encodings do not normally mention the possible presence of that final encoding instruction.

10.2.2 A conforming EXTENDED-XER encoding of an ASN.1 type with no final encoding instructions shall be the encoding produced by the basic XML encoding rules (BASIC-XER) specified in clause 8, with the additional encoder's options specified in 10.2.5 and 10.2.6.

NOTE – EXTENDED-XER decoders are required by 10.2.4 to accept and process W3C XML document type declarations, but these are not generated by conforming encoders, and do not form part of EXTENDED-XER encodings.

10.2.3 The EXTENDED-XER encoding of an ASN.1 type with final encoding instructions, or with components (at any depth, and after resolving all type references) that have associated encoding instructions, shall be the encoding specified in clause 17.

NOTE – The final encoding instructions are applied in an EXTENDED-XER encoding, and are also used by decoders and validators of EXTENDED-XER encodings.

10.2.4 EXTENDED-XER decoders (whether **MODIFIED-ENCODINGS** was used or not – see clause 26) shall process any document type declaration (see W3C XML 1.0, 2.8) that is present, in accordance with the requirements for non-validating XML processors (see W3C XML 1.0, 5.1). This processing shall be performed (conceptually) before applying all other decoding requirements in this Recommendation | International Standard. EXTENDED-XER encoders shall not include a document type declaration.

10.2.5 An EXTENDED-XER encoder can (as an encoder's option) insert XML Processing Instructions or XML Comment (in addition to any that might be required by clause 30) in the XML document element or XML prolog in any position permitted by W3C XML 1.0. The syntactic form and semantics of XML Processing Instructions is specified in W3C XML 1.0, 2.6. The syntactic form and semantics of XML Comment is specified in W3C XML 1.0, 2.5.

10.2.6 If there is no **GLOBAL-DEFAULTS** encoding instruction with a **MODIFIED-ENCODINGS** keyword (see clause 26) in the XER encoding control section, then:

a) the "XMLIntegerValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 19.9) may be either "XMLSignedNumber" or "EmptyElementInteger", as an encoder's option; and

b) the "XMLBitStringValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 22.9) may be any of the alternatives of this production, as an encoder's option. If the "XMLIdentifierList" is used, it shall be the "EmptyElementList".

10.2.7 If there is a **GLOBAL-DEFAULTS** encoding instruction with a **MODIFIED-ENCODINGS** keyword (see clause 26) in the XER encoding control section, then:

a) the "XMLBooleanValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 18.3) shall be "TextBoolean"; and

b) the "ExtendedXMLIntegerValue" (see 17.4) shall be the "ModifiedXMLIntegerValue" alternative, defined in 17.8; and

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NOTE 1 – This allows the use of a text value for "NamedNumber"s of an integer type, as an encoder's option, but also modifies the syntax for numeric encodings of an integer value.

c) the "ExtendedXMLEnumeratedValue" (see 34.3) shall not be "EmptyElementEnumerated"; and

NOTE 2 – In the absence of a **GLOBAL-DEFAULTS** of **MODIFIED-ENCODINGS**, it cannot be "TextEnumerated" (see 8.3.7 and 34.3).

d) the "ExtendedXMLRealValue" (see 17.4) shall be the "ModifiedXMLRealValue" alternative, defined in 17.9; and

e) the "XMLSpecialRealValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 21.6) shall be the "TextReal" alternative; and

f) the alternative of "XMLIdentifierList" in the "XMLBitStringValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 22.9) shall be "TextList" (see 10.2.8 b); and

g) the "XMLSequenceOfValue" and "XMLSetOfValue" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 26.3 and 28.3) shall be "XMLDelimitedItem" for all component types, with Table 5 ignored (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 26.5); and

h) the "xmlhstring" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.13) shall not contain "white-space" (see 8.1.4); and

i) all occurrences of "white-space" that is either outside XML tags or inside the values of XML attributes can be "white-space with escapes" (see 8.1.5) as an encoder's option.

NOTE 3 – There are some encoding instructions (such as **UNTAGGED**) that cannot be used unless there is a **GLOBAL-DEFAULTS** of **MODIFIED-ENCODINGS.**

10.2.8 If a **GLOBAL-DEFAULTS** encoding instruction with a **MODIFIED-ENCODINGS** keyword (see clause 26) is present in the XER encoding control section, then an **EXTENDED-XER** encoder can (as an encoder's option):

a) use the "TextInteger" alternative of "ModifiedXMLIntegerValue" (see 17.8), provided there is a "NamedNumber" for the integer value in the type definition (see also 10.2.7 b);

NOTE 1 – The use of this encoding with named values that have been added in a later version can make the abstract value represented unreadable by an implementation of an earlier version of the specification.

b) use "XMLIdentifierList" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 22.9) for an "XMLBitStringValue", provided the bitstring value to be encoded does not contain any "one" bits that are not named bits (see also 10.2.7 f);

NOTE 2 – The use of this encoding with named bits that have been added in a later version can make the abstract value represented unreadable by an implementation of an earlier version of the specification.

