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Information technology — Font information interchange —

Part 3: Glyph shape representation

Technologies de l'information — Échange d'informations sur les fontes —

Partie 3: Représentation de la forme de glyphes

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Contents

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 9541-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 18, *Document processing and related communication*.

ISO/IEC 9541 consists of the following parts, under the general title *Information technology — Font information interchange*:

— *Part 1: Architecture*

— *Part 2: Interchange Format*

— *Part 3: Glyph shape representation*

— *Part 4: Application-specific requirements*

Part 1 of ISO/IEC 9541 specifies the architecture of a font resource, i.e., the font description, font metrics, glyph description and glyph metrics properties required for font references and the interchange of font resources.

Part 2 of ISO/IEC 9541 specifies the interchange formats for font information, and the minimum subsets of that information required for interchange.

Part 3 of ISO/IEC 9541 specifies the architecture and interchange formats for glyph shape representations.

Part 4 of ISO/IEC 9541 specifies the architecture and interchange format extensions for application specific (e.g. typesetting of mathematics) requirements.

Annex A forms an integral part of this part of ISO/IEC 9541. Annexes B, C and D are for information only.

Introduction

The use of open networks for the interchange of documents in both office and publishing environments has shown the need for a mechanism enabling the interchange of font information.

It is foreseen that publishing and office technologies will merge and that this development will be facilitated by definition of a standard font resource architecture and a limited number of standard font resource interchange formats.

Information technology — Font information interchange —

Part 3:
Glyph shape representation

Section 1: General

1.1 Scope

ISO/IEC 9541, as a whole, specifies the architecture of font resources, as well as the formats for font interchange among information processing systems. It also specifies the architecture and formats that can be used to construct font references in general electronic document interchange.

This part of ISO/IEC 9541 specifies the architecture and interchange formats of glyph shape representations.

Font resources represented using the architecture and interchange formats defined in parts 1 and 2 of ISO/IEC 9541 are used in various document processing environments in which ASN.1 or SGML parsing algorithms are recognized. The encoding of font resource information as defined in this part of ISO/IEC 9541 is specified in both ASN.1 and SGML representations for consistent generation of font resources for use in these processing environments.

1.2 Conformance

A font resource conforming to this part of ISO/IEC 9541 is a conforming ISO/IEC 9541 font resource. The font resource must conform to the conformance conditions stated in clause 2 of ISO/IEC 9541-2:1991. A conforming implementation of the glyph procedure interpreter shall have the following minimum capabilities:

— represent at least numbers in the range of −8 000 to +8 000 with at least 12 bits of fractional information;

— hold at least 24 objects in the operand list.

1.3 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 9541. 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 9541 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 8824:1990, *Information technology — Open Systems Interconnection — Specification of Abstract Syntax Notation One (ASN.1).*

ISO/IEC 8825:1990, *Information technology — Open Systems Interconnection — Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*

ISO 8879:1986, *Information processing — Text and office systems — Standard Generalized Markup Language (SGML).*

ISO/IEC 9070:1991, *Information technology — SGML support facilities — Registration procedures for public text owner identifiers.*

ISO/IEC 9541-1:1991, *Information technology — Font information interchange — Part 1: Architecture.*

ISO/IEC 9541-2:1991, *Information technology — Font information interchange — Part 2: Interchange Format.*

ISO/IEC 10036:1993, *Information technology — Font information interchange — Procedure for registration of glyph and glyph collection identifiers.*

1.4 Notation

The formal structure of glyph shape properties is specified using the BNF notation described in clause 4 of ISO/IEC 9541.

1.5 Overview of glyph shape representation

Each glyph shape representation technique makes use of different properties in specifying glyph shapes and therefore has its own architecture and interchange format. In this part of ISO/IEC 9541 each glyph shape representation technique is defined in a separate section. The glyph shape representation currently defined is

— ISO Standard Type 1 Glyph Shape Representation (specified in section 2)

NOTE 1 This part of ISO/IEC 9541 may be extended in the future by the addition of further sections specifying additional glyph shape representation techniques.

