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AMENDMENT 1
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Information processing systems — Computer graphics — Metafile for the storage and transfer of picture description information —

Part 1 :
Functional specification

AMENDMENT 1

Systèmes de traitement de l'information — Infographie — Métafichier de stockage et de transfert des informations de description d'images —

Partie 1: Description fonctionnelle

AMENDEMENT 1

Reference number
ISO 8632-1 : 1987/Amd. 1 : 1990 (E)

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.

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

Part 1: Functional specification

AMENDMENT 1

Page 1

Add the following at the end of 0.1:

This picture description includes the capability for describing static pictures. Static pictures are those where elements which may lead to dynamic effects (for example those leading to regeneration) are prohibited within the picture body.

Page 1

Sub-clause 0.3: Add the following at the end of item c):

It should also not preclude further extensions to support future standards.

Page 1

Sub-clause 0.3: Add the following at the end of item d):

It should include the capability to support ISO 7942 (GKS) static picture-capture.

Page 3

Add the following at the end of 0.8:

There is a very close relationship between many of the elements in ISO 8632 and a subset of the functions in the CGI (Computer Graphics Interface - ISO/IEC 9636 (currently a Draft International Standard)).

Page 4

Clause 1: Add the following at the end of the first paragraph:

This picture description includes the capability for describing static images.

Page 5

Clause 2: Add the following to the list of references:

ISO/IEC 9636 *Information processing systems - Computer Graphics - Interfacing techniques for dialogues with graphical devices (CGI).* Parts 1-6 (currently a Draft International Standard).

Page 6

Clause 3: Add the following to the list of definitions and abbreviations:

3.1.49 anisotropic mapping: A mapping in which the scale factors applied along each axis are not equal. This is often used in reference to the mapping from VDC to distance units on the physical display surface. With anisotropic mapping, the angle between any pair of non-parallel line segments can change; circles cease to be circles and become post-transformed ellipses. See "isotropic mapping".

3.1.50 boundary: The mathematical locus that defines, in abstract VDC space, the limits of a region to be filled (for fill primitives and closed figures). The visual appearance of interior style 'hollow' consists of a depiction of the boundary obtained after clipping has been taken into account.

3.1.51 character set: The set of displayable symbols mapped to individual characters in a TEXT, APPEND TEXT, or RESTRICTED TEXT string. This corresponds to the "G-set" defined in ISO 2022. A character set is independent of the font or typeface; examples of character sets are: ASCII (X3.4), German and Katakana.

3.1.52 clipping mode: A generic term referring to one of Line Clipping, Marker Clipping or Edge Clipping Modes. An object clipping may be either 'locus', 'shape' or 'locus then shape'.

3.1.53 closed figure: A compound primitive that behaves as a fill primitive of more general shape. It is formed by bracketing a sequence of line or fill primitives, edge attributes, and certain control elements, with the elements BEGIN FIGURE and END FIGURE.

3.1.54 compound primitive: A compound primitive is specified by a sequence of CGM elements, as opposed to primitives represented by a single element. Compound text and closed figures are examples of compound primitives in the CGM.

3.1.55 compound text: A compound text primitive is formed through the use of APPEND TEXT. There may be attribute changes between portions of the resulting complete text string.

3.1.56 device coordinates: The coordinates native to a device; device-dependent coordinates; physical device coordinates.

3.1.57 device viewport: A rectangular subset of the physical display surface into which VDC EXTENT is mapped. See "effective viewport".

3.1.58 edge: The rendering of the perimiter of a filled region, controlled by edge attributes. Edges are clipped after being applied to the boundary, as distinct from the rendition of the boundary obtained from interior style 'hollow'. See "boundary".

3.1.59 effective viewport: The actual viewport resulting from forced isotropic mapping from the VDC extent to the viewport.

3.1.60 foreground colour: The colour used in the rendering process in which primitives are rendered on the display surface, as opposed to the BACKGROUND COLOUR or AUXILIARY COLOUR. The foreground colour is set separately for each class of primitive.

3.1.61 global segment: A segment that is defined in the Metafile Descriptor (see "segment"). It may be referenced from within any picture.

3.1.62 graphic object: A graphic object is a graphic primitive, including a compound primitive, together with the associated attributes.

3.1.63 isotropic mapping: A mapping which is invariant with respect to direction; equal scaling in all orthogonal representational dimensions. It is often used to describe the mapping from VDC to distance units on the physical display surface. With isotropic mapping, the angle between any pair of non-parallel line segments remains unchanged; for example, circles remain circles. See "anisotropic mapping".