10.2.9 Where encoder's options are permitted in an EXTENDED-XER encoding, conforming decoders and validators shall accept all options.

10.2.10 Conforming decoders and validators shall accept, but may ignore, the presence of a type identification attribute in any XML element of an encoding unless its presence and use is as specified in clauses 37 and 38. Encoders shall not generate such attributes except as specified in clauses 37 and 38.

NOTE – Other XML tools may insert such attributes. In general, an EXTENDED-XER decoder cannot easily determine the permitted value and meaning of type identification attributes. Their presence and value may be of use to an application if (for example) unexpected XML child elements are present that are (as a decoder's option) passed to the application – rather than being ignored or producing a fatal decoding error.

10.2.11 An ASN.1 specification is illegal unless it is possible, for all abstract values, for a decoder to determine unambiguously (using only the name of the XML tag and the contents of any previous XML element) the ASN.1 component (or extension marker) that an XML element is associated with.

NOTE 1 – The association cannot depend on the content of the XML element, or on its attributes, or on any subsequent XML element.

NOTE 2 – This condition is always satisfied when there are no XER encoding instructions, but the inappropriate use of **UNTAGGED** to remove associated tags round (for example) repetitions (sequence-of or set-of) and alternatives (choice) and the inappropriate use of **NAME** can result in illegal specifications.

NOTE 3 – Subclause 10.2.11 is a necessary condition for valid encodings, but it is recognized that it is in general not possible for an ASN.1 tool (or for a human author) to check for legality based on this top-level statement alone. Annex B provides a model of the effect of the use of **UNTAGGED**, and rules that, if followed, can ensure legality of the specification as defined in 10.2.11.

10.2.12 If an ASN.1 specification contains "ObjectClassFieldType"s that are open types (see Rec. ITU-T X.681 | ISO/IEC 8824-2, 14.2), with table constraints or type constraints, such constraints shall all be ignored in applying 10.2.11.

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10.3 Structure of an EXTENDED-XER encoding

10.3.1 A complete EXTENDED-XER encoding is a well-formed XML document consisting (in order) of:

a) an XML prolog (which may be empty as an encoder's option) as specified in 8.2; and

b) an XML document element which is the complete encoding of a value of a single ASN.1 type, called the root type, as specified in clause 17.

10.3.2 The "XMLValue" encodings used for BASIC-XER encodings are modified for EXTENDED-XER encodings by the final encoding instructions for the "Type"s that they encode, and the final encoding instructions for their components (to any depth), together with any **GLOBAL-DEFAULTS** encoding instructions.

NOTE – In an extreme case, the entire contents of the XML document element for a heavily nested ASN.1 structure can (through the use of the **UNTAGGED** encoding instruction) consist of nothing more than a linear sequence of XML elements, where only the root element has child elements. The use of **UNTAGGED** is restricted to ensure that all such resulting linear sequences of XML elements can be mapped without ambiguity to the components of an abstract value of the ASN.1 root type (see 10.2.11).

10.3.3 The XML document element in an EXTENDED-XER encoding consists of a single XML element that shall be an "ExtendedXMLTypedValue" for the type being encoded (the root type). It can include attributes in its start-tag or empty-element tag, and can have a content that includes both child elements (see W3C XML) and untagged text. The child elements may themselves have both attributes and a content that includes both child elements and untagged text.

10.3.4 The abstract values of the components of an enclosing type are encoded as "ExtendedXMLValue"s (see 17.4), possibly modified by encoding instructions applied to them or to their own components. These "ExtendedXMLValue"s:

a) can be preceded by an XML start-tag and followed by an XML end-tag (called the associated tags) to form an element within the "ExtendedXMLValue" of the enclosing type; or

b) can (by the use of an **UNTAGGED** encoding instruction on a type that is not character-encodable) form a partial XML element content for the "ExtendedXMLValue" of the enclosing type; or

NOTE – Annex B describes the result of applying **UNTAGGED** as the production of partial XML element content that can combine with other encodings to form the XML element content for some enclosing element whose type has not been **UNTAGGED**.

c) can (by the use of an **UNTAGGED** encoding instruction on a character-encodable type) form the complete "ExtendedXMLValue" of the component; or

d) can (by the use of an **ATTRIBUTE** encoding instruction on a character-encodable type) form the "CharacterEncodableValue" in the "QuotedValue" of an "Attribute" (see 20.3.3).

