Inside QuickTime

QuickTime Streaming Server Modules

February 2002

Apple Computer, Inc.
1 Infinite Loop
Cupertino, CA 95014
408-996-1010

Simultaneously published in the United States and Canada

Contents

Figures, Listings, and Tables

About This Manual

This manual describes version 4.0 of the programming interface for creating QuickTime Streaming Server modules. The QTSS programming interface provides an easy way for developers to add new functionality to the QuickTime Streaming Server. This version of the programming interface is compatible with QuickTime Streaming Server version 4.

What's New

Version 4.0 of the QTSS programming interface provides the following new features:

- Support for creating your own objects by calling a new callback routine, `QTSS_CreateObjectType`. Objects that you create can have static as well instance attributes. The new object type, `qtssDynamicObjectType`, allows you to create objects that have no static attributes.
- Support for creating your own object that is an attribute of another object by calling `QTSS_CreateObjectValue`.
- Locking callback routines, `QTSS_LockObject` and `QTSS_UnlockObject`, that prevent other threads from accessing an object's attributes. An object should be locked if it cannot be updated atomically, for example, when calling `QTSS_CreateObjectValue` to create a new object that is the value of another object's attribute and setting the value of the new object's attribute. You can also call `QTSS_GetValuePtr` to get the value of a non-preemptive-safe attribute if you lock the object before calling `QTSS_GetValuePtr`.

- The QTSS_SetValuePtr callback, which allows you to set the value of an attribute to point to a variable in your own module.
- String (char array) attributes can now have multiple values of different lengths. (Previous versions of QTSS required that multiple string values have the same length.)
- A new object type, qtssConnectedUserObjectType, which has attributes associated with a connected client. Use this object type to describe non-RTSP connections, such as MP3 connections.
- New attributes for the QTSS_ServerObject: qtssMP3SvrCurConn, qtssMP3SvrTotalConn, qtssMP3SvrCurBandwidth, qtssMP3SvrTotalBytes, and qtssMP3SvrAvgBandwidth.
- A new attribute for the QTSS_ModuleObject object: qtssModAttributes.
- A new attribute for the QTSS_RTPStreamObject object: qtssRTPStrNetworkMode. A new enumeration, QTSS_RTPNetworkMode, defines values for this attribute.
- New attributes for the QTSS_RTSPRequestObject object: qtssRTSPReqSkipAuthorization and qtssRTSPReqNetworkMode.
- New attributes for the QTSS_RTSPSessionObject object: qtssRTSPSesLocalPort and qtssRTSPSesRemotePort.

In addition, support for the following attributes has been removed: qtssPrefsTCPMinThinDelayToleranceInMSec, qtssPrefsTCPMaxThinDelayToleranceInMSec, qtssPrefsTCPVideoDelayToleranceInMSec, qtssPrefsTCPAudioDelayToleranceInMSec, qtssPrefsDefaultWindowSizeInK, qtssPrefsOverbufferBucketInterval, qtssPrefsTCPThickIntervalInSec.

Conventions Used in This Manual

The Letter Gothic font is used to indicate text that you type or see displayed. This manual includes special text elements to highlight important or supplemental information:

Note: Text set off in this manner presents sidelights or interesting points of information.

Important
Text set off in this manner—with the word Important—presents important information or instructions.

WARNING
Text set off in this manner—with the word Warning—indicates potentially serious problems.

For More Information

The following sources provide additional information that may be of interest to developers of QuickTime Streaming Server modules:

- RFC 2326, Real Time Streaming Protocol (RTSP), available at many locations on the Internet
- RFC 1889, RTP: A Transport Protocol for Real-Time Applications, available at many locations on the Internet
- RFC 2327, SDP: Session Description Protocol, available at many locations on the Internet

See `http://developer.apple.com/techpubs/quicktime` for QuickTime developer documentation.

The source code for the QuickTime Streaming Server is available at `http://www.publicsource.apple.com/projects/streaming`.

PREFACE 1

About This Manual

Concepts

This manual describes version 4.0 of the programming interface for creating QuickTime Streaming Server (QTSS) modules. This version of the programming interface is compatible with QuickTime Streaming Server version 4.

QTSS is an open-source, standards-based streaming server that runs on Windows NT and Windows 2000 and several UNIX implementations, including Mac OS X, Linux, FreeBSD, and the Solaris operating system. To use the programming interface for the QuickTime Streaming Server, you should be familiar with the following Internet Engineering Task Force (IETF) protocols that the server implements:

- Real Time Streaming Protocol (RTSP)
- Real Time Transport Protocol (RTP)
- Real Time Transport Control Protocol (RTCP)
- Session Description Protocol (SDP)

This manual describes how to use the QTSS programming interface to develop QTSS modules for the QuickTime Streaming Server. Using the programming interface described in this manual allows your application to take advantage of the server's scalability and protocol implementation in a way that will be compatible with future versions of the QuickTime Streaming Server. Most of the core features of the QuickTime Streaming Server are implemented as modules, so support for modules has been designed into the core of the server.

You can use the programming interface to develop QTSS modules that supplement the features of the QuickTime Streaming server. For example, you could write a module that

- acts as an RTSP proxy, which would be useful for streaming clients located behind a firewall

- supports virtual hosting, allowing a single server to serve multiple domains from multiple document roots.
- logs statistical information for particular RTSP and client sessions
- supports additional ways of storing content, such as storing movies in databases
- configures users' QuickTime Streaming Server preferences
- monitors and reports statistical information in real time
- tracks pay-per-view accounting information

Module Requirements

Every QTSS module must implement two routines:

- a main routine, which the server calls when it starts up to initialize the QTSS stub library with your module
- a dispatch routine, which the server uses when it calls the module for a specific purpose

Main Routine

Every QTSS modules must provide a main routine. The server calls the main routine as the server starts up and uses it to initialize the QTSS stub library so the server can invoke your module later.

For modules that are compiled into the server, the address of the module's main routine must be passed to the server's module initialization routine, as described in the section "Compiling a QTSS Module into the Server".

The body of the main routine must be written like this:

```
QTSS_Error MyModule_Main(void* inPrivateArgs)
{
     return _stublibrary_main(inPrivateArgs, MyModuleDispatch);
}
```

where MyModuleDispatch is the name of the module's dispatch routine, which is described in the following section, "Dispatch Routine" (page 17).

Important
For code fragment modules, the main routine must be named `MyModule_Main` where `MyModule` is the name of the file that contains the module.

Dispatch Routine

Every QTSS module must provide a dispatch routine. The server calls the dispatch routine when it invokes a module for a specific task, passing to the dispatch routine the name of the task and a task-specific parameter block. (The programming interface uses the term "role" to describe specific tasks. For information about roles, see "Module Roles" (page 25).)

The dispatch routine must have the following prototype:

```
void MyModuleDispatch(QTSS_Role inRole, QTSS_RoleParamPtr inParams);
```

where MyModuleDispatch is the name specified as the name of the dispatch routine by the module's main routine, `inRole` is the name of the role for which the module is being called, and `inParams` is a structure containing values of interest to the module.

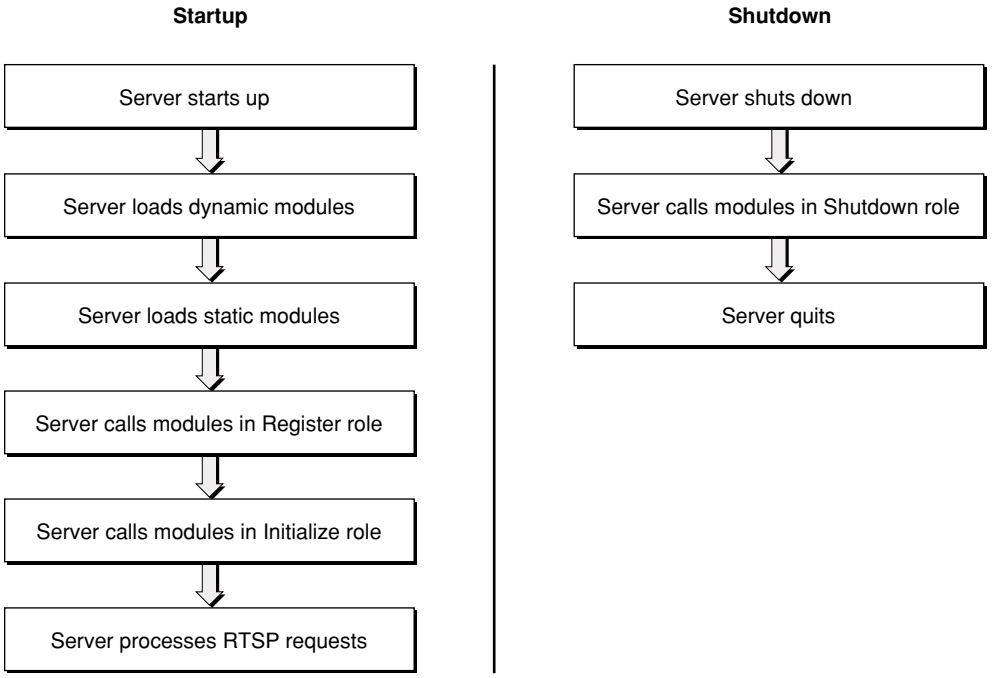
Overview of QuickTime Streaming Server Operations

The QuickTime Streaming Server works with modules to process requests from clients by invoking modules in a particular role. Each role is designed to perform a particular task. This section describes how the server works with roles when it starts up and shuts down and how the server works with roles when it processes client requests.

Server Startup and Shutdown

Figure 1-1 shows how the server works with the Register, Initialize, and Shutdown roles when the server starts up and shuts down.

Figure 2-1 QuickTime Streaming Server startup and shutdown



When the server starts up, it first loads modules that are not compiled into the server (dynamic modules) and then loads modules that are compiled into the server (static modules). If you are writing a module that replaces existing server functionality, compile it as a dynamic module so that it is loaded first.

Then the server invokes each QTSS module in the Register role, which is a role that every module must support. In the Register role, the module calls `QTSS_AddRole` to specify the other roles that the module supports.

Next, the server invokes the Initialize role for each module that has registered for that role. The Initialize role performs any initialization tasks that the module requires, such as allocating memory and initializing global data structures.

At shutdown, the server invokes the Shutdown role for each module that has registered for that role. When handling the Shutdown role, the module should perform cleanup tasks and free global data structures.

RTSP Request Processing

After the server calls each module that has registered for the Initialize role, the server is ready to receive requests from the client. These requests are known as RTSP requests. A sample RTSP request is shown in Figure 1-2.

Figure 2-2 Sample RTSP request

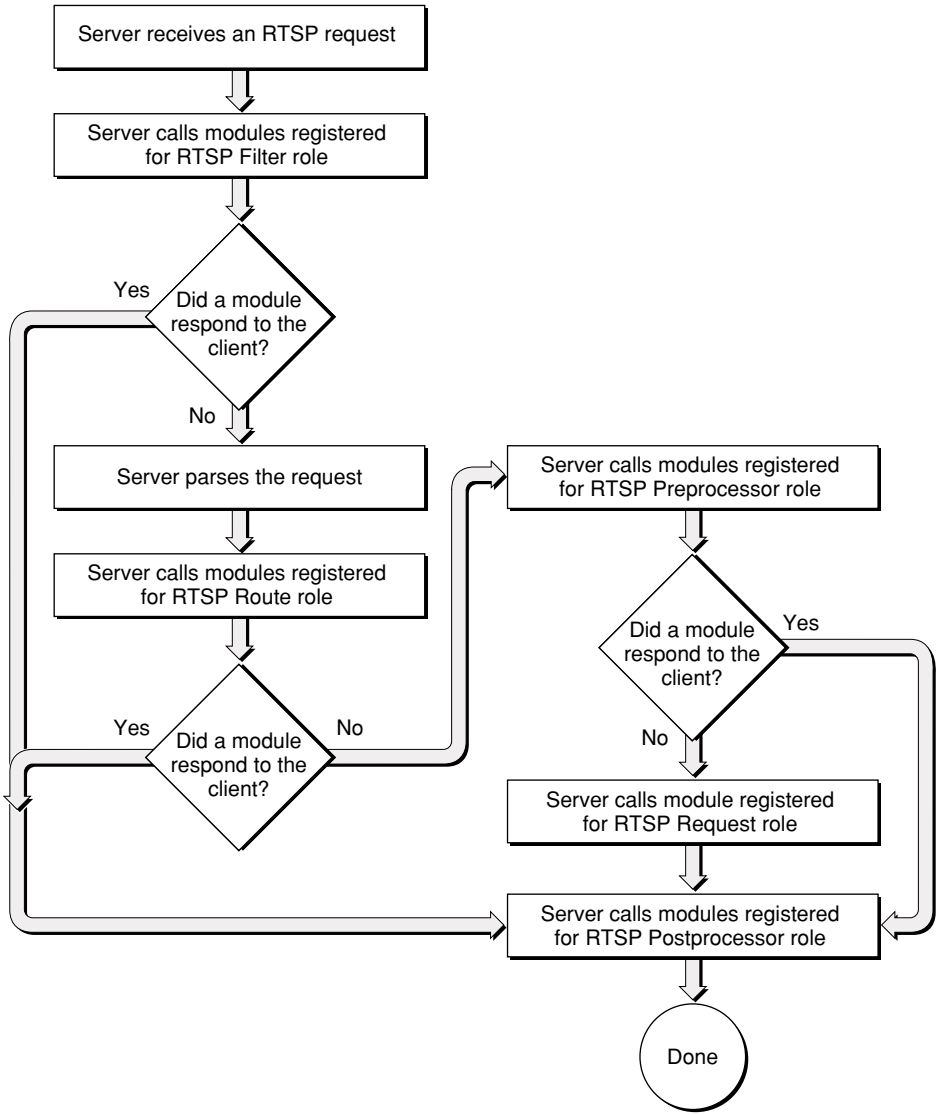
```
DESCRIBE rtsp://streaming.site.com/foo.mov RTSP/1.0
CSeq: 1
Accept: application/sdp
User-agent: QTS/1.0
```

When the server receives an RTSP request, it creates an RTSP request object, which is a collection of attributes that describe the request. At this point, the `qtssRTSPReqFullRequest` attribute is the only attribute that has a value and that value consists of the complete contents of the RTSP request.

Next, the server calls modules in specific roles according to a predetermined sequence. That sequence is shown in Figure 2-3.

Note: The order in which the server calls any particular module for any particular role is undetermined.

Figure 2-3 Summary of RTSP request processing



When processing an RTSP request, the first role that the server calls is the RTSP Filter role. The server calls each module that has registered for the RTSP Filter role

and passes to it the RTSP request object. Each module's RTSP Filter role has the option of changing the value of the `qtssRTSPReqFullRequest` attribute. For example, an RTSP Filter role might change `/foo/foo.mov` to `/bar/bar.mov`, thereby changing the folder that will be used to satisfy this request.

Important
Any module handling the RTSP Filter role that responds to the client causes the server to skip other modules that have registered for the RTSP Filter role, skip modules that have registered for other RTSP roles, and immediately call the RTSP Postprocessor role of the responding module. A response to a client is defined as any data the module may send to the client.

When all RTSP Filter roles have been invoked, the server parses the request. Parsing the request consists of filling in the remaining attributes of the RTSP object and creating two sessions:

- an RTSP session, which is associated with this particular request and closes when the client closes its RTSP connection to the server
- a client session, which is associated with the client connection that originated the request and remains in place until the client's streaming presentation is complete

After parsing the request, the server calls the RTSP Route role for each module that has registered in that role and passes the RTSP object. Each RTSP Route role has the option of using the values of certain attributes to determine whether to change the value of the `qtssRTSPReqRootDir` attribute, thereby changing the folder that is used to process this request. For example, if the language type is French, the module could change the `qtssRTSPReqRootDir` attribute to a folder that contains the French version of the requested file.

Important
Any module handling the RTSP Route role that responds to the client causes the server to skip other modules that have registered for the RTSP Route role, skip modules that have registered for other RTSP roles, and immediately calls the RTSP Postprocessor role of the responding module.

After all RTSP Route roles have been called, the server calls the RTSP Preprocessor role for each module that has registered for that role. The RTSP Preprocessor role typically uses the `qtssRTSPReqAbsoluteURL` attribute to determine whether the request matches the type of request that the module handles.

If the request matches, the RTSP Preprocessor role responds to the request by calling `QTSS_Write` or `QTSS_WriteV` to send data to the client. To send a standard response, the module can call `QTSS_SendStandardRTSPResponse`, or `QTSS_AppendRTSPHeader` and `QTSS_SendRTSPHeaders`.

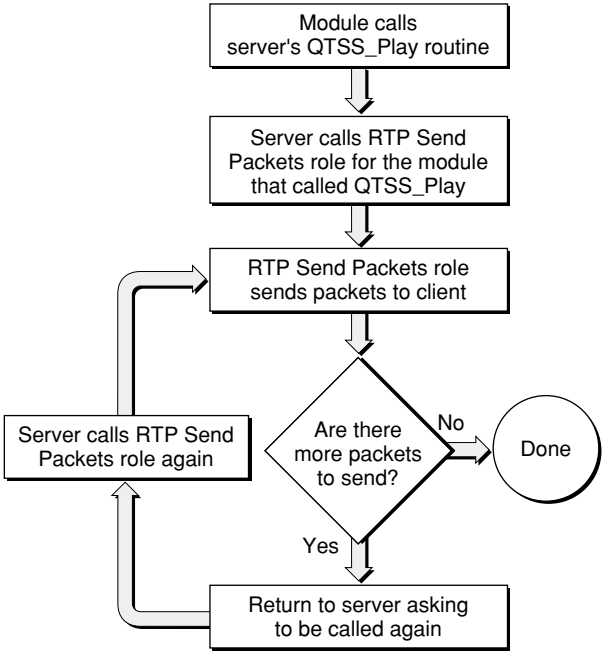
Important
Any module handling the RTSP Preprocessor role that responds to the client causes the server to skip other modules that have registered for the RTSP Preprocessor role, skip modules that have registered for other RTSP roles, and immediately calls the RTSP Postprocessor role of the responding module.

If no RTSP Preprocessor role responds to the RTSP request, the server invokes the RTSP Request role of the module that successfully registered for this role. (The first module that registers for the RTSP Request role is the only module that can register for the RTSP Request role.) The RTSP Request role is responsible for responding to all RTSP Requests that are not handled by modules registered for the RTSP Preprocessor role.

After the RTSP Request role processes the request, the server calls modules that have registered for the RTSP Postprocessor role. The RTSP Postprocessor role typically performs accounting tasks, such as logging statistical information.

A module handling the RTSP Preprocessor or RTSP Request role may generate the media data for a particular client session. To generate media data, the module calls `QTSS_Play`, which causes that module to be invoked in the RTP Send Packets role, as shown in Figure 2-4 (page 23).

Figure 2-4 Summary of the RTSP Preprocessor and RTSP Request roles



The RTP Send Packets role calls `QTSS_Write` or `QTSS_WriteV` to send data to the client over the RTP session. When the RTP Send Packets role has sent some packets, it returns to the server and specifies the time that is to elapse before the server calls the module's RTP Send Packets role again. This cycle repeats until all of the packets for the media have been sent or until the client requests that the client session be paused or torn down.

Runtime Environment for QTSS Modules

QTSS modules can spawn threads, use mutexes, and are completely free to use any operating system tools.

The QuickTime Streaming Server is fully multi-threaded, so QTSS modules must be prepared to be preempted. Global data structures and critical sections in code should be protected with mutexes. Unless otherwise noted, assume that preemption can occur at any time.

The server usually runs all activity from very few threads or possibly a single thread, which requires the server to use asynchronous I/O whenever possible. (The actual behavior depends on the platform and how the administrator configures the server.)

QTSS modules should adhere to the following rules:

- Perform tasks and return control to the server as quickly as possible. Returning quickly allows the server to load balance among a large number of clients.
- Be prepared for `QTSS_WouldBlock` errors when performing stream I/O. The `QTSS_Write`, `QTSS_WriteV`, and `QTSS_Read` callback routines return `QTSS_WouldBlock` if the requested I/O would block. For more information about streams, see "QTSS Streams" (page 73).
- Avoid using synchronous I/O wherever possible. An I/O operation that blocks may affect streaming quality for other clients.

Server Time

The QuickTime Streaming Server handles real-time delivery of media, so many elements of QTSS module programming interface are time values.

The server's internal clock counts the number of milliseconds that have elapsed since midnight, January 1st, 1970. The data type `QTSS_TimeVal` is used to store the value of the server's internal clock. To make it easy to work with time values, every attribute, parameter, and callback routine that deals with time specifies the time units explicitly. For example, the `qtssRTPStrBufferDelayInSecs` attribute specifies the client's buffer size in seconds. Unless otherwise noted, all time values are reported in milliseconds from the server's internal clock using a `QTSS_TimeVal` data type.

To get the current value of the server's clock, call `QTSS_Milliseconds` or get the value of the `qtssSvrCurrentTimeMilliseconds` attribute of the server object (`QTSS_ServerObject`). To convert a time obtained from the server's clock to the current time, call `QTSS_MilliSecsTo1970Secs`.

Naming Conventions

The QTSS programming interface uses a naming convention for the data types that it defines. The convention is to use the size of the data type in the name. Here are the data types that the QTSS programming interface uses:

- `Bool16` — A 16-bit Boolean value
- `SInt64` — A signed 64-bit integer value
- `SInt32` — A signed 32-bit integer value
- `UInt16` — An unsigned 16-bit integer value
- `UInt32` — An unsigned 32-bit integer value

Parameters for callback functions defined by the QTSS programming interface follow these naming conventions:

- Input parameters begin with `in`.
- Output parameters begin with `out`.
- Parameters that are used for both input and output begin with `io`.