3.1.64 local segment: A segment whose definition is local to the picture in which it appears.

3.1.65 object clipping: Object clipping is applied to a graphic object. For example, clipping is applied to a line after it has had the width attribute associated with it.

3.1.66 region: In the context of closed figures or the POLYGON SET element, an area that is explicitly or implicitly closed, that is a subset of the full area being filled. Regions can be nested, disjoint or overlapping. The boundaries of all regions are considered together when applying the interior test for filling a closed figure or POLYGON SET.

3.1.67 segment: A collection of primitives, primitive attributes and some additional attributes associated with the segment as a whole. See "segment attribute".

3.1.68 segment attribute: An attribute associated with a segment as a whole rather than attributes of individual primitives.

3.1.69 size specification mode: A generic term for Line Width Specification Mode, Edge Width Specification Mode, or Marker Size Specification Mode. A size specification mode may be 'absolute' or 'scaled', the latter being referenced to a nominal size in device coordinate space.

3.1.70 skewed: Used to describe stroke precision text when the CHARACTER ORIENTATION vectors are non-perpendicular; CELL ARRAYs when the three defining points form a parallelogram which is not a rectangle; or a segment transformation that causes rectangles to become non-rectangular parallelograms.

Page 7

Sub-clause 3.1.26: Definition of graphical elements

Insert "primitive" between "graphical" and "element".

Page 9

Sub-clause 4.1: Add the following at the end of the list of classes of elements:

Segment Elements, which enable the grouping and manipulation of elements.

Page 9

Sub-clause 4.1: Add the following after the third paragraph:

Graphical output primitives and attributes may be grouped in segments. Segment attribute elements control the appearance of segments.

Page 10

Sub-clause 4.2: Add the following at the end:

Primitives may be grouped together to form a composite primitive known as a closed figure. The primitives to be included in the closed figure being defined are delimited by the elements BEGIN FIGURE and END FIGURE.

Groups of elements, called segments, are delimited by BEGIN SEGMENT and END SEGMENT. Each segment is uniquely identified by a segment identifier. Segments may be defined in the Metafile Descriptor or within picture bodies.

Page 10

Sub-clause 4.3: Add the following to the list after the first paragraph:

NAME PRECISION
MAXIMUM VDC EXTENT
SEGMENT PRIORITY EXTENT

NOTE - Other elements, as defined in this part of ISO/IEC 8632, may appear within the Metafile Descriptor within the definition of a global segment.

Page 10

Add the following paragraph at the end of 4.3:

METAFILE VERSION and METAFILE ELEMENT LIST shall occur only once in the Metafile Descriptor for version 2 metafiles. It is recommended that they shall only appear once in version 1 metafiles.

NOTE - It is recommended that the following elements: METAFILE VERSION, METAFILE ELEMENT LIST and (possibly multiple occurrences of) METAFILE DESCRIPTION appear first in the Metafile Descriptor and in the order listed.

Page 10

Sub-clause 4.3.2 : Change the start of the third sentence from "Two shorthand names....." to:

Several shorthand names.......

Page 11

Add the following after 4.3.2.2:

4.3.2.3 Version 2 set

The Version-2 set may be used to indicate all the elements in the drawing-plus-control set and all the additional elements defined in this part of ISO/IEC 8632.

4.3.2.4 Extended primitives set

The extended-primitives set may be used to indicate those primitives which are not defined in ISO 7942 (GKS). These elements are:

DISJOINT POLYLINE
RESTRICTED TEXT
APPEND TEXT
POLYGON SET
RECTANGLE
CIRCLE
CIRCULAR ARC 3 POINT
CIRCULAR ARC 3 POINT CLOSE
CIRCULAR ARC CENTRE
CIRCULAR ARC CENTRE CLOSE
CIRCULAR ARC CENTRE REVERSED
ELLIPSE
ELLIPTICAL ARC
ELLIPTICAL ARC CLOSE
CONNECTING EDGE

4.3.2.5 Version 2 GKSM set

The Version-2-GKSM set includes elements for ISO 7942 (GKS) picture capture. The elements included in the Version-2-GKSM set are:

BEGIN METAFILE
BEGIN PICTURE
BEGIN PICTURE BODY
END PICTURE
BEGIN SEGMENT
END SEGMENT
END METAFILE
METAFILE VERSION
METAFILE DESCRIPTION
VDC TYPE
INTEGER PRECISION
REAL PRECISION
INDEX PRECISION
COLOUR PRECISION
COLOUR INDEX PRECISION
NAME PRECISION
MAXIMUM COLOUR INDEX
COLOUR VALUE EXTENT
METAFILE ELEMENT LIST
METAFILE DEFAULTS REPLACEMENT
FONT LIST
CHARACTER SET LIST
CHARACTER CODING ANNOUNCER
MAXIMUM VDC EXTENT
SEGMENT PRIORITY EXTENT
VDC EXTENT
DEVICE VIEWPORT
DEVICE VIEWPORT MAPPING
DEVICE VIEWPORT SPECIFICATION MODE
LINE REPRESENTATION

MARKER REPRESENTATION
TEXT REPRESENTATION
FILL REPRESENTATION
VDC INTEGER PRECISION
VDC REAL PRECISION
CLIP RECTANGLE
POLYLINE
POLYMARKER
TEXT
POLYGON
CELL ARRAY
GDP
LINE BUNDLE INDEX
LINE TYPE
LINE WIDTH
LINE COLOUR
MARKER BUNDLE INDEX
MARKER TYPE
MARKER SIZE
MARKER COLOUR
TEXT BUNDLE INDEX
TEXT FONT INDEX
TEXT PRECISION
CHARACTER EXPANSION FACTOR
CHARACTER SPACING
TEXT COLOUR
CHARACTER HEIGHT
CHARACTER ORIENTATION
TEXT PATH
TEXT ALIGNMENT
CHARACTER SET INDEX
ALTERNATE CHARACTER SET INDEX
FILL BUNDLE INDEX
INTERIOR STYLE
FILL COLOUR
HATCH INDEX
PATTERN INDEX
FILL REFERENCE POINT
PATTERN TABLE
PATTERN SIZE
COLOUR TABLE
ASPECT SOURCE FLAGS
PICK IDENTIFIER
ESCAPE
MESSAGE
APPLICATION DATA
SEGMENT TRANSFORMATION
SEGMENT HIGHLIGHTING
SEGMENT DISPLAY PRIORITY
SEGMENT PICK PRIORITY

Page 12

Sub-clause 4.4. Add the following text at the end of the first paragraph:

Some of the picture descriptor elements may appear outside the Picture Descriptor if this is permitted by the formal grammar for the metafile version. In such a case they do not set parameter values to apply for the entire picture.

Page 12

Sub-clause 4.4.2. Change the text to the following:

COLOUR SELECTION MODE selects either indexed or direct (RGB) colour specification and is described further under colour attributes. For version 1 metafiles the selection is for the whole picture.

Page 12

Add the following paragraph at the end of 4.4.4:

MAXIMUM VDC EXTENT defines an extent which bounds the VDC extent values which may be found in the metafile. It may be, but need not be, a closest bound in the sense that it exactly equals the union of the extent rectangles in the metafile. This element may be used, for example, to map integer virtual device coordinates of the metafile to a unit square in a normalized device space.

Page 14

Add the following after 4.4.6:

4.4.7 Device viewport control

The device viewport specifies the region of the device display surface into which the VDC extent is to be mapped on interpretation. VDC-to-Device mapping is determinied by the VDC extent, device viewport, and device viewport mapping.

The position of the device viewport is specified in one of three coordinate systems selected by the DEVICE VIEWPORT SPECIFICATION MODE element:

- by fraction [0.0 to 1.0] of the available display surface, which allows reasonable placement and relative sizing of the viewport;
- in millimetres times a scale factor, which allows absolute sizing of images;
- in physical device coordinates.

The device viewport is specified in terms of two points on the device display surface at diagonally opposite corners of the rectangle. Mirroring or 180^{0} rotation of the image may be achieved by specifying the corners in some way other than the first as below and to the left of the second.

The DEVICE VIEWPORT MAPPING element may be used to force isotropic mapping even if the specified VDC extent and device viewport would not otherwise have led to one. In such a case, the VDC extent is mapped on to a subset of the specified device viewport on interpretation. This subset is defined by shrinking either the vertical or horizontal dimension of the specified viewport as needed to reach the required aspect ratio. This smaller "effective viewport" is then used to define the coordinate mapping from VDC to the device's coordinates. The placement of the effective viewport rectangle within the original one can be specified. This placement can be one of 'left', 'right' or 'centred' when the shrinking is horizontal, and 'top', 'bottom' or 'centred' when it is vertical. These meanings are relative to the display surface of the device.

