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2. PEX Protocol Specification

2.1. Request Processing

Workstation regeneration and requests which process output commands are not guaranteed to be atomic with respect to concurrent rendering to the same destination drawable. However atomicity of execution is guaranteed for each individual output command primitive, excluding Execute Structure, GSE, GDP 3D, and GDP 2D. Also, requests and output commands will be executed in sequential order for a given connection.

2.2. Protocol Format

2.2.1. Request Format

Requests are listed in section 2.8 and in section 4 through the end of the document. Output Commands are described in section 3.

2.2.2. Reply Format

Replies are listed after the request.

2.2.3. Error Format

See section 2.5.7 for the encoding of particular errors.

2.2.4. Event Format

See section 2.6 for the encoding of events.

2.3. Syntax

As far as possible, this document uses the layout and syntactic conventions used in the X encoding document. In particular, note that all numbers are decimal, unless prefixed by #x, in which case they are hexadecimal. Also note that, for entities of a variable size, E, the notation pad(E) indicates the number of bytes required to pad the entity to a multiple of 4 bytes.

There are some unavoidable differences from the X encoding document conventions, however, because of the many variable sized entities and entities with optional data in PEX.

2.4. Naming Conventions

The names of the fields in requests, replies and lists of values match the names used in the *PEX Protocol Specification*.

2.5. Common Types

The types listed in this section are some of the types mentioned in the PEX protocol. Generally, derivative types (e.g. ENUM_TYPE_INDEX) are replaced by the primitive or primitives of which they are composed (e.g. INT16). Only when this is impractical is the derivative type used; generally this is when the type is of variable length or a list of compound types is used.

2.5.1. LISTofFOO

In this document, a LISTofFOO is a counted list of elements of type FOO, the count field preceding it in the request or reply.

In cases where the number of items in the list is easily computed from the length of the list, the number of items may not be supplied. (See, for example, the **Polyline3D** output command.) The goal is to reduce the burden on the client. Such cases are indicated in the encoding document.

There is also no count provided for a list that has an associated item_mask.

Unless otherwise marked, a LISTofLISTofFOO is implemented as follows: somewhere in the request or reply there is a number of lists field (perhaps several if there are multiple lists of lists). Each LIST is preceded by a CARD32 count field.

So the overall format is:

4	CARD32	number of lists
. . .		(potentially other things here)
4	CARD32	number of items in first list
n	FOO	first item of first list
n	FOO	second item of first list
. . .		
n	FOO	last item of first list
4	CARD32	number of items in second list
n	FOO	first item of second list
. . .		

In only one place in the PEX protocol is a LISTofLISTofLISTofFOO required, in the **SetOfFillAreaSets** output command. In this case, the number of lists is a CARD16. Other counts within the list are CARD16.

The format of this is:

2	CARD16	number of lists of lists
. . .		(potentially other things here)
2	CARD16	number of lists in first list of list
2	CARD16	number of items in first list
n	FOO	first item of first list
n	FOO	second item of first list
. . .		
n	FOO	last item of first list
2	CARD16	number of items in second list
n	FOO	first item of second list
. . .		
2	CARD16	number of lists in second list of list
2	CARD16	number of items in first list
n	FOO	first item of first list
n	FOO	second item of first list

. . .

n	FOO	last item of first list
2	CARD16	number of items in second list
n	FOO	first item of second list
. . .		
2	CARD16	number of lists in last list of list
2	CARD16	number of items in first list
n	FOO	first item of first list
n	FOO	second item of first list
. . .		
n	FOO	last item of first list
2	CARD16	number of items in second list
n	FOO	first item of second list
. . .		

2.5.2. BITMASK and LISTofVALUE

Because the values in a value list are of variable size, a list of values can only be interpreted serially; there is no way to find the Nth element without examining the N-1 previous elements.

Elements have all been padded to a multiple of 4 bytes. If values appear which could be encoded in less space, it is assumed that they will be placed in the least significant bits of the word. (Byte-swapping may occur between the client and the server.)

2.5.3. Floating Point Format - FLOAT

A FLOAT is a floating point quantity in one of the server supported formats. If the client wishes to communicate with the server in other than the server's native floating point format, the server must perform the necessary conversions. The format word of a request tells the server what format the client wishes to use.

Depending on the floating point format, the size of a FLOAT may be 4 or 8 bytes. Floating point values passed to the server may be in any one of the registered floating point formats:

1	IEEE_754_32	4 bytes
2	DEC_F_Floating	4 bytes
3	IEEE_754_64	8 bytes
4	DEC_D_Floating	8 bytes

Equations are provided for computing the length of the requests that contain floating point values, however these equations assume that one of the four registered floating point formats is being used. In all of these equations, the name *fp* refers to the size in bytes of a FLOAT in the floating point format indicated in the format word of the request.

2.5.4. Colors

Colors passed to the server may be of any one of the registered color types:

0	Indexed
1	RGBFloat
2	CIEFloat
3	HSVFloat
4	HLSFloat
5	RGBInt8
6	RGBInt16

Equations are provided for computing the length of the requests that contain colors, however these equations assume that one of the seven registered color types and one of the four registered floating point formats is being used.

2.5.5. Element Types

2.5.6. Types

Some PEX requests and replies contain matrices. These are denoted in this document as FLOAT[4][4] or FLOAT[3][3]. The elements of the matrices are sent over the wire in a row-wise manner. That is, the element of a 4×4 transformation matrix that indicates the translation in the X direction is the fourth element sent.

The following compound types appear in the rest of the encoding document. For a complete list of types refer to the protocol document. If a variable is given which computes the length of a compound type (e.g., the equation for d in OPT_DATA), that variable may be used later to express the length of a request or reply (e.g. the **TriangleStrip** output command).

CHARACTER

1	CARD8		byte character
		or	
2	CARD16		short character
		or	
4	CARD32		long character

COLOR

n = ((color type == Indexed)||(color type == RGBInt8) ? 1 : ((color type == RGBInt16) ? 2 : 3**fp*/4)
(color type is obtained from elsewhere in the request or output command)

4n	color value

COLOR_SPECIFIER

n = ((color type == Indexed)||(color type == RGBInt8) ? 1 : ((color type == RGBInt16) ? 2 : 3**fp*/4)

2	color type
2	unused
4n	color value

COORD_2D

fp	FLOAT	x
fp	FLOAT	y

COORD_3D

fp	FLOAT	x
fp	FLOAT	y
fp	FLOAT	z

COORD_4D

fp	FLOAT	x
fp	FLOAT	y
fp	FLOAT	z
fp	FLOAT	w

DC_HIT_BOX_DATA

2	INT16	x
2	INT16	y
fp	FLOAT	pick distance

DEVICE_COORD

2	INT16	x
2	INT16	y
fp	FLOAT	z

DEVICE_RECT

2	INT16	xmin
2	INT16	ymin
2	INT16	xmax
2	INT16	ymax

DIRECT_COLOR

n = ((color_type == RGBInt8) ? 1 : ((color_type == RGBInt16) ? 2 : 3**fp*/4)

4n		direct color

ELEMENT_REF

4	CARD32	structure ID
4	CARD32	offset

ENUM_DESC

2	INT16	index
2	n	string length
n	LISTofCARD8	string
p		unused, p=pad(n)

EXTENT_INFO

fp	FLOAT	lower left x
fp	FLOAT	lower left y
fp	FLOAT	upper right x
fp	FLOAT	upper right y
fp	FLOAT	concatpoint x
fp	FLOAT	concatpoint y

FACET

(maximum size, some fields may be missing, see below)

df	OPT_DATA	facet data (c and n may be set, but s is never set)
4	nv	number of vertices in list
nv(3**fp*+dv)	LISTofVERTEX	vertices

(let f be the size of a FACET in bytes.
let df be the size of the per facet OPT_DATA.
let dv be the size of the per vertex OPT_DATA.
fc is true if facet attributes specifies a color is present.
fn is true if facet attributes specifies a normal is present.

let sc be the size of a direct color in bytes.
sc = (color type == RGBInt8) ? 4 : ((color type == (RGBInt16) ? 8 : 3**fp*)
fi is true if facet color is indexed, false if color is direct. Then
df = (fc ? (fi ? 4 : sc) : 0) + (fn ? 3**fp* : 0)
vc is true if vertex attributes specifies a color is present.
vn is true if vertex attributes specifies a normal is present.
ve is true if vertex attributes specifies an edge flag is present.
vi is true if vertex color is indexed, false if color is direct. Then
dv = (vc ? (vi ? 4 : sc) : 0) + (vn ? 3**fp* : 0) + (ve ? 4 : 0)
so f = 4 + df + nv * (3**fp* + dv)
)

FONTINFO

4	CARD32		first glyph
4	CARD32		last glyph
4	CARD32		default glyph
1			all glyphs exist
	0	False	
	1	True	
1			stroke font
	0	False	
	1	True	
2			unused
4	n		number of properties
8n	LISTofFONTPROP		properties

FONTPROP

4	CARD32	name
4	CARD32	value

HALF_SPACE

fp	FLOAT	point x
fp	FLOAT	point y
fp	FLOAT	point z
fp	FLOAT	vector x
fp	FLOAT	vector y
fp	FLOAT	vector z

HALF_SPACE_2D

fp	FLOAT	point x
fp	FLOAT	point y
fp	FLOAT	vector x
fp	FLOAT	vector y

MONO_ENCODING

2	CARD16		character set
1			character set width (call this value w)
	0	csByte	
	1	csShort	
	2	csLong	

```
        1   CARD8              encoding state
    2                          unused
    2       c                  number of characters
    s       LISTofCHARACTER    string
    p                          unused, p=pad(s)

    (let m be the size of the mono encoding.
    let s be the size of the string in bytes.
    s = (w == 0) ? c : ((w == 1) ? 2c : 4c)
    m = 8 + s + p
    )
```

NAME_SET_PAIR

```
    4       CARD32             inclusion nameset ID
    4       CARD32             exclusion nameset ID
```

NPC_SUBVOLUME

```
    fp      FLOAT              min x
    fp      FLOAT              min y
    fp      FLOAT              min z
    fp      FLOAT              max x
    fp      FLOAT              max y
    fp      FLOAT              max z
```

OPT_DATA

```
    (maximum size, some fields may be missing, see below)
    sc = ((color type == Indexed)||(color type == RGBInt8)) ? 1 : ((color type == RGBInt16) ? 2 : 3*fp/4)
    4sc                        color
    fp      FLOAT              normal x
    fp      FLOAT              normal y
    fp      FLOAT              normal z
    4       CARD32             edges

    (let d be the size of an OPT_DATA in bytes.
    c is true if control word specifies a color is present.
    n is true if control word specifies a normal is present.
    s is true if control word specifies an edge switch is present.
    i is true if color is indexed, false if color is direct.
    f is 1 if color type is RGBInt8
            2 if color type is RGBInt16
            3 otherwise.
    Then d = (c ? ((i || (f == 1)) ? 4 : ((f == 2) ? 8 : 3*fp)) : 0) + (n ? 3*fp : 0) + (s ? 4 : 0)
    )
```

PICK_ELEMENT_REF

```
    4       CARD32             structure ID
    4       CARD32             offset
    4       CARD32             pick identifier
```

PICK_RECORD

n = ((pick type == NPC_HitVolume) ? (6**fp*/4) : (1+*fp*/4))

2	INT16		pick type
2			unused
4n			hit box

RENDERER_TARGET

1	CARD8		depth
1			unused
2			type
	0	don't care	
	1	window	
	2	pixmap	
	3	buffer	
4	CARD32		visual ID

STRING

2	n		length
n	LISTofCARD8		string
p			unused, p=pad(n+2)

STRUCTURE_INFO

4	CARD32		structure ID
fp	FLOAT		priority

TRIM_CURVE

1			visibility
	0	Off	
	1	On	
1			unused
2	CARD16		order
2			type
	0	Rational	
	1	NonRational	(t = (type == Rational) ? 3 : 2)
2	INT16		approximation method
fp	FLOAT		approximation tolerance
fp	FLOAT		tmin
fp	FLOAT		tmax
4	k		number of knots
4	p		number of points
*fp**k	LISTofFLOAT		knots
*fp**p*t	LISTofCOORD		points (COORD_3D or COORD_2D depending on t)

(let c be the size of a TRIM_CURVE in bytes.)
(c = 16 + *fp* * (3 + k + p*t))

VERTEX

fp	FLOAT		point x
fp	FLOAT		point y
fp	FLOAT		point z
d	OPT_DATA		data (see OPT_DATA for d)

(let v be the size of a VERTEX in bytes.)
(v = 3*fp + d)

2.5.7. Errors

BEC is the base error code for the extension, as returned by **QueryExtension**.

