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Part 3:
Specification of Encoding Control Notation (ECN)

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

Partie 3: Spécification de la notation de contrôle de codage (ECN)

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Introduction

The Encoding Control Notation (ECN) is a notation for specifying encodings of ASN.1 types that differ from those provided by standardized encoding rules. ECN can be used to encode all types of an ASN.1 specification, but can also be used with standardized encoding rules such as BER or PER (Rec. ITU-T X.690 | ISO/IEC 8825-1 and Rec. ITU-T X.691 | ISO/IEC 8825-2) to specify only the encoding of types that have special requirements.

An ASN.1 type specifies a set of abstract values. Encoding rules specify the representation of these abstract values as a series of bits. ECN is designed to meet the following encoding needs:

a) The need to write ASN.1 types (and get the support of ASN.1 tools in implementations) for established ("legacy") protocols where the encoding is already determined and differs from all standardized encoding rules.

b) The need to produce encodings that are minor variations on standardized rules.

The linkage provided in an ECN specification to an ASN.1 specification is well-defined and machine processable, so encoders and decoders can be automatically generated from the combined specifications. This is a significant factor in reducing both the amount of work and the possibility of errors in making interoperable systems. Another significant advantage is the ability to provide automatic tool support for testing.

These advantages are available with ASN.1 alone when standardized encoding rules suffice, but the ECN work provides these advantages in circumstances where the standardized encoding rules are not sufficient.

NOTE 1 – Currently ECN support only binary-based encodings, but could be extended in the future to cover character-based encodings.

Annex A forms an integral part of this Recommendation | International Standard, and details modifications to be made to Rec. ITU-T X.680 | ISO/IEC 8824-1 to support the notation used in this Recommendation | International Standard.

Annex B forms an integral part of this Recommendation | International Standard, and details modifications to be made to Rec. ITU-T X.681 | ISO/IEC 8824-2 to support the notation used in this Recommendation | International Standard.

Annex C forms an integral part of this Recommendation | International Standard, and details modifications to be made to Rec. ITU-T X.683 | ISO/IEC 8824-4 to support the notation used in this Recommendation | International Standard.

NOTE 2 – It is not intended that Annexes A, B and C be progressed as amendments to the referenced Recommendations | International Standards. The modifications are solely for the purpose of ECN definition (see clause 5 and 9.28).

Annex D does not form an integral part of this Recommendation | International Standard, and contains examples of the use of ECN.

Annex E does not form an integral part of this Recommendation | International Standard and provides more detail on the support for Huffman encodings in ECN.

Annex F does not form an integral part of this Recommendation | International Standard, and identifies a Web site providing access to further information and links relevant to ECN.

Annex G does not form an integral part of this Recommendation | International Standard, and provides a summary of ECN using the notation of clause 5.

INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – ASN.1 encoding rules: Specification of Encoding Control Notation (ECN)

1 Scope

This Recommendation | International Standard defines a notation for specifying encodings of ASN.1 types or of parts of types.

It provides several mechanisms for such specification, including:

- direct specification of the encoding using standardized notation;
- specification of the encoding by reference to standardized encoding rules;
- specification of the encoding of an ASN.1 type by reference to an encoding structure;
- specification of the encoding using non-ECN notation.

It also provides the means to link the specification of encodings to the type definitions to which they are to be applied.

ECN does not currently provide any support for specifications using the OID internationalized resource identifier type or the relative OID internationalized resource identifier type (see Rec. ITU-T X.680 | ISO/IEC 8824-1), and these are not referred to further in this Standard.

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 International 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.660 (2011) | ISO/IEC 9834-1:2012, *Information technology – Open Systems Interconnection – Procedures for the operation of OSI Registration Authorities: General procedures and top arcs of the international object identifier tree*.
- Recommendation ITU-T X.680 (2020) | ISO/IEC 8824-1:2020, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*
- Recommendation ITU-T X.681 (2020) | ISO/IEC 8824-2:2020, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification.*
- Recommendation ITU-T X.682 (2020) | ISO/IEC 8824-3:2020, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification.*
- Recommendation ITU-T X.683 (2020) | ISO/IEC 8824-4:2020, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications.*
- Recommendation ITU-T X.690 (2020) | ISO/IEC 8825-1:2020, *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 (2020) | ISO/IEC 8825-2:2020, *Information technology – ASN.1 encoding rules: Specification of Packed Encoding Rules (PER).*

NOTE 1 – Notwithstanding the ISO publication date, the above specifications are normally referred to as "ASN.1:2020".

