

# ***OpenFlight<sup>®</sup> Scene Description Database Specification***

Version 16.6  
Document Revision A  
November 2016

**PRE**SAGIS

***OpenFlight Scene Description Database Specification, version 16.6. November, 2016***

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October 18, 2016

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# 1 **OpenFlight<sup>®</sup> Scene Description**

This document describes the OpenFlight Scene Description Database Specification, commonly referred to as simply “OpenFlight”. OpenFlight is a 3D scene description file format that was created and is maintained by MultiGen-Paradigm, Inc. While OpenFlight databases are typically created and edited using MultiGen-Paradigm software tools, the format is widely adopted and as a result, many tools exist to read and write OpenFlight database files.

The primary audience for this document includes software developers whose applications are intended to read and/or write OpenFlight database files. To this end, this document discusses concepts incorporated in OpenFlight and contains a detailed description of the physical layout of OpenFlight files as represented on disk.

## **OpenFlight Concepts**

The OpenFlight database format supports both simple and relatively sophisticated real-time software applications. The full implementation of OpenFlight supports variable levels of detail, degrees of freedom, sound, instancing (both within a file and to external files), replication, animation sequences, bounding volumes for real-time culling, scene lighting features, light points and light point strings, transparency, texture mapping, material properties, and many other features.

A simple application that interprets an OpenFlight database can implement a subset of the database specification and use databases that contain that subset. Such an application could simply scan for the color palette, faces, and vertices, and ignores groups, objects, and other more sophisticated features.

## **Database Hierarchy**

The OpenFlight database hierarchy organizes the visual database into logical groupings and facilitates real-time functions such as field-of-view culling, level-of-detail switching, and instancing. Each OpenFlight database is organized in a tree structure.

The database tree structure consists of nodes (historically called beads). Most nodes can have child nodes as well as sibling nodes. In general, nodes can be thought of in three hierarchical classes. Starting from the top of the hierarchy, these three node classes include container nodes, geometry nodes and vertex nodes.

Container nodes are nodes that impose some logical grouping or behavior on the set of nodes it contains. The group node, for example allows you to “collect” similar nodes under one common parent for whatever reason your application needs. You might choose to group your nodes spatially or by some other criteria important to your application. Another common container node,

the level of detail node, imposes a particular visual behavior on the nodes it contains. It defines a range of distances inside which the nodes it contains are visible.

Geometry nodes are nodes that actually represent some physical (renderable) geometry. The attributes of geometry nodes typically include visual attributes such as color, material, texture, etc. The two main geometry nodes in OpenFlight are the face and mesh nodes. Other geometry nodes include the light point and text node. Though OpenFlight allows it, there are very few cases in which at least one geometry node is not contained somewhere below a container node.

Vertex nodes are the building blocks of geometry nodes. Individually, a vertex node represents a discrete point in space. Collected together under a geometry node such as a face node, a set of vertex nodes define a closed (or unclosed) loop. A closed loop of vertex nodes defines a face (or polygon). The “front” side of the face is determined by the ordering in which the vertex nodes appear under the face node. An unclosed loop of vertex nodes defines a set of line segments, again oriented according to the order in which the vertex nodes appear.

Each node type has data attributes specific to its function in the database. The principal node types in OpenFlight are described here:

**Header:** There is one header node per database file. It is always the first node in the file and represents the top of the database hierarchy and tree structure. For more information, see [“Header Record” on page 21](#).

**Group:** A group node distinguishes a logical subset of the database. Group nodes can be transformed (translated, rotated, scaled, etc.). The transformation applies to itself and to all its children. Groups can have child nodes and sibling nodes of any type, except a header node. For more information, see [“Group Record” on page 24](#).

**Object:** An object node contains a logical collection of geometry. It is effectively a low-level group node that offers some attributes distinct from the group node. For more information, see [“Object Record” on page 27](#).

**Face:** A face node represents geometry. Its children are limited to a set of vertices that describe a polygon, line, or point. For a polygon, the front side of the face is viewed from an in-order traversal of the vertices. Face attributes include color, texture, material, and transparency. For more information, see [“Face Record” on page 28](#).

**Mesh:** A mesh node defines geometric primitives that share attributes and vertices. See For more information, see [“Mesh Nodes” on page 30](#).

**Light point:** A light point node represents a collection of light point vertices or a replicated string of a single light point vertex. A light point is visible as one or more self-illuminated small points that do not illuminate surrounding objects. For more information, see [“Light Point Nodes” on page 36](#).

**Light point system:** A light point system enables you to collect a set of light points and enable/disable or brighten/dim them as a group. For more information, see [“Light Point System Record” on page 39](#).

**Subface:** A subface node is a face node that is assumed to be coplanar to, and drawn on top of, its superface. Subfaces can themselves be superfaces to allow multiple levels of “nesting”. This construct resolves the display of coplanar faces. A subface is introduced, after a face node, by a push subface control record and concluded by a pop subface control record. Note that the OpenFlight format does not enforce a subface to be coplanar with its superface but this is recommended.

**Light source:** A light source node serves as the location and orientation of a light source. The light source position and direction are transformed by the transformations above it in the tree (if any). For more information, see [“Light Source Record” on page 46](#).

**Sound:** A sound node serves as the location for a sound emitter. The emitter position is the sound offset transformed by the transformations above it in the tree (if any). For more information, see [“Sound Record” on page 45](#).

**Text:** A text node draws text in a string with a specified font, without injecting the actual geometry into the database as face nodes. This is a leaf node and therefore cannot have any children. For more information, see [“Text Record” on page 50](#).

**Vertex:** A vertex node represents a point in space, expressed as a double precision 3D coordinates. Each vertex is stored in the vertex palette record. Vertex attributes include x, y, z and optionally include color, normal and texture mapping information. Vertex nodes are the children of face nodes and light point nodes. For more information, see [“Vertex List Record” on page 42](#), [“Morph Vertex List Record” on page 42](#) and [“Vertex Palette Records” on page 71](#).

**Morph vertex:** A morph vertex node is a second vertex node. The vertex and morph vertex represent the two endpoints of a path between which the actual vertex may be interpolated. One endpoint represents the minimum (non morphed) weighting and the other represents the maximum (fully morphed) weighting. Each endpoint (or weight) is a reference into the vertex palette record. All vertex attributes may be morphed. Morph vertex nodes are the children of face nodes. For more information, see [“Morph Vertex List Record” on page 42](#).

**Clip region:** A clip node defines a set of clipping planes. Any geometry, of the clip node’s children, that falls outside the specified clipping planes is not displayed. For more information, see [“Clip Region Record” on page 50](#).

**Degree of freedom:** A degree of freedom (DOF) node serves as a local coordinate system with a predefined set of internal transformations. It specifies the articulation of parts in the database and set limits on the motion of those parts. For more information, see [“Degree of Freedom Record” on page 40](#).

**Level of detail:** A level of detail (LOD) node serves as a switch to turn the display of everything below it on or off based on its range from the viewer, according to its switch-in, switch-out distance and center location. For more information, see [“Level of Detail Record” on page 44](#).

**Switch:** A switch node is a more general case of an LOD node. It allows the selection of zero or more children by invoking a selector mask. Any combination of children can be selected per

mask and the number of definable masks is unlimited. For more information, see [“Switch Record” on page 52](#).

**External reference:** An external reference node serves to reference a node in another database file, or an entire database file. The referenced (child) node or database is considered an external part of the referencing (parent) database. For more information, see [“External Reference Record” on page 44](#).

## Node Attributes

Nodes in the OpenFlight scene contain attributes whose values describe different properties or characteristics of the node. Most attributes are represented directly on the node itself and are geared toward describing the specific characteristics of that type of node. The level of detail (LOD) node, for example, defines a switch in and switch out distance. Used together, these distances define a range within which the geometry contained in the LOD is visible.

Other attributes are represented indirectly on a node, using a lookup index into a table (palette) of attributes to describe the characteristics of a node. The face node, for example, defines several indirect attributes, including color index, material index and texture index. The values of these index attributes are used to map specific colors, materials and textures to the face node. The definitions of the colors, materials and textures referenced by these index attributes are stored in palettes in the database rather than directly on the nodes themselves.

This mechanism of indirect attribute mapping via palettes has some advantages. It can both save space in the OpenFlight file and can simplify the task of making global changes to nodes in the database.

To see how this indirection saves space, consider the material index attribute on the face node. A material is defined by over 15 separate color and other visual attributes. If each of these attributes were maintained per face in the database, the size of the database would get large quickly. Since it is common to map a single material to hundreds (or even thousands) of faces in the database, it is much more efficient to store a single material index attribute per face rather than storing the entire material definition.

Also, in terms of changing the appearance of a particular material in your database, when you do change the material definition in the palette, the faces that reference that material get updated automatically. This can make global changes much more simple to accomplish.

## Palettes

In the previous section, indirect attribute mapping was introduced. As part of that discussion, the notion of database palettes was also mentioned briefly. In fact, indirect attribute mapping is not possible without a robust implementation of database palettes. A database palette is a collection (or set) of attribute definitions. As mentioned in the previous section, the material pal-

ette defines a set of materials, each material being composed of several different color and visual attributes.

The OpenFlight database supports many different palettes. The most obvious palettes are the color, material and texture palettes. Most palettes support variable numbers of elements while others enforce fixed size constraints. The material and texture palettes are both variable sized palettes that can contain zero or more entries. The color palette, in contrast, is a fixed size palette that contains exactly 1024 entries.

Database palettes are not limited to supporting indirect attribute mapping. The vertex palette for example, defines a set of “shared” vertex nodes that can be indirectly referenced by multiple faces and/or light point nodes in the database. Similar to the space savings achieved by attribute palettes, the vertex palette also saves much disk space in the OpenFlight file when many geometry nodes share references to the same exact point in space (vertex).

All the database palettes supported by OpenFlight are described in [“Palette Records” on page 71](#). Specific palettes in OpenFlight include:

- [“Vertex Palette Records” on page 71](#)
- [“Name Table Record” on page 75](#)
- [“Color Palette Record” on page 74](#)
- [“Material Palette Record” on page 76](#)
- [“Extended Material Palette Records” on page 77](#)
- [“Texture Palette Record” on page 82](#)
- [“Texture Mapping Palette Record” on page 94](#)
- [“Sound Palette Record” on page 89](#)
- [“Light Source Palette Record” on page 89](#)
- [“Light Point Appearance Palette Record” on page 90](#)
- [“Line Style Palette Record” on page 93](#)
- [“Light Point Animation Palette Record” on page 93](#)
- [“Shader Palette Record” on page 99](#)
- [“Eyepoint and Trackplane Palette Record” on page 82](#)
- [“Linkage Palette Record” on page 86](#)
- [“Extension GUID Palette Record” on page 100](#)

## Material Palette

The material palette for a database may be composed of either *standard* material palette entries or *extended* material palette entries (or a mixture of both kinds). A standard material palette entry is represented by a single Material Palette Record while extended material palette entries are represented by a sequence of one or more Extended Material Palette Records. These are described further in sections [“Material Palette Record” on page 76](#) and [“Extended Material Palette Records” on page 77](#), respectively.

## Instancing

Instancing is the ability to define all or part of a database once, then reference it one or more times while applying various transformations. This allows you to define a piece of geometry once and place it multiple times in the scene. OpenFlight supports internal and external instancing with operations such as Rotate, Translate, Scale, and Put.

An internal instance is a subtree of the database that has been declared as an instance definition. An instance definition represents the root of a stand-alone subtree within the database. It is introduced by an instance definition record that contains a unique instance definition number. An instance definition is invoked by an instance reference record in a subsequent part of the database tree.

An external instance refers to an entire database file. It is introduced by an external reference node. An external reference node contains the name of the (child) database file to attach to that point in the referencing (parent) database tree. It also includes attributes that determine whether the child uses its own color, material, and texture palettes, or those of its parent.

Instance definitions can themselves contain instance definitions and references. Internal instances cannot reference themselves. External instances should not reference themselves directly or indirectly. The result of such use is undefined.

Instance definition and instance reference records are described in [“Hierarchy Instancing Records” on page 20](#). External reference records are described in [“External Reference Record” on page 44](#).

## Replication

Replication instances a subtree of the database several times, applying a transformation each time. For example, a string of trees can be represented by a single group node that is instantiated and translated to a new position several times.

Replication is legal for group, face, and light point nodes. Therefore a replication record is an ancillary record of a group, face, or light point node. In conjunction with a replication record there will be one or more ancillary transformation records.

## Bounding Volumes

Bounding volumes can be used by the application to determine if a particular subtree of the database is in view. A bounding volume can be a box, a sphere, or a cylinder. Each group node can have only one bounding volume. The volume normally encompasses the full geometric extent of the group node’s children, including any instances and replications. A bounding volume record is an ancillary record of a group node.

## Multitexture

OpenFlight supports eight textures per polygon or mesh as well as eight uv values per vertex. The texture information stored directly on the face, mesh and vertex record is referred to as “the base texture” or “texture layer 0”. Each additional texture layer is stored in ancillary records to the face, mesh and vertex list records and is referred to as “texture layer N” (for N=1..7). See [“Multitexture” on page 57](#) for more information.

## Extensions

OpenFlight is a rich file format that contains information to describe your visual scene. In addition to the data supported directly by the OpenFlight file format, the format allows you to include custom data in your OpenFlight file. You can extend the definition of existing OpenFlight node records and palette types as well as create new node types specific to your application. Your custom data will be saved in a valid OpenFlight database file that you can give to others.

The records that support OpenFlight extensions are:

- [“Extension Attribute Record” on page 67](#)
- [“Extension Field Records” on page 68](#)
- [“Extension GUID Palette Record” on page 100](#)



## 2 *OpenFlight File Format*

The hierarchical structure of an OpenFlight database is stored on disk as a file. The file consists of a linear stream of binary records. Byte ordering in the file is big endian. All OpenFlight records begin with a 4 byte sequence. The first two bytes of this sequence identifies the record type (opcode) and the second two bytes specify the length of the record. Note that the length includes this 4 byte sequence so the minimum length of any record (that does not contain any additional data) will be 4. Given this very regular structure, OpenFlight records can be read from disk and parsed easily.

- All OpenFlight records are a multiple of 4 bytes in length. When a record contains less than a full multiple of 4 bytes of data, the record is padded up (bytes added to the end of the record) to be a multiple of 4 bytes in length. In some cases, OpenFlight records are padded up to be multiples of 8 bytes in length.
- The length of all records (and fields in all records) as well as the offset of all fields are expressed in bytes.
- Unless explicitly stated otherwise, bit fields and masks are counted starting at 0 (i.e., the first bit is bit number 0).
- Unless explicitly stated otherwise, the elements of matrix records stored in OpenFlight appear in row major order. That is, the elements of the matrix appear in the following order:  
row0col0, row0col1, row0col2, row0col3,  
row1col0, row1col1, row1col2, row1col3,  
row2col0, row2col1, row2col2, row2col3,  
row3col0, row3col1, row3col2, row3col3
- The length of all OpenFlight records is limited to the largest value that can be encoded with 2 bytes or 16 bits (65535). For fixed-size records, this maximum size is sufficient. For variable-size records, this limitation is addressed with the Continuation Record. For more information, see [“Continuation Record”](#) on page 69.
- The maximum number of children nodes under any primary node is 65534.

### OpenFlight Record Types

There are four major categories of records: control records, node primary records, ancillary records and continuation records.

Control records mark the hierarchy of the tree. A push control record (a record containing the push opcode) indicates an increase in the depth of the tree. A push control record drops you down one level in the tree. A pop control record (a record containing a pop opcode) returns you to the previous level of hierarchy. All records between a push and a pop represent sibling nodes

at the same level of hierarchy. Other control records include: instance definition, instance reference, push subface, pop subface, push attribute, and pop attribute.

Each node is represented on disk by one primary record and zero or more ancillary records. The primary record identifies a node type and includes most of the node attribute data. Additional node attributes, such as comments, long ID, and transformations, are stored in subsequent ancillary records. Ancillary records follow the primary record, but precede any control records. Child nodes are introduced by a push control record and are concluded by a pop control record.

Palette records are ancillary records of the header node. Palette records generally follow the header node's primary record, with the exception of behavior (linkage) palette records. Behavior palette records, if present, are the last (non-control) records in the file.

Continuation records are used to "continue" a record in the OpenFlight Scene Description file stream, when the original record is larger than 65535 bytes. The continuation record appears in the stream immediately following the record that it "continues". The data contained in the continuation record is defined by the original record and is assumed to be directly appended onto the content of the original record. Multiple continuation records may follow a record, in which case all continuation records would be appended (in sequence) to the original record

Many records include an eight character ASCII ID consisting of the first seven characters of the node name plus a terminating <nil> character. If the node ID is longer than seven characters, an ancillary long ID record containing the complete ID follows the node primary record.

For example, a record with an object opcode is followed by a push control record. Next comes a record with a face opcode, also followed by a push control record. After that comes the vertex list record(s) that describe the vertices of the face, and then a pop control record. This, in turn, may be followed by another face record for the next face in the same object, or by a pop record to return to object level.

The fields within each OpenFlight record are stored in big-endian byte order. OpenFlight database files have the extension ".flt" by convention.

## Control Records

Control records indicate a change in the level of the database hierarchy. The three basic types of control records are: level changes, instance definition, and instance reference. Level changes are indicated by push and pop control records. Instance definitions and references are indicated by instance definition and instance reference control records.

### Hierarchy Level Change Records

A database contains three distinct types of hierarchy: generic, subface, and attribute. Hierarchy may be skipped by scanning past the push control record for the corresponding pop control record.

|           |   |
|-----------|---|
| Generic   | A push level control record introduces a generic subtree of the database hierarchy. A pop level control record concludes that subtree.                              |
| Subface   | A push subface control record introduces a subtree of coplanar faces. A pop subface control record concludes that subtree.  |
| Extension | A push extension control record introduces a subtree of user defined records. A pop extension control records concludes that subtree.                               |
| Attribute | A push attribute control record introduces a subtree of records reserved for internal use by Presagis, Inc.. A pop attribute control record concludes that subtree. |

### Push Level Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Push Level Opcode 10          |
| Unsigned Int | 2      | 2      | Length - length of the record |

### Pop Level Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Pop Level Opcode 11           |
| Unsigned Int | 2      | 2      | Length - length of the record |

### Push Subface Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Push Subface Opcode 19        |
| Unsigned Int | 2      | 2      | Length - length of the record |

### Pop Subface Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Pop Subface Opcode 20         |
| Unsigned Int | 2      | 2      | Length - length of the record |

### Push Extension Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Push Extension Opcode 21                           |
| Unsigned Int | 2      | 2      | Length - length of the record                      |
| Char         | 4      | 18     | Reserved   |
| Unsigned Int | 22     | 2      | Vertex reference index; -1 if not vertex extension |

### Pop Extension Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Pop Extension Opcode 22                            |
| Unsigned Int | 2      | 2      | Length - length of the record                      |
| Char         | 4      | 18     | Reserved   |
| Unsigned Int | 22     | 2      | Vertex reference index; -1 if not vertex extension |

**Push Attribute Record**

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Push Attribute Opcode 122                          |
| Unsigned Int | 2      | 2      | Length - length of the record                      |
| Int          | 4      | 4      | Vertex reference index; -1 if not vertex attribute |

**Pop Attribute Record**

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Pop Attribute Opcode 123      |
| Unsigned Int | 2      | 2      | Length - length of the record |

**Hierarchy Instancing Records**

An instance definition record introduces a stand-alone subtree of the database. The subtree is referenced one or more times from different branches in the database by instance reference records. At the point of reference, the subtree is copied (or possibly shared) as a child of the current parent node.

The instance definition record must appear in the file stream prior to the first instance reference record that references it. A typical usage of these records might look like:

```

INSTANCE DEFINITION 1
PUSH
    The records between this PUSH and POP define the
    stand-alone subtree that is INSTANCE DEFINITION 1
POP
...
GROUP
MATRIX
PUSH
INSTANCE REFERENCE 1
POP
GROUP
MATRIX
PUSH
INSTANCE REFERENCE 1
POP

```

In this example, both groups reference instance definition number 1, each presumably applying a different matrix to place the instance in different locations in the scene.

**Instance Definition Record**

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Instance Definition Opcode 62 |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 4      | Instance definition number    |

**Instance Reference Record**

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Instance Reference Opcode 61  |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 4      | Instance definition number    |

## Node Primary Records

### Header Record

The header record is the primary record of the header node and is always the first record in the database file. Attributes within the header record provide important information about the database file as a whole.

Format revision level indicates the OpenFlight version of the file. Correctly interpreting the attributes of other records, such as the face and vertex records, depends upon the format revision. The format revision encompasses both Flight and OpenFlight versions.

Some representative values for format revision are:

| Format Revision Value | Flight/OpenFlight Version  |
|-----------------------|----------------------------|
| 11                    | Flight V11                 |
| 12                    | Flight V12                 |
| 14                    | OpenFlight v14.0 and v14.1 |
| 1420                  | OpenFlight v14.2           |
| 1510                  | OpenFlight v15.1           |
| 1540                  | OpenFlight v15.4           |
| 1550                  | OpenFlight v15.5           |
| 1560                  | OpenFlight v15.6           |
| 1570                  | OpenFlight v15.7           |
| 1580                  | OpenFlight v15.8           |
| 1600                  | OpenFlight v16.0           |
| 1610                  | OpenFlight v16.1           |
| 1620                  | OpenFlight v16.2           |
| 1630                  | OpenFlight v16.3           |
| 1640                  | OpenFlight v16.4           |
| 1650                  | OpenFlight v16.5           |
| 1660                  | OpenFlight v16.6           |

This document describes OpenFlight version 16.6, therefore the attribute descriptions are based upon a format revision level of 1660.

Geographic attributes such as projection type, latitude, and longitude may be stored in the header record. The MultiGen Series II and Creator Terrain options set the value of these attributes when creating terrain databases. Positive latitudes reference the northern hemisphere and negative longitudes reference the western hemisphere.

Delta x, y and z attributes indicate the placement of the database when several separate databases, each with a local origin of zero, are used to represent an area.

### Header Record

| Data Type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Header Opcode 1   |
| Unsigned Int | 2      | 2      | Length - length of the record   |
| Char         | 4      | 8      | 7 char ASCII ID; <u>0 terminates</u> (usually set to "db")  |
| Int          | 12     | 4      | Format revision level   |
| Int          | 16     | 4      | Edit revision level   |
| Char         | 20     | 32     | Date and time of last revision  |
| Int          | 52     | 2      | Next Group node ID number   |
| Int          | 54     | 2      | Next LOD node ID number   |
| Int          | 56     | 2      | Next Object node ID number  |
| Int          | 58     | 2      | Next Face node ID number  |
| Int          | 60     | 2      | Unit multiplier (always 1)  |
| Int          | 62     | 1      | Vertex coordinate units<br>0 = Meters<br>1 = Kilometers<br>4 = Feet<br>5 = Inches<br>8 = Nautical miles                             |
| Int          | 63     | 1      | if TRUE set texwhite on new faces   |
| Int          | 64     | 4      | Flags (bits, from left to right)<br>0 = Save vertex normals<br>1 = Packed Color mode<br>2 = CAD View mode<br>3-31 = Spare           |
| Int          | 68     | 4*6    | Reserved  |
| Int          | 92     | 4      | Projection type<br>0 = Flat earth<br>1 = Trapezoidal<br>2 = Round earth<br>3 = Lambert<br>4 = UTM<br>5 = Geodetic<br>6 = Geocentric |
| Int          | 96     | 4*7    | Reserved  |
| Int          | 124    | 2      | Next DOF node ID number   |
| Int          | 126    | 2      | Vertex storage type<br>1 = Double precision float - should always be 1  |

## Header Record (Continued)

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 128    | 4      | Database origin<br>100 = OpenFlight<br>200 = DIG I/DIG II<br>300 = Evans and Sutherland CT5A/CT6<br>400 = PSP DIG<br>600 = General Electric CIV/CV/PT2000<br>700 = Evans and Sutherland GDF |
| Double    | 132    | 8      | Southwest database coordinate x   |
| Double    | 140    | 8      | Southwest database coordinate y   |
| Double    | 148    | 8      | Delta x to place database   |
| Double    | 156    | 8      | Delta y to place database   |
| Int       | 164    | 2      | Next sound node ID number   |
| Int       | 166    | 2      | Next path node ID number  |
| Int       | 168    | 4*2    | Reserved  |
| Int       | 176    | 2      | Next Clip node ID number  |
| Int       | 178    | 2      | Next Text node ID number  |
| Int       | 180    | 2      | Next BSP node ID number   |
| Int       | 182    | 2      | Next Switch node ID number  |
| Int       | 184    | 4      | Reserved  |
| Double    | 188    | 8      | Southwest corner latitude   |
| Double    | 196    | 8      | Southwest corner longitude  |
| Double    | 204    | 8      | Northeast corner latitude   |
| Double    | 212    | 8      | Northeast corner longitude  |
| Double    | 220    | 8      | Origin latitude   |
| Double    | 228    | 8      | Origin longitude  |
| Double    | 236    | 8      | Lambert upper latitude  |
| Double    | 244    | 8      | Lambert lower latitude  |
| Int       | 252    | 2      | Next Light source node ID number  |
| Int       | 254    | 2      | Next Light point node ID number   |
| Int       | 256    | 2      | Next Road node ID number  |
| Int       | 258    | 2      | Next CAT node ID number   |
| Int       | 260    | 2      | Reserved  |
| Int       | 262    | 2      | Reserved  |
| Int       | 264    | 2      | Reserved  |
| Int       | 266    | 2      | Reserved  |
| Int       | 268    | 4      | Earth ellipsoid model<br>0 = WGS 1984<br>1 = WGS 1972<br>2 = Bessel<br>3 = Clarke 1866<br>4 = NAD 1927<br>-1 = User defined ellipsoid   |
| Int       | 272    | 2      | Next Adaptive node ID number  |
| Int       | 274    | 2      | Next Curve node ID number   |
| Int       | 276    | 2      | UTM zone (for UTM projections - negative value means Southern hemisphere)   |
| Char      | 278    | 6      | Reserved  |

### Header Record (Continued)

| Data Type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Double       | 284    | 8      | Delta z to place database (used in conjunction with existing Delta x and Delta y values) |
| Double       | 292    | 8      | Radius (distance from database origin to farthest corner)                                |
| Unsigned int | 300    | 2      | Next Mesh node ID number   |
| Unsigned int | 302    | 2      | Next Light Point System ID number  |
| Unsigned int | 304    | 2      | Next Point ID number   |
| Int          | 306    | 2      | Reserved   |
| Double       | 308    | 8      | Earth major axis (for user defined ellipsoid) in meters                                  |
| Double       | 316    | 8      | Earth minor axis (for user defined ellipsoid) in meters                                  |

### Group Record

The group record is the primary record of the group node. Groups are the most generic hierarchical node present in the database tree. Attributes within the group record provide bounding volumes that encompass the group's children and real-time control flags.

Relative priority specifies a fixed ordering of the group relative to its sibling nodes. Ordering is from left (lesser values) to right (higher values). Nodes of equal priority may be arbitrarily ordered. All nodes have an implicit (default) relative priority value of zero.

A group can represent an animation sequence in which case each immediate child of the group represents one frame of the sequence. An animation sequence is made of one or more loops.

For a group with N children, both forward and backward loops consist of N frames. The frames of forward and backward loops are:

| Direction | Frame 1 | Frame 2   | Frame 3   | ... | Frame N |
|-----------|---------|-----------|-----------|-----|---------|
| Forward   | Child 1 | Child 2   | Child 3   | ... | Child N |
| Backward  | Child N | Child N-1 | Child N-2 | ... | Child 1 |

Independent of the direction of the loop, a loop can optionally *swing*. A swing loop is one that plays its children in the primary direction and then plays them in the opposite direction. Note that as the loop swings from the current direction to the opposite direction, the last frame in the current direction is not repeated. Therefore, for a group with N children, the first loop of both forward swing and backward swing animations consist of M frames where M equals  $((2*N)-1)$  frames. Subsequent loops of swing animations consist of M-1 frames.

The frames of the first loop of forward and backward swing animations are:

| Direction | Frame 1 | Frame 2   | ... | Frame N | Frame N+1 | Frame N+2 | ... | Frame M |
|-----------|---------|-----------|-----|---------|-----------|-----------|-----|---------|
| Forward   | Child 1 | Child 2   | ... | Child N | Child N-1 | Child N-2 | ... | Child 1 |
| Backward  | Child N | Child N-1 | ... | Child 1 | Child 2   | Child 3   | ... | Child N |

The frames of subsequent loops of forward and backward swing animations are:

| Direction | Frame 1   | Frame 2   | ... | Frame N | Frame N+1 | Frame N+2 | ... | Frame M-1 |
|-----------|-----------|-----------|-----|---------|-----------|-----------|-----|-----------|
| Forward   | Child 2   | Child 3   | ... | Child N | Child N-1 | Child N-2 | ... | Child 1   |
| Backward  | Child N-1 | Child N-2 | ... | Child 1 | Child 2   | Child 3   | ... | Child N   |

The number of times an animation loop repeats within the sequence is specified by the loop count attribute. A loop count of 0 indicates that the loop is to repeat forever.

The duration of one loop within the sequence is specified by the loop duration attribute and is measured in seconds. A loop duration of 0 indicates that the loop is to play as fast as possible.

For finite animation sequences (those with positive, non-zero loop count values), the duration that the last frame of the last loop is extended after the sequence has finished is specified by the last frame duration attribute and is measured in seconds. A last frame duration of 0 indicates that the last frame is not displayed any longer after the sequence finishes.

Special effect ID1 and ID2 are application-defined attributes. Their values can be used to enhance the meaning of existing attributes, such as the animation flags, or extend the interpretation of the group node. Normally, the value of these attributes is zero.

Significance can be used to assist real-time culling and load balancing mechanisms, by defining the visual significance of this group with respect to other groups in the database. Normally the value of this attribute is zero.

Layer ID is used by the Instrumentation Tools in the modeling products to identify (for display) a collection of groups, independent of their locations in the hierarchy. Normally the value of this attribute is zero.

### Group Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Group Opcode 2   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 2      | Relative priority  |
| Int          | 14     | 2      | Reserved   |
| Int          | 16     | 4      | Flags (bits, from left to right)<br>0 = Reserved<br>1 = Forward animation<br>2 = Swing animation<br>3 = Bounding box follows<br>4 = Freeze bounding box<br>5 = Default parent<br>6 = Backward animation<br>7 = Preserve at runtime<br>8-31 = Spare |
| Int          | 20     | 2      | Special effect ID1 - application defined   |
| Int          | 22     | 2      | Special effect ID2 - application defined   |
| Int          | 24     | 2      | Significance   |
| Int          | 26     | 1      | Layer code   |
| Int          | 27     | 1      | Reserved   |
| Int          | 28     | 4      | Reserved   |
| Int          | 32     | 4      | Loop count   |
| Float        | 36     | 4      | Loop duration in seconds   |
| Float        | 40     | 4      | Last frame duration in seconds   |

Here are some examples that show how the values of the animation flags (forward animation, backward animation and swing animation) affect the animation. Note that these flags define how one “loop” of the animation sequence behaves.

### Group Animation Flags Examples

| Forward Animation | Backward Animation | Swing Animation | Result  |
|-------------------|--------------------|-----------------|---|
| 0                 | 0                  | 0               | Group is not animated                                     |
| 1                 | 0                  | 0               | Animation loop is forward, no swing.                      |
| 0                 | 1                  | 0               | Animation loop is backward, no swing.                     |
| 1                 | 0                  | 1               | Animation loop is forward with swing.                     |
| 0                 | 1                  | 1               | Animation loop is backward with swing.                    |
| 1                 | 1                  | Any             | Undefined, must be either forward or backward (not both). |

Here are some examples that show how the loop duration, loop count and last frame duration attributes affect the animation. Note that these values are independent of the animation flags from above.

### Group Animation Count Examples

| Loop Duration  | Loop Count | Last Frame Duration | Result  |
|----------------|------------|---------------------|---|
| 0              | 0          | Any                 | Each loop plays as fast as possible.<br>Loops are played forever.<br>Last Frame Duration not applicable.  |
| T              | 0          | Any                 | Each loop lasts T seconds.<br>Loops are played forever.<br>Last Frame Duration not applicable.  |
| 0              | N          | 0                   | Each loop plays as fast as possible.<br>N loops are played.<br>Last frame displayed as long as any other frame.   |
| 0              | N          | T                   | Each loop plays as fast as possible.<br>N loops are played.<br>Last frame of last (Nth) loop displayed T seconds longer than any other frame.                 |
| T <sub>1</sub> | N          | 0                   | Each loop lasts T <sub>1</sub> seconds.<br>N loops are played.<br>Last frame of last (Nth) loop displayed as long as any other frame.                         |
| T <sub>1</sub> | N          | T <sub>2</sub>      | Each loop lasts T <sub>1</sub> seconds.<br>N loops are played.<br>Last frame of last (Nth) loop displayed T <sub>2</sub> seconds longer than any other frame. |

### Object Record

The object record is the primary record of the object node. Objects are low-level grouping nodes that contain attributes pertaining to the state of its child geometry. Only face and light point nodes may be the children of object nodes.

The time-of-day object flags can be used to inhibit the display of certain objects, depending on the current time of day.

The illumination flag, when set, makes an object self-illuminating, and is not subject to lighting calculations. In practice, geometric normals should be ignored.

The flat shading flag, when set, indicates that lighting calculations should produce a faceted appearance to the object's geometry. In practice, geometric normals should be constrained to face normals.

The shadow flag indicates the object represents the shadow of the rest of the group. When used as part of a moving model (e.g., an aircraft), the application can apply appropriate distortions, creating a realistic shadow on the terrain or runway.

Relative priority specifies a fixed ordering of the object relative to its sibling nodes. Ordering is from left (lesser values) to right (higher values). Nodes of equal priority may be arbitrarily ordered. All nodes have an implicit (default) value of zero.

When used, transparency applies to all an object's children (geometry). The value should be modulated with the transparency of the geometry and material alpha calculation, as described in the Face Record, Mesh Record and Material Record sections.

**Note:** The Presagis, Inc. modeling environment does not use the object transparency value for rendering as described above. However, when an object's transparency value is set in Creator, that value is set on all children faces of the object. Runtime applications may choose to use the transparency value at the object level at their discretion.

### Object Record

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Object Opcode 4   |
| Unsigned Int | 2      | 2      | Length - length of the record   |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates   |
| Int          | 12     | 4      | Flags (bits from to right)<br>0 = Don't display in daylight<br>1 = Don't display at dusk<br>2 = Don't display at night<br>3 = Don't illuminate<br>4 = Flat shaded<br>5 = Group's shadow object<br>6 = Preserve at runtime<br>7-31 = Spare |
| Int          | 16     | 2      | Relative priority   |
| Unsigned Int | 18     | 2      | Transparency<br>0 = Opaque<br>65535 = Totally clear   |
| Int          | 20     | 2      | Special effect ID1 - application defined  |
| Int          | 22     | 2      | Special effect ID2 - application defined  |
| Int          | 24     | 2      | Significance  |
| Int          | 26     | 2      | Reserved  |

### Face Record

The face record is the primary record of the face node. A face contains attributes describing the visual state of its child vertices. Only vertex and morph vertex nodes may be children of faces. This should not be confused with the fact that faces may have subfaces.

If a face contains a non-negative material index, the material affects the appearance of the face as described as follows.

If the material is an **extended** material, the visual appearance of the face is completely described by the **extended** material entry as described in [“Extended Material Palette Records” on page 77](#).

If the material is a **standard** material, the apparent color of the face is a combination of the face color and material color as described in “[Material Palette Record](#)” on page 76. Similarly, the total transparency of the face is the product of the material alpha and face transparency.

**Note:** As mentioned in “[Object Record](#)” on page 27, the object transparency is not used in the Presagis, Inc. modeling environment to determine the actual transparency value of a face.

If a face is a unidirectional or bidirectional light point, the face record is followed by a vector record (Vector Opcode 50) that contains the unit vector indicating the direction in which the primary color is displayed. For bidirectional light points, the alternate color is displayed in the opposite direction (180 degrees opposed).

**Note:** This method of defining light points is obsolete after OpenFlight version 15.2. Such light point faces will be turned into the new light point record when it is read into MultiGen II v1.4 or later.

Relative priority specifies a fixed ordering of the face relative to its sibling nodes. Ordering is from left (lesser values) to right (higher values). Nodes of equal priority may be arbitrarily ordered. All nodes have an implicit (default) value of zero.

### Face Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Face Opcode 5  |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 4      | IR color code  |
| Int          | 16     | 2      | Relative priority  |
| Int          | 18     | 1      | Draw type<br>0 = Draw solid with backface culling (front side only)<br>1 = Draw solid, no backface culling (both sides visible)<br>2 = Draw wireframe and close<br>3 = Draw wireframe<br>4 = Surround with wireframe in alternate color<br>8 = Omnidirectional light<br>9 = Unidirectional light<br>10 = Bidirectional light |
| Int          | 19     | 1      | Texture white = if TRUE, draw textured face white  |
| Unsigned Int | 20     | 2      | Color name index   |
| Unsigned Int | 22     | 2      | Alternate color name index   |
| Int          | 24     | 1      | Reserved   |
| Int          | 25     | 1      | Template (billboard)<br>0 = Fixed, no alpha blending<br>1 = Fixed, alpha blending<br>2 = Axial rotate with alpha blending<br>4 = Point rotate with alpha blending  |
| Int          | 26     | 2      | Detail texture pattern index, -1 if none   |
| Int          | 28     | 2      | Texture pattern index, -1 if none  |
| Int          | 30     | 2      | Material index, -1 if none   |

## Face Record (Continued)

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 32     | 2      | Surface material code (for DFAD)  |
| Int          | 34     | 2      | Feature ID (for DFAD)   |
| Int          | 36     | 4      | IR material code  |
| Unsigned Int | 40     | 2      | Transparency<br>0 = Opaque<br>65535 = Totally clear   |
| Unsigned Int | 42     | 1      | LOD generation control  |
| Unsigned Int | 43     | 1      | Line style index  |
| Int          | 44     | 4      | Flags (bits from left to right)<br>0 = Terrain<br>1 = No color<br>2 = No alternate color<br>3 = Packed color<br>4 = Terrain culture cutout (footprint)<br>5 = Hidden, not drawn<br>6 = Roofline<br>7-31 = Spare       |
| Unsigned Int | 48     | 1      | Light mode<br>0 = Use face color, not illuminated (Flat)<br>1 = Use vertex colors, not illuminated (Gouraud)<br>2 = Use face color and vertex normals (Lit)<br>3 = Use vertex colors and vertex normals (Lit Gouraud) |
| Char         | 49     | 7      | Reserved  |
| Unsigned Int | 56     | 4      | Packed color, primary (a, b, g, r) - only b, g, r used  |
| Unsigned Int | 60     | 4      | Packed color, alternate (a, b, g, r) - only b, g, r used  |
| Int          | 64     | 2      | Texture mapping index, -1 if none   |
| Int          | 66     | 2      | Reserved  |
| Unsigned Int | 68     | 4      | Primary color index, -1 if none   |
| Unsigned Int | 72     | 4      | Alternate color index, -1 if none   |
| Int          | 76     | 2      | Reserved  |
| Int          | 78     | 2      | Shader index, -1 if none  |

## Mesh Nodes

A mesh node defines a set of geometric primitives that share attributes and vertices. Prior to OpenFlight version 15.7, the fundamental geometric construct was the face (polygon) which was represented by a unique set of attributes and vertices. Meshes, by contrast, represent “sets” of related polygons, each sharing common attributes and vertices. Using a mesh, related polygons can be represented in a much more compact format. Each mesh consists of one set of “polygon” attributes (color, material, texture, etc.), a common “vertex pool” and one or more geometric primitives that use the shared attributes and vertices. Using a mesh, you can represent triangle strips, triangle fans, quadrilateral strips and indexed face sets.