ColorType

1	0	Error
1	*BEC*+0	code
2	CARD16	sequence number
4	CARD32	bad color type
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

RendererState

1	0	Error
1	*BEC*+1	code
2	CARD16	sequence number
4	CARD32	renderer ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

FloatingPointFormat

1	0	Error
1	*BEC*+2	code
2	CARD16	sequence number
4	CARD32	bad format
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

Label

1	0	Error
1	*BEC*+3	code
2	CARD16	sequence number
4	CARD32	bad label
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

LookupTable

1	0	Error
1	*BEC*+4	code
2	CARD16	sequence number
4	CARD32	bad table ID
2	CARD16	minor opcode
1	CARD8	major opcode

21		unused

Nameset

1	0	Error
1	*BEC*+5	code
2	CARD16	sequence number
4	CARD32	bad nameset ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

Path

1	0	Error
1	*BEC*+6	code
2	CARD16	sequence number
4	CARD32	index of bad path element
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

PEXFont

1	0	Error
1	*BEC*+7	code
2	CARD16	sequence number
4	CARD32	bad font ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

PhigsWKS

1	0	Error
1	*BEC*+8	code
2	CARD16	sequence number
4	CARD32	bad PHIGS workstation ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

PickMeasure

1	0	Error
1	*BEC*+9	code
2	CARD16	sequence number
4	CARD32	bad device ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

PipelineContext

1	0	Error
1	*BEC*+10	code

2	CARD16	sequence number
4	CARD32	bad pipeline context ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

Renderer

1	0	Error
1	*BEC*+11	code
2	CARD16	sequence number
4	CARD32	bad renderer ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

SearchContext

1	0	Error
1	*BEC*+12	code
2	CARD16	sequence number
4	CARD32	bad search context ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

Structure

1	0	Error
1	*BEC*+13	code
2	CARD16	sequence number
4	CARD32	bad structure ID
2	CARD16	minor opcode
1	CARD8	major opcode
21		unused

OutputCommand

1	0	Error
1	*BEC*+14	code
2	CARD16	sequence number
4	CARD32	renderer ID or structure ID
2	CARD16	minor opcode
1	CARD8	major opcode
1	CARD8	unused
2	CARD16	opcode of output command
2	CARD16	number of output commands in the request that were processed successfully
16		unused

2.5.8. Resource IDs

Some resources have attributes that contain IDs of other resources. It is possible for the referenced resource to be freed while the referencing resource remains in use. Attempts to query attributes containing the resource ID of a resource that has already been freed will return the value *AlreadyFreed* (whose value equals one).

2.6. Events

BEC is the base event code for the extension, as returned by **QueryExtension**.

MaxHitsReached

1	*BEC*+0	code
1		unused
2	CARD16	sequence number
4	CARD32	renderer id
24		unused

2.7. Padding

The contents of pad bytes is explicitly left undefined. In some cases, the length of a field is followed by its type which is shorter than the stated length of the field (e.g., "distinguish 4 CARD8"). In these cases, the value is placed in the least significant bits of the word and the entire word is byte swapped.

2.8. Extension Information

PEXGetExtensionInfo

1	CARD8	opcode (X11 assigned)
1	1	PEX opcode
2	2	request length
2	CARD16	client protocol major version
2	CARD16	client protocol minor version

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	(n+p)/4	reply length
2	CARD16	protocol major version
2	CARD16	protocol minor version
4	CARD32	release number
4	n	length of vendor name
4	CARD32	subset info
8		unused
n	LISTofCARD8	vendor
p		unused, p=pad(n)

PEXGetEnumeratedTypeInfo

1	CARD8		opcode (X11 assigned)
1	2		PEX opcode
2	4+(2n+p)/4		request length
4	CARD32		drawable ID
4			item mask
	#x00000001	index	
	#x00000002	mnemonic	
4	n		number of enumerated types
2n	LISTofCARD16		enum types

	1	MarkerType	
	2	ATextStyle	
	3	InteriorStyle	
	4	HatchStyle	
	5	LineType	
	6	SurfaceEdgeType	
	7	PickDeviceType	
	8	PolylineInterpMethod	
	9	CurveApproxMethod	
	10	ReflectionModel	
	11	SurfaceInterpMethod	
	12	SurfaceApproxMethod	
	13	ModelClipOperator	
	14	LightType	
	15	ColorType	
	16	FloatFormat	
	17	HLHSRMode	
	18	PromptEchoType	
	19	DisplayUpdateMode	
	20	ColorApproxType	
	21	ColorApproxModel	
	22	GDP	
	23	GDP3	
	24	GSE	
	25	TrimCurveApproxMethod	
	26	RenderingColorModel	
	27	ParametricSurfaceCharacteristics	
	28	Escape	
	29	PickOneMethod	
	30	PickAllMethod	
p		unused, p=pad(2n)	

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	m/4	reply length
4	n	number of lists
20		unused
m	LISTofENUM_DATA	types

The contents of ENUM_DATA depends on *item_mask*. If *item_mask* = 0 then only the counts are returned and ENUM_DATA is a CARD32. If *item_mask* = 1 then only the indices are returned and ENUM_DATA is a LISTofINT16. If *item_mask* = 2 then only the mnemonics are returned and ENUM_DATA is a LISTofSTRING. If *item_mask* = 3 then the indices and mnemonics are returned and ENUM_DATA is a LISTofENUM_DESC.

PEXGetImpDepConstants

1	CARD8	opcode (X11 assigned)
1	3	PEX opcode
2	4+(2n+p)/4	request length
2	INT16	floating point format
2		unused
4	CARD32	example drawable ID

4	n	number of names
2n	LISTofCONSTANT_NAME	names
p		unused, p=pad(2n)

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n	reply length
24		unused
4n	LISTofVALUE	constants (length implicit)

Names for **PEXGetImpDepConstants**: All names are 16 bit constants, returns CARD32, except for the names *ChromaticityRedU, ChromaticityRedV, LuminanceRed, ChromaticityGreenU, ChromaticityGreenV, LuminanceGreen, ChromaticityBlueU, ChromaticityBlueV, LuminanceBlue, ChromaticityWhiteU, ChromaticityWhiteV,* and *LuminanceWhite*, each of which returns a FLOAT.

Name		Value
DitheringSupported		1
0	False	
1	True	
MaxEdgeWidth		2
MaxLineWidth		3
MaxMarkerSize		4
MaxModelClipPlanes		5
MaxNameSetNames		6
MaxNonAmbientLights		7
MaxNURBOrder		8
MaxTrimCurveOrder		9
MinEdgeWidth		10
MinLineWidth		11
MinMarkerSize		12
NominalEdgeWidth		13
NominalLineWidth		14
NominalMarkerSize		15
NumSupportedEdgeWidths		16
NumSupportedLineWidths		17
NumSupportedMarkerSizes		18
BestColorApproxValues		19
0	ColorApproxAnyValues	
1	ColorApproxPowersOf2	
TransparencySupported		20
0	False	
1	True	
DoubleBufferingSupported		21
0	False	
1	True	
ChromaticityRedU		22
ChromaticityRedV		23
LuminanceRed		24
ChromaticityGreenU		25
ChromaticityGreenV		26

LuminanceGreen		27
ChromaticityBlueU		28
ChromaticityBlueV		29
LuminanceBlue		30
ChromaticityWhiteU		31
ChromaticityWhiteV		32
LuminanceWhite		33
MaxHitsEventSupported		34
0	False	
1	True	

PEXMatchRendererTargets

1	CARD8		opcode (X11 assigned)
1	94		PEX opcode
2	5		request length
4	CARD32		drawable ID
1	CARD8		depth
1			unused
2			type
		0 don’t care	
		1 window	
		2 pixmap	
		3 buffer	
4	CARD32		visual ID
4	CARD32		max targets

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	2n	reply length
24		unused
8n	LISTofRENDERER_TARGET	targets(length implicit)

PEXEscape

1	CARD8	opcode (X11 assigned)
1	95	PEX opcode
2	2+n	request length
4	CARD32	escape ID
4n		escape data

PEXEscapeWithReply

1	CARD8	opcode (X11 assigned)
1	96	PEX opcode
2	2+n	request length
4	CARD32	escape ID
4n		escape data

=>

1	1	Reply
1		unused
2	CARD16	sequence number

	4	n	reply length (n can be zero)
4		CARD32	escape ID
20			escape reply data
n			escape reply data

See the appendix for the encoding of registered escapes.

3. Output Commands

Output command numbers start at 1. Output command number 0 is reserved to mean *All* for element searching. Negative output command numbers are implemenation dependent.

3.1. Data Formats

3.2. Output Command Descriptions

MarkerType

2	1	output command number
2	2	output command length
2	INT16	marker type
2		unused

MarkerScale

2	2	output command number
2	1+*fp*/4	output command length
fp	FLOAT	scale

MarkerColorIndex

2	3	output command number
2	2	output command length
2	CARD16	indexed color
2		unused

MarkerColor

2	4	output command number
2	2+n	output command length
4+4*n	COLOR_SPECIFIER	color

MarkerBundleIndex

2	5	output command number
2	2	output command length
2	CARD16	marker bundle index
2		unused

TextFontIndex

2	6	output command number
2	2	output command length
2	CARD16	font index
2		unused

TextPrecision

2	7	output command number
2	2	output command length
2		precision

	0	StringPrecision	
	1	CharPrecision	
	2	StrokePrecision	
2			unused

CharacterExpansion

2	8	output command number
2	1+*fp*/4	output command length
fp	FLOAT	expansion

CharacterSpacing

2	9	output command number
2	1+*fp*/4	output command length
fp	FLOAT	spacing

TextColorIndex

2	10	output command number
2	2	output command length
2	CARD16	color index
2		unused

TextColor

2	11	output command number
2	2+n	output command length
4+4*n	COLOR_SPECIFIER	color

CharacterHeight

2	12	output command number
2	1+*fp*/4	output command length
fp	FLOAT	height

CharacterUpVector

2	13	output command number
2	1+*fp*/2	output command length
fp	FLOAT	up x
fp	FLOAT	up y

TextPath

2	14		output command number
2	2		output command length
2			path
	0	PathRight	
	1	PathLeft	
	2	PathUp	
	3	PathDown	
2			unused

TextAlignment

2	15		output command number
2	2		output command length
2			alignment vertical
	0	ValignNormal	
	1	ValignTop	
	2	ValignCap	
	3	ValignHalf	
	4	ValignBase	
	5	ValignBottom	
2			alignment horizontal
	0	HalignNormal	
	1	HalignLeft	
	2	HalignCenter	
	3	HalignRight	

AnnotationTextHeight

2	16		output command number
2	1+*fp*/4		output command length
fp	FLOAT		height

AnnotationTextUpVector

2	17		output command number
2	1+*fp*/2		output command length
fp	FLOAT		up x
fp	FLOAT		up y

AnnotationTextPath

2	18		output command number
2	2		output command length
2			path
	0	PathRight	
	1	PathLeft	
	2	PathUp	
	3	PathDown	
2			unused

AnnotationTextAlignment

2	19		output command number
2	2		output command length
2			alignment vertical
	0	ValignNormal	
	1	ValignTop	
	2	ValignCap	
	3	ValignHalf	
	4	ValignBase	
	5	ValignBottom	
2			alignment horizontal
	0	HalignNormal	
	1	HalignLeft	
	2	HalignCenter	
	3	HalignRight	

AnnotationTextStyle

2	20	output command number
2	2	output command length
2	INT16	annotation text style
2		unused

TextBundleIndex

2	21	output command number
2	2	output command length
2	CARD16	text bundle index
2		unused

LineType

2	22	output command number
2	2	output command length
2	INT16	line type
2		unused

LineWidth

2	23	output command number
2	1+*fp*/4	output command length
fp	FLOAT	width

LineColorIndex

2	24	output command number
2	2	output command length
2	CARD16	color index
2		unused

LineColor

2	25	output command number
2	2+n	output command length
4+4*n	COLOR_SPECIFIER	color

CurveApproximation

2	26	output command number
2	2+*fp*/4	output command length
2	INT16	approximation method
2		unused
fp	FLOAT	approximation tolerance

PolylineInterpolationMethod

2	27	output command number
2	2	output command length
2	INT16	polyline interpolation method
2		unused

LineBundleIndex

2	28	output command number
2	2	output command length
2	CARD16	line bundle index
2		unused

SurfaceInteriorStyle

2	29	output command number
2	2	output command length
2	INT16	interior style
2		unused

SurfaceInteriorStyleIndex

2	30	output command number
2	2	output command length
2	CARD16 | INT16	table index or interior style
2		unused

SurfaceColorIndex

2	31	output command number
2	2	output command length
2	CARD16	color index
2		unused

SurfaceColor

2	32	output command number
2	2+n	output command length
4+4*n	COLOR_SPECIFIER	color

SurfaceReflectionAttributes

2	33	output command number
2	2+5**fp*/4+n	output command length
fp	FLOAT	ambient coefficient
fp	FLOAT	diffuse coefficient
fp	FLOAT	specular coefficient
fp	FLOAT	specular concentration
fp	FLOAT	transmission coefficient
4+4*n	COLOR_SPECIFIER	specular color

SurfaceReflectionModel

2	34	output command number
2	2	output command length
2	INT16	reflection model
2		unused

SurfaceInterpolationMethod

2	35	output command number
2	2	output command length
2	INT16	surface interpolation method
2		unused

BackfaceSurfaceInteriorStyle

2	36	output command number
2	2	output command length
2	INT16	interior style
2		unused

BackfaceSurfaceInteriorStyleIndex

2	37	output command number
2	2	output command length
2	CARD16 | INT16	table index or interior style
2		unused

BackfaceSurfaceColorIndex

2	38	output command number
2	2	output command length
2	CARD16	color index
2		unused

BackfaceSurfaceColor

2	39	output command number
2	2+n	output command length
4+4*n	COLOR_SPECIFIER	color

BackfaceSurfaceReflectionAttributes

2	40	output command number
2	2+5**fp*/4+n	output command length
fp	FLOAT	ambient coefficient
fp	FLOAT	diffuse coefficient
fp	FLOAT	specular coefficient
fp	FLOAT	specular concentration
fp	FLOAT	transmission coefficient
4+4*n	COLOR_SPECIFIER	specular color

BackfaceSurfaceReflectionModel

2	41	output command number
2	2	output command length
2	INT16	reflection model
2		unused

