INTERNATIONAL STANDARD

ISO/IEC 8632-3

Second edition
1992-10-01

Information technology — Computer graphics — Metafile for the storage and transfer of picture description information —

Part 3:
Binary encoding

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Technologies de l'information — Infographie — Métafichier de stockage et de transfert des informations de description d'images —
Partie 3: Codage binaire

Reference number
ISO/IEC 8632-3:1992(E)

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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. 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 8632-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

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This second edition cancels and replaces the first edition (ISO 8632-3:1987), which has been technically revised.

ISO/IEC 8632 consists of the following parts, under the general title *Information technology – Computer graphics – Metafile for the storage and transfer of picture description information* :

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- *Part 1: Functional specification*
- *Part 2: Character encoding*
- *Part 3: Binary encoding*
- *Part 4: Clear text encoding*

Annex A forms an integral part of this part of ISO/IEC 8632. Annexes B and C are for information only.

Introduction

0.1 Purpose of the Binary Encoding

The Binary Encoding of the Computer Graphics Metafile (CGM) provides a representation of the Metafile syntax that can be optimized for speed of generation and interpretation, while still providing a standard means of interchange among computer systems. The encoding uses binary data formats that are much more similar to the data representations used within computer systems than the data formats of the other encodings.

Some of the data formats may exactly match those of some computer systems. In such cases processing is reduced very much relative to the other standardized encodings. On most computer systems processing requirements for the Binary Encoding will be substantially lower than for the other encodings.

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In cases where a computer system's architecture does not match the standard formats used in the Binary Encoding, and where absolute minimization of processing requirements is critical, and where interchange among dissimilar systems does not matter, it may be more appropriate to use a private encoding, conforming to the rules specified in clause 7 of ISO/IEC 8632-1.

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0.2 Objectives

This encoding has the following features.

a) Partitioning of parameter lists: metafile elements are coded in the Binary Encoding by one or more partitions (see clause 4); the first (or only) partition of an element contains the opcode (Element Class plus Element Id).

b) Alignment of elements: every element begins on a word boundary. When the data of an element (whether partitioned or not) does not terminate on an even-octet boundary, then the following element is aligned by padding after the data of the preceding element with zero bits to the next even-octet boundary. A no-op element is available in this encoding. It is skipped and ignored by interpreters. It may be used to align data on machine-dependent record boundaries for speed of processing.

c) Uniformity of format: all elements have an associated parameter length value. The length is specified as an octet count. As a result, it is possible to scan the metafile, without interpreting it, at high speed.

d) Alignment of coordinate data: at default precisions and by virtue of alignment of elements, coordinate data always start on word boundaries. This minimizes processing by ensuring, on a wide class of computing systems, that single coordinates do not have to be assembled from pieces of multiple computer words.

e) Efficiency of encoding integer data: other data such as indexes, colour and characters are encoded as one or more octets. The precision of every parameter is determined by the appropriate precision as given in the Metafile Descriptor.

f) Order of bit data: in each word, or unit within a word, the bit with the highest number is the most significant bit. Likewise, when data words are accessed sequentially, the least significant word follows the most significant.

g) Extensibility: the arrangement of Element Class and Element Id values has been designed to allow future growth, such as new graphical elements.

h) Format of real data: real numbers are encoded using either IEEE floating point representation or a metafile fixed-point representation.

i) Run length encoding: if many adjacent cells have the same colour (or colour index) efficient encoding is possible. For each run a cell count is specified followed by the colour (or colour index).

j) Packed list encoding: if adjacent colour cells do not have the same colour (or colour index) the metafile provides bit-stream lists in which the values are packed as closely as possible.

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0.3 Relationship to other International Standards

The floating point representation of real data in this part of ISO/IEC 8632 is that in ANSI/IEEE 754-1986.

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The representation of character data in this part of ISO/IEC 8632 follows the rules of ISO/IEC 646 and ISO 2022.

For certain elements, the CGM defines value ranges as being reserved for registration. The values and their

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1 Scope

This part of ISO/IEC 8632 specifies a binary encoding of the Computer Graphics Metafile. For each of the elements specified in ISO/IEC 8632-1, this part specifies an encoding in terms of data types. For each of these data types, an explicit representation in terms of bits, octets and words is specified. For some data types, the exact representation is a function of the precisions being used in the metafile, as recorded in the METAFILE DESCRIPTOR.

This encoding of the Computer Graphics Metafile will, in many circumstances, minimize the effort required to generate and interpret the metafile.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 8632. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO/IEC 8632 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange.*

ISO 2022:1986, *Information processing – ISO 7-bit and 8-bit coded character sets – Code extension techniques.*

ANSI/IEEE 754, *Standard for Binary Floating Point Arithmetic.*

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3 Notational conventions

"Command Header" is used throughout this part of ISO/IEC 8632 to refer to that portion of a Binary-Encoded element that contains the opcode (element class plus element id) and parameter length information (see clause 4).

Within this part, the terms "octet" and "word" have specific meanings. These meanings may not match those of a particular computer system on which this encoding of the metafile is used.