The VDC-to-Device mapping maps the first point specifying the VDC extent on to the corner of the effective viewport corresponding to the first point specifying the device viewport, and similarly for the second point. The mapping is linear in each dimension, but is not necessarily isotropic (for example, a circle in VDC may not appear as a circle to the viewer).

Both the way VDC space is oriented relative to the display surface and the way the effective viewport is placed on the physical device may lead to mirroring and 180^{0} rotation.

The behaviour of primitives and attributes with significance in VDC space under transformations is further described in 4.6.

If both device viewport and scaling mode appear in the same metafile then the last specified is used. If neither appear then the default values for device viewport take precedence.

4.4.8 Representations

The elements LINE REPRESENTATION, MARKER REPRESENTATION, TEXT REPRESENTATION, FILL REPRESENTATION and EDGE REPRESENTATION are used to set all of the attribute values in a bundle table entry at the same time. The attributes that may be bundled are described in 4.7.

Page 14

Add the following at the end of 4.5:

Some of the control elements may appear in the Picture Descriptor if this is permitted by the formal grammar for the metafile version.

Page 15

Add the following text at the end of 4.5.2:

There are three different clipping modes for lines, markers and edges. The required clipping mode is recorded in the metafile with the elements: LINE CLIPPING MODE, MARKER CLIPPING MODE , and EDGE CLIPPING MODE. When the CLIP INDICATOR associated with a graphical primitive is 'on', only those parts of a graphical primitive that are considered inside the effective clipping region are rendered on interpretation. The object clipping modes allow precise specification as to how clipping is applied to primitives on interpretation.

Clipping may be either 'locus', 'shape' or 'locus then shape'. Conceptually, a locus is a mathematical object like a point or line segment, while a shape is an area in 2-dimensional space. Loci are 0-, 1- or 2-dimensional subsets of real-valued 2-space. For markers and text they are points. For lines they are the individual line segments or portions of arcs. The locus of an area is the shape and the boundary. Shapes reflect the realization of geometric attributes and are generally 2-dimensional subsets of real-valued 2-space.

'Locus' clipping is applied for each portion of a graphic object based on its mathematical location and is independent of the area it will occupy after rendering. For example, no portion of a line segment is rendered if the ideal mathematical line lies outside the effective clipping region (even if its line width would carry some portion of the rendering of it into the clipping rectangle); no portion of a marker is rendered if its location lies outside the clipping rectangle.

If 'locus' clipping is used, the rendering is applied to the locus of the graphic object after clipping. The resulting rendered shape areas may therefore extend outside the effective clipping region.

'Shape' clipping is applied after the abstract rendering of shape in device coordinate space. The 2-dimensional point set associated with the graphic object is intersected with the effective clipping region, which has been transformed to device coordinate space.

'Locus then shape' clipping allows the specification that both 'locus' and 'shape' clipping be applied to graphic objects as described above. In this case however, the rendered shape will not extend outside the effective clipping region. A thick line whose locus is outside the clip rectangle will not have any portion visible even if its line width would carry some portion of the rendering inside the clip rectangle.

Figure 1a shows some examples of the effect of the clipping modes.

When a width or size specification mode is 'scaled', the rendering of shape proceeds in device coordinate space after application of the VDC-to-Device mapping.

When a width or size specification mode is 'absolute', the rendering of shape proceeds, conceptually, in VDC space before application of the copy transformation, before application of the segment transformation and before the VDC-to-Device mapping.

Fill and text primitives do not have associated object clipping modes (though the edge of a fill primitive and the boundary edges of a closed figure do). Clipping for fill primitives is always consistent with 'shape' clipping (see 4.6.4.5). For text primitives, the type of clipping is determined by the associated text precision:

For 'string' precision text, clipping proceeds, on a per string basis, in a manner consistent with 'locus' clipping.

For 'character' precision text, clipping proceeds, on a per character basis, in a manner consistent with 'locus' clipping.

For 'stroke' precision text, the clipping always proceeds in a manner consistent with 'shape' clipping.

NOTE - 'shape' clipping for all text precisions is always allowed by this part of ISO/IEC 8632.

Clip rectangles applied to graphical primitive elements within segments may be subject to transformations in VDC space. Intersection of clip rectangles (untransformed or transformed) may result in polygonal clipping boundaries (see 4.12.5).