BackfaceSurfaceInterpolationMethod

2	42	output command number
2	2	output command length
2	INT16	surface interpolation method
2		unused

SurfaceApproximation

2	43	output command number
2	2+*fp*/2	output command length
2	INT16	surface approximation method

2			unused
fp	FLOAT		approximation u tolerance
fp	FLOAT		approximation v tolerance

FacetCullingMode

2	44		output command number
2	2		output command length
2			culling mode
	0	None	
	1	BackFaces	
	2	FrontFaces	
2			unused

FacetDistinguishFlag

2	45		output command number
2	2		output command length
1			distinguish
	0	False	
	1	True	
3			unused

PatternSize

2	46	output command number
2	1+*fp*/2	output command length
fp	FLOAT	size x
fp	FLOAT	size y

PatternReferencePoint

2	47	output command number
2	1+*fp*/2	output command length
fp	FLOAT	point x
fp	FLOAT	point y

PatternReferencePointAndVectors

2	48	output command number
2	1+9**fp*/4	output command length
fp	FLOAT	reference point x
fp	FLOAT	reference point y
fp	FLOAT	reference point z
fp	FLOAT	vector1 x
fp	FLOAT	vector1 y
fp	FLOAT	vector1 z
fp	FLOAT	vector2 x
fp	FLOAT	vector2 y
fp	FLOAT	vector2 z

InteriorBundleIndex

2	49	output command number
2	2	output command length
2	CARD16	interior bundle index

2			unused

SurfaceEdgeFlag

2	50		output command number
2	2		output command length
1			onoff
	0	Off	
	1	On	
3			unused

SurfaceEdgeType

2	51	output command number
2	2	output command length
2	INT16	edge type
2		unused

SurfaceEdgeWidth

2	52	output command number
2	1+*fp*/4	output command length
fp	FLOAT	width

SurfaceEdgeColorIndex

2	53	output command number
2	2	output command length
2	CARD16	color index
2		unused

SurfaceEdgeColor

2	54	output command number
2	2+n	output command length
4+4*n	COLOR_SPECIFIER	color

EdgeBundleIndex

2	55	output command number
2	2	output command length
2	CARD16	edge bundle index
2		unused

SetIndividualASF

2	56		output command number
2	3		output command length
4			ASF attribute to be modified
	#x00000001	MarkerTypeASF	
	#x00000002	MarkerScaleASF	
	#x00000004	MarkerColorASF	
	#x00000008	TextFontIndexASF	
	#x00000010	TextPrecASF	
	#x00000020	CharExpansionASF	
	#x00000040	CharSpacingASF	

	#x00000080	TextColorASF	
	#x00000100	LineTypeASF	
	#x00000200	LineWidthASF	
	#x00000400	LineColorASF	
	#x00000800	CurveApproxASF	
	#x00001000	PolylineInterpASF	
	#x00002000	InteriorStyleASF	
	#x00004000	InteriorStyleIndexASF	
	#x00008000	SurfaceColorASF	
	#x00010000	SurfaceInterpASF	
	#x00020000	ReflectionModelASF	
	#x00040000	ReflectionAttrASF	
	#x00080000	BfInteriorStyleASF	
	#x00100000	BfInteriorStyleIndexASF	
	#x00200000	BfSurfaceColorASF	
	#x00400000	BfSurfaceInterpASF	
	#x00800000	BfReflectionModelASF	
	#x01000000	BfReflectionAttrASF	
	#x02000000	SurfaceApproxASF	
	#x04000000	SurfaceEdgesASF	
	#x08000000	SurfaceEdgeTypeASF	
	#x10000000	SurfaceEdgeWidthASF	
	#x20000000	SurfaceEdgeColorASF	
1			new ASF value
	0	Bundled	
	1	Individual	
3			unused

LocalTransform3D

2	57		output command number
2	2+4**fp*		output command length
2			composition type
	0	PreConcatenate	
	1	PostConcatenate	
	2	Replace	
2			unused
16**fp*	FLOAT[4][4]		matrix

LocalTransform2D

2	58		output command number
2	2+9**fp*/4		output command length
2			composition type
	0	PreConcatenate	
	1	PostConcatenate	
	2	Replace	
2			unused
9**fp*	FLOAT[3][3]		matrix

GlobalTransform3D

2	59		output command number
2	1+4**fp*		output command length

	16**fp*	FLOAT[4][4]	matrix

GlobalTransform2D

2	60	output command number
2	1+9**fp*/4	output command length
9**fp*	FLOAT[3][3]	matrix

ModelClip

2	61		output command number
2	2		output command length
1			clip switch
	0	Clip	
	1	NoClip	
3			unused

SetModelClipVolume3D

2	62	output command number
2	2+(3**fp**n)/2	output command length
2	INT16	operator
2	n	number of halfspaces
6**fp**n	LISTofHALF_SPACE	halfspaces

SetModelClipVolume2D

2	63	output command number
2	2+*fp**n	output command length
2	INT16	operator
2	n	number of halfspaces
4**fp**n	LISTofHALF_SPACE_2D	halfspaces

RestoreModelClipVolume

2	64	output command number
2	1	output command length

ViewIndex

2	65	output command number
2	2	output command length
2	CARD16	view index
2		unused

LightSourceState

2	66	output command number
2	2+(2e+2d+p1+p2)/4	output command length
2	CARD16	number of lights to enable
2	CARD16	number of lights to disable
2e	LISTofCARD16	lights to be enabled
p1		unused, p1=pad(2e)
2d	LISTofCARD16	lights to be disabled
p2		unused, p2=pad(2d)

DepthCueIndex

2	67		output command number
2	2		output command length
2	CARD16		depth cue index
2			unused

PickID

2	68		output command number
2	2		output command length
4	CARD32		pick identifier

HLHSRIdentifier

2	69		output command number
2	2		output command length
4	CARD32		HLHSR identifier

ColorApproximationIndex

2	70		output command number
2	2		output command length
2	CARD16		color approximation index
2			unused

RenderingColorModel

2	71		output command number
2	2		output command length
2	INT16		rendering color model
2			unused

ParametricSurfaceCharacteristics

2	72		output command number
2	2+(n+p)/4		output command length
2	INT16		characteristics
	1	None	
	2	implementation dependent	
	3	IsoparametricCurves	
	4	MC_LevelCurves	
	5	WC_LevelCurves	
2	n		length of data, bytes
n	LISTofCARD8		data
p			unused, p=pad(n)

The data records for the registered parametric surface characteristics are:

Type 1, None:
No data.

Type 2, implementation dependent:
No data.

Type 3, IsoparametricCurves:

2	CARD16		placement type
	0	Uniform	
	1	NonUniform	
2			unused
2	CARD16		number of curves in u direction
2	CARD16		number of curves in v direction

Type 4, MC_LevelCurves:

fp	FLOAT	MC origin x
fp	FLOAT	MC origin y
fp	FLOAT	MC origin z
fp	FLOAT	MC direction vector x
fp	FLOAT	MC direction vector y
fp	FLOAT	MC direction vector z
2	t	number of intersections
2		unused
t**fp*	FLOAT	intersection parameters

Type 5, WC_LevelCurves:

fp	FLOAT	WC origin x
fp	FLOAT	WC origin y
fp	FLOAT	WC origin z
fp	FLOAT	WC direction vector x
fp	FLOAT	WC direction vector y
fp	FLOAT	WC direction vector z
2	t	number of intersections
2		unused
t**fp*	FLOAT	intersection parameters

AddNamesToNameSet

2	73	output command number
2	1+n	output command length
4n	LISTofCARD32	list of names (length implicit)

RemoveNamesFromNameSet

2	74	output command number
2	1+n	output command length
4n	LISTofCARD32	list of names (length implicit)

ExecuteStructure

2	75	output command number
2	2	output command length
4	CARD32	structure ID

Label

2	76	output command number
2	2	output command length
4	INT32	label

ApplicationData

2	77	output command number
2	2+(n+p)/4	output command length
2	n	length of data
2		unused
n	LISTofCARD8	data
p		unused, p=pad(n)

GSE

2	78	output command number
2	3+(n+p)/4	output command length
4	INT32	GSE identifier
2	n	length of data
2		unused
n	LISTofCARD8	data
p		unused, p=pad(n)

Marker3D

2	79	output command number
2	1+3**fp**n/4	output command length
3**fp**n	LISTofCOORD_3D	points (length implicit)

Marker2D

2	80	output command number
2	1+*fp**n/2	output command length
2**fp**n	LISTofCOORD_2D	points (length implicit)

Text3D

2	81	output command number
2	2+s+(9**fp*+n)/4	output command length
fp	FLOAT	origin x
fp	FLOAT	origin y
fp	FLOAT	origin z
fp	FLOAT	vector1 x
fp	FLOAT	vector1 y
fp	FLOAT	vector1 z
fp	FLOAT	vector2 x
fp	FLOAT	vector2 y
fp	FLOAT	vector2 z
2	s	number of mono encodings
2		unused
		(let n be the sum of the sizes, m, of the MONO_ENCODINGs)
4s+n	LISTofMONO_ENCODING	string (see MONO_ENCODING for m)

Text2D

2	82	output command number
2	2+s+(2**fp*+n)/4	output command length
fp	FLOAT	origin x
fp	FLOAT	origin y
2	s	number of mono encodings

2		unused
		(let n be the sum of the sizes, m, of the MONO_ENCODINGs)
4s+n	LISTofMONO_ENCODING	string (see MONO_ENCODING for m)

AnnotationText3D

2	83	output command number
2	2+s+(6*fp+n)/4	output command length
fp	FLOAT	origin x
fp	FLOAT	origin y
fp	FLOAT	origin z
fp	FLOAT	offset x
fp	FLOAT	offset y
fp	FLOAT	offset z
2	s	number of mono encodings
2		unused
		(let n be the sum of the sizes, m, of the MONO_ENCODINGs)
4s+n	LISTofMONO_ENCODING	string (see MONO_ENCODING for m)

AnnotationText2D

2	84	output command number
2	2+s+(4*fp+n)/4	output command length
fp	FLOAT	origin x
fp	FLOAT	origin y
fp	FLOAT	offset x
fp	FLOAT	offset y
2	s	number of mono encodings
2		unused
		(let n be the sum of the sizes, m, of the MONO_ENCODINGs)
4s+n	LISTofMONO_ENCODING	string (see MONO_ENCODING for m)

Polyline3D

2	85	output command number
2	1+3*fp*n/4	output command length
3*fp*n	LISTofCOORD_3D	vertices (length implicit)

Polyline2D

2	86	output command number
2	1+fp*n/2	output command length
2*fp*n	LISTofCOORD_2D	vertices (length implicit)

PolylineSet3DWithData

2	87	output command number
2	3+n+m*v/4	output command length
2	INT16	color type
2		vertex attributes
	#x0001 color	
4	n	number of lists
		(let m be the number of vertices in the list of lists)
4n+m*v	LISTofLISTofVERTEX	vertices (see VERTEX for v)

NonUniformBSplineCurve

2	88		output command number
2	4+*fp**(2+k+t*p)/4		output command length
2	CARD16		order
2			type
	0	Rational	
	1	NonRational	(t = (type == Rational) ? 4 : 3)
fp	FLOAT		tmin
fp	FLOAT		tmax
4	k		number of knots
4	p		number of points
*fp**k	LISTofFLOAT		knots
*fp**t*p	LISTofCOORD		points (COORD_3D or COORD_4D depending on t)

FillArea3D

2	89		output command number
2	2+3**fp**p/4		output command length
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
1			ignore edges
	0	False	
	1	True	
1			unused
3**fp**p	LISTofCOORD_3D		vertices (length implicit)

FillArea2D

2	90		output command number
2	2+*fp**p/2		output command length
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
1			ignore edges
	0	False	
	1	True	
1			unused
2**fp**p	LISTofCOORD_2D		vertices (length implicit)

FillArea3DWithData

2	91		output command number
2	4+f/4		output command length
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
1			ignore edges

	0	False	
	1	True	
1			unused
2	INT16		color type
2			facet attributes
	#x0001	color	
	#x0002	normal	
2			vertex attributes
	#x0001	color	
	#x0002	normal	
2			unused
f	FACET		facet (see FACET for f)

FillAreaSet3D

(let m be the number of vertices in the list of lists)

2	92		output command number
2	3+n+3**fp**m/4		output command length
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
1			ignore edges
	0	False	
	1	True	
1			contour hint
	0	Disjoint	
	1	Nested	
	2	Intersecting	
	3	Unknown	
4	n		number of lists
4n+3**fp**m	LISTofLISTofCOORD_3D		vertices

FillAreaSet2D

(let m be the number of vertices in the list of lists)

2	93		output command number
2	3+n+*fp**m/2		output command length
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
1			ignore edges
	0	False	
	1	True	
1			contour hint
	0	Disjoint	
	1	Nested	
	2	Intersecting	
	3	Unknown	
4	n		number of lists
4n+2**fp**m	LISTofLISTofCOORD_2D		vertices

FillAreaSet3DWithData

(let m be the number of vertices in the list of lists)

2	94		output command number
2	5+n+(d+m*v)/4		output command length
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
1			ignore edges
	0	False	
	1	True	
1			contour hint
	0	Disjoint	
	1	Nested	
	2	Intersecting	
	3	Unknown	
2	INT16		color type
2			facet attributes
	#x0001	color	
	#x0002	normal	
2			vertex attributes
	#x0001	color	
	#x0002	normal	
	#x0004	edges	
2			unused
4	n		number of lists
d	OPT_DATA		facet data (see OPT_DATA for d)
4n+m*v	LISTofLISTofVERTEX		vertices (see VERTEX for v)