A mesh node is defined by three distinct record types:

- *Mesh Record* - defines the “polygon” attributes associated to all geometric primitives of the mesh.

- *Local Vertex Pool Record* - defines the set of vertices that are referenced by the geometric primitives of the mesh.
- *Mesh Primitive Record* - defines a geometric primitive (triangle-strip, triangle-fan, quadrilateral-strip or indexed face set) for the mesh.

A mesh node consists of one mesh record, one local vertex pool record, and one or more mesh primitive records. The mesh primitive records are delimited by push and pop control records as shown in this example:

```
MESH
LOCAL VERTEX POOL
PUSH
MESH PRIMITIVE
MESH PRIMITIVE
...
MESH PRIMITIVE
POP
```

### **Mesh Record**

The mesh record is the primary record of a mesh node and defines the common “face-like” attributes associated to all geometric primitives of the mesh. These attributes are identical to those of the face record. See “Face Record” on page 28.

#### **Mesh Record**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>   |
|------------------|---------------|---------------|--|
| Int              | 0             | 2             | Mesh Opcode 84   |
| Unsigned Int     | 2             | 2             | Length - length of the record  |
| Char             | 4             | 8             | 7 char ASCII ID; 0 terminates  |
| Int              | 12            | 4             | Reserved   |
| Int              | 16            | 4             | IR color code  |
| Int              | 20            | 2             | Relative priority  |
| Int              | 22            | 1             | Draw type<br>0 = Draw solid with backface culling (front side only)<br>1 = Draw solid, no backface culling (both sides visible)<br>2 = Draw wireframe and close<br>3 = Draw wireframe<br>4 = Surround with wireframe in alternate color<br>8 = Omnidirectional light<br>9 = Unidirectional light<br>10 = Bidirectional light |
| Int              | 23            | 1             | Texture white = if TRUE, draw textured face white  |
| Unsigned Int     | 24            | 2             | Color name index   |
| Unsigned Int     | 26            | 2             | Alternate color name index   |
| Int              | 28            | 1             | Reserved   |

## Mesh Record (Continued)

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 29     | 1      | Template (billboard)<br>0 = Fixed, no alpha blending<br>1 = Fixed, alpha blending<br>2 = Axial rotate with alpha blending<br>4 = Point rotate with alpha blending   |
| Int          | 30     | 2      | Detail texture pattern index, -1 if none  |
| Int          | 32     | 2      | Texture pattern index, -1 if none   |
| Int          | 34     | 2      | Material index, -1 if none  |
| Int          | 36     | 2      | Surface material code (for DFAD)  |
| Int          | 38     | 2      | Feature ID (for DFAD)   |
| Int          | 40     | 4      | IR material code  |
| Unsigned Int | 44     | 2      | Transparency<br>0 = Opaque<br>65535 = Totally clear   |
| Unsigned Int | 46     | 1      | LOD generation control  |
| Unsigned Int | 47     | 1      | Line style index  |
| Int          | 48     | 4      | Flags (bits from left to right)<br>0 = Terrain<br>1 = No color<br>2 = No alternate color<br>3 = Packed color<br>4 = Terrain culture cutout (footprint)<br>5 = Hidden, not drawn<br>6 = Roofline<br>7-31 = Spare       |
| Unsigned Int | 52     | 1      | Light mode<br>0 = Use mesh color, not illuminated (Flat)<br>1 = Use vertex colors, not illuminated (Gouraud)<br>2 = Use mesh color and vertex normals (Lit)<br>3 = Use vertex colors and vertex normals (Lit Gouraud) |
| Char         | 53     | 7      | Reserved  |
| Unsigned Int | 60     | 4      | Packed color, primary (a, b, g, r) - only b, g, r used  |
| Unsigned Int | 64     | 4      | Packed color, alternate (a, b, g, r) - only b, g, r used  |
| Int          | 68     | 2      | Texture mapping index, -1 if none   |
| Int          | 70     | 2      | Reserved  |
| Unsigned Int | 72     | 4      | Primary color index, -1 if none   |
| Unsigned Int | 76     | 4      | Alternate color index, -1 if none   |
| Int          | 80     | 2      | Reserved  |
| Int          | 82     | 2      | Shader index, -1 if none  |

### Local Vertex Pool Record

This record defines a set of vertices that is referenced by the geometry (primitives) of the mesh.

**Note:** Currently the Local Vertex Pool is used exclusively in the context of mesh nodes, but it is designed in a general way so that it may appear in other contexts in future versions of the OpenFlight Scene Description.

#### Local Vertex Pool Record

| Data Type    | Offset   | Length | Description  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
|--------------|--|--------|--|-------|-------------|---|---|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|----|--|----|--|
| Int          | 0  | 2      | Local Vertex Pool Opcode 85  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| Unsigned Int | 2  | 2      | Length - length of the record<br>Note: Since the length of this record is represented by an unsigned short, the maximum length of the vertex pool is $2^{16} - 1$ (or 65535 bytes). If the entire vertex pool cannot fit into this size, one or more continuation records will follow. (See " <a href="#">Continuation Record</a> " on page 69.)   |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| Unsigned Int | 4  | 4      | Number of vertices - number of vertices in the local vertex pool   |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| Unsigned Int | 8  | 4      | Attribute mask - Bit mask indicating what kind of vertex information is specified for each vertex in the local vertex pool. Bits are ordered from left to right as follows:<br><br><table border="1"> <thead> <tr> <th>Bit #</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Has Position - if set, data for each vertex in will include x, y, and z coordinates (3 doubles)</td> </tr> <tr> <td>1</td> <td>Has Color Index - if set, data for each vertex will include a color value that specifies a color table index as well as an alpha value</td> </tr> <tr> <td>2</td> <td>Has RGBA Color - if set, data for each vertex will include a color value that is a packed RGBA color value</td> </tr> </tbody> </table> <p>Note: Bits 1 and 2 are mutually exclusive - a vertex can have either color index or RGB color value or neither, but not both.</p> <table border="1"> <tbody> <tr> <td>3</td> <td>Has Normal - if set, data for each vertex will include a normal (3 floats)</td> </tr> <tr> <td>4</td> <td>Has Base UV - if set, data for each vertex will include uv texture coordinates for the base texture (2 floats)</td> </tr> <tr> <td>5</td> <td>Has UV Layer 1 - if set, data for each vertex will include uv texture coordinates for layer 1 (2 floats)</td> </tr> <tr> <td>6</td> <td>Has UV Layer 2 - if set, data for each vertex will include uv texture coordinates for layer 2 (2 floats)</td> </tr> <tr> <td>7</td> <td>Has UV Layer 3 - if set, data for each vertex will include uv texture coordinates for layer 3 (2 floats)</td> </tr> <tr> <td>8</td> <td>Has UV Layer 4 - if set, data for each vertex will include uv texture coordinates for layer 4 (2 floats)</td> </tr> <tr> <td>9</td> <td>Has UV Layer 5 - if set, data for each vertex will include uv texture coordinates for layer 5 (2 floats)</td> </tr> <tr> <td>10</td> <td>Has UV Layer 6 - if set, data for each vertex will include uv texture coordinates for layer 6 (2 floats)</td> </tr> <tr> <td>11</td> <td>Has UV Layer 7 - if set, data for each vertex will include uv texture coordinates for layer 7 (2 floats)</td> </tr> </tbody> </table> | Bit # | Description | 0 | Has Position - if set, data for each vertex in will include x, y, and z coordinates (3 doubles) | 1 | Has Color Index - if set, data for each vertex will include a color value that specifies a color table index as well as an alpha value | 2 | Has RGBA Color - if set, data for each vertex will include a color value that is a packed RGBA color value | 3 | Has Normal - if set, data for each vertex will include a normal (3 floats) | 4 | Has Base UV - if set, data for each vertex will include uv texture coordinates for the base texture (2 floats) | 5 | Has UV Layer 1 - if set, data for each vertex will include uv texture coordinates for layer 1 (2 floats) | 6 | Has UV Layer 2 - if set, data for each vertex will include uv texture coordinates for layer 2 (2 floats) | 7 | Has UV Layer 3 - if set, data for each vertex will include uv texture coordinates for layer 3 (2 floats) | 8 | Has UV Layer 4 - if set, data for each vertex will include uv texture coordinates for layer 4 (2 floats) | 9 | Has UV Layer 5 - if set, data for each vertex will include uv texture coordinates for layer 5 (2 floats) | 10 | Has UV Layer 6 - if set, data for each vertex will include uv texture coordinates for layer 6 (2 floats) | 11 | Has UV Layer 7 - if set, data for each vertex will include uv texture coordinates for layer 7 (2 floats) |
| Bit #        | Description  |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 0            | Has Position - if set, data for each vertex in will include x, y, and z coordinates (3 doubles)  |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 1            | Has Color Index - if set, data for each vertex will include a color value that specifies a color table index as well as an alpha value |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 2            | Has RGBA Color - if set, data for each vertex will include a color value that is a packed RGBA color value                             |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 3            | Has Normal - if set, data for each vertex will include a normal (3 floats)   |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 4            | Has Base UV - if set, data for each vertex will include uv texture coordinates for the base texture (2 floats)                         |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 5            | Has UV Layer 1 - if set, data for each vertex will include uv texture coordinates for layer 1 (2 floats)                               |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 6            | Has UV Layer 2 - if set, data for each vertex will include uv texture coordinates for layer 2 (2 floats)                               |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 7            | Has UV Layer 3 - if set, data for each vertex will include uv texture coordinates for layer 3 (2 floats)                               |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 8            | Has UV Layer 4 - if set, data for each vertex will include uv texture coordinates for layer 4 (2 floats)                               |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 9            | Has UV Layer 5 - if set, data for each vertex will include uv texture coordinates for layer 5 (2 floats)                               |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 10           | Has UV Layer 6 - if set, data for each vertex will include uv texture coordinates for layer 6 (2 floats)                               |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |
| 11           | Has UV Layer 7 - if set, data for each vertex will include uv texture coordinates for layer 7 (2 floats)                               |        |  |       |             |   |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |

## Local Vertex Pool Record (Continued)

|   |        |     |   |
|---|--------|-----|---|
|   |        |     | 12-31 Spare   |
| Then beginning at offset 12, the following fields are repeated for each vertex in the local vertex pool, depending on the bits set in the Attribute mask field above. |        |     |   |
| In the fields listed below, N ranges from 0 to Number of vertices - 1.  |        |     |   |
| Double  | Varies | 8*3 | Coordinate <sub>N</sub> - Coordinate of vertex N (x, y, z) - present if Attribute mask includes Has Position.   |
| Unsigned Int  | Varies | 4   | color <sub>N</sub> - Color for vertex N - present if Attribute mask includes Has Color Index or Has RGBA Color.<br>If Has Color Index, lower 3 bytes specify color table index, upper 1 byte is Alpha.<br>If Has RGBA Color, 4 bytes specify (a, b, g, r) values. |
| Float   | Varies | 4*3 | normal <sub>N</sub> - Normal for vertex N (i, j, k) - present if Attribute mask includes Has Normal.  |
| Float   | Varies | 4*2 | uvBase <sub>N</sub> - Texture coordinates (u, v) for base texture layer of vertex N - present if Attribute mask includes Has Base UV.   |
| Float   | Varies | 4*2 | uv1 <sub>N</sub> - Texture coordinates (u, v) for layer 1 of vertex N - present if Attribute mask includes Has UV Layer 1.  |
| Float   | Varies | 4*2 | uv2 <sub>N</sub> - Texture coordinates (u, v) for layer 2 of vertex N - present if Attribute mask includes Has UV Layer 2.  |
| Float   | Varies | 4*2 | uv3 <sub>N</sub> - Texture coordinates (u, v) for layer 3 of vertex N - present if Attribute mask includes Has UV Layer 3.  |
| Float   | Varies | 4*2 | uv4 <sub>N</sub> - Texture coordinates (u, v) for layer 4 of vertex N - present if Attribute mask includes Has UV Layer 4.  |
| Float   | Varies | 4*2 | uv5 <sub>N</sub> - Texture coordinates (u, v) for layer 5 of vertex N - present if Attribute mask includes Has UV Layer 5.  |
| Float   | Varies | 4*2 | uv6 <sub>N</sub> - Texture coordinates (u, v) for layer 6 of vertex N - present if Attribute mask includes Has UV Layer 6.  |
| Float   | Varies | 4*2 | uv7 <sub>N</sub> - Texture coordinates (u, v) for layer 7 of vertex N - present if Attribute mask includes Has UV Layer 7.  |

## Mesh Primitive Record

This record defines a geometric primitive (triangle strip, triangle fan, quadrilateral strip, or indexed polygon) for a mesh.

**Mesh Primitive Record**

| Data Type  | Offset            | Length     | Description  |
|--|-------------------|------------|--|
| Int  | 0                 | 2          | Mesh Primitive Opcode 86   |
| Unsigned Int   | 2                 | 2          | Length - length of the record  |
| Int  | 4                 | 2          | Primitive Type - specifies how the vertices of the primitive are interpreted<br>1 = Triangle Strip<br>2 = Triangle Fan<br>3 = Quadrilateral Strip<br>4 = Indexed Polygon |
| Unsigned Int   | 6                 | 2          | Index Size - specifies the length (in bytes) of each of the vertex indices that follow - will be either 1, 2, or 4   |
| Unsigned Int   | 8                 | 4          | Vertex Count - number of vertices contained in this primitive.   |
| The following field is repeated for each vertex referenced by the mesh primitive. These vertices are interpreted according to Primitive Type. In the field below, N ranges from 0 to Vertex Count - 1. |                   |            |  |
| Int  | 12+(N*Index Size) | Index Size | Index <sub>N</sub> - Index of vertex N of the mesh primitive.  |

Each mesh primitive is represented using the Mesh Primitive record above. The following descriptions explain how the vertices of each primitive type are interpreted as geometry:

- Triangle Strip** - This mesh primitive defines a connected group of triangles in the context of the enclosing mesh. Each triangle shares the “polygon” attributes defined by the enclosing mesh. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One triangle is defined for each vertex presented after the first two vertices. For odd  $n$ , vertices  $n$ ,  $n+1$ , and  $n+2$  define triangle  $n$ . For even  $n$ , vertices  $n+1$ ,  $n$ , and  $n+2$  define triangle  $n$ . The first triangle is  $n=1$ . The first vertex in the vertex pool is  $n=1$ .  $N$  vertices represent  $N-2$  triangles.
- Triangle Fan** - Like the Triangle Strip, this mesh primitive also defines a connected group of triangles in the context of the enclosing mesh. Each triangle shares the “polygon” attributes defined by the enclosing mesh. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One triangle is defined for each vertex presented after the first two vertices. Vertices 1,  $n+1$ , and  $n+2$  define triangle  $n$ . The first triangle is  $n=1$ . The first vertex in the vertex pool is  $n=1$ .  $N$  vertices represent  $N-2$  triangles.
- Quadrilateral Strip** - This mesh primitive defines a connected group of quadrilaterals in the context of the enclosing mesh. Each quadrilateral shares the “polygon” attributes defined by the enclosing mesh. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One quadrilateral is defined for each pair of vertices presented after the first pair. Vertices  $2n-1$ ,  $2n$ ,  $2n+2$ , and  $2n+1$  define quadrilateral  $n$ . The first quadrilateral is  $n=1$ . The first vertex in the vertex pool is  $n=1$ .  $N$  vertices represent  $(N/2)-1$  quadrilaterals.
- Indexed Polygon** - This mesh primitive defines a single polygon in the context of the enclosing mesh. This primitive is similar to the other mesh primitives in that it also shares the polygon attributes of

the enclosing mesh. It is different from the other mesh primitive types in that while triangle strips/fans and quadrilateral strips describe a set of connected triangles/quadrilaterals, the indexed polygon defines a single polygon. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One polygon is defined by the sequence of vertices in this record. N vertices represent 1 N-sided closed polygon or 1 (N-1)-sided unclosed polygon.

## Point Record

The Point node is used to specify a 3D position coordinate and optional normal and x-axis vectors. The position of the point node specifies the 3D location of the point while the normal and x-axis vectors (if present) provide additional “orientation” information about the point. The position along with x-axis and normal could, for example, be used to specify a coordinate system. Note that the y-axis of the coordinate system is not specified but is easily calculated as the cross product of the normal and the x-axis.

### Point Record

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Point Record Opcode 157   |
| Unsigned Int | 2      | 2      | Length - length of the record   |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates   |
| Int          | 12     | 4      | Reserved  |
| Int          | 16     | 4      | Flags (bits from left to right)<br>0 = Has Normal<br>1 = Has X Axis<br>2-31 = Spare |
| Int          | 20     | 4      | Reserved  |
| Double       | 24     | 8*3    | Position coordinate (x,y,z) of Point  |
| Float        | 48     | 4*3    | Normal vector (i,j,k) of Point - valid if Has Normal flag is set                    |
| Float        | 60     | 4*3    | X Axis (i,j,k) of Point - valid if Has X Axis flag is set                           |

## Light Point Nodes

The OpenFlight format supports two kinds of light point records, indexed and inline. In indexed light point records, the attributes are stored in two palettes; the light point appearance palette and the light point animation palette. The indexed light point record simply stores indices into these two palettes. In inline light point records, all the attributes are stored directly in the light point record itself. This section describes both of these records.

### ***Indexed Light Point Record***

The indexed light point record is one of the records that can represent a light point node.

The appearance index specifies an entry in the light point appearance palette that contains the visual attributes of the light point.

The animation index specifies an entry in the light point animation palette that contains the behavioral attributes of the light point.

The palette entries referenced by the indexed light point record describe the visual state of the light point's child vertices. Only vertex nodes may be children of light point nodes.

### Indexed Light Point Record

| Data type    | Offset | Length | Description                           |
|--------------|--------|--------|---------------------------------------|
| Int          | 0      | 2      | Indexed Light Point Record Opcode 130 |
| Unsigned Int | 2      | 2      | Length - length of the record         |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates         |
| Int          | 12     | 4      | Appearance index                      |
| Int          | 16     | 4      | Animation index                       |
| Int          | 20     | 4      | Draw order (for calligraphic lights)  |
| Int          | 24     | 4      | Reserved                              |

### Light Point Record

The light point record is one of the records that can represent a light point node. The light point record contains attributes describing the visual state of its child vertices. Only vertex nodes may be children of light point nodes.

Light points are geometric points that represent real world light sources such as runway lights, vehicle lights, street lights, and rotating beacons. Light points differ from light sources in that they do not illuminate the scene around them. They are primarily used to model important visual cues without incurring the tremendous rendering overhead associated with light sources.

Most light point attributes are specific to these unique requirements. Light points can be displayed on special purpose calligraphic imaging systems, the more familiar raster variety, or even hybrid raster/calligraphic (RASCAL) systems.

### Light Point Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Light Point Record Opcode 111                                |
| Unsigned Int | 2      | 2      | Length - length of the record                                |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates                                |
| Int          | 12     | 2      | Surface material code  |
| Int          | 14     | 2      | Feature ID   |
| Unsigned Int | 16     | 4      | Back color for bidirectional points                          |
| Int          | 20     | 4      | Display mode<br>0 = RASTER<br>1 = CALLIGRAPHIC<br>2 = EITHER |
| Float        | 24     | 4      | Intensity - scalar for front colors                          |
| Float        | 28     | 4      | Back intensity - scalar for back color                       |
| Float        | 32     | 4      | Minimum defocus - (0.0 - 1.0) for calligraphic points        |
| Float        | 36     | 4      | Maximum defocus - (0.0 - 1.0) for calligraphic points        |

## Light Point Record (Continued)

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 40     | 4      | Fading mode<br>0 = Enable perspective fading calculations<br>1 = Disable calculations      |
| Int       | 44     | 4      | Fog Punch mode<br>0 = Enable fog punch through calculations<br>1 = Disable calculations    |
| Int       | 48     | 4      | Directional mode<br>0 = Enable directional calculations<br>1 = Disable calculations        |
| Int       | 52     | 4      | Range mode<br>0 = Use depth (Z) buffer calculation<br>1 = Use slant range calculation      |
| Float     | 56     | 4      | Min pixel size - minimum diameter of points in pixels                                      |
| Float     | 60     | 4      | Max pixel size - maximum diameter of points in pixels                                      |
| Float     | 64     | 4      | Actual size - actual diameter of points in database units                                  |
| Float     | 68     | 4      | Transparent falloff pixel size - diameter in pixels when points become transparent         |
| Float     | 72     | 4      | Transparent falloff exponent<br>>= 0 - falloff multiplier exponent<br>1.0 - linear falloff |
| Float     | 76     | 4      | Transparent falloff scalar<br>> 0 - falloff multiplier scale factor                        |
| Float     | 80     | 4      | Transparent falloff clamp - minimum permissible falloff multiplier result                  |
| Float     | 84     | 4      | Fog scalar<br>>= 0 - adjusts range of points for punch threw effect.                       |
| Float     | 88     | 4      | Reserved   |
| Float     | 92     | 4      | Size difference threshold - point size transition hint to renderer                         |
| Int       | 96     | 4      | Directionality<br>0 = OMNIDIRECTIONAL<br>1 = UNIDIRECTIONAL<br>2 = BIDIRECTIONAL           |
| Float     | 100    | 4      | Horizontal lobe angle - total angle in degrees   |
| Float     | 104    | 4      | Vertical lobe angle - total angle in degrees   |
| Float     | 108    | 4      | Lobe roll angle - rotation of lobe about local Y axis in degrees                           |
| Float     | 112    | 4      | Directional falloff exponent<br>>= 0 - falloff multiplier exponent<br>1.0 - linear falloff |
| Float     | 116    | 4      | Directional ambient intensity - of points viewed off axis                                  |
| Float     | 120    | 4      | Animation period in seconds  |
| Float     | 124    | 4      | Animation phase delay in seconds - from start of period                                    |
| Float     | 128    | 4      | Animation enabled period in seconds  |
| Float     | 132    | 4      | Significance - drop out priority for RASCAL lights (0.0 - 1.0)                             |
| Int       | 136    | 4      | Calligraphic draw order - for rendering consistency  |

**Light Point Record (Continued)**

| Data type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 140    | 4      | Flags (bits, from left to right)<br>0 = reserved<br>1 = No back color<br>TRUE = don't use back color for bidirectional points<br>FALSE = use back color for bidirectional points<br>2 = reserved<br>3 = Calligraphic proximity occulting (Debunching)<br>4 = Reflective, non-emissive point<br>5-7 = Randomize intensity<br>0 = never<br>1 = low<br>2 = medium<br>3 = high<br>8 = Perspective mode<br>9 = Flashing<br>10 = Rotating<br>11 = Rotate Counter Clockwise<br>Direction of rotation about local Z axis<br>12 = reserved<br>13-14 = Quality<br>0 = Low<br>1 = Medium<br>2 = High<br>3 = Undefined<br>15 = Visible during day<br>16 = Visible during dusk<br>17 = Visible during night<br>18-31 = Spare |
| Float     | 144    | 4*3    | Axis of rotation for rotating animation (i, j, k)   |

**Light Point System Record**

The light point system record enables you to collect a set of light points and enable/disable or brighten/dim them as a group.

**Light Point System Record**

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Light Point System Record Opcode 131               |
| Unsigned Int | 2      | 2      | Length - length of the record                      |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates                      |
| Float        | 12     | 4      | Intensity  |
| Int          | 16     | 4      | Animation state<br>0 = On<br>1 = Off<br>2 = Random |

### Light Point System Record (Continued)

| Data type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 20     | 4      | Flags (bits, from left to right)<br>0 = Enabled<br>1-31 = Spare |

### Degree of Freedom Record

The degree of freedom (DOF) record is the primary record of the DOF node. The DOF node specifies a local coordinate system and the range allowed for translation, rotation, and scale with respect to that coordinate system.

The DOF record can be viewed as a series of applied transformations consisting of the following elements:

[ PTTTRRRSSSP ]

where “P” denotes “put,” “T” denotes “translate,” “R” denotes “rotate,” and “S” denotes “scale.”

It is important to understand the order in which these transformations are applied to the geometry. A pre-multiplication is assumed, so the sequence of transformations must be read from right to left, in order to describe its effect on the geometry contained below the DOF. In this manner, a DOF is interpreted as a Put followed by three Scales, three Rotates, three Translates, and a Put.

Taking the transformations in right to left order, they represent:

1. A Put (3 point to 3 point transformation). This matrix brings the DOF coordinate system to the world origin, with its x-axis aligned along the world x-axis and its y-axis in the world x-y plane. Testing against the DOF's constraints is performed in this standard position. This matrix is therefore the inverse of the last (See Step 11 below).
2. Scale in x.
3. Scale in y.
4. Scale in z.
5. Rotation about z (yaw).
6. Rotation about y (roll).
7. Rotation about x (pitch).
8. Translation in x.
9. Translation in y.
10. Translation in z.
11. A final Put. This matrix moves the DOF coordinate system back to its original position in the scene. The DOF record specifies the minimum, maximum, and current values for each transformation. Only the current value affects the actual transformation applied to the geometry. The increment

value specifies discrete allowable values within the range of legal values represented by the DOF.

### Degree of Freedom Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Degree-of-Freedom Opcode 14                                      |
| Unsigned Int | 2      | 2      | Length - length of the record                                    |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates                                    |
| Int          | 12     | 4      | Reserved   |
| Double       | 16     | 8*3    | Origin of DOF's local coordinate system (x, y, z)                |
| Double       | 40     | 8*3    | Point on x axis of DOF's local coordinate system (x, y, z)       |
| Double       | 64     | 8*3    | Point in xy plane of DOF's local coordinate system (x, y, z)     |
| Double       | 88     | 8      | Min z value with respect to local coordinate system              |
| Double       | 96     | 8      | Max z value with respect to local coordinate system              |
| Double       | 104    | 8      | Current z value with respect to local coordinate system          |
| Double       | 112    | 8      | Increment in z   |
| Double       | 120    | 8      | Min y value with respect to local coordinate system              |
| Double       | 128    | 8      | Max y value with respect to the local coordinate system          |
| Double       | 136    | 8      | Current y value with respect to local coordinate system          |
| Double       | 144    | 8      | Increment in y   |
| Double       | 152    | 8      | Min x value with respect to local coordinate system              |
| Double       | 160    | 8      | Max x value with respect to local coordinate system              |
| Double       | 168    | 8      | Current x value with respect to local coordinate system          |
| Double       | 176    | 8      | Increment in x   |
| Double       | 184    | 8      | Min pitch (rotation about the x axis)                            |
| Double       | 192    | 8      | Max pitch  |
| Double       | 200    | 8      | Current pitch  |
| Double       | 208    | 8      | Increment in pitch   |
| Double       | 216    | 8      | Min roll (rotation about the y axis)                             |
| Double       | 224    | 8      | Max roll   |
| Double       | 232    | 8      | Current roll   |
| Double       | 240    | 8      | Increment in roll  |
| Double       | 248    | 8      | Min yaw (rotation about the z axis)                              |
| Double       | 256    | 8      | Max yaw  |
| Double       | 264    | 8      | Current yaw  |
| Double       | 272    | 8      | Increment in yaw   |
| Double       | 280    | 8      | Min z scale (about local origin)                                 |
| Double       | 288    | 8      | Max z scale (about local origin)                                 |
| Double       | 296    | 8      | Current z scale (about local origin)                             |
| Double       | 304    | 8      | Increment for scale in z   |
| Double       | 312    | 8      | Min y scale (about local origin)                                 |
| Double       | 320    | 8      | Max y scale (about local origin)                                 |
| Double       | 328    | 8      | Current y scale (about local origin)                             |
| Double       | 336    | 8      | Increment for scale in y   |
| Double       | 344    | 8      | Min x scale (about local origin)                                 |
| Double       | 352    | 8      | Max x scale (about local origin)                                 |
| Double       | 360    | 8      | Current x scale (about local origin)                             |
| Double       | 368    | 8      | Increment for scale in x   |
| Int          | 376    | 4      | Flags (bits, from left to right)<br>0 = x translation is limited |

### Degree of Freedom Record (Continued)

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
|           |        |        | 1 = y translation is limited<br>2 = z translation is limited<br>3 = Pitch rotation is limited<br>4 = Roll rotation is limited<br>5 = Yaw rotation is limited<br>6 = x scale is limited<br>7 = y scale is limited<br>8 = z scale is limited<br>9 = Reserved<br>10 = Reserved<br>11-31 = Spare |
| Int       | 380    | 4      | Reserved   |

### Vertex List Record

A vertex list record is the primary record of a vertex node. Each record references one or more vertices in the vertex palette. See [“Vertex Palette Records” on page 71](#). A vertex node is a leaf node in the database and therefore cannot have any children.

#### Vertex List Record

| Data type   | Offset        | Length | Description  |
|---|---------------|--------|--|
| Int   | 0             | 2      | Vertex List Opcode 72  |
| Unsigned Int  | 2             | 2      | Length - length of the record  |
| The following field is repeated for each vertex contained in the vertex list record.                                |               |        |  |
| In the field below, N ranges from 0 to Number of vertices - 1, where Number of vertices = $(\text{Length} - 4) / 4$ |               |        |  |
| Int   | $4 + (N * 4)$ | 4      | Offset <sub>N</sub> - Byte offset into vertex palette of the actual vertex for vertex N. |

### Morph Vertex List Record

A morph vertex list record is the primary record of a morph vertex node. Like the vertex list record, each morph vertex list record references one or more vertices in the vertex palette. See [“Vertex Palette Records” on page 71](#). A morph vertex node is a leaf node in the database and therefore cannot have any children.

Each record references one or more pairs of vertices (weights) in the vertex palette. One weight is the 0 percent morph attributes and the other weight is the 100 percent morph attributes. Since each weight references a vertex, all vertex attributes including color, normal, and texture coordinates may be morphed.

When the eyepoint approaches the switch-in distance, the vertex attributes displayed are 100 percent morphed. When the eyepoint reaches the distance computed by LOD switch-in distance minus LOD transition range, the vertex attributes displayed are 0 percent morphed. Within the

LOD transition range, the vertex attributes displayed are interpolated between the two known vertex attributes.

Geometric morphing is controlled by the parent LOD node. Only morph vertex nodes are affected. Both morphing and static geometry (vertices) may exist within the same branch of the database hierarchy.

### Morph Vertex List Record

| Data type  | Offset  | Length | Description  |
|--|---------|--------|--|
| Int  | 0       | 2      | Morph Vertex List Opcode 89  |
| Unsigned Int   | 2       | 2      | Length - length of the record  |
| The following fields are repeated for each vertex contained in the morph vertex list record.<br>In the fields below, N ranges from 0 to Number of vertices - 1, where<br>Number of vertices = (Length - 4) / 8 |         |        |  |
| Int  | 4+(N*8) | 4      | Offset 0 <sub>N</sub> - Offset into vertex palette of Nth 0% vertex.     |
| Int  | 8+(N*8) | 4      | Offset 100 <sub>N</sub> - Offset into vertex palette of Nth 100% vertex. |

### Binary Separating Plane Record

The binary separating plane (BSP) record is the primary record of the BSP node. A BSP allows you to model 3D databases without depth (Z) buffer support.

An application uses this information to cull portions of the database according to which side of the plane the subtree is situated on with regard to eyepoint position and viewing direction.

This record contains an equation  $ax + by + cz + d = 0$  that describes the separating plane.

### Binary Separating Plane Record

| Data type    | Offset | Length | Description                              |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Binary Separating Plane (BSP) Opcode 55  |
| Unsigned Int | 2      | 2      | Length - length of the record            |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates            |
| Int          | 12     | 4      | Reserved                                 |
| Double       | 16     | 8*4    | Plane equation coefficients (a, b, c, d) |

## External Reference Record

The external reference record is the primary record of the external reference node. External references allow one database to reference, or instance, a node in another database (or an entire database). At the point of reference, the referenced node/database is copied (or possibly shared) as a child of the current parent node.

The override flags allow the referencing (parent) database to control use of the referenced (child) node/database palettes. If an override flag (e.g., material) is set, the child node/database uses its own (material) palette. Otherwise, the child node/database uses the current (parent's) palette. The override flags are hierarchical and may affect references made by the child node/database.

The view as bounding box field is used by the Presagis, Inc. modeling environment and is not expected to be used by runtime applications.

**External Reference Record**

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | External Reference Opcode 63   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 200    | 199-char ASCII path; 0 terminates<br>Format of this string is: filename<node name><br>if <node name> absent, references entire file  |
| Int          | 204    | 4      | Reserved   |
| Int          | 208    | 4      | Flags (bits, from left to right)<br>0 = Color palette override<br>1 = Material palette override<br>2 = Texture and texture mapping palette override<br>3 = Line style palette override<br>4 = Sound palette override<br>5 = Light source palette override<br>6 = Light point palette override<br>7 = Shader palette override<br>8-31 = Spare |
| Int          | 212    | 2      | View as bounding box<br>0 = View external reference normally<br>1 = View external reference as bounding box  |
| Int          | 214    | 2      | Reserved   |

## Level of Detail Record

The level of detail (LOD) record is the primary record of the LOD node. LOD's are perhaps the most important hierarchical node present in the database tree. Proper use of level-of-detail modeling concepts can vastly improve real-time playback of large databases. Attributes within the LOD record provide switching and transition distances for real-time culling and load management mechanisms.

The center coordinate can be used by a real-time application to calculate the slant range distance from the eyepoint to the LOD. Based upon the result of this calculation, a real-time application

can choose not to display the LOD's children and thus reduce system load. The center of the LOD is generally the transformed center of the geometry of the LOD's children. This should include the effects of instancing and (parent) group replication as well.

The use previous slant range flag indicates that the slant range for this LOD is the same as the previous (sibling) LOD, implying the center coordinate is also the same. The real-time application can reuse the previous slant range calculation when evaluating this LOD, thereby improving performance.

If the freeze center flag is not set, the Presagis, Inc. modeling environment as well as OpenFlight API based applications will recalculate the center point of the LOD when the OpenFlight file is saved.

Transition range specifies the range over which real-time smoothing effects should be employed while switching from one LOD to another. Smoothing effects include geometric morphing and image blending. The smoothing effect is active between: switch-in distance minus transition range (near), and switch-in distance (far). The center distance of the effect is therefore switch-in distance minus one half the transition range.

Significant size is a value used to calculate switch in and out distances based on viewing parameters of your simulation display system. This value is used internally by MultiGen-Paradigm and will be enhanced in future versions of OpenFlight.

### Level of Detail Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Level-of-Detail Opcode 73  |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 4      | Reserved   |
| Double       | 16     | 8      | Switch-in distance   |
| Double       | 24     | 8      | Switch-out distance  |
| Int          | 32     | 2      | Special effect ID1 - application defined   |
| Int          | 34     | 2      | Special effect ID2 - application defined   |
| Int          | 36     | 4      | Flags (bits, from left to right)<br>0 = Use previous slant range<br>1 = Additive LODs below<br>2 = Freeze center (don't recalculate)<br>3-31 = Spare |
| Double       | 40     | 8      | Center coordinate x of LOD   |
| Double       | 48     | 8      | Center coordinate y of LOD   |
| Double       | 56     | 8      | Center coordinate z of LOD   |
| Double       | 64     | 8      | Transition range   |
| Double       | 72     | 8      | Significant size   |

### Sound Record

The sound record is the primary record of the sound node. A sound node represents the position and orientation of a sound emitter in the database.

Amplitude and pitch blend are relative to the amplitude in the waveform file. Falloff defines how amplitude falls off when approaching the edge of the sound lobe, with maximum amplitude at the center of the lobe.

Priority determines which sounds are played when more emitters populate a scene than the sound system can play simultaneously.

Width defines the half angle of the sound lobe. Direction sets the type of sound lobe.

Doppler, absorption, and delay flags enable or disable the modeling of doppler, atmospheric absorption, and propagation delay in the sound environment.

Active indicates a sound is to be activated when read in to the modeling environment.

### Sound Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Sound Node Opcode 91   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 4      | Reserved   |
| Int          | 16     | 4      | Index into sound palette   |
| Int          | 20     | 4      | Reserved   |
| Double       | 24     | 8*3    | Coordinate of offset from local origin (x, y, z)   |
| Float        | 48     | 4*3    | Sound direction (vector) wrt local coordinate axes (i, j, k)   |
| Float        | 60     | 4      | Amplitude of sound   |
| Float        | 64     | 4      | Pitch bend of sound  |
| Float        | 68     | 4      | Priority of sound  |
| Float        | 72     | 4      | Falloff of sound   |
| Float        | 76     | 4      | Width of sound lobe  |
| Int          | 80     | 4      | Flags (bits, from left to right)<br>0 = Doppler<br>1 = Atmospheric absorption<br>2 = Delay<br>3-4 = Direction:<br>0 = Omnidirectional<br>1 = Unidirectional<br>2 = Bidirectional<br>5 = Active<br>6-31 = Spare |
| Int          | 84     | 4      | Reserved   |

### Light Source Record

The light source record is the primary record of the light source node. Light sources illuminate the database. They contain position and rotation data (overriding any information stored in the light palette), an index into the light palette, and information on how the light behaves within the hierarchy.

The enabled flag indicates whether the light is turned on and, therefore, a factor of the lighting (rendering) model.

The global flag specifies whether the light shines on the entire database or only on its children (for example, the cabin light in a car).

### Light Source Record

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Light Source Record Opcode 101  |
| Unsigned Int | 2      | 2      | Length - length of the record   |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates   |
| Int          | 12     | 4      | Reserved  |
| Int          | 16     | 4      | Index into light palette  |
| Int          | 20     | 4      | Reserved  |
| Int          | 24     | 4      | Flags (bits, from left to right)<br>0 = Enabled<br>1 = Global<br>2 = Reserved<br>3 = Export<br>4 = Reserved<br>5-31 = Spare |
| Int          | 28     | 4      | Reserved  |
| Double       | 32     | 8*3    | Position (for Local or Spot lights only) (x, y, z)  |
| Float        | 56     | 4      | Yaw (azimuth for Infinite or Spot lights only)  |
| Float        | 60     | 4      | Pitch (elevation for Infinite or Spot lights only)  |

### Road Segment Record

A road segment record is the primary record of a road segment node. It stores the attributes used to create and modify a road segment. The children of the road node represent the geometry and paths of the road and should not be manually edited. Any modification invalidates the road segment.