An octet is an 8-bit entity. All bits are significant. The bits are numbered from 7 (most significant) to 0 (least significant).

A word is a 16-bit entity. All bits are significant. The bits are numbered from 15 (most significant) to 0 (least significant).

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4 Overall structure

4.1 General form of metafile

All elements in the metafile are encoded using a uniform scheme. The elements are represented as variable length data structures, each consisting of opcode information (element class plus element id) designating the particular element, the length of its parameter data and finally the parameter data (if any).

The structure of the metafile is as follows. (For the purposes of this diagram only, MF is used as an abbreviation for METAFILE.)

BEGIN MF	MD	<picture> ...	END MF

The BEGIN METAFILE element is followed by the METAFILE DESCRIPTOR (MD). After this the pictures follow, each logically independent of each other. Finally the Metafile is ended with an END METAFILE element.

4.2 General form of pictures

Apart from the BEGIN METAFILE, END METAFILE and Metafile Descriptor elements, the metafile is partitioned into pictures. All pictures are mutually independent. A picture consists of a BEGIN PICTURE element, a PICTURE DESCRIPTOR (PD) element, a BEGIN PICTURE BODY element, an arbitrary number of control, graphical and attribute elements and finally an END PICTURE element. (For the purpose of this diagram only, PIC is used as an abbreviation for PICTURE and BEGIN BODY for BEGIN PICTURE BODY.)

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BEGIN PIC	PD	BEGIN BODY	<element> ...	END PIC

4.3 General structure of the binary metafile

The binary encoding of the metafile is a logical data structure consisting of a sequential collection of bits. For convenience in describing the length and alignment of metafile elements, fields of two different sizes are defined within the structure. These fields are used in the remainder of this part of ISO/IEC 8632 for illustrating the contents and structure of elements and parameters.

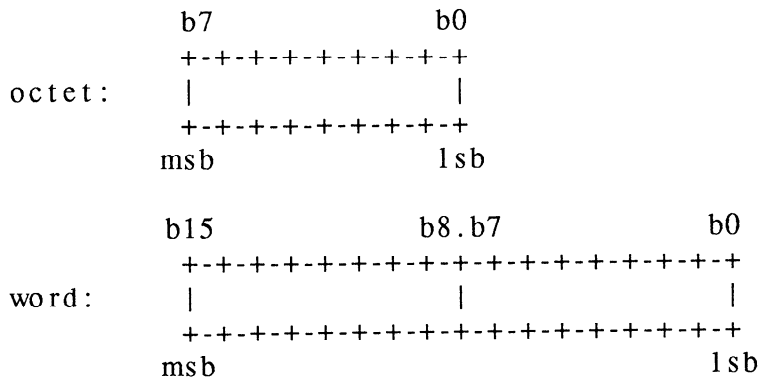
For measuring the lengths of elements the metafile is partitioned into octets, which are 8-bit fields.

The structure is also partitioned into 16-bit fields called words (these are logical metafile words). To optimize processing of the binary metafile on a wide collection of computers, metafile elements are constrained to start on word boundaries within the binary data structure (this alignment may necessitate padding an element with bits to a word boundary if the parameter data of the element does not fill to such a boundary).

The octet is the fundamental unit of organization of the binary metafile.

The bits of an octet are numbered 7 to 0, with 7 being the most significant bit. The bits of a word are numbered 15 to 0, with 15 being the most significant bit.

Overall structure **General structure of the binary metafile**



If the consecutive bits of the binary data structure are numbered 1..N, and the consecutive octets are numbered 1..N/8, and the consecutive words are numbered 1..N/16, then the logical correspondence of bits, octets, and words in the binary data structure is as illustrated in the following table:

metafile bit number	octet bit number	word bit number
1	b7/octet1	b15/word1
.	.	.
.	.	.
8	b0/octet1	b8/word1
9	b7/octet2	b7/word1
.	.	.
.	.	.
16	b0/octet2	b0/word1
17	b7/octet3	b15/word2
.	.	.
.	.	.
24	b0/octet3	b8/word2
25	b7/octet4	b7/word2
.	.	.
.	.	.

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4.4 Structure of the command header

Throughout this sub-clause, the term "command" is used to denote a binary-encoded element. Metafile elements are represented in the Binary Encoding in one of two forms — short-form commands and long-form commands. There are two differences between them:

— a short-form command always contains a complete element; the long-form command can accommodate partial elements (the data lists of elements can be partitioned);

— a short-form command only accommodates parameter lists up to 30 octets in length; the long-form command accommodates lengths up to 32767 octets per data partition.

The forms differ in the format of the Command Header that precedes the parameter list. The command form for an element (short or long) is established by the first word of the element. For the short-form, the Command Header consists of a single word divided into three fields: element class, element id and parameter list length.