Glyph shape representations are divided into two broad categories: outline and bitmap representations of glyph shapes.

An outline representation describes a glyph using a mathematical description of the edges of glyph shapes. This has the advantage of allowing transformations such as scaling, rotation, and skewing, and permits many variations of style without additional storage requirements. An outline format also facilitates incorporation of added scaling information, called hints, which aid in the preservation of proportions for all sizes of raster grids (however, their usefulness is not confined to raster devices). Hints can also aid in achieving nonlinear scaling as an optical correction for different absolute sizes of presented glyphs.

For raster devices, outline fonts are converted, after adjustments for scaling requirements, to bitmap representations for final imaging and presentation. However, the presentation of outline glyph shape descriptions is not limited to raster devices; it may also include vector devices such as plotters, signage cutters, engraving machines, or variable spot size raster and gravure devices. Different shape representation techniques may vary in their appropriateness for different presentation devices.

Bitmap representations describe the pattern of pels which are required for printing on raster devices. Bitmap glyph representations are less capable of being scaled or transformed in arbitrary ways while retaining a high standard of typographic quality. Bitmaps of glyph shapes can be represented either as ordered columns or rows of dots, or by a variety of schemes designed to provide more compact representations, particularly for larger sizes.

1.6 Specification of glyph shapes (GSHAPES)

Any font resource conforming to ISO/IEC 9541 and containing glyph shape information shall contain a GSHAPES property. GSHAPES is a property-list of shape-property-lists defining the sets of shape information associated with this font resource.

```
shapes-property-list ::= shapes-name, shapes-value-property-list
shapes-name ::= STRUCTURED-NAME  -- ISO/IEC 9541-3//GSHAPES
shapes-value-property-list ::= (t1-shape-property-list | property-list)*
```

This architecture allows any glyph shape representation to be defined. The architecture for ISO/IEC 9541 Standard Shape Representation Type 1 is defined in section 2.

1.7 Extensions to the font interchange format

ISO/IEC 9541 font information shall be interchanged using either the ASN.1 or SGML forms defined in ISO/IEC 9541-2. These interchange formats include "markers" to include a definition for interchange formats for glyph shape information. These formats are defined in this clause with further definitions of the detailed format for each glyph shape representation included in equivalent clauses in each of the following sections.

1.7.1 ASN.1

```
ISO9541-GSHAPES { 1 0 9541 3 0 } DEFINITIONS ::= BEGIN
IMPORTS T1-Shape-Property-List  FROM ISO9541-GST1 { 1 0 9541 3 0 0 }
Glyph-Shapes    ::= SET {
t1-shape-property-list      [0]  EXTERNAL  T1-Shape-Property-List  OPTIONAL,
                                 -- see Section 2 of this part
non-iso-properties          [99] IMPLICIT Property-List            OPTIONAL }
```


1.7.2 SGML

```
<!-- (c) International Organization for Standardization 1994
     Permission to copy in any form is granted for use with conforming
     SGML systems and applications as defined in ISO 8879:1986;
     provided this notice is included in all copies. -->
<!-- Public document type definition.  Typical invocation:
     <!DOCTYPE gshapes PUBLIC "ISO 9541-3:1994//DTD Glyph Shapes//EN">  -->
<!ELEMENT gshapes - o  (t1shapes? & niprop*)            -- GLYPHSHAPES -->
<!-- Type 1 shape information. Typical invocation:
     <!DOCTYPE t1shapes PUBLIC "ISO 9541-3:1994/DTD Type 1 Glyph Shapes//EN
-->
```

Section 2: Type 1 glyph shape representation

2.1 Scope

This section specifies the architecture and interchange format of one standard Glyph Shape Representation: ISO/IEC 9541 Standard TYPE 1. This representation technique is appropriate for, but not limited to, presentation on raster devices of low, moderate, and high resolution.