### Road Segment Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Road Segment Opcode 87        |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates |

### Road Construction Record

A road construction record is the primary record of a road construction node. It supersedes the Road Segment Record described previously. It is created by the Pathfinder option of MultiGen II Pro v1.5 as well as the Road Tool option beginning with Creator v2.1. It stores the parameters defining the road path construction for one road section. In practice, the children of the road construction node usually represent the geometry and paths of the road section. Although every

field in the road construction record may be modified, this data makes the most sense when it is kept in sync with the geometry that is created from it. Therefore, typical usage will be read-only access from applications able to analyze the road surface from this given data.

The Road type field dictates how the following fields define the current road section. For all road types, the Entry and Exit control points lie on the boundaries of the road section. The Alignment control point is only necessary for the Curve type as it defines a horizontal tangent with the other control points.

Other fields particular to the Curve type are the horizontal curve parameters. The horizontal components of the Curve type start and end with spiral transitions of specified lengths. An Arc Radius length is used to define the constant curve area. The Superelevation is specified in a rise over run slope measured laterally across the road for the maximum banking which is used throughout the constant curve component. The banking transitions along the spiral sections in one of three ways defined by the Spiral type field.

Both the Curve and Hill types may have a vertical curve component defined by the remaining fields. Slopes are given at both the entry and exit of the section. If the given slopes don't intersect within the road segment then two vertical parabolas are constructed instead of one, and the Additional vertical parabola flag is set. Note that this flag's value is only valid when the Road Tools version field is 3 or later. This flag may also be set when convergence of the slopes creates a vertical curve length less than Minimum curve length. Otherwise, Vertical curve length is used to define the horizontal distance covered by the single parabola vertical curve.

### Road Construction Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Road Construction Opcode 127   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Char         | 12     | 4      | Reserved   |
| Int          | 16     | 4      | Road type<br>0 = Curve<br>1 = Hill<br>2 = Straight                                       |
| Int          | 20     | 4      | Road Tools version   |
| Double       | 24     | 8*3    | Entry control point (x, y, z)  |
| Double       | 48     | 8*3    | Alignment control point (x, y, z)  |
| Double       | 72     | 8*3    | Exit control point (x, y, z)   |
| Double       | 96     | 8      | Arc radius   |
| Double       | 104    | 8      | Entry spiral length  |
| Double       | 112    | 8      | Exit spiral length   |
| Double       | 120    | 8      | Superelevation   |
| Int          | 128    | 4      | Spiral type<br>0 = Linear with length<br>1 = Linear with angle<br>2 = Cosine with length |
| Int          | 132    | 4      | Additional vertical parabola flag  |
| Double       | 136    | 8      | Vertical curve length  |
| Double       | 144    | 8      | Minimum curve length   |

**Road Construction Record (Continued)**

| Data type | Offset | Length | Description |
|-----------|--------|--------|-------------|
| Double    | 152    | 8      | Entry slope |
| Double    | 160    | 8      | Exit slope  |

**Road Path Record**

A road path record is the primary record of a road path node. A road path node is a child of a road segment node. It describes a lane of the parent road segment. The child of a road path node is a face node whose vertices provide the coordinates of the center of the lane.

Road path record attributes may also be written to an ASCII file for easy access by the application. The format of the file is described in "[Road Path Files](#)", page 109.

**Road Path Record**

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Road Path Opcode 92   |
| Unsigned Int | 2      | 2      | Length - length of the record                                   |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates                                   |
| Int          | 12     | 4      | Reserved  |
| Char         | 16     | 120    | Path name; 0 terminates   |
| Double       | 136    | 8      | Speed limit   |
| Boolean      | 144    | 4      | No passing  |
| Int          | 148    | 4      | Vertex normal type<br>0 = Up-vector<br>1 = Heading, Pitch, Roll |
| Int          | 152    | 480    | Reserved  |

## Clip Region Record

A clip region record is the primary record of a clip node. It defines those regions in 3D space in which drawing occurs. Clip regions only clip the geometry below the clip node in the hierarchy.

The coordinates create a four-sided face that defines the clip region in space. Planes are formed along the edges of the four-sided face normal to the face; a fifth plane clips the back side of the face.

### Clip Region Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Clip Region Opcode 98  |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 4      | Reserved   |
| Int          | 16     | 2      | Reserved   |
| Char         | 18     | 5      | Flags for enabling the individual clip planes<br>Char 0 is flag for edge defined by coordinate 0 and 1<br>Char 1 is flag for edge defined by coordinate 1 and 2<br>Char 2 is flag for edge defined by coordinate 2 and 3<br>Char 3 is flag for edge defined by coordinate 3 and 0<br>Char 5 is flag for plane that clips the half space behind the clip region   |
| Char         | 23     | 1      | Reserved   |
| Double       | 24     | 8*3    | 1st coordinate defining the clip region (x, y, z)  |
| Double       | 48     | 8*3    | 2nd coordinate defining the clip region (x, y, z)  |
| Double       | 72     | 8*3    | 3rd coordinate defining the clip region (x, y, z)  |
| Double       | 96     | 8*3    | 4th coordinate defining the clip region (x, y, z)  |
| Double       | 120    | 8*20   | Five plane equation coefficients (ax + by + cz + d)<br>Coefficients are ordered:<br>a <sub>0</sub> , a <sub>1</sub> , a <sub>2</sub> , a <sub>3</sub> , a <sub>4</sub><br>b <sub>0</sub> , b <sub>1</sub> , b <sub>2</sub> , b <sub>3</sub> , b <sub>4</sub><br>c <sub>0</sub> , c <sub>1</sub> , c <sub>2</sub> , c <sub>3</sub> , c <sub>4</sub><br>d <sub>0</sub> , d <sub>1</sub> , d <sub>2</sub> , d <sub>3</sub> , d <sub>4</sub> |

## Text Record

The text record is the primary record of the text node. Text draws a string of data using a specified font. The record specifies the visual characteristics of the text and formatting information.

The actual string for the text is stored in the comment record immediately following. The format of the text record is:

## Text Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Text Opcode 95   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 4      | Reserved   |
| Int          | 16     | 4      | Reserved   |
| Int          | 20     | 4      | Type<br>-1 = Static<br>0 = Text String<br>1 = Float<br>2 = Integer   |
| Int          | 24     | 4      | Draw type<br>0 = Solid<br>1 = Wireframe and close<br>2 = Wireframe<br>3 = Surround with wireframe in alternate color |
| Int          | 28     | 4      | Justification<br>0 = Left<br>1 = Right<br>2 = Center   |
| Double       | 32     | 8      | Floating point value   |
| Int          | 40     | 4      | Integer value  |
| Int          | 44     | 4*5    | Reserved   |
| Int          | 64     | 4      | Flags (bits, from left to right)<br>0 = Boxable (Unused)<br>1-31 = Spare   |
| Int          | 68     | 4      | Color  |
| Int          | 72     | 4      | Color 2 (Unused)   |
| Int          | 76     | 4      | Material   |
| Int          | 80     | 4      | Reserved   |
| Int          | 84     | 4      | Maximum number of lines (Unused)   |
| Int          | 88     | 4      | Maximum number of characters   |
| Int          | 92     | 4      | Current length of text (Unused)  |
| Int          | 96     | 4      | Next line number available (Unused)  |
| Int          | 100    | 4      | Line number at top of display (Unused)   |
| Int          | 104    | 4*2    | Low/high values for integers   |
| Double       | 112    | 8*2    | Low/high values for floats   |
| Double       | 128    | 8*3    | Lower-left corner of rectangle around text (x, y, z)   |
| Double       | 152    | 8*3    | Upper-right corner of rectangle around text (x, y, z)  |
| Char         | 176    | 120    | Font name  |
| Int          | 296    | 4      | Draw vertical  |
| Int          | 300    | 4      | Draw italic  |
| Int          | 304    | 4      | Draw bold  |
| Int          | 308    | 4      | Draw underline   |
| Int          | 312    | 4      | Line style   |
| Int          | 316    | 4      | Reserved   |

## Switch Record

A switch record is the primary record of a switch node. A switch represents a set of masks that control the display of the switch's children.

Each mask contains one bit for each child of the switch. Each mask bit indicates that the corresponding child is selected (1) or deselected (0). Each mask selects some, none, or all of the children for display according to the state of the mask bits.

Both the switch children and mask bits begin counting from 0. Therefore the selection state, for a particular switch child is derived from a given mask with the following calculation:

```
mask_bit = 1 << (child_num % 32)
mask_word = mask_words [mask_num * num_words + child_num / 32]
child_selected = mask_word & mask_bit
```

The current mask value is an index into the set of masks and indicates the selected mask.

The masks of a switch node can be named. These names are stored in the ancillary record, indexed string record. See [“Indexed String Record”](#) on page 57.

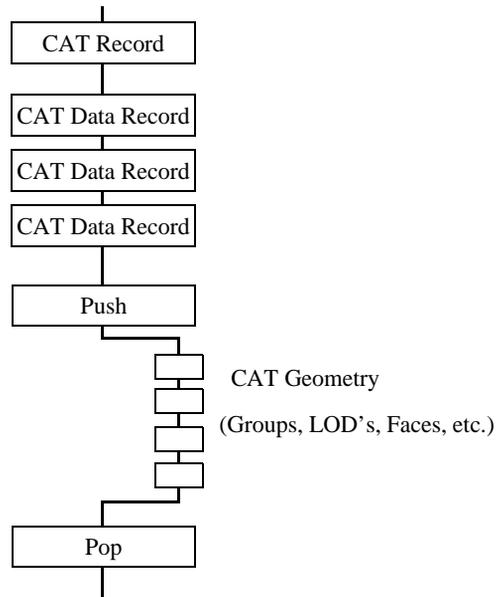
### Switch Record

| Data type    | Offset | Length   | Description   |
|--------------|--------|----------|---|
| Int          | 0      | 2        | Switch Opcode 96  |
| Unsigned Int | 2      | 2        | Length - length of the record   |
| Char         | 4      | 8        | 7 char ASCII ID; 0 terminates   |
| Int          | 12     | 4        | Reserved  |
| Int          | 16     | 4        | Current mask  |
| Int          | 20     | 4        | Number of masks   |
| Int          | 24     | 4        | Number of words per mask - the number of 32 bit words required for each mask, calculated as follows:<br>(number of children / 32) + X<br>where X equals:<br>0 if (number of children modulo 32) is zero<br>1 if (number of children modulo 32) is nonzero |
| Unsigned Int | 28     | Variable | Mask words.<br>The length (in bytes) can be calculated as follows:<br>Number of words per mask * Number of masks * 4 bytes  |

## CAT Record

A continuously adaptive terrain (CAT) record is the primary record of a CAT node. A continuously adaptive terrain skin is a hierarchical triangle mesh designed for high fidelity, real-time viewing.

A CAT skin is represented in OpenFlight by a record stream consisting of: a CAT record, a set of CAT data records, a push record, the CAT hierarchy and geometry, and a pop record. CAT hierarchy and geometry is represented by standard OpenFlight constructs of LOD's, groups, external references, faces, and vertices.



### CAT Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | CAT Opcode 115   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 4      | Reserved   |
| Int          | 16     | 4      | IR color code  |
| Int          | 20     | 1      | Draw type<br>0 = Hidden, don't draw<br>1 = Draw solid, no backface<br>2 = Draw wireframe |
| Int          | 21     | 1      | Texture white = if TRUE, draw textured face white  |
| Int          | 22     | 2      | Reserved   |
| Unsigned Int | 24     | 2      | Color name index   |
| Unsigned Int | 26     | 2      | Alternate color name index   |
| Int          | 28     | 2      | Detail texture pattern index, -1 if none   |
| Int          | 30     | 2      | Texture pattern index, -1 if none  |
| Int          | 32     | 2      | Material index, -1 if none   |
| Int          | 34     | 2      | Surface material code (for DFAD)   |
| Int          | 36     | 4      | IR material code   |
| Int          | 40     | 4*2    | Reserved   |
| Int          | 48     | 2      | Texture mapping index  |
| Int          | 50     | 2      | Reserved   |
| Unsigned Int | 52     | 4      | Primary color index  |
| Unsigned Int | 56     | 4      | Alternate color index  |

**CAT Record (Continued)**

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 60     | 4      | Reserved   |
| Double    | 64     | 8      | Reserved   |
| Int       | 72     | 4      | Flags (bits, from left to right)<br>0 = No color<br>1 = No alternate color<br>2-31 = Spare |
| Int       | 76     | 4      | Reserved   |

**Extension Record**

An extension node record is the primary record of an extension node. It introduces a user defined node type that is defined by an extension site that utilizes the extensibility of the OpenFlight format. It specifies the site information for a third party record which contains additional data that is not represented by the standard OpenFlight records. The content of the data itself is transparent to users other than the extension site. The data can be accessed by the combination of the OpenFlight API and the data dictionary defined by the extension site.

The relationship of an extension node relative to other hierarchical nodes is defined by the standard push and pop control records. For more information about extensions, please refer to the “OpenFlight API User’s Guide, Level 3: Extensions”.

The extension record (Opcode 100) may also introduce new attributes to existing nodes (See “Extension Attribute Record” on page 67.)

**Extension Record**

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Extension Opcode 100                                      |
| Unsigned Int | 2      | 2      | Length - length of the record (including data)            |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates                             |
| Char         | 12     | 8      | Site ID - Unique site name. 7 char ASCII ID; 0 terminates |
| Int          | 20     | 1      | Reserved  |
| Int          | 21     | 1      | Revision - site specific                                  |
| Unsigned Int | 22     | 2      | Record code - site specific                               |
| Char         | 24     | Varies | Extended data - site specific                             |

## Curve Record

A curve record is the primary record of a curve node. A curve node represents one or more curve segments joined together with at least  $G^0$  continuity. Let a curve segment be defined by 4 geometric constraints. We will call these geometric constraints control points in the curve record. The way the control points are grouped and used will be discussed below.

Let each control point be a double precision 3D coordinate,  $P = (x, y, z)$ .

Let the group of control points be  $(P_0, P_1, \dots, P_k)$ .

The currently defined curve types are B-spline, Cardinal, and Bezier.

If the curve type is Bezier,  $P_0, P_1, P_2,$  and  $P_3$  form the first curve segment.  $P_3, P_4, P_5,$  and  $P_6$  form the next segment, and so on. Notice that the last control point in the first segment becomes the first control point in the second segment.

If the curve type is either B-spline or Cardinal,  $P_0, P_1, P_2,$  and  $P_3$  form the first curve segment.  $P_1, P_2, P_3,$  and  $P_4$  from the next segment, and so on. Notice that the second control point in the first segment becomes the first control point in the second segment.

Note that the smoothness of the curve depends on how many times your renderer samples the curve equation into piece-wise linear elements. In the Presagis, Inc. modeling environment, each curve segment is evenly sampled 11 times to produce 10 lines per curve segment.

### Curve Record

| Data Type    | Offset | Length   | Description  |
|--------------|--------|----------|--|
| Int          | 0      | 2        | Curve Opcode 126   |
| Unsigned Int | 2      | 2        | Length - length of the record (including control points)   |
| Char         | 4      | 8        | 7 char ASCII ID; 0 terminates  |
| Int          | 12     | 4        | Reserved   |
| Int          | 16     | 4        | Curve type<br>4 = B-spline<br>5 = Cardinal<br>6 = Bezier   |
| Int          | 20     | 4        | Number of control points   |
| Char         | 24     | 8        | Reserved   |
| Double       | 32     | Variable | Coordinates of control points. Each coordinate is (x, y, z)<br>Coordinates are ordered:<br>$cp_0x, cp_0y, cp_0z,$<br>$cp_1x, cp_1y, cp_1z,$<br>...<br>$cp_Nx, cp_Ny, cp_Nz$<br>where N is Number of control points - 1<br>(Length = Number of control points * 3 * 8 bytes.) |

## Ancillary Records

Ancillary records follow node primary records. They contain supplementary attribute data for the node they follow. Ancillary records are optional but must precede any control record, following the node primary record, when present, as shown in this example:

```
GROUP
COMMENT
LONG ID
PUSH
...
POP
```

In this example, the comment and long ID ancillary records apply to the group record. There is no order dependency between ancillary records. The comment could appear before or after the long ID record in the example above, but must appear before any control record.

### Comment Record

A comment record is an ancillary record that contains text data that belongs to the preceding node primary record. The text description is a variable length ASCII string terminated by a <nil> character.

**Comment Record**

| Data Type    | Offset | Length     | Description                            |
|--------------|--------|------------|--|
| Int          | 0      | 2          | Comment Opcode 31                      |
| Unsigned Int | 2      | 2          | Length - length of the record          |
| Char         | 4      | Length - 4 | Text description of node; 0 terminates |

### Long ID Record

A long ID record is an ancillary record that contains the full name of the preceding node. It is present only when the name exceeds eight characters (seven characters plus a terminating <nil> character).

**Long ID Record**

| Data Type    | Offset | Length     | Description                    |
|--------------|--------|------------|--------------------------------|
| Int          | 0      | 2          | Long ID Opcode 33              |
| Unsigned Int | 2      | 2          | Length - length of the record  |
| Char         | 4      | Length - 4 | ASCII ID of node; 0 terminates |

## Indexed String Record

An indexed string record is an ancillary record that contains an integer index followed by a variable length character string. In this way, arbitrary strings can be associated to indices in a general way.

Currently, indexed string records are only used in the context of switch nodes, for which they represent the names of the masks contained in the switch node. The index specifies the mask number for which the string specifies the name. Mask numbers start at 0. Not all masks are required to have names. For more information on switch nodes, see [“Switch Record” on page 52](#).

**Indexed String Record**

| Data Type    | Offset | Length     | Description                   |
|--------------|--------|------------|-------------------------------|
| Int          | 0      | 2          | Indexed string Opcode 132     |
| Unsigned Int | 2      | 2          | Length - length of the record |
| Unsigned Int | 4      | 4          | Index                         |
| Char         | 8      | Length - 8 | ASCII string; 0 terminates    |

## Multitexture

OpenFlight supports eight textures per polygon or mesh as well as eight uv values per vertex. The current texture information stored on the polygon is referred to as “the base texture” or “texture layer 0”. Each additional texture is referred to as “texture layer N”. Therefore, to support eight textures per polygon, a base texture is required as well as seven additional texture layers. Not all layers are required. Nor is any mandate set forth requiring that layers be contiguous after the base layer. The additional texture layers for each polygon, mesh, and vertex are represented in ancillary records at the face, mesh and vertex primary node level as shown in this example:

```
FACE
MULTITEXTURE
PUSH
VERTEX LIST
UV LIST
POP
```

The records that are used to represent multitexture in the OpenFlight file are described in the following sections.

## Multitexture Record

The multitexture record is an ancillary record of face and mesh nodes. It specifies the texture layer information for the face or mesh.

### Multitexture Record

| Data Type  | Offset | Length | Description   |
|--|--------|--------|---|
| Unsigned Int   | 0      | 2      | Multitexture Opcode 52  |
| Unsigned Int   | 2      | 2      | Length - length of the record   |
| Int  | 4      | 4      | Attribute mask - Bit mask indicating what kind of multitexture information is present in this record. Bits are ordered from left to right and have the following definitions:<br><u>Bit #</u> <u>Description</u><br>0    Has Layer 1 - if set, multitexture information for texture layer 1 is present.<br>1    Has Layer 2 - if set, multitexture information for texture layer 2 is present.<br>2    Has Layer 3 - if set, multitexture information for texture layer 3 is present.<br>3    Has Layer 4 - if set, multitexture information for texture layer 4 is present.<br>4    Has Layer 5 - if set, multitexture information for texture layer 5 is present.<br>5    Has Layer 6 - if set, multitexture information for texture layer 6 is present.<br>6    Has Layer 7 - if set, multitexture information for texture layer 7 is present.<br>7-31   Spare |
| The following fields are repeated for each multitexture layer that is specified as present by the bits set in the Attribute mask field above. This mechanism allows for "sparse" multitexture layer information to be present and does not require that the information present be contiguous. |        |        |   |
| Unsigned Int   | Varies | 2      | texture <sub>N</sub> - Texture index for texture layer N  |
| Unsigned Int   | Varies | 2      | effect <sub>N</sub> - Multitexture effect for texture layer N<br>0 = Texture environment<br>1 = Bump map<br>2-100 = Reserved by Presagis, Inc.<br>>100 = user (runtime) defined   |
| Unsigned Int   | Varies | 2      | mapping <sub>N</sub> - Texture mapping index for texture layer N  |
| Unsigned Int   | Varies | 2      | data <sub>N</sub> - Texture data for layer N. This is user defined. For example, it may be used as a blend percentage or color or any other data needed by the runtime to describe texture layer N  |

## UV List Record

The uv list record is an ancillary record of vertex nodes. This record (if present) always follows the vertex list or morph vertex list record and contains texture layer information for the vertices represented in the vertex list record it follows.

### UV List Record

| Data Type    | Offset  | Length | Description  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
|--------------|---|--------|--|-------|-------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|------|-------|
| Unsigned Int | 0   | 2      | UV List Opcode 53  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| Unsigned Int | 2   | 2      | Length - length of the record  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| Int          | 4   | 4      | Attribute mask - Bit mask indicating what kind of multi-texture information is present in this record. Bits are ordered from left to right as follows:<br><table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Bit #</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Has Layer 1 - if set, uvs for layer 1 are present</td> </tr> <tr> <td>1</td> <td>Has Layer 2 - if set, uvs for layer 2 are present</td> </tr> <tr> <td>2</td> <td>Has Layer 3 - if set, uvs for layer 3 are present</td> </tr> <tr> <td>3</td> <td>Has Layer 4 - if set, uvs for layer 4 are present</td> </tr> <tr> <td>4</td> <td>Has Layer 5 - if set, uvs for layer 5 are present</td> </tr> <tr> <td>5</td> <td>Has Layer 6 - if set, uvs for layer 6 are present</td> </tr> <tr> <td>6</td> <td>Has Layer 7 - if set, uvs for layer 7 are present</td> </tr> <tr> <td>7-31</td> <td>Spare</td> </tr> </tbody> </table> | Bit # | Description | 0 | Has Layer 1 - if set, uvs for layer 1 are present | 1 | Has Layer 2 - if set, uvs for layer 2 are present | 2 | Has Layer 3 - if set, uvs for layer 3 are present | 3 | Has Layer 4 - if set, uvs for layer 4 are present | 4 | Has Layer 5 - if set, uvs for layer 5 are present | 5 | Has Layer 6 - if set, uvs for layer 6 are present | 6 | Has Layer 7 - if set, uvs for layer 7 are present | 7-31 | Spare |
| Bit #        | Description                                       |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 0            | Has Layer 1 - if set, uvs for layer 1 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 1            | Has Layer 2 - if set, uvs for layer 2 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 2            | Has Layer 3 - if set, uvs for layer 3 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 3            | Has Layer 4 - if set, uvs for layer 4 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 4            | Has Layer 5 - if set, uvs for layer 5 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 5            | Has Layer 6 - if set, uvs for layer 6 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 6            | Has Layer 7 - if set, uvs for layer 7 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 7-31         | Spare   |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |

The following fields are repeated for each vertex contained in the corresponding vertex list or morph vertex list record.

If this uv list record follows a vertex list record, the following fields are repeated for each layer present (as specified by the bits set in Attribute mask).

| Data Type | Length | Description  |
|-----------|--------|--|
| Float     | 4      | $u_{i,N}$ - Texture coordinate U for vertex i, layer N |
| Float     | 4      | $v_{i,N}$ - Texture coordinate V for vertex i, layer N |

The number of vertices represented in the uv list record that follows a vertex list record must be identical to the number of vertices contained in that vertex list record. This number can also be calculated as follows:

Number of vertices =  $(\text{Length} - 8) / (8 * X)$ , where X is the number of bits set in Attribute mask.

If this uv list record follows a morph vertex list record, the following fields are repeated for each layer present (as specified by the bits set in Attribute mask).

| Data Type | Length | Description   |
|-----------|--------|---|
| Float     | 4      | $u0_{i,N}$ - Texture U for the 0% vertex i, layer N     |
| Float     | 4      | $v0_{i,N}$ - Texture V for the 0% vertex i, layer N     |
| Float     | 4      | $u100_{i,N}$ - Texture U for the 100% vertex i, layer N |
| Float     | 4      | $v100_{i,N}$ - Texture V for the 100% vertex i, layer N |

Again, the number of vertices represented in the uv list record that follows a morph vertex list record must be identical to the number of vertices contained in that morph vertex list record. This number can also be calculated as follows:

Number of vertices =  $(\text{Length} - 8) / (16 * X)$ , where X is the number of bits set in Attribute mask.

### Example

Consider a triangular face (3 vertices) that contains morph vertex information and has texture layers 1 and 3 defined. The following example shows the contents of the uv list record corresponding to the morph vertex list record representing this triangle:

| Field    | Data Type    | Length | Description   |
|----------|--------------|--------|---|
| opcode   | Unsigned Int | 2      | 53 (UV List opcode).                                |
| length   | Unsigned Int | 2      | 200 (Length of the record)                          |
| uvmask   | Unsigned Int | 4      | 1010 0000 0000 0000 (layers 1 and 3 ON, others OFF) |
| u0 1,1   | Float        | 8      | Texture U for the 0% vertex 1, layer 1.             |
| v0 1,1   | Float        | 8      | Texture V for the 0% vertex 1, layer 1.             |
| u100 1,1 | Float        | 8      | Texture U for the 100% vertex 1, layer 1.           |
| v100 1,1 | Float        | 8      | Texture V for the 100% vertex 1, layer 1.           |
| u0 1,3   | Float        | 8      | Texture U for the 0% vertex 1, layer 3.             |
| v0 1,3   | Float        | 8      | Texture V for the 0% vertex 1, layer 3.             |
| u100 1,3 | Float        | 8      | Texture U for the 100% vertex 1, layer 3.           |
| v100 1,3 | Float        | 8      | Texture V for the 100% vertex 1, layer 3.           |
| u0 2,1   | Float        | 8      | Texture U for the 0% vertex 2, layer 1.             |
| v0 2,1   | Float        | 8      | Texture V for the 0% vertex 2, layer 1.             |
| u100 2,1 | Float        | 8      | Texture U for the 100% vertex 2, layer 1.           |
| v100 2,1 | Float        | 8      | Texture V for the 100% vertex 2, layer 1.           |
| u0 2,3   | Float        | 8      | Texture U for the 0% vertex 2, layer 3.             |
| v0 2,3   | Float        | 8      | Texture V for the 0% vertex 2, layer 3.             |
| u100 2,3 | Float        | 8      | Texture U for the 100% vertex 2, layer 3.           |
| v100 2,3 | Float        | 8      | Texture V for the 100% vertex 2, layer 3.           |
| u0 3,1   | Float        | 8      | Texture U for the 0% vertex 3, layer 1.             |
| v0 3,1   | Float        | 8      | Texture V for the 0% vertex 3, layer 1.             |
| u100 3,1 | Float        | 8      | Texture U for the 100% vertex 3, layer 1.           |
| v100 3,1 | Float        | 8      | Texture V for the 100% vertex 3, layer 1.           |
| u0 3,3   | Float        | 8      | Texture U for the 0% vertex 3, layer 3.             |
| v0 3,3   | Float        | 8      | Texture V for the 0% vertex 3, layer 3.             |
| u100 3,3 | Float        | 8      | Texture U for the 100% vertex 3, layer 3.           |
| v100 3,3 | Float        | 8      | Texture V for the 100% vertex 3, layer 3.           |

## Replicate Record

A replicate record is an ancillary record of group, face, and light (string) point nodes. It indicates the number of times the group, face, or light (string) point is instantiated. An ancillary transformation record must also be present. The transformation is iteratively applied to each instance to uniquely place it in the database.

**Replicate Record**

| Data Type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Replicate Opcode 60           |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 2      | Number of replications        |
| Int          | 6      | 2      | Reserved                      |

## Road Zone Record

The road zone record is an ancillary record of the header node. It references a road zone file that contains gridded elevation data. The format of the file is described in "[Road Zone Files](#)", [page 111](#).

**Road Zone Record**

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Road Path Opcode 88           |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Char         | 4      | 120    | Zone file name; 0 terminates  |
| Int          | 124    | 4      | Reserved                      |
| Double       | 128    | 8      | Lower-left x coordinate       |
| Double       | 136    | 8      | Lower-left y coordinate       |
| Double       | 144    | 8      | Upper-right x coordinate      |
| Double       | 152    | 8      | Upper-right y coordinate      |
| Double       | 160    | 8      | Grid interval                 |
| Int          | 168    | 4      | Number of posts along x axis  |
| Int          | 172    | 4      | Number of posts along y axis  |

## Transformation Records

Transformation records may be ancillary records of most nodes. All hierarchical nodes may be transformed except the header node. Some nodes may only be transformed implicitly, as part of some other operation, such as point replication within a light point string.

There are several distinct types of transformation records. For a transformation applied to any node, a matrix record is always present and represents the final (composite) transformation. Following the matrix record is zero or more other transformation records. When present, the transformation records that follow a matrix record represent the individual transformations applied to the node. If an application only needs the final transformation, the matrix record is sufficient and the transformation records that follow the matrix record can be ignored. The records fol-

lowing the matrix record are only needed by the application if it needs to decompose the transformation. The Presagis, Inc. modeling environment uses these records in order to allow the modeler to modify any of the discrete transformations applied to a node.

Again, each record that follows the matrix record represents a discrete transformation that has been concatenated to form the composite matrix. Concatenation is done in the order that the records are encountered, using premultiplication.

**Note:** The final and general matrices are only single-precision, while the discrete transformations are double-precision.

### Matrix Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Matrix Opcode 49              |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Float        | 4      | 4*16   | 4x4 matrix, row major order   |

### Rotate About Edge Record

| Data type    | Offset | Length | Description                    |
|--------------|--------|--------|--------------------------------|
| Int          | 0      | 2      | Rotate About Edge Opcode 76    |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Int          | 4      | 4      | Reserved                       |
| Double       | 8      | 8*3    | First point on edge (x, y, z)  |
| Double       | 32     | 8*3    | Second point on edge (x, y, z) |
| Float        | 56     | 4      | Angle by which to rotate       |
| Int          | 60     | 4      | Reserved                       |

### Translate Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Translate Opcode 78           |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 4      | Reserved                      |
| Double       | 8      | 8*3    | From point (x, y, z)          |
| Double       | 32     | 8*3    | Delta to translate (x, y, z)  |

### Scale Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Scale Opcode 79               |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 4      | Reserved                      |
| Double       | 8      | 8*3    | Scale center (x, y, z)        |
| Float        | 32     | 4      | x scale factor                |
| Float        | 36     | 4      | y scale factor                |
| Float        | 40     | 4      | z scale factor                |
| Int          | 44     | 4      | Reserved                      |

**Rotate About Point Record**

| Data type    | Offset | Length | Description                     |
|--------------|--------|--------|---------------------------------|
| Int          | 0      | 2      | Rotate About Point Opcode 80    |
| Unsigned Int | 2      | 2      | Length - length of the record   |
| Int          | 4      | 4      | Reserved                        |
| Double       | 8      | 8*3    | Rotation center point (x, y, z) |
| Float        | 32     | 4      | i, axis of rotation             |
| Float        | 36     | 4      | j, axis of rotation             |
| Float        | 40     | 4      | k, axis of rotation             |
| Float        | 44     | 4      | Angle by which to rotate        |

**Rotate and/or Scale to Point Record**

| Data type    | Offset | Length | Description                       |
|--------------|--------|--------|-----------------------------------|
| Int          | 0      | 2      | Rotate and/or Scale Opcode 81     |
| Unsigned Int | 2      | 2      | Length - length of the record     |
| Int          | 4      | 4      | Reserved                          |
| Double       | 8      | 8*3    | Scale center (x, y, z)            |
| Double       | 32     | 8*3    | Reference point (x, y, z)         |
| Double       | 56     | 8*3    | To point (x, y, z)                |
| Float        | 80     | 4      | Overall scale factor              |
| Float        | 84     | 4      | Scale factor in direction of axis |
| Float        | 88     | 4      | Angle by which to rotate          |
| Int          | 92     | 4      | Reserved                          |

**Put Record**

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Put Opcode 82                 |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 4      | Reserved                      |
| Double       | 8      | 8*3    | From point origin (x, y, z)   |
| Double       | 32     | 8*3    | From point align (x, y, z)    |
| Double       | 56     | 8*3    | From point track (x, y, z)    |
| Double       | 80     | 8*3    | To point origin (x, y, z)     |
| Double       | 104    | 8*3    | To point align (x, y, z)      |
| Double       | 128    | 8*3    | To point track (x, y, z)      |

**General Matrix Record**

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | General Matrix Opcode 94      |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Float        | 4      | 4*16   | 4x4 matrix, row major order   |

## Vector Record

A vector record is an ancillary record of the (pre v15.4) face node. Its only use is to provide the direction vector for old-style unidirectional and bidirectional light point faces.

### Vector Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Vector Opcode 50              |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Float        | 4      | 4      | i component                   |
| Float        | 8      | 4      | j component                   |
| Float        | 12     | 4      | k component                   |

## Bounding Volume Records

Bounding volumes are ancillary records for group nodes only. They generally encompass all the geometry of a group's children. A bounding volume may describe a box, sphere, cylinder, convex hull or histogram.

The center coordinate of a bounding volume is stored as a separate record. The orientation of a bounding volume is also stored as a separate record. The convex hull data is represented by a sequence of triangles forming the convex hull around the group geometry.

Applications may use the bounding volume information with culling and collision detection algorithms.

### Bounding Box Record

| Data type    | Offset | Length | Description                    |
|--------------|--------|--------|--------------------------------|
| Int          | 0      | 2      | Bounding Box Opcode 74         |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Int          | 4      | 4      | Reserved                       |
| Double       | 8      | 8      | x coordinate of lowest corner  |
| Double       | 16     | 8      | y coordinate of lowest corner  |
| Double       | 24     | 8      | z coordinate of lowest corner  |
| Double       | 32     | 8      | x coordinate of highest corner |
| Double       | 40     | 8      | y coordinate of highest corner |
| Double       | 48     | 8      | z coordinate of highest corner |

### Bounding Sphere Record

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Bounding Sphere Opcode 105    |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 4      | Reserved                      |
| Double       | 8      | 8      | Radius of the sphere          |

**Bounding Cylinder Record**

| Data type    | Offset | Length | Description                   |
|--------------|--------|--------|-------------------------------|
| Int          | 0      | 2      | Bounding Cylinder Opcode 106  |
| Unsigned Int | 2      | 2      | Length - length of the record |
| Int          | 4      | 4      | Reserved                      |
| Double       | 8      | 8      | Radius of the cylinder base   |
| Double       | 16     | 8      | Height of the cylinder        |

**Bounding Convex Hull Record**

| Data type   | Offset      | Length | Description                                       |
|---|-------------|--------|---|
| Int   | 0           | 2      | Bounding Convex Hull Opcode 107                   |
| Unsigned Int  | 2           | 2      | Length - length of the record                     |
| Int   | 4           | 4      | Number of triangles                               |
| The following fields are repeated for each triangle represented in the convex hull data.<br>In the fields listed below, N ranges from 0 to Number of triangles-1. |             |        |   |
| Double  | $8+(N*72)$  | 8      | x coordinate of vertex 1 of triangle <sub>N</sub> |
| Double  | $16+(N*72)$ | 8      | y coordinate of vertex 1 of triangle <sub>N</sub> |
| Double  | $24+(N*72)$ | 8      | z coordinate of vertex 1 of triangle <sub>N</sub> |
| Double  | $32+(N*72)$ | 8      | x coordinate of vertex 2 of triangle <sub>N</sub> |
| Double  | $40+(N*72)$ | 8      | y coordinate of vertex 2 of triangle <sub>N</sub> |
| Double  | $48+(N*72)$ | 8      | z coordinate of vertex 2 of triangle <sub>N</sub> |
| Double  | $56+(N*72)$ | 8      | x coordinate of vertex 3 of triangle <sub>N</sub> |
| Double  | $64+(N*72)$ | 8      | y coordinate of vertex 3 of triangle <sub>N</sub> |
| Double  | $72+(N*72)$ | 8      | z coordinate of vertex 3 of triangle <sub>N</sub> |

**Bounding Histogram Record**

| Data type    | Offset | Length   | Description  |
|--------------|--------|----------|--|
| Int          | 0      | 2        | Bounding Histogram Opcode 119  |
| Unsigned Int | 2      | 2        | Length - length of the record  |
| Char         | 4      | Variable | The contents of this record is reserved for use by Multi-Gen-Paradigm. |

**Bounding Volume Center Record**

| Data type    | Offset | Length | Description                       |
|--------------|--------|--------|-----------------------------------|
| Int          | 0      | 2      | Bounding Volume Center Opcode 108 |
| Unsigned Int | 2      | 2      | Length - length of the record     |
| Int          | 4      | 4      | Reserved                          |
| Double       | 8      | 8      | x coordinate of center            |
| Double       | 16     | 8      | y coordinate of center            |
| Double       | 24     | 8      | z coordinate of center            |

### Bounding Volume Orientation Record

| Data type    | Offset | Length | Description                            |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Bounding Volume Orientation Opcode 109 |
| Unsigned Int | 2      | 2      | Length - length of the record          |
| Int          | 4      | 4      | Reserved                               |
| Double       | 8      | 8      | Yaw angle                              |
| Double       | 16     | 8      | Pitch angle                            |
| Double       | 24     | 8      | Roll angle                             |

### CAT Data Record

The CAT data records contain the information needed to reconstruct a Continuously Adaptive Terrain skin from its OpenFlight representation. They provide the information which links faces between levels of detail within a CAT skin. CAT data is stored as a key table with an opcode of 116. For specific detail please refer to [“Key Table Records” on page 84](#).

Each CAT data record describes how a face within a CAT skin is related to faces at the next finer level of detail. The coarsest level of detail is level zero. The next finer level of detail is one, and so forth. Each data record is stored in the key table using an ordinal key, counting up from zero. The face node ID is stored in the data record, thereby providing the cross reference to the OpenFlight face node that represents it.

In OpenFlight, each CAT level of detail is parented by a LOD node. Each CAT triangle strip is parented by a group node.