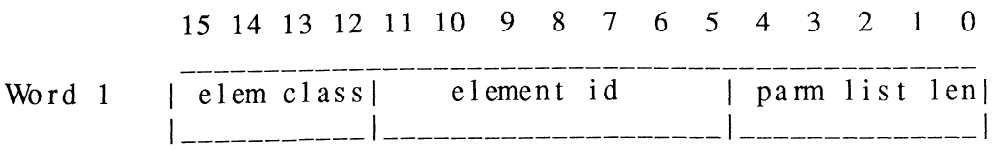

Figure 1 — Format of a short-form Command Header

The fields in the short-form Command Header are as follows:

bits 15 to 12 element class (value range 0 to 15)

bits 11 to 5 element id (value range 0 to 127)

bits 4 to 0 parameter list length: the number of octets of parameter data that follow for this command (value range 0 to 30)

This Command Header is then followed by the parameter list.

The first word of a long-form command is identical in structure to the first word of a short-form command. The presence of the value 11111 binary (decimal 31) in parameter list length field indicates that the command is a long-form command. The Command Header for the long-form command consists of two words. The second word contains the actual parameter list length. The two header words are then followed by the parameter list.

In addition to allowing longer parameter lists, the long-form command allows the parameter list to be partitioned. Bit 15 of the second word indicates whether the given data complete the element or more data follow. For subsequent data partitions of the element, the first word of the long-form Command Header (containing element class and element id) is omitted; only the second word, containing the parameter list length, is given. The parameter list length for each partition specifies the length of that partition, not the length of the complete element. The final partition of an element is indicated by bit 15 of the parameter list length word being zero.

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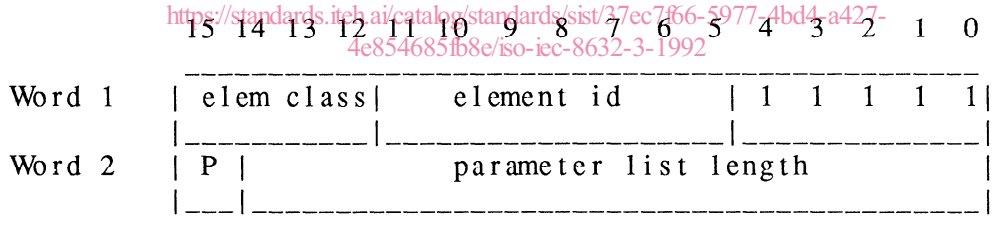

Figure 2 — Format of a long-form Command Header

The fields in the long-form Command Header are as follows:

Word 1

bits 15 to 12 element class (value range 0 to 15)

bits 11 to 5 element id (value range 0 to 127)

bits 4 to 0 binary value 11111 (decimal 31) indicating long-form

Word 2

bit 15 partition flag

— 0 for 'last' partition

— 1 for 'not-last' partition

bits 14 to 0 parameter list length: the number of octets of parameter data that follow for this command or partition (value range 0 to 32767).

The parameter values follow the parameter list length for either the long-form or short-form commands. The number of values is determined from the parameter list length and the type and precision of the operands. These parameter values have the format illustrated in clause 5 of this part of ISO/IEC 8632. The parameter type for coordinates is indicated in the Metafile Descriptor. For non-coordinate parameters, the parameter type is as specified in clause 5 of ISO/IEC 8632-1. If the parameter type is encoding dependent, its code is specified in the coding tables of clause 7 of this part. Unless otherwise stated, the order of parameters is as listed in clause 5 of ISO/IEC 8632-1.

Every command is constrained to begin on a word boundary. This necessitates padding the command with a single null octet at the end of the command if the command contains an odd number of octets of parameter data. In addition, in elements with parameters whose precisions are shorter than one octet (i.e., those containing a 'local colour precision' parameter) it is necessary to pad the last data-containing octet with null bits if the data do not fill the octet. In all cases, the parameter list length is the count of octets actually containing parameter data — it does not include the padding octet if one is present. It is only at the end of a command that padding is performed, with the single exception of the CELL ARRAY element.

The purpose of this command alignment constraint is to optimize processing on a wide class of computers. At the default metafile precisions, the parameters which are expected to occur in greatest numbers (coordinates, etc) will align on 16-bit boundaries, and Command Headers will align on 16-bit boundaries. Thus, at the default precisions the most frequently parsed entities will lie entirely within machine words in a large number of computer designs. The avoidance of assembling single metafile parameters from pieces of several computer words will approximately halve the amount of processing required to recover element parameters and command header fields from a binary metafile data stream.

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This optimization may be compromised or destroyed altogether if the metafile precisions are changed from default. Commands are still constrained to begin on 16-bit boundaries, but the most frequently expected parameters may no longer align on such boundaries as they do at the default precisions.

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The short form command header with element class 15, element id 127, and parameter list length 0 is reserved for extension of the number of available element classes in future revisions of this part of ISO/IEC 8632. It should be treated by interpreters as any other element, as far as parsing is concerned. The next "normal" element encountered will have an actual class value different from that encountered in the "element class" field of the command header — it will be adjusted by a bias as will be defined in a future revision of this part of ISO/IEC 8632.