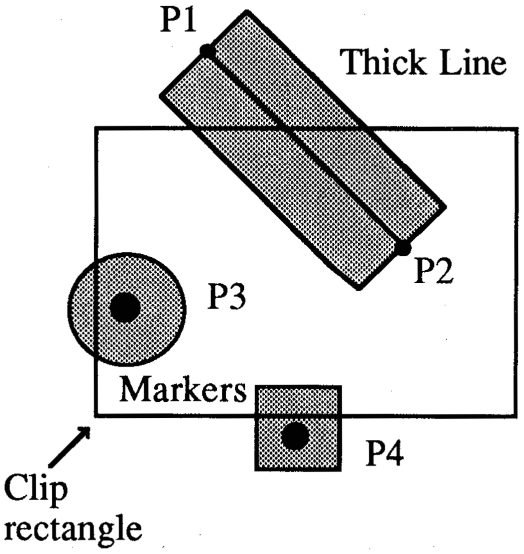
Page 15

Add the following after 4.5.2

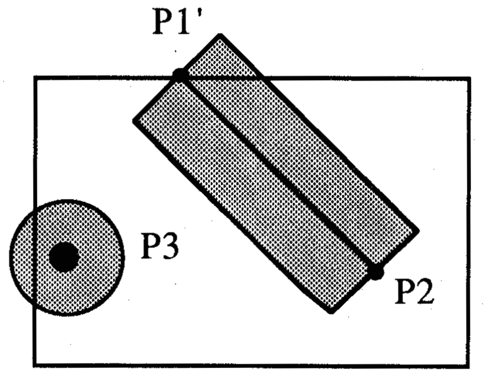
4.5.3 Save and restore primitive context

Two elements are provided to save and restore a context; that is, attributes and control elements as collections. This capability allows a list of attributes and control elements (see 5.5.11) to be stored in the metafile which can be referenced by name at a later point in the metafile. This capability can be used to save and restore attributes and control elements in conjunction with opening and closing segments.

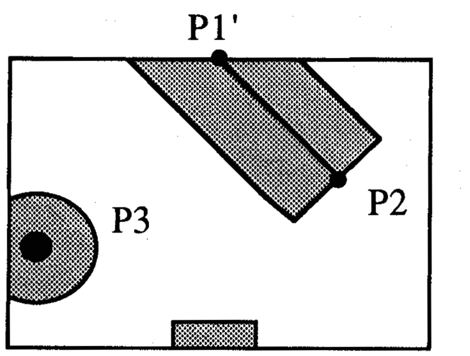
The values for attributes controlled by specification or selection modes are saved in the mode in which they were last specified along with the value of the corresponding mode. In restoring a context the current specification and selection modes are not changed.



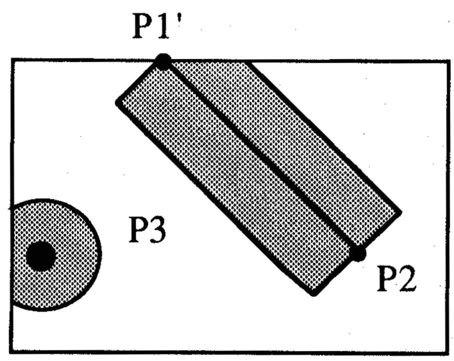
Primitives and clip rectangle stored in the CGM



Picture resulting from 'locus' clipping modes



Picture resulting from 'shape' clipping modes



Picture resulting from 'locus then shape' clipping modes

Figure 1a - Examples of the effects of object clipping modes

Page 15

Add the following to the list of graphical primitive elements and to the list of line elements in sub-clause 4.6:

CIRCULAR ARC CENTRE REVERSED
CONNECTING EDGE

Page 16

Add the following before sub-clause 4.6.1:

In addition to the graphical primitive elements listed above, this part of ISO/IEC 8632 defines elements permitting the definition of 'compound primitives' from several of the other graphical primitives. The following classes of compound primitives are defined: 'compound text' and 'closed figures'. The elements that may be used to specify compound primitives are listed in table 1a.

Table 1a - Contributing primitives to compound primitives

Compound Primitive	First Element	Primitives Included	Other Elements	Final Element
Compound Text	TEXT RESTRICTED TEXT (Note 1)	APPEND TEXT (Note2) GDP (Note 5)		APPEND TEXT (Note 3) GDP (Note 5)
Closed Figure	BEGIN FIGURE	Line Primitives Fill Primitives (Note 4) GDP (Note 5)	NEW REGION	END FIGURE

NOTES

1 The final/not final flag is 'not final'; the primitive defines the reference point of the entire compound text primitive; the text of the primitive is accumulated.

