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**Information technology — ASN.1  
encoding rules: Specification of Packed  
Encoding Rules (PER)**

*Technologies de l'information — Règles de codage ASN.1:  
Spécification des règles de codage compact (PER)*

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## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

This fifth edition cancels and replaces the fourth edition of ISO/IEC 8825-2:2008 which has been technically revised. It also incorporates ISO/IEC 8825-2:2008/Cor.1:2012, ISO/IEC 8825-5:2008/Cor.2:2012, ISO/IEC 8825-2:2008/Cor.3:2015 and ISO/IEC 8825-2:2008/Cor.4:2015.

ISO/IEC 8825-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in collaboration with ITU-T. The identical text is published as ITU-T X.691 (08/2015).

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International Telecommunication Union

**ITU-T**

TELECOMMUNICATION  
STANDARDIZATION SECTOR  
OF ITU

**X.691**

(08/2015)

SERIES X: DATA NETWORKS, OPEN SYSTEM  
COMMUNICATIONS AND SECURITY

OSI networking and system aspects – Abstract Syntax  
Notation One (ASN.1)

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**Information technology – ASN.1 encoding rules:  
Specification of Packed Encoding Rules (PER)**

Recommendation ITU-T X.691



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*For further details, please refer to the list of ITU-T Recommendations.*

**Information technology – ASN.1 encoding rules:  
Specification of Packed Encoding Rules (PER)**

## Summary

Recommendation ITU-T X.691 | ISO/IEC 8825-2 describes a set of encoding rules that can be applied to values of all ASN.1 types to achieve a much more compact representation than that achieved by the Basic Encoding Rules and its derivatives (described in Rec. ITU-T X.690 | ISO/IEC 8825-1).

## History

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2.2	ITU-T X.691 (1997) Amd. 1	1999-06-18	7	<a href="http://11.1002/1000/4706">11.1002/1000/4706</a>
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2.4	ITU-T X.691 (1997) Technical Cor. 3	2001-03-15	7	<a href="http://11.1002/1000/5338">11.1002/1000/5338</a>
3.0	ITU-T X.691	2002-07-14	17	<a href="http://11.1002/1000/6090">11.1002/1000/6090</a>
3.1	ITU-T X.691 (2002) Amd. 1	2003-10-29	17	<a href="http://11.1002/1000/7022">11.1002/1000/7022</a>
3.2	ITU-T X.691 (2002) Technical Cor. 1	2005-05-14	17	<a href="http://11.1002/1000/8513">11.1002/1000/8513</a>
3.3	ITU-T X.691 (2002) Technical Cor. 2	2005-11-29	17	<a href="http://11.1002/1000/8638">11.1002/1000/8638</a>
3.4	ITU-T X.691 (2002) Amd. 2	2006-06-13	17	<a href="http://11.1002/1000/8839">11.1002/1000/8839</a>
3.5	ITU-T X.691 (2002) Amd. 3	2007-05-29	17	<a href="http://11.1002/1000/9109">11.1002/1000/9109</a>
4.0	ITU-T X.691	2008-11-13	17	<a href="http://11.1002/1000/9609">11.1002/1000/9609</a>
4.1	ITU-T X.691 (2008) Cor. 1	2011-10-14	17	<a href="http://11.1002/1000/11379">11.1002/1000/11379</a>
4.2	ITU-T X.691 (2008) Cor. 2	2012-04-13	17	<a href="http://11.1002/1000/11585">11.1002/1000/11585</a>
4.3	ITU-T X.691 (2008) Cor. 3	2014-11-13	17	<a href="http://11.1002/1000/12337">11.1002/1000/12337</a>
4.4	ITU-T X.691 (2008) Cor. 4	2014-11-13	17	<a href="http://11.1002/1000/12339">11.1002/1000/12339</a>
5.0	ITU-T X.691	2015-08-13	17	<a href="http://11.1002/1000/12484">11.1002/1000/12484</a>

\* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

## FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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## Introduction

Specifications 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 types defined using the notation specified in Rec. ITU-T X.680 | ISO/IEC 8824-1. 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 are more than one set of encoding rules that can be applied to values of ASN.1 types. This Recommendation | International Standard defines a set of Packed Encoding Rules (PER), so called because they achieve a much more compact representation than that achieved by the Basic Encoding Rules (BER) and its derivatives described in Rec. ITU-T X.690 | ISO/IEC 8825-1 which is referenced for some parts of the specification of these Packed Encoding Rules.