TriangleStrip

2	95		output command number
2	4+((p-2)d+p*v)/4		output command length
2	INT16		color type
2			facet attributes
	#x0001	color	
	#x0002	normal	
2			vertex attributes
	#x0001	color	
	#x0002	normal	
2			unused
4	p		number of points
(p-2)d	LISTofOPT_DATA		facet data (see OPT_DATA for d)
p*v	LISTofVERTEX		vertices (see VERTEX for v)

QuadrilateralMesh

2	96		output command number
2	4+(d(m*n-n-m+1)+m*n*v)/4		output command length
2	INT16		color type
2	m		number of points in m direction
2	n		number of points in n direction
2			facet attributes

	#x0001	color	
	#x0002	normal	
2			vertex attributes
	#x0001	color	
	#x0002	normal	
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
(m-1)(n-1)d	LISTofOPT_DATA		facet data (see OPT_DATA for d)
m*n*v	LISTofVERTEX		vertices (see VERTEX for v)

SetOfFillAreaSets

(let s be the size of the data)

(s = fc*d + vc*v + ec*e + p1 + 2fc + 2cc + 2ec + p2)

2	97		output command number
2	6+s/4		output command length
2			shape
	0	Complex	
	1	Nonconvex	
	2	Convex	
	3	Unknown	
2	INT16		color type
2			fill area set attributes
	#x0001	color	
	#x0002	normal	
2			vertex attributes
	#x0001	color	
	#x0002	normal	
2			edge attributes (call this value e)
	#x0001	On	
1			contour hint
	0	Disjoint	
	1	Nested	
	2	Intersecting	
	3	Unknown	
1			all contour counts = 1
	0	False	
	1	True	
2	fc		number of fill area sets
2	vc		number of vertices
2	ec		number of edges (sum of all contour counts)
2	cc		number of contours
fc*d	LISTofOPT_DATA		fill area set data (see OPT_DATA for d)
vc*v	LISTofVERTEX		vertex data (see VERTEX for v)
ec*e	LISTofCARD8		edge data
p1			unused, p1=pad(ec*e)
			(note that the counts in the connectivity data are CARD16s)
2fc+2cc+2ec	LISTofLISTofLISTofCARD16		connectivity data
p2			unused, p2=pad(2fc+2cc+2ec)

NonUniformBSplineSurface

2	98		output command number
2	7+*fp**(uk+vk+m*n*s)/4+t+sc/4		output command length
2			type
	0	Rational	
	1	NonRational	(s = (type == Rational) ? 4 : 3)
2	CARD16		u order
2	CARD16		v order
2			unused
4	uk		number of u knots
4	vk		number of v knots
2	m		number of points in u direction
2	n		number of points in v direction
4	t		number of trim curve lists
*fp**uk	LISTofFLOAT		u knots
*fp**vk	LISTofFLOAT		v knots
m*n**fp**s	LISTofCOORD		points (COORD_3D or COORD_4D depending on s)
			(let sc be sum of sizes of TRIM_CURVEs in bytes)
4t+sc	LISTofLISTofTRIM_CURVE		trim curves

CellArray3D

2	99	output command number
2	3+(9**fp*+2q+p)/4	output command length
fp	FLOAT	point1 x
fp	FLOAT	point1 y
fp	FLOAT	point1 z
fp	FLOAT	point2 x
fp	FLOAT	point2 y
fp	FLOAT	point2 z
fp	FLOAT	point3 x
fp	FLOAT	point3 y
fp	FLOAT	point3 z
4	CARD32	dx
4	CARD32	dy (let q = dx * dy)
2q	LISTofCARD16	color indices
p		unused, p=pad(2q)

CellArray2D

2	100	output command number
2	3+*fp*+(2s+p)/4	output command length
fp	FLOAT	point1 x
fp	FLOAT	point1 y
fp	FLOAT	point2 x
fp	FLOAT	point2 y
4	CARD32	dx
4	CARD32	dy (let s = dx * dy)
2s	LISTofCARD16	color indices
p		unused, p=pad(2s)

ExtendedCellArray3D

(n = ((color type == Indexed) \|\| (color type == RGBInt8)) ? 1 : ((color type == RGBInt16) ? 2 : 3**fp*/4))

2	101	output command number
2	4+9**fp*/4+p*n	output command length
2	INT16	color type
2		unused
fp	FLOAT	point1 x
fp	FLOAT	point1 y
fp	FLOAT	point1 z
fp	FLOAT	point2 x
fp	FLOAT	point2 y
fp	FLOAT	point2 z
fp	FLOAT	point3 x
fp	FLOAT	point3 y
fp	FLOAT	point3 z
4	CARD32	dx
4	CARD32	dy (let p = dx * dy)
p*4*n	LISTofCOLOR	colors

GDP3D

2	102	output command number
2	4+(3**fp**p+d+q)/4	output command length
4	INT32	GDP identifier
4	p	number of points
4	d	number of bytes of data
3**fp**p	LISTofCOORD_3D	points
d	LISTofCARD8	data
q		unused, q=pad(d)

GDP2D

2	103	output command number
2	4+(2**fp**p+d+q)/4	output command length
4	INT32	GDP identifier
4	p	number of points
4	d	number of bytes of data
2**fp**p	LISTofCOORD_2D	points
d	LISTofCARD8	data
q		unused, q=pad(d)

Noop

2	104	output command number
2	1	output command length

4. Lookup Tables

LineBundle (12+2**fp*+4*n)

2	INT16		line type
2	INT16		polyline interpolation method
2	INT16		curve approximation method
2			unused
fp	FLOAT		curve approximation tolerance
fp	FLOAT		line width
4+4*n	COLOR_SPECIFIER		line color

MarkerBundle (8+*fp*+4*n)

2	INT16		marker type
2			unused
fp	FLOAT		marker scale
4+4*n	COLOR_SPECIFIER		marker color

TextBundle (8+2**fp*+4*n)

2	CARD16		font table index
2			text precision
	0	StringPrecision	
	1	CharPrecision	
	2	StrokePrecision	
fp	FLOAT		character expansion factor
fp	FLOAT		character spacing
4+4*n	COLOR_SPECIFIER		text color

InteriorBundle (36+12**fp*+4*(n+n1+n2+n3))

2	INT16	interior style
2	CARD16 | INT16	interior style index
2	INT16	reflection model
2	INT16	surface interpolation method
2	INT16	bf interior style
2	CARD16 | INT16	bf interior style index
2	INT16	bf reflection model
2	INT16	bf surface interpolation method
2	INT16	surface approximation method
2		unused
fp	FLOAT	surface approximation u tolerance
fp	FLOAT	surface approximation v tolerance
4+4*n	COLOR_SPECIFIER	surface color
fp	FLOAT	reflection attribute ambient coefficient
fp	FLOAT	reflection attribute diffuse coefficient
fp	FLOAT	reflection attribute specular coefficient
fp	FLOAT	reflection attribute specular concentration
fp	FLOAT	reflection attribute transmission coefficient
4+4*n1	COLOR_SPECIFIER	reflection attribute specular color
4+4*n2	COLOR_SPECIFIER	bf surface color
fp	FLOAT	bf reflection attribute ambient coefficient
fp	FLOAT	bf reflection attribute diffuse coefficient
fp	FLOAT	bf reflection attribute specular coefficient

fp	FLOAT		bf reflection attribute specular concentration
fp	FLOAT		bf reflection attribute transmission coefficient
4+4*n3	COLOR_SPECIFIER		bf reflection attribute specular color

EdgeBundle (8+*fp*+4*n)

1			surface edges
	0	Off	
	1	On	
1			unused
2	INT16		surface edge type
fp	FLOAT		surface edge width
4+4*n	COLOR_SPECIFIER		surface edge color

Pattern (8+c*4*n)

(n = ((color type == Indexed) || (color type == RGBInt8)) ? 1 : ((color type == RGBInt16) ? 2 : 3**fp*/4))

2	INT16	color type
2	CARD16	numx
2	CARD16	numy (let c = numx * numy)
2		unused
c*4n	LISTofCOLOR	colors

Color (4+4*n)

n = ((color type == RGBInt8) ? 1 : ((color type == RGBInt16) ? 2 : 3**fp*/4)

2	INT16	color type
2		unused
4n	DIRECT_COLOR	color

TextFont (4+4n)

4	n	number of font IDs
4n	LISTofCARD32	font IDs

View (4+38**fp*)

2			clip flags
	#x0001	clip_xy	
	#x0002	clip_back	
	#x0004	clip_front	
2			unused
fp	FLOAT		clip limits min x
fp	FLOAT		clip limits min y
fp	FLOAT		clip limits min z
fp	FLOAT		clip limits max x
fp	FLOAT		clip limits max y
fp	FLOAT		clip limits max z
16**fp*	FLOAT[4][4]		orientation
16**fp*	FLOAT[4][4]		mapping

Light (8+10**fp*+4*n)

2	INT16	light type
2		unused
fp	FLOAT	direction x

fp	FLOAT		direction y
fp	FLOAT		direction z
fp	FLOAT		point x
fp	FLOAT		point y
fp	FLOAT		point z
fp	FLOAT		concentration
fp	FLOAT		spread angle
fp	FLOAT		attenuation factor1
fp	FLOAT		attenuation factor2
4+4*n	COLOR_SPECIFIER		color

DepthCue (8+4**fp*+4*n)

1			mode
	0	Off	
	1	On	
3			unused
fp	FLOAT		front plane
fp	FLOAT		back plane
fp	FLOAT		front scaling
fp	FLOAT		back scaling
4+4*n	COLOR_SPECIFIER		color

ColorApprox (28+3**fp*)

2	INT16		color approximation type
2	INT16		color approximation model
2	CARD16		max1
2	CARD16		max2
2	CARD16		max3
1			dither
	0	Off	
	1	On	
1			unused
4	CARD32		multiplier1
4	CARD32		multiplier2
4	CARD32		multiplier3
fp	FLOAT		weight1
fp	FLOAT		weight2
fp	FLOAT		weight3
4	CARD32		base pixel

4.1. Lookup Table Resource Management

PEXCreateLookupTable

1	CARD8		opcode (X11 assigned)
1	4		PEX opcode
2	4		request length
4	CARD32		example drawable ID
4	CARD32		lookup table ID
2			table type
	1	LineBundle	

	2	MarkerBundle	
	3	TextBundle	
	4	InteriorBundle	
	5	EdgeBundle	
	6	Pattern	
	7	TextFont	
	8	Color	
	9	View	
	10	Light	
	11	DepthCue	
	12	ColorApprox	
2			unused

PEXCopyLookupTable

1	CARD8		opcode (X11 assigned)
1	5		PEX opcode
2	3		request length
4	CARD32		source lookup table ID
4	CARD32		destination lookup table ID

PEXFreeLookupTable

1	CARD8		opcode (X11 assigned)
1	6		PEX opcode
2	2		request length
4	CARD32		lookup table ID

4.2. Lookup Table Inquiry

PEXGetTableInfo

1	CARD8		opcode (X11 assigned)
1	7		PEX opcode
2	3		request length
4	CARD32		example drawable ID
2			table type
	1	LineBundle	
	2	MarkerBundle	
	3	TextBundle	
	4	InteriorBundle	
	5	EdgeBundle	
	6	Pattern	
	7	TextFont	
	8	Color	
	9	View	
	10	Light	
	11	DepthCue	
	12	ColorApprox	
2			unused

=>

1	1		Reply

1			unused
2	CARD16		sequence number
4	0		reply length
2			unused
2	CARD16		definable entries
2	CARD16		num predefined
2	CARD16		predefined min
2	CARD16		predefined max
14			unused

PEXGetPredefinedEntries

1	CARD8		opcode (X11 assigned)
1	8		PEX opcode
2	5		request length
2	INT16		floating point format
2			unused
4	CARD32		example drawable ID
2			table type
	1	LineBundle	
	2	MarkerBundle	
	3	TextBundle	
	4	InteriorBundle	
	5	EdgeBundle	
	6	Pattern	
	7	TextFont	
	8	Color	
	9	View	
	10	Light	
	11	DepthCue	
	12	ColorApprox	
2	CARD16		start
2	n		count
2			unused

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	s/4	reply length
4		unused
4	n	number of table entries
16		unused (let s be the sum of the sizes of the n table entries in bytes) (each entry may be a different size, depending on colors and floating point format)
s	LISTofTABLE_ENTRY	entries (each entry will be aligned on a 4-byte boundary)

PEXGetDefinedIndices

1	CARD8	opcode (X11 assigned)
1	9	PEX opcode
2	2	request length

4	CARD32		lookup table ID

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	(2n+p)/4		reply length
4	n		number of indices returned
20			unused
2n	LISTofCARD16		defined indices
p			unused, p=pad(2n)

PEXGetTableEntry

1	CARD8		opcode (X11 assigned)
1	10		PEX opcode
2	4		request length
2	INT16		floating point format
2			value type
	0	Set	
	1	Realized	
4	CARD32		lookup table ID
2	CARD16		index
2			unused

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	s/4		reply length
2			status
	0	Default	
	1	Defined	
2	t		table type
	1	LineBundle	
	2	MarkerBundle	
	3	TextBundle	
	4	InteriorBundle	
	5	EdgeBundle	
	6	Pattern	
	7	TextFont	
	8	Color	
	9	View	
	10	Light	
	11	DepthCue	
	12	ColorApprox	
20			unused
			(let s be size of entry of type t)
			(entry size differs, depending on colors and floating point format)
s	TABLE_ENTRY		entry

