
**Information technology — ASN.1
encoding rules —**

**Part 5:
Mapping W3C XML schema definitions
into ASN.1**

Technologies de l'information — Règles de codage ASN.1 —

Partie 5: Mappage en ASN.1 des définitions de schéma XML du W3C

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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.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

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Introduction

This Recommendation | International Standard specifies version 1 and version 2 of a mapping from a W3C XML Schema definition (an XSD Schema) into an Abstract Syntax Notation One (ASN.1) schema. The mappings can be applied to any XSD Schema. Both mappings specify the generation of one or more ASN.1 modules containing type definitions, together with ASN.1 XER encoding instructions. These are jointly described as an ASN.1 schema for Extensible Markup Language (XML) documents. This ASN.1 schema (produced by either version of the mapping), when used with the ASN.1 Extended XML Encoding Rules (EXTENDED-XER), can be used to generate and to validate the same set of W3C XML 1.0 documents as the original XSD Schema. The resulting ASN.1 types and encodings support the same semantic content as the XSD Schema. Thus ASN.1 tools can be used interchangeably with XSD tools for the generation and processing of the specified XML documents.

Other standardized ASN.1 encoding rules, such as the Distinguished Encoding Rules (DER) or the Packed Encoding Rules (PER), can be used in conjunction with this standardized mapping, but produce encodings for version 2 of the mapping that differ from (and are less verbose than) those produced by version 1 for XSD constructs involving dates and times or wildcards.

The combination of this Recommendation | International Standard with ASN.1 Encoding Rules provides fully standardized and vendor-independent compact and canonical binary encodings for data originally defined using an XSD Schema.

The ASN.1 schema provides a clear separation between the specification of the information content of messages (their abstract syntax) and the precise form of the XML document (e.g., use of attributes instead of elements). This results in both a clearer and generally a less verbose schema than the original XSD Schema.

Annex A forms an integral part of this Recommendation | International Standard, and is an ASN.1 module containing a set of ASN.1 type assignments that correspond to each of the XSD built-in types for version 1 of the mapping. Mappings of XSD Schemas into ASN.1 schemas either import the type reference names of those type assignments or include the type definitions in-line.

Annex B also forms an integral part of this Recommendation | International Standard and provides the ASN.1 module for version 2 of the mapping.

Annex C does not form an integral part of this Recommendation | International Standard, and summarizes the object identifier, OID internationalized resource identifier and object descriptor values assigned in this Recommendation | International Standard.

Annex D does not form an integral part of this Recommendation | International Standard, and gives examples of the mapping of XSD Schemas into ASN.1 schemas.

Annex E does not form an integral part of this Recommendation | International Standard, and describes the use of the mapping defined in this Recommendation | International Standard, in conjunction with standardized ASN.1 Encoding Rules, to provide compact and canonical encodings for data defined using an XSD Schema.

**INTERNATIONAL STANDARD
ITU-T RECOMMENDATION**

**Information technology – ASN.1 encoding rules: Mapping W3C XML
schema definitions into ASN.1**

1 Scope

This Recommendation | International Standard specifies two versions of a mapping from any XSD Schema into an Abstract Syntax Notation One (ASN.1) schema. The ASN.1 schema for both versions support the same semantics and validate the same set of XML documents.

This Recommendation | International Standard specifies the final XER encoding instructions that are to be applied as part of the defined mapping to ASN.1 types, but does not specify which syntactic form is to be used for the specification of those final XER encoding instructions, or the order or manner of their assignment.

NOTE – Implementers of tools generating these mappings may choose any syntactic form or order of assignment that results in the specified final XER encoding instructions being applied. Examples in this Recommendation | International Standard generally use the type prefix form, but use of an XER Encoding Control Section may be preferred for the mapping of a complete XSD Schema, as a matter of style.

There are different ways (syntactically) of assigning XER encoding instructions for use in EXTENDED-XER encodings (e.g., use of ASN.1 type prefix encoding instructions or use of an XER encoding control section). The choice of these syntactic forms is a matter of style and lies outside the scope of this Recommendation | International Standard.

2 Normative references

The following Recommendations | International Standards and W3C specifications 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, International Standards and W3C specifications 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, International Standards and W3C specifications 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. The W3C maintains a list of currently valid W3C specifications. 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.

2.1 Identical Recommendations | International Standards

NOTE – The complete set of ASN.1 Recommendations | International Standards is listed in this clause, as these documents can all be applicable in particular uses of this Recommendation | International Standard. Where these are not directly referenced in the body of this Recommendation | International Standard, a † symbol is added to the reference.