Module Roles

Roles provide modules with a well-defined state for performing certain types of processing. A selector of type `QTSS_Role` defines each role and represents the internal processing state of the server and the number, accessibility, and validity of server data. Depending on the role, the server may pass to the module one or more QTSS objects. In general, the server uses objects to exchange information with modules. For more information about QTSS objects, see "QTSS Objects" (page 41).

Table 2-1 lists the roles that this version of the QuickTime Streaming Server supports.

Table 2-1 Module roles

Name	Constant	Task
Register role	`QTSS_Register_Role`	Registers the roles the module supports.
Initialize role	`QTSS_Initialize_Role`	Performs tasks that initialize the module.
Shutdown role	`QTSS_Shutdown_Role`	Performs cleanup tasks.
Reread Preferences role	`QTSS_RereadPrefs_Role`	Rereads the modules's preferences.
Error Log role	`QTSS_ErrorLog_Role`	Logs errors.
RTSP Filter role	`QTSS_RTSPFilter_Role`	Makes changes to the contents of RTSP requests.
RTSP Route role	`QTSS_RTSPRoute_Role`	Routes requests from the client to the appropriate folder.
RTSP Preprocessor role	`QTSS_RTSPPreProcessor_Role`	Processes requests from the client before the server processes them.
RTSP Request role	`QTSS_RTSPRequest_Role`	Processes a request from the client if no other role responds to the request.
RTSP Postprocessor role	`QTSS_RTSPPostProcessor_Role`	Performs tasks, such as logging statistical information, after a request has been responded to.
RTP Send Packets role	`QTSS_RTPSendPackets_Role`	Sends packets.
Client Session Closing role	`QTSS_ClientSessionClosing_Role`	Performs tasks when a client session closes.
RTCP Process role	`QTSS_RTCPProcess_Role`	Processes RTCP receiver reports.
Open File Preprocess role	`QTSS_OpenFilePreProcess_Role`	Processes requests to open files.

Table 2-1 Module roles (continued)

Name	Constant	Task
Open File role	`QTSS_OpenFile_Role`	Processes requests to open files that are not handled by the Open File Preprocess role.
Advise File role	`QTSS_AdviseFile_Role`	Responds when a module (or the server) calls the `QTSS_Advise` callback for a file object.
Read File role	`QTSS_ReadFile_Role`	Reads a file.
Request Event File role	`QTSS_RequestEventFile_Role`	Handles requests for notification of when a file becomes available for reading.
Close File role	`QTSS_CloseFile_Role`	Closes a file that was previously opened.

With the exception of the Register, Shutdown, and Reread Preferences roles, when the server invokes a module for a role, the server passes to the module a structure specific to that particular role. The structure contains information that the modules uses in the execution of that role or provides a way for the module to return information to the server.

The RTSP roles have the option of responding to the client. A response is defined as any data that a module sends to a client. Modules can send data to the client in a variety of ways. They can, for example, call `QTSS_Write` or `QTSS_WriteV`.

Note: The order in which modules are called for any particular role is undetermined.

Register Role

Modules use the Register role to call `QTSS_AddRole` to tell the server the roles they support.

Modules also use the Register role to call `QTSS_AddService` to register services and to call `QTSS_AddStaticAttribute` to add static attributes to QTSS object types. (QTSS objects are collections of attributes, each having a value.)

The server calls a module's Register role once at startup. The Register role is always the first role that the server calls.

A module that returns any value other than `QTSS_NoErr` from its Register role is not loaded into the server.

Initialize Role

The server calls the Initialize role of those modules that have registered for this role after it calls the Register role for all modules. Modules use the Initialize role to initialize global and private data structures.

The server passes to each module's Initialize role objects that can be used to obtain the server's global attributes, preferences, and text error messages. The server also passes the error log stream reference, which can be used to write to the error log. All of these objects are globals, so they are valid for the duration of this run of the server and may be accessed at any time.

When called in the Initialize role, the module receives a `QTSS_Initialize_Params` structure which is defined as follows:

```
typedef struct
{
    QTSS_ServerObject    inServer;
    QTSS_PrefsObject     inPrefs;
    QTSS_TextMessagesObjectinMessages;
    QTSS_ErrorLogStream  inErrorLogStream;
    QTSS_ModuleObject    inModule;
} QTSS_Initialize_Params;
```

`inServer`

A `QTSS_ServerObject` object containing the server's global attributes and an attribute that contains information about all of the modules in the running server. For a description of each attribute, see the section "qtssServerObjectType" (page 68).

`inPrefs`

A `QTSS_PrefsObject` object containing the server's preferences. For a description of each attribute, see the section "qtssPrefsObjectType" (page 52).

`inMessages`

A `QTSS_TextMessagesObject` object that a module can use for providing localized text strings. See the section "qtssTextMessageObjectType" (page 73).

`inErrorLogStream`

A `QTSS_ErrorLogStream` stream reference that a module can use to write to the server's error log. Writing to this stream causes the module to be invoked in its Error Log role.

`inModule`

A `QTSS_ModuleObject` object that a module can use to store information about itself, including its name, version number, and a description of what the module does. See the section "qttsModuleObjectType" (page 50).

A module that wants to be called in the Initialize role must in its Register role call `QTSS_AddRole` and specify `QTSS_Initialize_Role` as the role.

A module that returns any value other than `QTSS_NoErr` from its Initialize role is not loaded into the server.

Shutdown Role

The server calls the Shutdown role of those modules that have registered for this role when the server is getting ready to shut down.

The server calls a module's Shutdown role without passing any parameters.

The module uses its Shutdown role to delete all data structures it has created and to perform any other cleanup task

A module that wants to be called in the Shutdown role must in its Register role call `QTSS_AddRole` and specify `QTSS_Shutdown_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

The server guarantees that the Shutdown role is the last time that the module is called before the server shuts down.

Reread Preferences Role

The server calls the Reread Preferences role of those modules that have registered for this role and rereads its own preferences when the server receives a `SIGHUP` signal or when a module calls the Reread Preferences service described in the section "QTSS Services" (page 76).

When called in this role, the module should reread its preferences, which may be stored in a file or in a QTSS object.

A module that wants to be called in the Reread Preferences role must in its Register role call `QTSS_AddRole` and specify `QTSS_RereadPrefs_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

Error Log Role

The server calls the Error Log role of those modules that have registered for this role when an error occurs. The module should process the error message by, for example, writing the message to a log file.

When called in the Error Log role, the module receives a `QTSS_ErrorLog_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_ErrorVerbosity inVerbosity;
    char * inBuffer;
} QTSS_ErrorLog_Params;
```

`inVerbosity`

Specifies the verbosity level of this error message. Modules should use the `inFlags` parameter of `QTSS_Write` to specify the verbosity level. The following constants are defined:

```
qtssFatalVerbosity = 0,
qtssWarningVerbosity = 1,
qtssMessageVerbosity = 2,
qtssAssertVerbosity = 3,
qtssDebugVerbosity = 4,
```

`inBuffer`

Points to a null-terminated string containing the error message.

Writing an error message at the level `qtssFatalVerbosity` causes the server to shut down immediately.

Writing to the error log cannot result in an `QTSS_WouldBlock` error.

A module that wants to be called in the Error Log role must in its Register role call `QTSS_AddRole` and specify `QTSS_ErrorLog_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

RTSP Roles

When the server receives an RTSP request, it goes through a series of steps to process the request and ensure that a response is sent to the client. The steps consist of calling certain roles in a predetermined order. This section describes each role in detail. For an overview of roles and the sequence in which they are called, see the section "Overview of QuickTime Streaming Server Operations" (page 17).

Note: All RTSP roles have the option of responding directly to the client. When any RTSP role responds to a client, the server immediately skips the RTSP roles that it would normally call and calls the RTSP Postprocessor role of the module that responded to the RTSP request.

RTSP Filter Role

The server calls the RTSP Filter role of those modules that have registered for the RTSP Filter role immediately upon receipt of an RTSP request. Processing the Filter role gives the module an opportunity to respond to the request or to change the RTSP request.

When called in the RTSP Filter role, the module receives a `QTSS_StandardRTSP_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_RTSPSessionObject       inRTSPSession;
```

```
    QTSS_RTSPRequestObject      inRTSPRequest;
    char**                      outNewRequest;
} QTSS_StandardRTSP_Params;
```

`inRTSPSession`

The `QTSS_RTSPSessionObject` object for this RTSP session. See the section "qtssRTSPSessionObjectType" (page 66) for information about RTSP session object attributes.

`inRTSPRequest`

The `QTSS_RTSPRequestObject` object for this RTSP request. When called in the RTSP Filter role, only the `qtssRTSPReqFullRequest` attribute has a value. See the section "qtssRTSPRequestObjectType" (page 62) for information about RTSP request object attributes.

outNewRequest

A pointer to a location in memory.

The module calls `QTSS_GetValuePtr` to get from the `qtssRTSPReqFullRequest` attribute the complete RTSP request that caused the server to call this role. The `qtssRTSPReqFullRequest` attribute is a read-only attribute. To change the RTSP request, the module should call `QTSS_New` to allocate a buffer, write the modified request into that buffer, and return a pointer to that buffer in the `outNewRequest` field of the `QTSS_StandardRTSP_Params` structure.

While a module is handling the RTSP Filter role, the server guarantees that the module will not be called for any other role referencing the RTSP session represented by `inRTSPSession`.

If module handling the RTSP Filter role responds directly to the client, the server next calls the responding module in the RTSP Postprocessor role. For information about that role, see the section "RTSP Postprocessor Role" (page 37).

A module that wants to be called in the RTSP Filter role must in its Register role call `QTSS_AddRole` and specify `QTSS_RTSPFilter_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

RTSP Route Role

The server calls the RTSP Route role after the server has called all modules that have registered for the RTSP Filter role. It is the responsibility of a module handling this role to set the appropriate root directory for each RTSP request by changing the `qtssRTSPReqRootDir` attribute for the request.

When called, an RTSP Route role receives a `QTSS_StandardRTSP_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_RTSPSessionObject      inRTSPSession;
    QTSS_RTSPRequestObject      inRTSPRequest;
    QTSS_RTSPHeaderObject       inRTSPHeaders;
    QTSS_ClientSessionObject    inClientSession;
} QTSS_StandardRTSP_Params;
```

`inRTSPSession`
: The `QTSS_RTSPSessionObject` object for this RTSP session. See the section "qtssRTSPSessionObjectType" (page 66) for information about RTSP session object attributes.

`inRTSPRequest`
: The `QTSS_RTSPRequestObject` object for this RTSP request. In the Route role and all subsequent RTSP roles, all of the attributes are filled in. See the section "qtssRTSPRequestObjectType" (page 62) for information about RTSP request object attributes.

`inRTSPHeaders`
: The `QTSS_RTSPHeaderObject` object for the RTSP headers. See the section "qtssRTSPHeaderObjectType" (page 61) for information about RTSP header object attributes.

`inClientSession`
: The `QTSS_ClientSessionObject` object for the client session. See the section "qtssClientSessionObjectType" (page 43) for information about client session object attributes.

Before calling modules in the RTSP Route role, the server parses the request. Parsing the request consists of filling in all of the attributes of the `QTSS_RTSPSessionObject` and `QTSS_RTSPRequestObject` members of the `QTSS_StandardRTSP_Params` structure.

A module processing the RTSP Route role has the option of changing the `qtssRTSPReqRootDir` attribute of the `QTSS_RTSPRequestObject` member of the `QTSS_StandardRTSP_Params` structure. Changing the `qtssRTSPReqRootDir` attribute changes the root folder for this RTSP request.

While a module is handling the RTSP Route role, the server guarantees that the module will not be called for any other role referencing the RTSP session represented by inRTSPSession.

If a module that is processing the RTSP Route role responds directly to the client, the server immediately skips the processing of any other roles and calls the responding module's RTSP Postprocessor role. For information about that role, see the section "RTSP Postprocessor Role" (page 37).

A module that wants to be called in the RTSP Route role must in its Register role call `QTSS_AddRole` and specify `QTSS_RTSPRoute_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

RTSP Preprocessor Role

The server calls the RTSP Preprocessor role after the server has called all modules that have registered for the RTSP Route role. If the module handles the type of RTSP request for which the module is called, it is the responsibility of a module handling this role to send a proper RTSP response to the client.

When called, an RTSP Preprocessor role receives a `QTSS_StandardRTSP_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_RTSPSessionObject   inRTSPSession;
    QTSS_RTSPRequestObject   inRTSPRequest;
    QTSS_RTSPHeaderObject    inRTSPHeaders;
    QTSS_ClientSessionObject inClientSession;
} QTSS_StandardRTSP_Params;
```

`inRTSPSession`

The `QTSS_RTSPSessionObject` object for this RTSP session. See the section "qtssRTSPSessionObjectType" (page 66) for information about RTSP session object attributes.

`inRTSPRequest`

The `QTSS_RTSPRequestObject` object for this RTSP request with a value for each attribute. See the section "qtssRTSPRequestObjectType" (page 62) for information about RTSP request object attributes.

`inRTSPHeaders`

The `QTSS_RTSPHeaderObject` object for the RTSP headers. See the section "qtssRTSPHeaderObjectType" (page 61) for information about RTSP header object attributes.

`inClientSession`

The `QTSS_ClientSessionObject` object for the client session. See the section "qtssClientSessionObjectType" (page 43) for information about client session object attributes.

The RTSP Preprocessor role typically uses the `qtssRTSPReqFilePath` attribute of the `inRTSPRequest` member of the `QTSS_StandardRTSP_Params` structure to determine whether the request matches the type of request that the module handles. For example, a module may only handle URLs that end in `.mov` or `.sdp`.

If the request matches, the module handling the RTSP Preprocessor role responds to the request by calling `QTSS_SendStandardRTSPResponse`, `QTSS_Write`, or `QTSS_WriteV`, or by calling `QTSS_AppendRTSPHeader`, and `QTSS_SendRTSPHeaders`. If this module is also responsible for generating RTP packets for this client session, it should call `QTSS_AddRTPStream` (page 180) to add streams to the client session, and `QTSS_Play`, which causes the server to invoke the RTP Send Packets role of the module whose RTSP Preprocessor role calls `QTSS_Play`.

While a module is handling the RTSP Preprocessor role, the server guarantees that the module will not be called for any other role referencing the RTSP session specified by `inRTSPSession` or the client session specified by `inClientSession`.

A module that wants to be called in the RTSP Preprocessor role must in its Register role call `QTSS_AddRole` and specify `QTSS_RTSPPreProcessor_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

RTSP Request Role

The server calls the RTSP Request role if no RTSP Preprocessor role responds to an RTSP request. Only one module is called in the RTSP Request role, and that is the first module to register for the RTSP Request role when the server starts up.

When called, the RTSP Request role receives a `QTSS_StandardRTSP_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_RTSPSessionObject       inRTSPSession;
    QTSS_RTSPRequestObject       inRTSPRequest;
    QTSS_RTSPHeaderObject        inRTSPHeaders;
    QTSS_ClientSessionObject     inClientSession;
} QTSS_StandardRTSP_Params;
```

`inRTSPSession`
: The `QTSS_RTSPSessionObject` object for this RTSP session. See the section "qtssRTSPSessionObjectType" (page 66) for information about RTSP session object attributes.

`inRTSPRequest`
: The `QTSS_RTSPRequestObject` object for this RTSP request with a value for each attribute. See the section"qtssRTSPRequestObjectType" (page 62) for information about RTSP request object attributes.

`inRTSPHeaders`
: The `QTSS_RTSPHeaderObject` object for the RTSP headers. See the section "qtssRTSPHeaderObjectType" (page 61) for information about RTSP header object attributes.

`inClientSession`
: The `QTSS_ClientSessionObject` object for the client session. See the section "qtssClientSessionObjectType" (page 43) for information about client session object attributes.

Like a module processing the RTSP Preprocessor role, a module that processes the RTSP Request Role should use an attribute, such as the `qtssRTSPReqFilePath` attribute of the `inRTSPRequest` member of the `QTSS_StandardRTSP_Params` structure, to determine whether the request matches the type of request that the module can handle.

A module handling the RTSP Request role should respond to the request by

- Sending an RTSP response to the client by calling `QTSS_AppendRTSPHeader` and `QTSS_SendRTSPHeaders`, by calling `QTSS_SendStandardRTSPResponse`, or by calling `QTSS_Write` or `QTSS_WriteV`.

- Preparing the `QTSS_ClientSessionObject` for streaming by using the RTP callbacks, such as `QTSS_AddRTPStream` and `QTSS_Play`. If `QTSS_Play` is called, the server will invoke the calling module in the RTP Send Packets role, at which time the module will be expected to generate RTP packets to send to the client.

A module that wants to be called in the RTSP Request role must in its Register role call `QTSS_AddRole` and specify `QTSS_RTSPRequest_Role` as the role. The first module that successfully calls `QTSS_AddRole` and specifies `QTSS_RTSPRequest_Role` as the role is the only module that is called in the RTSP Request role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

RTSP Postprocessor Role

The server calls a module's RTSP Postprocessor role whenever the module responds to an RTSP request if that module has registered for this role.

Modules can use the RTSP Postprocessor role to log statistical information.

When called, the RTSP Postprocessor role receives a `QTSS_StandardRTSP_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_RTSPSessionObject      inRTSPSession;
    QTSS_RTSPRequestObject      inRTSPRequest;
    QTSS_RTSPHeaderObject       inRTSPHeaders;
    QTSS_ClientSessionObject    inClientSession;
} QTSS_StandardRTSP_Params;
```

`inRTSPSession`
: The `QTSS_RTSPSessionObject` object for this RTSP session. See the section "qtssRTSPSessionObjectType" (page 66) for information about RTSP session object attributes.

`inRTSPRequest`
: The `QTSS_RTSPRequestObject` object for this RTSP request with a value for each attribute. See the section "qtssRTSPRequestObjectType" (page 62) for information about RTSP request object attributes.

`inRTSPHeaders`

The `QTSS_RTSPHeaderObject` object for the RTSP headers. See the section "qtssRTSPHeaderObjectType" (page 61) for information about RTSP header object attributes.

`inClientSession`

The `QTSS_ClientSessionObject` object for the client session. See the section "qtssClientSessionObjectType" (page 43) for information about client session object attributes.

While a module is handling the RTSP Postprocessor role, the server guarantees that the module will not be called for any role referencing the RTSP session specified by inRTSPSession or the client session specified by inClientSession.

A module that wants to be called in the RTSP Postprocessor role must in its Register role call `QTSS_AddRole` and specify `QTSS_RTSPPostProcessor_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

RTP Roles

This section describes RTP roles, which are used to send data to clients and to handle the closing of client sessions.

RTP Send Packets Role

The server calls a module's RTP Send Packets role when the module calls `QTSS_Play`. It is the responsibility of the RTP Send Packets role to send media data to the client and tell the server when the module's RTP Send Packets role should be called again.

When called, the RTP Send Packets role receives a `QTSS_RTPSendPackets_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_ClientSessionObject     inClientSession;
    SInt64                       inCurrentTime;
    QTSS_TimeVal                 outNextPacketTime;
} QTSS_RTPSendPackets_Params;
```

`inClientSession`

The `QTSS_ClientSessionObject` object for the client session. See the section "qtssClientSessionObjectType" (page 43) for information about client session object attributes.

`inCurrentTime`

The current time in server time units.

`outNextPacketTime`

A time offset in milliseconds. Before returning from this role, a module should set `outNextPacketTime` to the amount of time that the server should allow to elapse before calling the RTP Send Packets role again for this session.

The RTP Send Packets role is invoked whenever a module calls `QTSS_Play` for that client session. The module calls `QTSS_Write` or `QTSS_WriteV` to send data to the client.

While a module is handling the RTP Send Packets role, the server guarantees that the module will not be called for any role referencing the client session specified by `inClientSession`.

A module that wants to be called in the RTP Send Packets role must in its Register role call `QTSS_AddRole` and specify `QTSS_RTPSendPackets_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

Client Session Closing Role

The server calls a module's Client Session Closing role to allow the module to process the closing of client sessions.

When called, the Client Session Closing role receives a `QTSS_ClientSessionClosing_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_ClientClosing          inReason;
    QTSS_ClientSessionObject    inClientSession;
} QTSS_ClientSessionClosing_Params;
```

`inReason`

The reason why the session is closing. The session may be closing because the client sent an RTSP teardown (`qtssCliSesClosClientTeardown`), because this session has timed out (`qtssCliSesClosTimeout`), or because the client disconnected without issuing a teardown (`qtssCliSesClosClientDisconnect`).

`inClientSession`

The `QTSS_ClientSessionObject` object for the client session that is closing.

The Client Session Closing role is called whenever the client session specified by `inClientSession` is about to be torn down.

While a module is handling the Client Session Closing role, the server guarantees that the module will not be called for any role referencing the client session specified by `inClientSession`.

A module that wants to be called in the Client Session Closing role must in its Register role call `QTSS_AddRole` and specify `QTSS_ClientSessionClosing_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

RTCP Process Role

The server calls a module's RTCP Process role whenever it receives an RTCP receiver report from a client.

RTCP receiver reports contain feedback from the client on the quality of the stream. The feedback includes the percentage of lost packets, the number of times the audio has run dry, and frames per second. Many attributes in the `QTSS_RTPStreamObject` correlate directly to fields in the receiver report.