### CAT Data Header Record

| Data type  | Offset      | Length | Description   |
|--|-------------|--------|---|
| Int  | 0           | 2      | CAT Data Opcode 116   |
| Unsigned Int   | 2           | 2      | Length - length of the record   |
| Int  | 4           | 4      | Subtype<br>1 = indicates this record is a key table header  |
| Int  | 8           | 4      | Max number - maximum number of face keys  |
| Int  | 12          | 4      | Actual number - actual number of face keys  |
| Int  | 16          | 4      | Total length of packed face data  |
| Int  | 20          | 4      | Reserved  |
| Int  | 24          | 4      | Reserved  |
| Int  | 28          | 4      | Reserved  |
| The following fields are repeated for each face record represented in the CAT data.<br>In the fields listed below, N ranges from 0 to Actual number - 1. |             |        |   |
| Int  | $32+(N*12)$ | 4      | Face index <sub>N</sub> - index of face N   |
| Int  | $36+(N*12)$ | 4      | Reserved <sub>N</sub> - reserved space for face N   |
| Int  | $40+(N*12)$ | 4      | Face data offset <sub>N</sub> - offset for face data record N in the CAT data.<br>Note: This offset is measured relative to the Packed face data field in the CAT data face record described below. |

### CAT Data Face Record

| Data type  | Offset | Length | Description  |
|--|--------|--------|--|
| Int  | 0      | 2      | CAT Data Opcode 116  |
| Unsigned Int   | 2      | 2      | Length - length of the record  |
| Int  | 4      | 4      | Subtype<br>2 = indicates this record is a key data record  |
| Int  | 8      | 4      | Total length of all packed face records  |
| The following fields constitute one face record and are repeated for each face record represented in the CAT data. In the fields listed below, N ranges from 0 to Actual number - 1. Actual number is from the CAT data header record. |        |        |  |
| Int  | Varies | 4      | LOD <sub>N</sub> - Level of detail to which this face N belongs.                                   |
| Int  | Varies | 4      | Child index 1 <sub>N</sub> - The 1st child (within this table) of face N, or -1 for no face.       |
| Int  | Varies | 4      | Child index 2 <sub>N</sub> - The 2nd child (within this table) of face N, or -1 for no face.       |
| Int  | Varies | 4      | Child index 3 <sub>N</sub> - The 3rd child index (within this table) of face N, or -1 for no face. |
| Int  | Varies | 4      | Child index 4 <sub>N</sub> - The 4th child index (within this table) of face N, or -1 for no face. |
| Int  | Varies | 4      | ID Length <sub>N</sub> - length of face node ID string which follows                               |
| Char   | Varies | Varies | ID <sub>N</sub> - ASCII ID of the face to which this record applies.                               |

### Extension Attribute Record

The extension attribute record is an ancillary record defined by an extension site that utilizes the extensibility of the OpenFlight format. It specifies the site information of a third party extended record which describes additional data that is not represented by the standard OpenFlight records. The data itself is transparent to users other than the extension site. The data can be accessed by the combination of the OpenFlight API and the data dictionary defined by the extension site.

Any hierarchical node can contain extension attribute records. Extension attributes are introduced by a push extension control record and concluded by a pop extension control record.

The extension record (Opcode 100) may also introduce a new node type (See “[Extension Record](#)” on page 54.)

### Extension Attribute Record

| Data type    | Offset | Length   | Description  |
|--------------|--------|----------|--|
| Int          | 0      | 2        | Extension Opcode 100                                     |
| Unsigned Int | 2      | 2        | Length - length of the record (including extension data) |
| Char         | 4      | 8        | 7 char ASCII ID; 0 terminates                            |
| Char         | 12     | 8        | Site ID - Unique site name                               |
| Int          | 20     | 1        | Reserved   |
| Int          | 21     | 1        | Revision - site specific                                 |
| Unsigned Int | 22     | 2        | Record code - site specific                              |
| Char         | 24     | Variable | Extended data - site specific                            |

## Extension Field Records

Extension Field Records are ancillary records for node type records. They allow extension data to be attached to the node with which they appear. There are 6 different extension field records for the following data types:

- Boolean (true or false) - see [“Extension Field Boolean Record” on page 68](#)
- Integer (4 byte integer) - see [“Extension Field Integer Record” on page 68](#)
- Float (4 byte single precision floating point) - see [“Extension Field Float Record” on page 69](#)
- Double (8 byte double precision floating point) - see [“Extension Field Double Record” on page 69](#)
- String (unformatted ASCII character string) - see [“Extension Field String Record” on page 69](#)
- XML String (XML formatted ASCII character string) - see [“Extension Field XML String Record” on page 69](#)

Any hierarchical node can contain extension field records. Extension fields are introduced by a push extension control record and concluded by a pop extension control record as shown in this example:

```
FPOLY
FEXTPUSH
FEXTENSIONBOOL
FEXTENSIONINT
FEXTENSIONXMLSTRING
FEXTPOP
```

In the example above, a Boolean, Integer and XML String extension field are attached to the polygon. The description of each of the extension field records are listed below. Each contains the GUID to which the extension refers (see [“Extension GUID Palette Record” on page 100](#)) and the value of the data.

### Extension Field Boolean Record

| Data type    | Offset | Length | Description                               |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Extension Field Boolean Opcode 149        |
| Unsigned Int | 2      | 2      | Length - length of the record             |
| Int          | 4      | 4      | GUID palette index - identifies extension |
| Int          | 8      | 4      | Extension field boolean value (0 or 1)    |

### Extension Field Integer Record

| Data type    | Offset | Length | Description                               |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Extension Field Boolean Opcode 149        |
| Unsigned Int | 2      | 2      | Length - length of the record             |
| Int          | 4      | 4      | GUID palette index - identifies extension |
| Int          | 8      | 4      | Extension field integer value             |

**Extension Field Float Record**

| Data type    | Offset | Length | Description                               |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Extension Field Boolean Opcode 149        |
| Unsigned Int | 2      | 2      | Length - length of the record             |
| Int          | 4      | 4      | GUID palette index - identifies extension |
| Float        | 8      | 4      | Extension field float value               |

**Extension Field Double Record**

| Data type    | Offset | Length | Description                               |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Extension Field Boolean Opcode 149        |
| Unsigned Int | 2      | 2      | Length - length of the record             |
| Int          | 4      | 4      | GUID palette index - identifies extension |
| Double       | 8      | 8      | Extension field double value              |

**Extension Field String Record**

| Data type    | Offset | Length    | Description                                      |
|--------------|--------|-----------|--|
| Int          | 0      | 2         | Extension Field Boolean Opcode 149               |
| Unsigned Int | 2      | 2         | Length - length of the record (including string) |
| Int          | 4      | 4         | GUID palette index - identifies extension        |
| Int          | 8      | 4         | String length - length of string that follows    |
| Char         | 12     | Length-12 | Extension field string value                     |

**Extension Field XML String Record**

| Data type    | Offset | Length    | Description                                      |
|--------------|--------|-----------|--|
| Int          | 0      | 2         | Extension Field Boolean Opcode 149               |
| Unsigned Int | 2      | 2         | Length - length of the record (including string) |
| Int          | 4      | 4         | GUID palette index - identifies extension        |
| Int          | 8      | 4         | String length - length of string that follows    |
| Char         | 12     | Length-12 | Extension field XML string value                 |

**Continuation Record**

All OpenFlight records begin with a 4 byte sequence. The first two bytes identify the record (opcode) and the second two bytes specify the length of the record. Given this regular record structure, the length of all OpenFlight records is limited to the largest value that can be encoded with 2 bytes or 16 bits (65535). For fixed-size records, this maximum size is sufficient. For variable-size records, this limitation is addressed with the continuation record which is described in this section.

The continuation record accommodates variable size records in the OpenFlight Scene Description. The continuation record is used to “continue” a record in the OpenFlight file stream. It appears in the stream immediately following the record that it “continues” (the record that is being continued will be referred to as the “original” record). In this way, the continuation record is an ancillary record to any other record type. The data contained in the continuation record is defined by the original record and is assumed to be directly appended onto the content of the original record.

**Note:** Multiple continuation records may follow a record, in which case all continuation records would be appended (in sequence) to the original record.

### Continuation Record

| Data type    | Offset | Length   | Description  |
|--------------|--------|----------|--|
| Unsigned Int | 0      | 2        | Continuation Record Opcode 23  |
| Unsigned Int | 2      | 2        | Length - length of the record  |
| Varies       | 4      | Length-4 | Depends on the original record. The contents of this field are to be appended directly to the end of the original record contents (before the original record contents are parsed) |

In theory, any OpenFlight record may be “continued”, but in practice only variable length records, whose length is likely to exceed 65535 bytes, are. Following is a list of the variable length OpenFlight record types to which the continuation record is likely to apply:

- [“Local Vertex Pool Record” on page 33](#)
- [“Mesh Primitive Record” on page 35](#)
- [“Vertex List Record” on page 42](#)
- [“Morph Vertex List Record” on page 42](#)
- [“Extension Record” on page 54](#)
- [“Comment Record” on page 56](#)
- [“Bounding Convex Hull Record” on page 65](#)
- [“Name Table Record” on page 75](#)
- [“Extension Field String Record” on page 69](#)
- [“Extension Field XML String Record” on page 69](#)

**Example:** In the following example, the color name table is “too” big to fit in 65535 bytes so the primary palette record, NAME TABLE, is followed by one (or more) CONTINUATION records. The contents of each of the continuation records is appended to the contents of the name table record before the name table data is parsed.

```
NAME TABLE
CONTINUATION
CONTINUATION
```

## Palette Records

Palette records are ancillary records of the header node. They contain attribute data globally shared by other nodes in the database. Other nodes, such as face nodes, reference the palette data by index.

Individual palettes contain resources such as vertex, material, light source, texture pattern, and line style definitions.

### Vertex Palette Records

Double precision vertex records are stored in a vertex palette for the entire database. Vertices shared by one or more geometric entities are written only one time in the vertex palette. This reduces the overall size of the OpenFlight file by writing only “unique” vertices. Vertex palette records are referenced by faces and light points via vertex list and morph vertex list records. See [“Vertex List Record” on page 42](#) and [“Morph Vertex List Record” on page 42](#) for more information.

**Note:** The vertices referenced by mesh nodes are not contained in vertex palette records. Instead, they are contained in local vertex pool records. See [“Local Vertex Pool Record” on page 33](#).

The vertex palette record signifies the start of the vertex palette. It contains a one word entry specifying the total length of the vertex palette, which is equal to the length of this header record plus the length of the following vertex records. The individual vertex records follow this header, each starting with its own opcode. The length field in the vertex palette record makes it possible to skip over vertex records until the data is actually needed.

As stated above, vertices may be shared, and are accessed through the vertex and morph vertex list records following each face record. A face may contain all morph vertices, all non-morph vertices, or a mixture of both. Thus there can be one or more list records following each face. Consecutive vertices with the same type are grouped together within a list record. The length of each list record is determined by the number of consecutive vertices of each type. For each vertex, there is a one word field pointing to its vertex record in the vertex palette. Since this offset includes the length of the vertex palette record, the value of the first pointer is 8.

#### Vertex Palette Record

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Vertex Palette Opcode 67                                |
| Unsigned Int | 2      | 2      | Length - length of the record                           |
| Int          | 4      | 4      | Length of this record plus length of the vertex palette |

The vertex palette record is immediately followed by vertex records. Each vertex record contains all the attributes of a vertex that has been referenced one or more times in the database.

The Color name index references a name in the color name palette.

The Hard edge flag indicates this vertex starts an edge that is to be preserved by polygon reduction or decimation algorithms.

The Normal frozen flag indicates the normal is not to be updated by shading or lighting algorithms.

The No color flag indicates the vertex does not have a color. If set, neither the Packed color or Vertex color index fields are defined.

When a vertex has a color (the No color flag is not set), the Packed color field is always specified (regardless of the value of the Packed color flag) and contains the red, green, blue and alpha color components. For alpha, 0 represents fully transparent, 255 fully opaque. If the Packed color flag is set, the Vertex color index field will be undefined.

Here are some examples that show how vertex palette records can represent vertex colors:

| Packed Color Flag | Packed Color | Vertex Color Index | Result   |
|-------------------|--------------|--------------------|--|
| 0                 | a, g, b, r   | N                  | Vertex color index and Packed color attributes are both specified. a, b, g, r specify the vertex color components. g, b, r components match those of color index N in palette. |
| 1                 | a, g, b, r   | Not defined        | Vertex color index attribute is not specified, only packed color. a, b, g, r specify the vertex color components.  |

### Vertex with Color Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color Opcode 68  |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Int          | 32     | 4      | Packed color (a, b, g, r) - always specified when the vertex has color   |
| Unsigned Int | 36     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |

### Vertex with Color and Normal Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color and Normal Opcode 69   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Float        | 32     | 4*3    | Vertex normal (i, j, k)  |
| Int          | 44     | 4      | Packed color (a, b, g, r) - always specified when the vertex has color   |
| Unsigned Int | 48     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |
| Int          | 52     | 4      | Reserved   |

### Vertex with Color and UV Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color and UV Opcode 71   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Float        | 32     | 4*2    | Texture coordinate (u, v)  |
| Int          | 40     | 4      | Packed color (a, b, g, r) - always specified when the vertex has color   |
| Unsigned Int | 44     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |

### Vertex with Color, Normal and UV Record

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color, Normal and UV Opcode 70   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Float        | 32     | 4*3    | Vertex normal (i, j, k)  |
| Float        | 44     | 4*2    | Texture coordinate (u, v)  |
| Int          | 52     | 4      | Packed color (a, b, g, r) - always specified when the vertex has color   |
| Unsigned Int | 56     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |
| Int          | 60     | 4      | Reserved   |

### Color Palette Record

The color palette record contains all colors indexed by face and vertex nodes in the database. This record must follow the header record and precede the first push.

The color record is divided into two sections: one for color entries and one for color names. All color entries are in 32-bit packed format (a, b, g, r). Each color consists of red, green, and blue components of 8 bits each, plus 8 bits reserved for alpha (future). Currently alpha is always 0xff (fully opaque). The color entry section consists of 1024 ramped colors of 128 intensities each.

The color name section may or may not be included. If the length of the color palette record is greater than 4228, then you can assume that the color name section is included. When it is present, the color name section consists of a header followed by 0 or more color name entries. The header contains the number of names in the palette. If this value is 0, there are no names following in the palette. Each color name entry contains the name string, pointer to the associated color entry, and other reserved information. The name field is a variable-length, null-terminated ASCII string, with a maximum of 80 bytes.

### Color Palette Record

| Data type   | Offset | Length                 | Description  |
|---|--------|------------------------|--|
| Int   | 0      | 2                      | Color Palette Opcode 32  |
| Unsigned Int  | 2      | 2                      | Length - length of the record  |
| Char  | 4      | 128                    | Reserved   |
| Int   | 132    | 4                      | Brightest RGB of color 0, intensity 127 (a, b, g, r)   |
| Int   | 136    | 4                      | Brightest RGB of color 1, intensity 127 (a, b, g, r)   |
| etc.  | ...    | ...                    |  |
| Int   | 4224   | 4                      | Brightest RGB of color 1023, intensity 127 (a, b, g, r)  |
| As stated above, if the length of the color palette record is greater than 4228, then it also contains a color name section as shown below:                                   |        |                        |  |
| Int   | 4228   | 4                      | Number of color names  |
| The following fields are repeated for each color name entry present in the color palette record.<br>In the fields listed below, N ranges from 0 to Number of color names - 1. |        |                        |  |
| Unsigned Int  | Varies | 2                      | Length <sub>N</sub> - length of color name subrecord N. This length is the total length of this field plus the length of the next 3 fields plus the length of the Color name <sub>N</sub> field. |
| Int   | Varies | 2                      | Reserved <sub>N</sub> - reserved space for color name N  |
| Int   | Varies | 2                      | Color index <sub>N</sub> - index of color in palette corresponding to color name N   |
| Int   | Varies | 2                      | Reserved <sub>N</sub> - reserved space for color name N  |
| Char  | Varies | Length <sub>N</sub> -8 | Color name <sub>N</sub> - color name N; 0 terminates, max 80 bytes   |

### Name Table Record

The name table contains a lookup table of names referenced within the database. These names are typically used as attributes (e.g., color name index in the face record). The primary benefit of the name table is to allow name referencing, so each name string is only stored once. Each name entry in the name table contains fields for the its length, index, and string. The name index is used by the database to reference names within the table. The name string is a variable-length, null-terminated ASCII string, with a maximum of 80 bytes.

### Name Table Record

| Data type          | Offset | Length | Description  |
|--------------------|--------|--------|--|
| Int                | 0      | 2      | Name Table Opcode 114  |
| Unsigned Int       | 2      | 2      | Length - length of the record  |
| Int                | 4      | 4      | Number of names  |
| Unsigned Int       | 8      | 2      | Next available name index  |
| Name Table Entry 0 |        |        |  |
| Int                | 10     | 4      | Length <sub>0</sub> - length of entry 0  |
| Unsigned Int       | 14     | 2      | Name index <sub>0</sub> - index corresponding to entry 0   |
| Char               | 16     | Varies | Name string <sub>0</sub> - name for entry 0; 0 terminates.<br>Variable length, maximum of 80 chars |
| Name Table Entry 1 |        |        |  |
| Int                | Varies | 4      | Length <sub>1</sub> - length of entry 1  |
| Unsigned Int       | Varies | 2      | Name index <sub>1</sub> - index corresponding to entry 1   |

### Name Table Record (Continued)

| Data type  | Offset | Length | Description  |
|--|--------|--------|--|
| Char   | Varies | Varies | Name string <sub>1</sub> - name for entry 1; 0 terminates.<br>Variable length, maximum of 80 chars |
| ...  | ...    | ...    | ...  |
| Name Table Entry N, where N is Number of names - 1 |        |        |  |
| Int  | Varies | 4      | Length <sub>N</sub> - length of entry N  |
| Unsigned Int                                       | Varies | 2      | Name index <sub>N</sub> - index corresponding to entry N   |
| Char   | Varies | Varies | Name string <sub>N</sub> - name for entry N; 0 terminates.<br>Variable length, maximum of 80 chars |

### Material Palette Record

As stated in [“Material Palette” on page 13](#), the material palette for a database may be composed of *either* standard material palette entries or extended material palette entries (or a mixture of both kinds). This section describes standard material palette entries which are represented by Material Palette Records in the OpenFlight stream.

The material palette contains descriptions of “standard” materials used while drawing geometry. It is composed of an arbitrary number of material palette records. The material palette records must follow the header record and precede the first push.

The appearance of a face or mesh in OpenFlight is a combination of the geometry (face or mesh) color and the material properties. The geometry color is factored into the material properties as follows:

#### Ambient:

The displayed material's ambient component is the product of the ambient component of the material and the geometry color:

$$\text{Displayed ambient (red)} = \text{Material ambient (red)} * \text{geometry color (red)}$$

$$\text{Displayed ambient (green)} = \text{Material ambient (green)} * \text{geometry color (green)}$$

$$\text{Displayed ambient (blue)} = \text{Material ambient (blue)} * \text{geometry color (blue)}$$

For example, suppose the material has an ambient component of {1.0,.5,.5} and the geometry color is {100, 100, 100}. The displayed material has as its ambient color {100, 50, 50}.

#### Diffuse:

As with the ambient component, the diffuse component is the product of the diffuse component of the material and the geometry color:

$$\text{Displayed diffuse (red)} = \text{Material diffuse (red)} * \text{geometry color (red)}$$

$$\text{Displayed diffuse (green)} = \text{Material diffuse (green)} * \text{geometry color (green)}$$

$$\text{Displayed diffuse (blue)} = \text{Material diffuse (blue)} * \text{geometry color (blue)}$$

#### Specular:

Unlike ambient and diffuse components, the displayed specular component is taken directly from the material:

$$\text{Displayed specular (red)} = \text{Material specular (red)}$$

Displayed specular (green) = Material specular (green)

Displayed specular (blue) = Material specular (blue)

**Emissive:**

The displayed emissive component is taken directly from the material:

Displayed emissive (red) = Material emissive (red)

Displayed emissive (green) = Material emissive (green)

Displayed emissive (blue) = Material emissive (blue)

**Shininess:**

The Presagis, Inc. modeling environment uses the shininess directly from the material. Specular highlights are tighter, with higher shininess values.

**Alpha:**

An alpha of 1.0 is fully opaque, while 0.0 is fully transparent. The final alpha applied is a combination of the transparency value of the geometry (face or mesh) with the alpha value of the material record. The final alpha value is a floating point number between 0.0 (transparent) and 1.0 (opaque), and is computed as follows:

$$\text{Final alpha} = \text{material alpha} * (1.0 - (\text{geometry transparency} / 65535))$$

**Material Palette Record**

| Data type | Offset | Length | Description                                   |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Material Palette Opcode 113                   |
| Int       | 2      | 2      | Length - length of the record                 |
| Int       | 4      | 4      | Material index                                |
| Char      | 8      | 12     | Material name                                 |
| Int       | 20     | 4      | Flags<br>0 = Material is used<br>1-31 = Spare |
| Float     | 24     | 4*3    | Ambient component of material (r, g, b) *     |
| Float     | 36     | 4*3    | Diffuse component of material (r, g, b) *     |
| Float     | 48     | 4*3    | Specular component of material (r, g, b) *    |
| Float     | 60     | 4*3    | Emissive component of material (r, g, b) *    |
| Float     | 72     | 4      | Shininess - (0.0-128.0)                       |
| Float     | 76     | 4      | Alpha - (0.0-1.0) where 1.0 is opaque         |
| Int       | 80     | 4      | Reserved                                      |

\* normalized values between 0.0 and 1.0, inclusive.

**Extended Material Palette Records**

As stated in “Material Palette” on page 13, the material palette for a database may be composed of *either* standard material palette entries or extended material palette entries (or a mixture of both kinds). This section describes extended material palette entries.

Extended material palette entries are represented by a sequence of one or more Extended Material Palette Records in the OpenFlight stream. This sequence always includes exactly one Ex-

tended Material Header record followed by zero or more *optional* extended material palette records. In practice an extended material palette entry defined by an Extended Material Header with no other records following is not very useful, so in most situations the Extended Material Header will be followed by at least one extended material palette record. These records must follow the header record and precede the first push.

The Extended Material Header record specifies the name, index, etc of an extended material entry while the optional records that follow describe specific visual characteristics of the material. In this way, an extended material entry may be composed.

A typical usage of Extended Material Palette Records might look like:

```
EXTENDED MATERIAL HEADER - Starts a new material entry
EXTENDED MATERIAL AMBIENT
EXTENDED MATERIAL DIFFUSE
EXTENDED MATERIAL BUMP MAP
EXTENDED MATERIAL REFLECTION
EXTENDED MATERIAL PHYSICAL MATERIAL MAP

EXTENDED MATERIAL HEADER - Starts next material entry
EXTENDED MATERIAL AMBIENT
EXTENDED MATERIAL DIFFUSE
EXTENDED MATERIAL SPECULAR
EXTENDED MATERIAL NORMAL MAP
EXTENDED MATERIAL SHADOW MAP
EXTENDED MATERIAL PHYSICAL MATERIAL MAP
```

...

In this example, the first extended material entry is composed of ambient, diffuse, bump map reflection and physical material map components while the second is composed of ambient, diffuse, specular, normal map, shadow map and physical material map components. Note that when defining an extended material entry, at most one of each of the optional Extended Material Palette record types may appear. In other words, if an extended material, for example, has a Bump Map component, it will have exactly one Extended Material Bump Map record.

### Extended Material Header Record

| Data type | Offset | Length | Description                                   |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Extended Material Palette Header Opcode 135   |
| Int       | 2      | 2      | Length - length of the record                 |
| Int       | 4      | 4      | Material index                                |
| Char      | 8      | 12     | Material name                                 |
| Int       | 20     | 4      | Flags<br>0 = Material is used<br>1-31 = Spare |

### Extended Material Header Record (Continued)

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 24     | 4      | Shade Model<br>0 = Flat Shaded<br>1 = Per Vertex Phong<br>2 = Per Fragment Phong |

### Extended Material Ambient Record

| Data type | Offset | Length | Description                          |
|-----------|--------|--------|--------------------------------------|
| Int       | 0      | 2      | Extended Material Ambient Opcode 136 |
| Int       | 2      | 2      | Length - length of the record        |
| Float     | 4      | 4*3    | Ambient color (r, g, b) *            |
| Int       | 16     | 4      | Texture index for layer 0            |
| Int       | 20     | 4      | UV set for layer 0                   |
| Int       | 24     | 4      | Texture index for layer 1            |
| Int       | 28     | 4      | UV set for layer 1                   |
| Int       | 32     | 4      | Texture index for layer 2            |
| Int       | 36     | 4      | UV set for layer 2                   |
| Int       | 40     | 4      | Texture index for layer 3            |
| Int       | 44     | 4      | UV set for layer 3                   |

\* normalized values between 0.0 and 1.0, inclusive.

### Extended Material Diffuse Record

| Data type | Offset | Length | Description                          |
|-----------|--------|--------|--------------------------------------|
| Int       | 0      | 2      | Extended Material Diffuse Opcode 137 |
| Int       | 2      | 2      | Length - length of the record        |
| Float     | 4      | 4*3    | Diffuse color (r, g, b) *            |
| Int       | 16     | 4      | Texture index for layer 0            |
| Int       | 20     | 4      | UV set for layer 0                   |
| Int       | 24     | 4      | Texture index for layer 1            |
| Int       | 28     | 4      | UV set for layer 1                   |
| Int       | 32     | 4      | Texture index for layer 2            |
| Int       | 36     | 4      | UV set for layer 2                   |
| Int       | 40     | 4      | Texture index for layer 3            |
| Int       | 44     | 4      | UV set for layer 3                   |

\* normalized values between 0.0 and 1.0, inclusive.

### Extended Material Specular Record

| Data type | Offset | Length | Description                           |
|-----------|--------|--------|---------------------------------------|
| Int       | 0      | 2      | Extended Material Specular Opcode 138 |
| Int       | 2      | 2      | Length - length of the record         |
| Float     | 4      | 4      | Shininess - (0.0-128.0)               |
| Float     | 8      | 4*3    | Specular color (r, g, b) *            |
| Int       | 20     | 4      | Texture index for layer 0             |
| Int       | 24     | 4      | UV set for layer 0                    |
| Int       | 28     | 4      | Texture index for layer 1             |
| Int       | 32     | 4      | UV set for layer 1                    |

**Extended Material Specular Record (Continued)**

| Data type | Offset | Length | Description               |
|-----------|--------|--------|---------------------------|
| Int       | 36     | 4      | Texture index for layer 2 |
| Int       | 40     | 4      | UV set for layer 2        |
| Int       | 44     | 4      | Texture index for layer 3 |
| Int       | 48     | 4      | UV set for layer 3        |

\* normalized values between 0.0 and 1.0, inclusive.

**Extended Material Emissive Record**

| Data type | Offset | Length | Description                           |
|-----------|--------|--------|---------------------------------------|
| Int       | 0      | 2      | Extended Material Emissive Opcode 139 |
| Int       | 2      | 2      | Length - length of the record         |
| Float     | 4      | 4*3    | Emissive color (r, g, b) *            |
| Int       | 16     | 4      | Texture index for layer 0             |
| Int       | 20     | 4      | UV set for layer 0                    |
| Int       | 24     | 4      | Texture index for layer 1             |
| Int       | 28     | 4      | UV set for layer 1                    |
| Int       | 32     | 4      | Texture index for layer 2             |
| Int       | 36     | 4      | UV set for layer 2                    |
| Int       | 40     | 4      | Texture index for layer 3             |
| Int       | 44     | 4      | UV set for layer 3                    |

\* normalized values between 0.0 and 1.0, inclusive.

**Extended Material Alpha Record**

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 0      | 2      | Extended Material Alpha Opcode 140   |
| Int       | 2      | 2      | Length - length of the record  |
| Float     | 4      | 4      | Alpha - (0.0-1.0) where 1.0 is opaque                                      |
| Int       | 8      | 4      | Texture index for layer 0  |
| Int       | 12     | 4      | UV set for layer 0   |
| Int       | 16     | 4      | Texture index for layer 1  |
| Int       | 20     | 4      | UV set for layer 1   |
| Int       | 24     | 4      | Texture index for layer 2  |
| Int       | 28     | 4      | UV set for layer 2   |
| Int       | 32     | 4      | Texture index for layer 3  |
| Int       | 36     | 4      | UV set for layer 3   |
| Int       | 40     | 4      | Quality<br>0 = Multisample transparency<br>1 = High quality alpha blending |

\* normalized values between 0.0 and 1.0, inclusive.

**Extended Material Light Map Record**

| Data type | Offset | Length | Description                            |
|-----------|--------|--------|--|
| Int       | 0      | 2      | Extended Material Light Map Opcode 141 |
| Int       | 2      | 2      | Length - length of the record          |

**Extended Material Light Map Record (Continued)**

| Data type | Offset | Length | Description       |
|-----------|--------|--------|-------------------|
| Float     | 4      | 4      | Maximum intensity |
| Int       | 8      | 4      | Texture index     |
| Int       | 12     | 4      | UV set            |

**Extended Material Normal Map Record**

| Data type | Offset | Length | Description                             |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Extended Material Normal Map Opcode 142 |
| Int       | 2      | 2      | Length - length of the record           |
| Int       | 4      | 4      | Texture index                           |
| Int       | 8      | 4      | UV set                                  |

**Extended Material Bump Map Record**

| Data type | Offset | Length | Description                           |
|-----------|--------|--------|---------------------------------------|
| Int       | 0      | 2      | Extended Material Bump Map Opcode 143 |
| Int       | 2      | 2      | Length - length of the record         |
| Int       | 4      | 4      | Texture index                         |
| Int       | 8      | 4      | UV set                                |
| Int       | 12     | 4      | UV set for tangent vectors            |
| Int       | 16     | 4      | UV set for binormal vectors           |

**Extended Material Shadow Map Record**

| Data type | Offset | Length | Description                             |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Extended Material Shadow Map Opcode 145 |
| Int       | 2      | 2      | Length - length of the record           |
| Float     | 4      | 4      | Maximum intensity                       |
| Int       | 8      | 4      | Texture index                           |
| Int       | 12     | 4      | UV set                                  |

**Extended Material Reflection Map Record**

| Data type | Offset | Length | Description                                 |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Extended Material Reflection Map Opcode 147 |
| Int       | 2      | 2      | Length - length of the record               |
| Float     | 4      | 4*3    | Tint color (r, g, b) *                      |
| Int       | 16     | 4      | Texture index for reflection (mask) map     |
| Int       | 20     | 4      | UV set for reflection map                   |
| Int       | 24     | 4      | Texture index for environment (base) map    |
| Int       | 28     | 4      | Reserved                                    |

\* normalized values between 0.0 and 1.0, inclusive.

### Extended Material Physical Material Map Record

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 0      | 2      | Extended Material Physical Material Map Opcode 155 |
| Int       | 2      | 2      | Length - length of the record                      |
| Int       | 4      | 4      | Texture index for physical material map            |
| Int       | 8      | 4      | UV set for physical material map                   |

### Texture Palette Record

There is one record for each texture pattern referenced in the database. These records must follow the header record and precede the first push.

A palette and pattern system can be used to reference the texture patterns. A texture palette is made up of 256 patterns. The pattern index for the first palette is 0 - 255, for the second palette 256 - 511, etc. Note: If less than 256 patterns exist on a palette, several pattern indices are unused. The x and y palette locations are used to store offset locations in the palette for display.

### Texture Palette Record

| Data type    | Offset | Length | Description                            |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Texture Palette Opcode 64              |
| Unsigned Int | 2      | 2      | Length - length of the record          |
| Char         | 4      | 200    | File name of texture pattern           |
| Int          | 204    | 4      | Texture pattern index                  |
| Int          | 208    | 4*2    | Location in the texture palette (x, y) |

### Eyepoint and Trackplane Palette Record

OpenFlight files can contain up to ten eyepoint and trackplane positions. The first eyepoint and trackplane in the file is reserved as the “last” one set during the modeling session. The other nine are user-defined. Both the eyepoints and trackplanes are combined in the Eyepoint and Trackplane palette record which is described in this section.

### Eyepoint and Trackplane Palette Record

| Data type  | Offset | Length | Description                               |
|--|--------|--------|---|
| Int  | 0      | 2      | Eyepoint and Trackplane Palette Opcode 83 |
| Unsigned Int                                       | 2      | 2      | Length - length of the record             |
| Int  | 4      | 4      | Reserved                                  |
| The following fields are repeated for 10 eyepoints |        |        |   |
| Eyepoint 0 - 272 bytes                             |        |        |   |
| Double   | 8      | 8*3    | Rotation center (x, y, z)                 |
| Float  | 32     | 4*3    | Yaw, pitch, and roll angles               |
| Float  | 44     | 16*4   | 4x4 rotation matrix, row major order      |
| Float  | 108    | 4      | Field of view                             |

**Eyepoint and Trackplane Palette Record (Continued)**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>                                      |
|------------------|---------------|---------------|---|
| Float            | 112           | 4             | Scale   |
| Float            | 116           | 4             | Near clipping plane                                     |
| Float            | 120           | 4             | Far clipping plane                                      |
| Float            | 124           | 16*4          | 4x4 fly-through matrix, row major order                 |
| Float            | 188           | 3*4           | Eyepoint position (x, y, z)                             |
| Float            | 200           | 4             | Yaw of fly-through                                      |
| Float            | 204           | 4             | Pitch of fly-through                                    |
| Float            | 208           | 3*4           | Eyepoint direction vector (i, j, k)                     |
| Int              | 220           | 4             | No fly through - 1 if no fly-through                    |
| Int              | 224           | 4             | Ortho view - 1 if ortho drawing mode                    |
| Int              | 228           | 4             | Valid eyepoint - 1 if this is a valid eyepoint          |
| Int              | 232           | 4             | Image offset x  |
| Int              | 236           | 4             | Image offset y  |
| Int              | 240           | 4             | Image zoom  |
| Int              | 244           | 4*8           | Reserved  |
| Int              | 276           | 4             | Reserved  |
| Eyepoint 1       | 280           | 272           | Eyepoint 1 - the fields listed above are repeated here. |
| Eyepoint 2       | 552           | 272           | Eyepoint 2 - the fields listed above are repeated here. |
| Eyepoint 3       | 824           | 272           | Eyepoint 3 - the fields listed above are repeated here. |
| Eyepoint 4       | 1096          | 272           | Eyepoint 4 - the fields listed above are repeated here. |
| Eyepoint 5       | 1368          | 272           | Eyepoint 5 - the fields listed above are repeated here. |
| Eyepoint 6       | 1640          | 272           | Eyepoint 6 - the fields listed above are repeated here. |
| Eyepoint 7       | 1912          | 272           | Eyepoint 7 - the fields listed above are repeated here. |
| Eyepoint 8       | 2184          | 272           | Eyepoint 8 - the fields listed above are repeated here. |
| Eyepoint 9       | 2456          | 272           | Eyepoint 9 - the fields listed above are repeated here. |

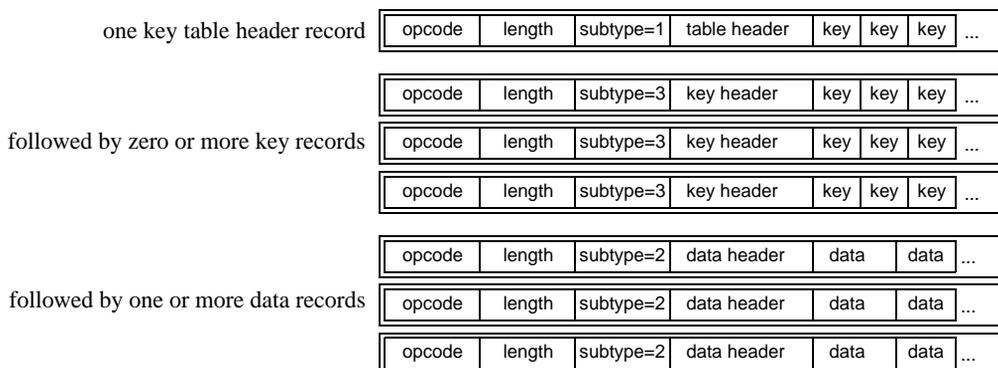
### Eyepoint and Trackplane Palette Record (Continued)

| Data type  | Offset | Length | Description  |
|--|--------|--------|--|
| The following fields are repeated for 10 trackplanes |        |        |  |
| Trackplane 0 - 128 bytes                             |        |        |  |
| Int  | 2728   | 4      | Valid trackplane - 1 if this is a valid trackplane   |
| Int  | 2732   | 4      | Reserved   |
| Double   | 2736   | 8*3    | Trackplane origin coordinate (x, y, z)   |
| Double   | 2760   | 8*3    | Trackplane alignment coordinate (x, y, z)  |
| Double   | 2784   | 8*3    | Trackplane plane coordinate (x, y, z)  |
| Boolean  | 2808   | 1      | Grid visible - 1 if grid is visible  |
| Int  | 2809   | 1      | Grid type flag<br>0 = rectangular grid<br>1 = radial grid  |
| Int  | 2810   | 1      | Grid under flag<br>0 = draw grid over scene<br>1 = draw grid under scene<br>2 = draw grid depth buffered |
| Int  | 2811   | 1      | Reserved   |
| Float  | 2812   | 4      | Grid angle for radial grid   |
| Double   | 2816   | 8      | Grid spacing in X. Radius if radial grid.  |
| Double   | 2824   | 8      | Grid spacing in Y  |
| Int  | 2832   | 1      | Radial grid spacing direction control  |
| Int  | 2833   | 1      | Rectangular grid spacing direction control   |
| Boolean  | 2834   | 1      | Snap cursor to grid - 1 if snap cursor to grid is on   |
| Int  | 2835   | 1      | Reserved   |
| Int  | 2836   | 4      | Reserved   |
| Double   | 2840   | 8      | Grid size (a power of 2)   |
| Boolean  | 2848   | 4      | Mask of visible grid quadrants   |
| Int  | 2852   | 4      | Reserved   |
| Trackplane 1   | 2856   | 128    | Trackplane 1 - the fields listed above are repeated here.  |
| Trackplane 2   | 2984   | 128    | Trackplane 2 - the fields listed above are repeated here.  |
| Trackplane 3   | 3112   | 128    | Trackplane 3 - the fields listed above are repeated here.  |
| Trackplane 4   | 3240   | 128    | Trackplane 4 - the fields listed above are repeated here.  |
| Trackplane 5   | 3368   | 128    | Trackplane 5 - the fields listed above are repeated here.  |
| Trackplane 6   | 3496   | 128    | Trackplane 6 - the fields listed above are repeated here.  |
| Trackplane 7   | 3624   | 128    | Trackplane 7 - the fields listed above are repeated here.  |
| Trackplane 8   | 3752   | 128    | Trackplane 8 - the fields listed above are repeated here.  |
| Trackplane 9   | 3880   | 128    | Trackplane 9 - the fields listed above are repeated here.  |

### Key Table Records

Key table records store variable length data records and their identifiers. The linkage editor, sound palette, and CAT Data are stored as key table records. The first key table record contains the key table header and a set of keys. If all the keys cannot fit into the first record, additional key records are written. This is followed by one or more key table data records.

A key table consists of:



For an example of the use of key table records, see [“Sound Palette Record”](#) on page 89.

### Key Table Header Record

| Data Type   | Offset    | Length | Description   |
|---|-----------|--------|---|
| Int   | 0         | 2      | Opcode - opcode of record using key table for storage   |
| Unsigned Int  | 2         | 2      | Length - length of the record   |
| Int   | 4         | 4      | Subtype<br>1 = indicates this record is a key table header  |
| Int   | 8         | 4      | Max number - maximum number of entries  |
| Int   | 12        | 4      | Actual number - actual number of entries  |
| Int   | 16        | 4      | Total length of packed data   |
| Int   | 20        | 4*3    | Reserved  |
| The following fields are repeated for each key in the key table.<br>In the fields listed below, N ranges from 0 to Actual number - 1. |           |        |   |
| Int   | 32+(N*12) | 4      | Key value <sub>N</sub> - key value N  |
| Int   | 36+(N*12) | 4      | Reserved <sub>N</sub> - reserved space for key N, defined by record using key table for storage   |
| Int   | 40+(N*12) | 4      | Data offset <sub>N</sub> - offset for data corresponding to key N.<br>Note: This offset is measured relative to the Packed data field in the key table data record described below. |

### Key Table Data

| Data Type    | Offset | Length      | Description  |
|--------------|--------|-------------|--|
| Int          | 0      | 2           | Opcode - opcode of record using key table for storage  |
| Unsigned Int | 2      | 2           | Length - length of the record  |
| Int          | 4      | 4           | Subtype<br>2 = indicates this record is a key table data record  |
| Int          | 8      | 4           | Data length  |
| Char         | 12     | Data length | Packed data<br>Data is always 4 byte aligned, with unused bytes set to 0.<br>Data length can be calculated as follows: Length - 12 |

## Linkage Palette Record

Database linkages use key table records. Linkage data consists of two different constructs: nodes and arcs. Nodes usually contain data pertaining to database entities such as DOFs. In addition, the nodes may represent modeling driver functions and code nodes. The arcs contain information on how all the nodes are connected to each other. For most nodes, the value of the node is contained in the following Entity name subrecord. For example, this node value can be a node name, when the node represents a database entity, or a math formula as a string, in the case of a formula node. Names are stored as null-terminated ASCII strings.