PEXGetTableEntries

1	CARD8		opcode (X11 assigned)

1	11		PEX opcode
2	4		request length
2	INT16		floating point format
2			value type
	0	Set	
	1	Realized	
4	CARD32		lookup table ID
2	CARD16		start
2	n		count

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	s/4		reply length
2	t		table type
	1	LineBundle	
	2	MarkerBundle	
	3	TextBundle	
	4	InteriorBundle	
	5	EdgeBundle	
	6	Pattern	
	7	TextFont	
	8	Color	
	9	View	
	10	Light	
	11	DepthCue	
	12	ColorApprox	
			(let s be the sum of the sizes of the n table entries in bytes) (each entry may be a different size, depending on colors and floating point format)
2			unused
4	n		number of table entries
16			unused
s	LISTofTABLE_ENTRY		entries

4.3. Lookup Table Modification

PEXSetTableEntries

1	CARD8	opcode (X11 assigned)
1	12	PEX opcode
2	4+s/4	request length
2	INT16	floating point format
2		unused
4	CARD32	lookup table ID
2	CARD16	start
2	n	count
		(let s be the sum of the sizes of the n table entries in bytes) (each entry may be a different size, depending on colors and floating point format)
s	LISTofTABLE_ENTRY	entries

PEXDeleteTableEntries

1	CARD8	opcode (X11 assigned)
1	13	PEX opcode
2	3	request length
4	CARD32	lookup table ID
2	CARD16	start
2	CARD16	count

5. Pipeline Contexts

The following components may appear in the requests **PEXCreatePipelineContext** and **PEXChangePipelineContext**; they may also appear in replies to **PEXGetPipelineContext**. Because the components are not of a fixed size (as they are in X11), the list must be parsed serially to know where one component ends and the next begins. A bitmap mask of three CARD32s specifies which components are to be found in a list. Proceding from the least significant bit of the first CARD32 through to the last used bit of the third CARD32, if the bit is set, the next item in the list is of the specified type.

PC_BITMASK

First CARD32:
```
    #x00000001   marker_type
    #x00000002   marker_scale
    #x00000004   marker_color
    #x00000008   marker_bundle_index
    #x00000010   text_font_index
    #x00000020   text_precision
    #x00000040   char_expansion
    #x00000080   char_spacing
    #x00000100   text_color
    #x00000200   char_height
    #x00000400   char_up_vector
    #x00000800   text_path
    #x00001000   text_alignment
    #x00002000   atext_height
    #x00004000   atext_up_vector
    #x00008000   atext_path
    #x00010000   atext_alignment
    #x00020000   atext_style
    #x00040000   text_bundle_index
    #x00080000   line_type
    #x00100000   line_width
    #x00200000   line_color
    #x00400000   curve_approx
    #x00800000   polyline_interp
    #x01000000   line_bundle_index
    #x02000000   interior_style
    #x04000000   interior_style_index
    #x08000000   surface_color
    #x10000000   reflection_attr
    #x20000000   reflection_model
    #x40000000   surface_interp
    #x80000000   bf_interior_style
```
Second CARD32:
```
    #x00000001   bf_interior_style_index
    #x00000002   bf_surface_color
    #x00000004   bf_reflection_attr
    #x00000008   bf_reflection_model
    #x00000010   bf_surface_interp
    #x00000020   surface_approx
    #x00000040   culling_mode
    #x00000080   distinguish
```

#x00000100pattern_size
#x00000200 pattern_ref_pt
#x00000400 pattern_ref_vec1
#x00000800 pattern_ref_vec2
#x00001000 interior_bundle_index
#x00002000 surface_edges
#x00004000 surface_edge_type
#x00008000 surface_edge_width
#x00010000 surface_edge_color
#x00020000 edge_bundle_index
#x00040000 local_transform
#x00080000 global_transform
#x00100000 model_clip
#x00200000 model_clip_volume
#x00400000 view_index
#x00800000 light_state
#x01000000 depth_cue_index
#x02000000 asfs
#x04000000 pick_id
#x08000000 HLHSR_identifier
#x10000000 name_set
#x20000000 color_approx_index
#x40000000 rdr_color_model
#x80000000 psurf_char

Third CARD32:
No bits are yet defined. Must be zero.

ASF flags bits:
#x00000001 marker_type_asf
#x00000002 marker_scale_asf
#x00000004 marker_color_asf
#x00000008 text_font_index_asf
#x00000010 text_precison_asf
#x00000020 char_expansion_asf
#x00000040 char_spacing_asf
#x00000080 text_color_asf
#x00000100 line_type_asf
#x00000200 line_width_asf
#x00000400 line_color_asf
#x00000800 curve_approx_asf
#x00001000 polyline_interp_asf
#x00002000 interior_style_asf
#x00004000 interior_style_index_asf
#x00008000 surface_color_asf
#x00010000 surface_interp_asf
#x00020000 reflection_model_asf
#x00040000 reflection_attr_asf
#x00080000 bf_interior_style_asf
#x00100000 bf_interior_style_index_asf
#x00200000 bf_surface_color_asf
#x00400000 bf_surface_interp_asf
#x00800000 bf_reflection_model_asf
#x01000000 bf_reflection_attr_asf

#x02000000	surface_approx_asf
#x04000000	surface_edges_asf
#x08000000	surface_edge_type_asf
#x10000000	surface_edge_width_asf
#x20000000	surface_edge_color_asf

Note that entries in the list are all padded to a multiple of 4 bytes. If values appear which could be encoded in less space, it is assumed that they will be placed in the least significant bits of the word. If a component has sub-fields, the sizes, types and interpretations of the sub-fields are on subsequent lines.

Attribute Name	**Length**	**Type**		
marker_type	4	INT16		
marker_scale	*fp*	FLOAT		
marker_color	4+4*n	COLOR_SPECIFIER		
marker_bundle_index	4	CARD16		
text_font_index	4	CARD16		
text_precision	4	CARD16		
		0	StringPrecision	
		1	CharPrecision	
		2	StrokePrecision	
char_expansion	*fp*	FLOAT		
char_spacing	*fp*	FLOAT		
text_color	4+4*n	COLOR_SPECIFIER		
char_height	*fp*	FLOAT		
char_up_vector	2**fp*			
	fp	FLOAT		x
	fp	FLOAT		y
text_path	4	CARD16		
		0	PathRight	
		1	PathLeft	
		2	PathUp	
		3	PathDown	
text_alignment	4			
	2	CARD16		alignment vertical
		0	ValignNormal	
		1	ValignTop	
		2	ValignCap	
		3	ValignHalf	
		4	ValignBase	
		5	ValignBottom	
	2	CARD16		alignment horizontal
		0	HalignNormal	
		1	HalignLeft	
		2	HalignCenter	
		3	HalignRight	
atext_height	*fp*	FLOAT		
atext_up_vector	2**fp*			
	fp	FLOAT		x
	fp	FLOAT		y
atext_path	4	CARD16		

	0	PathRight		
		1	PathLeft	
		2	PathUp	
		3	PathDown	
atext_alignment	4			
	2	CARD16		alignment vertical
		0	ValignNormal	
		1	ValignTop	
		2	ValignCap	
		3	ValignHalf	
		4	ValignBase	
		5	ValignBottom	
	2	CARD16		alignment horizontal
		0	HalignNormal	
		1	HalignLeft	
		2	HalignCenter	
		3	HalignRight	
atext_style	4	INT16		
text_bundle_index	4	CARD16		
line_type	4	INT16		
line_width	*fp*	FLOAT		
line_color	4+4*n	COLOR_SPECIFIER		
curve_approx	4+*fp*			
	4	INT16		curve approximation method
	fp	FLOAT		curve approximation tolerance
polyline_interp	4	INT16		
line_bundle_index	4	CARD16		
interior_style	4	INT16		
interior_style_index	4	INT16 | CARD16		
surface_color	4+4*n	COLOR_SPECIFIER		
reflection_attr	4+5*fp*+4*n			
	fp	FLOAT		ambient coefficient
	fp	FLOAT		diffuse coefficient
	fp	FLOAT		specular coefficient
	fp	FLOAT		specular concentration
	fp	FLOAT		transmission coefficient
	4+4*n	COLOR_SPECIFIER		specular color
reflection_model	4	INT16		
surface_interp	4	INT16		
bf_interior_style	4	INT16		
bf_interior_style_index	4	INT16 | CARD16		
bf_surface_color	4+4*n	COLOR_SPECIFIER		
bf_reflection_attr	4+5*fp*+4*n			
	fp	FLOAT		ambient coefficient
	fp	FLOAT		diffuse coefficient
	fp	FLOAT		specular coefficient
	fp	FLOAT		specular concentration
	fp	FLOAT		transmission coefficient
	4+4*n	COLOR_SPECIFIER		specular color
bf_reflection_model	4	INT16		
bf_surface_interp	4	INT16		
surface_approx	4+2**fp*			
	4	INT16		surface approximation method

	fp	FLOAT		surface approximation u tolerance
	fp	FLOAT		surface approximation v tolerance
culling_mode	4	CARD16		
		0	None	
		1	BackFaces	
		2	FrontFaces	
distinguish	4	CARD8		
		0	False	
		1	True	
pattern_size	2*fp			
	fp	FLOAT		x
	fp	FLOAT		y
pattern_ref_pt	3*fp			
	fp	FLOAT		x
	fp	FLOAT		y
	fp	FLOAT		z
pattern_ref_vec1	3*fp			
	fp	FLOAT		x
	fp	FLOAT		y
	fp	FLOAT		z
pattern_ref_vec2	3*fp			
	fp	FLOAT		x
	fp	FLOAT		y
	fp	FLOAT		z
interior_bundle_index	4	CARD16		
surface_edges	4	CARD16		
		0	Off	
		1	On	
surface_edge_type	4	INT16		
surface_edge_width	*fp*	FLOAT		
surface_edge_color	4+4*n	COLOR_SPECIFIER		
edge_bundle_index	4	CARD16		
local_transform	16*fp	FLOAT[4][4]		
global_transform	16*fp	FLOAT[4][4]		
model_clip	4	CARD16		
		0	Clip	
		1	NoClip	
model_clip_volume	4+6*fp*n			
	4	n		number of half spaces
	6*fp*n	LISTofHALF_SPACE		
view_index	4	CARD16		
light_state	4+2n+p			
	4	n		number of lights in active list
	2n	LISTofCARD16		indices of active lights
	p			unused, p=pad(2n)
depth_cue_index	4	CARD16		
asf_enables	4	CARD32		(see note below)
asfs	4	CARD32		
		0	Bundled	
		1	Individual	
pick_id	4	CARD32		
HLHSR_identifier	4	CARD32		
name_set	4	CARD32		

color_approx_index	4	CARD16	
rdr_color_model	4	INT16	
psurf_char	4+n		
	2	INT16	characteristics
	2	n	length of data in bytes
	n	LISTofCARD8	data (explicitly padded)

Note: The asf_enables field is only used for the **PEXCreatePipelineContext** and **PEXChangePipelineContext** requests. For those requests, if the asf_enables bit for a particular asf is set, the asf value is taken from the corresponding bit in the asfs field. For the **PEXGetPipelineContext** reply, asf_enables is present, but has no meaning and must have all defined asf bits set.

5.1. Pipeline Context Resource Management

PEXCreatePipelineContext

1	CARD8	opcode (X11 assigned)
1	14	PEX opcode
2	6+n/4	request length
2	INT16	floating point format
2		unused
4	CARD32	pipeline context ID
12	PC_BITMASK	item mask
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

PEXCopyPipelineContext

1	CARD8	opcode (X11 assigned)
1	15	PEX opcode
2	6	request length
4	CARD32	source pipeline context ID
4	CARD32	destination pipeline context ID
12	PC_BITMASK	item mask

PEXFreePipelineContext

1	CARD8	opcode (X11 assigned)
1	16	PEX opcode
2	2	request length
4	CARD32	pipeline context ID

5.2. Pipeline Context Inquiry

PEXGetPipelineContext

1	CARD8	opcode (X11 assigned)
1	17	PEX opcode
2	6	request length
2	INT16	floating point format
2		unused
4	CARD32	pipeline context ID
12	PC_BITMASK	item mask

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n/4	reply length
24		unused
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

5.3. Pipeline Context Modification

PEXChangePipelineContext

1	CARD8	opcode (X11 assigned)
1	18	PEX opcode
2	6+n/4	request length
2	INT16	floating point format
2		unused
4	CARD32	pipeline context ID
12	PC_BITMASK	item mask
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

6. Renderers

R_BITMASK

#x00000001	pipeline_context_id
#x00000002	current_path
#x00000004	marker_bundle
#x00000008	text_bundle
#x00000010	line_bundle
#x00000020	interior_bundle
#x00000040	edge_bundle
#x00000080	view_table
#x00000100	color_table
#x00000200	depth_cue_table
#x00000400	light_table
#x00000800	color_approx_table
#x00001000	pattern_table
#x00002000	text_font_table
#x00004000	highlight_inclusion
#x00008000	highlight_exclusion
#x00010000	invisibility_inclusion
#x00020000	invisibility_exclusion
#x00040000	renderer_state
#x00080000	HLHSR_mode
#x00100000	NPC_subvolume
#x00200000	viewport
#x00400000	clip_list
#x00800000	pick_inclusion
#x01000000	pick_exclusion
#x02000000	pick_start_path
#x04000000	background_color
#x08000000	clear_I
#x10000000	clear_Z
#x20000000	echo_mode

Note that entries in the list are all padded to a multiple of 4 bytes. If values appear which could be encoded in less space, it is assumed that they will be placed in the least significant bits of the word. If a component has sub-fields, the sizes, types and interpretations of the sub-fields are on subsequent lines.

