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Information technology — ASN.1 encoding rules —

Part 7: Specification of Octet Encoding Rules (OER)

Technologies de l'information — Règles de codage ASN.1 — Partie 7: Spécification des règles de codage des octets (OER)

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Foreword

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This document 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.696 (02/2021).

This third edition cancels and replaces the second edition (ISO/IEC 8825-7:2015), which has been technically revised. It also incorporates ISO/IEC 8825-7:2015/Cor 2:2017, ISO/IEC 8825-7:2015/Cor 3:2018, ISO/IEC 8825-7:2015/Cor 4:2018.

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

The publications 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 which have been defined using the notation specified in the above-mentioned publications. 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 two sets of Octet Encoding Rules, so-called because the encoding of every type takes a whole number of octets. Encoding and decoding data with the Octet Encoding Rules is usually faster than encoding and decoding the same data with the Basic Encoding Rules (described in Rec. ITU-T X.690 | ISO/IEC 8825-1) or the Packed Encoding Rules (described in Rec. ITU-T X.691 | ISO/IEC 8825-2).

NOTE – The encoding rules specified in this Recommendation | International Standard derive from the Octet Encoding Rules (OER) published by American Association of State Highway and Transportation Officials (AASHTO), Institute of Transportation Engineers (ITE) and National Electrical Manufacturers Association (NEMA) as NTCIP 1102:2004. In most practical cases, an implementation of this Recommendation | International Standard can interoperate with an implementation of NTCIP 1102.

Clauses 8 to 30 specify the BASIC-OER encoding of ASN.1 types.

Clause 31 specifies the CANONICAL-OER encoding of ASN.1 types.

Annex A is informative and contains examples of BASIC-OER and CANONICAL-OER encodings.

Annex B is informative and addresses the Interoperability of the encoding rules with NTCIP 1102:2004.

INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – ASN.1 encoding rules: Specification of Octet Encoding Rules (OER)

1 Scope

This Recommendation | International Standard specifies a set of Basic Octet Encoding Rules (BASIC-OER) that may be used to derive a transfer syntax for values of the types defined in 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. This Recommendation | International Standard also specifies a set of Canonical Octet Encoding Rules (CANONICAL-OER) which provides constraints on the Basic Octet Encoding Rules and produces a unique encoding for any given ASN.1 value. It is implicit in the specification of these encoding rules that they are also to be 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 encoding/decoding speed 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.

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).*

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

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/IEC 2375:2003, *Information technology – Procedure for registration of escape sequences and coded character sets.*

– *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 (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.

3.6 Packed Encoding Rules (PER)

This Recommendation | International Standard makes use of the following terms defined in Rec. ITU-T X.691 | ISO/IEC 8825-2:

a) canonical encoding;

b) composite type;

c) composite value;

d) known-multiplier character string type;

e) outermost type;

f) relay-safe encoding;

g) simple type;

h) textually dependent.

3.7 Additional definitions

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

3.7.1 abstract syntax value: A value of an abstract syntax (defined as a set of values of a single ASN.1 type) which is to be encoded by BASIC-OER or CANONICAL-OER, or which is generated by BASIC-OER or CANONICAL-OER decoding.

3.7.2 effective value constraint (of an integer type): The smallest integer range that includes all the values of the integer type that are permitted by the OER-visible constraints (see 8.2.7).

3.7.3 effective size constraint (of a string type): The smallest integer range that includes the lengths of all the values of the string type that are permitted by the OER-visible constraints (see 8.2.8).

3.7.4 fixed-size signed number: A word (see 3.7.13) representing a negative, zero or positive whole number encoded as a signed integer encoding (see 3.7.9).

NOTE 1 – The least significant bit of the whole number is stored in bit 1 of the last octet of the word.

NOTE 2 – The range of integers that can be encoded as fixed-size signed numbers is −128 to 127 for a one-octet word, −32768 to 32767 for a two-octet word, −2147483648 to 2147483647 for a four-octet word, and −9223372036854775808 to 9223372036854775807 for an eight-octet word.

3.7.5 fixed-size unsigned number: A word (see 3.7.13) representing a zero or positive whole number encoded as an unsigned integer encoding (see 3.7.10).

NOTE 1 – The least significant bit of the whole number is stored in bit 1 of the last octet of the word.

NOTE 2 – The smallest integer that can be encoded as fixed-size unsigned numbers of any size is 0. The largest integer that can be encoded as a fixed-size unsigned number is 255 for a one-octet word, 65535 for a two-octet word, 4294967295 for a four-octet word, and 18446744073709551615 for an eight-octet word.