- 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)*.
- 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.693 (2021) | ISO/IEC 8825-4:2021, *Information technology – ASN.1 encoding rules: XML Encoding Rules (XER)*.

- 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

- ISO 8601:2019, *Date and time – Representation for information interchange – Part 1: Basic rules*.
- W3C XML 1.0:2008, *Extensible Markup Language (XML) 1.0* (Fifth Edition), W3C Recommendation, Copyright © [26 November 2008] World Wide Web Consortium (Massachusetts Institute of Technology, Institut National de Recherche en Informatique et en Automatique, Keio University), <http://www.w3.org/TR/xml/>.
- W3C XML Namespaces:1999, *Namespaces in XML*, W3C Recommendation, Copyright © [14 January 1999] World Wide Web Consortium (Massachusetts Institute of Technology, Institut National de Recherche en Informatique et en Automatique, Keio University), <http://www.w3.org/TR/1999/REC-xml-names-19990114>.
- W3C XML Information Set:2004, *XML Information Set* (Second Edition), W3C Recommendation, Copyright © [4 February 2004] World Wide Web Consortium (Massachusetts Institute of Technology, Institut National de Recherche en Informatique et en Automatique, Keio University), <http://www.w3.org/TR/xml-infoset/>.
- W3C XML Schema:2004, *XML Schema Part 1: Structures* (Second Edition), W3C Recommendation, Copyright © [28 October 2004] World Wide Web Consortium (Massachusetts Institute of Technology, Institut National de Recherche en Informatique et en Automatique, Keio University), <http://www.w3.org/TR/xmlschema-1/>.
- W3C XML Schema:2004, *XML Schema Part 2: Datatypes* (Second Edition), W3C Recommendation, Copyright © [28 October 2004] World Wide Web Consortium (Massachusetts Institute of Technology, Institut National de Recherche en Informatique et en Automatique, Keio University), <http://www.w3.org/TR/xmlschema-2/>.

NOTE – When the reference "W3C XML Schema" is used in this Recommendation | International Standard, it refers to W3C XML Schema Part 1 and W3C XML Schema Part 2.

- IETF RFC 2396 (1998), *Uniform resource identifiers (URI): Generic syntax*.
- IETF RFC 3066 (2001), *Tags for the Identification of Languages*.

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3 Definitions

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

3.1 Imported definitions

3.1.1 This Recommendation | International Standard uses the terms defined in Rec. ITU-T X.680 | ISO/IEC 8824-1 and in Rec. ITU-T X.693 | ISO/IEC 8825-4.

NOTE – In particular, the terms "final encoding instructions", "type prefix" and "XER encoding control section" are defined in the Recommendations | International Standards mentioned in this clause.

3.1.2 This Recommendation | International Standard also uses the terms defined in W3C XML Schema and W3C XML Information Set.

NOTE 1 – It is believed that these terms do not conflict with the terms referenced in 3.1.1. If such a conflict occurs, the definition of the term in 3.1.1 applies.

NOTE 2 – In particular, the terms "schema component" is defined in W3C XML Schema, and the terms "element information item" and "attribute information item" are defined in W3C XML Information Set.

NOTE 3 – The terms "top-level **simple type definition**" and "top-level **complex type definition**" do not include XSD built-in types, when used in this Recommendation | International Standard.

3.2 Additional definitions

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

3.2.1 XSD namespace: A namespace with a uniform resource identifier of "http://www.w3.org/2001/XMLSchema".

3.2.2 XSI namespace: A namespace with a uniform resource identifier of "<http://www.w3.org/2001/XMLSchema-instance>".

3.2.3 XML namespace: A namespace with a uniform resource identifier of "http://www.w3.org/XML/1998/namespace".

4 Abbreviations

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

ASN.1	Abstract Syntax Notation One
BER	(ASN.1) Basic Encoding Rules
DER	(ASN.1) Distinguished Encoding Rules
OID	Object Identifier
PER	(ASN.1) Packed Encoding Rules
URI	(IETF) Uniform Resource Identifier
XER	(ASN.1) XML Encoding Rules
XML	(W3C) Extensible Markup Language
XSD	(W3C) XML Schema

5 Notation

5.1 This Recommendation | International Standard references the notation defined by Rec. ITU-T X.680 | ISO/IEC 8824-1, Rec. ITU-T X.682 | ISO/IEC 8824-3, W3C XML 1.0 and W3C XML Schema.