See [“Linkage Editor Parameter IDs” on page 113](#) for parameter ID values and descriptions.

### Linkage Palette Header Record

| Data Type   | Offset    | Length | Description   |
|---|-----------|--------|---|
| Int   | 0         | 2      | Linkage Palette Opcode 90   |
| Unsigned Int  | 2         | 2      | Length - length of the record   |
| Int   | 4         | 4      | Subtype<br>1 = indicates this record is a key table header  |
| Int   | 8         | 4      | Max number - maximum number of entries. Each entry is either a node, arc, or entity name.   |
| Int   | 12        | 4      | Actual number - actual number of entries. Each entry is either a node, arc, or entity name.   |
| Int   | 16        | 4      | Total length of data  |
| Int   | 20        | 4*3    | Reserved  |
| The following fields are repeated for each key in the key table.  |           |        |   |
| In the fields listed below, N ranges from 0 to Actual number - 1. |           |        |   |
| Int   | 32+(N*12) | 4      | Key value <sub>N</sub> - key value N  |
| Int   | 36+(N*12) | 4      | Data type <sub>N</sub> - data type for key N<br>0x12120001 = Node data<br>0x12120002 = Arc data<br>0x12120004 = Database entity name  |
| Int   | 40+(N*12) | 4      | Data offset <sub>N</sub> - offset for data corresponding to key N.<br>Note: This offset is measured relative to the Packed data field in the linkage palette data record described below. |

### Linkage Palette Data Record

| Data Type    | Offset | Length      | Description   |
|--------------|--------|-------------|---|
| Int          | 0      | 2           | Linkage Palette Opcode 90   |
| Unsigned Int | 2      | 2           | Length - length of the record   |
| Int          | 4      | 4           | Subtype<br>2 = indicates this record is a key data record   |
| Int          | 8      | 4           | Data length   |
| Char         | 12     | Data length | Packed data. Each packed data item is either a node data subrecord, arc data subrecord or entity name subrecord. Node data subrecords can be either general nodes, formula nodes, or driver nodes. All these subrecords are described in the following sections.<br>Data length can be calculated as follows: Length - 12 |

The offsets listed in the following subrecords are measured from the start of the subrecord, not from the start of the linkage palette data record that contains this packed data.

**General Node Data Subrecord**

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 0      | 4      | Identifier   |
| Int       | 4      | 4      | Reserved   |
| Int       | 8      | 4      | Node type<br>0x12120003 = Header node<br>0x12120005 = Database entity node |
| Int       | 12     | 4*4    | Reserved   |
| Int       | 28     | 4      | Sinks  |
| Int       | 32     | 4      | Sources  |
| Int       | 36     | 4      | Next node identifier   |
| Int       | 40     | 4      | Previous node identifier   |
| Int       | 44     | 4      | Arc source identifier  |
| Int       | 48     | 4      | Arc sink identifier  |

**Formula Node Data Subrecord**

| Data Type | Offset | Length | Description                            |
|-----------|--------|--------|--|
| Int       | 0      | 4      | Identifier                             |
| Int       | 4      | 4      | Reserved                               |
| Int       | 8      | 4      | Data type<br>0x12150000 = Formula node |
| Int       | 12     | 4      | Reserved                               |
| Int       | 16     | 4      | Reserved                               |
| Int       | 20     | 4      | Reserved                               |
| Int       | 24     | 4      | Reserved                               |
| Int       | 28     | 4      | Sinks                                  |
| Int       | 32     | 4      | Sources                                |
| Int       | 36     | 4      | Next node identifier                   |
| Int       | 40     | 4      | Previous node identifier               |
| Int       | 44     | 4      | Arc source identifier                  |
| Int       | 48     | 4      | Arc sink identifier                    |
| Int       | 52     | 4      | Reserved                               |
| Int       | 56     | 4      | Reserved                               |
| Int       | 60     | 4      | Reserved                               |
| Int       | 64     | 4      | Reserved                               |
| Int       | 68     | 4      | Reserved                               |
| Int       | 72     | 4      | Reserved                               |
| Int       | 76     | 4      | Reserved                               |
| Int       | 80     | 4      | Reserved                               |

**Driver Node Data Subrecord**

| Data Type | Offset | Length | Description |
|-----------|--------|--------|-------------|
| Int       | 0      | 4      | Identifier  |
| Int       | 4      | 4      | Reserved    |

**Driver Node Data Subrecord (Continued)**

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 8      | 4      | Node type<br>0x12140001 = Ramp driver node<br>0x12140004 = Variable driver node<br>0x12140005 = External file driver node |
| Int       | 12     | 4      | Reserved  |
| Int       | 16     | 4      | Reserved  |
| Int       | 20     | 4      | Reserved  |
| Int       | 24     | 4      | Reserved  |
| Int       | 28     | 4      | Sinks   |
| Int       | 32     | 4      | Sources   |
| Int       | 36     | 4      | Next node identifier  |
| Int       | 40     | 4      | Previous node identifier  |
| Int       | 44     | 4      | Arc source identifier   |
| Int       | 48     | 4      | Arc sink identifier   |
| Float     | 52     | 4      | Current value   |
| Float     | 56     | 4      | Min amplitude   |
| Float     | 60     | 4      | Max amplitude   |
| Float     | 64     | 4      | Wave offset   |
| Float     | 68     | 4      | Min time  |
| Float     | 72     | 4      | Max time  |
| Float     | 76     | 4      | Time steps  |
| Int       | 80     | 4      | Reserved  |
| Int       | 84     | 4      | Reserved  |
| Int       | 88     | 4      | Reserved  |
| Int       | 92     | 4      | Reserved  |

**Arc Data Subrecord**

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 0      | 4      | Identifier   |
| Int       | 4      | 4      | Reserved   |
| Int       | 8      | 4      | Data type<br>0x12120002 = Arc data subrecord   |
| Int       | 12     | 4      | Reserved   |
| Int       | 16     | 4      | Reserved   |
| Int       | 20     | 4      | Priority   |
| Int       | 24     | 4      | Source parameter - parameter ID if source node is a node   |
| Int       | 28     | 4      | Sink parameter - parameter ID if sink node is a node<br>number (0...7) for variables (x1...x8)<br>Only valid if sink node is a formula |
| Int       | 32     | 4      | Reserved   |
| Int       | 36     | 4      | Next source identifier   |
| Int       | 40     | 4      | Next sink identifier   |
| Int       | 44     | 4      | Node source identifier   |
| Int       | 48     | 4      | Node sink identifier   |

**Entity Name Subrecord**

| Data Type | Offset | Length   | Description                |
|-----------|--------|----------|----------------------------|
| Char      | 0      | Variable | ASCII string; 0 terminates |

## Sound Palette Record

The sound palette uses key table records to store the sound index and file name. The index is the key value, and the file name is the data record, formatted as a null-terminated ASCII string. The sound palette header record indicates the number of sounds associated with the database.

### Sound Palette Header Record

| Data  | Offset      | Length | Description  |
|---|-------------|--------|--|
| Int   | 0           | 2      | Sound Palette Opcode 93  |
| Unsigned Int  | 2           | 2      | Length - length of the record  |
| Int   | 4           | 4      | Subtype<br>1 = indicates this record is a key table header   |
| Int   | 8           | 4      | Max number - the maximum number of sounds in palette   |
| Int   | 12          | 4      | Actual number - the actual number of sounds in palette   |
| Int   | 16          | 4      | Total length - total length of the sound file names contained in the sound palette data record, which follows this record and is described below   |
| Int   | 20          | 4*3    | Reserved   |
| The following fields are repeated for each sound represented in the palette.<br>In the fields listed below, N ranges from 0 to Actual number - 1. |             |        |  |
| Int   | $32+(N*12)$ | 4      | Sound index <sub>N</sub> - index of sound N in the palette   |
| Int   | $36+(N+12)$ | 4      | Reserved <sub>N</sub> - reserved space for sound N in the palette  |
| Int   | $40+(N*12)$ | 4      | File name offset <sub>N</sub> - starting offset for file name of sound N in the palette. This offset is measured relative to the Packed file names field in the sound palette data record described below. |

### Sound Palette Data Record

| Data Type    | Offset | Length      | Description  |
|--------------|--------|-------------|--|
| Int          | 0      | 2           | Sound Palette Opcode 93  |
| Unsigned Int | 2      | 2           | Length - length of the record  |
| Int          | 4      | 4           | Subtype<br>2 = indicates this record is a key data record  |
| Int          | 8      | 4           | Total length of all packed sound file names  |
| Char         | 12     | Data length | Packed file names.<br>Use File name offsets contained in sound palette key table header to locate individual names in this data blocks.<br>Data length can be calculated as follows: Length - 12 |

## Light Source Palette Record

These records represent entries in the light source palette. Entries are referenced by light source nodes using the palette index. Lights can be flagged as modeling lights, which illuminate a scene without being stored as part of the hierarchy. A modeling light is always positioned at the

eye; its direction is stored in the palette. A light referenced by a node obtains its position and direction from the node. In this case, the palette yaw and pitch components are ignored.

### Light Source Palette Record

| Data Type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Light Source Palette Opcode 102  |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Int          | 4      | 4      | Light source index   |
| Int          | 8      | 2*4    | Reserved   |
| Char         | 16     | 20     | Light source name; 0 terminates  |
| Int          | 36     | 4      | Reserved   |
| Float        | 40     | 4*4    | Ambient component of light source (r, g, b, a) - alpha unused  |
| Float        | 56     | 4*4    | Diffuse component of light source (r, g, b, a) - alpha unused  |
| Float        | 72     | 4*4    | Specular component of light source (r, g, b, a) - alpha unused   |
| Int          | 88     | 4      | Light type<br>0 = Infinite<br>1 = Local<br>2 = Spot  |
| Int          | 92     | 4*10   | Reserved   |
| Float        | 132    | 4      | Spot exponential dropoff term  |
| Float        | 136    | 4      | Spot cutoff angle (in degrees)   |
| Float        | 140    | 4      | Yaw  |
| Float        | 144    | 4      | Pitch  |
| Float        | 148    | 4      | Constant attenuation coefficient   |
| Float        | 152    | 4      | Linear attenuation coefficient   |
| Float        | 156    | 4      | Quadratic attenuation coefficient  |
| Int          | 160    | 4      | Modeling light<br>0 = Light source is not active during modeling<br>1 = Light source is active during modeling |
| Int          | 164    | 4*19   | Reserved   |

### Light Point Appearance Palette Record

The light point appearance palette record defines the visual attributes of light points.

#### Light Point Appearance Palette Record

| Data Type    | Offset | Length | Description                               |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Light Point Appearance Palette Opcode 128 |
| Unsigned Int | 2      | 2      | Length - length of the record             |
| Int          | 4      | 4      | Reserved                                  |
| Char         | 8      | 256    | Appearance name; 0 terminates             |
| Int          | 264    | 4      | Appearance index                          |
| Int          | 268    | 2      | Surface material code                     |
| Int          | 270    | 2      | Feature ID                                |
| Unsigned Int | 272    | 4      | Back color for bidirectional points       |

**Light Point Appearance Palette Record (Continued)**

| <b>Data Type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>   |
|------------------|---------------|---------------|--|
| Int              | 276           | 4             | Display mode<br>0 = RASTER<br>1 = CALLIGRAPHIC<br>2 = EITHER                               |
| Float            | 280           | 4             | Intensity - scalar for front colors  |
| Float            | 284           | 4             | Back intensity - scalar for back color   |
| Float            | 288           | 4             | Minimum defocus - (0.0 - 1.0) for calligraphic points                                      |
| Float            | 292           | 4             | Maximum defocus - (0.0 - 1.0) for calligraphic points                                      |
| Int              | 296           | 4             | Fading mode<br>0 = Enable perspective fading calculations<br>1 = Disable calculations      |
| Int              | 300           | 4             | Fog Punch mode<br>0 = Enable fog punch through calculations<br>1 = Disable calculations    |
| Int              | 304           | 4             | Directional mode<br>0 = Enable directional calculations<br>1 = Disable calculations        |
| Int              | 308           | 4             | Range mode<br>0 = Use depth (Z) buffer calculation<br>1 = Use slant range calculation      |
| Float            | 312           | 4             | Min pixel size - minimum diameter of points in pixels                                      |
| Float            | 316           | 4             | Max pixel size - maximum diameter of points in pixels                                      |
| Float            | 320           | 4             | Actual size - actual diameter of points in database units                                  |
| Float            | 324           | 4             | Transparent falloff pixel size - diameter in pixels when points become transparent         |
| Float            | 328           | 4             | Transparent falloff exponent<br>>= 0 - falloff multiplier exponent<br>1.0 - linear falloff |
| Float            | 332           | 4             | Transparent falloff scalar<br>> 0 - falloff multiplier scale factor                        |
| Float            | 336           | 4             | Transparent falloff clamp - minimum permissible falloff multiplier result                  |
| Float            | 340           | 4             | Fog scalar<br>>= 0 - adjusts range of points for punch threew effect.                      |
| Float            | 344           | 4             | Fog intensity  |
| Float            | 348           | 4             | Size difference threshold - point size transition hint to renderer                         |
| Int              | 352           | 4             | Directionality<br>0 = OMNIDIRECTIONAL<br>1 = UNIDIRECTIONAL<br>2 = BIDIRECTIONAL           |
| Float            | 356           | 4             | Horizontal lobe angle - total angle in degrees   |
| Float            | 360           | 4             | Vertical lobe angle - total angle in degrees   |
| Float            | 364           | 4             | Lobe roll angle - rotation of lobe about local Y axis in degrees                           |
| Float            | 368           | 4             | Directional falloff exponent<br>>= 0 - falloff multiplier exponent<br>1.0 - linear falloff |

## Light Point Appearance Palette Record (Continued)

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Float     | 372    | 4      | Directional ambient intensity - of points viewed off axis   |
| Float     | 376    | 4      | Significance - drop out priority for RASCAL lights (0.0 - 1.0)  |
| Int       | 380    | 4      | Flags (bits, from left to right)<br>0 = reserved<br>1 = No back color<br>TRUE = don't use back color for bidirectional points<br>FALSE = use back color for bidirectional points<br>2 = Calligraphic proximity occulting (Debunching)<br>3 = Reflective, non-emissive point<br>4-6 = Randomize intensity<br>0 = never<br>1 = low<br>2 = medium<br>3 = high<br>7 = Perspective mode<br>8 = Conforming<br>9-10 = Quality<br>0 = Low<br>1 = Medium<br>2 = High<br>3 = Undefined<br>11 = Visible during day<br>12 = Visible during dusk<br>13 = Visible during night<br>14-31 = Spare |
| Float     | 384    | 4      | Visibility range (> 0.0)  |
| Float     | 388    | 4      | Fade range ratio - percentage of total range at which light points start to fade (0.0 - 1.0)  |
| Float     | 392    | 4      | Fade in duration - time it takes (seconds) light point to fade in when turned on  |
| Float     | 396    | 4      | Fade out duration - time it takes (seconds) light point to fade out when turned off   |
| Float     | 400    | 4      | LOD range ratio - percentage of total range at which light points LODs are active (0.0 - 1.0)   |
| Float     | 404    | 4      | LOD scale - size of light point LOD polygon relative to light point diameter  |
| Int       | 408    | 2      | Texture pattern index, -1 if none   |
| Int       | 410    | 2      | Reserved  |

## Light Point Animation Palette Record

The light point animation palette record defines the behavioral attributes of light points.

**Light Point Animation Palette Record**

| Data Type   | Offset      | Length | Description  |
|---|-------------|--------|--|
| Int   | 0           | 2      | Light Point Animation Opcode 129   |
| Unsigned Int  | 2           | 2      | Length - length of the record  |
| Int   | 4           | 4      | Reserved   |
| char  | 8           | 256    | Animation name; 0 terminates   |
| Int   | 264         | 4      | Animation index  |
| Float   | 268         | 4      | Animation period in seconds. Note: Rate = 1/Period   |
| Float   | 272         | 4      | Animation phase delay in seconds - from start of period  |
| Float   | 276         | 4      | Animation enabled period (time on) in seconds  |
| Float   | 280         | 4*3    | Axis of rotation for rotating animation (i, j, k)  |
| Int   | 292         | 4      | Flags (bits, from left to right)<br>0 = Flashing<br>1 = Rotating<br>2 = Rotate counter clockwise<br>3-31 = Spare |
| Int   | 296         | 4      | Animation type<br>0 = Flashing sequence<br>1 = Rotating<br>2 = Strobe<br>3 = Morse code                          |
| Int   | 300         | 4      | Morse code timing<br>0 = Standard timing<br>1 = Farnsworth timing  |
| Int   | 304         | 4      | Word rate (for Farnsworth timing)  |
| Int   | 308         | 4      | Character rate (for Farnsworth timing)   |
| char  | 312         | 1024   | Morse code string  |
| Int   | 1336        | 4      | Number of sequences (for Flashing sequence)  |
| The following fields are repeated for each sequence represented in the light point animation palette entry. In the fields listed below, N ranges from 0 to Number of sequences - 1. |             |        |  |
| Unsigned Int  | 1340+(N*12) | 4      | Sequence State <sub>N</sub> - state of sequence N<br>0 = On<br>1 = Off<br>2 = Color change                       |
| Float   | 1344+(N*12) | 4      | Sequence Duration <sub>N</sub> - duration of sequence N in seconds   |
| Unsigned Int  | 1348+(N*12) | 4      | Sequence Color <sub>N</sub> - color for sequence N.<br>Defined if Sequence state is On or Color change           |

## Line Style Palette Record

Line style records define the outline displayed around faces in wireframe or wireframe-over-solid mode. The Pattern field defines a mask to control the display of segments of the line. For example, if all the bits of the mask are set, the line is drawn as a solid line. If every other bit is on, the line is displayed as a dashed line. The Line Width field controls the width of the line in

pixels. Line style 0 is the default. Faces are assigned line styles in the Line Style field of the face record. One of these records appears for each line style defined in the OpenFlight file.

### Line Style Palette Record

| Data Type | Offset | Length | Description                         |
|-----------|--------|--------|-------------------------------------|
| Int       | 0      | 2      | Line Style Palette Record Opcode 97 |
| Int       | 2      | 2      | Length - length of the record       |
| Int       | 4      | 2      | Line style index                    |
| Int       | 6      | 2      | Pattern mask                        |
| Int       | 8      | 4      | Line width                          |

### Texture Mapping Palette Record

The texture mapping palette record defines methods and parameters used to map textures onto geometry. One record is created for each texture mapping reference in the palette. These records must follow the header record and precede the first push.

### Texture Mapping Palette Record

| Data Type  | Offset | Length | Description  |
|--|--------|--------|--|
| Int  | 0      | 2      | Texture Mapping Palette Opcode 112   |
| Int  | 2      | 2      | Length - length of the record  |
| Int  | 4      | 4      | Reserved   |
| Int  | 8      | 4      | Texture mapping index  |
| Char   | 12     | 20     | Texture mapping name   |
| Int  | 32     | 4      | Texture mapping type<br>0 = None<br>1 = 3 Point Put<br>2 = 4 Point Put<br>3 = Reserved<br>4 = Spherical Project<br>5 = Radial Project<br>6 = Environment |
| Int  | 36     | 4      | Warped flag; if TRUE, 8 point warp applied   |
| Double   | 40     | 8*16   | 4x4 Transformation matrix (for types 1, 2, 4 & 5), row major   |
| Depending on the Texture mapping type field, different parameter blocks follow.<br>These blocks are described in the following sections. |        |        |  |

The parameters for put texture mapping will appear immediately following the texture mapping palette record if Texture mapping type is 1.

**Parameters for 3 Point Put Texture Mapping (Type 1)**

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 168    | 4      | State of Put Texture tool<br>0 = Start state - no points entered<br>1 = One point entered<br>2 = Two points entered<br>3 = Three points entered |
| Int       | 172    | 4      | Active geometry point<br>1 = Origin point<br>2 = Alignment point<br>3 = Shear point   |
| Double    | 176    | 8*3    | Lower-left corner of bounding box for geometry using this mapping when mapping was created (x, y, z)  |
| Double    | 200    | 8*3    | Upper-right corner of bounding box for geometry using this mapping when mapping was created (x, y, z)   |
| Int       | 224    | 4*3    | Use real world size flags for each of the put points  |
| Int       | 236    | 4      | Reserved  |
| Double    | 240    | 8*3    | Texture origin point (x, y, z)  |
| Double    | 264    | 8*3    | Texture alignment point (x, y, z)   |
| Double    | 288    | 8*3    | Texture shear point (x, y, z)   |
| Double    | 312    | 8*3    | Geometry origin point (x, y, z)   |
| Double    | 336    | 8*3    | Geometry alignment point (x, y, z)  |
| Double    | 360    | 8*3    | Geometry shear point (x, y, z)  |
| Int       | 384    | 4      | Active texture point<br>1 = Origin point<br>2 = Alignment point<br>3 = Shear point  |
| Int       | 388    | 4      | UV display type<br>1 = XY<br>2 = UV   |
| Float     | 392    | 4      | U Repetition  |
| Float     | 396    | 4      | V Repetition  |

The parameters for 4 point put texture mapping will appear immediately following the texture mapping palette record if Texture mapping type is 2

### Parameters for 4 Point Put Texture Mapping (Type 2)

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 168    | 4      | State of 4 Point Put Texture tool<br>0 = Start state - no points entered<br>1 = One point entered<br>2 = Two points entered<br>3 = Three points entered<br>4 = Four points entered |
| Int       | 172    | 4      | Active geometry point<br>1 = Origin point<br>2 = Alignment point<br>3 = Shear point<br>4 = Perspective point   |
| Double    | 176    | 8*3    | Lower-left corner of bounding box for geometry using this mapping when mapping was created (x, y, z)   |
| Double    | 200    | 8*3    | Upper-right corner of bounding box for geometry using this mapping when mapping was created (x, y, z)  |
| Int       | 224    | 4*3    | Use real world size flags for each of the put points   |
| Int       | 236    | 4      | Reserved   |
| Double    | 240    | 8*3    | Texture origin point (x, y, z)   |
| Double    | 264    | 8*3    | Texture alignment point (x, y, z)  |
| Double    | 288    | 8*3    | Texture shear point (x, y, z)  |
| Double    | 312    | 8*3    | Texture perspective point (x, y, z)  |
| Double    | 336    | 8*3    | Geometry origin point (x, y, z)  |
| Double    | 360    | 8*3    | Geometry alignment point (x, y, z)   |
| Double    | 384    | 8*3    | Geometry shear point (x, y, z)   |
| Double    | 408    | 8*3    | Geometry perspective point (x, y, z)   |
| Int       | 432    | 4      | Active texture point<br>1 = Origin point<br>2 = Alignment point<br>3 = Shear point<br>4 = Perspective point  |
| Int       | 436    | 4      | UV display type<br>1 = XY<br>2 = UV  |
| Float     | 440    | 4      | Depth scale factor   |
| Int       | 444    | 4      | Reserved   |
| Double    | 448    | 8*16   | 4x4 Transformation matrix for the 4 point projection plane, row major order  |
| Float     | 576    | 4      | U Repetition   |
| Float     | 580    | 4      | V Repetition   |

The parameters for spherical project mapping will appear immediately following the texture mapping palette record if Texture mapping type is 4.

**Parameters for Spherical Project Texture Mapping (Type 4)**

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Float     | 168    | 4      | Scale  |
| Int       | 172    | 4      | Reserved   |
| Double    | 176    | 8*3    | Center of the projection sphere (x, y, z)                                      |
| Float     | 200    | 4      | Scale / (maximum dimension of the mapped geometry bounding box                 |
| Float     | 204    | 4      | Maximum dimension of the mapped geometry bounding box when mapping was created |

The parameters for radial project mapping will appear immediately following the texture mapping palette record if Texture mapping type is 5.

**Parameters for Radial Project Texture Mapping (Type 5)**

| Data   | Offset | Length | Description   |
|--------|--------|--------|---|
| Int    | 168    | 4      | Active geometry point<br>1 = End point 1 of cylinder center line<br>2 = End point 2 of cylinder center line |
| Int    | 172    | 4      | Reserved  |
| Float  | 176    | 4      | Radial scale  |
| Float  | 180    | 4      | Scale along length of cylinder  |
| Double | 184    | 8*16   | 4x4 Trackplane to XY plane transformation matrix, row major order   |
| Double | 312    | 8*3    | End point 1 of cylinder center line (x, y, z)   |
| Double | 336    | 8*3    | End point 2 of cylinder center line (x, y, z)   |

The parameters for warped mapping will be included if the Warped flag is set in the texture mapping palette record. This parameter block will appear immediately following the texture mapping parameter block to which the warp applies. In the offset fields below, X is equal to the size of the texture mapping palette record plus the size of the texture mapping parameter block to which the warp applies.

### Parameters for Warped Mapping (Warped Flag Set)

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | X+0    | 4      | Active geometry point<br>0 = First warp FROM point<br>1 = Second warp FROM point<br>2 = Third warp FROM point<br>3 = Fourth warp FROM point<br>4 = Fifth warp FROM point<br>5 = Sixth warp FROM point<br>6 = Seventh warp FROM point<br>7 = Eighth warp FROM point<br>8 = First warp TO point<br>9 = Second warp TO point<br>10 = Third warp TO point<br>11 = Fourth warp TO point<br>12 = Fifth warp TO point<br>13 = Sixth warp TO point<br>14 = Seventh warp TO point<br>15 = Eighth warp TO point |
| Int       | X+4    | 4      | Warp tool state<br>0 = Start state - no points entered<br>1 = One FROM point entered<br>2 = Two FROM point entered<br>3 = Three FROM point entered<br>4 = Four FROM point entered<br>5 = Five FROM point entered<br>6 = Six FROM point entered<br>7 = Seven FROM point entered<br>8 = All FROM point entered  |
| Int       | X+8    | 8      | Reserved  |
| Double    | X+16   | 8*8*2  | FROM points transformed to XY plane by above matrix.<br>8 FROM points are ordered 1, 2, ... 8. Each point is (x, y)   |
| Double    | X+144  | 8*8*2  | TO points transformed to XY plane by above matrix.<br>8 TO points are ordered 1, 2, ... 8. Each point is (x, y)   |

## Shader Palette Record

The shader palette contains descriptions of shaders used while drawing geometry. It is composed of an arbitrary number of shader palette records. The shader palette records must follow the header record and precede the first push.

### Shader Palette Record

| Data Type   | Offset | Length | Description  |
|---|--------|--------|--|
| Int   | 0      | 2      | Shader Opcode 133  |
| Unsigned Int  | 2      | 2      | Length - length of the record                                    |
| Int   | 4      | 4      | Shader index   |
| Int   | 8      | 4      | Shader type<br>0 = Cg<br>1 = CgFX<br>2 = OpenGL Shading Language |
| Char  | 12     | 1024   | Shader name  |
| Depending on the Shader type field, different parameter blocks follow.<br>These blocks are described in the following sections. |        |        |  |

The parameters for Cg shader will appear immediately following the shader palette record if Shader type is 0.

### Parameters for Cg Shader

| Data Type | Offset | Length | Description                  |
|-----------|--------|--------|------------------------------|
| Char      | 1036   | 1024   | Vertex program file name     |
| Char      | 2060   | 1024   | Fragment program file name   |
| Int       | 3084   | 4      | Vertex program profile       |
| Int       | 3088   | 4      | Fragment program profile     |
| Char      | 3092   | 256    | Vertex program entry point   |
| Char      | 3348   | 256    | Fragment program entry point |

The parameters for OpenGL Shading Language shader will appear immediately following the shader palette record if Shader type is 2.

### Parameters for OpenGL Shading Language Shader

| Data Type   | Offset | Length | Description                        |
|---|--------|--------|------------------------------------|
| Int   | 1036   | 4      | Number of vertex program files     |
| Int   | 1040   | 4      | Number of fragment programs files  |
| The following field is repeated for each vertex program file in the shader record.<br>In the field listed below, N ranges from 0 to Number of vertex program files.     |        |        |                                    |
| Char  | Varies | 1024   | Vertex program file <sub>N</sub>   |
| The following field is repeated for each fragment program file in the shader record.<br>In the field listed below, N ranges from 0 to Number of fragment program files. |        |        |                                    |
| Char  | Varies | 1024   | Fragment program file <sub>N</sub> |

## Extension GUID Palette Record

The extension GUID palette contains descriptions of the extension field GUIDs contained (used) in the OpenFlight file. Each subsequent extension field record that accompanies a node record in the file will reference one of these GUID palette records. In this way, the GUID associated with an extension does not need to appear with each instance of the extension. Instead it can appear once in the extension GUID palette and then be referenced by several node records in the file. The extension GUID palette records must follow the header record and precede the first push.

For more information on extension fields, see [“Extension Field Records” on page 68](#).

### Extension GUID Palette Record

| Data Type    | Offset | Length | Description                              |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Extension GUID Palette Record Opcode 148 |
| Unsigned Int | 2      | 2      | Length - length of the record            |
| Int          | 4      | 4      | GUID palette index                       |
| Int          | 8      | 40     | GUID string                              |

# 3 *Texture Files*

## Texture Pattern Files

OpenFlight does not have its own texture pattern format, but rather uses existing texture formats and references patterns by file name. See “Texture Palette Record” on page 82.

Since OpenFlight references a texture pattern by name only and provides no direct support for the contents of the pattern, there is no restriction on the file types supported. Of course, the application reading the OpenFlight file must be able to “recognize” the texture pattern if the contents of the pattern is to be loaded or otherwise referenced in the application.

Some formats supported by the Presagis Creator application include:

- AT&T<sup>®</sup> image 8 format (8-bit color lookup)
- AT&T image 8 template format
- SGI intensity modulation
- SGI intensity modulation with alpha
- SGI RGB
- SGI RGB with alpha
- GIF
- JPEG/JFIF
- TIFF
- IFF/ILBM
- BMP/DIB
- PCX
- PNG
- PPM
- Sun<sup>™</sup> Raster
- Direct Draw Surface (DDS)
- Targa<sup>™</sup>
- Alias<sup>™</sup> Pix
- SGI clip texture

The format of the file is determined by the file name extension, the magic numbers within the file, or the texture attribute file, as described in the following section.

## Texture Attribute Files

A corresponding attribute file is created for each texture pattern, with the name of the attribute file the same as the texture file, followed by the extension “.attr”. These attribute files are used by the modeling software, and may not be necessary for the application using the database.

The attribute file contains information specifying how to parse the texture pattern file, set the texture hardware and software environment for the texture pattern, or position the image in a database.

The format of the texture attribute file is described in this section.

### Texture Attribute File Format

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 0      | 4      | Number of texels in u direction  |
| Int       | 4      | 4      | Number of texels in v direction  |
| Int       | 8      | 4      | Real world size u direction (obsolete - not used)  |
| Int       | 12     | 4      | Real world size v direction (obsolete - not used)  |
| Int       | 16     | 4      | x component of up vector   |
| Int       | 20     | 4      | y component of up vector   |
| Int       | 24     | 4      | File format type<br>0 = AT&T image 8 pattern<br>1 = AT&T image 8 template<br>2 = SGI intensity modulation<br>3 = SGI intensity w/alpha<br>4 = SGI RGB<br>5 = SGI RGB w/alpha   |
| Int       | 28     | 4      | Minification filter type<br>0 = Point<br>1 = Bilinear<br>2 = Mipmap (obsolete)<br>3 = Mipmap Point<br>4 = Mipmap linear<br>5 = Mipmap bilinear<br>6 = Mipmap trilinear<br>7 = None<br>8 = Bicubic<br>9 = Bilinear greater/equal<br>10 = Bilinear less/equal<br>11 = Bicubic greater/equal<br>12 = Bicubic less/equal |

## Texture Attribute File Format (Continued)

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 32     | 4      | Magnification filter type<br>0 = Point<br>1 = Bilinear<br>2 = None<br>3 = Bicubic<br>4 = Sharpen<br>5 = Add Detail<br>6 = Modulate Detail<br>7 = Bilinear greater/equal<br>8 = Bilinear less/equal<br>9 = Bicubic greater/equal<br>10 = Bicubic less/equal |
| Int       | 36     | 4      | Wrap method u,v - only used when either Wrap method u or Wrap method v is set to None<br>0 = Repeat<br>1 = Clamp<br>4 = Mirrored Repeat  |
| Int       | 40     | 4      | Wrap method u<br>0 = Repeat<br>1 = Clamp<br>3 = None - use Wrap method u,v<br>4 = Mirrored Repeat  |
| Int       | 44     | 4      | Wrap method v<br>0 = Repeat<br>1 = Clamp<br>3 = None - use Wrap method u,v<br>4 = Mirrored Repeat  |
| Int       | 48     | 4      | Modified flag - for internal use only  |
| Int       | 52     | 4      | x pivot point for rotating textures  |
| Int       | 56     | 4      | y pivot point for rotating textures  |
| Int       | 60     | 4      | Environment type<br>0 = Modulate<br>1 = Blend<br>2 = Decal<br>3 = Replace<br>4 = Add   |
| Int       | 64     | 4      | TRUE if intensity pattern to be loaded in alpha with white in color  |
| Int       | 68     | 4*8    | Reserved   |
| Int       | 100    | 4      | Reserved   |
| Double    | 104    | 8      | Real world size u direction  |
| Double    | 112    | 8      | Real world size v direction  |
| Int       | 120    | 4      | Code for origin of imported texture  |
| Int       | 124    | 4      | Kernel version number  |

### Texture Attribute File Format (Continued)

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 128    | 4      | Internal format type<br>0 = Default<br>1 = TX_I_12A_4<br>2 = TX_IA_8<br>3 = TX_RGB_5<br>4 = TX_RGBA_4<br>5 = TX_IA_12<br>6 = TX_RGBA_8<br>7 = TX_RGBA_12<br>8 = TX_I_16 (shadow mode only)<br>9 = TX_RGB_12 |
| Int       | 132    | 4      | External format type<br>0 = Default<br>1 = TX_PACK_8<br>2 = TX_PACK_16  |
| Int       | 136    | 4      | TRUE if using following 8 floats for MIPMAP kernel  |
| Float     | 140    | 4*8    | 8 floats for kernel of separable symmetric filter   |
| Int       | 172    | 4      | if TRUE send:   |
| Float     | 176    | 4      | LOD0 for TX_CONTROL_POINT   |
| Float     | 180    | 4      | SCALE0 for TX_CONTROL_POINT   |
| Float     | 184    | 4      | LOD1 for TX_CONTROL_POINT   |
| Float     | 188    | 4      | SCALE1 for TX_CONTROL_POINT   |
| Float     | 192    | 4      | LOD2 for TX_CONTROL_POINT   |
| Float     | 196    | 4      | SCALE2 for TX_CONTROL_POINT   |
| Float     | 200    | 4      | LOD3 for TX_CONTROL_POINT   |
| Float     | 204    | 4      | SCALE3 for TX_CONTROL_POINT   |
| Float     | 208    | 4      | LOD4 for TX_CONTROL_POINT   |
| Float     | 212    | 4      | SCALE4 for TX_CONTROL_POINT   |
| Float     | 216    | 4      | LOD5 for TX_CONTROL_POINT   |
| Float     | 220    | 4      | SCALE5 for TX_CONTROL_POINT   |
| Float     | 224    | 4      | LOD6 for TX_CONTROL_POINT   |
| Float     | 228    | 4      | SCALE6 for TX_CONTROL_POINT   |
| Float     | 232    | 4      | LOD7 for TX_CONTROL_POINT   |
| Float     | 236    | 4      | SCALE7 for TX_CONTROL_POINT   |
| Float     | 240    | 4      | Control Clamp   |

## Texture Attribute File Format (Continued)

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 244    | 4      | Magnification filter type for alpha<br>0 = Point<br>1 = Bilinear<br>2 = None<br>3 = Bicubic<br>4 = Sharpen<br>5 = Add Detail<br>6 = Modulate Detail<br>7 = Bilinear greater/equal<br>8 = Bilinear less/equal<br>9 = Bicubic greater/equal<br>10 = Bicubic less/equal |
| Int       | 248    | 4      | Magnification filter type for color<br>0 = Point<br>1 = Bilinear<br>2 = None<br>3 = Bicubic<br>4 = Sharpen<br>5 = Add Detail<br>6 = Modulate Detail<br>7 = Bilinear greater/equal<br>8 = Bilinear less/equal<br>9 = Bicubic greater/equal<br>10 = Bicubic less/equal |
| Float     | 252    | 4      | Reserved   |
| Float     | 256    | 4*8    | Reserved   |
| Double    | 288    | 8      | Lambert conic projection central meridian  |
| Double    | 296    | 8      | Lambert conic projection upper latitude  |
| Double    | 304    | 8      | Lambert conic projection lower latitude  |
| Double    | 312    | 8      | Reserved   |
| Float     | 320    | 4*5    | Reserved   |
| Int       | 340    | 4      | TRUE if using next 5 integers for TX_DETAIL  |
| Int       | 344    | 4      | J argument for TX_DETAIL   |
| Int       | 348    | 4      | K argument for TX_DETAIL   |
| Int       | 352    | 4      | M argument for TX_DETAIL   |
| Int       | 356    | 4      | N argument for TX_DETAIL   |
| Int       | 360    | 4      | Scramble argument for TX_DETAIL  |
| Int       | 364    | 4      | TRUE if using next 4 floats for TX_TILE  |
| Float     | 368    | 4      | Lower-left u value for TX_TILE   |
| Float     | 372    | 4      | Lower-left v value for TX_TILE   |
| Float     | 376    | 4      | Upper-right u value for TX_TILE  |
| Float     | 380    | 4      | Upper-right v value for TX_TILE  |
| Int       | 384    | 4      | Projection<br>0 = Flat earth<br>3 = Lambert conic<br>4 = UTM<br>7 = Undefined projection   |

### Texture Attribute File Format (Continued)

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 388    | 4      | Earth model<br>0 = WGS84<br>1 = WGS72<br>2 = Bessel<br>3 = Clark 1866<br>4 = NAD27 |
| Int       | 392    | 4      | Reserved   |
| Int       | 396    | 4      | UTM zone   |
| Int       | 400    | 4      | Image origin<br>0 = Lower left<br>1 = Upper left                                   |
| Int       | 404    | 4      | Geospecific points units<br>0 = Degrees<br>1 = Meters<br>2 = Pixels                |
| Int       | 408    | 4      | Reserved   |
| Int       | 412    | 4      | Reserved   |
| Int       | 416    | 4      | Hemisphere for geospecific points units<br>0 = Southern<br>1 = Northern            |
| Int       | 420    | 4      | Reserved   |
| Int       | 424    | 4      | Reserved   |
| Int       | 428    | 4      | Reserved   |
| Int       | 432    | 4      | TRUE if texture is used for cubemap  |
| Int       | 436    | 4*147  | Reserved   |
| Char      | 1024   | 512    | Comments; 0 terminates   |
| Int       | 1536   | 4*13*  | Reserved   |
| Int       | 1588   | 4      | Reserved   |
| Int       | 1592   | 4      | Attribute file version number  |
| Int       | 1596   | 4      | Number of geospecific control points   |

If the value of the Number of geospecific control points field is greater than 0, the following fields are also contained in the attribute file:

### Geospecific Control Point subrecord

| Data Type  | Length | Description   |
|--|--------|---|
| Int  | 4      | Reserved  |
| The following fields are repeated for each geospecific control point in the texture attribute file.<br><b>Note:</b> In the fields below, N ranges from 0 to Number of geospecific control points - 1<br>The earth coordinates depend on the projection, earth model, and geospecific points units. |        |   |
| Double   | 8      | Texel $u_N$ - texel u of control point                        |
| Double   | 8      | Texel $v_N$ - texel v of control point                        |
| Double   | 8      | Earth coordinate $x_N$ - earth x coordinate of control point. |
| Double   | 8      | Earth coordinate $y_N$ - earth y coordinate of control point. |

After all the geospecific control points are listed, the following subtexture information appears:

| <b>Data Type</b> | <b>Length</b> | <b>Description</b>    |
|------------------|---------------|-----------------------|
| Int              | 4             | Number of subtextures |

If the value of the Number of subtextures field is greater than 0, the following fields are repeated for each subtexture in the texture attribute file.

