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Technical Note TN1035

QuickTime VR 1.0 Panorama Movie File Format

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This Technote is intended to provide multimedia developers with the knowledge necessary to create QuickTime VR 1.0 panorama movie files from their own applications.

You should be thoroughly familiar with the QuickTime Movie Toolbox, as documented in *Inside Macintosh: QuickTime*. In particular, knowledge of the sections on creating a movie and working with media samples is essential for making use of the information in this document.

Note:

Although this file format will be supported in future versions of QuickTime VR, be aware that the panorama movie file format will change significantly in the next release.

Updated: [Feb 1 1996]

About the Panorama Movie File Format

The simplest panoramic movie is a single node movie that contains one video track and one panorama track. The video track, called the scene track in QuickTime VR, is inactive and is used by the panorama track as an image store.

In a single node movie the panorama track contains one media sample. In a multinode panorama, the panorama track contains one sample for each node in the movie. Data in each sample contain information about the panoramic image for the particular node. The scene track contains the panoramic image, usually multiple samples comprising the diced frames of the panorama for a particular node.

When the panorama needs to be imaged, the video samples are decompressed into an offscreen buffer, reconstructing the original uncorrected panoramic image. Based on the current pan, tilt, and zoom angle, a portion of the uncorrected image

is copied and partially corrected (1D correction) to another offscreen buffer, whose size is the same as the display window. Then the contents of that buffer are copied to the screen, going through the final correction phase (2D correction). If circumstances (such as a non-rectangular clipped view) do not allow writing directly to the screen, then a second offscreen correction buffer is used and the image is then copied to the screen. If the imaging update mode is set to partial or no correction, then the corresponding correction steps are skipped.

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QuickTime VR Panorama Movie Authoring

To author a QuickTime VR panorama movie, you need to make extensive use of the QuickTime Movie Toolbox, including such calls as `CreateMovieFile`, `NewMovieTrack`, `NewTrackMedia`, `AddMediaSample`, `InsertMediaIntoTrack`, and many other calls.

Two things to keep in mind:

- The QuickTime VR components must be registered when you are authoring a QuickTime VR movie. If the components are not registered, `NewTrackMedia` will fail when you try to create media for the panorama track.
- QuickTime VR 1.0 requires that QuickTime 2.0 or greater be installed in your system.

The Movie File

A QuickTime VR panorama movie file is a QuickTime movie file. The only difference between a panorama movie file and a regular linear QuickTime movie file is the type and usage of the tracks contained in the movie and the user data attached to the movie. In particular, for the Macintosh, the file type should be set to 'MooV', and on Windows the file extension should be `.mov`. The file's creator type on the Macintosh should be 'vrod', which is the creator type for the QTVRPlayer application.

Also, as with any QuickTime file that is intended to be played on both platforms, a data fork version of the file should be created using the `FlattenMovie` Movie Toolbox call with the `flattenAddMovieToDataFork` flag set.

Movie Controller User Data

When you create a new QuickTime VR panorama movie, you must add a special piece of user data that identifies which movie controller to invoke for this movie. The movie controller type for QuickTime VR 1.0 panorama movies is 'STpn'. This user data is examined by the Movie Toolbox when `NewMovieController` is called. The following lines of code add the appropriate user data to a new movie:

```
UserData uDat;
OSType controllerSubType = 'STpn';
uDat = GetMovieUserData(newMovie);
SetUserDataItem(uDat, &controllerSubType,
                sizeof(controllerSubType), 'ctyp', 1);
```

The Scene and Hot Spot Tracks

The scene track contains the actual panoramic image for each node. It is a standard QuickTime video track. The panoramic image itself may have been created by the QuickTime VR stitcher tool, a graphics rendering application, or directly from a panoramic camera. In order to process the panorama most efficiently, QuickTime VR expects the panoramic image to be rotated 90deg. counterclockwise. For disk access and memory efficiency, each full panorama is usually diced into smaller frames. Each diced frame is compressed and added to the scene track as a new video sample. You can choose to use any image compressor you deem appropriate to the image; you must not, however, use temporal compression (frame differencing).