5.2 When it is necessary in the body of this Recommendation | International Standard to specify, either formally or in examples, the assignment of XER encoding instructions, the type prefix notation is generally used (but see 6.3 and 6.4). In Annex A, an XER encoding control section is used.

5.3 In this Recommendation | International Standard, **bold Courier** is used for ASN.1 notation and **bold Arial** is used for XSD notation and for XSD terms and concepts.

5.4 The XSD Schemas used in the examples in this Recommendation | International Standard use the prefix **xsd:** to identify the XSD namespace.

6 Purpose and extent of standardization

6.1 The mapping to ASN.1 that is specified in this Recommendation | International Standard ensures that:

- any resulting ASN.1 modules generated by tools conforming to this Recommendation | International Standard (from the same XSD Schema) define the same (structured) abstract values;
- all BASIC-XER, CXER, EXTENDED-XER, and binary encodings of that resulting ASN.1 specification will produce the same encodings (subject to encoder's options); and
- all XML documents that conform to the source XSD Schema are valid EXTENDED-XER encodings of abstract values of that ASN.1 specification.

6.2 There are many aspects of an ASN.1 definition (such as the use of white-space, or of encoding control sections or type prefixes) that affect neither the abstract values being defined nor the XER or binary encodings of those values. Such aspects of the ASN.1 definition are generally not standardized in this Recommendation | International Standard.

6.3 There are many different ways in ASN.1 of assigning an XER encoding instruction to a type, including:

- use of a type prefix for every encoding instruction to be assigned; or
- use of an encoding control section, with a separate encoding instruction for each required assignment; or
- use of an encoding control section, with a single encoding instruction making a global assignment, possibly supplemented by use of a negating encoding instruction for specific types.

6.4 This Recommendation | International Standard specifies when a final XER encoding instruction shall be present, and uses the syntax of 6.3 a) in most of its examples. However, the use of the different options in 6.3 is not standardized, and conforming implementations of the mapping may choose any syntactic form (or a mixture of syntactic forms) for the assignment of final XER encoding instructions.

NOTE – The choice among these options does not affect the final binary or XML encodings.

6.5 A formal specification of the required mapping is not provided.

6.6 This Recommendation | International Standard is concerned only with the mapping of XSD Schemas that conform to W3C XML Schema.

NOTE – Such conformance can be either by the provision of one or more W3C XSD schema documents or by other means as specified in W3C XML Schema.

7 Mapping XSD Schemas

7.1 A mapping is based on a source XSD Schema, which is a set of schema components (see W3C XML Schema Part 1, 2.2). No particular representation of schema components or sets of schema components is required or assumed for the mapping, although it is expected that the source XSD Schema will usually be provided as one or more XML schema documents (see W3C XML Schema Part 1, 3.15.2).

NOTE 1 – The schema components represented in multiple XML schema documents become part of the same XSD Schema through the use of the **xsd:include**, **xsd:redefine**, and **xsd:import** element information items.

NOTE 2 – Since the mapping is defined in terms of schema components (and not in terms of their XML representation), it is not affected by details of the XML representation, such as the use of multiple schema documents linked by **xsd:include** and **xsd:redefine** element information items, the placement of element information items in one or another schema documents, the order of **xsd:attribute** element information items within a **xsd:complexType** element information item, and so on.

NOTE 3 – Two sets of schema documents that differ in many aspects but represent the same set of schema components generate the same set of ASN.1 type assignments, with the same final encoding instructions assigned to them and to their components to any depth.

7.2 The source XSD Schema shall meet all the constraints imposed by the XSD specification. If the source XSD Schema is represented (in part or all) as a set of XML schema documents, each schema document shall be valid according to the XSD Schema for Schemas (see W3C XML Schema Part 1, Appendix A).

7.3 One or more ASN.1 modules shall be generated for a source XSD Schema. The number of ASN.1 modules generated is an implementation option. Each ASN.1 module shall contain zero or more type assignments corresponding to top-level schema components (see 7.6), and zero or more special ASN.1 type assignments (see clauses 29, 30, and 31). The physical order of type assignments within each ASN.1 module is an implementation option. When multiple ASN.1 modules are generated, the way the generated type assignments are distributed across those ASN.1 modules is also an implementation option.