In the fields below, N ranges from 0 to Number of subtextures - 1.

The Left, Bottom, Right and Top fields are all measured in texels.

### Subtexture subrecord

| <b>Data Type</b> | <b>Length</b> | <b>Description</b>  |
|------------------|---------------|---|
| Char             | 32            | Name <sub>N</sub> - name of subtexture N; 0 terminates          |
| Int              | 4             | Left <sub>N</sub> - Coordinate of left edge of subtexture N     |
| Int              | 4             | Bottom <sub>N</sub> - Coordinate of bottom edge of subtexture N |
| Int              | 4             | Right <sub>N</sub> - Coordinate of right edge of subtexture N   |
| Int              | 4             | Top <sub>N</sub> - Coordinate of top edge of subtexture N       |



# 4 Road Path Files

A road path file contains the attributes of a road path node in ASCII format. The name of the file is user defined. Each attribute is denoted by a keyword, a literal colon, a space, and the value(s). Boolean values are denoted by the string literals “TRUE” and “FALSE”. For the “POINT” keyword its values consist of an XYZ coordinate and an orientation vector, separated by spaces. The orientation vector is specified as either a normal up-vector, or in degrees of heading, pitch, and roll. The “STORE\_HPR” keyword specifies which method is used. For path nodes that define the road’s centerline path, construction information for the correlated road section is also stored with additional keywords. Here’s an example:

```
ROAD_ID: 2.0 _____ This is the first section (a curve) in Road #2 of the database. Section numbers start at zero.
ROAD_TYPE: Curve _____ Road ID also appears on database node.
ARC_RADIUS: 175.000000 _____
SPIRAL_LEN1: 80.000000 _____
SPIRAL_LEN2: 80.000000 _____
SUPERELEVATION: 0.080000 _____
CONTROL_POINT: 0.000000 300.000000 0.000000 _____ Horizontal and vertical curve control
VCURVE_LEN: 400.000000 _____ values
VCURVE_MIN: 20.000000 _____
SLOPE1: 0.000000 _____
SLOPE2: 0.000000 _____
WIDTH: 12.000000 _____ Road width and centerline placement
CENTER2LEFT: 6.000000 _____
NUM_LANES: 2 _____
LANE_OFFSET: 1.825000 _____ Lane information for the road section
LANE_OFFSET: -1.825000 _____
PROFILE_NAME: /usr/people/db/road/crown.flt _____ Lofting information, including the database file that
PROFILE_POINT: 12.000000 0.000000 _____ contains the lofting profile, and (X,Z) points for the
PROFILE_POINT: 9.823453 0.300000 _____ lofted section. Lofting information is only printed
PROFILE_POINT: 6.000000 0.500000 _____ for the first reference to the profile database.
PROFILE_POINT: 3.200000 0.300000 _____
PROFILE_POINT: 0.000000 0.000000 _____
SPEED: 70.000000 _____ Passing lane flag (path attribute page)
NO_PASSING: TRUE _____
STORE_HPR: TRUE _____ Heading, Pitch and Roll data will be stored and reported
NUM_POINTS: 12 _____
POINT: 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 _____
POINT: 0.000000 83.548590 0.000000 0.000000 0.000000 0.000000 _____
POINT: 2.906056 145.953096 0.000000 8.000000 0.000000 3.574879 _____
POINT: 6.072530 163.131640 0.000000 13.096178 0.000000 4.573921 _____
POINT: 13.249899 186.467582 0.000000 21.096178 0.000000 4.573921 _____
POINT: 36.936741 229.031118 0.000000 37.096180 0.000000 4.573921 _____
POINT: 71.438096 263.416837 0.000000 53.096180 0.000000 4.573921 _____
POINT: 114.080915 286.960649 0.000000 69.096176 0.000000 4.573921 _____
POINT: 136.868360 293.927470 0.000000 76.903824 0.000000 4.573921 _____
POINT: 166.586342 298.521248 0.000000 84.903824 0.000000 2.853243 _____
POINT: 216.451410 300.000000 0.000000 90.000000 0.000000 0.000000 _____
POINT: 300.000000 300.000000 0.000000 90.000000 0.000000 0.000000 _____
```

Data for each point, in the following order:  
X, Y, Z, H, P, R



# 5 Road Zone Files

Zone files are gridded posts files containing elevation and attribute data for a road. The zone data is followed immediately by a series of:

(Number of data points in x) \* (Number of data points in y) elevation data points.

The elevation data points are followed immediately by a series of:

(Number of data points in x) \* (Number of data points in y) surface types corresponding to each of the elevation data points above.

The elevation data points as well as the surface types begin at the lower-left corner. Values are ordered from bottom to top, then in columns from left to right.

## Road Zone File Format

| Data Type | Offset | Length | Description                                 |
|-----------|--------|--------|---|
| Int       | 0      | 4      | Version - road tools format version         |
| Int       | 4      | 4      | Reserved                                    |
| Double    | 8      | 8*3    | Lower left corner (x, y, z)                 |
| Double    | 32     | 8*3    | Upper right corner (x, y, z)                |
| Double    | 56     | 8      | Grid interval - spacing between data points |
| Int       | 64     | 4      | Number of data points in x                  |
| Int       | 68     | 4      | Number of data points in y                  |
| Float     | 72     | 4      | Low z elevation data point                  |
| Float     | 76     | 4      | High z elevation data point                 |
| Char      | 80     | 440    | Reserved                                    |

The following field is repeated for each data point in the road zone file.

In this field, N ranges from 0 to Number of data points - 1, where

Number of data points = Number of data points in x \* Number of data points in y.

## Elevation Data Point subrecord

| Data Type | Offset    | Length | Description                                       |
|-----------|-----------|--------|---|
| Float     | 520+(N*4) | 4      | Z <sub>N</sub> - elevation value for data point N |

The following field is repeated for each data point in the road zone file.

In this field, N ranges from 0 to Number of data points - 1, where

Number of data points = Number of data points in x \* Number of data points in y and M is equal to Number of data points.

## Surface Type subrecord

| Data Type | Offset      | Length | Description  |
|-----------|-------------|--------|--|
| Char      | 520+(M*4)+N | 1      | Surface type <sub>N</sub> - user defined surface type for data point N |



## 6 *Linkage Editor Parameter IDs*

### Vertex Node Parameters

| ID  | Description          |
|-----|----------------------|
| 258 | X coordinate         |
| 259 | Y coordinate         |
| 260 | Z coordinate         |
| 261 | Texture U coordinate |
| 262 | Texture V coordinate |
| 265 | Color                |
| 266 | Hard edge flag       |
| 267 | Freeze normal flag   |
| 269 | Normal I component   |
| 270 | Normal J component   |
| 271 | Normal K component   |

### Face Node Parameters

| ID  | Description                  |
|-----|------------------------------|
| 514 | Color                        |
| 515 | Polygon drawing              |
| 516 | Lighting mode                |
| 518 | Relative priority            |
| 519 | Draw both sides flag         |
| 520 | Texture index                |
| 521 | Template                     |
| 522 | Infrared                     |
| 523 | Terrain flag                 |
| 525 | Material index               |
| 526 | Feature ID                   |
| 527 | Surface material code        |
| 529 | Draw textured faces white    |
| 530 | IR material                  |
| 534 | Detail texture index         |
| 535 | Transparency                 |
| 536 | Alternate color              |
| 537 | LOD control                  |
| 538 | Line style index             |
| 539 | Light point directional mode |
| 540 | Texture mapping              |

## Object Node Parameters

| ID  | Description               |
|-----|---------------------------|
| 770 | Relative priority         |
| 771 | Inhibit during day flag   |
| 772 | Inhibit during dusk flag  |
| 773 | Inhibit during night flag |
| 774 | No illumination flag      |
| 775 | Flat shading flag         |
| 776 | Shadow flag               |
| 777 | Transparency              |
| 778 | Special #1                |
| 779 | Special #2                |
| 782 | Significance              |

## LOD Node Parameters

| ID   | Description               |
|------|---------------------------|
| 1026 | Switch-in distance        |
| 1027 | Switch-out distance       |
| 1028 | Special #1                |
| 1029 | Special #2                |
| 1030 | Use previous range flag   |
| 1031 | Center X coordinate       |
| 1032 | Center Y coordinate       |
| 1033 | Freeze center flag        |
| 1034 | Center Z coordinate       |
| 1036 | Additive LOD's below flag |
| 1037 | Transition distance       |

## Group Node Parameters

| ID   | Description          |
|------|----------------------|
| 1282 | Relative priority    |
| 1284 | Animation type       |
| 1286 | Bounding volume type |
| 1287 | Special #1           |
| 1288 | Special #2           |
| 1289 | Replication count    |
| 1290 | Significance         |
| 1291 | Layer                |

## DOF Node Parameters

| ID   | Description                     |
|------|---------------------------------|
| 1538 | Current Z                       |
| 1539 | Minimum Z                       |
| 1540 | Maximum Z                       |
| 1542 | Current Y                       |
| 1543 | Minimum Y                       |
| 1544 | Maximum Y                       |
| 1546 | Current X                       |
| 1547 | Minimum X                       |
| 1548 | Maximum X                       |
| 1550 | Current pitch                   |
| 1551 | Minimum pitch                   |
| 1552 | Maximum pitch                   |
| 1554 | Current roll                    |
| 1555 | Minimum roll                    |
| 1556 | Maximum roll                    |
| 1558 | Current yaw                     |
| 1559 | Minimum yaw                     |
| 1560 | Maximum yaw                     |
| 1562 | Current Z scale                 |
| 1563 | Minimum Z scale                 |
| 1564 | Maximum Z scale                 |
| 1566 | Current Y scale                 |
| 1567 | Minimum Y scale                 |
| 1568 | Maximum Y scale                 |
| 1570 | Current X scale                 |
| 1571 | Minimum X scale                 |
| 1572 | Maximum X scale                 |
| 1574 | X constrained motion flag       |
| 1575 | Y constrained motion flag       |
| 1576 | Z constrained motion flag       |
| 1577 | Pitch constrained motion flag   |
| 1578 | Roll constrained motion flag    |
| 1579 | Yaw constrained motion flag     |
| 1580 | X scale constrained motion flag |
| 1581 | Y scale constrained motion flag |
| 1582 | Z scale constrained motion flag |
| 1583 | Repeating texture flag          |
| 1584 | Membrane mode flag              |

## Sound Node Parameters

| ID   | Description                  |
|------|------------------------------|
| 1796 | Amplitude                    |
| 1797 | Pitch bend                   |
| 1798 | Priority                     |
| 1799 | Falloff                      |
| 1800 | Width                        |
| 1801 | Doppler                      |
| 1802 | Absorption                   |
| 1803 | Delay                        |
| 1804 | Directivity                  |
| 1805 | X coordinate                 |
| 1806 | Y coordinate                 |
| 1807 | Z coordinate                 |
| 1808 | Direction vector I component |
| 1809 | Direction vector J component |
| 1810 | Direction vector K component |
| 1812 | Active flag                  |

## Switch Node Parameters

| ID   | Description        |
|------|--------------------|
| 2050 | Current mask index |

## Text Node Parameters

| ID   | Description                    |
|------|--------------------------------|
| 2307 | Text type                      |
| 2308 | Draw type                      |
| 2310 | Color                          |
| 2311 | Alternate color                |
| 2312 | Material index                 |
| 2315 | Integer value minimum          |
| 2316 | Integer value maximum          |
| 2317 | Float value minimum            |
| 2318 | Float value maximum            |
| 2325 | Current integer value          |
| 2326 | Current float value            |
| 2327 | Decimal places for float value |
| 2329 | Line style index               |
| 2330 | Justification type             |
| 2331 | Vertical flag                  |
| 2332 | Bold flag                      |
| 2333 | Italic flag                    |
| 2334 | Underline flag                 |

## Light Source Node Parameters

| ID   | Description  |
|------|--------------|
| 2819 | Enabled flag |
| 2820 | Global flag  |
| 2821 | X coordinate |
| 2822 | Y coordinate |
| 2823 | Z coordinate |
| 2824 | Yaw          |
| 2825 | Pitch        |

## Clip Node Parameters

| ID   | Description    |
|------|----------------|
| 3074 | Plane 0 enable |
| 3075 | Plane 1 enable |
| 3076 | Plane 2 enable |
| 3077 | Plane 3 enable |
| 3078 | Plane 4 enable |



# 7 OpenFlight Opcodes

## Valid Opcodes

| Opcode | Record Type                      | For more information, see..  |
|--------|----------------------------------|--|
| 1      | Header                           | <a href="#">“Header Record” on page 21</a>                           |
| 2      | Group                            | <a href="#">“Group Record” on page 24</a>                            |
| 4      | Object                           | <a href="#">“Object Record” on page 27</a>                           |
| 5      | Face                             | <a href="#">“Face Record” on page 28</a>                             |
| 10     | Push Level                       | <a href="#">“Push Level Record” on page 19</a>                       |
| 11     | Pop Level                        | <a href="#">“Pop Level Record” on page 19</a>                        |
| 14     | Degree of Freedom                | <a href="#">“Degree of Freedom Record” on page 40</a>                |
| 19     | Push Subface                     | <a href="#">“Push Subface Record” on page 19</a>                     |
| 20     | Pop Subface                      | <a href="#">“Pop Subface Record” on page 19</a>                      |
| 21     | Push Extension                   | <a href="#">“Push Extension Record” on page 19</a>                   |
| 22     | Pop Extension                    | <a href="#">“Pop Extension Record” on page 19</a>                    |
| 23     | Continuation                     | <a href="#">“Continuation Record” on page 69</a>                     |
| 31     | Comment                          | <a href="#">“Comment Record” on page 56</a>                          |
| 32     | Color Palette                    | <a href="#">“Color Palette Record” on page 74</a>                    |
| 33     | Long ID                          | <a href="#">“Long ID Record” on page 56</a>                          |
| 49     | Matrix                           | <a href="#">“Matrix Record” on page 62</a>                           |
| 50     | Vector                           | <a href="#">“Vector Record” on page 64</a>                           |
| 52     | Multitexture                     | <a href="#">“Multitexture Record” on page 58</a>                     |
| 53     | UV List                          | <a href="#">“UV List Record” on page 59</a>                          |
| 55     | Binary Separating Plane          | <a href="#">“Binary Separating Plane Record” on page 43</a>          |
| 60     | Replicate                        | <a href="#">“Replicate Record” on page 61</a>                        |
| 61     | Instance Reference               | <a href="#">“Instance Reference Record” on page 21</a>               |
| 62     | Instance Definition              | <a href="#">“Instance Definition Record” on page 21</a>              |
| 63     | External Reference               | <a href="#">“External Reference Record” on page 44</a>               |
| 64     | Texture Palette                  | <a href="#">“Texture Palette Record” on page 82</a>                  |
| 67     | Vertex Palette                   | <a href="#">“Vertex Palette Record” on page 71</a>                   |
| 68     | Vertex with Color                | <a href="#">“Vertex with Color Record” on page 72</a>                |
| 69     | Vertex with Color and Normal     | <a href="#">“Vertex with Color and Normal Record” on page 73</a>     |
| 70     | Vertex with Color, Normal and UV | <a href="#">“Vertex with Color, Normal and UV Record” on page 74</a> |
| 71     | Vertex with Color and UV         | <a href="#">“Vertex with Color and UV Record” on page 73</a>         |
| 72     | Vertex List                      | <a href="#">“Vertex List Record” on page 42</a>                      |
| 73     | Level of Detail                  | <a href="#">“Level of Detail Record” on page 44</a>                  |
| 74     | Bounding Box                     | <a href="#">“Bounding Box Record” on page 64</a>                     |
| 76     | Rotate About Edge                | <a href="#">“Rotate About Edge Record” on page 62</a>                |
| 78     | Translate                        | <a href="#">“Translate Record” on page 62</a>                        |
| 79     | Scale                            | <a href="#">“Scale Record” on page 62</a>                            |
| 80     | Rotate About Point               | <a href="#">“Rotate About Point Record” on page 63</a>               |

| Opcode | Record Type                         | For more information, see..   |
|--------|-------------------------------------|---|
| 81     | Rotate and/or Scale to Point        | <a href="#">“Rotate and/or Scale to Point Record” on page 63</a>    |
| 82     | Put                                 | <a href="#">“Put Record” on page 63</a>                             |
| 83     | Eyepoint and Trackplane Palette     | <a href="#">“Eyepoint and Trackplane Palette Record” on page 82</a> |
| 84     | Mesh                                | <a href="#">“Mesh Record” on page 31</a>                            |
| 85     | Local Vertex Pool                   | <a href="#">“Local Vertex Pool Record” on page 33</a>               |
| 86     | Mesh Primitive                      | <a href="#">“Mesh Primitive Record” on page 35</a>                  |
| 87     | Road Segment                        | <a href="#">“Road Segment Record” on page 47</a>                    |
| 88     | Road Zone                           | <a href="#">“Road Zone Record” on page 61</a>                       |
| 89     | Morph Vertex List                   | <a href="#">“Morph Vertex List Record” on page 42</a>               |
| 90     | Linkage Palette                     | <a href="#">“Linkage Palette Record” on page 86</a>                 |
| 91     | Sound                               | <a href="#">“Sound Record” on page 45</a>                           |
| 92     | Road Path                           | <a href="#">“Road Path Record” on page 49</a>                       |
| 93     | Sound Palette                       | <a href="#">“Sound Palette Record” on page 89</a>                   |
| 94     | General Matrix                      | <a href="#">“General Matrix Record” on page 63</a>                  |
| 95     | Text                                | <a href="#">“Text Record” on page 50</a>                            |
| 96     | Switch                              | <a href="#">“Switch Record” on page 52</a>                          |
| 97     | Line Style Palette                  | <a href="#">“Line Style Palette Record” on page 93</a>              |
| 98     | Clip Region                         | <a href="#">“Clip Region Record” on page 50</a>                     |
| 100    | Extension                           | <a href="#">“Extension Record” on page 54</a>                       |
| 101    | Light Source                        | <a href="#">“Light Source Record” on page 46</a>                    |
| 102    | Light Source Palette                | <a href="#">“Light Source Palette Record” on page 89</a>            |
| 103    | Reserved                            |   |
| 104    | Reserved                            |   |
| 105    | Bounding Sphere                     | <a href="#">“Bounding Sphere Record” on page 64</a>                 |
| 106    | Bounding Cylinder                   | <a href="#">“Bounding Cylinder Record” on page 65</a>               |
| 107    | Bounding Convex Hull                | <a href="#">“Bounding Convex Hull Record” on page 65</a>            |
| 108    | Bounding Volume Center              | <a href="#">“Bounding Volume Center Record” on page 65</a>          |
| 109    | Bounding Volume Orientation         | <a href="#">“Bounding Volume Orientation Record” on page 66</a>     |
| 110    | Reserved                            |   |
| 111    | Light Point                         | <a href="#">“Light Point Record” on page 37</a>                     |
| 112    | Texture Mapping Palette             | <a href="#">“Texture Mapping Palette Record” on page 94</a>         |
| 113    | Material Palette                    | <a href="#">“Material Palette Record” on page 76</a>                |
| 114    | Name Table                          | <a href="#">“Name Table Record” on page 75</a>                      |
| 115    | Continuously Adaptive Terrain (CAT) | <a href="#">“CAT Record” on page 53</a>                             |
| 116    | CAT Data                            | <a href="#">“CAT Data Record” on page 66</a>                        |
| 117    | Reserved                            |   |
| 118    | Reserved                            |   |
| 119    | Bounding Histogram                  | <a href="#">“Bounding Histogram Record” on page 65</a>              |
| 120    | Reserved                            |   |
| 121    | Reserved                            |   |
| 122    | Push Attribute                      | <a href="#">“Push Attribute Record” on page 20</a>                  |
| 123    | Pop Attribute                       | <a href="#">“Pop Attribute Record” on page 20</a>                   |
| 124    | Reserved                            |   |

| Opcode | Record Type                      | For more information, see..  |
|--------|----------------------------------|--|
| 125    | Reserved                         |  |
| 126    | Curve                            | <a href="#">“Curve Record” on page 55</a>                            |
| 127    | Road Construction                | <a href="#">“Road Construction Record” on page 47</a>                |
| 128    | Light Point Appearance Palette   | <a href="#">“Light Point Appearance Palette Record” on page 90</a>   |
| 129    | Light Point Animation Palette    | <a href="#">“Light Point Animation Palette Record” on page 93</a>    |
| 130    | Indexed Light Point              | <a href="#">“Indexed Light Point Record” on page 36</a>              |
| 131    | Light Point System               | <a href="#">“Light Point System Record” on page 39</a>               |
| 132    | Indexed String                   | <a href="#">“Indexed String Record” on page 57</a>                   |
| 133    | Shader Palette                   | <a href="#">“Shader Palette Record” on page 99</a>                   |
| 134    | Reserved                         |  |
| 135    | Extended Material Header         | <a href="#">“Extended Material Header Record” on page 78</a>         |
| 136    | Extended Material Ambient        | <a href="#">“Extended Material Ambient Record” on page 79</a>        |
| 137    | Extended Material Diffuse        | <a href="#">“Extended Material Diffuse Record” on page 79</a>        |
| 138    | Extended Material Specular       | <a href="#">“Extended Material Specular Record” on page 79</a>       |
| 139    | Extended Material Emissive       | <a href="#">“Extended Material Emissive Record” on page 80</a>       |
| 140    | Extended Material Alpha          | <a href="#">“Extended Material Alpha Record” on page 80</a>          |
| 141    | Extended Material Light Map      | <a href="#">“Extended Material Light Map Record” on page 80</a>      |
| 142    | Extended Material Normal Map     | <a href="#">“Extended Material Normal Map Record” on page 81</a>     |
| 143    | Extended Material Bump Map       | <a href="#">“Extended Material Bump Map Record” on page 81</a>       |
| 144    | Reserved                         |  |
| 145    | Extended Material Shadow Map     | <a href="#">“Extended Material Shadow Map Record” on page 81</a>     |
| 146    | Reserved                         |  |
| 147    | Extended Material Reflection Map | <a href="#">“Extended Material Reflection Map Record” on page 81</a> |
| 148    | Extension GUID Palette           | <a href="#">“Extension GUID Palette Record” on page 100</a>          |
| 149    | Extension Field Boolean          | <a href="#">“Extension Field Boolean Record” on page 68</a>          |
| 150    | Extension Field Integer          | <a href="#">“Extension Field Integer Record” on page 68</a>          |
| 151    | Extension Field Float            | <a href="#">“Extension Field Float Record” on page 69</a>            |
| 152    | Extension Field Double           | <a href="#">“Extension Field Double Record” on page 69</a>           |
| 153    | Extension Field String           | <a href="#">“Extension Field String Record” on page 69</a>           |
| 154    | Extension Field XML String       | <a href="#">“Extension Field XML String Record” on page 69</a>       |

## Obsolete Opcodes

| Opcode | Record Type  |
|--------|--|
| 3      | Level of Detail (single precision floating point, replaced by Opcode 73)             |
| 6      | Vertex with ID (scaled integer coordinates, replaced by Opcodes 68-71)               |
| 7      | Short Vertex w/o ID (scaled integer coordinates, replaced by Opcodes 68-71)          |
| 8      | Vertex with Color (scaled integer coordinates, replaced by Opcodes 68-71)            |
| 9      | Vertex with Color and Normal (scaled integer coordinates, replaced by Opcodes 68-71) |
| 12     | Translate (replaced by Opcode 78)  |
| 13     | Degree of Freedom (scaled integer coordinates, replaced by Opcode 14)                |
| 16     | Instance Reference (replaced by Opcode 61)   |
| 17     | Instance Definition (replaced by Opcode 62)  |
| 40     | Translate (replaced by Opcode 78)  |
| 41     | Rotate about Point (replaced by Opcode 80)   |
| 42     | Rotate about Edge (replaced by Opcode 76)  |
| 43     | Scale (replaced by Opcode 79)  |
| 44     | Translate (replaced by Opcode 78)  |
| 45     | Scale nonuniform (replaced by Opcode 79)   |
| 46     | Rotate about Point (replaced by Opcode 80)   |
| 47     | Rotate and/or Scale to Point (replaced by Opcode 81)                                 |
| 48     | Put (replaced by Opcode 82)  |
| 51     | Bounding Box (replaced by Opcode 74)   |
| 65     | Eyepoint Palette (only eyepoints, replaced by Opcode 83)                             |
| 66     | Material Palette (fixed size 64 entries, replaced by Opcode 80)                      |
| 77     | Scale (replaced by Opcode 79)  |

# A *Summary of Changes Version 15.7*

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 15.6 and 15.7. OpenFlight version 15.7 coincides with MultiGen Creator versions 2.4 through 2.5.1 and the OpenFlight API versions 2.4 through 2.5.1. The changes made for this version are:

- [“Continuation Record” on page 123](#)
- [“Header Record” on page 124](#)
- [“Mesh Record” on page 125](#)
- [“Local Vertex Pool Record” on page 126](#)
- [“Mesh Primitive Record” on page 128](#)
- [“Multitexture Record” on page 130](#)
- [“UV List Record” on page 132](#)
- [“Texture Attribute File” on page 133](#)

## Format Changes

### Continuation Record

All OpenFlight records begin with a 4 byte sequence. The first two bytes identify the record (opcode) and the second two bytes specify the length of the record. Given this regular record structure, the length of all OpenFlight records is limited to the largest value that can be encoded with 2 bytes or 16 bits (65535). In most cases, this maximum size is sufficient but there are cases where it is not. For fixed size records, this is not a problem. For variable size records, this limitation is being addressed with this version.

A new record, called the continuation record is introduced in this version to accommodate variable size records in the OpenFlight Scene Description. The continuation record is used to “continue” a record in the OpenFlight Scene Description file stream. It would appear in the stream immediately following the record that it “continues” (the record that is being continued will be referred to as the “original” record). The data contained in the continuation record is defined by the original record and is assumed to be directly appended onto the content of the original record.

**Note:** Multiple continuation records may follow a record, in which case all continuation records would be appended (in sequence) to the original record.

### Continuation Record New record for OpenFlight 15.7

| Data type    | Offset | Length   | Description  |
|--------------|--------|----------|--|
| Unsigned Int | 0      | 2        | Continuation Record Opcode 23  |
| Unsigned Int | 2      | 2        | Length - length of the record  |
| Varies       | 4      | Length-4 | Depends on the original record. The contents of this field are to be appended directly to the end of the original record contents (before the original record contents are parsed) |

For a complete description of the continuation record, see [“Continuation Record” on page 69](#).

### Header Record

New attributes have been appended to the end of the existing header record (see [“Header Record” on page 21](#)). The following fields were added at the specified offsets in the header record.

### Header Record changes for OpenFlight 15.7 New Fields

| Data Type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Double       | 284    | 8      | Delta z to place database (used in conjunction with existing Delta x and Delta y values) |
| Double       | 292    | 8      | Radius (distance from database origin to farthest corner)                                |
| Unsigned Int | 300    | 2      | Next Mesh node ID number   |
| Unsigned Int | 302    | 2      | Reserved   |

### Mesh Nodes

A mesh node defines a set of geometric primitives that share attributes and vertices. In previous versions of OpenFlight, the fundamental geometric construct was the polygon. Each polygon has a unique set of attributes and vertices. Meshes are used to represent “sets” of related polygons, each sharing common attributes and vertices. Using a mesh, related polygons can be represented in a much more compact format. Each mesh will share one set of “polygon” attributes (color, material, texture, etc.), a common “vertex pool” and one or more geometric primitives that use the shared attributes and vertices. Using a mesh you can represent triangle strips, triangle fans, quadrilateral strips and indexed face sets.

A mesh node is defined by three distinct record types:

- *Mesh Record* - defines the “polygon” attributes associated to all geometric primitives of the mesh.

- *Local Vertex Pool Record* - defines the set of vertices that are referenced by the geometric primitives of the mesh.
- *Mesh Primitive Record* - defines a geometric primitive (triangle-strip, triangle-fan, quadrilateral-strip or indexed face set) for the mesh.

A mesh node consists of one mesh record, one local vertex pool record, and one or more mesh primitive records. The mesh primitive records are delimited by push and pop control records as shown in this example:

```
MESH
LOCAL VERTEX POOL
PUSH
MESH PRIMITIVE
MESH PRIMITIVE
. . .
MESH PRIMITIVE
POP
```

### ***Mesh Record***

The mesh record is the primary record of a mesh node and defines the common “face-like” attributes associated to all geometric primitives of the mesh. These attributes are identical to those of the face record. See “Face Record” on page 28.

### **Mesh Record** **New record for OpenFlight 15.7**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>  |
|------------------|---------------|---------------|---|
| Int              | 0             | 2             | Mesh Opcode 84  |
| Unsigned Int     | 2             | 2             | Length - length of the record   |
| Char             | 4             | 8             | 7 char ASCII ID; 0 terminates   |
| Int              | 12            | 4             | IR color code   |
| Int              | 16            | 2             | Relative priority   |
| Int              | 18            | 1             | Draw type<br>0 = Draw solid with backface culling<br>1 = Draw solid, no backface culling<br>2 = Draw wireframe<br>3 = Draw wireframe and close<br>4 = Surround with wireframe in alternate color<br>8 = Omnidirectional light<br>9 = Unidirectional light<br>10 = Bidirectional light |
| Int              | 19            | 1             | Texture white = if TRUE, draw textured face white   |
| Unsigned Int     | 20            | 2             | Color name index  |
| Unsigned Int     | 22            | 2             | Alternate color name index  |
| Int              | 24            | 1             | Reserved  |

## Mesh Record

### New record for OpenFlight 15.7 (Continued)

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 25     | 1      | Template (billboard)<br>0 = Fixed, no alpha blending<br>1 = Fixed, alpha blending<br>2 = Axial rotate with alpha blending<br>4 = Point rotate with alpha blending                               |
| Int          | 26     | 2      | Detail texture pattern index, -1 if none  |
| Int          | 28     | 2      | Texture pattern index, -1 if none   |
| Int          | 30     | 2      | Material index, -1 if none  |
| Int          | 32     | 2      | Surface material code (for DFAD)  |
| Int          | 34     | 2      | Feature ID (for DFAD)   |
| Int          | 36     | 4      | IR material code  |
| Unsigned Int | 40     | 2      | Transparency<br>0 = Opaque<br>65535 = Totally clear   |
| Unsigned Int | 42     | 1      | LOD generation control  |
| Unsigned Int | 43     | 1      | Line style index  |
| Int          | 44     | 4      | Flags (bits from left to right)<br>0 = Terrain<br>1 = No color<br>2 = No alternate color<br>3 = Packed color<br>4 = Terrain culture cutout (footprint)<br>5 = Hidden, not drawn<br>6-31 = Spare |
| Unsigned Int | 48     | 1      | Light mode<br>0 = Use mesh color, not illuminated<br>1 = Use vertex colors, not illuminated<br>2 = Use mesh color and vertex normals<br>3 = Use vertex colors and vertex normals                |
| Char         | 49     | 7      | Reserved  |
| Unsigned Int | 56     | 4      | Packed color, primary (a, b, g, r)  |
| Unsigned Int | 60     | 4      | Packed color, alternate (a, b, g, r)  |
| Int          | 64     | 2      | Texture mapping index   |
| Int          | 66     | 2      | Reserved  |
| Unsigned Int | 68     | 4      | Primary color index   |
| Unsigned Int | 72     | 4      | Alternate color index   |
| Int          | 76     | 4      | Reserved  |

### ***Local Vertex Pool Record***

This record defines a set of vertices that is referenced by the geometry (primitives) of the mesh.

**Note:** Currently the Local Vertex Pool is used exclusively in the context of mesh nodes, but it is designed in a general way so that it may appear in other contexts in future versions of the OpenFlight Scene Description.

### Local Vertex Pool Record New record for OpenFlight 15.7

| Data Type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Local Vertex Pool Opcode 85  |
| Unsigned Int | 2      | 2      | Length - length of the record<br>Note: Since the length of this record is represented by an unsigned short, the maximum length of the vertex pool is $2^{16} - 1$ (or 65535 bytes). If the entire vertex pool cannot fit into this size, one or more continuation records will follow. (See " <a href="#">Continuation Record</a> " on page 69.)   |
| Unsigned Int | 4      | 4      | Number of vertices - number of vertices in the local vertex pool   |
| Unsigned Int | 8      | 4      | Attribute mask - Bit mask indicating what kind of vertex information is specified for each vertex in the local vertex pool. Bits are ordered from left to right as follows:<br><b>Bit #</b> <b>Description</b><br>0        Has Position - if set, data for each vertex in will include x, y, and z coordinates (3 doubles)<br>1        Has Color Index - if set, data for each vertex will include a color value that is a color table index (1 int)<br>2        Has RGB Color - if set, data for each vertex will include a color value that is a packed RGB color (1 int)<br>Note: Bits 1 and 2 are mutually exclusive - a vertex can have either color index or RGB color value or neither, but not both.<br>3        Has Normal - if set, data for each vertex will include a normal (3 floats)<br>4        Has Base UV - if set, data for each vertex will include uv texture coordinates for the base texture (2 floats)<br>5        Has UV Layer 1 - if set, data for each vertex will include uv texture coordinates for layer 1 (2 floats)<br>6        Has UV Layer 2 - if set, data for each vertex will include uv texture coordinates for layer 2 (2 floats)<br>7        Has UV Layer 3 - if set, data for each vertex will include uv texture coordinates for layer 3 (2 floats)<br>8        Has UV Layer 4 - if set, data for each vertex will include uv texture coordinates for layer 4 (2 floats)<br>9        Has UV Layer 5 - if set, data for each vertex will include uv texture coordinates for layer 5 (2 floats)<br>10       Has UV Layer 6 - if set, data for each vertex will include uv texture coordinates for layer 6 (2 floats)<br>11       Has UV Layer 7 - if set, data for each vertex will include uv texture coordinates for layer 7 (2 floats)<br>12-31   Spare |

## Local Vertex Pool Record

### New record for OpenFlight 15.7 (Continued)

Then beginning at offset 12, the following fields are repeated for each vertex in the local vertex pool, depending on the bits set in the Attribute mask field above:  
 In the fields listed below, N ranges from 0 to Number of vertices - 1.

|              |        |     |  |
|--------------|--------|-----|--|
| Double       | Varies | 8*3 | Coordinate <sub>N</sub> - Coordinate of vertex N (x, y, z) - present if Attribute mask includes Has Position.  |
| Unsigned Int | Varies | 4   | color <sub>N</sub> - Color for vertex N - present if Attribute mask includes Has Color Index or Has RGB Color.<br>If Has Color Index, specifies color table index.<br>If Has RGB Color, 4 bytes specify (a, b, g, r) values (alpha ignored). |
| Float        | Varies | 4*3 | normal <sub>N</sub> - Normal for vertex N (i, j, k) - present if Attribute mask includes Has Normal.   |
| Float        | Varies | 4*2 | uvBase <sub>N</sub> - Texture coordinates (u, v) for base texture layer of vertex N - present if Attribute mask includes Has Base UV.  |
| Float        | Varies | 4*2 | uv1 <sub>N</sub> - Texture coordinates (u, v) for layer 1 of vertex N - present if Attribute mask includes Has UV Layer 1.   |
| Float        | Varies | 4*2 | uv2 <sub>N</sub> - Texture coordinates (u, v) for layer 2 of vertex N - present if Attribute mask includes Has UV Layer 2.   |
| Float        | Varies | 4*2 | uv3 <sub>N</sub> - Texture coordinates (u, v) for layer 3 of vertex N - present if Attribute mask includes Has UV Layer 3.   |
| Float        | Varies | 4*2 | uv4 <sub>N</sub> - Texture coordinates (u, v) for layer 4 of vertex N - present if Attribute mask includes Has UV Layer 4.   |
| Float        | Varies | 4*2 | uv5 <sub>N</sub> - Texture coordinates (u, v) for layer 5 of vertex N - present if Attribute mask includes Has UV Layer 5.   |
| Float        | Varies | 4*2 | uv6 <sub>N</sub> - Texture coordinates (u, v) for layer 6 of vertex N - present if Attribute mask includes Has UV Layer 6.   |
| Float        | Varies | 4*2 | uv7 <sub>N</sub> - Texture coordinates (u, v) for layer 7 of vertex N - present if Attribute mask includes Has UV Layer 7.   |

### ***Mesh Primitive Record***

This record defines a geometric primitive (triangle strip, triangle fan, quadrilateral strip, or indexed polygon) for a mesh.