You can optionally store a low-resolution version of the panoramic image in a video track called the low-resolution scene track. If the low-resolution scene track exists and there is not enough memory to use the normal scene track, then QuickTime VR uses the low-resolution scene track. The low-resolution track contains diced frames just like the higher resolution track, but the reconstructed panoramic image is half the height and half the width of the higher resolution version. The number of diced frames for the low-resolution scene track is usually half that of the scene track.

The hot-spot track is another optional video track that contains a parallel panorama, with colored regions corresponding to hot spots in the scene track's panorama. The hot spot panoramic image must be 8 bits deep. Each diced frame of the hot spot panoramic image must be compressed with a lossless compressor such as QuickTime's Graphics compressor. The dimensions of the hot spot panoramic image is usually the same as that of the scene track's panoramic image, but it is not required. The dimensions must, however, have the same aspect ratio as the scene track's panoramic image.

As with the scene track, the panoramic images corresponding to the low resolution scene track and the hot spot track must be rotated 90deg. counterclockwise.

The Panorama Track

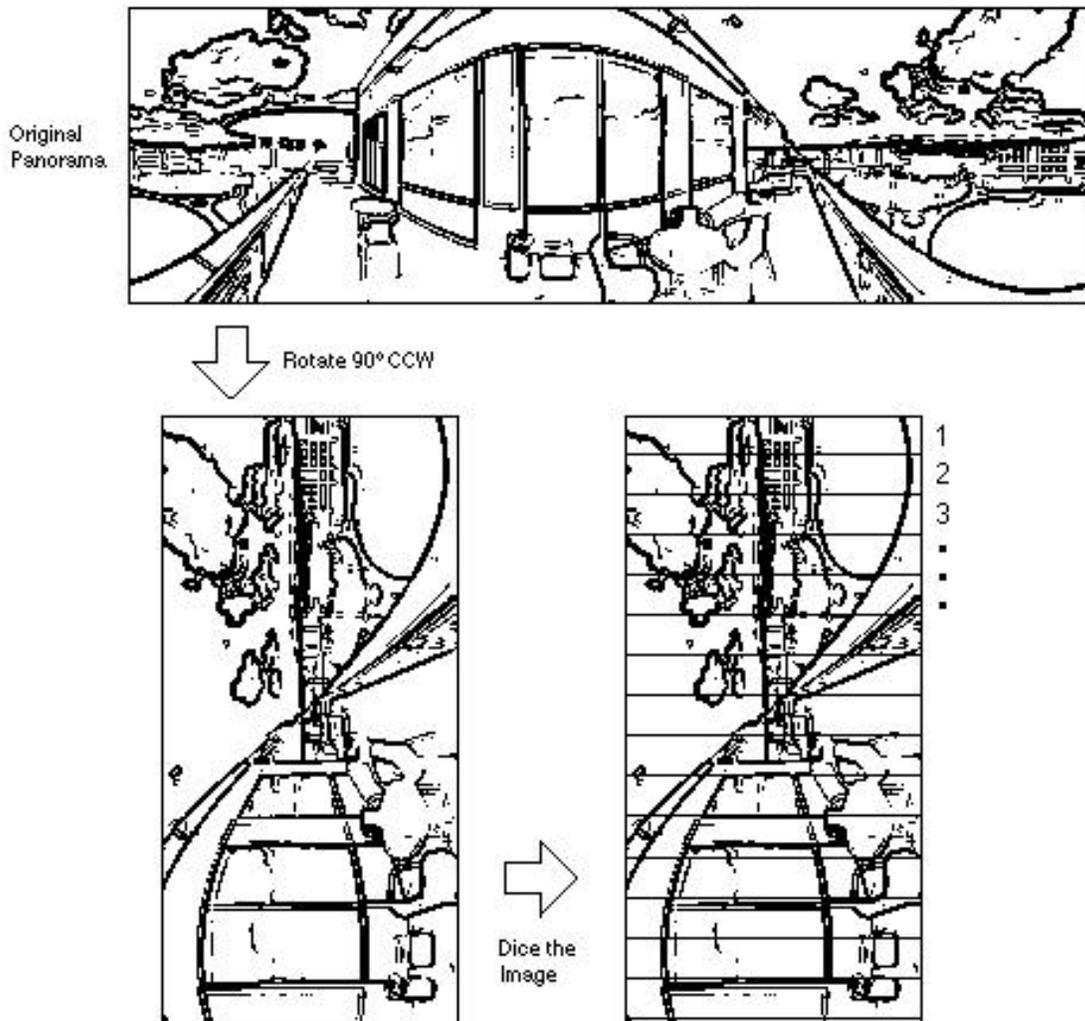
The panorama track is a special type of QuickTime track specific to panorama movies. Its media type is 'STpn'. The panorama media's media info data contains general scene and node location information.