2.2 Definitions

The following definitions are specific to this section.

2.2.1 ciphertext: Information which has been encrypted.

2.2.2 current point: The last point referenced by a path-construction operator in the glyph description language; this point may be either the end point of the most recently drawn line or curve or the point most recently positioned by an rmoveto or setcurrentpoint operator.

2.2.3 encryption key: Integer number required for encrypting or decrypting a glyph procedure.

2.2.4 font program: A computer program incorporating a structured set of glyph procedures and descriptive data.

2.2.5 ghost stem: An imaginary horizontal stem, applied only at the Max-Y and Min-Y extents of a glyph, for which an hstem hint operator must be specified if correct vertical alignment is required.

2.2.6 glyph procedure: A computer program written using the standard glyph shape description operators defined in this section and represented in the interchange format defined herein.

2.2.7 glyph procedure interpreter: A computer process capable of interpreting a glyph procedure for the purpose of constructing an outline representation of the glyph and the associated data structure required for scan conversion.

2.2.8 hint: A procedural or declarative specification of information additional to the geometric shape of a glyph, which aids in the preservation of proportions and features of that glyph during rasterizing for presentation on a raster device.

2.2.9 overshoot: The part of a rounded or pointed glyph extremity which extends slightly beyond the position of flat-shaped extremities; used to achieve optically correct vertical alignment of glyphs for the horizontal writing mode.

2.2.10 path: A possibly disjoint set of subpaths and regions, constructed by one or more path construction operators; the set of all subpaths in a glyph is a single path.

2.2.11 plaintext: Information which is not encrypted.

2.2.12 rasterization: A two-step process which involves determining the areas of a glyph which must be filled, and then creating a bitmap to represent those areas.

2.2.13 region: A geometric area.

2.2.14 segment: The curve or straight line generated by a single graphics drawing command; the curve or straight line between consecutive points on the path defining a glyph shape.

2.2.15 snap: A mechanism for forcing a collection of glyph stems of varying nominal widths (in their device independent outline representation) to convert to the same width when converted to a bitmap representation.

2.2.16 subpath: A sequence of connected straight or curved line segments constructed by one or more path construction operators.

2.2.17 typographic color: The relative boldness of the presented font; based on the relative width of the dominant type of stems in the font; also a comparative measure of the surface area of the presented glyph shapes relative to the area of the presentation surface.

2.3 Overview of Type 1 glyph shape representation architecture

Type 1 glyph shape representation is an outline font representation which uses graphical drawing operators to describe the shape of a glyph. This approach has the advantage that the glyph can be scaled, rotated, and transformed in various ways, and can be rasterized to create a bitmap for presentation. Properties defining glyph shapes may be either procedural constructs or additional declarative data defined at the font or glyph level.

The glyph procedures may contain optional declarative hints. Hints consist of information in the font program which assists the glyph procedure interpreter in preserving the proportions and features of a glyph as it is scaled and optimized for the pel grid of a raster device, but their usefulness is not limited to this application. Font-level hints may be defined for the entire font and help to control the alignment and stem widths. Glyph-level hints apply only to the glyph in which they are defined, and primarily help to control the rasterization of vertical and horizontal stems.

Glyph shapes are defined by procedural constructs and additional declarative data called *properties*. These additional data help to accomplish a variety of goals:

— General Properties help to identify the font program and the type of glyph shape representation used (see 2.6.1).

— Typographic color properties help to control the apparent weight of scaled and presented glyphs as well as to achieve uniform stroke widths (see 2.6.2).

— Glyph procedure properties primarily provide parameters and subroutines for use by glyph procedures (see 2.6.3).

NOTE 2 Glyph shape representations which conform to this part of ISO 9541 constitute computer programs or procedures and as such may be subject to protection under laws covering intellectual property rights.