## Mesh Primitive Record

### New record for OpenFlight 15.7

| Data Type  | Offset            | Length     | Description  |
|--|-------------------|------------|--|
| Int  | 0                 | 2          | Mesh Primitive Opcode 86   |
| Unsigned Int   | 2                 | 2          | Length - length of the record  |
| Int  | 4                 | 2          | Primitive Type - specifies how the vertices of the primitive are interpreted<br>1 = Triangle Strip<br>2 = Triangle Fan<br>3 = Quadrilateral Strip<br>4 = Indexed Polygon |
| Unsigned Int   | 6                 | 2          | Index Size - specifies the length (in bytes) of each of the vertex indices that follow - will be either 1, 2, or 4   |
| Unsigned Int   | 8                 | 4          | Vertex Count - number of vertices in this primitive.   |
| The following field is repeated for each vertex referenced by the mesh primitive. These vertices are interpreted according to Primitive Type. In the field below, N ranges from 0 to Vertex Count - 1. |                   |            |  |
| Int  | 12+(N*Index Size) | Index Size | Index <sub>N</sub> - Index of vertex N of the mesh primitive.  |

Each mesh primitive is represented using the Mesh Primitive record above. The following descriptions explain how the vertices of each primitive type are interpreted as geometry:

- Triangle Strip** - This mesh primitive defines a connected group of triangles in the context of the enclosing mesh. Each triangle shares the “polygon” attributes defined by the enclosing mesh. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One triangle is defined for each vertex presented after the first two vertices. For odd  $n$ , vertices  $n$ ,  $n+1$ , and  $n+2$  define triangle  $n$ . For even  $n$ , vertices  $n+1$ ,  $n$ , and  $n+2$  define triangle  $n$ . The first triangle is  $n=1$ . The first vertex in the vertex pool is  $n=1$ .  $N$  vertices represent  $N-2$  triangles.
- Triangle Fan** - Like the Triangle Strip, this mesh primitive also defines a connected group of triangles in the context of the enclosing mesh. Each triangle shares the “polygon” attributes defined by the enclosing mesh. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One triangle is defined for each vertex presented after the first two vertices. Vertices 1,  $n+1$ , and  $n+2$  define triangle  $n$ . The first triangle is  $n=1$ . The first vertex in the vertex pool is  $n=1$ .  $N$  vertices represent  $N-2$  triangles.
- Quadrilateral Strip** - This mesh primitive defines a connected group of quadrilaterals in the context of the enclosing mesh. Each quadrilateral shares the “polygon” attributes defined by the enclosing mesh. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One quadrilateral is defined for each pair of vertices presented after the first pair. Vertices  $2n-1$ ,  $2n$ ,  $2n+2$ , and  $2n+1$  define quadrilateral  $n$ . The first quadrilateral is  $n=1$ . The first vertex in the vertex pool is  $n=1$ .  $N$  vertices represent  $(N/2)-1$  quadrilaterals.
- Indexed Polygon** - This mesh primitive defines a single polygon in the context of the enclosing mesh. This primitive is similar to the other mesh primitives in that it also shares the polygon attributes of the enclosing mesh. It is different from the other mesh primitive types in that while triangle strips/fans and quadrilateral strips describe a set of connected triangles/quadrilaterals, the indexed polygon

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defines a single polygon. This primitive contains a sequence of indices that reference vertices from the local vertex pool. One polygon is defined by the sequence of vertices in this record. N vertices represent 1 N-sided closed polygon or 1 (N-1)-sided unclosed polygon.

## **Multitexture**

OpenFlight supports 8 textures per polygon or mesh as well as 8 uv's per vertex. The current texture information stored on the polygon is referred to as “the base texture” or “texture layer 0”. Each additional texture is referred to as “texture layer N”. Therefore, to support 8 textures per polygon, a base texture is required as well as 7 additional texture layers. The additional texture layers for each polygon, mesh, and vertex will be represented in ancillary records at the Face, Mesh, and Vertex primary node levels as shown in this example:

```
FACE
MULTITEXTURE
PUSH
VERTEX LIST
UV LIST
POP
```

The records that are used to represent multitexture in the OpenFlight file are described in the following sections.

### ***Multitexture Record***

The multitexture record is an ancillary record of face and mesh nodes. It specifies the texture layer information for the face or mesh.

## Multitexture Record

### New record for OpenFlight 15.7

| Data Type   | Offset   | Length | Description  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
|---|--|--------|--|-------|-------------|---|--|---|--|---|--|---|--|---|--|---|--|---|--|------|-------|
| Unsigned Int  | 0  | 2      | Multitexture Opcode 52   |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| Unsigned Int  | 2  | 2      | Length - length of the record  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| Int   | 4  | 4      | <p>Attribute mask - Bit mask indicating what kind of multitexture information is present in this record. Bits are ordered from left to right as follows:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Bit #</th> <th style="text-align: left;">Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Has Layer 1 - if this bit is set, multitexture information for texture layer 1 is present.</td> </tr> <tr> <td>1</td> <td>Has Layer 2 - if this bit is set, multitexture information for texture layer 2 is present.</td> </tr> <tr> <td>2</td> <td>Has Layer 3 - if this bit is set, multitexture information for texture layer 3 is present.</td> </tr> <tr> <td>3</td> <td>Has Layer 4 - if this bit is set, multitexture information for texture layer 4 is present.</td> </tr> <tr> <td>4</td> <td>Has Layer 5 - if this bit is set, multitexture information for texture layer 5 is present.</td> </tr> <tr> <td>5</td> <td>Has Layer 6 - if this bit is set, multitexture information for texture layer 6 is present.</td> </tr> <tr> <td>6</td> <td>Has Layer 7 - if this bit is set, multitexture information for texture layer 7 is present.</td> </tr> <tr> <td>7-31</td> <td>Spare</td> </tr> </tbody> </table> | Bit # | Description | 0 | Has Layer 1 - if this bit is set, multitexture information for texture layer 1 is present. | 1 | Has Layer 2 - if this bit is set, multitexture information for texture layer 2 is present. | 2 | Has Layer 3 - if this bit is set, multitexture information for texture layer 3 is present. | 3 | Has Layer 4 - if this bit is set, multitexture information for texture layer 4 is present. | 4 | Has Layer 5 - if this bit is set, multitexture information for texture layer 5 is present. | 5 | Has Layer 6 - if this bit is set, multitexture information for texture layer 6 is present. | 6 | Has Layer 7 - if this bit is set, multitexture information for texture layer 7 is present. | 7-31 | Spare |
| Bit #   | Description  |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 0   | Has Layer 1 - if this bit is set, multitexture information for texture layer 1 is present. |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 1   | Has Layer 2 - if this bit is set, multitexture information for texture layer 2 is present. |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 2   | Has Layer 3 - if this bit is set, multitexture information for texture layer 3 is present. |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 3   | Has Layer 4 - if this bit is set, multitexture information for texture layer 4 is present. |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 4   | Has Layer 5 - if this bit is set, multitexture information for texture layer 5 is present. |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 5   | Has Layer 6 - if this bit is set, multitexture information for texture layer 6 is present. |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 6   | Has Layer 7 - if this bit is set, multitexture information for texture layer 7 is present. |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| 7-31  | Spare  |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| <p>The following fields are repeated for each multitexture layer that is specified as present by the bits set in the Attribute mask field above. This mechanism allows for “sparse” multitexture layer information to be present and does not require that the information present be contiguous.</p> |  |        |  |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| Unsigned Int  | Varies   | 2      | texture <sub>N</sub> - Texture index for texture layer N   |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| Unsigned Int  | Varies   | 2      | effect <sub>N</sub> - Multitexture effect for texture layer N<br>0 = Texture environment<br>1 = Bump map<br>2-100 = Reserved by MultiGen-Paradigm<br>>100 = user (runtime) defined   |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| Unsigned Int  | Varies   | 2      | mapping <sub>N</sub> - Texture mapping index for texture layer N   |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |
| Unsigned Int  | Varies   | 2      | data <sub>N</sub> - Texture data for layer N. This is user defined. For example, it may be used as a blend percentage or color or any other data needed by the runtime to describe texture layer N   |       |             |   |  |   |  |   |  |   |  |   |  |   |  |   |  |      |       |

## UV List Record

The uv list record is an ancillary record of vertex nodes. This record (if present) always follows the vertex list or morph vertex list record and contains texture layer information for the vertices represented in the vertex list record it follows.

### UV List Record New record for OpenFlight 15.7

| Data Type    | Offset  | Length | Description  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
|--------------|---|--------|--|-------|-------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|------|-------|
| Unsigned Int | 0   | 2      | UV List Opcode 53  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| Unsigned Int | 2   | 2      | Length - length of the record  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| Int          | 4   | 4      | Attribute mask - Bit mask indicating what kind of multi-texture information is present in this record. Bits are ordered from left to right as follows:<br><table border="1"><thead><tr><th>Bit #</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>Has Layer 1 - if set, uvs for layer 1 are present</td></tr><tr><td>1</td><td>Has Layer 2 - if set, uvs for layer 2 are present</td></tr><tr><td>2</td><td>Has Layer 3 - if set, uvs for layer 3 are present</td></tr><tr><td>3</td><td>Has Layer 4 - if set, uvs for layer 4 are present</td></tr><tr><td>4</td><td>Has Layer 5 - if set, uvs for layer 5 are present</td></tr><tr><td>5</td><td>Has Layer 6 - if set, uvs for layer 6 are present</td></tr><tr><td>6</td><td>Has Layer 7 - if set, uvs for layer 7 are present</td></tr><tr><td>7-31</td><td>Spare</td></tr></tbody></table> | Bit # | Description | 0 | Has Layer 1 - if set, uvs for layer 1 are present | 1 | Has Layer 2 - if set, uvs for layer 2 are present | 2 | Has Layer 3 - if set, uvs for layer 3 are present | 3 | Has Layer 4 - if set, uvs for layer 4 are present | 4 | Has Layer 5 - if set, uvs for layer 5 are present | 5 | Has Layer 6 - if set, uvs for layer 6 are present | 6 | Has Layer 7 - if set, uvs for layer 7 are present | 7-31 | Spare |
| Bit #        | Description                                       |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 0            | Has Layer 1 - if set, uvs for layer 1 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 1            | Has Layer 2 - if set, uvs for layer 2 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 2            | Has Layer 3 - if set, uvs for layer 3 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 3            | Has Layer 4 - if set, uvs for layer 4 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 4            | Has Layer 5 - if set, uvs for layer 5 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 5            | Has Layer 6 - if set, uvs for layer 6 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 6            | Has Layer 7 - if set, uvs for layer 7 are present |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |
| 7-31         | Spare   |        |  |       |             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |      |       |

The following fields are repeated for each vertex contained in the corresponding vertex list or morph vertex list record.

If this uv list record follows a vertex list record, the following fields are repeated for each layer present (as specified by the bits set in the Attribute mask field).

| Data Type | Length | Description                                      |
|-----------|--------|--|
| Float     | 4      | $u_{i,N}$ - Texture U for vertex $i$ , layer $N$ |
| Float     | 4      | $v_{i,N}$ - Texture V for vertex $i$ , layer $N$ |

If this uv list record follows a morph vertex list record, the following fields are repeated for each layer present (as specified by the bits set in the Attribute mask field).

| Data Type | Length | Description  |
|-----------|--------|--|
| Float     | 4      | $u0_{i,N}$ - Texture U for the 0% vertex $i$ , layer $N$     |
| Float     | 4      | $v0_{i,N}$ - Texture V for the 0% vertex $i$ , layer $N$     |
| Float     | 4      | $u100_{i,N}$ - Texture U for the 100% vertex $i$ , layer $N$ |
| Float     | 4      | $v100_{i,N}$ - Texture V for the 100% vertex $i$ , layer $N$ |

## Texture Attribute File

### Subtexture

Subtexture definitions have been added to the end of the Texture Attribute File (see “[Texture Attribute Files](#)” on page 102). After all the geospecific control points are listed, the following subtexture information now appears:

### Texture Attribute File Format changes for OpenFlight 15.7 New Fields

| Data Type | Length | Description           |
|-----------|--------|-----------------------|
| Int       | 4      | Number of subtextures |

If the value of the Number of subtextures field is greater than 0, the following fields are repeated for each subtexture in the texture attribute file.

In the fields below, N ranges from 0 to Number of subtextures - 1.

The Left, Bottom, Right and Top fields are all measured in texels.

| Data Type | Length | Description   |
|-----------|--------|---|
| Char      | 32     | Name <sub>N</sub> - name of subtexture N; 0 terminates          |
| Int       | 4      | Left <sub>N</sub> - Coordinate of left edge of subtexture N     |
| Int       | 4      | Bottom <sub>N</sub> - Coordinate of bottom edge of subtexture N |
| Int       | 4      | Right <sub>N</sub> - Coordinate of right edge of subtexture N   |
| Int       | 4      | Top <sub>N</sub> - Coordinate of top edge of subtexture N       |



# B *Summary of Changes Version 15.8*

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 15.7 and 15.8 as well as the errors contained in previous versions of this document that have been corrected in this version.

OpenFlight version 15.8 coincides with MultiGen Creator version 2.6 and the OpenFlight API version 2.6. The changes made for this version are:

- [“Header Record” on page 137](#)
- [“Group Record” on page 138](#)
- [“Level of Detail Record” on page 139](#)
- [“External Reference Record” on page 140](#)
- [“Indexed String Record” on page 140](#) (for Switch nodes)
- [“Face Record” on page 141](#)
- [“Mesh Record” on page 141](#)
- [“Local Vertex Pool Record” on page 142](#)
- [“Vertex Palette Records” on page 143](#)
- [“Light Point Appearance Palette Record” on page 146](#)
- [“Light Point Animation Record” on page 149](#)
- [“Indexed Light Point Record” on page 150](#)
- [“Light Point System Record” on page 150](#)
- [“Texture Mapping Palette Record” on page 151](#)

Also new in this version of the document is the addition of the “offset” column in the record format tables.

## Document Corrections

The errors corrected in this version of the document are described in the sections that follow.

---

## Text Record

The Reserved field, previously omitted in prior versions of this document, has been documented in the specification for OpenFlight 15.8. The offsets of fields following this field have been adjusted accordingly.

### Text Record error corrected in OpenFlight 15.8 specification Reserved field (documented)

| Data Type | Offset | Length | Description |
|-----------|--------|--------|-------------|
| Int       | 16     | 4      | Reserved    |

The Draw bold field, previously omitted in prior versions of this document, has been documented in the specification for OpenFlight 15.8. The offsets of fields following this field have been adjusted accordingly.

### Text Record error corrected in OpenFlight 15.8 specification Draw bold field (documented)

| Data Type | Offset | Length | Description |
|-----------|--------|--------|-------------|
| Int       | 304    | 4      | Draw bold   |

For a complete description of the text record, see [“Text Record” on page 50](#).

## CAT Record

The Relative priority field, included erroneously in the previous version of this document, has been removed from the specification for OpenFlight 15.8. The offsets of fields following this field have been adjusted accordingly.

### CAT Record error corrected in OpenFlight 15.8 specification Relative priority field (removed)

| Data Type | Offset | Length | Description       |
|-----------|--------|--------|-------------------|
| Int       | 20     | 2      | Relative priority |

The Feature ID field, included erroneously in the previous version of this document, has been removed from the specification for OpenFlight 15.8. The offsets of fields following this field have been adjusted accordingly.

### CAT Record error corrected in OpenFlight 15.8 specification Feature ID field (removed)

| Data Type | Offset | Length | Description       |
|-----------|--------|--------|-------------------|
| Int       | 38     | 2      | Relative priority |

The Reserved field, previously omitted in prior versions of this document, has been documented in the specification for OpenFlight 15.8. The offsets of fields following this field have been adjusted accordingly.

### CAT Record error corrected in OpenFlight 15.8 specification Reserved field (documented)

| Data Type | Offset | Length | Description |
|-----------|--------|--------|-------------|
| Int       | 60     | 4      | Reserved    |

For a complete description of the CAT record, see [“CAT Record” on page 53](#).

## Format Changes

### Header Record

The header record has been modified to include additional projection attributes. New attributes have been appended to the end of the existing header record and some of the existing fields have new values possible.

The following fields were added to the end (at the specified offsets) of the header record.

### Header Record changes for OpenFlight 15.8 New Fields

| Data Type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Unsigned Int | 302    | 2      | Next Light Point System ID number                       |
| Int          | 304    | 4      | Reserved  |
| Double       | 308    | 8      | Earth major axis (for user defined ellipsoid) in meters |
| Double       | 316    | 8      | Earth minor axis (for user defined ellipsoid) in meters |

The Projection type field has been changed to include two new possible values, Geocentric and Geodetic as shown here. New values are shown in **bold font**:

### Header Record changes for OpenFlight 15.8 Projection type field

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 92     | 4      | Projection type<br>0 = Flat earth<br>1 = Trapezoidal<br>2 = Round earth<br>3 = Lambert<br>4 = UTM<br><b>5 = Geocentric</b><br><b>6 = Geodetic</b> |

The Earth ellipsoid model field has been changed to include one new possible value, User defined ellipsoid as shown here. This new value is shown in **bold font**.

### Header Record changes for OpenFlight 15.8 Earth ellipsoid field

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 268    | 4      | Earth ellipsoid model<br>0 = WGS 1984<br>1 = WGS 1972<br>2 = Bessel<br>3 = Clarke 1866<br>4 = NAD 1927<br><b>5 = User defined ellipsoid</b> |

A field, previously labeled “Reserved” in prior versions of this document, has been described. It is the UTM zone for UTM projections and is shown here.

### Header Record changes for OpenFlight 15.8 UTM zone field

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 276    | 2      | UTM zone (for UTM projections - negative value means Southern hemisphere) |

For a complete description of the header record, see [“Header Record” on page 21](#).

## Group Record

The group record has been modified to include additional animation attributes. New attributes have been appended to the end of the existing group record and some of the existing fields have new values possible.

The following fields were added to the end (at the specified offsets) of the group record.

### Group Record changes for OpenFlight 15.8 New Fields

| Data Type | Offset | Length | Description                    |
|-----------|--------|--------|--------------------------------|
| Int       | 32     | 4      | Loop count                     |
| Float     | 36     | 4      | Loop duration in seconds       |
| Float     | 40     | 4      | Last frame duration in seconds |

The Flags field has been changed to include a new bit which can be used to specify backwards animations as shown here. The new bit is shown in **bold font**.

### Group Record changes for OpenFlight 15.8 Flags field

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 16     | 4      | Flags (bits, from left to right)<br>0 = Reserved<br>1 = Forward animation<br>2 = Swing animation<br>3 = Bounding box follows<br>4 = Freeze bounding box<br>5 = Default parent<br><b>6 = Backward animation</b><br>7-31 = Spare |

For a complete description of the group record, see [“Group Record” on page 24](#).

### Level of Detail Record

The level of detail record has been modified to include an additional attribute, Significant size. This new value helps an application to calculate switch ranges for the geometry more effectively for different display settings (field of view, screen size and resolution).

The following field was added to the end (at the specified offset) of the level of detail record.

### LOD Record changes for OpenFlight 15.8 New Field

| Data Type | Offset | Length | Description      |
|-----------|--------|--------|------------------|
| Double    | 72     | 8      | Significant size |

For a complete description of the level of detail record, see [“Level of Detail Record” on page 44](#).

---

## External Reference Record

The Flags field of the external reference record has been modified to include a new bit, Light point palette override, which is used to specify that the light point appearance and animation palettes override those contained in the master file. The new bit is shown in **bold font**.

### External Reference Record changes for OpenFlight 15.8 Flags field

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 208    | 4      | Flags (bits, from left to right)<br>0 = Color palette override<br>1 = Material palette override<br>2 = Texture and texture mapping palette override<br>3 = Line style palette override<br>4 = Sound palette override<br>5 = Light source palette override<br><b>6 = Light point palette override</b><br>7-31 = Spare |

For a complete description of the external reference record, see [“External Reference Record” on page 44](#).

## Indexed String Record

Switch nodes now allow individual masks to be named. These names are stored in a new ancillary record called the Indexed String record. While these new ancillary records are currently only applicable to Switch records, they are not limited to Switch records and may be useful in future versions of OpenFlight in other contexts.

The new Indexed String Record is an ancillary record that contains an integer index followed by a variable length character string. In this way, arbitrary strings can be associated to indices in a general way.

With respect to Switch mask names, the index specifies the mask number for which the string specifies a name. Mask numbers start at 0. Not all masks are required to have names.

### Indexed String Record New record for OpenFlight 15.8

| Data type    | Offset | Length     | Description                   |
|--------------|--------|------------|-------------------------------|
| Int          | 0      | 2          | Indexed string Opcode 132     |
| Unsigned Int | 2      | 2          | Length - length of the record |
| Unsigned Int | 4      | 2          | Index                         |
| Char         | 8      | Length - 8 | ASCII string; 0 terminates    |

For a complete description of the indexed string record, see [“Indexed String Record” on page 57](#).

## Face Record

The Flags field of the face record has been modified to include a new bit, Roofline, which is used to specify that a face is part of a building's roof as viewed from above. The new specification of the Flags field is shown here. The new bit is shown in **bold font**.

### Face Record changes for OpenFlight 15.8 Flags field

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 44     | 4      | Flags (bits from left to right)<br>0 = Terrain<br>1 = No color<br>2 = No alternate color<br>3 = Packed color<br>4 = Terrain culture cutout (footprint)<br>5 = Hidden, not drawn<br><b>6 = Roofline</b><br>7-31 = Spare |

For a complete description of the face record, see [“Face Record” on page 28](#).

## Mesh Record

Similar to the Face record described above, the Flags field of the mesh record has been modified to include a new bit, Roofline, which is used to specify that a mesh is part of a building's roof as viewed from above. The new specification of the Flags field is shown here. The new bit is shown in **bold font**.

### Mesh Record changes for OpenFlight 15.8 Flags field

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 44     | 4      | Flags (bits from left to right)<br>0 = Terrain<br>1 = No color<br>2 = No alternate color<br>3 = Packed color<br>4 = Terrain culture cutout (footprint)<br>5 = Hidden, not drawn<br><b>6 = Roofline</b><br>7-31 = Spare |

For a complete description of the mesh record, see [“Mesh Record” on page 31](#).

## Local Vertex Pool Record

The Local Vertex Pool record has been modified to include an alpha color component for those vertices in the pool that have color. The alpha color component is represented as a 1 byte integer value whose range is 0 (fully transparent) to 255 (fully opaque).

The definition of the Attribute mask field has been changed as shown here.

**Note:** The physical layout of this field has not changed, only its definition. The bits for which new definitions apply are shown in **bold font**:

### Local Vertex Pool Record changes for OpenFlight 15.8 Attribute mask field

| Data Type    | Offset  | Length | Description   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
|--------------|---|--------|---|--------------|--------------------|---|---|----------|---|----------|---|---|--|---|--|---|--|---|--|---|--|---|--|---|--|----|--|----|--|-------|-------|
| Unsigned Int | 8   | 4      | <p>Attribute mask - Bit mask indicating what kind of vertex information is specified for each vertex in the local vertex pool. Bits are ordered from left to right as follows:</p> <table><thead><tr><th><u>Bit #</u></th><th><u>Description</u></th></tr></thead><tbody><tr><td>0</td><td>Has Position - if set, data for each vertex in will include x, y, and z coordinates (3 doubles)</td></tr><tr><td><b>1</b></td><td><b>Has Color Index - if set, data for each vertex will include a color value that specifies a color table index as well as an alpha value</b></td></tr><tr><td><b>2</b></td><td><b>Has RGBA Color - if set, data for each vertex will include a color value that is a packed RGBA color value</b></td></tr></tbody></table> <p>Note: Bits 1 and 2 are mutually exclusive - a vertex can have either color index or RGB color value or neither, but not both.</p> <table><tbody><tr><td>3</td><td>Has Normal - if set, data for each vertex will include a normal (3 floats)</td></tr><tr><td>4</td><td>Has Base UV - if set, data for each vertex will include uv texture coordinates for the base texture (2 floats)</td></tr><tr><td>5</td><td>Has UV Layer 1 - if set, data for each vertex will include uv texture coordinates for layer 1 (2 floats)</td></tr><tr><td>6</td><td>Has UV Layer 2 - if set, data for each vertex will include uv texture coordinates for layer 2 (2 floats)</td></tr><tr><td>7</td><td>Has UV Layer 3 - if set, data for each vertex will include uv texture coordinates for layer 3 (2 floats)</td></tr><tr><td>8</td><td>Has UV Layer 4 - if set, data for each vertex will include uv texture coordinates for layer 4 (2 floats)</td></tr><tr><td>9</td><td>Has UV Layer 5 - if set, data for each vertex will include uv texture coordinates for layer 5 (2 floats)</td></tr><tr><td>10</td><td>Has UV Layer 6 - if set, data for each vertex will include uv texture coordinates for layer 6 (2 floats)</td></tr><tr><td>11</td><td>Has UV Layer 7 - if set, data for each vertex will include uv texture coordinates for layer 7 (2 floats)</td></tr><tr><td>12-31</td><td>Spare</td></tr></tbody></table> | <u>Bit #</u> | <u>Description</u> | 0 | Has Position - if set, data for each vertex in will include x, y, and z coordinates (3 doubles) | <b>1</b> | <b>Has Color Index - if set, data for each vertex will include a color value that specifies a color table index as well as an alpha value</b> | <b>2</b> | <b>Has RGBA Color - if set, data for each vertex will include a color value that is a packed RGBA color value</b> | 3 | Has Normal - if set, data for each vertex will include a normal (3 floats) | 4 | Has Base UV - if set, data for each vertex will include uv texture coordinates for the base texture (2 floats) | 5 | Has UV Layer 1 - if set, data for each vertex will include uv texture coordinates for layer 1 (2 floats) | 6 | Has UV Layer 2 - if set, data for each vertex will include uv texture coordinates for layer 2 (2 floats) | 7 | Has UV Layer 3 - if set, data for each vertex will include uv texture coordinates for layer 3 (2 floats) | 8 | Has UV Layer 4 - if set, data for each vertex will include uv texture coordinates for layer 4 (2 floats) | 9 | Has UV Layer 5 - if set, data for each vertex will include uv texture coordinates for layer 5 (2 floats) | 10 | Has UV Layer 6 - if set, data for each vertex will include uv texture coordinates for layer 6 (2 floats) | 11 | Has UV Layer 7 - if set, data for each vertex will include uv texture coordinates for layer 7 (2 floats) | 12-31 | Spare |
| <u>Bit #</u> | <u>Description</u>  |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 0            | Has Position - if set, data for each vertex in will include x, y, and z coordinates (3 doubles)   |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| <b>1</b>     | <b>Has Color Index - if set, data for each vertex will include a color value that specifies a color table index as well as an alpha value</b> |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| <b>2</b>     | <b>Has RGBA Color - if set, data for each vertex will include a color value that is a packed RGBA color value</b>                             |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 3            | Has Normal - if set, data for each vertex will include a normal (3 floats)  |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 4            | Has Base UV - if set, data for each vertex will include uv texture coordinates for the base texture (2 floats)                                |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 5            | Has UV Layer 1 - if set, data for each vertex will include uv texture coordinates for layer 1 (2 floats)                                      |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 6            | Has UV Layer 2 - if set, data for each vertex will include uv texture coordinates for layer 2 (2 floats)                                      |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 7            | Has UV Layer 3 - if set, data for each vertex will include uv texture coordinates for layer 3 (2 floats)                                      |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 8            | Has UV Layer 4 - if set, data for each vertex will include uv texture coordinates for layer 4 (2 floats)                                      |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 9            | Has UV Layer 5 - if set, data for each vertex will include uv texture coordinates for layer 5 (2 floats)                                      |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 10           | Has UV Layer 6 - if set, data for each vertex will include uv texture coordinates for layer 6 (2 floats)                                      |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 11           | Has UV Layer 7 - if set, data for each vertex will include uv texture coordinates for layer 7 (2 floats)                                      |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |
| 12-31        | Spare   |        |   |              |                    |   |   |          |   |          |   |   |  |   |  |   |  |   |  |   |  |   |  |   |  |    |  |    |  |       |       |

The color field of the vertex pool data (data for each vertex) has been modified to include an alpha color component as shown here. The affected field is shown in **bold font**.

### Local Vertex Pool Record changes for OpenFlight 15.8 Color field

| Data Type    | Length | Description   |
|--------------|--------|---|
| Unsigned Int | 4      | <b>color<sub>N</sub> - Color for vertex N - present if Attribute mask includes Has Color Index or Has RGBA Color.</b><br><b>If Has Color Index, lower 3 bytes specify color table index, upper 1 byte is Alpha.</b><br><b>If Has RGBA Color, 4 bytes specify (a, b, g, r) values.</b> |

For a complete description of the local vertex pool record, see [“Local Vertex Pool Record”](#) on [page 33](#).

### Vertex Palette Records

Vertex Palette Records have been modified to include an alpha color component. The alpha color component is represented as a 1 byte integer value whose range is 0 (fully transparent) to 255 (opaque).

Prior to OpenFlight version 15.8, vertex colors were represented in vertex palette records in one of two ways: Packed Color or Color Index. Depending on the value of the Packed color flag, either the Packed color (a, b, g, r) attribute or the Vertex color index attribute was valid, but not both. For example, if the Packed color flag was TRUE, then the Packed color attribute contained the RGB components of the vertex color and the Vertex color index attribute was not specified. Conversely, if the Packed color flag was FALSE, then the Vertex color index attribute contained the index (in the Color Palette) of the vertex color and the Packed color attribute was not specified. Furthermore, the A (alpha) component of the Packed color attribute was not valid and was ignored.

In OpenFlight version 15.8, the A (alpha) component of the Packed color attribute is valid and all vertex records include the Packed color (a, b, g, r) attribute, even those that also include the Vertex color index attribute. For those vertices that include the Vertex color index attribute, the RGB components of the Packed color attribute will match those of the color specified by the Vertex color index attribute if it was looked up in the color palette. This implies that an application concerned only with the RGB components of a vertex color can simply reference the Packed color attribute and ignore the Vertex color index attribute in all cases.

All the updated vertex palette records are shown here. The Packed color is shown in **bold font** to emphasize that it is always specified (for both color index and packed color specifications).

## Vertex with Color Record changes for OpenFlight 15.8

### Packed color field

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color Opcode 68  |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Int          | 32     | 4      | <b>Packed color (a, b, g, r) - always specified when the vertex has color</b>  |
| Unsigned Int | 36     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |

## Vertex with Color and Normal Record changes for OpenFlight 15.8

### Packed color field

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color and Normal Opcode 69   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Float        | 32     | 4*3    | Vertex normal (i, j, k)  |
| Int          | 44     | 4      | <b>Packed color (a, b, g, r) - always specified when the vertex has color</b>  |
| Unsigned Int | 48     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |
| Int          | 52     | 4      | Reserved   |

## Vertex with Color and UV Record changes for OpenFlight 15.8

### Packed color field

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color and UV Opcode 71   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Float        | 32     | 4*2    | Texture coordinate (u, v)  |
| Int          | 40     | 4      | <b>Packed color (a, b, g, r) - always specified when the vertex has color</b>  |
| Unsigned Int | 44     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |

## Vertex with Color, Normal and UV Record changes for OpenFlight 15.8

### Packed color field

| Data type    | Offset | Length | Description  |
|--------------|--------|--------|--|
| Int          | 0      | 2      | Vertex with Color, Normal and UV Opcode 70   |
| Unsigned Int | 2      | 2      | Length - length of the record  |
| Unsigned Int | 4      | 2      | Color name index   |
| Int          | 6      | 2      | Flags (bits, from left to right)<br>0 = Start hard edge<br>1 = Normal frozen<br>2 = No color<br>3 = Packed color<br>4-15 = Spare |
| Double       | 8      | 8*3    | Vertex coordinate (x, y, z)  |
| Float        | 36     | 4*3    | Vertex normal (i, j, k)  |
| Float        | 44     | 4*2    | Texture coordinate (u, v)  |
| Int          | 52     | 4      | <b>Packed color (a, b, g, r) - always specified when the vertex has color</b>  |
| Unsigned Int | 56     | 4      | Vertex color index - valid only if vertex has color and Packed color flag is not set   |
| Int          | 60     | 4      | Reserved   |

For a complete description of the vertex palette records, see [“Vertex Palette Records” on page 71](#).

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## Light Points

The representation of Light Points in OpenFlight version 15.8 is significantly different from prior versions. Previously, all light point attributes were described completely within the primary record of the light point node.

In OpenFlight version 15.8, light point attributes have been divided into two categories, appearance and behavioral. To accommodate this, two new palettes have been created, the Light Point Appearance Palette and the Light Point Animation palette. A new Indexed Light Point node record has been added that references entries from the Light Point Appearance and Animation palettes. In effect, this moves the light point attributes out of the node record itself into entries of the two palettes and makes it much easier to share common attributes between multiple light points.

Note that the Light Point Record (Opcode 111) used in previous versions of OpenFlight remains valid for applications that require the data in this other format. Creator and the OpenFlight API versions 2.6 support both light point formats.

Following is a description of the new records in OpenFlight version 15.8 used to describe Light Point Palettes and Indexed Light Points.

### ***Light Point Appearance Palette Record***

The light point appearance palette record defines the visual attributes of light points.

#### **Light Point Appearance Palette Record New record for OpenFlight 15.8**

| <b>Data Type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>  |
|------------------|---------------|---------------|---|
| Int              | 0             | 2             | Light Point Appearance Palette Opcode 128   |
| Unsigned Int     | 2             | 2             | Length - length of the record   |
| Int              | 4             | 4             | Reserved  |
| Char             | 8             | 256           | Appearance name; 0 terminates   |
| Int              | 264           | 4             | Appearance index  |
| Int              | 268           | 2             | Surface material code   |
| Int              | 270           | 2             | Feature ID  |
| Unsigned Int     | 272           | 4             | Back color for bidirectional points   |
| Int              | 276           | 4             | Display mode<br>0 = RASTER<br>1 = CALLIGRAPHIC<br>2 = EITHER                          |
| Float            | 280           | 4             | Intensity - scalar for front colors   |
| Float            | 284           | 4             | Back intensity - scalar for back color  |
| Float            | 288           | 4             | Minimum defocus - (0.0 - 1.0) for calligraphic points                                 |
| Float            | 292           | 4             | Maximum defocus - (0.0 - 1.0) for calligraphic points                                 |
| Int              | 296           | 4             | Fading mode<br>0 = Enable perspective fading calculations<br>1 = Disable calculations |

## Light Point Appearance Palette Record

### New record for OpenFlight 15.8 (Continued)

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 300    | 4      | Fog Punch mode<br>0 = Enable fog punch through calculations<br>1 = Disable calculations    |
| Int       | 304    | 4      | Directional mode<br>0 = Enable directional calculations<br>1 = Disable calculations        |
| Int       | 308    | 4      | Range mode<br>0 = Use depth (Z) buffer calculation<br>1 = Use slant range calculation      |
| Float     | 312    | 4      | Min pixel size - minimum diameter of points in pixels                                      |
| Float     | 316    | 4      | Max pixel size - maximum diameter of points in pixels                                      |
| Float     | 320    | 4      | Actual size - actual diameter of points in database units                                  |
| Float     | 324    | 4      | Transparent falloff pixel size - diameter in pixels when points become transparent         |
| Float     | 328    | 4      | Transparent falloff exponent<br>>= 0 - falloff multiplier exponent<br>1.0 - linear falloff |
| Float     | 332    | 4      | Transparent falloff scalar<br>> 0 - falloff multiplier scale factor                        |
| Float     | 336    | 4      | Transparent falloff clamp - minimum permissible falloff multiplier result                  |
| Float     | 340    | 4      | Fog scalar<br>>= 0 - adjusts range of points for punch threw effect.                       |
| Float     | 344    | 4      | Fog intensity  |
| Float     | 348    | 4      | Size difference threshold - point size transition hint to renderer                         |
| Int       | 352    | 4      | Directionality<br>0 = OMNIDIRECTIONAL<br>1 = UNIDIRECTIONAL<br>2 = BIDIRECTIONAL           |
| Float     | 356    | 4      | Horizontal lobe angle - total angle in degrees   |
| Float     | 360    | 4      | Vertical lobe angle - total angle in degrees   |
| Float     | 364    | 4      | Lobe roll angle - rotation of lobe about local Y axis in degrees                           |
| Float     | 368    | 4      | Directional falloff exponent<br>>= 0 - falloff multiplier exponent<br>1.0 - linear falloff |
| Float     | 372    | 4      | Directional ambient intensity - of points viewed off axis                                  |
| Float     | 376    | 4      | Significance - drop out priority for RASCAL lights (0.0 - 1.0)                             |

## Light Point Appearance Palette Record

### New record for OpenFlight 15.8 (Continued)

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 380    | 4      | Flags (bits, from left to right)<br>0 = reserved<br>1 = No back color<br>TRUE = don't use back color for bidirectional points<br>FALSE = use back color for bidirectional points<br>2 = reserved<br>3 = Calligraphic proximity occulting (Debunching)<br>4 = Reflective, non-emissive point<br>5-7 = Randomize intensity<br>0 = never<br>1 = low<br>2 = medium<br>3 = high<br>8 = Perspective mode<br>9 = Flashing<br>10 = Rotating<br>11 = Rotate Counter Clockwise<br>Direction of rotation about local Z axis<br>12 = reserved<br>13-14 = Quality<br>0 = Low<br>1 = Medium<br>2 = High<br>3 = Undefined<br>15 = Visible during day<br>16 = Visible during dusk<br>17 = Visible during night<br>18-31 = Spare |
| Float     | 384    | 4      | Visibility range (> 0.0)  |
| Float     | 388    | 4      | Fade range ratio - percentage of total range at which light points start to fade (0.0 - 1.0)  |
| Float     | 392    | 4      | Fade in duration - time it takes (seconds) light point to fade in when turned on  |
| Float     | 396    | 4      | Fade out duration - time it takes (seconds) light point to fade out when turned off   |
| Float     | 400    | 4      | LOD range ratio - percentage of total range at which light points LODs are active (0.0 - 1.0)   |
| Float     | 404    | 4      | LOD scale - size of light point LOD polygon relative to light point diameter  |

For a complete description of the light point appearance palette record, see [“Light Point Appearance Palette Record”](#) on page 90.

## Light Point Animation Record

The light point animation palette record defines the behavioral attributes of light points.

### Light Point Animation Palette Record New record for OpenFlight 15.8

| Data Type  | Offset      | Length | Description  |
|--|-------------|--------|--|
| Int  | 0           | 2      | Light Point Animation Opcode 129   |
| Unsigned Int   | 2           | 2      | Length - length of the record  |
| Int  | 4           | 4      | Reserved   |
| char   | 8           | 256    | Animation name; 0 terminates   |
| Int  | 264         | 4      | Animation index  |
| Float  | 268         | 4      | Animation period in seconds. Note: Rate = 1/Period   |
| Float  | 272         | 4      | Animation phase delay in seconds - from start of period  |
| Float  | 276         | 4      | Animation enabled period (time on) in seconds  |
| Float  | 280         | 4      | Axis of rotation for rotating animation, I   |
| Float  | 284         | 4      | Axis of rotation for rotating animation, J   |
| Float  | 288         | 4      | Axis of rotation for rotating animation, K   |
| Int  | 292         | 4      | Flags (bits, from left to right)<br>0 = Flashing<br>1 = Rotating<br>2 = Rotate counter clockwise<br>3-31 = Spare |
| Int  | 296         | 4      | Animation type<br>0 = Flashing sequence<br>1 = Rotating<br>2 = Strobe<br>3 = Morse code                          |
| Int  | 300         | 4      | Morse code timing<br>0 = Standard timing<br>1 = Farnsworth timing  |
| Int  | 304         | 4      | Word rate (for Farnsworth timing)  |
| Int  | 308         | 4      | Character rate (for Farnsworth timing)   |
| char   | 312         | 1024   | Morse code string  |
| Int  | 1336        | 4      | Number of sequences (for Flashing sequence)  |
| The following fields are repeated for each sequence represented in the light point animation palette entry.<br>In the fields listed below, N ranges from 0 to Number of sequences - 1. |             |        |  |
| Unsigned Int   | 1340+(N*12) | 4      | Sequence State <sub>N</sub> - state of sequence N<br>0 = On<br>1 = Off<br>2 = Color change                       |
| Float  | 1344+(N*12) | 4      | Sequence Duration <sub>N</sub> <sub>i</sub> - duration of sequence N in seconds                                  |
| Unsigned Int   | 1348+(N*12) | 4      | Sequence Color <sub>N</sub> - color for sequence N.<br>Defined if Sequence state is On or Color change           |

For a complete description of the light point animation palette record, see “[Light Point Animation Palette Record](#)” on page 93.