Each sample in the panorama track corresponds to one node in the scene. Panorama track samples with similar characteristics share a sample description of type *PanoramaDescription*. This data structure contains data that specifies the track IDs of the scene and hot spot tracks. It also contains information about how the panoramic image has been diced.

Each individual panorama track sample contains data about one node. This includes default view angles, pan and zoom constraints, and hot spot information.

The format of the media info, panorama description, and panorama samples are described in the following sections. Figure 1 illustrates how a scene track is created.

Creating the Scene Track



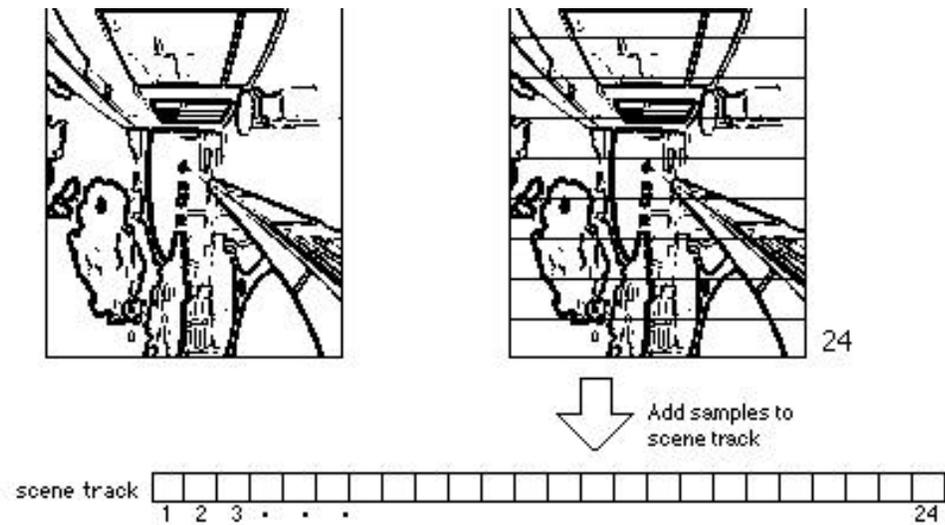


Figure 1. Creating the Scene Track

Note:

In the following data structure descriptions, here are the sizes of the standard Macintosh data types used:

Type	bit size
long	32
unsigned long	32
short	16
unsigned short	16
Fixed	32
OSType	32
Str31	256
TimeValue	32
Rect	64

The structures all use Macintosh 68K alignment. To ensure Mac 68K alignment, place this pragma statment in front of all data structures:

```
#pragma options align = mac68k
```

The Media Info Data

For a multinode panorama, general scene and node location information is stored in the panorama media handler's media info data structure, which is a chunk of private data that QuickTime maintains for certain media handlers. You use the `MediaGetMediaInfo` call to add the information to the panorama track's media. Yes, that's Get, not Set. The call is named from the point of view of the media handler.