Attribute Name	**Length**	**Type**	
pipeline_context	4	CARD32	
current_path	4+8n		
	4	n	number of element references
	8n	LISTofELEMENT_REF	
marker_bundle	4	CARD32	
text_bundle	4	CARD32	
line_bundle	4	CARD32	
interior_bundle	4	CARD32	
edge_bundle	4	CARD32	
view_table	4	CARD32	
color_table	4	CARD32	
depth_cue_table	4	CARD32	

light_table	4	CARD32		
color_approx_table	4	CARD32		
pattern_table	4	CARD32		
text_font_table	4	CARD32		
highlight_inclusion	4	CARD32		
highlight_exclusion	4	CARD32		
invisibility_inclusion	4	CARD32		
invisibility_exclusion	4	CARD32		
renderer_state	4	CARD16		
		0	Idle	
		1	Rendering	
		2	Picking	
HLHSR_mode	4	INT16		
NPC_subvolume	6**fp*			
	fp	FLOAT		min x
	fp	FLOAT		min y
	fp	FLOAT		min z
	fp	FLOAT		max x
	fp	FLOAT		max y
	fp	FLOAT		max z
viewport	12+2**fp*			
	2	INT16		min x
	2	INT16		min y
	fp	FLOAT		min z
	2	INT16		max x
	2	INT16		max y
	fp	FLOAT		max z
	1	CARD8		use drawable
		0	False	
		1	True	
	3			unused
clip_list	4+8n			
	4	n		number of device rectangles
	8n	LISTofDEVICE_RECT		
pick_inclusion	4	CARD32		
pick_exclusion	4	CARD32		
pick_start_path	4+8n			
	4	n		number of element refs
	8n	LISTofELEMENT_REF		
background_color	4+4n	COLOR_SPECIFIER		
clear_I	4	CARD8		
		0 False		
		1 True		
clear_Z	4	CARD8		
		0 False		
		1 True		
echo_mode	4	CARD16		
		0 NoEcho		
		1 Echo		
		2 UnEcho		

6.1. Renderer Resource Management

PEXCreateRenderer

1	CARD8	opcode (X11 assigned)
1	19	PEX opcode
2	5+n/4	request length
2	INT16	floating point format
2		unused
4	CARD32	renderer ID
4	CARD32	example drawable ID
4	R_BITMASK	item mask
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

PEXFreeRenderer

1	CARD8	opcode (X11 assigned)
1	20	PEX opcode
2	2	request length
4	CARD32	renderer ID

6.2. Renderer Modification

PEXChangeRenderer

1	CARD8	opcode (X11 assigned)
1	21	PEX opcode
2	4+n/4	request length
2	INT16	floating point format
2		unused
4	CARD32	renderer ID
4	R_BITMASK	item mask
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

6.3. Renderer Inquiry

PEXGetRendererAttributes

1	CARD8	opcode (X11 assigned)
1	22	PEX opcode
2	4	request length
2	INT16	floating point format
2		unused
4	CARD32	renderer ID
4	R_BITMASK	item mask

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n/4	reply length
24		unused
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

PEXGetRendererDynamics

1	CARD8		opcode (X11 assigned)
1	23		PEX opcode
2	2		request length
4	CARD32		renderer ID

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	0		reply length
4			tables
	#x00000001	DynMarkerBundle	
	#x00000002	DynTextBundle	
	#x00000004	DynLineBundle	
	#x00000008	DynInteriorBundle	
	#x00000010	DynEdgeBundle	
	#x00000020	DynViewTable	
	#x00000040	DynColorTable	
	#x00000080	DynDepthCueTable	
	#x00000100	DynLightTable	
	#x00000200	DynColorApproxTable	
	#x00000400	DynPatternTable	
	#x00000800	DynTextFontTable	
	#x00010000	DynMarkerBundleContents	
	#x00020000	DynTextBundleContents	
	#x00040000	DynLineBundleContents	
	#x00080000	DynInteriorBundleContents	
	#x00100000	DynEdgeBundleContents	
	#x00200000	DynViewTableContents	
	#x00400000	DynColorTableContents	
	#x00800000	DynDepthCueTableContents	
	#x01000000	DynLightTableContents	
	#x02000000	DynColorApproxTableContents	
	#x04000000	DynPatternTableContents	
	#x08000000	DynTextFontTableContents	
4			namesets
	#x00000001	DynHighlightNameset	
	#x00000002	DynInvisibilityNameset	
	#x00000004	DynPickNameset	
	#x00010000	DynHighlightNamesetContents	
	#x00020000	DynInvisibilityNamesetContents	
	#x00040000	DynPickNamesetContents	
4			attributes
	#x00000001	DynHLHSRMode	
	#x00000002	DynNPCSubvolume	
	#x00000004	DynViewport	
	#x00000008	DynClipList	
	#x00000010	DynEchoMode	
12			unused

6.4. Client-Side Traversal Support

PEXBeginRendering

1	CARD8		opcode (X11 assigned)
1	24		PEX opcode
2	3		request length
4	CARD32		renderer ID
4	CARD32		drawable ID

PEXEndRendering

1	CARD8		opcode (X11 assigned)
1	25		PEX opcode
2	3		request length
4	CARD32		renderer ID
1			flush
	0	False	
	1	True	
3			unused

PEXBeginStructure

1	CARD8		opcode (X11 assigned)
1	26		PEX opcode
2	3		request length
4	CARD32		renderer ID
4	CARD32		structure ID

PEXEndStructure

1	CARD8		opcode (X11 assigned)
1	27		PEX opcode
2	2		request length
4	CARD32		renderer ID

6.5. Rendering Commands

PEXRenderOutputCommands

1	CARD8	opcode (X11 assigned)
1	28	PEX opcode
2	4+s/4	request length
2	INT16	floating point format
2		unused
4	CARD32	renderer ID
4	n	number of commands
		(let s be the total size of the output commands in bytes)
s	LISTofOUTPUT_COMMAND	cmds

PEXRenderElements

1	CARD8	opcode (X11 assigned)
1	97	PEX opcode
2	7	request length

4	CARD32		renderer ID
4	CARD32		structure ID
2			position1 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position1 offset
2			position2 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position2 offset

PEXAccumulateState

1	CARD8	opcode (X11 assigned)
1	98	PEX opcode
2	3+2n	request length
4	CARD32	renderer ID
4	n	number element refs
8n	LISTofELEMENT_REF	path

PEXRenderNetwork

1	CARD8	opcode (X11 assigned)
1	29	PEX opcode
2	4	request length
4	CARD32	renderer ID
4	CARD32	drawable ID
4	CARD32	structure ID

7. Renderer Picking

7.1. Pick One

PEXBeginPickOne

1	CARD8	opcode (X11 assigned)
1	99	PEX opcode
2	6+n	request length
2	INT16	floating point format
2	INT16	pick one method
	1 Last	
	2 ClosestZ	
	3 VisibleAny	
	4 VisibleClosest	
4	CARD32	renderer ID
4	CARD32	drawable ID
4	INT32	structure identifer (not resource ID)
4+4n	PICK_RECORD	pick data

PEXEndPickOne

1	CARD8	opcode (X11 assigned)
1	100	PEX opcode
2	2	request length
4	CARD32	renderer ID

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	3n	reply length
4	n	number of pick element refs
2		pick status
	0 NoPick	
	1 Ok	
	2 Aborted	
1		better pick
	0 False	
	1 True	
17		unused
12n	LISTofPICK_ELEMENT_REF	pick path

PEXPickOne

1	CARD8	opcode (X11 assigned)
1	101	PEX opcode
2	6+n	request length
2	INT16	floating point format
2	INT16	pick one method
	1 Last	
	2 ClosestZ	

	3 VisibleAny	
	4 VisibleClosest	
4	CARD32	renderer ID
4	CARD32	drawable ID
4	CARD32	structure identifer
4+4n	PICK_RECORD	pick data

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	3n	reply length
4	n	number of pick element refs
2		pick status
	0 NoPick	
	1 Ok	
	2 Aborted	
1		better pick
	0 False	
	1 True	
17		unused
12n	LISTofPICK_ELEMENT_REF	pick path

7.2. Pick All

PEXBeginPickAll

1	CARD8	opcode (X11 assigned)
1	102	PEX opcode
2	8+n	request length
2	INT16	floating point format
2	INT16	pick all method
	1 All	
	2 Visible	
1	CARD8	send_event
	0 False	
	1 True	
3		unused
4	CARD32	renderer ID
4	CARD32	drawable ID
4	INT32	structure identifer (not resource ID)
4	CARD32	pick max hits
4+4n	PICK_RECORD	pick data

PEXEndPickAll

1	CARD8	opcode (X11 assigned)
1	103	PEX opcode
2	2	request length
4	CARD32	renderer ID

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n+3m	reply length
		(let m be the number of element refs)
4	n	number pick paths
2		pick status
	0 NoPick	
	1 Ok	
	2 Aborted	
2		more picks
	0 MoreHits	
	1 NoMoreHits	
	2 MayBeMoreHits	
16		unused
4n+12m	LISTofLISTofPICK_ELEMENT_REF	pick paths

PEXPickAll

1	CARD8	opcode (X11 assigned)
1	104	PEX opcode
2	6+n	request length
2	INT16	floating point format
2	INT16	pick all method
	1 All	
	2 Visible	
4	CARD32	renderer ID
4	CARD32	drawable ID
4	CARD32	pick max hits
4+4n	PICK_RECORD	pick data

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n+3m	reply length
		(let m be the number of element refs)
4	n	number pick paths
2		pick status
	0 NoPick	
	1 Ok	
	2 Aborted	
2		more picks
	0 MoreHits	
	1 NoMoreHits	
	2 MayBeMoreHits	
16		unused
4n+12m	LISTofLISTofPICK_ELEMENT_REF	pick paths

8. Structures

8.1. Structure Resource Management

PEXCreateStructure

1	CARD8		opcode (X11 assigned)
1	30		PEX opcode
2	2		request length
4	CARD32		structure ID

PEXCopyStructure

1	CARD8		opcode (X11 assigned)
1	31		PEX opcode
2	3		request length
4	CARD32		source structure ID
4	CARD32		destination structure ID

PEXDestroyStructures

1	CARD8		opcode (X11 assigned)
1	32		PEX opcode
2	2+n		request length
4	CARD32		number of structure IDs
4n	LISTofCARD32		list of structure IDs

8.2. Structure Inquiry

PEXGetStructureInfo

1	CARD8		opcode (X11 assigned)
1	33		PEX opcode
2	3		request length
2	INT16		floating point format
2			item mask
	#x0001	element_ptr	
	#x0002	num_elements	
	#x0004	total_length	
	#x0008	has_refs	
	#x0010	editing_mode	
4	CARD32		structure ID

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	0		reply length
2			editing mode
	0	StructureInsert	
	1	StructureReplace	
2			unused
4	CARD32		element pointer

4	CARD32		number of elements
4	CARD32		total length
2			has references
	0	False	
	1	True	
6			unused

PEXGetElementInfo

1	CARD8		opcode (X11 assigned)
1	34		PEX opcode
2	7		request length
2	INT16		floating point format
2			unused
4	CARD32		structure ID
2			position1 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position1 offset
2			position2 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position2 offset

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n	reply length
4	n	number of element info
20		unused
4n	LISTofELEMENT_INFO	info

PEXGetStructuresInNetwork

1	CARD8		opcode (X11 assigned)
1	35		PEX opcode
2	3		request length
4	CARD32		structure ID
2			which
	0	All	
	1	NoCrossRefs	
2			unused

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n	reply length
8		unused

4	n		number of structures
12			unused
4n	LISTofSTRUCTURE_ID		structure IDs

PEXGetAncestors

1	CARD8		opcode (X11 assigned)
1	36		PEX opcode
2	4		request length
4	CARD32		structure ID
2			path part
	0	TopPart	
	1	BottomPart	
2			unused
4	CARD32		path depth

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n+2s	reply length
12		unused
4	n	number of element reference lists
8	unused	
		(let s be the sum of these n numbers)
4n+8s	LISTofLISTofELEMENT_REF	paths

PEXGetDescendants

1	CARD8		opcode (X11 assigned)
1	37		PEX opcode
2	4		request length
4	CARD32		structure ID
2			path part
	0	TopPart	
	1	BottomPart	
2			unused
4	CARD32		path depth

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n+2s	reply length
12		unused
4	n	number of element reference lists
8	unused	
		(let s = sum of these n numbers)
4n+8s	LISTofLISTofELEMENT_REF	paths

PEXFetchElements

1	CARD8	opcode (X11 assigned)
1	38	PEX opcode

2	7		request length
2	INT16		floating point format
2			unused
4	CARD32		structure ID
2			position1 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position1 offset
2			position2 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position2 offset

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	s/4	reply length
4	CARD32	number of output commands
20		unused
		(let s be the total size of the output commands in bytes)
s	LISTofOUTPUT_COMMAND	elements

8.3. Structure Resource Attribute Modification

PEXSetEditingMode

1	CARD8		opcode (X11 assigned)
1	39		PEX opcode
2	3		request length
4	CARD32		structure ID
2			mode
	0	StructureInsert	
	1	StructureReplace	
2			unused

