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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 condensées (PER)

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Contents

		Page
1	Scope	1
2	Normative references	1
	2.1 Identical Recommendations I International Standards	1
	2.2 Additional references	2
3	Definitions	2
	3.1 Basic Presentation Service Definition	2
	3.2 Specification of Basic Notation	2
	3.3 ASN.1 Extensibility	2
	3.4 Information Object Specification	2
	3.5 Constraint Specification	2
	3.6 Parameterization of ASN.1 Specification	3
	3.7 Basic Encoding Rules	3
	3.8 Additional definitions	3
4	Abbreviations	5
5	Notation	5
6	Convention	6
7	Encoding rules defined in this Recommendation I International Standard	6
8	Conformance	7
9	The approach to encoding used for PER	7
	9.1 Use of the type notation	7
	9.2 Use of tags to provide a canonical order	7
	9.3 PER-visible constraints	7
	9.4 Type and value model used for encoding	8
	9.5 Structure of an encoding	9
	9.6 Types to be encoded	9
10	Encoding procedures	10
	10.1 Production of the complete encoding	10
	10.2 Open type fields	10
	10.3 Encoding as a non-negative-binary-integer	10
	10.4 Encoding as a 2's-complement-binary-integer	11
	10.5 Encoding of a constrained whole number	11
	10.6 Encoding of a normally small non-negative whole number	12
	10.7 Encoding of a semi-constrained whole number	12
	10.8 Encoding of an unconstrained whole number	13
	10.9 General rules for encoding a length determinant	13
11	Encoding the boolean type	15
12	Encoding the integer type	16
13	Encoding the enumerated type	16

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Document Sharing Hub

Full document details: ISO_IEC 8825-2_1996

14 Encoding the real type 17
15 Encoding the bitstring type 17
16 Encoding the octetstring type 18
17 Encoding the null type 19
18 Encoding the sequence type 19
19 Encoding the sequence-of type 19
20 Encoding the set type 20
21 Encoding the set-of type 21
22 Encoding the choice type 21
23 Encoding the object identifier type 21
24 Encoding the embedded-pdv type 22
25 Encoding of a value of the external type 23
26 Encoding the restricted character string types 24
27 Encoding the unrestricted character string type 25
28 Object identifiers for transfer syntaxes 27
Annex A – Example of encodings 28
A.1 Record that does not use subtype constraints 28
A.2 Record that uses subtype constraints 31
A.3 Record that uses extension markers 34
Annex B – Observations on combining PER-visible constraints 38
Annex C – Support for the PER algorithms 39
Annex D – Support for the ASN.1 rules of extensibility 40
Annex E – Tutorial annex on concatenation of PER encodings 41
Annex F – Assignment of object identifier values 42

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-2_1996

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. 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.

International Standard ISO/IEC 8825-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 21, *Open Systems interconnection, data management and open distributed processing,* in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.691.

ISO/IEC 8825-2 consists of the following parts, under the general title *Information technology — ASN.1 encoding rules*:

— *Part 1: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

— *Part 2: Specification of Packed Encoding Rules (PER)*

Annexes A to F of this part of ISO/IEC 8825 are for information only.

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Introduction

The publications ITU-T Rec. X.680 | ISO/IEC 8824-1, ITU-T Rec. X.681 | ISO/IEC 8824-2, ITU-T Rec. X.682 | ISO/IEC 8824-3, ITU-T Rec. X.683 | ISO/IEC 8824-4, ITU-T Rec. X.680/Amd. 1 | ISO/IEC 8824-1/Amd. 1, ITU-T Rec. X.681/Amd. 1 | ISO/IEC 8824-2/Amd. 1 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 ITU-T Rec. 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 more compact representation than that achieved by the Basic Encoding Rules (BER) and its derivatives described in ITU-T Rec. X.690 | ISO/IEC 8825-1 which is referenced for some parts of the specification of these Packed Encoding Rules.