`MediaGetMediaInfo` is defined in the header file `MediaHandlers.h` and documented in the Derived Media Handler Components section of *Inside Macintosh: QuickTime Components*, although again, it is documented from the point of view of the media handler implementor. You pass a handle to the `PanoMediaInfo` structure when you call `MediaGetMediaInfo`. QuickTime VR will make a copy of the data. You are responsible for disposing of your copy of the handle.

```

struct PanoMediaInfo {
    long          size;          // the size of the entire media info
    OSType        type;         // must be 'pInf'

    Str31         name;         // the name of the scene
    unsigned long defNodeID;    // the node to display initially
    Fixed         defZoom;     // the default zoom for all nodes
    long          reserved;    // must be zero

    short         pad;         // must be zero
    short         numEntries;  // the number of nodes in the scene
    IDTableEntry idToTime[1];  // table mapping node IDs to movie time
};

struct IDTableEntry {
    unsigned long nodeID;
    TimeValue    time;
};

```

The `idToTime` field maps node IDs to the movie time of the panorama sample corresponding to the node. The table must be sorted in ascending order by node ID. The node IDs are used to identify a particular node and are used by the link hot spots when determining which node to jump to.

The following code snippet adds the media info for a two node scene with node IDs 6 and 9.

```

PanoMediaInfo **mediaInfoH;
long numNodes = 2;
mediaInfoH = (PanoMediaInfo **) NewHandleClear(sizeof(PanoMediaInfo)
    + (numNodes-1)*sizeof(IDTableEntry));
(*mediaInfoH )->size = GetHandleSize((Handle) mediaInfoH );
(*mediaInfoH )->type = 'pInf';
(*mediaInfoH )->defNodeID = 6;
(*mediaInfoH )->defZoom = 65L << 16;
(*mediaInfoH )->numEntries = numNodes;
(*mediaInfoH )->idToTime[0].nodeID = 6;
(*mediaInfoH )->idToTime[0].time = 0;
(*mediaInfoH )->idToTime[1].nodeID = 9;
(*mediaInfoH )->idToTime[1].time = 7200;
MediaGetMediaInfo(panoMediaHandler, (Handle)mediaInfoH);
    // Yes, that's Get, not Set!
DisposeHandle((Handle) mediaInfoH);

```

The Panorama Track's Sample Description

The panorama track contains one sample for each node in the panorama. The sample description for the panorama media contains information that is usually shared by many nodes. Many of the fields are reserved and should be set to the values indicated in the description that follows. Other fields indicate information about the source panorama image, such as its size and how it was diced. In the following description, typical values for a high resolution panorama file are given.

```
struct PanoramaDescription {
    long    size;           // total size of the PanoramaDescription
    long    type;           // must be 'pano'

    long    reserved1;      // must be zero
    long    reserved2;      // must be zero

    short   majorVersion;   // must be zero
    short   minorVersion;   // must be zero

    long    sceneTrackID;    // ID of video track that contains
                            // panoramic scene
    long    loResSceneTrackID; // ID of video track that contains low
                            // res panoramic scene
    long    reserved3[6];    // must be zero
    long    hotSpotTrackID;  // ID of video track that contains
                            // hotspot image
    long    reserved4[9];    // must be zero

    Fixed   hPanStart;      // horizontal pan range start angle
                            // (e.g. 0)
    Fixed   hPanEnd;        // horizontal pan range end angle
                            // (e.g. 360)
    Fixed   vPanTop;        // vertical pan range top angle
                            // (e.g. 42.5)
    Fixed   vPanBottom;     // vertical pan range bottom angle
                            // (e.g. -42.5)
    Fixed   minimumZoom;    // minimum zoom angle (e.g. 5; use 0 for
                            // default)
    Fixed   maximumZoom;    // maximum zoom angle (e.g. 65; use 0
                            // for default)

    // Info for highest res version of scene track
    long    sceneSizeX;     // pixel width of the panorama (e.g. 768)
    long    sceneSizeY;     // pixel height of the panorama (e.g.
                            // 2496)
    long    numFrames;      // number of diced frames (e.g. 24)
    short   reserved5;      // must be zero
    short   sceneNumFramesX; // diced frames wide (e.g. 1)
    short   sceneNumFramesY; // diced frames high (e.g. 24)
    short   sceneColorDepth; // bit depth of the scene track (e.g. 32)

    // Info for highest res version of hotSpot track
    long    hotSpotSizeX;   // pixel width of the hot spot panorama
                            // (e.g. 768)
    long    hotSpotSizeY;   // pixel height of the hot spot panorama
                            // (e.g. 2496)
    short   reserved6;      // must be zero
    short   hotSpotNumFramesX; // diced frames wide (e.g. 1)
    short   hotSpotNumFramesY; // diced frames high (e.g. 24)
    short   hotSpotColorDepth; // must be 8
};
```