This section defines the properties of glyph shapes in the following clauses:

2.4 explains Type 1 glyph shape concepts
2.5 explains the glyph procedure interpreter model
2.6 defines Type 1 glyph shape properties
2.7 defines glyph-level procedure semantics
2.8 defines the use of subroutine procedures
2.9 defines the interchange format

2.4 Type 1 glyph shape concepts

The following clauses explain concepts related to the Type 1 glyph shape technology.

2.4.1 Glyph coordinate system

The Type 1 glyph shape technology uses a continuous glyph coordinate system as described in subclause 8.2 of ISO/IEC 9541-1:1991.

NOTE 3 Throughout this section, any example value specified as a constant number of units is based on an assumption of a RELUNITS value of 1 000.

2.4.2 Glyph procedure language

The glyph procedure language is used to specify glyph shapes and hinting parameters. This language allows the specification of one path, which may consist of multiple disjoint subpaths. After constructing the entire path, the glyph procedure interpreter causes the glyph to be filled or stroked as one entity, depending on the value of the PAINTTYPE property.

2.4.3 Glyph procedure interpreter

The glyph procedure interpreter is a virtual machine (see 2.7.1) which interprets glyph procedures written in the glyph procedure language.

2.4.4 Alignment position

An alignment position is a single position offset which refers to a y-coordinate at which glyph extremities may align in the y direction. Alignment positions are only used in pairs to define alignment zones (see 2.4.8) for font resources with WRMODENAME values of LEFT-TO-RIGHT or RIGHT-TO-LEFT. A font resource with an ALIGNNAME value of BASE-ALIGN has its baseline on the x-axis. Alignment positions are specified by the BLUEVALUES and OTHERBLUES font-level properties and are specified in pairs consisting of a *flat* and an *overshoot* position (see 2.4.5 and 2.4.6).

Font resources with a WRMODENAME value of TOP-TO-BOTTOM, or an ALIGNNAME value of CENTRE-ALIGN, such as those containing East Asian ideographic glyphs, generally have glyphs centered on a single alignment position (which need not be specified in the font), and do not have separate alignment positions for extremities of the glyph shapes.

2.4.5 Flat position

A flat position is the alignment position to which primarily flat shaped glyph extremities align. The judgment as to what a flat shape is depends on an artistic decision by the typeface designer. Extremities which are judged to be almost flat may also be considered to be appropriate to align to a flat position. The concept of a flat position is not applicable to fonts with an ALIGNNAME value of CENTRE-ALIGN, or a WRMODENAME value of TOP-TO-BOTTOM.

2.4.6 Overshoot position

The overshoot position is an alignment position associated with, and occurring just beyond, a flat position (see figure 1), to which non-flat glyph extremities may align. The purpose is to allow glyphs of various shapes to appear to align precisely, allowing for optical illusions, in the vertical direction. The overshoot position is not applicable to fonts with an ALIGNNAME value of CENTRE-ALIGN, or a WRMODENAME value of TOP-TO-BOTTOM.

NOTE 4 Which glyphs require overshoots, and how much a glyph extremity extends past the flat position in the ideal outline representation, is a decision made by the typeface designer or developer. The Outline Modification and Intelligent Fill (rasterization) process (not part of this part of ISO/IEC 9541: see figure 7) may control these extensions so that the resulting bitmap representation exhibits correct vertical alignment for the required size of glyph and characteristics of the presentation device.

2.4.7 Overshoot suppression

Overshoot suppression refers to a mechanism for not allowing overshoots to be rasterized at small sizes even though the scaling process might otherwise cause the overshoot features to round to one pel beyond the flat position.

2.4.8 Alignment zone

An alignment zone is the area lying between two alignment positions—beginning at a flat position and extending to the maximum overshoot position of the tops of glyphs (termed a *top zone*), or from a maximum overshoot

position to the flat position of the bottoms of glyphs (a *bottom zone*). There may be multiple such zones. One bottom and two top zones are shown in figure 1. The concept of an alignment zone is not applicable to fonts with an ALIGNNAME value of CENTRE-ALIGN, or a WRMODENAME value of TOP-TO-BOTTOM.