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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 ITU-T Rec. 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 ITU-T Rec. X.680/Amd. 1 | ISO/IEC 8824-1/Amd. 1.

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 editions of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunications Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

- ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.*
- ITU-T Recommendation X.216 (1994) | ISO/IEC 8822:1994, *Information technology – Open Systems Interconnection – Presentation service definition.*
- ITU-T Recommendation X.226 (1994) | ISO/IEC 8823-1:1994, *Information technology – Open Systems Interconnection – Connection-oriented presentation protocol: Protocol specification.*
- ITU-T Recommendation X.680 (1994) | ISO/IEC 8824-1:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation.*
- ITU-T Recommendation X.680 (1994)/Amd. 1 (1995) | ISO/IEC 8824-1:1995/Amd. 1:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation – Amendment 1: Rules of extensibility.*
- ITU-T Recommendation X.681 (1994) | ISO/IEC 8824-2:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification.*
- ITU-T Recommendation X.681 (1994)/Amd. 1 (1995) | ISO/IEC 8824-2:1995/Amd. 1:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification – Amendment 1: Rules of extensibility.*
- ITU-T Recommendation X.682 (1994) | ISO/IEC 8824-3:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification.*

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Full document details: ISO_IEC 8825-2_1996

- ITU-T Recommendation X.683 (1994) | ISO/IEC 8824-4:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications.*
- ITU-T Recommendation X.690 (1994) | ISO/IEC 8825-1:1995, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER).*

2.2 Additional references

- CCITT Rec. X.208 (1988), *Specification of Abstract Syntax Notation One (ASN.1).*
- ISO/IEC 2022:1994, *Information technology – Character code structure and extension techniques.*
- ISO 2375:1985, *Data processing – Procedure for registration of escape sequences.*
- ISO 6093:1985, *Information processing – Representation of numerical values in character strings for information interchange.*
- ISO/IEC 8824:1990, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1).*
- *ISO International Register of Coded Character Sets to be Used with Escape Sequences.*
- ISO/IEC 10646-1:1993, *Information technology – Universal Multiple-Octet Coded Character Set (UCS) – Part 1: Architecture and Basic Multilingual Plane.*

3 Definitions

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

3.1 Basic Presentation Service Definition

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.216 | ISO/IEC 8822:

a) defined context set;

b) presentation context identifier.

3.2 Specification of Basic Notation

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

3.3 ASN.1 Extensibility

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.680/Amd. 1 | ISO/IEC 8824-1/Amd. 1:

a) extension marker;

b) extension series;

c) extension root;

d) extension addition.

3.4 Information Object Specification

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

3.5 Constraint Specification

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

a) component relation constraint;

b) table constraint.

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3.6 Parameterization of ASN.1 Specification

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

– variable constraint.

3.7 Basic Encoding Rules

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. 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.

3.8 Additional definitions

In addition, the following definitions apply.

3.8.1 2's-complement-binary-integer encoding: The encoding of a whole number into an octet-aligned-bit-field 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 10.4.

NOTES

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.

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

3.8.2 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.

3.8.3 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, and do not necessarily begin on an octet boundary in the complete encoding of the abstract syntax value.

3.8.4 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.

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

3.8.6 composite value: The value of a composite type.

3.8.7 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.

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3.8.8 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 – 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"))

3.8.9 effective PermittedAlphabet constraint (for a constrained restricted character string type): A single PermittedAlphabet 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 any character position of any of the values in the constrained restricted character string type.

NOTE – An effective PermittedAlphabet constraint is either the entire alphabet of the unconstrained character string type or a PermittedAlphabet specification that happens to be a superset of all PermittedAlphabet constraints imposed on the type. For example, in

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

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

"Ax" has an effective PermittedAlphabet constraints that consist of the entire IA5String alphabet since there is no PermittedAlphabet constraint that applies to all values of "Ax". The same is true for "Bx". On the other hand, the following has an effective PermittedAlphabet constraint of "ABCDE" since there is a PermittedAlphabet constraint specified that applies to all values:

A ::= IA5String (FROM("AB") | FROM("CD") | FROM("ABCDE"))

3.8.10 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".