A value of 0 for a track ID indicates there is no corresponding track. The `sceneTrackID` field must refer to a valid scene track. The low-resolution scene track and hot spot track are optional. The pan and zoom range values are used to indicate the extent of the panorama. A full wraparound panorama would have `hPanStart` and `hPanEnd` values of 0 and 360 (shifted left 16 since they are Fixed values). Partial panoramas will have different appropriate values. The `vPanTop` and `vPanBottom` angles define the vertical field of view, where 0 is the straight-ahead view angle.

Note:

`hPan`, `vPan`, and zoom angles will be called pan, tilt, and field of view in future versions of QuickTime VR.

You can specify a minimum and maximum zoom angle, or use 0 to get QuickTime VR's default. It's a good idea to specify a minimum zoom angle so that you can prevent the user from zooming all the way until all you see is giant pixels. The general rules that govern the size values are that the height and width of the panorama should be set so that each can be divided into an even number of whole diced frames. The dimensions of the diced frames should be divisible by 4. Since the panorama is stored rotated 90 degrees counterclockwise, the height is generally larger than the width.

The Panorama Track Samples

The samples in the panorama track contain information about the node, tables of hot spot information, and a table of Pascal strings for storing names and comments. The data in each sample is organized as atom data structures.

Note:

This file format pre-dates the QuickTime 2.1 Atom Data routines and is not compatible with them.

Each atom has a header that consists of a 4-byte size followed by a 4-byte type field. The atoms can appear in any order within the panorama sample data.

The panorama header atom (type '`pHdr`') contains information about the node itself, such as its node ID, the default viewing angles, and panning and zooming constraints specific to this node. If there are no constraints specific to this node, then 0 should be used for the min and max values. The `nameStrOffset` and `commentStrOffset` fields (in this and other atoms) contain offsets into the string table atom.

```

struct PanoSampleHeaderAtom {
    long        size;
    OSType      type;           // must be 'pHdr'

    unsigned long    nodeID;           // corresponds to a node ID in the
                                    idToTime table above
    Fixed          defHPan;           // default horizontal pan angle when
                                    displaying this node
    Fixed          defVPan;           // default vertical pan angle when
                                    displaying this node
    Fixed          defZoom;           // default zoom angle when displaying
                                    this node

    // constraints for this node; use zero for default
    Fixed          minHPan;
    Fixed          minVPan;
    Fixed          minZoom;
    Fixed          maxHPan;
    Fixed          maxVPan;
    Fixed          maxZoom;

    long          reserved1;         // must be zero
    long          reserved2;         // must be zero
    long          nameStrOffset;     // offset into string table atom
    long          commentStrOffset;  // offset into string table atom
};

```

The string table atom (type 'strT') is a table of Pascal strings concatenated together. The offset value for a particular string gives the offset into the table of the length byte of the string (with length number of characters following). The offset value includes the size and type fields of the string table atom; thus the first string in the table would be at offset 8. An offset value of 0 indicates there is no string in the table for this item.

```

struct StringTableAtom {
    long    size;
    OSType  type;           // must be 'strT'
    char    bunchOstrings[1]; // concatenated Pascal strings
};