2 The final/not final flag is 'not final'.

3 The final/not final flag is 'final'; the text of the primitive is accumulated before the compound primitive is closed.

4 All primitives of the identified classes may be included.

5 Whether a GDP may contribute to compound text or closed figures, and whether or how it specifies that the compound text state or closed figure state be opened, maintained or closed, is specified with the definition of the GDP in the International Register of Graphical Items.

Graphical primitive elements and compound primitive elements may be subject to transformation in VDC space (segment and copy transformation, see 4.12.4.2 and 4.12.5). Such a transformation may change the shape of some primitives. If there is a skew, a primitive initially specified as a rectangle may become a parallelogram. If there is an anisotropic scaling, a primitive initially specified as a circle may become an ellipse. Note that the shape of markers is not affected by such transformations. Anisotropic transformation will change the angle at which non-parallel lines intersect; isotropic transformation will preserve the angle at which non-parallel lines intersect.

Page 16

Sub-clause 4.6.1.1. Add the following text to the paragraph describing CIRCULAR ARC xxx:

A reverse direction arc can also be specified; see 5.6.20.

Page 16

Add the following at the end of 4.6.1.1:

CONNECTING EDGE A line segment connecting the last point of the preceding line element to the next point is generated during the construction of a closed figure. The next point is either the first point of the next line element or the current closure point.

Page 16

Add the following at the end of 4.6.1.3:

In version 2 metafiles, line clipping is controlled by the LINE CLIPPING MODE element, which can have one of the following values: 'locus', 'shape', or 'locus then shape'. However, clipping applies only if the CLIP INDICATOR is 'on'.

For 'locus' clipping, the mathematical locus of the line is clipped at the intersection with the clip rectangle before shape rendering is applied. Hence, part of the shape of a clipped line may appear outside the clip rectangle.

For 'shape' clipping, the shape of the rendered line is clipped to the intersection with the clip rectangle; that is, nothing is drawn outside the clip rectangle. A portion of a widened line may appear inside the clip rectangle even though the mathematical locus of the line itself may be entirely outside the clip rectangle.

For 'locus then shape' clipping, the mathematical locus of the line is clipped, as with locus clipping, and then subsequently the rendered shape of the clipped locus is again clipped. Note that, since the mathematical locus of the line may have changed as a result of locus clipping, subsequent shape rendering and clipping may produce a different appearance of a line from either of the other two clipping modes.

If the line width is measured in VDC units it is subject to the VDC-to-Device mapping (4.4.7) as well as to both segment and copy transformation (4.12.4.2 and 4.12.5). Note that the entire locus of an arc is subject to these transformations. In the case of an anisotropic mapping or transformation the rendered width of the line will change with the direction of the line segment. If the line width is specified as a scale factor it is not affected by any transformations.

Page 17

Add the following before the first paragraph of 4.6.2.3:

The following discussion applies to version 1 metafiles.

Page 17

Sub-clause 4.6.2.3: at the end of the first paragraph change "is not standardized." to the following:

is not standardized for version 1 metafiles.

Page 17

Add the following at the end of 4.6.2.3:

In version 2 metafiles, marker clipping is controlled by the MARKER CLIPPING MODE element, which can have one of the following values: 'locus', 'shape' or 'locus then shape'. However, clipping applies only if the CLIP INDICATOR is 'on'.

For 'locus' clipping, the specifying points of each marker are clipped at the intersection with the clip rectangle before shape rendering is applied. The marker is only visible if its specifying point is within the clip rectangle. Hence, part of the shape of a marker may appear outside the clip rectangle providing its specifying point is within the clip rectangle.

For 'shape' clipping, the shape of the rendered marker symbols are clipped to the intersection with the clip rectangle; that is, nothing is drawn outside the clip rectangle. Portions of the marker symbol may appear inside the clip rectangle even if the marker's position is outside.

For 'locus then shape' clipping, the clipping is first applied to the specifying points of each marker, as with 'locus' clipping, and then subsequently the rendered shape of the markers are again clipped.