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### ***Indexed Light Point Record***

The indexed light point record is one of the records that can represent a light point node.

The appearance index specifies an entry in the light point appearance palette that contains the visual attributes of the light point.

The animation index specifies an entry in the light point animation palette that contains the behavioral attributes of the light point.

The palette entries referenced by the indexed light point record describe the visual state of the light point's child vertices. Only vertex nodes may be children of light point nodes.

### **Indexed Light Point Record New record for OpenFlight 15.8**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>                    |
|------------------|---------------|---------------|---------------------------------------|
| Int              | 0             | 2             | Indexed Light Point Record Opcode 130 |
| Unsigned Int     | 2             | 2             | Length - length of the record         |
| Char             | 4             | 8             | 7 char ASCII ID; 0 terminates         |
| Int              | 12            | 4             | Appearance index                      |
| Int              | 16            | 4             | Animation index                       |
| Int              | 20            | 4             | Draw order (for calligraphic lights)  |
| Int              | 24            | 4             | Reserved                              |

For a complete description of the indexed light point records, see [“Indexed Light Point Record” on page 36](#).

### ***Light Point System Record***

The light point system record enables you to collect a set of light points and enable/disable or brighten/dim them as a group.

### **Light Point System Record New record for OpenFlight 15.8**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>  |
|------------------|---------------|---------------|---|
| Int              | 0             | 2             | Light Point System Record Opcode 130                            |
| Unsigned Int     | 2             | 2             | Length - length of the record                                   |
| Char             | 4             | 8             | 7 char ASCII ID; 0 terminates                                   |
| Float            | 12            | 4             | Intensity   |
| Int              | 16            | 4             | Animation state<br>0 = On<br>1 = Off<br>2 = Random              |
| Int              | 20            | 4             | Flags (bits, from left to right)<br>0 = Enabled<br>1-31 = Spare |

For a complete description of the light point system record, see [“Light Point System Record”](#) on page 39.

## Texture Mapping Palette Record

### **Parameters for 3 Point Put Texture Mapping (Type 1)**

The UV display type field, previously labeled Reserved in prior versions of this document, has been re-labeled in the specification for OpenFlight 15.8. The physical layout of the record was not changed.

#### **Parameters for 3 Point Put Texture Mapping (Type 2) changes for OpenFlight 15.8 UV display type field (re-labeled)**

| Data Type | Offset | Length | Description                         |
|-----------|--------|--------|-------------------------------------|
| Int       | 388    | 4      | UV display type<br>1 = XY<br>2 = UV |

### **Parameters for 4 Point Put Texture Mapping (Type 2)**

The following fields were added to the end (at the specified offsets) of the parameter subrecord.

#### **Parameters for 4 Point Put Texture Mapping (Type 2) changes for OpenFlight15.8 New Fields**

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--------------|
| Float     | 576    | 4      | U Repetition |
| Float     | 580    | 4      | V Repetition |

The UV display type field, previously labeled Reserved in prior versions of this document, has been re-labeled in the specification for OpenFlight 15.8. The physical layout of the record was not changed.

#### **Parameters for 4 Point Put Texture Mapping (Type 2) changes for OpenFlight 15.8 UV display type field (re-labeled)**

| Data Type | Offset | Length | Description                         |
|-----------|--------|--------|-------------------------------------|
| Int       | 436    | 4      | UV display type<br>1 = XY<br>2 = UV |



# C Summary of Changes Version 16.0

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 15.8 and 16.0 as well as the errors contained in previous versions of this document that have been corrected in this version.

OpenFlight version 16.0 coincides with MultiGen Creator version 3.0 and the OpenFlight API version 3.0. The changes made for this version are:

- [“External Reference Record” on page 157](#)
- [“Face Record” on page 158](#)
- [“Mesh Record” on page 158](#)
- [“Light Point Appearance Palette Record” on page 158](#)
- [“Shader Palette Record” on page 159](#)
- [“Texture Attribute File” on page 159](#)
- [“Texture Mapping Palette Record” on page 160](#)

## Document Corrections

The errors corrected in this version of the document are described in the sections that follow.

### Header Record

The value corresponding to User defined ellipsoid for the Earth ellipsoid model field has been corrected. It was previously listed as having a value of 5. The correct value is -1. The corrected value is shown in **bold font**.

#### Header Record error corrected in OpenFlight 16.0 specification Earth ellipsoid model field (corrected)

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 268    | 4      | Earth ellipsoid model<br>0 = WGS 1984<br>1 = WGS 1972<br>2 = Bessel<br>3 = Clarke 1866<br>4 = NAD 1927<br><b>-1 = User defined ellipsoid</b> |

---

For a complete description of the header record, see [“Header Record” on page 21](#).

## Face Record

The possible values listed for the Draw type field have been corrected. The affected values are shown in **bold font**.

### Face Record error corrected in OpenFlight 16.0 specification Draw type field (corrected)

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 18     | 1      | Draw type<br>0 = Draw solid with backface culling<br>1 = Draw solid, no backface culling<br><b>2 = Draw wireframe and close</b><br><b>3 = Draw wireframe</b><br>4 = Surround with wireframe in alternate color<br>8 = Omnidirectional light<br>9 = Unidirectional light<br>10 = Bidirectional light |

For a complete description of the face record, see [“Face Record” on page 28](#).

## Mesh Record

The Reserved field at offset 12, previously omitted in prior versions of this document, has been documented in the specification for OpenFlight 16.0. The offsets of fields following this field have been adjusted accordingly.

### Mesh Record error corrected in OpenFlight 16.0 specification Reserved field (documented)

| Data Type | Offset | Length | Description |
|-----------|--------|--------|-------------|
| Int       | 12     | 4      | Reserved    |

The possible values listed for the Draw type field have been corrected. The affected values are shown in **bold font**.

### Mesh Record error corrected in OpenFlight 16.0 specification Draw type field (corrected)

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 18     | 1      | Draw type<br>0 = Draw solid with backface culling<br>1 = Draw solid, no backface culling<br><b>2 = Draw wireframe and close</b><br><b>3 = Draw wireframe</b><br>4 = Surround with wireframe in alternate color<br>8 = Omnidirectional light<br>9 = Unidirectional light<br>10 = Bidirectional light |

For a complete description of the mesh record, see [“Mesh Record” on page 31](#).

### Switch Record

The order of the fields were corrected. The affected fields are shown here.

### Switch Record error corrected in OpenFlight 16.0 specification field order (corrected)

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 20     | 4      | Number of masks  |
| Int       | 24     | 4      | Number of words per mask - the number of 32 bit words required for each mask, calculated as follows:<br>$(\text{number of children} / 32) + X$<br>where X equals:<br>0 if (number of children modulo 32) is zero<br>1 if (number of children modulo 32) is nonzero |

For a complete description of the switch record, see [“Switch Record” on page 52](#).

### Texture Mapping Palette Record

The parameters for warped mapping in the texture mapping palette record were corrected. The 128 byte 4x4 Trackplane to XY plane transformation matrix was erroneously listed where an 8

byte reserved field was located. The entire record is shown here. The corrected field and offsets are shown in **bold font**:

**Parameters for Warped Mapping error corrected in OpenFlight 16.0  
specification  
Reserved field (corrected)**

| <b>Data Type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>  |
|------------------|---------------|---------------|---|
| Int              | X+0           | 4             | Active geometry point<br>0 = First warp FROM point<br>1 = Second warp FROM point<br>2 = Third warp FROM point<br>3 = Fourth warp FROM point<br>4 = Fifth warp FROM point<br>5 = Sixth warp FROM point<br>6 = Seventh warp FROM point<br>7 = Eighth warp FROM point<br>8 = First warp TO point<br>9 = Second warp TO point<br>10 = Third warp TO point<br>11 = Fourth warp TO point<br>12 = Fifth warp TO point<br>13 = Sixth warp TO point<br>14 = Seventh warp TO point<br>15 = Eighth warp TO point |
| Int              | X+4           | 4             | Warp tool state<br>0 = Start state - no points entered<br>1 = One FROM point entered<br>2 = Two FROM point entered<br>3 = Three FROM point entered<br>4 = Four FROM point entered<br>5 = Five FROM point entered<br>6 = Six FROM point entered<br>7 = Seven FROM point entered<br>8 = All FROM point entered  |
| Int              | X+8           | 8             | <b>Reserved</b>   |
| Double           | <b>X+16</b>   | 8*8*2         | FROM points transformed to XY plane by above matrix.<br>8 FROM points are ordered 1, 2, ... 8. Each point is (x, y)   |
| Double           | <b>X+144</b>  | 8*8*2         | TO points transformed to XY plane by above matrix.<br>8 TO points are ordered 1, 2, ... 8. Each point is (x, y)   |

For a complete description of the texture mapping palette record, see [“Texture Mapping Palette Record”](#) on page 94.

## Indexed String Record

The length of the Index field has been corrected. It was previously listed as 2 bytes. The correct length is 4 bytes. The corrected field and length are shown in **bold font**:

### Indexed String Record

| Data Type    | Offset | Length     | Description                   |
|--------------|--------|------------|-------------------------------|
| Int          | 0      | 2          | Indexed string Opcode 132     |
| Unsigned Int | 2      | 2          | Length - length of the record |
| Unsigned Int | 4      | <b>4</b>   | <b>Index</b>                  |
| Char         | 8      | Length - 8 | ASCII string; 0 terminates    |

## Bounding Convex Hull Record

The description of this previously undocumented record has been added to the specification. For a complete description of this record, see [“Bounding Convex Hull Record” on page 65](#).

## Bounding Histogram Record

The description of this previously undocumented record has been added to the specification. For a complete description of this record, see [“Bounding Histogram Record” on page 65](#).

# Format Changes

## External Reference Record

The Flags field of the external reference record has been modified to include a new bit, Shader palette override, which is used to specify that the shader palette override those contained in the master file. The new bit is shown in **bold font**:

### External Reference Record changes for OpenFlight 16.0 Flags field

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 208    | 4      | Flags (bits, from left to right)<br>0 = Color palette override<br>1 = Material palette override<br>2 = Texture and texture mapping palette override<br>3 = Line style palette override<br>4 = Sound palette override<br>5 = Light source palette override<br>6 = Light point palette override<br><b>7 = Shader palette override</b><br>8-31 = Spare |

---

For a complete description of the external reference record, see [“External Reference Record” on page 44.](#)

## Face Record

The face record has been modified to include a new attribute, Shader index, which is used to specify the shader (if any) that is applied to the face.

### Face Record changes for OpenFlight 16.0 Flags field

| Data Type | Offset | Length | Description              |
|-----------|--------|--------|--------------------------|
| Int       | 78     | 2      | Shader index, -1 if none |

For a complete description of the face record, see [“Face Record” on page 28.](#)

## Mesh Record

Similar to the Face record described above, the mesh record has been modified to include a new attribute, Shader index, which is used to specify the shader (if any) that is applied to the mesh.

### Mesh Record changes for OpenFlight 16.0 Flags field

| Data Type | Offset | Length | Description              |
|-----------|--------|--------|--------------------------|
| Int       | 78     | 2      | Shader index, -1 if none |

For a complete description of the mesh record, see [“Mesh Record” on page 31.](#)

## Light Point Appearance Palette Record

The light point appearance palette record has been modified to include a new attribute, Texture pattern index, which is used to specify the texture (if any) that is applied to the light point appearance. Note that the new Reserved field is necessary to insure proper length of record.

### Light Point Appearance Record changes for OpenFlight 16.0 Texture pattern index field

| Data Type | Offset | Length | Description                       |
|-----------|--------|--------|-----------------------------------|
| Int       | 408    | 2      | Texture pattern index, -1 if none |
| Int       | 410    | 2      | Reserved                          |

For a complete description of the light point appearance palette record, see [“Light Point Appearance Palette Record” on page 90.](#)

## Shader Palette Record

The shader palette contains descriptions of shaders used while drawing geometry. It is composed of an arbitrary number of shader palette records. The shader palette records must follow the header record and precede the first push.

### Shader Palette Record New record for OpenFlight 16.0

| Data Type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Shader Opcode 133   |
| Unsigned Int | 2      | 2      | Length - length of the record   |
| Int          | 4      | 4      | Shader index  |
| Int          | 8      | 4      | Shader type<br>0 = Cg<br>1 = CgFX<br>2 = OpenGL Shading Language      |
| char         | 12     | 1024   | Shader name; 0 terminates   |
| char         | 1036   | 1024   | Vertex program file name; 0 terminates<br>(Cg Shader type specific)   |
| char         | 2060   | 1024   | Fragment program file name; 0 terminates<br>(Cg Shader type specific) |
| Int          | 3084   | 4      | Vertex program profile (Cg Shader type specific)                      |
| Int          | 3088   | 4      | Fragment program profile (Cg Shader type specific)                    |
| char         | 3092   | 256    | Vertex program entry point (Cg Shader type specific)                  |
| char         | 3348   | 256    | Fragment program entry point (Cg Shader type specific)                |

## Texture Attribute File

The Wrap method fields (Wrap method u,v, Wrap method u and Wrap method v) have been changed to include a new possible value, Mirrored repeat as shown here. This new value is shown in **bold font**:

### Texture Attribute File Format changes for OpenFlight 16.0 Wrap method fields

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 36     | 4      | Wrap method u,v - only used when either Wrap method u or Wrap method v is set to None<br>0 = Repeat<br>1 = Clamp<br><b>4 = Mirrored Repeat</b> |
| Int       | 40     | 4      | Wrap method u<br>0 = Repeat<br>1 = Clamp<br>3 = None - use Wrap method u,v<br><b>4 = Mirrored Repeat</b>                                       |

## Texture Attribute File Format changes for OpenFlight 16.0

### Wrap method fields

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 44     | 4      | Wrap method v<br>0 = Repeat<br>1 = Clamp<br>3 = None - use Wrap method u,v<br><b>4 = Mirrored Repeat</b> |

The Environment type field has been changed to include a new possible value, Add as shown here. This new value is shown in **bold font**:

## Texture Attribute File Format changes for OpenFlight 16.0

### Environment type field

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 60     | 4      | Environment type<br>0 = Modulate<br>1 = Blend<br>2 = Decal<br>3 = Replace<br><b>4 = Add</b> |

## Texture Mapping Palette Record

### *Parameters for 3 Point Put Texture Mapping (Type 1)*

The following fields were added to the end (at the specified offsets) of the parameter subrecord.

### Parameters for 3 Point Put Texture Mapping (Type 1) changes for OpenFlight 16.0 New Fields

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--------------|
| Float     | 392    | 4      | U Repetition |
| Float     | 396    | 4      | V Repetition |

# D Summary of Changes Version 16.1

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 16.0 and 16.1 as well as the errors contained in previous versions of this document that have been corrected in this version.

OpenFlight version 16.1 coincides with MultiGen Creator version 3.1 and the OpenFlight API version 3.1. The changes made for this version are:

- [“Shader Palette Record” on page 159](#)
- [“Texture Attribute File” on page 159](#)

## Document Corrections

The errors corrected in this version of the document are described in the sections that follow.

### Mesh Record

The offset for the first Reserved field has been corrected. It was previously listed as 4. The correct offset is 12. The corrected field and offset are shown in **bold font**:

#### Mesh Record error corrected in OpenFlight 16.1 specification Reserved field (corrected)

| Data Type | Offset    | Length | Description |
|-----------|-----------|--------|-------------|
| Int       | <b>12</b> | 4      | Reserved    |

For a complete description of the mesh record, see [“Mesh Record” on page 31](#).

### General Matrix Record

The opcode for this record has been corrected. It was previously listed as 82. The correct opcode is 94. The corrected field and opcode are shown in **bold font**:

#### General Matrix Record error corrected in OpenFlight 16.1 specification Opcode (corrected)

| Data Type | Offset | Length | Description                     |
|-----------|--------|--------|---------------------------------|
| Int       | 0      | 2      | <b>General Matrix Opcode 94</b> |

---

For a complete description of the general matrix record, see [“General Matrix Record”](#) on page 63.

## Parameters for Spherical Project Mapping

The reserved field at offset 172, previously omitted in prior versions of this document, has been documented in the specification for OpenFlight 16.1. The offsets of fields following this field have been adjusted accordingly.

### Parameters for Spherical Project Mapping error corrected in OpenFlight 16.1 specification Reserved field (documented)

| Data Type | Offset | Length | Description |
|-----------|--------|--------|-------------|
| Int       | 172    | 4      | Reserved    |

For a complete description of the parameters for spherical project mapping, see [“Texture Mapping Palette Record”](#) on page 94.

## Format Changes

### Shader Palette Record

The Shader palette record has been modified to support OpenGL Shading Language shader program files. The following parameter block will appear in the Shader palette record when the Shader type is 2 (OpenGL Shading Language).

#### Parameters for OpenGL Shading Language Shader

| Data Type  | Offset | Length | Description                       |
|--|--------|--------|-----------------------------------|
| char   | 1036   | 4      | Number of vertex program files    |
| char   | 1040   | 4      | Number of fragment programs files |
| The following field is repeated for each vertex program file in the shader record.   |        |        |                                   |
| Int  | Varies | 1024   | Vertex program file N             |
| The following field is repeated for each fragment program file in the shader record. |        |        |                                   |
| Int  | Varies | 1024   | Fragment program file N           |

For a complete description of the shader palette record, see [“Shader Palette Record”](#) on page 99.

## Texture Attribute File

The previously reserved field at offset 432 is now in use.

### Texture Attribute File Format changes for OpenFlight 16.1 Cubemap field

| Data Type | Offset | Length | Description                         |
|-----------|--------|--------|-------------------------------------|
| Int       | 432    | 4      | TRUE if texture is used for cubemap |

For a complete description of texture attribute files, see [“Texture Attribute Files” on page 102](#).



# E Summary of Changes Version 16.2

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 16.1 and 16.2 as well as the errors contained in previous versions of this document that have been corrected in this version.

OpenFlight version 16.2 coincides with MultiGen Creator version 3.2 and the OpenFlight API version 3.2. The changes made for this version are:

- [“Group Record” on page 165](#)
- [“Object Record” on page 166](#)

## Format Changes

### Group Record

The Flags field has been changed to include a new bit which can be used to specify that the group is significant to the runtime system and therefore should be “preserved”. The new bit is shown in **bold font**.

#### Group Record changes for OpenFlight 16.2 Flags field

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 16     | 4      | Flags (bits, from left to right)<br>0 = Reserved<br>1 = Forward animation<br>2 = Swing animation<br>3 = Bounding box follows<br>4 = Freeze bounding box<br>5 = Default parent<br>6 = Backward animation<br><b>7 = Preserve at runtime</b><br>8-31 = Spare |

For a complete description of the group record, see [“Group Record” on page 24](#).

---

## Object Record

The Flags field has been changed to include a new bit which can be used to specify that the object is significant to the runtime system and therefore should be “preserved”. The new bit is shown in **bold font**.

### Object Record changes for OpenFlight 16.2 Flags field

| Data Type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 12     | 4      | Flags (bits from to right)<br>0 = Don't display in daylight<br>1 = Don't display at dusk<br>2 = Don't display at night<br>3 = Don't illuminate<br>4 = Flat shaded<br>5 = Group's shadow object<br><b>6 = Preserve at runtime</b><br>7-31 = Spare |

For a complete description of the object record, see [“Object Record” on page 27](#).

# F Summary of Changes Version 16.3

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 16.2 and 16.3 as well as the errors contained in previous versions of this document that have been corrected in this version.

OpenFlight version 16.3 coincides with MultiGen Creator version 3.4, Presagis Creator version 3.5 and OpenFlight API versions 3.4 - 3.5. The changes made for this version are:

- [“Extended Material Palette Records” on page 168](#)

## Document Corrections

The errors corrected in this version of the document are described in the sections that follow.

### Instance Definition Record

The offset and length of the Instance definition number field have been corrected. The corrected offset and length are shown in **bold font**:

#### Instance Definition Record error corrected in OpenFlight 16.3 specification

| Data Type | Offset   | Length   | Description                |
|-----------|----------|----------|----------------------------|
| Int       | <b>4</b> | <b>4</b> | Instance definition number |

For a complete description of the mesh record, see [“Mesh Record” on page 31](#).

### Instance Reference Record

The offset and length of the Instance definition number field have been corrected. The corrected offset and length are shown in **bold font**:

#### Instance Reference Record error corrected in OpenFlight 16.3 specification

| Data Type | Offset   | Length   | Description                |
|-----------|----------|----------|----------------------------|
| Int       | <b>4</b> | <b>4</b> | Instance definition number |

For a complete description of the mesh record, see [“Mesh Record” on page 31](#).

---

## Light Point System Record

The opcode for this record has been corrected. It was previously listed as 130. The correct opcode is 131. The corrected field and opcode are shown in **bold font**:

### General Matrix Record error corrected in OpenFlight 16.1 specification Opcode (corrected)

| Data Type | Offset | Length | Description                                 |
|-----------|--------|--------|---|
| Int       | 0      | 2      | <b>Light Point System Record Opcode 131</b> |

For a complete description of the mesh record, see [“Light Point System Record” on page 39](#).

## Format Changes

### Extended Material Palette Records

The material palette for a database may now be composed of either *standard* material palette entries or *extended* material palette entries (or a mixture of both kinds). A new set of material records have been introduced to define extended material entries. Standard material entries are still represented using the [“Material Palette Record” on page 76](#).

Extended material palette entries are represented by a sequence of one or more Extended Material Palette Records in the OpenFlight stream. This sequence always includes exactly one Extended Material Header record followed by zero or more *optional* extended material palette records. These new extended material palette records are listed here:

### Extended Material Header Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 0      | 2      | Extended Material Palette Header Opcode 135                                      |
| Int       | 2      | 2      | Length - length of the record  |
| Int       | 4      | 4      | Material index   |
| Char      | 8      | 12     | Material name  |
| Int       | 20     | 4      | Flags<br>0 = Material is used<br>1-31 = Spare                                    |
| Int       | 24     | 4      | Shade Model<br>0 = Flat Shaded<br>1 = Per Vertex Phong<br>2 = Per Fragment Phong |

For a complete description of the extended material header record, see [“Extended Material Header Record” on page 78](#).

### Extended Material Ambient Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                          |
|-----------|--------|--------|--------------------------------------|
| Int       | 0      | 2      | Extended Material Ambient Opcode 136 |
| Int       | 2      | 2      | Length - length of the record        |
| Float     | 4      | 4*3    | Ambient color (r, g, b) *            |
| Int       | 16     | 4      | Texture index for layer 0            |
| Int       | 20     | 4      | UV set for layer 0                   |
| Int       | 24     | 4      | Texture index for layer 1            |
| Int       | 28     | 4      | UV set for layer 1                   |
| Int       | 32     | 4      | Texture index for layer 2            |
| Int       | 36     | 4      | UV set for layer 2                   |
| Int       | 40     | 4      | Texture index for layer 3            |
| Int       | 44     | 4      | UV set for layer 3                   |

\* normalized values between 0.0 and 1.0, inclusive.

For a complete description of the extended material ambient record, see [“Extended Material Ambient Record”](#) on page 79.

### Extended Material Diffuse Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                          |
|-----------|--------|--------|--------------------------------------|
| Int       | 0      | 2      | Extended Material Diffuse Opcode 137 |
| Int       | 2      | 2      | Length - length of the record        |
| Float     | 4      | 4*3    | Diffuse color (r, g, b) *            |
| Int       | 16     | 4      | Texture index for layer 0            |
| Int       | 20     | 4      | UV set for layer 0                   |
| Int       | 24     | 4      | Texture index for layer 1            |
| Int       | 28     | 4      | UV set for layer 1                   |
| Int       | 32     | 4      | Texture index for layer 2            |
| Int       | 36     | 4      | UV set for layer 2                   |
| Int       | 40     | 4      | Texture index for layer 3            |
| Int       | 44     | 4      | UV set for layer 3                   |

\* normalized values between 0.0 and 1.0, inclusive.

For a complete description of the extended material diffuse record, see [“Extended Material Diffuse Record”](#) on page 79.

### Extended Material Specular Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                           |
|-----------|--------|--------|---------------------------------------|
| Int       | 0      | 2      | Extended Material Specular Opcode 138 |
| Int       | 2      | 2      | Length - length of the record         |

## Extended Material Specular Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                |
|-----------|--------|--------|----------------------------|
| Float     | 4      | 4      | Shininess - (0.0-128.0)    |
| Float     | 8      | 4*3    | Specular color (r, g, b) * |
| Int       | 20     | 4      | Texture index for layer 0  |
| Int       | 24     | 4      | UV set for layer 0         |
| Int       | 28     | 4      | Texture index for layer 1  |
| Int       | 32     | 4      | UV set for layer 1         |
| Int       | 36     | 4      | Texture index for layer 2  |
| Int       | 40     | 4      | UV set for layer 2         |
| Int       | 44     | 4      | Texture index for layer 3  |
| Int       | 48     | 4      | UV set for layer 3         |

\* normalized values between 0.0 and 1.0, inclusive.

For a complete description of the extended material specular record, see [“Extended Material Specular Record” on page 79.](#)

## Extended Material Emissive Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                           |
|-----------|--------|--------|---------------------------------------|
| Int       | 0      | 2      | Extended Material Emissive Opcode 139 |
| Int       | 2      | 2      | Length - length of the record         |
| Float     | 4      | 4*3    | Emissive color (r, g, b) *            |
| Int       | 16     | 4      | Texture index for layer 0             |
| Int       | 20     | 4      | UV set for layer 0                    |
| Int       | 24     | 4      | Texture index for layer 1             |
| Int       | 28     | 4      | UV set for layer 1                    |
| Int       | 32     | 4      | Texture index for layer 2             |
| Int       | 36     | 4      | UV set for layer 2                    |
| Int       | 40     | 4      | Texture index for layer 3             |
| Int       | 44     | 4      | UV set for layer 3                    |

\* normalized values between 0.0 and 1.0, inclusive.

For a complete description of the extended material emissive record, see [“Extended Material Emissive Record” on page 80.](#)

## Extended Material Alpha Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                           |
|-----------|--------|--------|---------------------------------------|
| Int       | 0      | 2      | Extended Material Alpha Opcode 140    |
| Int       | 2      | 2      | Length - length of the record         |
| Float     | 4      | 4      | Alpha - (0.0-1.0) where 1.0 is opaque |
| Int       | 8      | 4      | Texture index for layer 0             |
| Int       | 12     | 4      | UV set for layer 0                    |
| Int       | 16     | 4      | Texture index for layer 1             |

### Extended Material Alpha Record New record for OpenFlight 16.3 (Continued)

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 20     | 4      | UV set for layer 1   |
| Int       | 24     | 4      | Texture index for layer 2  |
| Int       | 28     | 4      | UV set for layer 2   |
| Int       | 32     | 4      | Texture index for layer 3  |
| Int       | 36     | 4      | UV set for layer 3   |
| Int       | 40     | 4      | Quality<br>0 = Multisample transparency<br>1 = High quality alpha blending |

\* normalized values between 0.0 and 1.0, inclusive.

For a complete description of the extended material alpha record, see [“Extended Material Alpha Record”](#) on page 80.

### Extended Material Light Map Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                            |
|-----------|--------|--------|--|
| Int       | 0      | 2      | Extended Material Light Map Opcode 141 |
| Int       | 2      | 2      | Length - length of the record          |
| Float     | 4      | 4      | Maximum intensity                      |
| Int       | 8      | 4      | Texture index                          |
| Int       | 12     | 4      | UV set                                 |

For a complete description of the extended material light map record, see [“Extended Material Light Map Record”](#) on page 80.

### Extended Material Normal Map Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                             |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Extended Material Normal Map Opcode 142 |
| Int       | 2      | 2      | Length - length of the record           |
| Int       | 4      | 4      | Texture index                           |
| Int       | 8      | 4      | UV set                                  |

For a complete description of the extended material normal map record, see [“Extended Material Normal Map Record”](#) on page 81.

### Extended Material Bump Map Record New record for OpenFlight 16.3

| Data type | Offset | Length | Description                           |
|-----------|--------|--------|---------------------------------------|
| Int       | 0      | 2      | Extended Material Bump Map Opcode 143 |

## Extended Material Bump Map Record

### New record for OpenFlight 16.3

| Data type | Offset | Length | Description                   |
|-----------|--------|--------|-------------------------------|
| Int       | 2      | 2      | Length - length of the record |
| Int       | 4      | 4      | Texture index                 |
| Int       | 8      | 4      | UV set                        |
| Int       | 12     | 4      | UV set for tangent vectors    |
| Int       | 16     | 4      | UV set for binormal vectors   |

For a complete description of the extended material bump map record, see [“Extended Material Bump Map Record”](#) on page 81.

## Extended Material Shadow Map Record

### New record for OpenFlight 16.3

| Data type | Offset | Length | Description                             |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Extended Material Shadow Map Opcode 145 |
| Int       | 2      | 2      | Length - length of the record           |
| Float     | 4      | 4      | Maximum intensity                       |
| Int       | 8      | 4      | Texture index                           |
| Int       | 12     | 4      | UV set                                  |

For a complete description of the extended material shadow map record, see [“Extended Material Shadow Map Record”](#) on page 81.

## Extended Material Reflection Map Record

### New record for OpenFlight 16.3

| Data type | Offset | Length | Description                                 |
|-----------|--------|--------|---|
| Int       | 0      | 2      | Extended Material Reflection Map Opcode 147 |
| Int       | 2      | 2      | Length - length of the record               |
| Float     | 4      | 4*3    | Tint color (r, g, b) *                      |
| Int       | 16     | 4      | Texture index for reflection (mask) map     |
| Int       | 20     | 4      | UV set for reflection map                   |
| Int       | 24     | 4      | Texture index for environment (base) map    |
| Int       | 28     | 4      | Reserved                                    |

\* normalized values between 0.0 and 1.0, inclusive.

For a complete description of the extended material reflection map record, see [“Extended Material Reflection Map Record”](#) on page 81.

# G Summary of Changes Version 16.4

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 16.3 and 16.4 as well as the errors contained in previous versions of this document that have been corrected in this version.

OpenFlight version 16.4 coincides with Presagis Creator version 4.0 and the OpenFlight API version 4.0. The changes made for this version are:

- [“Extension GUID Palette” on page 174](#)
- [“Extension Field Records” on page 175](#)

## Document Corrections

The errors corrected in this version of the document are described in the sections that follow.

### Level of Detail Record

Bit 1 of the Flags field, previously labeled “Reserved” in prior versions of this document, has been described. It indicates that there Additive LODs below this record and is shown in **bold font**:

| Data type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 36     | 4      | Flags (bits, from left to right)<br>0 = Use previous slant range<br><b>1 = Additive LODs below</b><br>2 = Freeze center (don't recalculate)<br>3-31 = Spare |

For a complete description of the level of detail record, see [“Level of Detail Record” on page 44](#).

---

## Light Point Appearance Palette Record

The Flags fields has been corrected. The affected bits are shown in **bold font**:

### Light Point Appearance Record error corrected in OpenFlight 16.4 specification

| Data Type | Offset | Length | Description   |
|-----------|--------|--------|---|
| Int       | 380    | 4      | Flags (bits, from left to right)<br>0 = reserved<br>1 = No back color<br>TRUE = don't use back color for bidirectional points<br>FALSE = use back color for bidirectional points<br><b>2 = Calligraphic proximity occulting (Debunching)</b><br><b>3 = Reflective, non-emissive point</b><br><b>4-6 = Randomize intensity</b><br>0 = never<br>1 = low<br>2 = medium<br>3 = high<br><b>7 = Perspective mode</b><br><b>8 = Conforming</b><br><b>9-10 = Quality</b><br>0 = Low<br>1 = Medium<br>2 = High<br>3 = Undefined<br><b>11 = Visible during day</b><br><b>12 = Visible during dusk</b><br><b>13 = Visible during night</b><br><b>14-31 = Spare</b> |

For a complete description of the light point appearance record, see "[Light Point Appearance Palette Record](#)" on page 90

## Format Changes

A new method for extending the OpenFlight format was introduced in this version. Several new records were introduced to describe and define your extension data.

### Extension GUID Palette

Extension data is uniquely identified by Universally Unique Identifiers (UUID or GUID). The extension GUID palette contains the GUIDs of the extensions that are used in the OpenFlight

file. Subsequent extension field records that follow in the OpenFlight file will reference one of these GUID palette records..

### **Extension GUID Palette Record New record for OpenFlight 16.4**

| <b>Data Type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>                       |
|------------------|---------------|---------------|--|
| Int              | 0             | 2             | Extension GUID Palette Record Opcode 148 |
| Unsigned Int     | 2             | 2             | Length - length of the record            |
| Int              | 4             | 4             | GUID palette index                       |
| Int              | 8             | 40            | GUID string                              |

For a complete description of the extension GUID palette record, see [“Extension GUID Palette Record”](#) on page 100.

### **Extension Field Records**

When extension data is associated to a node record, one or more extension field records will appear as ancillary records to the node record. There are 6 different extension field record types:

#### **Extension Field Boolean Record New record for OpenFlight 16.4**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>                        |
|------------------|---------------|---------------|---|
| Int              | 0             | 2             | Extension Field Boolean Opcode 149        |
| Unsigned Int     | 2             | 2             | Length - length of the record             |
| Int              | 4             | 4             | GUID palette index - identifies extension |
| Int              | 8             | 4             | Extension field boolean value (0 or 1)    |

#### **Extension Field Integer Record New record for OpenFlight 16.4**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>                        |
|------------------|---------------|---------------|---|
| Int              | 0             | 2             | Extension Field Boolean Opcode 149        |
| Unsigned Int     | 2             | 2             | Length - length of the record             |
| Int              | 4             | 4             | GUID palette index - identifies extension |
| Int              | 8             | 4             | Extension field integer value             |

#### **Extension Field Float Record New record for OpenFlight 16.4**

| <b>Data type</b> | <b>Offset</b> | <b>Length</b> | <b>Description</b>                        |
|------------------|---------------|---------------|---|
| Int              | 0             | 2             | Extension Field Boolean Opcode 149        |
| Unsigned Int     | 2             | 2             | Length - length of the record             |
| Int              | 4             | 4             | GUID palette index - identifies extension |
| Float            | 8             | 4             | Extension field float value               |

**Extension Field Double Record**  
**New record for OpenFlight 16.4**

| Data type    | Offset | Length | Description                               |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Extension Field Boolean Opcode 149        |
| Unsigned Int | 2      | 2      | Length - length of the record             |
| Int          | 4      | 4      | GUID palette index - identifies extension |
| Double       | 8      | 8      | Extension field double value              |

**Extension Field String Record**  
**New record for OpenFlight 16.4**

| Data type    | Offset | Length    | Description                                      |
|--------------|--------|-----------|--|
| Int          | 0      | 2         | Extension Field Boolean Opcode 149               |
| Unsigned Int | 2      | 2         | Length - length of the record (including string) |
| Int          | 4      | 4         | GUID palette index - identifies extension        |
| Int          | 8      | 4         | String length - length of string that follows    |
| Char         | 12     | Length-12 | Extension field string value                     |

**Extension Field XML String Record**  
**New record for OpenFlight 16.4**

| Data type    | Offset | Length    | Description                                      |
|--------------|--------|-----------|--|
| Int          | 0      | 2         | Extension Field Boolean Opcode 149               |
| Unsigned Int | 2      | 2         | Length - length of the record (including string) |
| Int          | 4      | 4         | GUID palette index - identifies extension        |
| Int          | 8      | 4         | String length - length of string that follows    |
| Char         | 12     | Length-12 | Extension field XML string value                 |

For a complete description of the extension field records, see [“Extension Field Records” on page 68.](#)

# H *Summary of Changes Version 16.5*

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 16.4 and 16.5. OpenFlight version 16.5 coincides with Presagis Creator version 15.0 and the OpenFlight API version 15.0. The changes made for this version are:

- [“Extended Material Physical Material Map” on page 177](#)

## Format Changes

A new Extended Material Palette record was introduced in this version. This record, when included in the definition of an Extended Material, provides a raster-based material classification of your scene. This new record is described below:

### Extended Material Physical Material Map

#### Extended Material Physical Material Map Record New record for OpenFlight 16.5

| Data type | Offset | Length | Description  |
|-----------|--------|--------|--|
| Int       | 0      | 2      | Extended Material Physical Material Map Opcode 155 |
| Int       | 2      | 2      | Length - length of the record                      |
| Int       | 4      | 4      | Texture index for physical material map            |
| Int       | 8      | 4      | UV set for physical material map                   |

For a complete description of the extended material physical material map record, see [“Extended Material Physical Material Map Record” on page 82](#).



# I Summary of Changes Version 16.6

## Overview

This section describes the changes in the OpenFlight Scene Description between versions 16.5 and 16.6. OpenFlight version 16.6 coincides with Presagis Creator version 16.0 and the OpenFlight API version 16.0. The changes made for this version are:

- [“Point Record” on page 179](#)
- [“Header Record” on page 180](#)

## Format Changes

A new Point record was introduced in this version. This record specifies a 3D position coordinate and optional normal and x-axis vectors. This new record is described below:

### Point Record

**Point Record**  
**New record for OpenFlight 16.6**

| Data type    | Offset | Length | Description   |
|--------------|--------|--------|---|
| Int          | 0      | 2      | Point Record Opcode 157   |
| Unsigned Int | 2      | 2      | Length - length of the record   |
| Char         | 4      | 8      | 7 char ASCII ID; 0 terminates   |
| Int          | 12     | 4      | Reserved  |
| Int          | 16     | 4      | Flags (bits from left to right)<br>0 = Has Normal<br>1 = Has X Axis<br>2-31 = Spare |
| Int          | 20     | 4      | Reserved  |
| Double       | 24     | 8*3    | Position coordinate (x,y,z) of Point  |
| Float        | 48     | 4*3    | Normal vector (i,j,k) of Point - valid if Has Normal flag is set                    |
| Float        | 60     | 4*3    | X Axis (i,j,k) of Point - valid if Has X Axis flag is set                           |

For a complete description of the point record, see [“Point Record” on page 36](#).

---

## Header Record

A new attribute has been added to the existing header record (see [“Header Record” on page 21](#)). A previously spare field was used to hold this attribute. The following shows the new field and the affected spare field.

### Header Record changes for OpenFlight 16.6 New Fields

| Data Type    | Offset | Length | Description          |
|--------------|--------|--------|----------------------|
| Unsigned int | 304    | 2      | Next Point ID number |
| Int          | 306    | 2      | Reserved             |

For a complete description of the header record, see [“Header Record” on page 21](#).

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