```

The hot spot table atom lists all of the hot spots in the node. Each entry in the table gives general information about the particular hot spot, such as the hot spot ID and type ('link', 'navg', etc), its canonical or "best" viewing position, bounding rectangle, and special cursor IDs. The hot spot ID corresponds to the pixel value found in the hot spot track. The hot spot types known by QuickTime VR are 'link' and 'navg'. For 'link' and 'navg' hot spots, the typeData field is the ID of an entry in the 'link' or 'navg' tables. For any other hot spot type, typeData is undefined. The cursor IDs are used to override the default hot spot cursors provided by QuickTime VR. They are used when the mouse moves over or is clicked on the particular hot spot. The cursor IDs must be set to 0 if the default cursors are to be used.

```

struct HotSpotTableAtom {
    long        size;
    OSType      type;          // must be 'pHot'

    short      pad;           // must be zero
    short      numHotSpots;
    HotSpot    hotSpots[1];
};

struct HotSpot {
    unsigned short hotSpotID;    // the ID of this hot spot
    short          reserved1;    // must be zero
    OSType         type;        // the hot spot type (e.g. 'link',
                                'navg', etc)
    unsigned long  typeData;    // for link and navg, the ID in the link
                                and navg table

    // canonical view for this hot spot
    Fixed         viewHPan;
    Fixed         viewVPan;
    Fixed         viewZoom;

    Rect          hotSpotRect;  // bounding rectangle of the hot spot in
                                the panorama

    long          mouseOverCursorID;
    long          mouseDownCursorID;
    long          mouseUpCursorID;
    long          reserved2;    // must be zero
    long          nameStrOffset; // offset into string table atom
    long          commentStrOffset; // offset into string table atom
};

```

The link table atom is what QuickTime VR uses to automatically jump from node to node when the user clicks on a link hot spot. The link table atom (type 'pLnk') lists all the links from this node to other nodes in the scene. Each link contains its link ID, which is the value referred to by the typeData field in the link hot spot atom. A link also contains the destination node id as well as the viewing angles to use at the new node. If the toZoom field is set to 0, then the current zoom angle is maintained when jumping to the node.

```
struct LinkTableAtom {
    long        size;
    OSType      type;           // must be 'pLnk'

    short       pad;           // must be zero
    short       numLinks;
    PanoLink    links[1];
};

struct PanoLink {
    unsigned short linkID;      // ID referred to by the typeData
                                field in the hot spot atom
    short         reserved1;    // must be zero
    long          reserved2;    // must be zero
    long          reserved3;    // must be zero
    unsigned long toNodeID;     // the node id of the destination
                                node
    long          reserved4[3]; // must be zero
    Fixed         toHPan;       // horizontal pan angle to set at
                                the destination node
    Fixed         toVPan;       // vertical pan angle to set at the
                                destination node
    Fixed         toZoom;       // zoom angle to set at the
                                destination node
    long          reserved5;    // must be zero
    long          reserved6;    // must be zero
    long          nameStrOffset; // offset into string table atom
    long          commentStrOffset; // offset into string table atom
};
```

The 'navg' table atom stores information about navigable objects that may appear in the scene.

Note:

Navigable Object movies are called simply Object movies in future versions of QuickTime VR; the term "navigable" is going away.

QuickTime VR does not do any automatic linking to navigable object movies. The 'navg' table atom is stored here so that applications can extract the information and use it to perform its own object movie transitions. Each entry contains its object ID, which is the value referred to by the typeData field in the 'navg' hot spot atom. It also stores information that can be used by the Navigable Movie Controller. The `navgHPan`, `navgVPan`, and `navgZoom` fields specify the orientation of the corresponding object movie that best represents the orientation of the object as it appears in the panoramic scene. The `zoomRect` field specifies a rectangle that can be used by the Navigable Movie Controller as a starting point for a zoom-out transition effect. The `zoomRect` value is in the coordinate system of the panorama. It is similar to the `hotSpotRect` field in the hot spot atom, but generally is a bit larger, since it represents the view of the object as seen in the object movie, rather than the tight bounding rectangle represented by the `hotSpotRect`. Also, the `zoomRect` field value needs to be converted to window coordinates (based on the current viewing angles) before it is passed to the Navigable Movie Controller.

```

struct NavgTableAtom {
    long      size;
    OSType    type;          // must be 'pNav'

    short     pad;          // must be zero
    short     numObjects;
    NavgObject objects[1];  // navigable objects
};

struct NavgObject {
    unsigned short  objID;          // ID referred to by the typeData
                                // field in the hot spot atom
    short           reserved1;      // must be zero
    long            reserved2;      // must be zero

    // Info for Navigable Movie Controller
    Fixed           navgHPan;       // the object's orientation in the
                                // scene
    Fixed           navgVPan;
    Fixed           navgZoom;
    Rect            zoomRect;       // starting rect for zoom out
                                // transition

    long           reserved3;      // must be zero
    long           nameStrOffset;   // offset into string table atom
    long           commentStrOffset; // offset into string table atom
};