3.8.11 extensible for PER encoding: A property of a type whose definition contains an extension marker that affects the PER encoding.

3.8.12 field-list: An ordered set of bit-field and/or octet-aligned-bit-field values that is produced as a result of applying these encoding rules to components of a value.

NOTE – (Tutorial) The model employed in this Recommendation | International Standard uses the term "field-list" to indicate a linked list of buffers each containing an encoding, a length in bits, and an octet alignment indicator of "bit-field" or "octet-aligned-bit-field". Each encoding is that of a value of an ASN.1 type. The octet alignment indicator says whether the encoding is to be aligned on an octet boundary when used to form the complete encoding of the abstract syntax value, or if it should be added immediately after the last bit of the previous encoding in the complete encoding. The notion of "field-list" is for descriptive purposes only and does not suggest an implementation method.

3.8.13 indefinite-length: An encoding whose length is greater than 64K-1 or whose maximum length cannot be determined from the ASN.1 notation.

3.8.14 fixed-length type: A type such that the value of the outermost length determinant in an encoding of this type can be determined (using the mechanisms specified in this Recommendation | International Standard) from the type notation (after the application of PER-visible constraints only) and is the same for all possible values of the type.

3.8.15 fixed value: A value such that it can be determined (using the mechanisms specified in this Recommendation | International Standard) that this is the only permitted value (after the application of PER-visible constraints only) of the type governing it.

3.8.16 known-multiplier character string type: A restricted character string type where the number of octets in the encoding is a known fixed multiple of the number of characters in the character string for all permitted character string values. The known-multiplier character string types are IA5String, PrintableString, VisibleString, NumericString, UniversalString and BMPString.

3.8.17 length determinant: A count (of bits, octets, characters, or components) determining the length of part or all of a PER encoding.

3.8.18 normally small non-negative whole number: A part of an encoding which represents values of an unbounded non-negative integer, but where small values are more likely to occur than large ones.

3.8.19 normally small length: A length encoding which represents values of an unbounded length, but where small lengths are more likely to occur than large ones.

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3.8.20 octet-aligned-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, but which are required to begin on an octet boundary in the complete encoding of the abstract syntax value.

3.8.21 non-negative-binary-integer encoding: The encoding of a constrained or semi-constrained whole number into either a bit-field of a specified length, or into an octet-aligned-bit-field of a specified length, or into the minimum number of octets that will accommodate that whole number encoded as a non-negative-binary-integer which provides representations for whole numbers greater than or equal to zero, as specified in 10.3.

NOTE – 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.

3.8.22 PER-visible constraint: An instance of use of the ASN.1 constraint notation which affects the PER encoding of a value.

3.8.23 relay-safe encoding: A complete encoding of an abstract syntax value which can be decoded (including any embedded encodings) without knowledge of the presentation layer defined context set that formed the environment in which the encoding was performed.

3.8.24 semi-constrained whole number: A whole number which is constrained by PER-visible constraints to exceed or equal some value "lb" with the value "lb" as a permitted value, and which is not a constrained whole number.

NOTE – Semi-constrained whole numbers occur in the encoding of the length of unconstrained (and in some cases constrained) character, octet and bit string types, the count of the number of components in unconstrained (and in some cases constrained) sequence-of and set-of types, and the value of an integer type that has been constrained to exceed some minimum value.

3.8.25 simple type: A type that is not a composite type.

3.8.26 textually dependent: A term used to identify the case where if some reference name is used in evaluating an element set, the value of the element set is considered to be dependent on that reference name, regardless of whether the actual set arithmetic being performed is such that the final value of the element set is independent of the actual element set value assigned to the reference name.