NOTE 2 – The above references 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 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS).*

NOTE – The above reference shall be interpreted as a reference to ISO/IEC 10646 together with all its published amendments and technical corrigenda.

3 Definitions

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

3.1 ASN.1 definitions

This Recommendation | International Standard uses the terms defined in clause 3 of 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, Rec. ITU-T X.690 | ISO/IEC 8825-1 and Rec. ITU-T X.691 | ISO/IEC 8825-2.

3.2 ECN-specific definitions

3.2.1 alignment point: The point in an encoding (usually its start) which serves as a reference point when an encoding specification requires alignment to some boundary.

3.2.2 auxiliary field: A field of a replacement structure (that is added in the ECN specification) whose value is set directly by the encoder without the use of any abstract value provided by the application.

NOTE – An example of an auxiliary field is a length determinant for an integer encoding or for a repetition.

3.2.3 bit-field: Contiguous bits or octets in an encoding which are decoded as a whole, and which either represent an abstract value, or provide information (such as a length determinant for some other field – see 3.2.31) needed for successful decoding, or both.

NOTE – It is in legacy protocols that "or both" sometimes occurs.

3.2.4 bit-field class: An encoding class whose objects specify the encoding of abstract values (of some ASN.1 type) into bits.

NOTE – Other encoding classes are concerned with more general encoding procedures, such as those required to determine the end of repetitions of bit-field class encodings, or to determine which of a set of alternative bit-field encodings is present.

3.2.5 bounds condition: A condition on the existence of bounds of an integer field (and whether they allow negative values or not) which, if satisfied, means that specified encoding rules are to be applied.

3.2.6 choice determinant: A bit-field which determines which of several possible encodings (each representing different abstract values) is present in some other bit-field.

3.2.7 combined encoding object set: A temporary set of encoding objects produced by the combination of two sets of encoding objects for the purpose of applying encodings.

3.2.8 conditional encoding: An encoding which is to be applied only if some specified condition is satisfied.

NOTE – The condition may be a bounds condition or a size range condition, or other more complex conditions.

3.2.9 containing type: An ASN.1 type (or encoding structure field) where a contents constraint has been applied to the values of that type (or to the values associated with that encoding structure field).

NOTE – The ASN.1 types to which a contents constraint (using **`CONTAINING/ENCODED BY`**) can be applied are the bitstring and the octetstring types.

3.2.10 current application point: The point in an encoding structure at which a combined encoding object set is being applied.

3.2.11 differential encoding-decoding: The specification of rules for a decoder that require the acceptance of encodings that cannot be produced by an encoder conforming to the current specification.

NOTE – Differential encoding-decoding supports the specification of decoding by a decoder (conforming to an initial version of a standard) which is intended to enable it to successfully decode encodings produced by a later version of that standard. This is sometimes referred to as support for extensibility.

3.2.12 encoding class: The set of all possible encodings for a specific part of the procedures needed to perform the encoding or decoding of an ASN.1 type.

NOTE – Encoding classes are defined for the encoding of primitive ASN.1 types, but are also defined for the procedures associated with ASN.1 tag notation, the use of **OPTIONAL** and for encoding constructors.

3.2.13 encoding class category: Encoding classes with some common characteristics.

NOTE – Examples are the integer category, the boolean category, and the concatenation category.

3.2.14 encoding constructor: An encoding class whose encoding objects define procedures for combining, selecting, or repeating parts of an encoding. (Examples are the **#ALTERNATIVES**, **#CHOICE**, **#CONCATENATION**, **#SEQUENCE**, etc. classes.)

3.2.15 Encoding Definition Modules (EDM): Modules that define encodings for application in the Encoding Link Module.

3.2.16 Encoding Link Module (ELM): The (unique, for any given application) module that assigns encodings to ASN.1 types.

3.2.17 encoding object: The specification of some part of the procedures needed to perform the encoding or decoding of an ASN.1 type.

NOTE – Encoding objects can specify the encoding of primitive ASN.1 types, but can also specify the procedures associated with ASN.1 tag notation, the use of **OPTIONAL** and with encoding constructors.

3.2.18 encoding object set: A set of encoding objects.