3.7.6 length determinant: A group of one or more consecutive octets encoding the length of a series of octets (see 8.6).

3.7.7 octet: A group of eight consecutive bits, numbered from bit 8 (the most significant bit) to bit 1 (the least significant bit).

NOTE – Within an OER encoding, each octet starts at a location that is a whole multiple of eight bits from the first bit of the encoding.

3.7.8 OER-visible constraint: An instance of use of the ASN.1 constraint notation that affects the OER encoding of a value.

3.7.9 signed integer encoding: The encoding of a whole number into a group of consecutive octets of a specified length as a 2's-complement binary integer, which provides representations for whole numbers that are equal to, greater than or less than zero.

NOTE – The value of a signed integer encoding is derived by numbering the bits in the octets of the group, starting with bit 1 of the last octet 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 (starting from 0) in the above numbering sequence. The value of the signed integer encoding 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.

3.7.10 unsigned integer encoding: The encoding of a whole number into a group of consecutive octets of a specified length as an unsigned binary integer, which provides representations for whole numbers that are equal to or greater than zero.

NOTE – The value of an unsigned integer encoding is derived by numbering the bits in the octets of the group, starting with bit 1 of the last octet 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 (starting from 0) in the above numbering sequence. The value of the unsigned integer encoding is obtained by summing the numerical values assigned to each bit for those bits which are set to one.

3.7.11 variable-size signed number: A group of one or more consecutive octets containing a negative, zero, or positive whole number encoded as a signed integer encoding, with the least significant bit of the binary number stored in bit 1 of the last octet of the variable-size signed number.

NOTE – There are no restrictions to the length of such a group of octets. In particular, the Basic Octet Encoding Rules (but not the Canonical Octet Encoding Rules) allow the presence of redundant octets set to 0 (for zero or positive values) or 255 (for negative values) at the beginning of the group.

3.7.12 variable-size unsigned number: A group of one or more consecutive octets containing a zero or positive whole number encoded as an unsigned integer encoding, with the least significant bit of the binary number stored in bit 1 of the last octet of the variable-size unsigned number.

NOTE – There are no restrictions to the length of such a group of octets. In particular, the Basic Octet Encoding Rules (but not the Canonical Octet Encoding Rules) allow the presence of redundant octets set to 0 at the beginning of the group.

3.7.13 word: A group of one, two, four or eight consecutive octets containing the encoding of a whole number, where the first octet contains the most significant part of the number and the last octet contains the least significant part of the number.

NOTE 1 – A single octet is also a word according to this definition. The octet ordering of words consisting of 2, 4 or 8 octets is big-endian.

NOTE 2 – Within an OER encoding, a word can start at any location within the encoding that is a whole number of octets from the beginning of the encoding (that is, there is no requirement that a word should start on a word boundary).

4 Abbreviations

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

ASN.1	Abstract Syntax Notation One
BER	Basic Encoding Rules of ASN.1
ITS	Intelligent Transportation Systems
NTCIP	National Transportation Communications for ITS Protocol
OER	Octet Encoding Rules of ASN.1
PER	Packed Encoding Rules of ASN.1
PDU	Protocol Data Unit

5 Convention

For the purposes 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 is the least significant bit.

6 Encodings specified by this Recommendation | International Standard

6.1 This Recommendation | International Standard specifies two sets of 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.

6.2 Without knowledge of the type of the value encoded, it is not possible to determine the structure of the encoding. In particular, the end of the encoding cannot be determined from the encoding itself without knowledge of the type being encoded.

6.3 OER 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 OSI presentation context identifiers.

6.4 The most general set of encoding rules specified in this Recommendation | International Standard is BASIC-OER, which does not in general produce a canonical encoding.

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

NOTE 1 – CANONICAL-OER produces encodings that have applications when authenticators need to be applied to abstract values.

NOTE 2 – Any implementation conforming to CANONICAL-OER for encoding is conformant to BASIC-OER for encoding. Any implementation conforming to BASIC-OER for decoding is conformant to CANONICAL-OER for decoding. Thus, encodings made according to CANONICAL-OER are encodings that are permitted by BASIC-OER.

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

6.7 OER encodings are self-delimiting only with knowledge of the type of the encoded value. Encodings are always a whole 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 OER, in which case the value may be encoded as a single ASN.1 type (i.e., an open type). When carried in an OSI presentation protocol, the "full encoding" (as defined in Rec. ITU-T X.226 | ISO/IEC 8823-1) with the **OCTET STRING** alternative shall be used.