NOTE – For example, the following definition of "Foo" is textually dependent on "Bar" even though "Bar" has no effect on "Foo"s set of values (thus, according to 9.3.4 the constraint on "Foo" is not PER-visible since "Bar" is constrained by a table constraint and "Foo" is textually dependent on "Bar").

```
MY-CLASS ::= CLASS { &name PrintableString, &age INTEGER } WITH SYNTAX{&name , &age}
MyObjectSet MY-CLASS ::= { {"Jack", 7} | {"Jill", 5} }
Bar ::= MY-CLASS.&age ({MyObjectSet})
Foo ::= INTEGER (Bar | 1..100)
```

3.8.27 unconstrained whole number: A whole number which is not constrained by PER-visible constraints.

NOTE – Unconstrained whole numbers occur only in the encoding of a value of the integer type.

4 Abbreviations

ASN.1	Abstract Syntax Notation One
BER	Basic Encoding Rules of ASN.1
PER	Packed Encoding Rules of ASN.1
CER	Canonical Encoding Rules of ASN.1
16K	16384
32K	32768
48K	49152
64K	65536

5 Notation

This Recommendation | International Standard references the notation defined by ITU-T Rec. X.680 | ISO/IEC 8824-1.

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6 Convention

6.1 This Recommendation | International Standard defines the value of each octet in an encoding by use of the terms "most significant bit" and "least significant bit".

NOTE – Lower layer specifications use the same notation to define the order of bit transmission on a serial line, or the assignment of bits to parallel channels.

6.2 For the purpose of this Recommendation | International Standard, the bits of an octet are numbered from 8 to 1, where bit 8 is the "most significant bit" and bit 1 the "least significant bit".

6.3 The term "octet" is frequently used in this Recommendation | International Standard to stand for "eight bits". The use of this term in place of "eight bits" does not carry any implications of alignment. Where alignment is intended it is explicitly stated in this Recommendation | International Standard.

7 Encoding rules defined in this Recommendation | International Standard

7.1 This Recommendation | International Standard specifies four encoding rules (together with their associated object identifiers) which can be used to encode and decode the values of an abstract syntax defined as the values of a single (known) ASN.1 type. This clause describes their applicability and properties.

7.2 Without knowledge of the type of the value encoded, it is not possible to determine the structure of the encoding (under any of the PER encoding rule algorithms). In particular, the end of the encoding cannot be determined from the encoding itself without knowledge of the type being encoded.

7.3 PER encodings are always relay-safe provided the abstract values of the types EXTERNAL, EMBEDDED PDV and CHARACTER STRING are constrained to prevent the carriage of presentation context identifiers.

7.4 The most general encoding rule algorithm specified in this Recommendation | International Standard is BASIC-PER, which does not in general produce a canonical encoding.

7.5 A second encoding rule algorithm specified in this Recommendation | International Standard is CANONICAL-PER, which produces encodings that are canonical. This is defined as a restriction of implementation-dependent choices in the BASIC-PER encoding. CANONICAL-PER produces canonical encodings that have applications when authenticators need to be applied to abstract values, as described in ITU-T Rec. X.690 | ISO/IEC 8825-1, Annex D.

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

7.6 If a type encoded with BASIC-PER or CANONICAL-PER contains EMBEDDED PDV, CHARACTER STRING or EXTERNAL types, then the outer encoding ceases to be relay-safe unless the transfer syntax used for all the EMBEDDED PDV, CHARACTER STRING and EXTERNAL types is relay safe. If a type encoded with BASIC-PER or CANONICAL-PER contains EMBEDDED PDV, EXTERNAL or CHARACTER STRING types, then the outer encoding ceases to be canonical unless the transfer syntax used for all the EMBEDDED PDV, EXTERNAL and CHARACTER STRING types is canonical.