NOTE 1 – The inclusion in the same ASN.1 module of type assignments generated from XSD schema components with different **target namespaces** is permitted by this clause but not recommended. The preferred mapping is to generate one ASN.1 module per namespace whenever possible. It is also recommended that each special ASN.1 type assignment be inserted in the same ASN.1 module as its associated ASN.1 type assignment (see 29.5, 30.4, and 31.4).

NOTE 2 – The generation of ASN.1 type assignments (see 7.6 and 10.4) is not affected by the number of ASN.1 modules being generated (except for the possible use of "ExternalTypeReference" as specified in 10.2.2), nor by the way the generated type assignments are distributed across those modules, nor by the physical order of the type assignments within each module. In particular, the type reference names of those type assignments are the same whatever mapping style is used by the implementation.

NOTE 3 – A full description of the relationship between the namespace concept of W3C XML Namespaces and naming in ASN.1 is provided in Rec. ITU-T X.693 | ISO/IEC 8825-4, clause 16. Type reference names and identifiers defined in an ASN.1 module are assigned a namespace by means of a **NAMESPACE** encoding instruction, and otherwise do not have a namespace. The mapping generates **NAMESPACE** encoding instructions where needed.

7.4 All ASN.1 modules generated by the mapping shall contain (in the XER encoding control section) a **GLOBAL-DEFAULTS MODIFIED-ENCODINGS** encoding instruction and a **GLOBAL-DEFAULTS CONTROL-NAMESPACE** encoding instruction specifying the XSI namespace.

7.5 A source XSD Schema shall be processed as follows:

- a) for each top-level **element declaration**, an ASN.1 type assignment shall be generated by applying clause 14 to the **element declaration**;
- b) for each top-level **attribute declaration**, an ASN.1 type assignment shall be generated by applying clause 15 to the **attribute declaration**;
- c) for each top-level **simple type definition**, an ASN.1 type assignment shall be generated by applying clause 13 to the **simple type definition**;

- d) for each top-level **complex type definition**, an ASN.1 type assignment shall be generated by applying clause 20 to the **complex type definition**;
- e) for each **model group definition** whose **model group** has a **compositor** of **sequence** or **choice**, an ASN.1 type assignment shall be generated by applying clause 17 to the **model group definition**.

NOTE 1 – The remaining schema components of the source XSD schema will be processed as a result of mapping these schema components.

NOTE 2 – The order in which schema components are to be mapped is specified in 10.4. The order of the items of the foregoing list has no significance for the mapping.

7.6 Column 1 of Table 1 lists schema components. Column 2 gives the reference to the clause in W3C XML Schema that defines the schema component. Column 3 lists the clause that defines the mapping of those schema components into ASN.1.

Table 1 – Mapping of XSD schema components

XSD schema component	W3C XML Schema reference	Mapping defined by
attribute declaration	Part 1, 3.2	Clause 15
element declaration	Part 1, 3.3	Clause 14
complex type definition	Part 1, 3.4	Clause 20
attribute use	Part 1, 3.5	Clause 22
attribute group definition	Part 1, 3.6	<i>not mapped as such</i>
model group definition	Part 1, 3.7	Clause 17
model group	Part 1, 3.8	Clause 18
particle	Part 1, 3.9	Clause 19
wildcard	Part 1, 3.10	Clause 21
identity-constraint definition	Part 1, 3.11	<i>ignored by the mapping</i>
notation declaration	Part 1, 3.12	<i>ignored by the mapping</i>
annotation	Part 1, 3.13	<i>ignored by the mapping</i>
simple type definition	Part 1, 3.14	Clauses 11, 13
schema	Part 1, 3.15	Clause 9
ordered	Part 2, 4.2.2.1	<i>ignored by the mapping</i>
bounded	Part 2, 4.2.3.1	<i>ignored by the mapping</i>
cardinality	Part 2, 4.2.4.1	<i>ignored by the mapping</i>
numeric	Part 2, 4.2.5.1	<i>ignored by the mapping</i>
length	Part 2, 4.3.1.1	Clause 12
minLength	Part 2, 4.3.2.1	Clause 12
maxLength	Part 2, 4.3.3.1	Clause 12
pattern	Part 2, 4.3.4.1	Clause 12
enumeration	Part 2, 4.3.5.1	Clause 12
whiteSpace	Part 2, 4.3.6.1	Clause 12
maxInclusive	Part 2, 4.3.7.1	Clause 12
maxExclusive	Part 2, 4.3.8.1	Clause 12
minExclusive	Part 2, 4.3.9.1	Clause 12
minInclusive	Part 2, 4.3.10.1	Clause 12
totalDigits	Part 2, 4.3.11.1	Clause 12
fractionDigits	Part 2, 4.3.12.1	Clause 12

8 Ignored schema components and properties

8.1 The mapping shall ignore the schema components and properties that are listed in this clause.

8.2 All **annotations** (see W3C XML Schema Part 1, 3.13) shall be ignored.

NOTE – All attribute information items in a schema document with names qualified with namespaces other than the XSD namespace (see W3C XML Schema Part 1, 3.13.1) are a property of **annotations**, and are ignored.