```

Track Layout

Each sample in the panorama track corresponds to one node in the scene. The time base of the movie is used to locate the proper video samples in the scene track for a particular node. The video sample for the first diced frame of a node's panoramic image is located in the scene track at the same time as the corresponding panorama sample. The duration of all of the video samples together for one node is the same as the duration of the corresponding panorama sample (Figures 2 & 3).

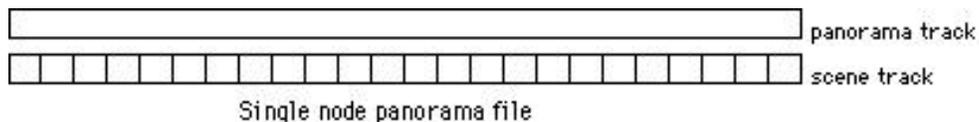


Figure 2. Single Node Panorama File

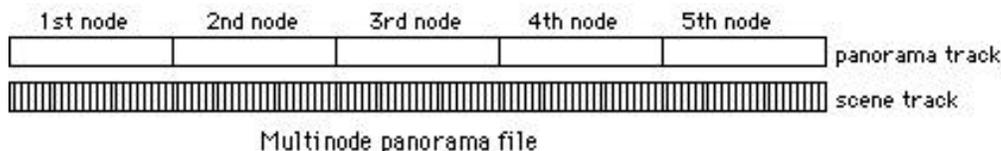


Figure 3. Multinode Panorama File

The video samples corresponding to the low-resolution scene track, if one exists, are also located at the same time and total duration as the panorama sample. Likewise, the hot spot track, if it exists, has its samples for a particular node located at the same time and total duration as the panorama sample. (Figure 4).

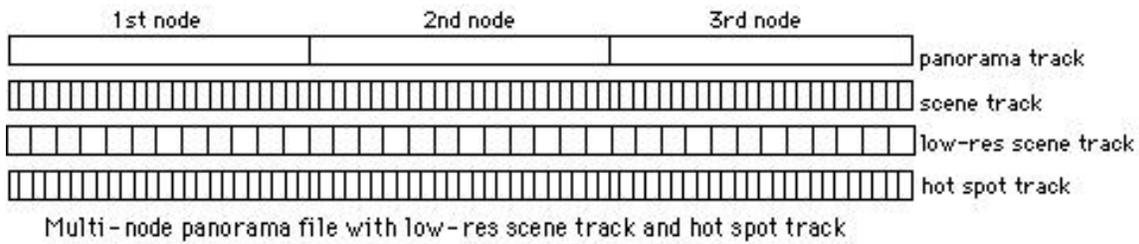


Figure 4. Multinode Panorama File with Low-Res Scene Track and Hot Spot Track

In a panorama movie file the scene track, low-resolution scene track, and hot spot track are all disabled. Only the panorama track is enabled. The track dimensions and track matrix of the panorama track determine the rectangle returned by the `GetMovieBox` call.

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Summary

This Technote has shown how you can create a QuickTime VR panorama movie from a set of panorama pics. Hotspots may be added to allow the user to jump between panoramas, to pick QuickTime VR objects, or any user-defined hot spot picking.

Authoring a multi-node panorama file with hot spots is a complex process. Make sure you verify the resulting file using `QTVRPlayer`.

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References

Inside Macintosh: QuickTime

Inside Macintosh: QuickTime Components

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