NOTE – The character transfer syntaxes supporting all character abstract syntaxes of the form {iso standard 10646 level-1 (1) ....} are canonical. Those supporting {iso standard 10646 level-2 (2) ....} and {iso standard 10646 level-3 (3) ....} are not always canonical. All the above character transfer syntaxes are relay-safe.

7.7 Both BASIC-PER and CANONICAL-PER come in two variants, the ALIGNED variant, and the UNALIGNED variant. In the ALIGNED variant, padding bits are inserted from time to time to restore octet alignment. In the UNALIGNED variant, no padding bits are ever inserted.

7.8 There are no interworking possibilities between the ALIGNED variant and the UNALIGNED variant.

7.9 PER encodings are self-delimiting only with knowledge of the type of the encoded value. Encodings are always a multiple of eight bits. When carried in an EXTERNAL type they shall be carried in the OCTET STRING choice alternative, unless the EXTERNAL type itself is encoded in PER, in which case the value may be encoded as a single ASN.1 type (i.e. an open type). When carried in OSI presentation protocol, the "full encoding" (as defined in ITU-T Rec. X.226 | ISO/IEC 8823-1) with the OCTET STRING choice alternative shall be used.

7.10 The rules of this Recommendation | International Standard apply to both algorithms and to both variants unless otherwise stated.

7.11 Annex C is informative, and gives recommendations on which combinations of PER to implement in order to maximize the chances of interworking.

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8 Conformance

8.1 Dynamic conformance is specified by clause 9 onwards.

8.2 Static conformance is specified by those standards which specify the application of these Packed Encoding Rules.

NOTE – Annex C of this Recommendation | International Standard provides guidance on static conformance in relation to support for the two variants of the two encoding rule algorithms. This guidance is designed to ensure interworking, while recognizing the benefits to some applications of encodings that are neither relay-safe nor canonical.

8.3 The rules in this Recommendation | International Standard are specified in terms of an encoding procedure. Implementations are not required to mirror the procedure specified, provided the bit string produced as the complete encoding of an abstract syntax value is identical to one of those specified in this Recommendation | International Standard for the applicable transfer syntax.

8.4 Implementations performing decoding are required to produce the abstract syntax value corresponding to any received bit string which could be produced by a sender conforming to the encoding rules identified in the transfer syntax associated with the material being decoded.

NOTES

1 In general there are no alternative encodings defined for the BASIC-PER explicitly stated in this Recommendation | International Standard. The BASIC-PER becomes canonical by specifying relay-safe operation and by restricting some of the encoding options of other ISO/IEC Standards that are referenced. CANONICAL-PER provides an alternative to both the Distinguished Encoding Rules and Canonical Encoding Rules (see ITU-T Rec. X.690 | ISO/IEC 8825-1) where a canonical and relay-safe encoding is required.

2 When CANONICAL-PER is used to provide a canonical encoding, it is recommended that any resulting encrypted hash value that is derived from it should have associated with it an algorithm identifier that identifies CANONICAL-PER as the transformation from the abstract syntax value to an initial bitstring (which is then hashed).

9 The approach to encoding used for PER

9.1 Use of the type notation

9.1.1 These encoding rules make specific use of the ASN.1 type notation as specified in ITU-T Rec. X.680 | ISO/IEC 8824-1, and can only be applied to encode the values of a single ASN.1 type specified using that notation.

9.1.2 In particular, but not exclusively, they are dependent on the following information being retained in the ASN.1 type and value model underlying the use of the notation:

a) the nesting of choice types within choice types;

b) the tags placed on the components in a set type, and on the alternatives in a choice type, and the values given to an enumeration;

c) whether a set or sequence type component is optional or not;

d) whether a set or sequence type component has a DEFAULT value or not;

e) the restricted range of values of a type which arise through the application of PER-visible constraints (only);

f) whether a component is an open type;

g) whether an extension marker is present.