If the marker size is measured in VDC units, it is subject to the VDC-to-Device mapping (4.4.7) as well as to both segment and copy transformation (4.12.4.2 and 4.12.5). The shape of markers is never affected by transformations; for example, a circle used as a marker type shall always appear as a circle. Only the marker size may be transformed. For this purpose, conceptually, vectors with length equal to the marker size and arbitrary orientations are transformed; the resulting marker size is determined by the orientation of the vector which maximizes the length under the transformation.

If the marker size is specified as a scale factor it is not affected by any transformations.

Page 18

Add the following at the end of 4.6.3.3:

Clipping of text strings is described in 4.7.6.

The vectors specified by the CHARACTER ORIENTATION element (4.7.6) are subject to the VDC-to-Device mapping (4.4.7) as well as to both segment and copy transformation (4.12.4.2 and 4.12.5).

Page 19

Add the following at the end of 4.6.4.5:

Edge clipping is controlled by the EDGE CLIPPING MODE element, which has the same enumerations as LINE CLIPPING MODE. Edges are clipped in the same way that lines are clipped; see 4.6.1.3.

Page 19

Add the following after 4.6.4.5:

4.6.4.6 Transformation

The entire mathematical locus of rectangles, circular and elliptical filled-area elements is subject to the VDC-to-Device mapping (4.4.7), segment transformations (2.12.4.2) and copy transformations (4.12.5). Because anisotropic transformation does not preserve angles between non-parallel lines, rectangles may become parallelograms and circles may become ellipses.

The vectors of the PATTERN SIZE element are subject to all transformations.

The edge widths are treated in exactly the same way as line widths (4.6.1.3).

Under certain conditions the clip rectangle is subject to the copy transformation (4.12.5).

Page 20

Add the following after 4.6.7

4.6.8 Closed figures

4.6.8.1 Construction of closed figures

A closed figure is a fill type compound object which commences with a BEGIN FIGURE element, followed by an ordered sequence of line and fill primitives (and optionally attributes and NEW REGION elements), and followed by END FIGURE. Edge attribute values are associated with the edge portions of the closed figure and fill attribute values are associated with the complete graphic object. BEGIN FIGURE and END FIGURE elements are delimiter elements; NEW REGION is a control element. The entire fill object is considered as a single unit on interpretation.

4.6.8.1.1 Closure point

The first point of the first line primitive in a new region is the closure point for that region. On interpretation this closure point is retained for use in closing the region. When the region is closed (with a NEW REGION or END FIGURE element, or by a fill primitive which begins a new region) an implicit boundary portion from the last point of the last line primitive in the region to this closure point is added to the closed figure on interpretation, unless these points are already coincident.

4.6.8.1.2 Regions

A closed figure consists of one or more regions. A region has a closed boundary which may be concave, convex, or self intersecting. A region is formed either by invoking a fill primitive inbetween BEGIN FIGURE and END FIGURE elements (FIGURE OPEN state; see 4.10) which closes the last region and contributes one or more complete regions, by invoking NEW REGION to start new regions to be formed from line primitives, or by a final invocation of END FIGURE. A closed figure constructed from only line primitives without use of NEW REGION consists of a single region.

The NEW REGION element may occur at any time during the closed figure construction. If the current region is closed, the element is ignored on interpretation. If the current region is open, an implicit boundary portion is added from the last point of the last primitive to the current closure point unless CONNECTING EDGE has been invoked after the last line primitive, in which case, an explicit boundary portion and edge portion is added by the CONNECTING EDGE line primitive.

4.6.8.2 Boundaries and edges

The boundary of each region consists of a combination of implicit boundary portions and edge portions.

4.6.8.2.1 Explicit boundary portions

Explicit boundary portions and edge portions are those added by the inclusion of primitives during closed figure construction. These are generated in the following situations:

- For fill primitives other than POLYGON SET, the complete edge becomes an explicit boundary portion and edge portion in the closed figure.

- For line primitives, those portions which would be rendered outside closed figure construction become explicit boundary portions and edge portions. In particular for DISJOINT POLYLINE, only the segments from the first point to the second point, from the third point to the fourth point, and so on, become explicit boundary portions and edge portions when incorporated into closed figures.

- A CONNECTING EDGE primitive which precedes an action which would normally have added an implicit boundary portion to the closed figure either to close a region (including closing the closed figure itself) or to connect two line primitives results in the portion added being an explicit boundary portion and edge portion. CONNECTING EDGE preceding or following DISJOINT POLYLINE or POLYGON SET does not affect the interpretation of those elements with respect to boundaries and edges.