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INTERNATIONAL STANDARD  
ITU-T RECOMMENDATION

# Information technology – ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)

## 1 Scope

This Recommendation | International Standard specifies a set of Packed Encoding Rules that may be used to derive a transfer syntax for values of types defined in Rec. ITU-T X.680 | ISO/IEC 8824-1. These Packed Encoding Rules are also to be applied for decoding such a transfer syntax in order to identify the data values being transferred.

The encoding rules specified in this Recommendation | International Standard:

- are used at the time of communication;
- are intended for use in circumstances where minimizing the size of the representation of values is the major concern in the choice of encoding rules;
- allow the extension of an abstract syntax by addition of extra values, preserving the encodings of the existing values, for all forms of extension described in Rec. ITU-T X.680 | ISO/IEC 8824-1;
- can be modified in accordance with the provisions of Rec. ITU-T X.695 | ISO/IEC 8825-6.

## 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. It cannot be applied using later versions of this standard.

### 2.1 Identical Recommendations | International Standards

- Recommendation ITU-T X.680 (2015) | ISO/IEC 8824-1:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation.*
- Recommendation ITU-T X.681 (2015) | ISO/IEC 8824-2:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification.*
- Recommendation ITU-T X.682 (2015) | ISO/IEC 8824-3:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification.*
- Recommendation ITU-T X.683 (2015) | ISO/IEC 8824-4:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications.*
- Recommendation ITU-T X.690 (2015) | ISO/IEC 8825-1:2015, *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.695 (2015) | ISO/IEC 8825-6:2015, *Information technology – ASN.1 encoding rules: Registration and application of PER encoding instructions.*

### 2.2 Additional references

- ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange.*
- ISO/IEC 2022:1994, *Information technology – Character code structure and extension techniques.*

## ISO/IEC 8825-2: 2015 (E)

- ISO/IEC 2375:2003, *Information technology – Procedure for registration of escape sequences and coded character sets*.
- ISO 6093:1985, *Information processing – Representation of numerical values in character strings for information interchange*.
- *ISO International Register of Coded Character Sets to be Used with Escape Sequences*.
- ISO/IEC 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS)*.

### 3 Definitions

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

#### 3.1 Specification of Basic Notation

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

#### 3.2 Information Object Specification

For the purposes of this Recommendation | International Standard, all the definitions in Rec. ITU-T X.681 | ISO/IEC 8824-2 apply.

#### 3.3 Constraint Specification

This Recommendation | International Standard makes use of the following terms defined in Rec. ITU-T X.682 | ISO/IEC 8824-3:

- a) component relation constraint;
- b) table constraint.

#### 3.4 Parameterization of ASN.1 Specification

This Recommendation | International Standard makes use of the following term defined in Rec. ITU-T X.683 | ISO/IEC 8824-4:

- variable constraint.

#### 3.5 Basic Encoding Rules

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

- a) dynamic conformance;
- b) static conformance;
- c) data value;
- d) encoding (of a data value);
- e) sender;
- f) receiver.

#### 3.6 PER Encoding Instructions

This Recommendation | International Standard makes use of the following term defined in Rec. ITU-T X.695 | ISO/IEC 8825-6:

- identifying keyword.

#### 3.7 Additional definitions

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

**3.7.1 2's-complement-binary-integer encoding:** The encoding of a whole number into a bit-field (octet-aligned in the ALIGNED variant) of a specified length, or into the minimum number of octets that will accommodate that whole

number encoded as a 2's-complement-integer, which provides representations for whole numbers that are equal to, greater than, or less than zero, as specified in 11.4.