9.2 Use of tags to provide a canonical order

This Recommendation | International Standard requires components of a set type and a choice type to be canonically ordered independent of the textual ordering of the components. The canonical order is determined by sorting the tags of the components, as specified in 6.4 of ITU-T Rec. X.680 | ISO/IEC 8824-1.

9.3 PER-visible constraints

NOTE – The fact that some ASN.1 constraints may not be PER-visible for the purposes of encoding and decoding does not in any way affect the use of such constraints in the handling of errors detected during decoding, nor does it imply that values violating such constraints are allowed to be transmitted by a conforming sender.

9.3.1 Constraints that are expressed in human-readable text or in ASN.1 comment are not PER-visible.

9.3.2 Variable constraints are not PER-visible (see 10.4 and 10.5 of ITU-T Rec. X.683 | ISO/IEC 8824-4).

9.3.3 Table constraints are not PER-visible (see ITU-T Rec. X.682 | ISO/IEC 8824-3).

Documents
Document Sharing Hub
Full document details: ISO_IEC 8825-2_1996

9.3.4 Constraints whose evaluation is textually dependent on a table constraint or a component relation constraint are not PER-visible (see ITU-T Rec. X.682 | ISO/IEC 8824-3).

9.3.5 Component relation constraints are not PER-visible (see ITU-T Rec. X.682 | ISO/IEC 8824-3).

9.3.6 Constraints on restricted character string types which are not (see clause 34 of ITU-T Rec. X.680 | ISO/IEC 8824-1) known-multiplier character string types are not PER-visible (see 3.8.16).

9.3.7 Subject to the above, all size constraints are PER-visible.

9.3.8 The effective size constraint for a constrained type is a single size constraint such that a size is permitted if and only if there is some value of the constrained type that has that (permitted) size. If the constrained type has values of a size that does not satisfy the constraint there is no effective size constraint.

9.3.9 PermittedAlphabet constraints on known-multiplier character string types are PER-visible.

9.3.10 The effective PermittedAlphabet constraint for a constrained type is a single PermittedAlphabet constraint such that a character is allowed if and only if there is some value of the constrained type that contains that character. If all characters of the type being constrained can be present in some value of the constrained type, then the effective PermittedAlphabet constraint is the set of characters defined for the unconstrained type.

NOTES

1 In the definition of a constrained type, multiple PER-visible constraints may be applied either directly or through the use of "ContainedSubtype"s.

2 See Annex B for observations on the effect of combining constraints that individually are PER-visible.

9.3.11 An inner type constraint applied to a real type is PER-visible.

9.3.12 An inner type constraint applied to an unrestricted character string or embedded-pdv type is PER-visible only when it is used to restrict the value of the "syntaxes" component to a single value, or when it is used to restrict "identification" to the "fixed" alternative (see clauses 24 and 27).

9.3.13 Constraints on the useful types are not PER-visible.

9.3.14 Subject to the above, all other constraints are PER-visible if and only if they are applied to an integer type or, single value constraints excluded, to a known-multiplier character string type.

9.3.15 If a PER-visible constraint other than PermittedAlphabet has an extension marker, then the type is defined to be extensible for PER encodings.

NOTES

1 If an extension marker is present in a ConstraintSpec which is not PER-visible, and there is no other extension marker present in the constraint, then the type is encoded by PER as if it has no extension marker.

2 If there are multiple SizeConstraint specifications applied to a type and one of them is extensible, then the type is encoded in PER as if the extension marker was present on all the SizeConstraint specifications.

9.3.16 A type is also extensible for PER encodings if any of the following occurs:

a) it is derived from an ENUMERATED type (by subtyping, type referencing, or tagging) and there is an extension marker in the "Enumerations" production; or

b) it is derived from a SEQUENCE type (by subtyping, type referencing, or tagging) and there is an extension marker in the "ComponentTypeLists" or in the "SequenceType" productions; or

c) it is derived from a SET type (by subtyping, type referencing, or tagging) and there is an extension marker in the "ComponentTypeLists" or in the "SetType" productions; or

d) it is derived from a CHOICE type (by subtyping, type referencing, or tagging) and there is an extension marker in the "AlternativeTypeLists" production.