PEXSetElementPointer

1	CARD8		opcode (X11 assigned)
1	40		PEX opcode
2	4		request length
4	CARD32		structure ID
2			position whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position offset

PEXSetElementPointerAtLabel

1	CARD8		opcode (X11 assigned)
1	41		PEX opcode
2	4		request length
4	CARD32		structure ID
4	INT32		label
4	INT32		offset

PEXElementSearch

1	CARD8		opcode (X11 assigned)
1	42		PEX opcode
2	7+(2i+2e+p+p2)/4		request length
4	CARD32		structure ID
2			position whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position offset
4			direction
	0	Forward	
	1	Backward	
4	i		number of elements in inclusion list
4	e		number of elements in exclusion list
2i	LISTofCARD16		inclusion list
p			unused, p=pad(2i)
2e	LISTofCARD16		exclusion list
p2			unused, p2=pad(2e)

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	0		reply length
2			status
	1	NotFound	
	2	Found	
2			unused
4	CARD32		found offset
16			unused

8.4. Structure Editing

PEXStoreElements

1	CARD8		opcode (X11 assigned)
1	43		PEX opcode
2	4+s/4		request length
2	INT16		floating point format
2			unused
4	CARD32		structure ID
4	n		number of output commands

			(let s be the total size of the output commands in bytes)
s	LISTofOUTPUT_COMMAND		elements

PEXDeleteElements

1	CARD8		opcode (X11 assigned)
1	44		PEX opcode
2	6		request length
4	CARD32		structure ID
2			position1 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position1 offset
2			position2 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position2 offset

PEXDeleteElementsToLabel

1	CARD8		opcode (X11 assigned)
1	45		PEX opcode
2	5		request length
4	CARD32		structure ID
2			position whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		position offset
4	INT32		label

PEXDeleteElementsBetweenLabels

1	CARD8		opcode (X11 assigned)
1	46		PEX opcode
2	4		request length
4	CARD32		structure ID
4	INT32		label1
4	INT32		label2

PEXCopyElements

1	CARD8		opcode (X11 assigned)
1	47		PEX opcode
2	9		request length
4	CARD32		source structure ID
2			source position1 whence
	0	Beginning	
	1	Current	
	2	End	

2			unused
4	INT32		source position1 offset
2			source position2 whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		source position2 offset
4	CARD32		destination structure ID
2			destination position whence
	0	Beginning	
	1	Current	
	2	End	
2			unused
4	INT32		destination position offset

PEXChangeStructureReferences

1	CARD8	opcode (X11 assigned)
1	48	PEX opcode
2	3	request length
4	CARD32	old structure ID
4	CARD32	new structure ID

9. Name Sets

9.1. Name Set Resource Management

PEXCreateNameSet

1	CARD8	opcode (X11 assigned)
1	49	PEX opcode
2	2	request length
4	CARD32	nameset ID

PEXCopyNameSet

1	CARD8	opcode (X11 assigned)
1	50	PEX opcode
2	3	request length
4	CARD32	source nameset ID
4	CARD32	destination nameset ID

PEXFreeNameSet

1	CARD8	opcode (X11 assigned)
1	51	PEX opcode
2	2	request length
4	CARD32	nameset ID

9.2. Name Set Inquiry

PEXGetNameSet

1	CARD8	opcode (X11 assigned)
1	52	PEX opcode
2	2	request length
4	CARD32	nameset ID

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n	reply length
4	n	number of names
20		unused
4n	LISTofNAME	names

9.3. Name Set Modification

PEXChangeNameSet

1	CARD8	opcode (X11 assigned)
1	53	PEX opcode
2	3+n	request length
4	CARD32	nameset ID

2			action
	0	Add	
	1	Remove	
	2	Replace	
2			unused
4n	LISTofNAME		names (length implicit)

10. Search Contexts

SC_BITMASK

#x0001	search_pos
#x0002	search_dist
#x0004	search_ceiling
#x0008	model_clip_flag
#x0010	start_path
#x0020	normal_list
#x0040	inverted_list

Note that entries in the list are all padded to a multiple of 4 bytes. If values appear which could be encoded in less space, it is assumed that they will be placed in the least significant bits of the word. If a component has sub-fields, the sizes, types and interpretations of the sub-fields are on subsequent lines.

Attribute Name	**Length**	**Type**		
search_pos	3**fp*			
	fp	FLOAT		x
	fp	FLOAT		y
	fp	FLOAT		z
search_dist	*fp*	FLOAT		
search_ceiling	4	CARD16		
model_clip_flag	4	CARD8		
		0	False	
		1	True	
start_path	4+8n			
	4	n		length of LIST
	8n	LISTofELEMENT_REF		
normal_list	4+8n			
	4	n		length of LIST
	8n	LISTofNAME_SET_PAIR		
inverted_list	4+8n			
	4	n		length of LIST
	8n	LISTofNAME_SET_PAIR		

10.1. Search Context Resource Management

PEXCreateSearchContext

1	CARD8	opcode (X11 assigned)
1	54	PEX opcode
2	4+n/4	request length
2	INT16	floating point format
2		unused
4	CARD32	search context ID
4	SC_BITMASK	item mask
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

PEXCopySearchContext

1	CARD8	opcode (X11 assigned)

1	55	PEX opcode
2	4	request length
4	CARD32	source search context ID
4	CARD32	destination search context ID
4	SC_BITMASK	item mask

PEXFreeSearchContext

1	CARD8	opcode (X11 assigned)
1	56	PEX opcode
2	2	request length
4	CARD32	search context ID

10.2. Search Context Inquiry

PEXGetSearchContext

1	CARD8	opcode (X11 assigned)
1	57	PEX opcode
2	4	request length
2	INT16	floating point format
2		unused
4	CARD32	search context ID
4	SC_BITMASK	item mask

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n/4	reply length
24		unused
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

10.3. Search Context Modification

PEXChangeSearchContext

1	CARD8	opcode (X11 assigned)
1	58	PEX opcode
2	4+n/4	request length
2	INT16	floating point format
2		unused
4	CARD32	search context ID
4	SC_BITMASK	item mask
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

10.4. Structure Network Searching

PEXSearchNetwork

1	CARD8	opcode (X11 assigned)
1	59	PEX opcode

2	2	request length
4	CARD32	search context ID

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	2n	reply length
4		unused
4	n	number of element references
16		unused
8n	LISTofELEMENT_REF	found path

11. PHIGS Workstations

11.1. PHIGS Workstation Resource Management

PEXCreatePhigsWKS

1	CARD8		opcode (X11 assigned)
1	60		PEX opcode
2	19		request length
4	CARD32		PHIGS workstation ID
4	CARD32		drawable ID
4	CARD32		marker bundle ID
4	CARD32		text bundle ID
4	CARD32		line bundle ID
4	CARD32		interior bundle ID
4	CARD32		edge bundle ID
4	CARD32		color table ID
4	CARD32		depth cue table ID
4	CARD32		light table ID
4	CARD32		color approximation table ID
4	CARD32		pattern table ID
4	CARD32		text font table ID
4	CARD32		highlight inclusion ID
4	CARD32		highlight exclusion ID
4	CARD32		invisibility inclusion ID
4	CARD32		invisibility exclusion ID
2			buffer mode
	0	Single	
	1	Double	
2			unused

PEXFreePhigsWKS

1	CARD8	opcode (X11 assigned)
1	61	PEX opcode
2	2	request length
4	CARD32	PHIGS workstation ID

11.2. PHIGS Workstation Inquiry

PEXGetWKSInfo

1	CARD8	opcode (X11 assigned)
1	62	PEX opcode
2	5	request length
2	INT16	floating point format
2		unused
4	CARD32	PHIGS workstation ID
8	WKS_BITMASK	item mask (see below)

=>

1	1	Reply

1		unused
2	CARD16	sequence number
4	n/4	reply length
24		unused
n	LISTofVALUE	item list (see below)
		(let n be the size of the list, in bytes.)

The following components may appear in the reply of **PEXGetWKSInfo**. Because the components are not of a fixed size (as they are in X11), the list must be parsed serially to know where one component ends and the next begins. A bitmap mask of two CARD32s in the request specifies which components are to be found in the reply. Proceding from the least significant bit of the first CARD32 through to the last used bit of the second CARD32, if the bit is set, the next item in the list is of the specified type.

WKS_BITMASK

First CARD32:

#x00000001	display_update
#x00000002	visual_state
#x00000004	display_surface
#x00000008	view_update
#x00000010	defined_views
#x00000020	wks_update
#x00000040	req_NPC_subvolume
#x00000080	cur_NPC_subvolume
#x00000100	req_wks_viewpt
#x00000200	cur_wks_viewpt
#x00000400	HLHSR_update
#x00000800	req_HLHSR_mode
#x00001000	cur_HLHSR_mode
#x00002000	drawable_id
#x00004000	marker_bundle
#x00008000	text_bundle
#x00010000	line_bundle
#x00020000	interior_bundle
#x00040000	edge_bundle
#x00080000	color_table
#x00100000	depth_cue_table
#x00200000	light_table
#x00400000	color_approx_table
#x00800000	pattern_table
#x01000000	text_font_table
#x02000000	highlight_inclusion
#x04000000	highlight_exclusion
#x08000000	invisibility_inclusion
#x10000000	invisibility_exclusion
#x20000000	posted_structs
#x40000000	num_priorities
#x80000000	buffer_update

Second CARD32:

#x00000001	req_buffer_mode
#x00000002	cur_buffer_mode

Note that entries in the list are all padded to a multiple of 4 bytes. If values appear which could be encoded in less space, it is assumed that they will be placed in the least significant bits of the word. If a component has sub-fields, the sizes, types and interpretations of the sub-fields are on subsequent lines.

Attribute Name	**Length**	**Type**		
display_update	4	INT16		
visual_state	4	CARD8		
		0	Correct	
		1	Deferred	
		2	Simulated	
display_surface	4	CARD8		
		0	Empty	
		1	NotEmpty	
view_update	4	CARD8		
		0	NotPending	
		1	Pending	
defined_views	4+4n			
	4	n		length
	4n	LISTofCARD16		
wks_update	4	CARD8		
		0	NotPending	
		1	Pending	
req_NPC_subvolume	6**fp*			
	fp	FLOAT		min x
	fp	FLOAT		min y
	fp	FLOAT		min z
	fp	FLOAT		max x
	fp	FLOAT		max y
	fp	FLOAT		max z
cur_NPC_subvolume	6**fp*			
	fp	FLOAT		min x
	fp	FLOAT		min y
	fp	FLOAT		min z
	fp	FLOAT		max x
	fp	FLOAT		max y
	fp	FLOAT		max z
req_wks_viewpt	12+2**fp*			
	2	INT16		min x
	2	INT16		min y
	fp	FLOAT		min z
	2	INT16		max x
	2	INT16		max y
	fp	FLOAT		max z
	1	CARD8		use drawable
		0	False	
		1	True	
	3			unused
cur_wks_viewpt	12+2**fp*			
	2	INT16		min x
	2	INT16		min y
	fp	FLOAT		min z
	2	INT16		max x

	2	INT16	max y	
	fp	FLOAT		max z
	1	CARD8		use drawable
		0	False	
		1	True	
	3			unused
HLHSR_update	4	CARD8		
		0	NotPending	
		1	Pending	
req_HLHSR_mode	4	INT16		
cur_HLHSR_mode	4	INT16		
drawable_id	4	CARD32		
marker_bundle	4	CARD32		
text_bundle	4	CARD32		
line_bundle	4	CARD32		
interior_bundle	4	CARD32		
edge_bundle	4	CARD32		
color_table	4	CARD32		
depth_cue_table	4	CARD32		
light_table	4	CARD32		
color_approx_table	4	CARD32		
pattern_table	4	CARD32		
text_font_table	4	CARD32		
highlight_inclusion	4	CARD32		
highlight_exclusion	4	CARD32		
invisibility_inclusion	4	CARD32		
invisibility_exclusion	4	CARD32		
posted_structs	4+(4+*fp*)*n			
	4	n		length of list
	(4+*fp*)*n	LISTofSTRUCTURE_INFO		
num_priorities	4	CARD32		
buffer_update	4	CARD8		
		0	NotPending	
		1	Pending	
req_buffer_mode	4	CARD16		
		0	Single	
		1	Double	
cur_buffer_mode	4	CARD16		
		0	Single	
		1	Double	

PEXGetDynamics

1	CARD8	opcode (X11 assigned)
1	63	PEX opcode
2	2	request length
4	CARD32	drawable ID

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	0	reply length
1		view rep

1		marker bundle
1		text bundle
1		line bundle
1		interior bundle
1		edge bundle
1		color table
1		pattern table
1		workstation transform
1		highlight filter
1		invisibility filter
1		HLHSR mode
1		structure modify
1		post structure
1		unpost structure
1		delete structure
1		reference modify
1		buffer modify
1		light table
1		depth cue table
1		color approx table
3		unused

The following constants are used for the reply fields above:

0	IMM
1	IRG
2	CBS

PEXGetViewRep

1	CARD8		opcode (X11 assigned)
1	64		PEX opcode
2	3		request length
2	INT16		floating point format
2	CARD16		view index
4	CARD32		PHIGS workstation ID