8.3 All **identity-constraint definitions** (see W3C XML Schema Part 1, 3.11) shall be ignored.

NOTE – The **identity-constraint definition** provides mechanisms for specifying referential constraints that can be required in a valid instance. ASN.1 currently has no concept of such constraints, and such constraints cannot be mapped into a formal ASN.1 specification, but they may be included as normative comments that are binding on an application implementation.

8.4 All **notation declarations** (see W3C XML Schema Part 1, 3.12) shall be ignored.

8.5 All schema components that are the **fundamental facets** (**ordered**, **bounded**, **cardinality**, **numeric**) of **simple type definitions** (see W3C XML Schema Part 2, 4.2) shall be ignored.

8.6 The properties **identity-constraint definitions**, **substitution group exclusions** and **disallowed substitutions** of **element declarations** shall be ignored.

8.7 The properties **final**, **abstract**, and **prohibited substitutions** of **complex type definitions** shall be ignored.

8.8 The property **process contents** of **wildcards** shall be ignored.

NOTE – There is no support in ASN.1 for any action other than **skip**.

8.9 The properties **fundamental facets** and **final** of **simple type definitions** shall be ignored.

8.10 All **value constraints** that are present on any **element declarations** or **attribute declarations** whose **type definition** is either **xsd:QName** or a **simple type definition** derived from **xsd:QName** or **xsd:NOTATION** shall be ignored.

8.11 All **attribute group definitions** shall be ignored.

NOTE – The **attribute uses** in an **attribute group definition** become part of the **attribute uses** of the **complex type definitions** whose XML representation contains a reference to the **attribute group definition**.

9 ASN.1 modules

9.1 The mapping of an XSD Schema generates one or more ASN.1 modules (see 7.3).

9.2 The ASN.1 "ModuleIdentifier" (see Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 13) to be generated by the mapping is not standardized. Where **IMPORTS** statements are used, the ASN.1 module names and module identifiers in the **IMPORTS** statements shall be those generated for the ASN.1 modules generated by the mapping.

NOTE – The choice of "ModuleIdentifier" does not affect the encodings in any of the standard encoding rules.

9.3 The ASN.1 modules shall have a "TagDefault" of **AUTOMATIC TAGS**.

9.4 In each ASN.1 module generated by a version 1 mapping, there shall be an ASN.1 **IMPORTS** statement importing the ASN.1 type reference names in the module named **XSD {joint-iso-itu-t asn1(1) specification(0) modules(0) xsd-module(2) version1(1)}** specified in Annex A that are referenced in the ASN.1 module.

9.5 In each ASN.1 module generated by a Version 2 mapping, there shall be an ASN.1 **IMPORTS** statement importing the ASN.1 type reference names in the module named **XSD {joint-iso-itu-t asn1(1) specification(0) modules(0) xsd-module(2) version2(2)}** specified in Annex B that are referenced in the generated ASN.1 module.

NOTE – The term "XSD module" in this Recommendation | International Standard refers to the module defined in Annex A (version 1 mapping) or in Annex B (version 2 mapping), according to the version of the mapping.

9.6 The **IMPORTS** statement shall also import the ASN.1 type reference names of type assignments that have been placed (as a result of the mapping) in other ASN.1 modules but are referenced in this ASN.1 module.

9.7 There shall be no **EXPORTS** statement.

NOTE – This means that all ASN.1 type reference names in the ASN.1 module can be imported into other modules.

10 Name conversion

10.1 General

10.1.1 This Recommendation | International Standard specifies the generation of:

- ASN.1 type reference names corresponding to the **names** of **model group definitions**, top-level **element declarations**, top-level **attribute declarations**, top-level **complex type definitions**, and top-level **simple type definitions**;
- ASN.1 identifiers corresponding to the **names** of top-level **element declarations**, top-level **attribute declarations**, local **element declarations**, and local **attribute declarations**;