9.4 Type and value model used for encoding

9.4.1 An ASN.1 type is either a simple type or is a type built using other types. The notation permits the use of type references and tagging of types. For the purpose of these encoding rules the use of type references and tagging have no effect on the encoding and are invisible in the model, except as stated in 9.2. The notation also permits the application of constraints and of error specifications. PER-visible constraints are present in the model as a restriction of the values of a type. Other constraints and error specifications do not affect encoding and are invisible in the PER type and value model.

9.4.2 A value to be encoded can be considered as either a simple value or as a composite value built using the structuring mechanisms from components which are either simple or composite values, paralleling the structure of the ASN.1 type definition.

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Full document details: ISO_IEC 8825-2_1996

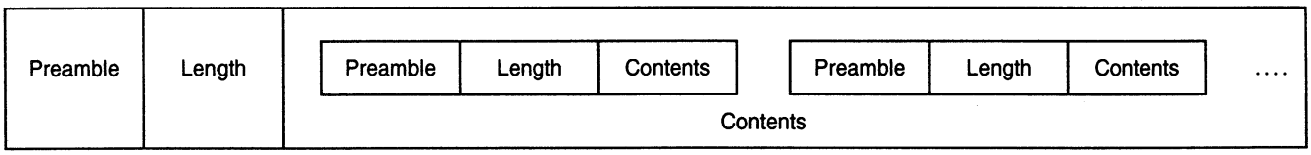
9.5 Structure of an encoding

9.5.1 These encoding rules specify:

a) the encoding of a simple value into a field-list; and

b) the encoding of a composite value into a field-list, using the field-lists generated by application of these encoding rules to the components of the composite value; and

c) the transformation of the field-list of the outermost value into the complete encoding of the abstract syntax value (see 10.1).



NOTE – The preamble, length, and contents are all "fields" which, concatenated together, form a "field-list". The field-list of a composite type other than the choice type may consist of the fields of several values concatenated together. Either the preamble, length and/or contents of any value may be missing.

Figure 1 – Encoding of a composite value into a field-list

9.5.2 The encoding of a component of a data value either:

a) consists of three parts, as shown in Figure 1, which appear in the following order:

1) a preamble (see clauses 18, 20 and 22);

2) a length determinant (see 10.9);

3) contents; or

b) (where the contents are large) consists of an arbitrary number of parts, as shown in Figure 2, of which the first is a preamble (see clauses 18, 20 and 22) and the following parts are pairs of octet-aligned-bit-fields, the first being a length determinant for a fragment of the contents, and the second that fragment of the contents; the last pair of fields is identified by the length determinant part, as specified in 10.9.

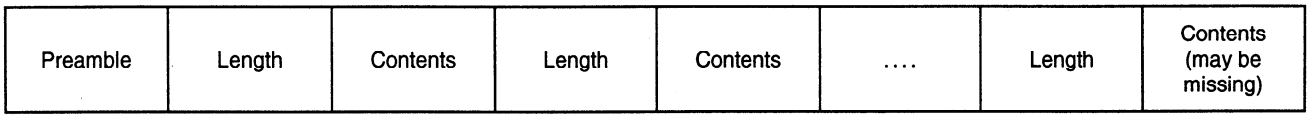


Figure 2 – Encoding of a long data value

9.5.3 Each of the parts mentioned in 9.5.2 generates either:

a) a null field (nothing); or

b) a bit-field; or

c) an octet-aligned-bit-field; or

d) a field-list which may contain either bit-fields, octet-aligned-bit-fields, or both.

9.6 Types to be encoded

9.6.1 The following clauses specify the encoding of the following types into a field-list: boolean, integer, enumerated, real, bitstring, octetstring, null, sequence, sequence-of, set, set-of, choice, open, object identifier, embedded-pdv, external, restricted character string and unrestricted character string types.