NOTE – An encoding object set is normally used in the Encoding Link Module to determine the encoding of all the top-level types used in an application.

3.2.19 encoding property: A piece of information used to define an encoding using the notation specified in clauses 23, 24 and 25.

3.2.20 encoding space: The number of bits (or octets, words or other units) used to encode an abstract value into a bit-field (see 9.21.5).

3.2.21 encoding structure: The structure of an encoding, defined either from the structure of an ASN.1 type definition, or in an EDM using bit-field classes and encoding constructors.

NOTE 1 – Use of an encoding structure is only one of several mechanisms (but an important one) that the Encoding Control Notation provides for the definition of encodings for ASN.1 types.

NOTE 2 – Definition of an encoding structure is also the definition of a corresponding encoding class.

3.2.22 explicitly generated encoding structure: An encoding structure derived from an implicitly generated encoding structure by use of the renames clause in an EDM.

3.2.23 extensibility: Provisions in an early version of a standard that are designed to maximize the interworking of implementations of that early version with the expected implementations of a later version of that standard.

3.2.24 fully-qualified name: A reference to an encoding class, object, or object set that includes either the name of the EDM module in which that encoding class, object, or object set was defined, or (in the case of an implicitly generated encoding class) the name of the ASN.1 module in which it was generated. (See also 3.2.43.)

NOTE – A fully-qualified name (see production "ExternalEncodingClassReference" in 10.6) has to be used in the body of a module if the encoding class is an implicitly generated encoding structure whose name is the same as a reserved class name, or if use of the name alone would produce ambiguity due to multiple imports of classes with that name. (See A.1/13.16).

3.2.25 generated encoding structure: An implicitly or explicitly generated encoding structure whose purpose is to define the encodings of the corresponding ASN.1 type through application of encodings in the ELM.

3.2.26 governor: A part of an ECN specification which determines the syntactic form (and semantics) of some other part of the ECN specification.

NOTE – A governor is an encoding class reference, and it determines the syntax to be used for the definition of an encoding object (of that class). The concept is the same as the concept of a type reference in ASN.1 acting as the governor for ASN.1 value notation.

3.2.27 handle value set: The specified set of all possible values of the identification handle that is exhibited by an encoding object.

3.2.28 identification handle: Part of an encoding which serves to distinguish the encodings produced by one encoding object (of a given class) from those produced by other encoding objects (of other classes).

NOTE – The ASN.1 Basic Encoding Rules use tags to provide identification handles in BER encodings.

3.2.29 implicitly generated encoding structure: The encoding structure that is implicitly generated and exported whenever a type is defined in an ASN.1 module.

3.2.30 initial application point: The point in an encoding structure at which any given combined encoding object set is first applied (in the ELM and in EDMs) .

3.2.31 length determinant: A bit-field that determines the length of some other bit-field.

3.2.32 negative integer value: A value less than zero.

3.2.33 non-negative integer value: A value greater than or equal to zero.

3.2.34 non-positive integer value: A value less than or equal to zero.

3.2.35 optional bit-field: A bit-field that is sometimes included (to encode an abstract value) and is sometimes omitted.

3.2.36 positive integer value: A value greater than zero.

3.2.37 presence determinant: A bit-field that determines whether an optional bit-field is present or not.

3.2.38 primitive class: An encoding class which is not an encoding structure, and which cannot be de-referenced to some other class (see 16.1.14).

3.2.39 recursive definition (of a reference name): A reference name for which resolution of the reference name, or of the governor of the definition of the reference name, requires resolution of the original reference name.

NOTE – Recursive definition of an encoding class (including an encoding structure) or an encoding object is permitted (but see 17.1.4). Recursive definition of an encoding object set is forbidden by 18.1.3.

3.2.40 recursive instantiation (of a parameterized reference name): An instantiation of a reference name, where resolution of the actual parameters requires resolution of the original reference name.

NOTE – Recursive instantiation of an encoding class (including an encoding structure) or an encoding object is permitted (but see 17.1.4). Recursive instantiation of an encoding object set is forbidden by 18.1.3.

3.2.41 replacement structure: A parameterized structure used to replace some or all parts of a construction before encoding the construction.

3.2.42 self-delimiting encoding: An encoding for a set of abstract values such that there is no abstract value that has an encoding that is an initial sub-string of the encoding of any other abstract value in the set.