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	4+76**fp*		reply length
2			view update
	0	NotPending	
	1	Pending	
22			unused
2	CARD16		requested view index
2			unused
2			requested clip flags
	#x0001	clip_xy	
	#x0002	clip_back	
	#x0004	clip_front	
2			unused

fp	FLOAT		requested clip limits min x
fp	FLOAT		requested clip limits min y
fp	FLOAT		requested clip limits min z
fp	FLOAT		requested clip limits max x
fp	FLOAT		requested clip limits max y
fp	FLOAT		requested clip limits max z
16**fp*	FLOAT[4][4]		requested orientation
16**fp*	FLOAT[4][4]		requested mapping
2	CARD16		current view index
2			unused
2			current clip flags
	#x0001	clip_xy	
	#x0002	clip_back	
	#x0004	clip_front	
2			unused
fp	FLOAT		current clip limits min x
fp	FLOAT		current clip limits min y
fp	FLOAT		current clip limits min z
fp	FLOAT		current clip limits max x
fp	FLOAT		current clip limits max y
fp	FLOAT		current clip limits max z
16**fp*	FLOAT[4][4]		current orientation
16**fp*	FLOAT[4][4]		current mapping

11.3. PHIGS Workstation Manipulation

PEXRedrawAllStructures

1	CARD8	opcode (X11 assigned)
1	65	PEX opcode
2	2	request length
4	CARD32	PHIGS workstation ID

PEXUpdateWorkstation

1	CARD8	opcode (X11 assigned)
1	66	PEX opcode
2	2	request length
4	CARD32	PHIGS workstation ID

PEXRedrawClipRegion

1	CARD8	opcode (X11 assigned)
1	67	PEX opcode
2	3+2n	request length
4	CARD32	PHIGS workstation ID
4	n	number of device rectangles
8n	LISTofDEVICE_RECT	clip list

PEXExecuteDeferredActions

1	CARD8	opcode (X11 assigned)
1	68	PEX opcode
2	2	request length

4	CARD32		PHIGS workstation ID

PEXSetViewPriority

1	CARD8		opcode (X11 assigned)
1	69		PEX opcode
2	4		request length
4	CARD32		PHIGS workstation ID
2	CARD16		index1
2	CARD16		index2
2			priority
	0	Higher	
	1	Lower	
2			unused

PEXSetDisplayUpdateMode

1	CARD8	opcode (X11 assigned)
1	70	PEX opcode
2	3	request length
4	CARD32	PHIGS workstation ID
2	INT16	display update
2		unused

PEXMapDCtoWC

1	CARD8	opcode (X11 assigned)
1	71	PEX opcode
2	4+(4+*fp*)*n/4	request length
2	INT16	floating point format
2		unused
4	CARD32	PHIGS workstation ID
4	n	number of coordinates
(4+*fp*)*n	LISTofDEVICE_COORD	DC points

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	3**fp**n/4	reply length
2	CARD16	view index
2		unused
4	n	number of coordinates being returned
16		unused
3**fp**n	LISTofCOORD_3D	WC points

PEXMapWCtoDC

1	CARD8	opcode (X11 assigned)
1	72	PEX opcode
2	4+3**fp**n/4	request length
2	INT16	floating point format
2	CARD16	view index
4	CARD32	PHIGS workstation ID
4	n	number of coordinates

3**fp**n	LISTofCOORD_3DWC points		

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	(4+*fp*)*n/4	reply length
4		unused
4	n	number of coordinates being returned
16		unused
(4+*fp*)*n	LISTofDEVICE_COORD	DC points

11.4. PHIGS Workstation Update

PEXSetViewRep

1	CARD8		opcode (X11 assigned)
1	73		PEX opcode
2	5+38**fp*/4		request length
2	INT16		floating point format
2			unused
4	CARD32		PHIGS workstation ID
2	CARD16		view rep index
2			unused
2			view rep clip flags
	#x0001	clip_xy	
	#x0002	clip_back	
	#x0004	clip_front	
2			unused
fp	FLOAT		view rep clip limits min x
fp	FLOAT		view rep clip limits min y
fp	FLOAT		view rep clip limits min z
fp	FLOAT		view rep clip limits max x
fp	FLOAT		view rep clip limits max y
fp	FLOAT		view rep clip limits max z
16**fp*	FLOAT[4][4]		view rep orientation
16**fp*	FLOAT[4][4]		view rep mapping

PEXSetWKSWindow

1	CARD8	opcode (X11 assigned)
1	74	PEX opcode
2	3+6**fp*/4	request length
2	INT16	floating point format
2		unused
4	CARD32	PHIGS workstation ID
fp	FLOAT	NPC subvolume min x
fp	FLOAT	NPC subvolume min y
fp	FLOAT	NPC subvolume min z
fp	FLOAT	NPC subvolume max x
fp	FLOAT	NPC subvolume max y
fp	FLOAT	NPC subvolume max z

PEXSetWKSViewport

1	CARD8		opcode (X11 assigned)
1	75		PEX opcode
2	6+2**fp*/4		request length
2	INT16		floating point format
2			unused
4	CARD32		PHIGS workstation ID
2	INT16		viewport min x
2	INT16		viewport min y
fp	FLOAT		viewport min z
2	INT16		viewport max x
2	INT16		viewport max y
fp	FLOAT		viewport max z
1			viewport use drawable
	0	False	
	1	True	
3			unused

PEXSetHLHSRMode

1	CARD8		opcode (X11 assigned)
1	76		PEX opcode
2	3		request length
4	CARD32		PHIGS workstation ID
2	INT16		mode
2			unused

PEXSetWKSBufferMode

1	CARD8		opcode (X11 assigned)
1	77		PEX opcode
2	3		request length
4	CARD32		PHIGS workstation ID
2			buffer mode
	0	Single	
	1	Double	
2			unused

11.5. Posting/Unposting Structures

PEXPostStructure

1	CARD8		opcode (X11 assigned)
1	78		PEX opcode
2	4+*fp*/4		request length
2	INT16		floating point format
2			unused
4	CARD32		PHIGS workstation ID
4	CARD32		structure ID
fp	FLOAT		priority

PEXUnpostStructure

1	CARD8		opcode (X11 assigned)

1	79	PEX opcode
2	3	request length
4	CARD32	PHIGS workstation ID
4	CARD32	structure ID

PEXUnpostAllStructures

1	CARD8	opcode (X11 assigned)
1	80	PEX opcode
2	2	request length
4	CARD32	PHIGS workstation ID

PEXGetWKSPostings

1	CARD8	opcode (X11 assigned)
1	81	PEX opcode
2	2	request length
4	CARD32	structure ID

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n	reply length
24		unused
4n	LISTofPHIGS_WKS_ID	PHIGS workstation IDs (length implicit)

12. Workstation Picking

P_BITMASK

#x0001	pick_status
#x0002	pick_path
#x0004	pick_path_order
#x0008	pick_inclusion
#x0010	pick_exclusion
#x0020	pick_data_rec
#x0040	prompt_echo_type
#x0080	echo_volume
#x0100	echo_switch

Note that entries in the list are all padded to a multiple of 4 bytes. If values appear which could be encoded in less space, it is assumed that they will be placed in the least significant bits of the word. If a component has sub-fields, the sizes, types and interpretations of the sub-fields are on subsequent lines.

Attribute Name	**Length**	**Type**		
pick_status	4	CARD16		
		0	NoPick	
		1	Ok	
pick_path	4+12n			
	4	n		number of pick element references
	12n	LISTofPICK_ELEMENT_REF		
pick_path_order	4	CARD16		
		0	TopFirst	
		1	BottomFirst	
pick_inclusion	4	CARD32		
pick_exclusion	4	CARD32		
pick_data_rec	4+n+p			
	4	n		length
	n	LISTofCARD8		
	p			unused, p=pad(n)
prompt_echo_type	4	INT16		
echo_volume	12+2**fp*			
	2	INT16		min x
	2	INT16		min y
	fp	FLOAT		min z
	2	INT16		max x
	2	INT16		max y
	fp	FLOAT		max z
	1	CARD8		use drawable
		0	False	
		1	True	
	3			unused
echo_switch	4	CARD16		
		0	NoEcho	
		1	Echo	

12.1. Pick Device Descriptors

PEXGetPickDevice

1	CARD8	opcode (X11 assigned)
1	82	PEX opcode
2	4	request length
2	INT16	floating point format
2	INT16	device type
4	CARD32	PHIGS workstation ID
4	P_BITMASK	item mask

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n/4	reply length
24		unused
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

PEXChangePickDevice

1	CARD8	opcode (X11 assigned)
1	83	PEX opcode
2	5+n/4	request length
2	CARD16	floating point format
2		unused
4	CARD32	PHIGS workstation ID
2	INT16	device type
2		unused
4	P_BITMASK	item mask
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

12.2. Pick Measure

PEXCreatePickMeasure

1	CARD8	opcode (X11 assigned)
1	84	PEX opcode
2	4	request length
4	CARD32	PHIGS workstation ID
4	CARD32	pick measure ID
2	INT16	device type
2		unused

PEXFreePickMeasure

1	CARD8	opcode (X11 assigned)
1	85	PEX opcode
2	2	request length
4	CARD32	pick measure ID

PM_BITMASK

#x0001pick_status
#x0002 picked_prim

Note that entries in the list are all padded to a multiple of 4 bytes. If values appear which could be encoded in less space, it is assumed that they will be placed in the least significant bits of the word. If a component has sub-fields, the sizes, types and interpretations of the sub-fields are on subsequent lines.

Attribute Name	Length	Type		
pick_status	4	CARD16		
		0	NoPick	
		1	Ok	
picked_prim	4+12n			
	4	n		number of pick element references
	12n	LISTofPICK_ELEMENT_REF		

PEXGetPickMeasure

1	CARD8	opcode (X11 assigned)
1	86	PEX opcode
2	3	request length
4	CARD32	pick measure ID
4	PM_BITMASK	item mask

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	n/4	reply length
24		unused
n	LISTofVALUE	item list (let n be the size of the list, in bytes.)

12.3. Pick Operations

PEXUpdatePickMeasure

1	CARD8	opcode (X11 assigned)
1	87	PEX opcode
2	3+(n+p)/4	request length
4	CARD32	pick measure ID
4	n	length of list
n	LISTofCARD8	input record
p		unused, p=pad(n)

The input data records for the registered pick devices are:

Pick Device 1, DC_HitBox:

2	INT16	pick position x
2	INT16	pick position y
fp	FLOAT	pick distance

Pick Device 2, NPC_HitVolume:

fp	FLOAT	min x
fp	FLOAT	min y
fp	FLOAT	min z
fp	FLOAT	max x
fp	FLOAT	max y
fp	FLOAT	max z

13. PEX Fonts

13.1. PEX Font Resource Management

PEXOpenFont

1	CARD8	opcode (X11 assigned)
1	88	PEX opcode
2	3+(n+p)/4	request length
4	CARD32	font ID
4	n	length of name
n	LISTofCARD8	name
p		unused, p=pad(n)

PEXCloseFont

1	CARD8	opcode (X11 assigned)
1	89	PEX opcode
2	2	length
4	CARD32	font ID

13.2. PEX Font Inquiry

PEXQueryFont

1	CARD8	opcode (X11 assigned)
1	90	PEX opcode
2	2	request length
4	CARD32	font ID

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	f/4	reply length
4	f	length of FONTINFO
20		unused
f	FONTINFO	font info

PEXListFonts

1	CARD8	opcode (X11 assigned)
1	91	PEX opcode
2	2+(n+p)/4	request length
2	CARD16	max names
2	n	number of bytes in pattern
n	LISTofCARD8	pattern
p		unused, p=pad(n)

=>

1	1	Reply
1		unused
2	CARD16	sequence number

4	r/4		reply length
4	CARD32		number of STRINGs in list
20			unused
r	LISTofSTRING		font names

PEXListFontsWithInfo

1	CARD8		opcode (X11 assigned)
1	92		PEX opcode
2	3+(n+p)/4		request length
2			unused
2	CARD16		max names
2	n		number of characters in pattern
2			unused
n	LISTofCARD8		pattern
p			unused, p=pad(n)

=>

1	1		Reply
1			unused
2	CARD16		sequence number
4	1+(r+f)/4		reply length
4	CARD32		number of STRINGs in list
20			unused
r	LISTofSTRING		font names
4	CARD32		number of FONTINFO in list
f	LISTofFONTINFO		fonts

PEXQueryTextExtents

1	CARD8		opcode (X11 assigned)
1	93		PEX opcode
2	6+(3**fp*+q+p)/4		request length
2	INT16		floating point format
2			path
	0	PathRight	
	1	PathLeft	
	2	PathUp	
	3	PathDown	
2	CARD16		font group table index
2			unused
4	CARD32		resource ID (renderer, WKS or TextFont table)
fp	FLOAT		expansion
fp	FLOAT		spacing
fp	FLOAT		height
2			alignment vertical
	0	ValignNormal	
	1	ValignTop	
	2	ValignCap	
	3	ValignHalf	
	4	ValignBase	
	5	ValignBottom	
2			alignment horizontal
	0	HalignNormal	

	1	HalignLeft	
	2	HalignCenter	
	3	HalignRight	
4	CARD32		number of strings
q	LISTofLISTofMONO_ENCODING		strings

=>

1	1	Reply
1		unused
2	CARD16	sequence number
4	6n	reply length
24		unused
6**fp**n	LISTofEXTENT_INFO	extents (length implicit)

Appendix: Registered PEX Escapes

PEXSetEchoColor

1	CARD8	opcode (X11 assigned)
1	95	PEX opcode (see PEXEscape)
2	5+n	request length
4	1	escape ID
2	INT16	floating point format
2		unused
4	CARD32	renderer ID
4+4n	COLOR_SPECIFIER	color