9.6.2 The ANY type, defined in CCITT Rec. X.208 (1988) | ISO/IEC 8824:1990, shall be encoded as an open type.

9.6.3 The selection type shall be encoded as an encoding of the selected type.

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Full document details: ISO_IEC 8825-2_1996

9.6.4 Encoding of tagged types is not included in this Recommendation | International Standard as, except as stated in 9.2, tagging is not visible in the type and value model used for these encoding rules. Tagged types are thus encoded according to the encoding of the type which has been tagged.

9.6.5 The following "useful types" of clause 38 of ITU-T Rec. X.680 | ISO/IEC 8824-1 shall be encoded as if they had been replaced by their definitions given in ITU-T Rec. X.680 | ISO/IEC 8824-1:

- generalized time;
- universal time;
- object descriptor.

Constraints on the useful types are not PER-visible.

10 Encoding procedures

10.1 Production of the complete encoding

10.1.1 The field-list produced as a result of applying this Recommendation | International Standard to the outermost value shall be used to produce the complete encoding of the abstract syntax value as follows: each field in the field-list shall be taken in turn and concatenated to the end of the bit string which is to form the complete encoding of the abstract syntax value preceded by additional zero bits for padding as specified below.

10.1.2 In the UNALIGNED variant of these encoding rules, all fields shall be concatenated without padding. If the result of encoding the outermost value is an empty bit string, the bit string shall be replaced with a single octet with all bits set to 0. If it is a non-empty bit string and it is not a multiple of eight bits, (zero to seven) zero bits shall be appended to it to produce a multiple of eight bits.

10.1.3 In the ALIGNED variant of these encoding rules, any bit-fields in the field-list shall be concatenated without padding, and any octet-aligned-bit-fields shall be concatenated after (zero to seven) zero bits have been concatenated to make the length of the encoding produced so far a multiple of eight bits. If the result of encoding the outermost value is an empty bit string, the bit string shall be replaced with a single octet with all bits set to 0. If it is a non-empty bit string and it is not a multiple of eight bits, (zero to seven) zero bits shall be appended to it to produce a multiple of eight bits.

NOTE – The encoding of the outermost value is the empty bit string if, for example, the abstract syntax value is of the null type or of an integer type constrained to a single value.

10.1.4 The resulting bit string is the complete encoding of the abstract syntax value.

10.2 Open type fields

10.2.1 In order to encode an open type field, the value of the actual type occupying the field shall be encoded to a field-list which shall then be converted to a complete encoding of an abstract syntax value as specified in 10.1 to produce an octet string of length "n" (say).

10.2.2 The field-list for the value in which the open type is to be embedded shall then have added to it (as specified in 10.9) an unconstrained length of "n" (in units of octets) and an associated octet-aligned-bit-field containing the bits produced in 10.2.1.

NOTE – Where the number of octets in the open type encoding is large, the fragmentation procedures of 10.9 will be used, and the encoding of the open type will be broken without regard to the position of the fragment boundary in the encoding of the type occupying the open type field.

10.3 Encoding as a non-negative-binary-integer

NOTE – (Tutorial) This subclause gives precision to the term "non-negative-binary-integer encoding", putting the integer into a field which is a fixed number of bits, a field which is a fixed number of octets, or a field that is the minimum number of octets needed to hold it.

10.3.1 Subsequent clauses refer to the generation of a non-negative-binary-integer encoding of a non-negative whole number into either a bit-field of specified length, a single octet, a double octet, or the minimum number of octets for the value. This clause specifies the precise encoding to be applied when such references are made.

10.3.2 The leading bit of the field is defined as the most significant bit of the first octet, and the trailing bit of the field is defined as the least significant bit of the last octet.

10.3.3 For the following definition only, the bits shall be numbered zero for the trailing bit of the field, one for the next bit, and so on up to the leading bit of the field.

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