Edge portions have associated edge attribute values taken from the current attribute values on interpretation. These values can be changed between the line and fill primitives that result in edge portions in a closed figure, and hence each edge portion has a distinct set of attribute values associated with it.

4.6.8.2.2 Implicit boundary portions

Edge attributes are never associated with implicit boundary portions. Implicit boundary portions are only rendered on interpretation for interior style HOLLOW and are a special representation of the interior, not a representation of any portion of the edge.

Implicit boundary portions are added on interpretation to the closed figure definition under the following circumstances:

- When NEW REGION, END FIGURE, or a fill primitive is interpreted and the current region has not been explicitly closed and CONNECTING EDGE has not occurred since the last line primitive, an implicit boundary portion is added from the last point of the last primitive to the current closure point to close the region.

- When the last point of the preceding line primitive is not coincident with the first point of the current line primitive, an implicit boundary portion is created to connect the last point of the preceding line primitive to the first point of the current line primitive.

- When portions of a DISJOINT POLYLINE primitive would not normally be rendered (i.e. from the second point to the third point, from the fourth point to the fifth point, and so on), implicit boundary portions are added between these points. (These are additional to the ones which may be added to connect to a preceding or following line primitive or to effect region closure after the disjoint polyline.)

- The portions of a POLYGON SET primitive as described below.

4.6.8.2.3 Conditions under which no boundary or edge is added

No boundary or edge portion is ever created connecting two regions, regardless of how those regions were created or closed.

4.6.8.3 Contribution of primitive elements to the closed figure

4.6.8.3.1 Contribution of line elements to the closed figure

For line primitives, the 'first point' of a line primitive is connected to the 'last point' of the preceding line primitive, and the connecting implicit boundary portion becomes part of the boundary of the closed figure on interpretation. For each of the line primitives the first and last points are defined to be as follows:

POLYLINE p1, p2, ..., pn:
p1 is the first point; pn is the last point.

DISJOINT POLYLINE p1, p2, ..., pn:
p1 is the first point; pn is the last point.

CIRCULAR ARC 3 POINT p1, p2, p3:
p1 is the first point; p3 is the last point.

CIRCULAR ARC CENTRE:
CIRCULAR ARC CENTRE REVERSED:
The first point is the intersection of the circle with the ray (dx start, dy start) from the centre point (i.e. the clockwise end of the arc for CIRCULAR ARC CENTRE, the anti-clockwise end of the arc for CIRCULAR ARC CENTRE REVERSED); the last point is the intersection of the circle with the ray (dx end, dy end) from the centre point (i.e. the anti-clockwise end of the arc for CIRCULAR ARC CENTRE, the clockwise end of the arc for CIRCULAR ARC CENTRE REVERSED).

ELLIPTICAL ARC:
The first point is the intersection of the ellipse with the ray (dx start, dy start) from the centre point; the last point is the intersection of the ellipse with the ray (dx end, dy end) from the centre point.

GENERALIZED DRAWING PRIMITIVE:
For GDPs which generate line primitives, the first point is the first point of the point list; and the last point is the last point of the point list, as defined in the in the GDP registration and associated documentation.

CONNECTING EDGE:
If the region is open, the start point of the connecting edge is the last point of the last line primitive, and the end point of the connecting edge is either the first point of the following primitive or the current closure point as described above. If the connecting edge would be of zero length (i.e. if the two points it connects are coincident), the element is ignored on interpretation. The current modal values of the edge attributes are associated with any edge portion generated by this element.

If the current region is not open, invocations of the CONNECTING EDGE elements encoutered are ignored on interpretation (i.e. CONNECTING EDGE shall not be used to connect regions).

Invoking CONNECTING EDGE multiple times after a line primitive results in the first instance (with its associated attributes) being used on interpretation.

On interpretation the theoretical definitions of the line primitives, not their renditions on the display surface, are used to define the explicit boundary portions of the closed figure. In particular, clipping does not apply to the construction of the closed figure, and the gaps or spaces of the edge type or the rendered width of the edge width do not affect the definition of the boundary of the closed figure.

4.6.8.3.2 Contribution of fill elements to the closed figure

Each fill primitive contributes a complete region to the figure (POLYGON SET may contribute more than one), after first closing the current region if one is open. On interpretation, an implicit NEW REGION is performed before and after a fill primitive (i.e. the new region resulting from a fill primitive is closed, and the next primitive begins a new region.)

The unclipped boundary of each fill primitive contributes to the unclipped boundary of the closed figure.