10.3.5 If an "ExtendedXMLValue" is empty, and its associated tags have not been removed by the use of an **UNTAGGED** encoding instruction, then the associated preceding and following tags can (as an encoder's option) be replaced with an XML empty-element tag (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 17.8). This is called the associated empty-element tag.

10.3.6 The transformation specified in 10.3.5 is performed conceptually after completion of the entire encoding process, and can be prevented by a **PI-OR-COMMENT** encoding instruction (see clause 30) producing one or more XML Processing Instruction or XML Comment elements between the start-tag and end-tag.

10.3.7 The associated preceding tag, the associated following tag, and the associated empty-element tag are jointly referred to as the associated tags. The XML element names in the associated tags are called the associated tag names, and are (in the absence of final **NAME** and **NAMESPACE** encoding instructions) identifiers, type reference names, or "xmlasn1typename"s (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.36).

11 Notation, character set and lexical items used in XER encoding instructions

11.1 The notation used in specifying the syntax of an "EncodingInstruction" in an XER type prefix (see clause 13), and in an "EncodingInstructionAssignmentList" in an XER encoding control section (see clause 14) is that defined by Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 5.

11.2 Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 11, applies to an XER "EncodingInstruction" and to an XER "EncodingInstructionAssignmentList".

NOTE – In particular, arbitrary ASN.1 white-space characters can appear between lexical items in both of these syntactic constructs unless the "&" notation is used (see Rec. ITU-T X.680 | ISO/IEC 8824-1, 5.4).

11.3 The general rules specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.1, also apply to an XER "EncodingInstruction" and to an XER "EncodingInstructionAssignmentList".

NOTE – In particular, ASN.1 comment can be included wherever ASN.1 white-space is allowed, and requirements for the insertion of white-space or comment between lexical items that could otherwise be confused are those specified in Rec. ITU-T X.680 | ISO/IEC 8824-1.

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11.4 The following lexical items are used in this Recommendation | International Standard:

comment	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.6)
cstring	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.14)
identifier	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.3)
modulereference	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.5)
number	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.8)
typereference	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.2)
"{"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"}"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"."	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
":"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"["	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"]"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
","	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
";"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"|"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"*"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"::="	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.20)
"<"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
">"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.37)
"</"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.28)
"/>"	(see Rec. ITU-T X.680 | ISO/IEC 8824-1, 12.29)

Additional lexical items ("modifiedXMLNumber" and "modifiedXMLRealNumber") are defined and used in 17.8.3 and in 17.9.

12 Keywords

12.1 The words specified in 12.3 and 12.4 below are used in either or both of XER "EncodingInstruction"s and XER "EncodingInstructionAssignmentList"s (in addition to some ASN.1 reserved words), and can appear in such syntactic constructs only with the meaning assigned to them in the following clauses of this Recommendation | International Standard, except as specified in 12.2.

12.2 Keywords are not reserved words, but if an ASN.1 "typereference" that is the same as a keyword listed in 12.3 is needed in an XER "EncodingInstruction" or an XER "EncodingInstructionAssignmentList", then the production "ModuleAndTypeReference" (see 14.2.2) shall be used.

12.3 The keywords are:

AFTER-TAG	**DEFAULT-FOR-EMPTY**	**REPLACE**
AFTER-VALUE	**ELEMENT**	**TEXT**
ANY-ATTRIBUTES	**EMBED-VALUES**	**UNCAPITALIZED**
ANY-ELEMENT	**GLOBAL-DEFAULTS**	**UNTAGGED**
AS	**IN**	**UPPERCASED**
ATTRIBUTE	**LIST**	**USE-NIL**
BASE64	**LOWERCASED**	**USE-NUMBER**
BEFORE-TAG	**MODIFIED-ENCODINGS**	**USE-ORDER**
BEFORE-VALUE	**NAME**	**USE-QNAME**
CAPITALIZED	**NAMESPACE**	**USE-TYPE**
COLLAPSE	**NOT**	**USE-UNION**
CONTROL-NAMESPACE	**PI-OR-COMMENT**	**WHITESPACE**
DECIMAL	**PREFIX**	

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