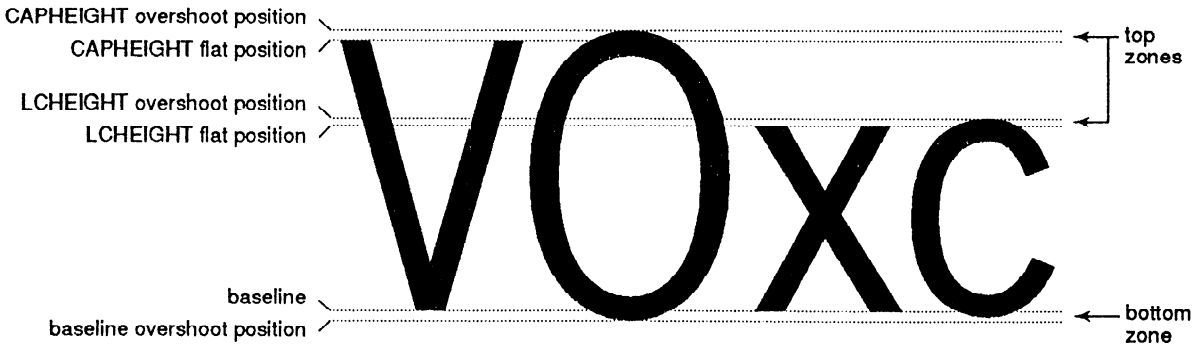

Figure 1 — Three alignment zones, showing flat and overshoot positions for top and bottom zones

2.4.9 Hints

Hint information may be of two general types: font-level and glyph-level. Font-level hints are declared as properties and contain parameters which apply to all glyphs in the font. Font-level hints allow specification of alignment zones to control vertical alignment as well as to control stem widths for all glyphs in the font resource (see 2.6.2.8.1 through 2.6.2.8.5). Glyph-level hints are declared in glyph procedures, using glyph procedure operators, and apply only to the glyph procedure in which they are defined.

Within a glyph procedure, glyph-level declarative hints may be added to control the rasterization of horizontal and vertical stems. Stems may be either straight or curved. The hint operators indicate to the glyph procedure interpreter the *hint zone* (see 2.4.10) which extends from the coordinate specified by the first operand to the relative position indicated by the second operand. The *hstem* hint is used to control the number of pels, measured vertically, to which a horizontal stem is converted. The *vstem* hint is used to control the number of pels, measured horizontally, to which a vertical stem is converted. For the hint operators to be effective, the operands must refer to the exact coordinates of segment endpoints which are at the extremities of the stem.

This allows the glyph procedure interpreter to adjust the glyph outlines to help preserve design features and proportions for scaling to various sizes and resolutions. Figure 2 shows examples of hstem and vstem hints as applied to a Kanji glyph. This illustration shows a detail of the glyph which shows the path segment endpoints and the corresponding boundaries of the associated hstem hint zone.

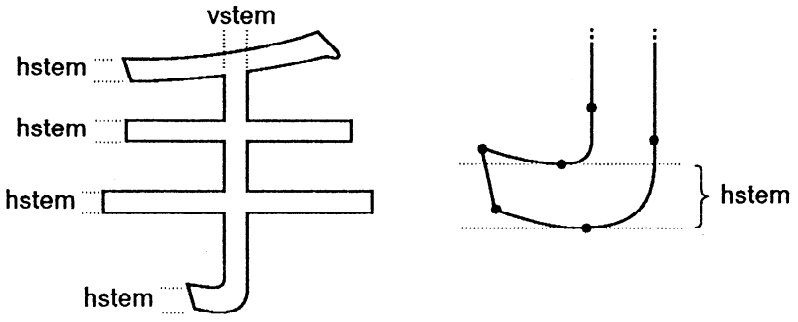

Figure 2 — Hstem and vstem examples