NOTE – This includes not only fixed-length encodings of a bounded integer, but also encodings generally described as "Huffman encodings" (see Annex E).

3.2.43 simple reference name: A reference to an encoding class, object, or object set that includes neither the name of the EDM module in which that encoding class, object, or object set was defined, nor (in the case of an implicitly generated encoding class) the name of the ASN.1 module in which it was generated.

NOTE – A simple reference name can only be used when the reference to the encoding class is unambiguous, otherwise a fully-qualified name (see 3.2.24) has to be used in the body of a module.

3.2.44 size range condition: A condition on the existence of effective size constraints on a string or repetition field (and whether the constraint includes zero, and/or allows multiple sizes) which, if satisfied, means that specified encoding rules are to be applied.

3.2.45 source governor (or source class): The governor that determines the notation for specifying abstract values associated with a source class when mapping them to a target class.

3.2.46 start pointer: An auxiliary field indicating the presence or absence of an optional bit-field, and in the case of presence, containing the offset from the current position to the bit-field.

3.2.47 target governor (or target class): The governor that determines the notation for specifying abstract values associated with a target class when mapping to them from a source class.

3.2.48 top-level type(s): Those ASN.1 type(s) in an application that are used by the application in ways other than to define the components of other ASN.1 types.

NOTE 1 – Top-level types may also be used (but usually are not) as components of other ASN.1 types.

NOTE 2 – Top-level types are sometimes referred to as "the application's messages", or "PDUs". Such types are normally treated specially by tools, as they form the top-level of programming language data-structures that are presented to the application.

3.2.49 transforms: Encoding objects of the class **`#TRANSFORM`** which specify that the encoding of the abstract values associated with some class (or of transform composites – see 3.2.50) is to be the encoding of different abstract values associated with the same or a different class (or of transform composites).

NOTE – Transforms can be used, for example, to specify simple arithmetic operations on integer values, or to map integer values into characterstrings or bitstrings.

3.2.50 transform composites: An ordered list of elements that can itself be the source or the result of transforms.

NOTE – All the elements of a composite are required to have the same classification (see 9.18.2).

3.2.51 value encoding: The way in which an encoding space is used to represent an abstract value (see 9.21.5).

4 Abbreviations

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

ASN.1	Abstract Syntax Notation One
BCD	Binary Coded Decimal
BER	Basic Encoding Rules of ASN.1
CER	Canonical Encoding Rules of ASN.1
DER	Distinguished Encoding Rules of ASN.1
ECN	Encoding Control Notation for ASN.1
EDM	Encoding Definition Module
ELM	Encoding Link Module
PDU	Protocol Data Unit
PER	Packed Encoding Rules of ASN.1

5 Definition of ECN syntax

5.1 This Recommendation | International Standard employs the notational convention defined in Rec. ITU-T X.680 | ISO/IEC 8824-1, clause 5.

5.2 This Recommendation | International Standard employs the notation for information object classes defined in Rec. ITU-T X.681 | ISO/IEC 8824-2 as modified by Annex B.

5.3 This Recommendation | International Standard references productions defined in Rec. ITU-T X.680 | ISO/IEC 8824-1 as modified by Annex A, Rec. ITU-T X.681 | ISO/IEC 8824-2 as modified by Annex B, and Rec. ITU-T X.683 | ISO/IEC 8824-4 as modified by Annex C.

6 Encoding conventions and notation

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 is the "least significant bit".

6.3 For the purposes of this Recommendation | International Standard, encodings are defined as a string of bits starting from a "leading bit" through to a "trailing bit". On transmission, the first eight bits of this string of bits starting with the "leading bit" shall be placed in the first transmitted octet with the leading bit as the most significant bit of that octet. The next eight bits shall be placed in the next octet, and so on. If the encoding is not a multiple of eight bits, then the remaining bits shall be transmitted as if they were bits 8 downwards of a subsequent octet.

NOTE – A complete ECN encoding is not necessarily always a multiple of eight bits, but an ECN specification can determine the addition of padding to ensure this property.

6.4 When figures are shown in this Recommendation | International Standard, the "leading bit" is always shown on the left of the figure.

7 The ECN character set

7.1 Use of the term "character" throughout this Recommendation | International Standard refers to the characters specified in ISO/IEC 10646, and full support for all possible ECN specifications can require the representation of all these characters.