NOTE 1 – The value of a two's complement binary number is derived by numbering the bits in the contents octets, starting with bit 1 of the last octet as bit zero and ending the numbering with bit 8 of the first octet. Each bit is assigned a numerical value of  $2^N$ , where N is its position in the above numbering sequence. The value of the two's complement binary number is obtained by summing the numerical values assigned to each bit for those bits which are set to one, excluding bit 8 of the first octet, and then reducing this value by the numerical value assigned to bit 8 of the first octet if that bit is set to one.

NOTE 2 – *Whole number* is a synonym for the mathematical term *integer*. It is used here to avoid confusion with the ASN.1 type *integer*.

**3.7.2 abstract syntax value:** A value of an abstract syntax (defined as the set of values of a single ASN.1 type), which is to be encoded by PER, or which is to be generated by PER decoding.

NOTE – The single ASN.1 type associated with an abstract syntax is formally identified by an object of class **ABSTRACT-SYNTAX**.

**3.7.3 bit-field:** The product of some part of the encoding mechanism that consists of an ordered set of bits that are not necessarily a multiple of eight.

NOTE – If the use of this term is followed by "octet-aligned in the ALIGNED variant", this means that the bit-field is required to begin on an octet boundary in the complete encoding for the aligned variant of PER.

**3.7.4 canonical encoding:** A complete encoding of an abstract syntax 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 bitstrings in the transfer syntax and values in the abstract syntax.

**3.7.5 composite type:** A set, sequence, set-of, sequence-of, choice, embedded-pdv, external or unrestricted character string type.

**3.7.6 composite value:** The value of a composite type.

**3.7.7 constrained whole number:** A whole number which is constrained by PER-visible constraints to lie within a range from "lb" to "ub" with the value "lb" less than or equal to "ub", and the values of "lb" and "ub" as permitted values.

NOTE – Constrained whole numbers occur in the encoding which identifies the chosen alternative of a choice type, the length of character, octet and bit string types whose length has been restricted by PER-visible constraints to a maximum length, the count of the number of components in a sequence-of or set-of type that has been restricted by PER-visible constraints to a maximum number of components, the value of an integer type that has been constrained by PER-visible constraints to lie within finite minimum and maximum values, and the value that denotes an enumeration in an enumerated type.

**3.7.8 effective size constraint (for a constrained string type):** A single finite size constraint that could be applied to a built-in string type and whose effect would be to permit all and only those lengths that can be present in the constrained string type.

NOTE 1 – For example, the following has an effective size constraint:

```
A ::= IA5String (SIZE(1..4) | SIZE(10..15))
```

since it can be rewritten with a single size constraint that applies to all values:

```
A ::= IA5String (SIZE(1..4 | 10..15))
```

whereas the following has no effective size constraint since the string can be arbitrarily long if it does not contain any characters other than 'a', 'b' and 'c':

```
B ::= IA5String (SIZE(1..4) | FROM("abc"))
```

NOTE 2 – The effective size constraint is used only to determine the encoding of lengths.

**3.7.9 effective permitted-alphabet constraint (for a constrained restricted character string type):** A single permitted-alphabet constraint that could be applied to a built-in known-multiplier character string type and whose effect would be to permit all and only those characters that can be present in at least one character position of any one of the values in the constrained restricted character string type.

NOTE 1 – For example, in:

```
Ax ::= IA5String (FROM("AB") | FROM("CD"))
```

```
Bx ::= IA5String (SIZE(1..4) | FROM("abc"))
```

**Ax** has an effective permitted-alphabet constraint of "ABCD". **Bx** has an effective permitted-alphabet constraint that consists of the entire **IA5String** alphabet since there is no smaller permitted-alphabet constraint that applies to all values of **Bx**.

NOTE 2 – The effective permitted-alphabet constraint is used only to determine the encoding of characters.

**3.7.10 enumeration index:** The non-negative whole number associated with an "EnumerationItem" in an enumerated type. The enumeration indices are determined by sorting the "EnumerationItem"s into ascending order by their enumeration value, then by assigning an enumeration index starting with zero for the first "EnumerationItem", one for the second, and so on up to the last "EnumerationItem" in the sorted list.

NOTE – "EnumerationItem"s in the "RootEnumeration" are sorted separately from those in the "AdditionalEnumeration".