When called, the RTP Process role receives a `QTSS_RTCPProcess_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_RTPStreamObject         inRTPStream;
    QTSS_ClientSessionObject     inClientSession;
```

```
    void*                       inRTCPPacketData;
    UInt32                      inRTCPPacketDataLen;
} QTSS_RTCPProcess_Params;
```

`inRTPStream`

The `QTSS_RTPStreamObject` object for the RTP stream that this RTCP packet belongs to. See the section "qtssRTPStreamObjectType" (page 57) for information about RTP stream object attributes.

`inClientSession`

The `QTSS_ClientSessionObject` object for the client session. See the section "qtssClientSessionObjectType" (page 43) for information about client session object attributes.

`inRTCPPacketData`

A pointer to a buffer containing the packets that are to be processed.

`inRTCPPacketDataLen`

The length of valid data in the buffer pointed to by `inRTCPPacketData`.

A module handling the RTCP Process role typically monitors the status of the connection. It might, for example, track the percentage of packets lost for each connected client and update its counters.

While a module is handling the RTCP Process role, the server guarantees that the module will not be called for any role referencing the RTP stream specified by `inRTPStream`.

A module that wants to be called in the RTCP Process role must in its Register role call `QTSS_AddRole` and specify `QTSS_RTCPProcess_Role` as the role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

QTSS Objects

QTSS objects provide a way for modules and the server to exchange data with each other. QTSS objects consist of attributes that are used to store data. Every attribute has a name, an attribute ID, a data type, and permissions for reading and writing the attribute's value. Built-in attributes are attributes that the server always defines

for an object type. For example, the `QTSS_RTSPRequestObject` object has a built-in URL attribute that other modules can read to obtain the URL associated with a particular RTSP request.

This section describes the attributes for each object type. The object types are

- `qtssAttrInfoObjectType` (page 42)
- `qtssClientSessionObjectType` (page 43)
- `qtssConnectedUserObjectType` (page 47)
- `qtssDynamicObjectType` (page 49)
- `qtssFileObjectType` (page 49)
- `qttsModuleObjectType` (page 50)
- `qtssModulePrefsObjectType` (page 52)
- `qtssPrefsObjectType` (page 52)
- `qtssRTPStreamObjectType` (page 57)
- `qtssRTSPHeaderObjectType` (page 61)
- `qtssRTSPRequestObjectType` (page 62)
- `qtssRTSPSessionObjectType` (page 66)
- `qtssServerObjectType` (page 68)
- `qtssTextMessageObjectType` (page 73)

qtssAttrInfoObjectType

An object of type `qtssAttrInfoObjectType` consists of attributes whose values describe an attribute: the attribute's name, attribute ID, data type, and permissions for reading and writing the attribute's value. An attribute information object (`QTSS_AttrInfoObject`) is an instance of this object type. There is one `QTSS_AttrInfoObject` for every attribute.

Table 2-2 lists the attributes for objects of type `qtssAttrInfoObjectType`.

Note: All of these attributes are preemptive safe, so they can be read by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, or `QTSS_GetValuePtr`.

Table 2-2 Attributes of objects of type `qtssAttrInfoObjectType`

Attribute Name and Content	Access	Data Type
`qtssAttrName` The attribute's name.	Readable, preemptive safe	`char array`
`qtssAttrID` The attribute's identifier.	Readable, preemptive safe	`QTSS_AttributeID`
`qtssAttrDataType` The attribute's data type.	Readable, preemptive safe	`QTSS_AttrDataType`
`qtssAttrPermissions` Permissions for reading and writing the attribute's value, and whether getting the attribute's value is preemptive safe.	Readable, preemptive safe	`QTSS_AttrPermission`

qtssClientSessionObjectType

An object of type `qtssClientSessionObjectType` consists of attributes that describe a client session, where a client session is defined as a single client streaming presentation. A client session object (`QTSS_ClientSessionObject`) is an instance of this object type. The attributes of a client session object are valid for all roles that receive a value of type `QTSS_ClientSessionObject` in the structure the server passes to them.

Table 2-3 lists the attributes for objects of type `qtssClientSessionObjectType`.

Note: All of these attributes are preemptive safe, so they can be read by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, or `QTSS_GetValuePtr`.

Table 2-3 Attributes of objects of type `qtssClientSessionObjectType`

Attribute Name and Content	Access	Data Type
`qtssCliSesStreamObjects` Iterated attribute containing all RTP stream references (`QTSS_RTPStreamObject`) belonging to this session.	Readable, preemptive safe	`QTSS_RTPStreamObject`
`qtssCliSesCreateTimeInMsec` The time in milliseconds that the session was created.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssCliSesFirstPlayTimeInMsec` The time in milliseconds at which `QTSS_Play` was first called.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssCliSesPlayTimeInMsec` The time in milliseconds at which `QTSS_Play` was most recently called.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssCliSesAdjustedPlayTimeInMsec` The time in milliseconds at which the most recent play was issued, adjusted forward to delay sending packets until the play response is issued.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssCliSesRTPBytesSent` The number of RTP bytes sent for this session.	Readable, preemptive safe	`SInt32`
`qtssCliSesRTPPacketsSent` The number of RTP packets sent for this session.	Readable, preemptive safe	`SInt32`
`qtssCliSesState` The state of this session. Possible values are `qtssPausedState` and `qtssPlayingState`.	Readable, preemptive safe	`QTSS_RTPSessionState`

Table 2-3 Attributes of objects of type `qtssClientSessionObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssCliSesPresentationURL` The presentation URL for this session. This URL is the "base" URL for the session. RTSP requests to the presentation URL are assumed to affect all streams of the session.	Readable, preemptive safe	`char array`
`qtssCliSesMovieDurationInSecs` Duration of the movie for this session in seconds. The value is zero unless set by a module.	Readable, writable, preemptive safe	`Float64`
`qtssCliSesMovieSizeInBytes` Movie size in bytes. The value is zero unless set by a module.	Readable, writable, preemptive safe	`UInt64`
`qtssCliSesMovieAverageBitRate` The average bits per second based on total RTP bits/movie duration. The value is zero unless set by a module.	Readable, writable, preemptive safe	`UInt32`
`qtssCliSesFullURL` The full presentation URL for this session. Same as the `qtssCliSesPresentationURL` attribute but includes the `rtsp://`*domain_name* prefix.	Readable, preemptive safe	`char array`
`qtssCliSesHostName` The host name for this session. Also the *domain_name* `portion of the qtssCliSesFullURL attribute`.	Readable, preemptive safe	`char array`
`qtssCliRTSPSessRemoteAddrStr` The IP address of the client in dotted decimal format.	Readable, preemptive safe	`char array`
`qtssCliRTSPSessLocalDNS` The DNS name of the local IP address for this RTSP connection.	Readable, preemptive safe	`char array`

Table 2-3 Attributes of objects of type `qtssClientSessionObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssCliRTSPSessLocalAddrStr` The local IP address for this RTSP connection in dotted decimal format.	Readable, preemptive safe	`char array`
`qtssCliRTSPSesUserName` The name of the user from the most recent request.	Readable, preemptive safe	`char array`
`qtssCliRTSPSesURLRealm` The realm from the most recent request.	Readable, preemptive safe	`char array`
`qtssCliRTSPReqRealStatusCode` The status from the most recent request. (Same as the `qtssRTSPReqRealStatusCode` session.)	Readable, preemptive safe	`UInt32`
`qtssCliTeardownReason` The teardown reason. If not requested by the client, the reason for the disconnection must be set by the module that calls `QTSS_Teardown`.	Readable, writable, preemptive safe,	`QTSS_CliSesTeardownReason`
`qtssCliSesReqQueryString` The query string from the request that created this client session.	Readable, preemptive safe	`char array`
`qtssCliRTSPReqRespMsg` The error message sent to the client for the most recent request if the response was an error.	Readable, preemptive safe	`char array`
`qtssCliSesCurrentBitRate` The movie bit rate.	Readable, preemptive safe	`UInt32`

Table 2-3 Attributes of objects of type `qtssClientSessionObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssCliSesPacketLossPercent` Percentage of packets lost; for example, .5 = 50%	Readable, preemptive safe	`Float32`
`qtssCliSesTimeConnectedinMsec` Time in milliseconds that the client session has been connected.	Readable, preemptive safe	`SInt64`
`qtssCliSesCounterID` A counter-based unique ID for the session.	Readable, preemptive safe	`UInt32`

qtssConnectedUserObjectType

An object of type `qtssConnectedUserObjectType` consists of attributes associated with a connected user, irrespective of the transport. Users connecting to a QuickTime movie are already represented by objects of type `qtssClientSessionObjectType`, so this object is used for other connected users, such as those requesting MP3 streams.

A connected user object (`QTSS_ConnectedUserObject`) is an instance of this object type. A `QTSS_ConnectedUserObject` can be created in any module. It can be added to the `qtssSvrConnectedUsers` attribute of the `QTSS_ServerObject` (described in the section "qtssServerObjectType" (page 68)).

Table 2-4 lists the attributes for objects of type `qtssConnectedUserObjectType`.

Note: All of these attributes are preemptive safe, so they can be read by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, `QTSS_GetValuePtr`.

Table 2-4 Attributes of objects of type `qtssConnectedUserObjectType`

Attribute Name and Content	Access	Data Types
`qtssConnectionType` The user's connection type, such as "MP3".	Readable, preemptive safe	`char array`
`qtssConnectionCreateATimeInMsec` The time in milliseconds at which the session was created.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssConnectionTimeConnectedInMsec` Time in milliseconds the session has been connected.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssConnectionBytesSent` Number of RTP bytes sent so far for this session.	Readable, preemptive safe	`UInt32`
`qtssConnectionMountPoint` Presentation URL for this session. This URL is the "base" URL for the session. RTSP requests to this URL are assumed to affect all of the session's streams.	Readable, preemptive safe	char array
`qtssConnectionHostName` The host name of the connected client.	Readable, preemptive safe	`char array`
`qtssConnectionSessRemoteAddrStr` IP address of the client in dotted-decimal format.	Readable, preemptive safe	`char array`

Table 2-4 Attributes of objects of type `qtssConnectedUserObjectType` (continued)

Attribute Name and Content	Access	Data Types
`qtssConnectionSessLocalAddrStr` Local IP address for this connection in dotted-decimal format.	Readable, preemptive safe	`char array`
`qtssConnectionCurrentBitRate` Combined current bit rate in bits per second of all of the streams for this session. This is not an average.	Readable, preemptive safe	`UInt32`
`qtssConnectionPacketLossPercent` Combined current percent loss as a fraction; for example, .5 = 50%. This is not an average.	Readable, preemptive safe	`Float32`

qtssDynamicObjectType

An object of type `qtssDynamicObjectType` can be used to create an object that doesn't have any static attributes.

qtssFileObjectType

An object of type `qtssFileObject` consists of attributes that describe a file that has been opened. A file object (`QTSS_FileObject`) is an instance of this object type. These attributes are valid for all roles that receive a `QTSS_FileObject` in the structure the server passes to them.

Table 2-5 lists the attributes for objects of type `qtssFileObjectType`.

Note: All of these attributes are preemptive safe, so they can be read by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, or `QTSS_GetValuePtr`.

Table 2-5 Attributes of objects of type qtss`FileObjectType`

Attribute Name and Content	Access	Data Type
`qtssFlObjStream` The stream reference for this file object.	Readable, preemptive safe	`QTSS_Stream Ref`
`qtssFlOjFileSysModuleName` The name of the file system module that handles this file object	Readable, preemptive safe	`char array`
`qtssFlObjLength` The length of the file in bytes.	Readable, writable, preemptive safe	`UInt64`
`qtssFlObjPosition` The current position in bytes of the file's file pointer from the beginning of the file (byte zero).	Readable, writable, preemptive safe	`UInt64`
`qtssFlObjModDate` The date and time of the last time the file was modified.	Readable, writable, preemptive safe	`QTSS_TimeVal`

qttsModuleObjectType

An object of type `qtssModuleObject` consists of attributes that describe a particular QTSS module, including its name, version number, a description of what the module does, its preferences, and the roles the module is registered for. A module object (`QTSS_ModuleObject`) is an instance of this object type. These attributes are valid for all roles that receive a `QTSS_ModuleObject` in the structure the server passes to them.

For each module the server loads, the server creates a module object and passes it to the module in the module's Initialize role. Modules can get information about other modules the server has loaded by accessing the `qtssSvrModuleObject` attribute of the `QTSS_ServerObject` object.

In addition to the attributes that store the module's name, version number and description, this object type has a module preferences attribute, `qtssModPrefs`. The `qtssModPrefs` attribute itself is an object whose attributes store the module's preferences as instance attributes. All modifications to the `qtssModPrefs` attribute are persistent between invocations of the server because the contents of each module's `qtssModPrefs` attribute are written to the server's configuration file, which is read when the server starts up.

Table 2-6 lists the attributes for objects of type `qtssModuleObjectType`.

Note: With the exception of `qtssModDesc` and `qtssModVersion`, these attributes are preemptive safe and can be read by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, or `QTSS_GetValuePtr`.

Table 2-6 Attributes of objects of type `QTSS_ModuleObjectType`

Attribute Name and Content	Access	Data Type
`qtssModName` The module's name.	Readable, preemptive safe	`char array`
`qtssModDesc` A description of what the module does.	Readable, write not preemptive safe	`char array`
`qtssModVersion` The module's version number in the format 0x*MM.m.v.bbbb*, where *MM* = major version, *m* = minor version, *v* = very minor version, and *b* = build number.	Readable, writable, not preemptive safe	`UInt32`
`qtssModRoles` A list of all the roles for which this module is registered.	Readable, preemptive safe	`QTSS_Role`
`qtssModPrefs` An object whose attributes store the preferences for this module.	Readable, preemptive safe	`QTSS_ModulePrefsObject`
`qtssModAttributes` An object that modules can use to store any local attributes other than preferences.	Readable, writable, preemptive safe	`QTSS_Object`

qtssModulePrefsObjectType

An object of type `QTSS_ModulePrefsObject` consists of attributes that contain a module's preferences. A module preferences object (`QTSS_ModulePrefsObject`) is an instance of this object type.

Each module is responsible for adding attributes to its module preferences object and setting their values. The values of the attributes in the module preferences object are persistent between invocations of the server because the server writes the module preferences object for each module to a configuration file that the server reads when it is started.

qtssPrefsObjectType

An object of type `qtssPrefsObjectType` consists of attributes that describe the server's internal preference storage system. A preference object (`QTSS_PrefsObject`) is an instance of this object type. The attribute values for objects of this type are stored in the server's configuration file named `streamingserver.xml`. There is a single instance of this object type per server.

In previous versions of the QTSS programming interface, module preferences were stored in this object. Since version 4.0, module preferences have been stored in each module's `QTSS_ModuleObject` object.

Table 2-7 lists the attributes for objects of type `qtssPrefsObjectType`.

Note: None of these attributes is preemptive safe, so they can must be read by calling `QTSS_GetValue` or by locking the object, calling `QTSS_GetValuePtr, and unlocking the object.`

Table 2-7 Attributes of objects of type `qtssPrefsObjectType`

Attribute Name and Content	Access	Data Type
`qtssPrefsRTSPTimeout` Amount of time in seconds the server tells clients it will wait before disconnecting idle RTSP clients.	Readable, writable, not preemptive safe	`UInt32`
`qtssPrefsRealRTSPTimeout` The amount of time in seconds the server actually waits before disconnecting idle RTSP clients. This timer is reset each time the server receives a new RTSP request from the client. A value of zero means that there is no timeout.	Readable writable, not preemptive safe	`UInt32`
`qtssPrefsRTPTimeout` The amount of time in seconds the server will wait before disconnecting idle RTP clients. This timer is reset each time the server receives an RTCP status packet from a client. A value of zero means there is no timeout.	Readable, write not preemptive safe	`UInt32`
`qtssPrefsMaximumConnections` The maximum number of concurrent RTP connections the server allows. A value of –1 means that an unlimited number of connections are allowed.	Readable writable, not preemptive safe	`SInt32`
`qtssPrefsMaximumBandwidth` The maximum amount of bandwidth the server is allowed to serve in K bits. If the server exceeds this value, it responds to new client requests for additional streams with RTSP error 453, “Not Enough Bandwidth.” A value of –1 means the amount of bandwidth the server is allowed to serve is unlimited.	Readable, writable, not preemptive safe	`SInt32`

Table 2-7 Attributes of objects of type `qtssPrefsObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssPrefsMovieFolder` The path to the root movie folder.	Readable, writable, not preemptive safe	`char array`
`qtssPrefsRTSPIPAddr` Specifies the IP address in dotted-decimal format the server should accept RTSP client connections on. A value of 0 means the server should accept connections on all IP addresses that are currently enabled on the system.	Readable, writable, not preemptive safe	`char array`
`qtssPrefsBreakOnAssert` If `true`, the server will stop and enter the debugger when an assert fails	Readable, write not preemptive safe	`Bool16`
`qtssPrefsAutoRestart` If `true`, the server automatically restarts itself if it crashes.	Readable, writable, not preemptive safe	`Bool16`
`qtssPrefsTotalBytesUpdate` The interval in seconds between updates of the server's total bytes and current bandwidth statistics.	Readable, writable, not preemptive safe	`UInt32`
`qtssPrefsAvgBandwidthUpdate` The interval in seconds between computations of the server's average bandwidth.	Readable, writable, not preemptive safe	`UInt32`
`qtssPrefsSafePlayDuration` If the server finds it is serving more than its allowed maximum bandwidth (using the average bandwidth computation), it will attempt to disconnect the most recently connected clients until the average bandwidth drops to acceptable levels. However, it will not disconnect clients if they've been connected for longer than the time in seconds specified by this attribute. If this value is set to zero, the server does not disconnect clients.	Readable, write not preemptive safe	`UInt32`

Table 2-7 Attributes of objects of type `qtssPrefsObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssPrefsModuleFolder` The path to the folder containing dynamic loadable server modules. The configuration file sets this attribute to `/Library/QuickTimeStreaming/Modules (Mac OS X)`, `/usr/local/sbin/StreamingServer/Modules (Darwin platforms)`, and `c:\Program Files\Darwin StreamingServer\QTSSModules` (Win32 platforms).	Readable, writable, not preemptive safe	`char array`
The built-in error log module that loads before all other modules uses the following seven attributes:		
`qtssPrefsErrorLogName` Sets the name of the error log file. The configuration file sets this value to "Error."	Readable, writable, not preemptive safe	`char array`
`qtssPrefsErrorLogDir` Sets the path to the directory containing the error log file. The configuration file sets this value to `/Library/QuickTimeStreaming/Logs`.	Readable, writable, not preemptive safe	`char array`
`qtssPrefsErrorRollInterval` The interval in days between rolling the error log file. A value of zero means that there is no interval.	Readable, writable, not preemptive safe	`UInt32`
`qtssPrefsMaxErrorLogSize` The maximum size in bytes of the error log. A value of zero means that the server does not impose a limit.	Readable, writable, not preemptive safe	`UInt32`

Table 2-7 Attributes of objects of type `qtssPrefsObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssPrefsErrorLogVerbosity` Sets the verbosity level of messages the error logger logs. The following values are meaningful: 0 = log fatal errors 1 = log fatal errors and warnings 2 = log fatal errors, warnings, and asserts 3 = log fatal errors, warnings, asserts, and debug messages	Readable, writable, not preemptive safe	`UInt32`
`qtssPrefsScreenLogging` Set to `true` to true to write error log messages to the terminal window. Note that in order to see the messages, the server must be launched from the command line in foreground mode (triggered by the use of the `-d` flag).	Readable, writable, not preemptive safe	`Bool16`
`qtssPrefsErrorLogEnabled` Set to `true` to enable error logging.	Readable, writable, not preemptive safe	`Bool16`
`qtssPrefsDoReportHTTPConnectionAddress` When behind a round-robin DNS, the client needs to be told the IP address of the machine that is handling its request. This attribute tells the server to report its IP address in the reply to the HTTP GET request when tunneling RTSP through HTTP.	Readable, writable, not preemptive safe	`Bool16`
`qtssPrefsRunUserName` Run under the specified user name.	Readable, writable, not preemptive safe	`char array`
`qtssPrefsRunGroupName` Run under the specified group name.	Readable, writable, not preemptive safe	`char array`

Table 2-7 Attributes of objects of type `qtssPrefsObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssPrefsSrcAddrInTransport` If set to `true`, the server will add its source address to its transport headers. This is necessary on certain networks where the source address is not necessarily known.	Readable, writable, not preemptive safe	`Bool16`
`qtssPrefsRTSPPorts` Ports for accepting RTSP client connections. By default, ports 554 and 7070 are set. Add port 80 to this list if you are streaming across the Internet and want clients behind firewalls to be able to connect to the server.	Readable, writable, not preemptive safe	`UInt16`
`qtssPrefsAltTransportIPAddr` The server appends its own IP address to the transport header. If you want an alternate address placed there, use this attribute to specify the address.	Readable, writable, not preemptive safe	`char array`
`qtssPrefsReliableUDPSlowStart` Set to `true` if reliable UDP slow start is enabled. Disabling UDP slow start may lead to an initial burst of packet loss due to mis-estimate of the client's available bandwidth. Enabling UDP slow start may lead to premature reduction of the bit rate (known as “thinning”).	Readable, writable, not preemptive safe	`Bool16`
`qtssPrefsAuthenticationScheme` Set this attribute to the authentication scheme you want the server to use. The currently supported values are “basic,” “digest,” and “none.”	Readable, writable, not preemptive safe	`char array`

qtssRTPStreamObjectType

An object of type `qtssRTPStreamObjectType` consists of attributes that describe a particular RTP stream whether it’s an audio, video, or text stream. An RTP stream object (`QTSS_RTPStreamObject`) is an instance of this object type and is created by

calling QTSS_AddRTPStream. An RTP stream object must be associated with a single client session object (QTSS_ClientSessionObject). A client session object may be associated with any number of RTP stream objects. These attributes are valid for all roles that receive a QTSS_RTPStreamObject in the structure the server passes to them.

Table 2-8 lists the attributes for objects of type qtssRTPStreamObjectType.

Note: All of these attributes are preemptive safe, so they can be read by calling QTSS_GetValue, QTSS_GetValueAsString, or QTSS_GetValuePtr.

Table 2-8 Attributes of objects of type qtssRTPStreamObjectType

Attribute Name and Content	Access	Data Type
qtssRTPStrTrackID Unique ID that identifies each RTP stream.	Readable, writable, preemptive safe	UInt32
qtssRTPStrSSRC Synchronization source (SSRC) generated by the server. The SSRC is guaranteed to be unique among all streams in the session. The server includes the SSRC in all RTCP Sender Reports that the server generates.	Readable, preemptive safe	UInt32
qtssRTPStrPayloadName Name of the media for this stream. This attribute is empty unless a module explicitly sets it.	Readable, writable, preemptive safe	char array
qtssRTPStrPayloadType Payload type of the media for this stream. The value of this attribute is qtssUnknownPayloadType unless a module sets it to qtssVideoPayloadType or qtssAudioPayloadType.	Readable, writable, preemptive safe	QTSS_RTPPayloadType

Table 2-8 Attributes of objects of type `qtssRTPStreamObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssRTPStrFirstSeqNumber` Sequence number of the first packet after the last PLAY request was issued. If known, this attribute must be set by a module before calling `QTSS_Play`. The server uses this attribute to generate a proper RTSP PLAY response.	Readable, writable, preemptive safe	`SInt16`
`qtssRTPStrFirstTimestamp`RTP timestamp of the first RTP packet generated for this stream after the last PLAY request was issued. If known, this attribute must be set by a module before calling `QTSS_Play`. The server uses this attribute to generate a proper RTSP PLAY response.	Readable, writable, preemptive safe	`SInt32`
`qtssRTPStrTimescale` Timescale for the track. If known, this must be set before calling `QTSS_Play`.	Readable, writable, preemptive safe	`SInt32`
`qtssRTPStrBufferDelayInSecs` Size of the client's buffer. The server sets this attribute to three seconds, but the module is responsible for determining the buffer size and setting this attribute accordingly.	Readable, preemptive safe	`Float32`
`qtssRTPStrNetworkMode` Network mode for the RTP stream. Possible values are `qtssRTPNetworkModeDefault`, `qtssRTPNetworkModeMulticast`, and `qtssNetworkModeUnicast`.	Readable, preemptive safe	`UInt32`

The values of the following attributes come from the most recent RTCP packet received on a stream. If a field in the most recent RTCP packet is blank, the server sets the value of the corresponding attribute to zero.

`qtssRTPStrFractionLostPackets` The fraction of packets that have been lost for this stream.	Readable, preemptive safe	`UInt32`

Table 2-8 Attributes of objects of type `qtssRTPStreamObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssRTPStrTotalLostPackets` The total number of packets that have been lost for this stream.	Readable, preemptive safe	`UInt32`
`qtssRTPStrJitter` Cumulative jitter for this stream.	Readable, preemptive safe	`UInt32`
`qtssRTPStrRecvBitRate` Average bit rate received by the client in bits per second.	Readable, preemptive safe	`UInt32`
`qtssRTPStrAvgLateMilliseconds` Average in milliseconds of packets that the client received late.	Readable, preemptive safe	`UInt16`
`qtssRTPStrPercentPacketsLost` Fixed percentage of lost packets for this stream.	Readable, preemptive safe	`UInt16`
`qtssRTPStrAvgBugDelayInMsec` Average buffer delay in milliseconds.	Readable, preemptive safe	`UInt16`
`qtssRTPStrGettingBetter` A non-zero value if the client reports that the stream is getting better.	Readable, preemptive safe	`UInt16`
`qtssRTPStrGettingWorse` A non-zero value if the client reports that the stream is getting worse.	Readable, preemptive safe	`UInt16`
`qtssRTPStrNumEyes` Number of clients connected to this stream.	Readable, preemptive safe	`UInt32`
`qtssRTPStrNumEyesActive` Number of clients playing this stream.	Readable, preemptive safe	`UInt32`
`qtssRTPStrNumEyesPaused` Number of clients connected but currently paused.	Readable, preemptive safe	`UInt32`
`qtssRTPStrTotPacketsRecv` Total packets received by the client.	Readable, preemptive safe	`UInt32`

Table 2-8 Attributes of objects of type `qtssRTPStreamObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssRTPStrTotPacketsDropped` Total packets dropped by the client.	Readable, preemptive safe	`UInt16`
`qtssRTPStrTotPacketsLost` Total packets lost.	Readable, preemptive safe	`UInt16`
`qtssRTPStrClientBufFill` How full the client buffer is in tenths of a second.	Readable, preemptive safe	`UInt16`
`qtssRTPStrFrameRate` The current frame rate in frames per second.	Readable, preemptive safe	`UInt16`
`qtssRTPStrExpFrameRate` The expected frame rate in frames per second.	Readable, preemptive safe	`UInt16`
`qtssRTPStrAudioDryCount` Number of times the audio has run dry.	Readable, preemptive safe	`UInt16`
`qtssRTPStrIsTCP` If this RTP stream is being sent over TCP, this attribute is `true`. If this RTP stream is being sent over UDP, this attribute is `false`.	Readable, preemptive safe	`Bool16`
`qtssRTPStrStreamRef` A `QTSS_StreamRef` used for sending RTP or RTCP packets to the client. Use `QTSS_WriteFlags` to specify whether each packet is an RTP or RTCP packet.	Readable, preemptive safe	`QTSS_StreamRef`
`qtssRTPStrTransportType` The transport type.	Readable, preemptive safe	`QTSS_RTPTransportType`

qtssRTSPHeaderObjectType

An object of type `qtssRTSPHeaderObjectType` consists of attributes containing all of the RTSP request headers associated with an individual RTSP request. An RTSP header object (`QTSS_RTSPHeaderObject) is an instance of this object type.`

The names of the attributes are the names of the RTSP headers associated with that RTSP request. For example, the following RTSP request has a Session header and a User-agent header:

```
DESCRIBE /foo.mov RTSP/1.0
Session: 20fj02ijf
User-agent: QTS/4.0.3
```

In this case, the value of the Session attribute is "20fj02ijf" and the value of the User-agent attribute is "QTS/4.0.3". Modules can get the value of a given header by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, or `QTSS_GetValuePtr`.

qtssRTSPRequestObjectType

An object of type `qtssRTSPRequestObjectType` consists of attributes that describe a particular RTSP request. An RTSP request object (`QTSS_RTSPRequestObject`) is an instance of this object type and exists from the time the server receives a complete RTSP request from a client until the response is sent and the server moves on to the next request. An RTSP request object must be associated with a single RTSP session object (`QTSS_RTSPSessionObject`) for a given request made over a given connection.

With the exception of the RTSP Filter role, the value of each attribute is available in all roles that receive an object of type `QTSS_RTSPRequestObject`. When the RTSP Filter role receives an object of type `QTSS_RTSPRequestObject`, the only attribute that has a value is the `qtssRTSPReqFullRequest` attribute.

Each text name is identical to its enumerated type name.

Table 2-9 lists the attributes for objects of type `qtssRTSPRequestObjectType`.

Note: All of these attributes are preemptive safe, so they can be read by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, or `QTSS_GetValuePtr`.

Table 2-9 Attributes of type `qtssRTSPRequestObjectType`

Attribute Name and Content	Access	Data Type
`qtssRTSPReqFullRequest` The complete RTSP request as sent by the client. This attribute is available in every role that receives an object of type `QTSS_RTSPRequestObject`.	Readable, preemptive safe	`char array`
`qtssRTSPReqMethodStr` The RTSP method of this request.	Readable, preemptive safe	`char array`
`qtssRTSPReqFilePath` URI for this request, converted to a local file system path.	Readable, preemptive safe	`char array`
`qtssRTSPReqURI` URI for this request.	Readable, preemptive safe	`char array`
`qtssRTSPReqFilePathTrunc` Same as `qtssRTSPReqFilePath`, but without the last element of the path.	Readable, preemptive safe	`char array`
`qtssRTSPReqFileName` All characters after the last path separator in the file system path.	Readable, preemptive safe	`char array`
`qtssRTSPReqFileDigit` If the URI ends with one or more digits, this attribute points to those digits.	Readable, preemptive safe	`char array`
`qtssRTSPReqAbsoluteURL` The full URL starting with "rtsp://".	Readable, preemptive safe	`char array`
`qtssRTSPReqTruncAbsoluteURL` The URL without last element of the path.	Readable, preemptive safe	`char array`
`qtssRTSPReqMethod` The RTSP method as a value of type `QTSS_RTSPMethod`.	Readable, preemptive safe	`QTSS_RTSPMethod`

Table 2-9 Attributes of type `qtssRTSPRequestObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssRTSPReqStatusCode` The current status code for the request as `QTSS_RTSPStatusCode`. By default, the value is `qtssSuccessOK`. If a module sets this attribute and calls `QTSS_SendRTSPHeaders`, the status code in the header that the server generates contains the value of this attribute.	Readable, writable, preemptive safe	`QTSS_RTSPStatusCode`
`qtssRTSPReqStartTime` The start time specified in the Range header of the PLAY request.	Readable, preemptive safe	`Float64`
`qtssRTSPReqStopTime` The stop time specified in the Range header of the PLAY request.	Readable, preemptive safe	`Float64`
`qtssRTSPReqRespKeepAlive` Set this attribute to `true` if you want the server to keep the connection open after completion of the request. Otherwise, set this attribute to `false` if you want the server to terminate the connection upon completion of the request.	Readable, writable, preemptive safe	`Bool16`
`qtssRTSPReqRootDir` The root directory for this request. The default value for this attribute is the server's media folder path. Modules can set this attribute from the RTSP Route role.	Readable, writable, preemptive safe	`char array`
`qtssRTSPReqRealStatusCode` Same as the `qtssRTSPReqStatusCode` attribute but translated from a `QTSS_RTSPStatusCode` to an actual RTSP status code.	Readable, preemptive safe	`UInt32`

Table 2-9 Attributes of type `qtssRTSPRequestObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssRTSPReqStreamRef` A value of type `QTSS_StreamRef` for sending data to the RTSP client. This stream reference, unlike the one provided as an attribute in the `QTSS_RTSPSessionObject`, never returns `QTSS_WouldBlock` in response to a `QTSS_Write` or a `QTSS_WriteV` call.	Readable, preemptive safe	`QTSS_StreamRef`
`qtssRTSPReqUserName` The decoded user name, if provided by the RTSP request.	Readable, preemptive safe	`char array`
`qtssRTSPReqURLRealm` The authorization entity for the client to display in the following string: "Please enter password for realm at server-name. The default value of this attribute is "Streaming Server."	Readable, writable, preemptive safe	`char array`
`qtssRTSPReqIfModSinceDate` If the RTSP request contains an If-Modified-Since header, this attribute is the if-modified date converted to a value of type `QTSS_TimeVal`.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssRTSPReqRespMsg` The error message that is sent back to the client if the response was an error. A module sending an RTSP error to the client should set this attribute to be a text message that describes why the error occurred. It is also useful to write this message to a log file. Once the RTSP response has been sent, this attribute contains the response message.	Readable, writable, preemptive safe	`char array`
`qtssRTSPReqContentLen` Content length of incoming RTSP request body.	Readable, preemptive safe	`UInt32`

Table 2-9 Attributes of type `qtssRTSPRequestObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssRTSPReqSpeed` Value of the speed header.	Readable, preemptive safe	`Float32`
`qtssRTSPReqLateTolerance` Value of the late-tolerance field in the `x-RTP-Options` header, or –1 if not present.	Readable, preemptive safe	`Float32`
`qtssRTSPReqSkipAuthorization` Set by a module that wants this request to be allowed by all authorization modules.	Readable, writable, preemptive safe	`Bool16`
`qtssRTSPReqNetworkMode` Network mode for the request. Possible values are `qtssRTPNetworkModeDefault`, `qtssRTPNetworkModeMulticast`, and `qtssRTPNetworkModeUnicast`.	Readable, preemptive safe	`Bool16`

qtssRTSPSessionObjectType

An object of type `qtssRTSPSessionObjectType` consists of attributes associated with an RTSP client-server connection. An RTSP session object (`QTSS_RTSPSessionObject`) is an instance of this object type and exists as long as the RTSP client is connected to the server. These attributes are valid for all roles that receive a `QTSS_RTSPSessionObject` in the structure the server passes to them.

Table 2-10 lists the attributes for objects of type `qtssRTSPSessionObjectType`.

Note: All of these attributes are preemptive safe, so they can be read by calling `QTSS_GetValue`, `QTSS_GetValueAsString`, or `QTSS_GetValuePtr`.

Table 2-10 Attributes of objects of type `QTSS_RTSPSessionObjectType`

Attribute Name and Content	Access	Data Type
`qtssRTSPSesID` An ID that uniquely identifies each RTSP session since the server started up.	Readable, preemptive safe	`UInt32`
`qtssRTSPSesLocalAddr` Local IP address for this RTSP session.	Readable, preemptive safe	`UInt32`
`qtssRTSPSesLocalAddrStr` Local IP address for the RTSP session in dotted-decimal format.	Readable, preemptive safe	`char array`
`qtssRTSPSesLocalDNS` DNS name that corresponds to the local IP address for this RTSP session.	Readable, preemptive safe	`char array`
`qtssRTSPSesRemoteAddr` IP address of the client.	Readable, preemptive safe	`UInt32`
`qtssRTSPSesRemoteAddrStr` IP address of the client in dotted-decimal format.	Readable, preemptive safe	`char array`
`qtssRTSPSesEventCntxt` An event context for the RTCP connection to the client. This attribute should primarily be used to wait for flow-controlled `EV_WR` event when responding to a client.	Readable, preemptive safe	`QTSS_EventContextRef`
`qtssRTSPSesType` The RTSP session type. Possible values are `qtssRTSPSession`, `qtssRTSPHTTPSession` (an HTTP tunneled RTSP session), and `qtssRTSPHTTPInputSession`. Sessions of type `qtssRTSPHTTPInputSession` are usually very short lived.	Readable, preemptive safe	`QTSS_RTSPSessionType`

Table 2-10 Attributes of objects of type `QTSS_RTSPSessionObjectType`

Attribute Name and Content	Access	Data Type
`qtssRTSPSesStreamRef` A `QTSS_StreamRef` used for sending data to the RTSP client.	Readable, preemptive safe	`QTSS_RTSPSessionStream`
`qtssRTSPSesLocalPort` Local port for the connection.	Readable, preemptive safe	`UInt16`
`qtssRTSPSesRemotePort` Remote (client) port for the connection.	Readable, preemptive safe	`UInt16`

qtssServerObjectType

An object of type `qtssServerObjectType` consists of attributes that contain global server information, such as server statistics. A server object (`QTSS_ServerObject) is an instance of this object type.` There is a single instance of this object type for each server. These attributes are valid for all roles that receive a `QTSS_ServerObject` in the structure the server passes to them.

Table 2-11 lists the attributes for objects of type `qtssServerObjectType`.

Note: Some of these attributes are not preemptive safe, as noted in Table 2-11.

Table 2-11 Attributes of objects of type `qtssServerObjectType`

Attribute Name and Content	Access	Data Type
`qtssServerAPIVersion` The API version supported by this server. The format of this value is 0x*MMMMmmmm*, where *M* is the major version number and *m* is the minor version number.	Readable, preemptive safe	`UInt32`
`qtssSvrDefaultDNSName` The "default" DNS name of the server.	Readable, preemptive safe	`char array`
`qtssSvrDefaultIPAddr` The "default" IP address of the server.	Readable, preemptive safe	`UInt32`
`qtssSvrServerName` The name of the server.	Readable, preemptive safe	`char array`
`qtssSvrServerVersion` The version of the server.	Readable, preemptive safe	`char array`
`qtssSvrServerBuildDate` Date that the server was built.	Readable, preemptive safe	`char array`
`qtssSvrRTSPServerHeader` The header that the server uses when responding to RTSP clients.	Readable, preemptive safe	`char array`
`qtssSvrConnectedUsers` The number of connected clients. The QTSSMP3StreamingModule is the only module that adds `QTSS_ConnectedUserObject` objects to this attribute, but other modules can add `QTSS_ConnectedUserObject` objects filled in with their own data.	Readable, writable, not preemptive safe	`QTSS_ConnectedUserObject`
`qtssMP3SvrCurConn` Number of currently connected MP3 client sessions.	Readable, writable, preemptive safe	`UInt32`

Table 2-11 Attributes of objects of type `qtssServerObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssMP3TotalConn` Total number of MP3 client sessions since the server started up.	Readable, writable, preemptive safe	`UInt32`
`qtssMP3SvrCurBandwidth` MP3 bandwidth in bits per second that the server is currently sending.	Readable, writable, preemptive safe	`UInt32`
`qtssMP3SvrTotalBytes` Total number of MP3 bytes sent since the server started up.	Readable, writable, preemptive safe	`UInt32`
`qtssMP3SvrAvgBandwidth` Average MP3 bandwidth in bits per second that the server is currently sending.	Readable, writable, preemptive safe	`UInt32`
`qtssSvrState` The current state of the server. Possible values are `qtssStartingUpState`, `qtssRunningState`, `qtssRefusingConnectionsState`, `qtssFatalErrorState`, `qtssShuttingDownState`, and`qtssIdleState`. Modules can set the server state. If a module sets the server state, the server responds accordingly. Setting the server state to `qtssRefusingConnectionsState` causes the server to refuse new connections. Setting the server state to `qtssFatalErrorState` or to `qtssShuttingDownState` causes the server to quit. The `qtssFatalErrorState state indicates that a fatal error has occurred but the server is not shutting down yet.`	Readable, writable, not preemptive safe	`QTSS_ServerState`
`qtssSvrRTSPPorts` An indexed attribute containing all the ports the server is listening on.	Readable, not preemptive safe	`char array`

Table 2-11 Attributes of objects of type `qtssServerObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssSvrIsOutOfDescriptors` If the server has run out of file descriptors, this attribute is `true`; otherwise, this attribute is `false`.	Readable, not preemptive safe	`Bool16`
`qtssRTSPCurrentSessionCount` The number of clients that are currently connected over standard RTSP.	Readable, not preemptive safe	`UInt32`
`qtssRTSPHTTPCurrentSessionCount` The number of clients that are currently connected over RTSP/HTTP.	Readable, not preemptive safe	`UInt32`
`qtssRTPSvrNumUDPSockets` Number of UDP sockets currently being used by the server.	Readable, not preemptive safe	`UInt32`
`qtssRTPSvrCurConn` The number of clients currently connected to the server.	Readable, not preemptive safe	`UInt32`
`qtssRTPSvrTotalConn` Total number of clients that have connected to the server since the server started up.	Readable, not preemptive safe	`UInt32`
`qtssRTPSvrCurBandwidth` Current bandwidth being output by the server in bits per second.	Readable, not preemptive safe	`UInt32`
`qtssRTPSvrTotalBytes` Total number of bytes output since the server started up.	Readable, not preemptive safe	`UInt64`
`qtssRTPSvrAvgBandwidth` Average bandwidth output by the server in bits per second.	Readable, not preemptive safe	`UInt32`
`qtssRTPSvrCurPackets` Current packets per second being output by the server.	Readable, not preemptive safe	`UInt32`

Table 2-11 Attributes of objects of type `qtssServerObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssRTPSvrTotalPackets` Total number of bytes output since the server started up.	Readable, not preemptive safe	`UInt64`
`qtssSvrHandledMethods` The methods that the server supports. Modules should append the methods they support to this attribute in their `QTSS_Initialize_Role`.	Readable, writable, not preemptive safe	`QTSS_RTSPMethod`
`qtssSvrCurrentTimeMilliseconds` The server's current time in milliseconds. Getting the value of this attribute is equivalent to calling `QTSS_Milliseconds`.	Readable, not preemptive safe	`QTSS_TimeVal`
`qtssSvrCPULoadPercent` The percentage of CPU time the server is currently using.	Readable, not preemptive safe	`Float32`
`qtssSvrModuleObjects` A module object representing each module.	Readable, preemptive safe	`QTSS_ModuleObject`
`qtssSvrStartupTime` The time at which the server started up.	Readable, preemptive safe	`QTSS_TimeVal`
`qtssSvrGMTOffsetInHrs` The time zone in which the server is running (offset from GMT in hours).	Readable, preemptive safe	`SInt32`
`qtssSvrDefaultIPAddrStr` The default IP address of the server as a string.	Readable, preemptive safe	`char array`

Table 2-11 Attributes of objects of type `qtssServerObjectType` (continued)

Attribute Name and Content	Access	Data Type
`qtssSvrPreferences` An object representing each of the server's preferences.	Readable, preemptive safe	`QTSS_PrefsObject`
`qtssSvrClientSessions` An object containing all client sessions stored as indexed `QTSS_ClientSessionObject` objects.	Read	`QTSS_Object`
`qtssSvrMessages` An object containing the server's error messages.	Readable, preemptive safe	`QTSS_Object`

qtssTextMessageObjectType

An object of type `qtssTextMessageObjectType` consists of attributes whose values are intended for display to the user or that are returned to the client. A text message object (`QTSS_TextMessageObject`) is an instance of this object type. To make localization easier, the attribute values are text strings.

QTSS Streams

The QTSS programming interface provides QTSS stream references as a generalized stream abstraction. Streams can be used for reading and writing data to many types of I/O sources, including, but not limited to files, the error log, and sockets and for communicating with the client via RTSP or RTP. In all RTSP roles, for example, modules receive an object of type `QTSS_RTSPRequestObject` that has a `qtssRTSPReqStreamRef` attribute. The value of this attribute is of type `QTSS_StreamRef`, and it can be used for sending RTSP response data to the client.

Unless otherwise noted, all streams are asynchronous. When using the asynchronous QTSS file system callbacks, modules should be prepared to receive the `QTSS_WouldBlock` result code, subject to the restrictions and rules of each stream

type described in this section. The QTSS_WouldBlock error is returned from a stream callback when completing the requested operation would require the current thread to block. For instance, QTSS_Write on a socket will return QTSS_WouldBlock if the socket is currently subject to flow control. For information on threading and asynchronous I/O, see the section "Runtime Environment for QTSS Modules" (page 23).

When a module receives the QTSS_WouldBlock result code, modules should call the QTSS_RequestEvent callback routine to request a notification from the server when the specified stream becomes available for I/O. After calling QTSS_RequestEvent, the module should return control immediately to the server. The module will be re-invoked in the same role in the exact same state when the specified stream is available for I/O.

All stream references are of type QTSS_StreamRef. The QTSS programming interface uses following stream types:

QTSS_ErrorLogStream
: Used for writing binary data to the server's error log. There is a single instance of this stream type, which is passed to each module in the Initialize role. When data is written to this stream, modules that have registered for the Error Log role are invoked. For information about this role, see the section "Error Log Role" (page 30). All operations on this stream type are synchronous.

QTSS_FileStream
: Represents a file and is obtained by making the QTSS_OpenFileStream callback. If the file stream is opened with the qtssFileStreamAsync flag, callers should expect to receive a result code of QTSS_WouldBlock when they call QTSS_Read, QTSS_Write, and QTSS_WriteV.

QTSS_RTSPSessionStream
: Used for reading data (QTSS_Read) from an RTSP client and writing data (QTSS_Write or QTSS_WriteV) to an RTSP client. The server may encounter flow control conditions, so modules should be prepared to handle QTSS_WouldBlock result codes when reading from or writing to this stream type. Calling QTSS_Read means that you are reading the request body sent by the client to the server. This stream reference is an attribute of the object QTSS_RTSPSessionObject.

QTSS_RTSPRequestStream

Used for reading data (QTSS_Read) from an RTSP client and writing data (QTSS_Write or QTSS_WriteV) to an RTSP client. This stream is identical to the QTSS_RTSPSessionStream stream except that data written to streams of this type is buffered in memory until a full RTSP response is constructed. Because the data is buffered internally, modules do not receive QTSS_WouldBlock errors when writing to streams of this type. Calling QTSS_Read on this type of stream means that you are reading the request body sent by the client to the server. Modules that call QTSS_Read to read this type of stream should be prepared to handle a result code of QTSS_WouldBlock. This stream reference is an attribute of the object QTSS_RTSPRequestObject.

QTSS_RTPStreamStream

Used for writing data to an RTP client. When writing to a stream of this type, a single write call corresponds to a single, complete RTP packet, including headers. Currently, it is not possible to use the QTSS_RequestEvent callback to receive events for this stream, so if QTSS_Write or QTSS_WriteV returns QTSS_WouldBlock, modules must poll periodically for the blocking condition to be lifted. This stream reference is an attribute of the object QTSS_RTPStreamObject.

QTSS_SocketStream

Represents a socket. This stream type allows modules to use the QTSS stream event mechanism (QTSS_RequestEvent) for raw socket I/O. (In fact, the QTSS_RequestEvent callback is the only stream callback available for this type of stream.) Modules should read sockets asynchronously and should use the operating system's socket function to read from and write to sockets. When those routines reach a blocking condition, the module can call QTSS_RequestEvent to be notified when the blocking condition has cleared.

Table 2-12 uses an "X" to summarize the I/O-related callback routines that are appropriate for each type of stream.

Table 2-12 Streams and appropriate callback routines

Stream Type	Read	Seek	Flush	Advise	Write	WriteV	Request Event	Signal Stream
File Stream	X	X		X			X	X
Error Log					X			
Socket Stream							X	
RTSP Session Stream	X		X		X	X	X	
RTSP Request Stream	X		X		X	X	X	
RTP Stream	X		X		X	X		

QTSS Services

QTSS services are services the modules can access. The service may be a built-in service provided by the server or an added service provided by another module. An example of a service would be a logging module that allows other modules to write messages to the error log.

Modules use the callback routines described in the section "Service Callback Routines" (page 174) to register and invoke services. Modules add and find services in a way that is similar to the way in which they add and find attributes of an object.

Every service has a name. To invoke a service, the calling module must know the name of the service and resolve that name into an ID.

Each service has its own specific parameter block format. Modules that export services should carefully document the services they export. Modules that call services should fail gracefully if the service isn't available or returns an error.

A module that implements a service calls `QTSS_AddService` in its Register role to add the service to the server's internal database of services, as shown in the following code:

```
void MyAddService()
{
    QTSS_Error theErr = QTSS_AddService("MyService", &MyServiceFunction);
}
```

The `MyServiceFunction` corresponds to the name of a function that must be implemented in the same module. Here is a stub implementation of the `MyServiceFunction`:

```
QTSS_Error MyServiceFunction(MyServiceArgs* inArgs)
{
    // Each service function must take a single void* argument
    // Implement the service here.
    // Return a QTSS_Error.
}
```

To use a service, a module must get the service's ID by calling `QTSS_IDForService` and providing the name of the service as a parameter. With the service's ID, the module calls `QTSS_DoService` to cause the service to run, as shown in Listing 2-1.

Listing 2-1 Starting a service

```
void MyInvokeService()
{
    // Service functions take a single void* parameter that corresponds
    // to a parameter block specific to the service.
```

```
    MyServiceParamBlock theParamBlock;

    // Initialize service-specific parameters in the parameter block.
    theParamBlock.myArgument = xxx;
    QTSS_ServiceID theServiceID = qtssIllegalServiceID;
    // Get the service ID by providing the name of the service.
    QTSS_Error theErr = QTSS_IDForService('MyService', &theServiceID);
    if (theErr != QTSS_NoErr)
        return; // The service isn't available.

    // Run the service.
    theErr = QTSS_DoService(theServiceID, &theParamBlock);
}
```

Built-in Services

The QuickTime Streaming Server provides built-in services that modules may invoke using the service routines. In this version of the QTSS programming interface, there is one built-in service:

```
#define QTSS_REREAD_PREFS_SERVICE "ReadPreferences"
```

Invoking the Reread Preferences service causes the server to reread its preferences and invoke each module in the Reread Preferences role, if they have registered for that role.

To invoke a built-in service, retrieve the service ID of the service by calling `QTSS_IDForService`. Then call `QTSS_DoService` to run the service.

Automatic Broadcasting

The QuickTime Streaming Server (QTSS) can accept RTSP ANNOUNCE requests from QuickTime broadcasters. Support for ANNOUNCE requests and the ability of the server to act as an RTSP client allow the server to initiate new relay sessions. This section describes the two ways in which an automatic broadcast can be initiated, how ANNOUNCE requests work with SDP, and how the `qtaccess` and `qtusers` files control automatic broadcasting.

Automatic Broadcasting Scenarios

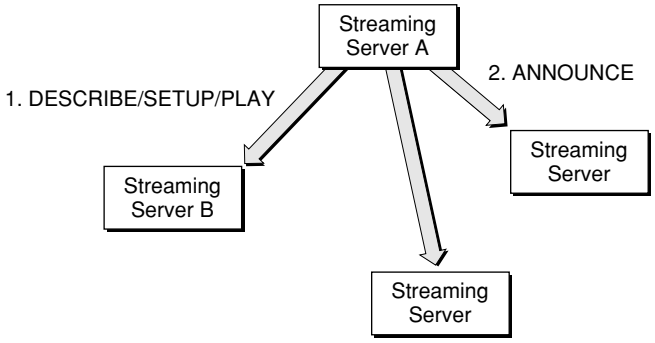
QTSS supports two automatic broadcasting scenarios:

- Pull then push. To initiate automatic broadcast, an RTSP client sends standard RTSP requests to request a stream and the server then relays the stream to one or more other streaming servers. This scenario is described in the section "Pull Then Push" (page 79).
- Listen then push. In this scenario, an automatic broadcast is initiated when the streaming server receives an ANNOUNCE request. This scenario is described in the section "Listen Then Push" (page 80).

Pull Then Push

The user can request a stream from a remote source by making standard DESCRIBE/SETUP/PLAY requests and then relay it to one or more destinations. This functionality can be useful when an organization only wants one copy of an outside stream to consume bandwidth on its Internet connection. The relay would sit just inside the corporate network and push the stream to a reflector (possibly itself). Figure 2-5 provides an example of the pull-then-push scenario.

Figure 2-5 Pull-then-push automatic broadcasting



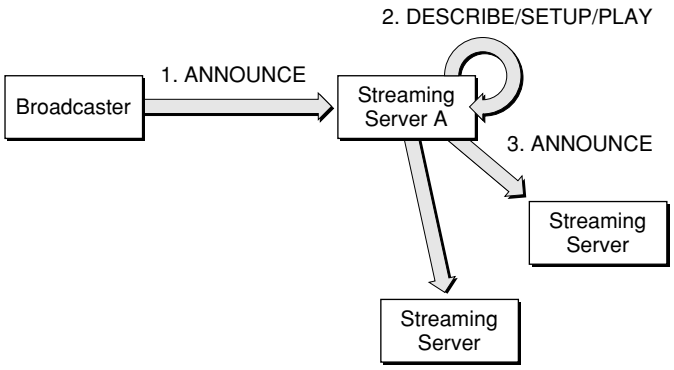
Using Figure 2-5 as a reference, the steps for the pull-then-push scenario are as follows:

1. Streaming Server A (the relay client) sends standard RTSP client DESCRIBE/SETUP/PLAY requests to a remote server, Streaming Server B.
2. The relay "client" (Streaming Server A) that requested the stream will begin receiving it and then send an ANNOUNCE to all of the destinations listed in the relay configuration for that particular incoming stream.

Listen Then Push

The streaming server can be configured to send incoming streams created by an ANNOUNCE request to one or more destination machines automatically. This can be useful for setting up an automated broadcast network. Figure 2-6 provides an example of the pull-then-push scenario.

Figure 2-6 Listen-then-push automatic broadcasting



Using Figure 2-6 as a reference, the steps for the listen -then-push scenario are as follows:

- A remote machine (a broadcaster or a relay) sends an ANNOUNCE request to Streaming Server A. The streaming server may accept or deny the request. If it accepts the request, the streaming server checks its relay configuration to determined whether the stream should be relayed.
- If the stream should be relayed, the streaming server will send standard RTSP client DESCRIBE/SETUP/PLAY request to itself.

- The relay "client" (Streaming Server A) that requested the stream will begin receiving it and then send an ANNOUCE to all of the destinations listed in its relay configuration for that particular incoming stream.

By default, authentication is required for automatic broadcasts. ANNOUNCE requests from broadcasters are filtered through the authentication mechanism active in the server. To support broadcast authentication, a new WRITE directive has been added to qtaccess file. The new directive allows SDP files to be written to the `movies` folder.

ANNOUNCE and SDP

The ANNOUNCE request contains the Session Description Protocol (SDP) information for the broadcast. The ANNOUNCE request's URI value may contain path delimiters in order to provide name space functionality.

When a broadcast is initiated by an ANNOUNCE request, the SDP information is stored in an in-memory broadcast list. To terminate a broadcast, the broadcaster sends to the server a TEARDOWN request, which causes the server to close the broadcast session and discard the SDP information. Similarly, dropped RTSP connections and broadcasters that do no send RTCP sender reports to the server within a 90-second window cause the server to close the broadcast session and discard the SDP information.

To support multiple SDP references to the same broadcast for announced UDP and TCP broadcasts, the port setting is zero in the ANNOUNCE header. Here is an example:

```
m=audio 0 RTP/AVP
```

The a=x-urlmap tag is required to support sharing streams between broadcasts (where one stream comes from one broadcaster and another stream comes from another broadcaster). The a=x-urlmap tag should appear in the SDP that references the source SDP. Here is an example:

```
a=x-urlmap: someotherbroadcastURL/TrackID=1
```

Access Control of Announced Broadcasts

To control automatic broadcasting, two new user tags have been defined in the qtaccess file. Table 2-13 lists the new tags.

Table 2-13 Access control user tags

Tag	Purpose
`valid-user`	Specifies that the user can have access to the requested movie if the client provides a name and password that match an entry in the qtusers file. The tag is written as `require valid-user`.
`any-user`	Specifies that any user can have access to the requested movie, with no requirement that the user be defined in the `qtusers` file or that the client provide a name and password that is checked. The tag is written as `require any-user`.

By default, the `qtaccess` file allows read access for all directives in the file. To allow announced broadcasts, the `qtaccess` file must contain a `Limit` directive that allows writing.

The purpose of the `Limit` directive is to restrict the effect of access controls to RTSP readers or writers. The following example limits the `require` access control so that only users defined in the `qtusers` file can RTSP PLAY a broadcast to the server. All other normal client PLAY requests are available to any user:

```
<Limit WRITE>
require valid-user
</Limit>
```

Note: The termination of the Limit directive (`</Limit>`) must be placed on its own line.

The following example allows movie viewing by any user in the `qtusers` file that is in the `movie_watchers` group and the user `john`. Broadcasters must be in the `movie_broadcasters` group to broadcast to this directory or its protected branches.

```
<Limit READ>
require group movie_watchers
require user john
```

```
</Limit>
<Limit WRITE>
require group movie_broadcasters
</Limit>
```

Note: Strings in the `qtaccess` file are case-sensitive.

The following example has the same effect as the previous example. It works because the default behavior is to limit access to reading when no limit field is specified.

```
require group movie_watchers
<Limit WRITE>
require group movie_broadcasters
</Limit>

require user john
```

The following example allows movie viewing and broadcasting by any user in the `qtusers` file that is in the `movie_watchers_and_broadcasters` group:

```
<Limit READ WRITE>
require group movie_watchers_and_broadcasters
</Limit>
```

Broadcaster-to-Server Example

This section shows a typical exchange between a client and a server in order to initiate an announced broadcast.

Client to server:

```
ANNOUNCE rtsp://server.example.com/meeting RTSP/1.0
CSeq: 90
Content-Type: application/sdp
Content-Length: 121
v=0
o=camera1 3080117314 3080118787 IN IP4 195.27.192.36
s=IETF Meeting, Munich - 1
i=The thirty-ninth IETF meeting will be held in Munich, Germany
u=http://www.ietf.org/meetings/Munich.html
```

```
e=IETF Channel 1 <ietf39-mbone@uni-koeln.de>
p=IETF Channel 1 +49-172-2312 451
c=IN IP4 224.0.1.11/127
t=3080271600 3080703600
a=tool:sdr v2.4a6
a=type:test
m=audio 0 RTP/AVP 5
a=control:trackID=1
c=IN IP4 224.0.1.11/127
a=ptime:40
m=video 0 RTP/AVP 31
a=control:trackID=2
c=IN IP4 224.0.1.12/127
```

Server to client:

```
RTSP/1.0 200 OK
CSeq: 90
```

Client to server:

```
SETUP rtsp://server.example.com/meeting/trackID=1 RTSP/1.0
CSeq: 91
Transport: RTP/AVP;multicast;destination=224.0.1.11;
client_port=21010-21011;mode=receive;ttl=127
```

Server to client:

```
RTSP/1.0 200 OK
CSeq: 91
Session: 50887676
Transport: RTP/AVP;multicast;destination=224.0.1.11;
client_port=21010-21011;serverport=6000-6001;mode=receive;ttl=127
```

Client to server:

```
SETUP rtsp://server.example.com/meeting/trackID=2 RTSP/1.0
CSeq: 92
Session: 50887676
Transport: RTP/AVP;multicast;destination=224.0.1.12;
client_port =61010-61011;mode=receive;ttl=127
```

Server to client:

```
RTSP/1.0 200 OK
CSeq: 92
Transport: RTP/AVP;multicast;destination=224.0.1.12;
client_port =61010-61011;serverport=6002-6003;mode=receive;ttl=127
```

Client to server:

```
PLAY rtsp://server.example.com/meeting RTSP/1.0
CSeq: 93
Session: 50887676
```

Server to client:

```
RTSP/1.0 200 OK
CSeq: 93
```

Stream Caching

This version of QTSS includes RTSP and RTP features that make it as easy for a caching proxy server to capture and manage a pristine copy of a media stream. Some of these features are elements of RTSP that were not supported in previous versions of QTSS, and other features are additions to RTSP and RTP. The features are

- *Speed RTSP header.* This version of QTSS supports the speed header wherever possible. The speed header allows a caching proxy server to request that a stream be delivered faster than real time so that the caching proxy server can move the stream into the cache as quickly as possible. This header is described in the section "Speed RTSP Header" (page 86).
- *x-Transport-Options RTSP header.* This version of QTSS supports the non-standard RTSP header, `x-Transport-Options`. Caching proxy servers can use this header to tell the streaming server how late packets the streaming server can send packets and have them still be useful to the caching proxy server. This header is described in the section "x-Transport-Options Header" (page 87).

- *RTP payload meta-information.* This version of QTSS fully supports RTP payload meta-information (an IETF draft), which includes information such as the packet transmission time, unique packet number, and video frame type. Caching proxy servers can use this information to provide the same quality of service to clients as the originating server. This header is described in the section "RTP Payload Meta-Information" (page 88).
- *x-Packet-Range RTSP header.* This version of QTSS supports the non-standard RTSP header, `x-Packet-Range`. This header is similar to the `Range` RTSP header but allows the client to specify a specific range of packets instead of a range of time. A caching proxy server can use the `x-Packet-Range` header to tell the originating server to selectively retransmit only those packets that the caching proxy server needs in order to fill in holes in its cached copy of the stream. This header is described in the section "x-Packet-Range RTSP Header" (page 95).

The following sections describe each of these features.

Speed RTSP Header

Clients can send to the server the optional Speed RTSP header to request that the server send data to the client at a particular speed. The server must respond by echoing the Speed RTSP header to the client. If the server does not echo the Speed RTSP header, the client must assume that the server cannot accommodate the request at this time. The server may modify the value of the Speed RTSP header argument. If the server modifies the value of the argument, the client must accept the modified value.

The value of the `Speed` RTSP header argument is expressed as a decimal ratio. The following example asks the server to send data twice as fast as normal:

```
Speed: 2.0
```

Note: An argument of zero is invalid.

If the request also contains a Range argument, the new speed value will take effect at the specified time.

This header is intended for use when preview of the presentation at a higher or lower rate is necessary. Bandwidth for the session may have been negotiated earlier (by means other than RTSP), and therefore re-negotiation may be necessary.

When data is delivered over UDP, it is highly recommended that means such as RTCP be used to track packet loss rates.

x-Transport-Options Header

The optional `x-Transport-Options` RTSP header should be sent from a client (typically a caching proxy server) to the server in an RTSP SETUP request and must echoed by the server. If the server does not echo the `x-Transport-Options` header, the client must assume that the server does not support this header. The server may modify the value of the `x-Transport-Options` header argument. If the server modifies the value of the argument, the client must accept the modified value.

The body of this header contains one or more arguments delimited by the semicolon character. For this version of QTSS, there is only one argument, the late-tolerance argument.

The value of the `late-tolerance` argument is a positive integer that represents the number of seconds late that the server can send a media packet and still have it be useful to the client. The server should use the value of the `late-tolerance` argument as a guide for making a best-effort attempt to deliver all media data so that the delivered data is no older than the late-tolerance value.

Here is an example:

```
x-Transport-Options: late-tolerance=30
```

If this example were for a video stream, the server would send all video frames that are less than 30 seconds old. The server would drop frames that are more than 30 seconds old because they are stale.

Caching proxy servers can use the `x-Transport-Options` header to prevent the media server from dropping frames or lowering the stream bit rate in the event it falls behind in sending media data. If the caching proxy server knows the duration of the media, it can prevent the server from dropping any frames by setting the `late-tolerance` argument to the duration of the media, allowing the cache to receive a complete copy of the media data.

For a live broadcast, a caching proxy server may want to do extra buffering to improve quality for its clients. It could use the `x-Transport-Options` header to advertise the length of its buffer to the server.

RTP Payload Meta-Information

Certain RTP clients, such as caching proxy servers, require per-packet meta information that goes beyond the sequence number and timestamp already provided in the RTP header. For instance, a caching proxy server may want to provide stream thinning to its clients in case those clients are bandwidth constrained. If that stream thinning is based on the type of video frame being sent by the originating server, there is no payload-independent way for the caching proxy server to determine the frame type.

The RTP payload meta-information solves this deficiency by including information that RTP clients can use to provide the same quality of service to clients as the originating server. The following section, "RTP Data" (page 88), describes the RTP data that the server delivers in the RTP payload meta-information type.

RTP Data

The server uses the RTP payload meta-information type to provide the following information to the RTP client:

- Transmission time, described in the section "Transmission Time" (page 88)
- Frame type, described in the section "Frame Type" (page 89)
- Packet number, described in the section "Packet Number" (page 89)
- Packet position, described in the section "Packet Position" (page 89)
- Media data, described in the section "Media Data" (page 90)
- Sequence number, described in the section "Sequence Number" (page 90)

Transmission Time

The server sends the transmission time as a single four-octet unsigned integer representing the recommended transmission time of the RTP packet in milliseconds.

The transmission time is always offset from the start of the media presentation. For example, if the SDP response for a URL includes a range of 0-729.45 and the client makes a PLAY request with a range of 100-729.45, the first RTP packet from the server should provide a transmission time value of approximately 100,000. (It may

not be exactly 100,000 because the server is free to find a frame nearby the requested time.) If the SDP for a URL does not contain a range, the client can at least use these values as relative offsets.

Frame Type

The server sends the frame type as a single 16-bit unsigned integer value for which several well-known values representing different frame types are defined. The well-known values are as follows:

- 0 represents an unknown frame type
- 1 represents a key frame
- 2 represents a b-frame
- 3 represents a p-frame

Note: The frame type is valid for video RTP streams only.

Packet Number

The server sends the packet number as a single 64-bit unsigned integer value. The value is the packet number offset from the absolute start of the stream. For example, if the SDP response for a URL includes a range of 0-729.45 and the client makes a PLAY request with a range of 0-729.45, the packet number value of the first packet will be 0 and will increment by 1 for each subsequent packet. If there are 1000 packets between in the first 60 seconds of a stream and a client makes a PLAY request of 60-729.45, the packet number of the first packet will be 1001 and will increment by 1 for each subsequent packet.

Packet Position

The server sends the packet position as a single 64-bit unsigned integer value. The value is the byte offset of this packet from the absolute start of the stream. For example, if the SDP response for a URL includes a range of 0-729.45 and the client makes a PLAY request with a range of 100-729.45, the packet position value of the first video RTP packet will be the total number of bytes of the video RTP packets between 0 and 100. Only the RTP packet payload bytes are used to compute each packet position value.

The server cannot provide the packet position for live or dynamic media. In general, if the media SDP has a range attribute, the server can provide the packet position.

Media Data

The server sends media data for the underlying RTP protocol.

Sequence Number

The server sends the RTP sequence number as a two-octet value. The sequence number is useful for mapping RTP meta-information to the underlying payload data that they refer to, if that data is being sent out-of-band.

Standard Format

The RTP payload meta-information returned by the server consists of a series of fields. Each field consists of a header and data. When returned in standard format, the first bit of the header is zero to indicate that the field is in standard format (that is, not compressed).

The first bit is followed by the 15-bit Name subfield. The Name subfield contains two ASCII alphanumeric characters that represent one of the RTP data types listed in the section "RTP Data" (page 88). The first character is seven bits long, so the value of the Name subfield must consist of seven-bit ASCII characters.

Table 2-14 lists the Name subfield values for each of the RTP data types.

Table 2-14 Defined Name subfield values

RTP data type	Name subfield value
Transmission time	`tt`
Frame type	`ft`
Packet number	`pn`
Packet position	`pp`
Media	`md`
Sequence number	`sn`

The Name subfield is followed by a two-octet Length subfield that contains the full length of the Data subfield.

Figure 2-7 shows the format of the Name subfield in standard format.

Figure 2-7 Standard RTP payload meta-information format

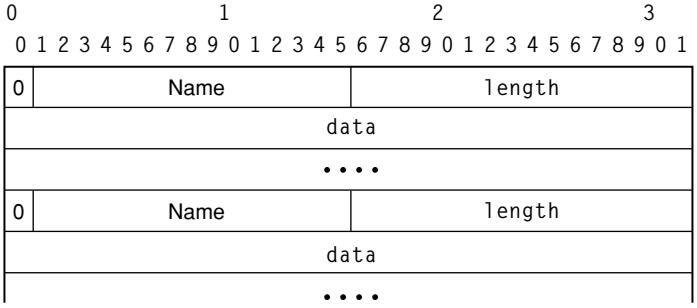
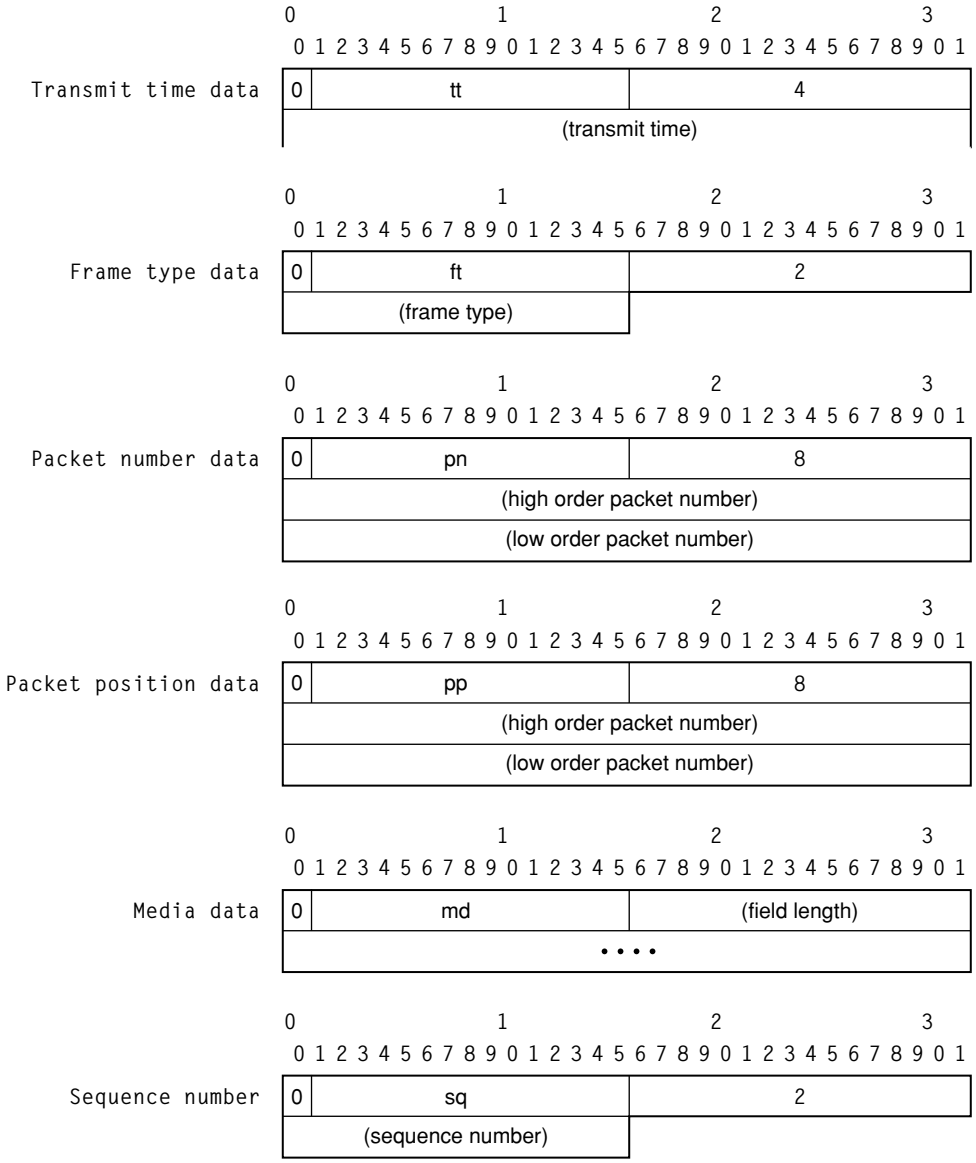


Figure 2-8 (page 92) shows the format of the RTP data in standard format.

Figure 2-8 RTP data in standard format



Compressed Format

When the server provides a field of RTP meta-information in compressed format, the field consists of a header and data. The first bit of the header is set to one to indicate that the rest of the header is in compressed format.

The first bit is followed by a seven-bit ID subfield that identifies the type of data in the Data subfield. The meaning of the ID subfield is assigned by the server, as described in the section "x-RTP-Meta-Info RTSP Header Negotiation" (page 94).

The ID subfield is followed by the one-octet Length subfield that contains the full length of the Data subfield that follows the Length subfield.

Figure 2-9 shows the format of the ID subfield in compressed format.

Figure 2-9 Compressed RTP payload meta-information format

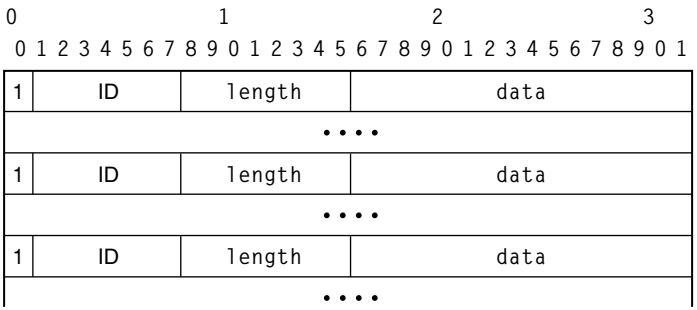
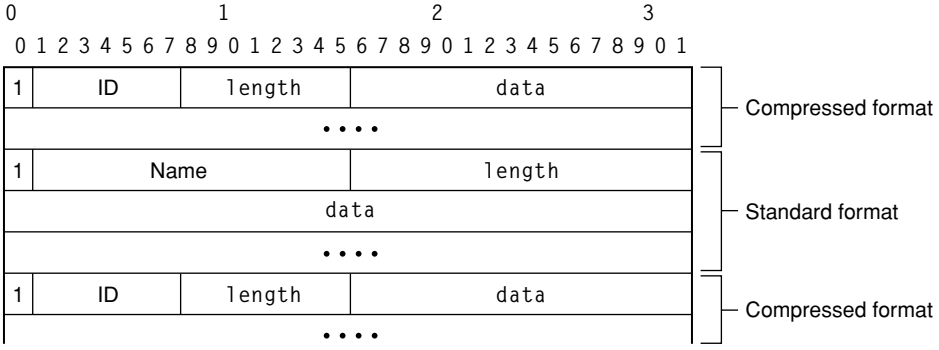


Figure 2-10 (page 94) shows an RTP payload meta-information packet when some fields are in compressed format and some fields are in standard format.

Figure 2-10 Mixed RTP payload meta-information format



Negotiation for Use of Compressed Format

Use of the compressed format requires out-of-band negotiation between client and server. During the negotiation process, the server assigns a seven-bit ID for each RTP data type. Instead sending the name of the RTP data type (for example, `ft`) in the RTP payload, only the ID is sent.

Negotiation for using the compressed format can occur in two ways:

- Through the x-RTP-Meta-Info RTSP header, described in the section "x-RTP-Meta-Info RTSP Header Negotiation" (page 94)
- Through the SDP description of the data, described in the section "Describing RTP-Meta-Info Payload in SDP" (page 95)

x-RTP-Meta-Info RTSP Header Negotiation

The client can negotiate compression with the server for any payload by sending an x-RTP-Meta-Info RTSP header to the server in a SETUP request. If the server does not echo the header in its SETUP response, the client must assume that the server does not support this header.

The client's SETUP request specifies the RTP data types the client wants to receive in the specified RTP stream. Here is an example of a client request:

```
x-RTP-Meta-Info: to;bi;bo
```

The server's response lists the names of the RTP data that the server will provide for that RTP stream. If the server supports the compressed format, the response may also contain ID mappings for some or all of the names. The server may return a subset of the names if it doesn't support all of the requested names, or if some requested names don't apply to the RTP stream specified by the SETUP request. Here are two examples of a server response:

```
x-RTP-Meta-Info: to=0;bi;bo=1
x-RTP-Meta-Info: to;bi
```

In the first response, the server indicates that it will provide bi data in standard format. The server will send to data in compressed format and use an ID of 0 to indicate fields that contain to data. The server will send bo data in compressed format and use an ID of 1 to indicate fields that contain bo data. Because IDs are represented by seven bits, an ID must be between 0 and 127.

In the second response, the server indicates that it will provide to and bi data in standard format.

Describing RTP-Meta-Info Payload in SDP

The originator of RTP-Meta-Info payload packets should describe the contents of the payload as part of the SDP description of the media. RTP-Meta-Info descriptions consist of two additional a= headers.

The `a=x-embedded-rtpmap` header tells the client the payload type of the underlying RTP payload.

The `a=x-RTP-Meta-Info` header tells the client the RTP data types the server will provide. Here is an example of an SDP description of the RTP-Meta-Info payload:

```
m=other 5084 RTP/AVP 96
a=rtpmap:96 x-RTP-Meta-Info
a=x-embedded-rtpmap:96 x-QT}
a=x-RTP-Meta-Info: standard;to;bi;bo
```

x-Packet-Range RTSP Header

The x-Packet-Range RTSP header allows the client (typically a caching proxy server) to specify a range of packets that the server should retransmit, thereby allowing the client to fill in holes in its cached copy of the stream. The client should

send the x-Packet-Range RTSP header in a PLAY request in place of the Range header. If the server does not support this header, it sends the client a "501 Header Not Implemented" response.

The body of this header contains a start and stop packet number for this PLAY request. The specified packet numbers must be based on the packet number RTP-Meta-Info field. For information on how to request packet numbers as part of the RTP stream, see the RTP-Meta-Info payload format IETF Draft.

The header format consists of two arguments delimited by the semicolon character. The first argument must be the packet number range, with the start and stop packet numbers separated by a hyphen (-). The second argument must be the stream URL to which the specified packets belong.

The following example requests packet numbers 4551 through 4689 for trackID3:

```
x-Packet-Range: pn=4551-4689;url=trackID3
```

The stop packet number must be equal to or greater than the start packet number. Otherwise, the server may return an error or may not send any media data after the PLAY response.

Reliable RTP

Reliable RTP is a set of features for RTP that improve the protocol's ability to present a good quality stream to the RTP client even in the event of packet loss and network congestion. Reliable RTP also includes congestion control, so streams behave in a TCP-friendly fashion without disturbing the real-time nature of the protocol.

To work well with TCP traffic on the Internet, Reliable RTP uses retransmission and congestion control algorithms that are similar to the algorithms used by TCP. Additionally, those algorithms are time tested to utilize available bandwidth in a near optimal fashion.

RTP features include

- Client acknowledgment of packets sent by the server to the client

- Windowing and congestion control so the server does not exceed the currently available bandwidth
- Server retransmission to the client in the event of packet loss
- Faster than real-time streaming known as “overbuffering”

Whether a client uses Reliable RTP is determined by the content of the client’s RTSP SETUP request.

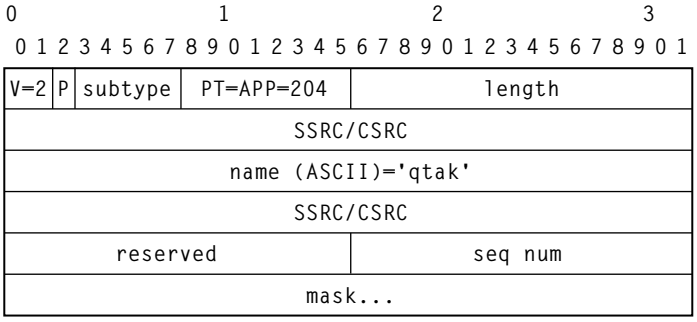
Acknowledgment Packets

The Reliable RTP server expects to receive an acknowledgment for each RTP packet it sends. If the server does not receive an acknowledgment for a packet, it may retransmit the packet. The client does not need to send an acknowledgment packet for each RTP packet it receives. Instead, the client can coalesce acknowledgments for several packets and send them to the server in a single packet.

The Reliable RTP acknowledgment packet format is a type of RTCP APP packet. After the standard RTCP APP packet headers, the payload for an acknowledgment packet consists of an RTP sequence number followed by a variable length bit mask. The sequence number identifies the first RTP packet that the client is acknowledging. Each additional RTP packet being acknowledged is represented by a bit set in the bitmask. The bit mask is an offset from the specified sequence number, where the high order bit of the first byte in the mask is one greater than the sequence number, the second bit is two greater, and so on. Bit masks must be sent in multiples of four octets. Setting a bit to 0 in the mask simply means that the client does not wish to acknowledge this sequence number right now and does not imply a negative acknowledgment.

Figure 2-11 shows the format of the Reliable RTP acknowledgment packet.

Figure 2-11 Reliable RTP acknowledgment packet format



RTSP Negotiation

Whether to use Reliable RTP is negotiated out of band in RTSP. If a client wants to use Reliable RTP, it should include an x-Retransmit header in its RTSP SETUP request. The body of the header contains the retransmit protocol name (`our-retransmit`) followed by a list of arguments delimited by the semicolon character.

Currently, one argument can be passed from the client to the server: the window argument. If included, the window argument tells the Reliable RTP server the size of the client's window in KBytes.

Here is an example:

```
x-Retransmit: our-retransmit;window=128
```

The server must echo the header and all parameters. If the x-Retransmit header is not in the SETUP response, the client must assume that Reliable RTP will not be used for this stream. If the server changes the parameter values, the client must use the new values.

Tunneling RTSP and RTP Over HTTP

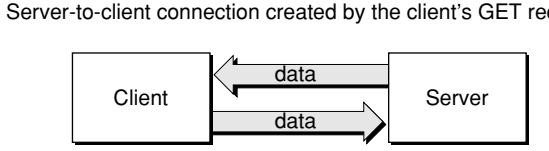
Using standard RTSP/RTP, a single TCP connection can be used to stream a QuickTime presentation to a user. Such a connection is not sufficient to reach users on private IP networks behind firewalls where HTTP proxy servers provide clients with indirect access to the Internet. To reach such clients, QuickTime 4.1 supports the placement of RTSP and RTP data in HTTP requests and replies. As a result, viewers behind firewalls can access QuickTime presentations through HTTP proxy servers.

The QuickTime HTTP transport is built from two separate HTTP GET and POST method requests initiated by the client. The server then binds the connections to form a virtual full-duplex connection. The protocol that forms this type of connection is must meet the following requirements:

- Work with unmodified RTSP/RTP packets
- Be acceptable to HTTP proxy servers
- Indicate to proxy servers that requests and replies are not to be cached
- Work in an environment where the client originates all requests
- Provide a way to uniquely identify request pairs so that they can be bound together to form a full-duplex connection
- Ensure that related requests connect to the same RTSP server in spite of load-balancing algorithms such as round-robin DNS servers
- Identify any request as one that will eventually tunnel an RTSP conversation and RTP data

The QuickTime HTTP transport exploits the capability of HTTP's GET and POST methods to carry an indefinite amount of data in their reply and message body respectively. In the most simple case, the client makes an HTTP GET request to the server to open the server-to-client connection. Then the client makes a HTTP POST request to the server to open the client-to-server connection. The resulting virtual full-duplex connection (shown in Figure 2-12) makes it possible to send unmodified RTSP and RTP data over the connection.

Figure 2-12 Required connections for tunneling



HTTP Client Request Requirements

To work with the QuickTime HTTP transport, client HTTP requests must

- Be made using HTTP version 1.0
- Include in the header an `x-sessioncookie` directive whose value is a globally unique identifier (GUID). The GUID makes it possible for the server to unambiguously bind the two connections by passing it as an opaque token to the C library `strcmp` function
- In POST requests, the `application/x-rtsp-tunneled` MIME type for both the `Content-Type` and `Accept` directives must be specified; this MIME type reflects the data type that is expected and delivered by the client and server
- Direct POST requests to the specified IP address if a server's reply to an initial GET request includes the `x-server-ip-address` directive and an IP address

In addition to these requirements, client HTTP POST request headers may include other directives in order to help HTTP proxy servers handle RTSP streams optimally.

Sample Client GET Request

Here is an example of a client GET request:

```
GET /sw.mov HTTP/1.0
User-Agent: QTS (qtver=4.1;cpu=PPC;os=Mac8.6)
x-sessioncookie: tD9hKgAAfB8ABCftAAAAAw
```

Sample Client POST Request

Here is an example of a client POST request:

```
POST /sw.mov HTTP/1.0
User-Agent: QTS (qtver=4.1;cpu=PPC;os=Mac8.6)
Content-Type: application/x-rtsp-tunnelled
Pragma: no-cache
Cache-Control: no-cache
Content-Length: 32767
Expires: Sun, 9 Jan 1972 00:00:00 GMT
```

Note: The server does not respond to client POST requests. The client will continue to send RTSP data as the message body of this POST request.

The sample client POST request includes three optional header directives that are present to control the behavior of HTTP proxy servers so that they handle RTSP streams optimally:

- The `Pragma: no-cache` directive tells many HTTP 1.0 proxy servers not to cache the transaction.
- The `Cache-Control: no-cache` directive tells many HTTP 1.1 proxy servers not to cache the transaction.
- The `Expires` directive specifies an arbitrary time in the past. This directive is intended to prevent proxy servers from caching the transaction.

HTTP requires that all POST requests have a content-length header. In the sample client POST request, the content length of 32767 is an arbitrary value. In practice, the actual value seems to be ignored by proxy servers, so it is possible to send more than this amount of data in the form of RTSP requests. The QuickTime Server ignores the content-length header.

HTTP Server Reply Requirements

When the server receives an HTTP GET request from a client, it must respond with a reply whose header specifies the `application/x-rtsp-tunneled` MIME type for both the `Content-Type` and `Accept` directives.

Note: The server must reply to all client HTTP GET requests but never replies to client HTTP POST requests.

Server reply headers may optionally include the `Cache-Control: no-store` and `Pragma: no-cache` directives to prevent HTTP proxy servers from caching the transaction. It is recommended that implementations honor these headers if they are present.

Server clusters are often allocated connections by a round-robin DNS or other load-balancing algorithm. To insure that client requests are directed to the same server among potentially several servers in a server farm, the server may optionally include the `x-server-ip-address` directive followed by an IP address in dotted decimal format in the header of its reply to a client's initial GET request. When this directive is present, the client must direct its POST request to the specified IP address regardless of the IP address returned by a DNS lookup.

In the absence of an HTTP error, the server reply header contains "200 OK". An HTTP error in a server reply reflects the inability of the server to form the virtual full-duplex connection; an HTTP error does not imply an RTSP error. When an HTTP error occurs, the server simply closes the connection.

Sample Server Reply to a GET Request

Here is an example of a server reply to a GET request:

```
HTTP/1.0 200 OK
Server: QTSS/2.0 [v101] MacOSX
Connection: close
Date: Thu, 19 Aug 1982 18:30:00 GMT
Cache-Control: no-store
Pragma: no-cache
Content-Type: application/x-rtsp-tunnelled
```

Including the following header directives in a reply is not required but is recommended because the directives they tell proxy servers to behave in a way that allows them to handle RTSP streams optimally:

- The `Date` directive specifies an arbitrary time in the past. This keeps proxy servers from caching the transaction.
- The `Cache-Control: no-cache` directive tells many HTTP 1.1 proxy servers not to cache the transaction.
- The `Pragma: no-cache` directive tells many HTTP 1.0 proxy servers not to cache the transaction.

RTSP Request Encoding

RTSP requests made by the client on the POST connection must be encoded using the base64 method. (See RFC 2045 “Internet Message Bodies”, section 6.8, Base64 Content-Transfer-Encoding, and RFC 1421 “Privacy Enhancements for Electronic Mail,” section 4.3.2.4, Printable Encoding.) The base64 encoding prevents HTTP proxy server from determining that an embodied RTSP request is a malformed HTTP requests.

Here is a sample RTSP request before it is encoded:

```
DESCRIBE rtsp://tuckru.apple.com/sw.movRTSP/1.0
CSeq: 1
Accept: application/sdp
Bandwidth: 1500000
Accept-Language: en-US
User-Agent: QTS (qtver=4.1;cpu=PPC;os=Mac8.6)
```

Here is the same request after encoding:

```
REVTQ1JJQkUgcnRzcDovL3R1Y2tydS5hcHBsZS5jb20vc3cubW92IFJUU1AvMS4w
DQpDU2VxOiAxDQpBY2N1cHQ6IGFwcGxpY2FOaW9uL3NkcAOKQmFuZHdpZHRoOiAx
NTAwMDAwDQpBY2N1cHQtTGFuZ3VhZ2U6IGVuLVVTDQpVc2VyLUFnZW50OiBRVFMg
KHFOdmVyPTQuMTtjcHU9UFBDO29zPU1hYyA4LjYpDQoNCg==
```

Connection Maintenance

The client may close the POST connection at any time. Doing so frees socket and memory resources at the server that might otherwise be unused for a long time. In QuickTime HTTP streaming, the best time to close the POST connection usually occurs after the PLAY request.

Support For Other HTTP Features

Support for HTTP features that are not documented here is not required in order to implement the tunneling of QuickTime RTSP and RTP over HTTP. The tunnel should mimic a normal TCP connection as closely as possible without adding unnecessary features.

Concepts

Tasks

This chapter describes common QTSS tasks:

- Compiling and installed a QTSS module, described in "Compiling a QTSS Module into the Server" (page 106).
- Getting and setting attribute values, described in "Working with Attributes" (page 107). This section also tells you how to add your own attributes to an object.
- Using the server's file module to open, read, and close files, described in "Using Files" (page 113). This section also tells you how to implement your own file system module.
- Communicating with the server with the Admin protocol, described in "Using the Admin Protocol" (page 126).

Building a QuickTime Streaming Server Module

You can add a QTSS module to the QuickTime Streaming Server by compiling the code directly into the server itself or by building a module as a separate code fragment that is loaded when the server starts up.

Whether compiled into the server or built as a separate module, the code for the module is the same. The only difference is the way in which the code is compiled.

Compiling a QTSS Module into the Server

If you have the source code for the QuickTime Streaming Server, you can compile your module into the server.

Note: The source code for the server is available at

```
http://www.publicsource.apple.com/projects/streaming
```

To compile your code into the server, locate the function `QTSServer::LoadCompiledInModules` in `QTSServer.cpp` and add to it the following lines

```
QTSSModule* myModule = new QTSSModule("__XYZ__");
(void)myModule->Initialize(&sCallbacks, &__XYZMAIN__);
(void)AddModule(myModule);
```

where `XYZ` is the name of your module and `XYZMAIN` is your module's main routine.

Some platforms require that each module use unique function names. To prevent name conflicts when you compile a module into the server, make your functions static.

Modules that are compiled into the server are known as static modules.

Building a QTSS Module as a Code Fragment

To have the server load at runtime a QTSS module that is a code fragment, follow these steps:

1. Compile the source for your module as a dynamic shared library for the platform you are targeting. For Mac OS X, the project type must be `loadable bundle`.
2. Link the resulting file against the QTSS API stub library for the platforms you are targeting.
3. Place the resulting file in the `/Library/QuickTimeStreaming/Modules` directory (Mac OS X), `/usr/local/sbin/StreamingServerModules (Darwin platforms)`, and `c:\Program Files\Darwin StreamingServer\QTSSModules`. The server will load your module the next time it restarts.

Some platforms require that each module use unique function names. To prevent name conflicts when the server loads your module, strip the symbols from your module before you have the server load it.

Working with Attributes

QTSS objects consist of attributes that are used to store data. Every attribute has a name, an attribute ID, a data type, and permissions for reading and writing the attribute's value. There are two attribute types:

- static attributes. Static attributes are present in all instances of an object type. A module can add static attributes to objects from its Register role only. All of the server's built-in attributes are static attributes. For information about adding static attributes to object types, see the section "Adding Attributes" (page 111)
- instance attributes. Instance attributes are added to a specific instance of any object type. A module can use any role to add an instance attribute to an object and can also remove instance attributes that it has added to an object. For information about adding instance attributes to objects, see the section "Adding Attributes" (page 111).

Note: Adding static attributes is more efficient than adding instance attributes, so adding static attributes instead of adding instance attributes is strongly recommended.

Getting Attribute Values

Modules use attributes stored in objects to exchange information with the server, so they frequently get attribute values. Three callback routines get attribute values:

- `QTSS_GetValue`, which copies the attribute value into a buffer provided by the module. This callback can be used to get the value of any attribute, but it is not as efficient as `QTSS_GetValuePtr`.
- `QTSS_GetValueAsString`, which copies the attribute value as a string into a buffer provided by the module. This callback can be used to get the value of any attribute. This is the least efficient way to get the value of an attribute

- QTSS_GetValuePtr, which returns a pointer to the server's internal copy of the attribute value. This is the most efficient way to get the value of preemptive safe attributes. It can also be used to get the value of non-preemptive safe attributes, but the object must first be locked and must be unlocked after QTSS_GetValuePtr is called. When getting the value of a single non-preemptive-safe attribute, calling QTSS_GetValue may be more efficient than locking the object, calling QTSS_GetValuePtr and unlocking the object.

The sample code in Listing 3-1 calls QTSS_GetValue to get the value of the qtssRTPSvrCurConn attribute, which is not preemptive safe, from the QTSS_ServerObject object.

Listing 3-1 Getting the value of an attribute by calling QTSS_GetValue

```
UInt32 MyGetNumCurrentConnections(QTSS_ServerObject inServerObject)
{
    // qtssRTPSvrCurConn is a UInt32, so provide a UInt32 for the result.
    UInt32 theNumConnections = 0;
    // Pass in the size of the attribute value.
    UInt32 theLength = sizeof(theNumConnections);
    // Retrieve the value.
    QTSS_Error theErr = QTSS_GetValue(inServerObject, qtssRTPSvrCurConn, 0,
        &theNumConnections, &theLength);
    // Check for errors. If the length is not what was expected, return 0.
    if ((theErr != QTSS_NoErr) || (theLength != sizeof(theNumConnections))
        return 0;
    return theNumConnections;
}
```

The sample code in Listing 3-2 (page 108) calls QTSS_GetValuePtr, which is the preferred way to get the value of preemptive-safe attributes. In this example, value of the qtssRTSPReqMethod attribute is obtained from the object QTSS_RTSPRequestObject.

Listing 3-2 Getting the value of an attribute by calling QTSS_GetValuePtr

```
QTSS_RTSPMethod MyGetRTSPRequestMethod(QTSS_RTSPRequestObject
inRTSPRequestObject)
{
```

```
    QTSS_RTSPMethod* theMethod = NULL;
    UInt32 theLen = 0;

QTSS_Error theErr = QTSS_GetValuePtr(inRTSPRequestObject, qtssRTSPReqMethod,
0,
    (void**)&theMethod, &theLen);
if ((theErr != QTSS_NoErr) || (theLen != sizeof(QTSS_RTSPMethod))
    return -1;   // Return a -1 if there is an error, which is not a valid
                 // QTSS_RTSPMethod index
else
    return *theMethod;
}
```

You can obtain the value any attribute by calling `QTSS_GetValueAsString`, which gets the attribute's value as a C string. Calling `QTSS_GetValueAsString` is convenient when you don't know the type of data the attribute contains. In Listing 3-3, the value of the `qtssRTPSvrCurConn` attribute is obtained as a string from the `QTSS_ServerObject`.

Listing 3-3 Getting the value of an attribute by calling QTSS_GetValueAsString

```
void MyPrintNumCurrentConnections(QTSS_ServerObject inServerObject)
{
    // Provide a string pointer for the result
    char* theCurConnString = NULL;
    // Retrieve the value as a string.
    QTSS_Error theErr = QTSS_GetValueAsString(inServerObject,
qtssRTPSvrCurConn, 0, &theCurConnString);
    if (theErr != QTSS_NoErr) return;
    // Print out the result. Because the value was returned as a string, use
    // %s in the printf format.
    ::printf("Number of currently connected clients: %s\n",
theCurConnString);
    // QTSS_GetValueAsString allocates memory, so reclaim the memory by
calling QTSS_Delete.
    QTSS_Delete(theCurConnString);
}
```

Setting Attribute Values

Two QTSS callback routines are available for setting the value of an attribute: `QTSS_SetValue` and `QTSS_SetValuePtr`.

The sample code in Listing 3-4 would be found handling the Route role. It calls `QTSS_GetValuePtr` to get the value of the `qtssRTSPReqFilePath`. If the path matches a certain string, the function sets a new request root directory by calling `QTSS_SetValue` to set the `qtssRTSPReqRootDir` attribute to a new path.

Listing 3-4 Setting the value of an attribute by calling QTSS_SetValue

```
// First get the file path for this request using QTSS_GetValuePtr
char* theFilePath = NULL;
UInt32 theFilePathLen = 0;
QTSS_Error theErr = QTSS_GetValuePtr(inParams->inRTSPRequest,
qtssRTSPReqFilePath, 0, &theFilePath,
                &theFilePathLen);

// Check for any errors
if (theErr != QTSS_NoErr) return;
// See if this path is a match. If it is, use QTSS_SetValue to set the root
directory for this request.
if ((theFilePathLen == sStaticFilePathLen) &&
                    (::strncmp(theFilePath, sStaticFilePath,
theFilePathLen) == 0))
{
    theErr = QTS_SetValue(inParams->inRTSPRequest, qtssRTSPReqRootDir, 0,
sNewRootDirString,
            sNewRootDirStringLen);
    if (theErr != QTSS_NoErr) return;
}
```

Listing 3-5 (page 111) demonstrates the use of the `QTSS_SetValuePtr` callback. The `QTSS_SetValuePtr` callback associates an attribute with the value of a module's variable. This code sample modifies the `QTSS_ServerObject` object nonatomically, so it calls `QTSS_LockObject` to prevent other threads from accessing the attributes of the `QTSS_ServerObject` before the value has been set.

Then the code sample calls `QTSS_CreateObjectValue` to create a `QTSS_ConnectedUserObject` object as the value of the `qtssSvrConnectedUsers` attribute of the `QTSS_ServerObject` object. Then the code sample calls `QTSS_SetValuePtr` to set the value of the `qtssConnectionBytesSent` attribute of the `QTSS_ConnectedUserObject` object to the module's `fBytesSent` variable. Thereafter, when any module gets the value of the `qtssConnectionBytesSent` attribute, it will get the current value of the module's `fBytesSent` variable.

After calling `QTSS_SetValuePtr`, the code sample calls `QTSS_UnlockObject` to unlock the `QTSS_ServerObject` object.

Listing 3-5 Setting the value of an attribute by calling QTSS_SetValuePtr

```
UInt32 index;
QTSS_LockObject(sServer);

QTSS_CreateObjectValue(sServer, qtssSvrConnectedUsers,
qtssConnectedUserTypeObject, &index, &fQTSSObject);

QTSS_CreateObjectValue(sServer, qtssSvrConnectedUsers,
qtssConnectedUserObjectType, &index, &fQTSSObject);

QTSS_SetValuePtr(fQTSSObject, qtssConnectionBytesSent, &fBytesSent,
sizeof(fBytesSent));

QTSS_UnlockObject(sServer);
```

Adding Attributes

Any module can add an attribute to a QTSS object type by calling the `QTSS_AddStaticAttribute` callback routine from its Register role. Modules can also call `QTSS_AddInstanceAttribute` from any role to add an attribute to an instance of an object.

Note: Adding one or more attributes to an object type or to an instance of an object is the most efficient and the recommended way for modules to store data that is specific to a particular session.

Once added, the new attribute is included in every object of that type that the server creates and its value can be set and obtained by calling that same callback routines that set and obtain the value of the server's built-in attributes: `QTSS_SetValue`, `QTSS_SetValuePtr`, `QTSS_GetValue`, and `QTSS_GetValuePtr`.

Note: If you are adding attributes to an object that your module created, you must first lock the object by calling `QTSS_LockObject`. When all of the attributes have been added, call `QTSS_UnlockObject` to unlock the object.

The sample code in Listing 3-6 calls `QTSS_AddStaticAttribute` to add an attribute to the object `QTSS_ClientSessionObject`.

Listing 3-6 Adding a static attribute

```
QTSS_Error MyRegisterRoleFunction()
{
    // Add the static attribute. The third parameter is always NULL.
    QTSS_Error theErr = QTSS_AddStaticAttribute(qtssClientSessionObjectType,
                                “MySampleAttribute”, NULL,
qtssAttrDataTypeUInt32);
    // Retrieve the ID for this attribute. This ID can be passed into
QTSS_GetValue,
    // QTSS_SetValue, and QTSS_GetValuePtr.
    QTSS_AttributeID theID;
    theErr = QTSS_IDForAttr(qtssClientSessionObjectType, MySampleAttribute",
&theID);
    // Store the attribute ID in a global for later use. Attribute IDs do not
    // change while the server is running.
    gMyExampleAttrID = theID;
}
```

Note: Attribute permissions for an added attribute (static or instance) are automatically set to readable, writable, and preemptive safe.

Using Files

QTSS supports file system modules so that QTSS can transparently and easily work with custom file systems. For example, a QTSS file system module can allow a QTSS module to read a custom networked file system or a custom database. Support for reading files consists of the following:

- QTSS file system callback routines that any module can use to open, read, and close files. Calling the file system callback routines is described in the section "Reading Files Using Callback Routines" (page 113). The QTSS file system callback routines allow QTSS to easily work with many different file system types. A QTSS module that uses the file system callbacks for reading all files can transparently use whatever file system is deployed on a server.
- File system roles for which modules that implement file systems register. These roles provide a bridge between QTSS and a specific file system. The file system roles are described in the section "Implementing a QTSS File System Module" (page 115). You could, for example, write a file system module that interfaces QTSS to a custom database or a custom networked file system.

Reading Files Using Callback Routines

In QTSS, a file is represented by a QTSS stream, so you can use existing QTSS stream callback routines to read files. The callback routines that are available for working with files are:

- `QTSS_OpenFileObject`, which is called to open a file in the local operating system. This call is one of two callback routines that is only used when working with files.
- `QTSS_CloseFileObject`, which is called to close a file that was opened by a previous call to `QTSS_OpenFileObject`. This call is one of two callback routines that is only used when working with files.
- `QTSS_Read`, which is called to read data from a file object's stream that was created by a previous call to `QTSS_OpenFileObject`.
- `QTSS_Seek`, which is called to set the current position of a file object's stream.

- QTSS_Advise, which is called to tell a file system module that a specified section of one of its streams will be read soon.
- QTSS_RequestEvent, which is called to tell a file system module that the calling module wants to be notified when one of the events in the specified event mask occurs. The events are when a stream becomes readable and when a stream becomes writable.

In QTSS, a file is QTSS_Object that has its own object type, QTSS_FileObject, that allows you to use standard QTSS callbacks (QTSS_GetValue, QTSS_GetValueAsString, and QTSS_GetValuePtr) to get meta information about a file, such as its length and modification date. You can use standard QTSS callbacks to store any amount of file system meta information with the file object. For example, a module working with a POSIX file system would want to add an attribute to the file object that stores the POSIX file system descriptor. A file object also has a QTSS stream reference that can be used when calling QTSS stream routines that work with files, such as QTSS_Read.

The sample code in Listing 3-7 shows how to open a file, determine the file's length, read the entire file, close the file, and return the data it contains.

Listing 3-7 Reading a file

```
QTSS_Error ReadEntireFile(char* inPath, void** outData, UInt32* outDataLen)
{

    QTSS_Object theFileObject = NULL;
    QTSS_Error theErr = QTSS_OpenFileObject(inPath, qtssOpenFileNoFlags,
&theFileObject);
    if (theErr != QTSS_NoErr)
        return theErr; // The file wasn't found or it couldn't be opened.

    // The file is open. Find out how long it is.
    UInt64* theLength = NULL;
    UInt32 theParamLen = 0;
    theErr = QTSS_GetValuePtr(theFileObject, qtssFlObjLength, 0,
(void**)&theLength, &theParamLen);

    if (theErr != QTSS_NoErr)
        return theErr;
    if (theParamLen != sizeof(UInt64))
        return QTSS_RequestFailed;;
```

```
    // Allocate memory for the file data.
    *outData = new char[*theLength + 1];
    *outDataLen = *theLength;

    // Read the data
    UInt32 recvLen = 0;
    theErr = QTSS_Read(theFileObject, *outData, *outDataLen, &recvLen);

    if ((theErr != QTSS_NoErr) || (recvLen != *outDataLen))
    {
        delete *outData;
        return theErr;
    }

    // Close the file.
    (void)QTSS_CloseFileObject(theFileObject);
}
```

Implementing a QTSS File System Module

A file system module provides a way for QTSS modules to read files in a specific file system regardless of that file system's type. Typically, a file system module handles a subset of paths in a file system, but it may handle all paths on the system. If a file system module handles only a certain subset of paths, it usually handles all paths inside a certain root path. For example, a module handling files stored in a certain database may only respond to paths that begin with `/Local/database_root/`.

Implementing a QTSS file system module begins with registering for one of the following roles:

- Open File Preprocess role, which the server calls in response to a module (or the server) that calls the `QTSS_OpenFileObject` callback routine to open a file. If the module does not handle files of the specified type, the module immediately returns `QTSS_FileNotFound`. If the module handles the files of the specified type, it opens the file, updates a file object provided by the server and returns `QTSS_NoErr`. If an error occurs during this setup period, the module returns `QTSS_RequestFailed`. Once the module returns `QTSS_NoErr`, it should be prepared to handle the Advise File, Read File, Request Event File and Close File roles for

the opened file. The server calls each module registered in the Open File Preprocess role until one of the called modules returns `QTSS_NoErr` or `QTSS_RequestFailed`.

- Open File role, which the server calls in response to a module (or the server) that calls the `QTSS_OpenFileObject` callback routine for which all modules handling the Open File Preprocess role return `QTSS_FileNotFound`. Only one module can register for the Open File role. Like modules called for the Open File Preprocess role, the module called for the Open File role must determine whether it can handle the specified file. It it can, it opens the file, updates the file object provided by the server and returns `QTSS_NoErr`. If an error occurs during the setup process or if the module cannot handle the specified file, the module returns `QTSS_RequestFailed` or `QTSS_FileNotFound`, respectively.

A file system module should register in the Open File Preprocess role if it handles a subset of files available on the system. For instance, a file system module that serves files out of a database may only handle files rooted at a certain path. All other paths should fall through to other modules that handle other paths.

A file system module should register in the Open File role if it implements the default file system on a system. For instance, on a UNIX system the module handling the Open File Role would probably provide an interface between the server and the standard POSIX file system.

Once a module returns `QTSS_NoErr` from either the Open File Role or the Open File Preprocess role, it is responsible for the newly opened file. It should be prepared to handle the following roles on behalf of that file:

- Advise File role, which is called in response to a module (or the server) calling the `QTSS_Advise` callback for a file object. The `QTSS_Advise` callback is made to inform the file system module that a specific region of the file will be needed soon.
- Read File role, which is called in response to a module (or the server) calling the `QTSS_Read` callback for a file object. It is the responsibility of a file system module handling this role to make a best-effort attempt to fill the buffer provided by the caller with the appropriate file data.
- Request Event File role, which is called in response to a module (or the server) calling the `QTSS_RequestEvent` callback on a file object.

- Close File role, which is called in response to a module (or the server) calling the `QTSS_Close` callback on a file object. The module should clean up any file-system and module-specific data structures for this file. This role is always the last role a file system module will be invoked in for a given file object.

Note: Modules do not need to explicitly register for the Advise File, Read File, Request Event File or Close File roles in order to handle them. Instead, returning `QTSS_NoErr` or `QTSS_RequestFailed` from one of the open file roles constitutes taking ownership for a specific file object, and therefore means that the module has implicitly registered for those roles.

File System Module Roles

This section describes the file system module roles. The roles are:

- "Open File Preprocess Role" (page 117) which is called to process requests to open files.
- "Open File Role" (page 119) which is the default role that is called when none of the modules registered for the Open File Preprocess role opens the specified file.
- "Advise File Role" (page 120) which is called to tell a file system module about the caller's I/O preferences.
- "Read File Role" (page 121) which is called to read a file.
- "Close File Role" (page 122) which is called to close a file.
- "Request Event File Role" (page 123) which is called to request notification when a file becomes available for reading or writing.

Open File Preprocess Role

The server calls the Open File Preprocess role in response to a module that calls the `QTSS_OpenFileObject` callback routine to open a file. It is the responsibility of a module handling this role to determine whether it handles the type of file specified to be opened. If it does and if the file exists, the module opens the file, updates the file object provided by the server, and returns `QTSS_NoErr`.

When called, an Open File Preprocess role receives a `QTSS_OpenFile_Params` structure, which is defined as follows:

```
typedef struct
```

```
{
    char*               inPath;
    QTSS_OpenFileFlags  inFlags;
    QTSS_Object         inFileObject;
} QTSS_OpenFile_Params;s
```

`inPath`

A pointer to a null-terminated C string containing the full path to the file that is to be opened.

`inFlags`

Open flags specifying whether the module that called `QTSS_OpenFileObject` can handle asynchronous read operations (`qtssOpenFileAsync`) or expects to read the file in order from beginning to end (`qtssOpenFileReadAhead`).

`inFileObject`

A QTSS object that the module updates if it can open the file specified by `inPath`.

If the file is a file the module handles, the module should do whatever work is necessary to open and set up the file. It can use `inFileObject` to store any module-specific information for that file. In addition, the module should set the value of the file object's `qtssFlObjLenth` and `qtssFlObjModDate` attributes.

If the file is a file the module handles but an error occurs while attempting to set up the file, the module should return `QTSS_RequestFailed`.

If every module registered for the Open File Preprocess role returns `QTSS_FileNotFound`, the server calls the one module that is registered in the Open File role.

A module that wants to be called in the Open File Preprocess role must in its Register role call `QTSS_AddRole` and specify `QTSS_OpenFilePreprocess_Role` as the role. Modules that register for this role must also handle the following roles, but they do not need to explicitly register for them: Advise File, Read File, Request Event File, and Close File.

Open File Role

The server calls the module registered for the Open File role when all modules registered for the Open File Preprocess role have been called and have returned `QTSS_FileNotFound`. Only one module can be registered for the Open File role, and that module is the first module that registers for this role when QTSS starts up.

Like modules called for the Open File Preprocess role, it is the responsibility of a module handling the Open File role to determine whether it handles the type of file specified to be opened. If it does and if the file exists, the module opens the file, updates the file object provided by the server, and returns `QTSS_NoErr`.

When called, the module receives a `QTSS_OpenFile_Params` structure, which is defined as follows:

```
typedef struct
{
    char*               inPath;
    QTSS_OpenFileFlags  inFlags;
    QTSS_Object         inFileObject;
} QTSS_OpenFile_Params;
```

`inPath`

A pointer to a null-terminated C string containing the full path to the file that is to be opened.

`inFlags`

Open flags specifying whether the module that called `QTSS_OpenFileObject` can handle asynchronous read operations (`qtssOpenFileAsync`) or expects to read the file in order from beginning to end (`qtssOpenFileReadAhead`).

`inFileObject`

A QTSS object that the module updates if it can open the file specified by `inPath`.

If the file is a file the module handles, the module should do whatever work is necessary to open and set up the file. It can use `inFileObject` to store any module-specific information for that file. In addition, the module should set the value of the file object's `qtssFlObjLength` and `qtssFlObjModDate` attributes.

If the file is a file the module handles but an error occurs while attempting to set up the file, the module should return `QTSS_RequestFailed`.

A module that wants to be called in the Open File role must in its Register role call `QTSS_AddRole` and specify `QTSS_OpenFile_Role` as the role. Modules that register for this role must also handle the following roles, but they do not need to explicitly register for them: Advise File, Read File, Request Event File, and Close File.

Advise File Role

The server calls modules for the Advise File role in response to a module (or the server) calling the `QTSS_Advise` callback routine for a file object in order to inform the file system module that the calling module will soon read the specified section of the file.

When called, an Advise File role receives a `QTSS_AdviseFile_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_Object          inFileObject;
    UInt64               inPosition;
    UInt32               inSize;
} QTSS_AdviseFile_Params;
```

`inFileObject`

The file object for the opened file. The file system module uses the file object to determine the file for which the `QTSS_Advise` callback routine was called.

`inPosition`

The offset in bytes from the beginning of the file that represents the beginning of the section that is soon to be read.

`inSize`

The number of bytes that are soon to be read.

The file system module is not required to do anything while handling this role, but it may take this opportunity to read the specified section of the file.

File system modules do not need to explicitly register for this role.

Modules should always return QTSS_NoErr when they finish handling this role.

Read File Role

The server calls modules for the Read File role in response to a module (or the server) calling the `QTSS_Read` callback routine for a file object in order to read the specified file.

When called, a Read File role receives a `QTSS_ReadFile_Params` structure, which is defined as follows:

```
typedef struct
{   QTSS_Object  inFileObject;
    UInt64       inFilePosition;
    void*        ioBuffer;
    UInt32       inBufLen;
    UInt32*      outLenRead;
} QTSS_ReadFile_Params;
```

`inFileObject`
: The file object for the file that is to be read. The file system module uses the file object to determine the file for which the `QTSS_Read` callback routine was called.

`inFilePosition`
: The offset in bytes from the beginning of the file that represents the beginning of the section that is to be read. The server maintains the file position as an attribute of the file object, so the file system module does not have to cache the file position internally and can obtain the position at any time.

`ioBuffer`
: A pointer to the buffer in which the file system module is to place the data that is read.

`ioBufLen`
: The length of the buffer pointed to by `ioBuffer`.

`outLenRead`
: The number of bytes actually read.

The file system module should make a best-effort attempt to fill the buffer pointed to by `ioBuffer` with data from the file that is being read starting with the position specified by `inFilePosition`.

If the file was opened with the `qtssOpenFileAsync` flag, the module should return `QTSS_WouldBlock` if reading the data will cause the thread to block. Otherwise, the module should block the thread until all of the data has become available. When the buffer pointed to by `ioBuffer` is full or the end of file has been reached, the file system module should set `outLenRead` to the number of bytes read and return `QTSS_NoErr`.

If the read fails for any reason, the file system module handling this role should return `QTSS_RequestFailed`.

File system modules do not need to explicitly register for this role.

Close File Role

The server calls modules for the Close File role in response to a module (or the server) calling the `QTSS_CloseFile` callback routine for a file object in order to close a file that has been opened.

When called, a Close File role receives a `QTSS_CloseFile_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_Object          inFileObject;
} QTSS_CloseFile_Params;
```

`inFileObject`
: The file object for the file that is to be closed. The file system module uses the file object to determine the file for which the `QTSS_Close` callback routine was called.

A module handling this role should dispose of any data structures that it has created for the file that is to be closed.

This role is always the last role for which a file system module will be invoked for any given file object.

File system modules do not need to explicitly register for this role.

Modules should always return QTSS_NoErr when they finish handling this role.

Request Event File Role

The server calls modules for the Request Event File role in response to a module (or the server) calling the `QTSS_RequestEvent` callback routine. If a module or the server calls the `QTSS_OpenFileObject` callback routine and specifies the `qtssOpenFileAsync` flag, the file system module handling that file object may return `QTSS_WouldBlock` from its Read File role. When that occurs, the caller of `QTSS_Read` may call `QTSS_RequestEvent` callback to tell the server that the caller of `QTSS_Read` wants to be notified when the data becomes available for reading.

When called, a Request Event File role receives a `QTSS_RequestEventFile_Params` structure, which is defined as follows:

```
typedef struct
{
    QTSS_Object     inFileObject;
    QTSS_EventType  inEventMask;
} QTSS_RequestEventFile_Params;
```

`inFileObject`
: The file object for the file for which notifications are requested. The file system module uses the file object to determine the file for which the `QTSS_RequestEvent` callback routine was called.

`inEventMask`
: A mask specifying the type of events for which notification is requested. Possible values are `QTSS_ReadableEvent` and `QTSS_WriteableEvent`.

If the file system that the file system module is implementing supports notification, the file system module should do whatever setup is necessary to receive an event for the file for which the `QTSS_RequestEvent` callback routine was called. When the file becomes readable, the file system module should call the `QTSS_SignalStream` callback routine and pass the stream reference for this file object (which can be obtained through the file object's `qtssFlObjStream` attribute). Calling the `QTSS_SignalStream` callback routine tells the server that the caller of `QTSS_RequestEvent` should be notified that the file is now readable.

File system modules do not need to explicitly register for this role.

Modules should always return `QTSS_NoErr` when they finish handling this role.

Sample Code for the Open File Role

The sample code in Listing 3-8 handles the Open File role, but it could also be used to handle the Open File Preprocess role. This code uses the POSIX file system layer as the file system and does not support asynchronous I/O.

Listing 3-8 Handling the Open File Role

```
QTSS_Error OpenFile(QTSS_OpenFile_Params* inParams)
{
    // Use the POSIX open call to attempt to open the specified file.
    // If it doesn't exist, return QTSS_FileNotFound

    int theFile = open(inParams->inPath, O_RDONLY);
    if (theFile == -1)
        return QTSS_FileNotFound;

    // Use the POSIX stat call to get the length and the modification date
    // of the file. This information must be set in the QTSS_FileObject
    // by every file system module.

    UInt64 theLength = 0;
    time_t theModDate = 0;
    struct stat theStatStruct;
    if (::fstat(fFile, &theStatStruct) >= 0)
    {
        theLength = buf.st_size;
        theModDate = buf.st_mtime;
    }
    else
    {
        ::close(theFile);
        return QTSS_RequestFailed; // Stat failed
    }

    // Set the file length and the modification date attributes of this file
    // object before returning

    (void)QTSS_SetValue(inParams->inFileObject, qtssFlObjLength, 0,
&theLength, sizeof(theLength));
```

```
    (void)QTSS_SetValue(inParams->inFileObject, qtssFlObjModDate, 0,
&theModDate, sizeof(theModDate));

    // Place the file reference in a custom attribute in the QTSS_FileObject.
    // This way, we can easily get the file reference in other role handlers,
    // such as the QTSS_ReadFile_Role and the QTSS_CloseFile_Role.

    QTSS_Error theErr = QTSS_SetValue(inParams->inFileObject, sFileRefAttr,
0,
&theFile, sizeof(theFileSource));

    if (theErr != QTSS_NoErr)
    {
        ::close(theFile);
        return QTSS_RequestFailed;
    }

    return QTSS_NoErr;
}
```

Implementing Asynchronous Notifications

If a module, or the server, calls the `QTSS_OpenFileObject` and specifies the `qtssOpenFileAsync` flag, the file system module handling that file object may return `QTSS_WouldBlock` from its `QTSS_ReadFile_Role` handler. Once that happens, the caller of `QTSS_Read` may want to be notified when the requested data becomes available for reading. This is possible by calling the `QTSS_RequestEvent` callback, which tells the server that the caller would like to be notified when data is available to be read from the file.

Not all file systems support notification mechanisms, and if they do, the notification mechanisms are particular to each file system architecture. Therefore, whether a file system module supports notifications is at the discretion of the developer of the file system module. In general it is better for a file system module to support asynchronous notifications and not block in `QTSS_ReadFile_Role` because blocking on one file operation may disrupt service for many of the server's clients.

Two facilities allow file system modules to implement notifications:

- `QTSS_RequestEventFile_Role`, which is called in response to a module (or the server) calling the `QTSS_RequestEvent` callback on a file object. Modules do not need to explicitly register for this role. If a module doesn't implement asynchronous notifications, it should return `QTSS_RequestFailed` from this role. If a module does implement asynchronous notifications, it should do whatever setup is necessary to receive an event for this file when the file becomes readable.
- `QTSS_SendEventToStream` callback, called by a file system module when a file does become readable. Calling `QTSS_SendEventToStream` tells the server that the caller of `QTSS_RequestEvent` should be notified that the file is now readable.

Using the Admin Protocol

You can use the Admin protocol to communicate with QTSS. The Admin Protocol relies on the URI mechanism defined by RFC 2396 for specifying a container entity using a path and on the request and response mechanism for the Hypertext Transfer Protocol defined in RFC 1945.

The server's internal data is mapped to a hierarchical tree of element arrays. Each element is a named type including a container type for retrieval of sub-node elements.

The server state machine and database can be accessed through a regular expression. The Admin Protocol abstracts the QTSS module API to handle data access and in some cases to provide data access triggers for execution of server functions.

Server streaming threads are blocked while the Admin Protocol accesses the server's internal data. To minimize blocking, the Admin Protocol allows scoped access to the server's data structures by allowing specific URL paths to any element.

The Admin Protocol uses the HTTP GET as the request and response method. At the end of each response, the session between client and server is closed. The Admin Protocol also supports the Authorization request header field as described in RFC 1945, section 10.2.

Access to Server Data

The Admin Protocol uses URIs to specify the location of server data. The following URI references the top level of the server's hierarchical data tree using a simple HTTP GET request.

```
GET /modules/admin
```

Request Syntax

A valid request is an absolute reference followed by the server URI. An absolute reference is a path beginning with a forward slash character (/). A path represents the server's virtual hierarchical data structure of containers and is expressed as a URL.

Here is the request syntax:

[*absolute URL*]?[parameters=*"values"*]+[command=*"value"*]+[“option”=*"value"*]

The following rules govern URIs:

- */path* is an absolute reference.
- *path*/* is defined as all elements contained in the “path” container.
- An asterisk (*) in the current URL location causes each element in that location to be iterated.
- A question mark (?) indicates that options follow. Options are specified as name=*"value"* pairs delimited by the plus (+) character.
- Space and tab characters are treated as stop characters.
- Values can be enclosed by the double quotation characters (“). Enclosing double quotation characters is required for values that contain spaces and tabs.
- These characters cannot be used: period (.), two periods (..), and semicolon (;).

Here is an example of a request:

```
GET /modules/admin/server/qtssSvrClientSessions?parameters=rt+command=get
```

Request Functionality

Requests can contain an array iterator, a name lookup, a recursive tree walk, and a filtered response. All functions can execute in a single URI query.

Here is a request that gets the stream time scale and stream payload name for every stream in every session:

```
GET /modules/admin/server/qtssSvrClientSessions/*/qtssCliSesStreamObjects?
parameters=r+command=get+filter1=qtssRTPStrTimescale+filter2=qtssRTPStrPayl
oadName
```

where

- `*` iterates the array of sessions
- `r` in `parameter=rt` specifies a recursive walk and t specifies that data types are to be included in the result
- `filter=qtssRTPStrTimescale` specifies that the stream time scale is to be returned
- `filter2=qtssRTPStrPayloadName` specifies that the stream payload is to be returned

This request gets all server module names and their descriptions:

```
GET /modules/admin/server/qtssSvrModuleObjects?
parameters=r+command=get+filter2=qtssModDesc+filter1=qtssModName
```

The following example does a recursive search and gets all server attributes and their data types:

```
GET /modules/admin/server/?parameters=rt
```

Note: Repeated recursive searches should be avoided because they impact server performance.

The following examples return server attributes and their paths:

```
GET /modules/admin/server/*
GET /modules/admin/server/qtssSvrPreferences/*
```

Data References

All elements are arrays. Single element arrays may be referenced in any of the following ways:

- *path*/*element*
- *path*/*element*/
- *path*/*element*/*
- *path*/*element*/1

The references listed above are all evaluated as the same request.

Request Options

URIs that do not include a question mark (?) default to a GET request option.

URIs that include a question mark (?) must be followed by a "command=*command-option*" request option, where *command-option* is GET, SET, ADD, or DEL. URIs may also be followed by a "parameters=*parameter-option*" that refines the action of the command option.

Request options are not case-sensitive, but request option values are case-sensitive.

The Admin Protocol ignores any request option that it does not recognize as well any request options that a command does not require.

Command Options

The Admin Protocol recognizes the following command options:

- GET, described in the section "GET Command Option" (page 130)
- SET, described in the section "SET Command Option" (page 130)
- DEL, described in the section "DEL Command Option" (page 130)
- ADD, described in the section "ADD Command Option" (page 131)

Any unknown command option is reported as an error.

The effect of a command option may be modified by in the inclusion of one or more of the following modifiers:

- `value` — used to specify a value
- `type` — used to specify a data type
- `name` — used to specify an element name

GET Command Option

The `GET` command option gets the data identified by the URI. It is the default command option. For that reason, it does not have to be specified, as shown in the following example:

```
GET /modules/admin/example_count
```

The `GET` command does not require any request options. If any request options were specified, they would be ignored.

SET Command Option

The `SET` command option sets the data identified by the URI. No value checking is performed. Conversion between the text value and the actual value is type-specific. Here are two examples of the `SET command option`:

```
GET /modules/admin/example_count?command=SET+value=5
GET /modules/admin/maxcount?command=SET+value=5+type=SInt32
```

If the `type` option is included in the command, type checking of the server element type and the set type is performed. If the types do not match, an error is returned and the command fails.

DEL Command Option

The `DEL` command option deletes the element referenced by the URL and any data it contains. Here is an example:

```
GET /modules/admin/maxcount?command=DEL
```

ADD Command Option

The `ADD` command option adds the data specified by the URI to the specified element.

If the end of the URL is an element, the `ADD` command performs an add to the array of elements referenced by the element name. The following example adds 6 to `example_count` if the data type of example_count is `SInt16`:

```
GET /modules/admin/example_count?command=ADD+value=6+type=SInt16
```

If the element at the end of the URL is a `QTSS_Object` container, the `ADD` command option adds the element to the container. The following example adds 5 to the element whose name is `maxcount` if the data type of `maxcount` is `SInt16`:

```
GET /modules/admin/?command=ADD+value=5+name=maxcount+type=SInt16
```

Parameter Options

Parameter options are single characters without delimiters that appear after the URL.

The Admin Protocol recognizes the following parameter options:

- `r` — Walk downward in the hierarchy starting at end of the URL. Recursion should be avoided if "*" iterators or direct URL access to elements can be used instead.
- `v` — Return the full path in *name*.
- `a` — Return the access type.
- `t` — Return the data type of *value*.
- `d` — Return debugging information if an error occurs.
- `c` — Return the count of elements in the path.

Here is an example that uses the r and t parameter options to recursively get the data type of all `qtssSvrClientSessions`:

```
GET /modules/admin/server/qtssSvrClientSessions?parameters=rt+command=get
```

Attribute Access Types

The following access types are used to control access to server data:

- `r` — Read access type
- `w` — Write access type
- `p` — Preemptive safe access type

Data Types

Data types can be any server-allowed text value. New data types can be defined and returned by the server, so data types are not limited to the basic set listed here:

`UInt8`	`SInt16`	`UInt64`	`Float64`	`char array`
`SInt8`	`UInt32`	`SInt64`	`Bool8`	`QTSS_Object`
`UInt16`	`SInt32`	`Float32`	`Bool16`	`void_pointer`

Values of type `QTSS_Object`, pointers, and unknown data types always converted to a host-ordered string of hexadecimal values. Here is an example of a hexadecimal value result:

```
unknown_pointer=halogen; type=void_pointer
```

Server Responses

This section describes the data that is returned in response to a request. The information on response data is organized in the following sections:

Unauthorized Response

Here is an example of an unauthorized response:

```
HTTP/1.1 401 Unauthorized
WWW-Authenticate: Basic realm="QTSS/modules/admin"
Server: QTSS
Connection: Close
Content-Type: text/plain
```

OK Response

Here is an example of an "OK" response:

```
HTTP/1.0 200 OK
Server: QTSS/4.0 [v408]-MacOSX
Connection: Close
Content-Type: text/plain
Container="/"
admin/
error:(0)
```

All OK response end with `error:(0)`.

Response Data

All entity references in response data follow this form:

[*NAME=VALUE*];[*attribute="value*"],[*attribute="value"*]

where brackets ([ ]) indicate that the enclosed response data is optional. Therefore, the response data may take the following forms:

NAME=VALUE

NAME=VALUE;*attribute="value"*

NAME=VALUE;*attribute="value"* ,*attribute="value"*

All container references follow this form:

[*NAME/*];[*attribute="value"*],[*attribute="value"*]

where brackets ([ ]) indicate that the enclosed response data is optional. Therefore, response data may take the following forms:

NAME/

NAME/;*attribute*="*value*"

NAME;*attribute*="*value*",*attribute*="*value*"

The order of appearance of container references and the container's entity references are important. This is especially true when the response is a recursive walk of a container hierarchy.

Each new level in the hierarchy must begin with a `Container=` reference. Each container list of elements must be a complete list of the contained elements and any containers. The appearance of a `Container=` reference indicates the end of a previous container's contents and the beginning of a new container.

This example shows how each new container is identified with a unique path:

```
Container="/level1/"
field1="value"
field2="value"
level2a/
level2b/
Container="/level1/level2a/"
field1="value"
level3a/
level3b/
Container="/level1/level2a/level3a"
field1="value"
Container="/level1/level2a/level3b"
Container="/level1/level2b/"
field1="value"
level3a/
Container="/level1/level2b/level3a/"
field1="value"
```

Array Values

For arrays of elements, a numerical value represents the index. Arrays are containers. Here is an example:

```
Container="/level1/"
field1="value"
field2="value"
array1/
Container="/level1/array1/"
1=value
2=value
```

Array elements may be containers, as shown in this example:

```
Container="/level1/array1/"
1/
2/
3/

Container="/level1/array1/1/"
field1="value"
field2="value"
Container="/level1/array1/2/"
Container="/level1/array1/3/"
field1="value"
```

Response Root

The root for responses is `/admin`.

Errors in Responses

For each response, the error state for the request is reported at the end of the data. Here are some examples:

`Error:(0)` indicates that no error occurred

`Error:(404)` indicates that no data was found

The number enclosed by parentheses is an HTTP error code followed by an error string when debugging is turned on using the `"parameters=d"` query option. Here is an example:

```
error:(404);reason="No data found"
```

Request and Response Examples

An easy way to make requests is to use a web browser and a URL like this:

```
http://IP-address:554/modules/admin/?parameters=a+command=get
```

The following example uses basic authentication and shows the HTTP response headers:

Request: `GET /modules/admin?parameters=a+command=get`

Authorization: Basic QWXtaW5pT3RXYXRvcjXkZWZhdWx0

Response:

```
HTTP/1.0 200 OK
Server: QTSS/4.0 [v408]-MacOSX
Connection: Close
Content-Type: text/plain

Container="/"
admin/;a=r
error:(0)
```

The following recursive request gets the value of each element in `/modules/admin`:

```
GET /modules/admin?command=get+parameters=r
```

The following recursive request returns the access type and data type for the value of each element in `/modules/admin`:

```
GET /modules/admin?command=get+parameters=rat
```

The following request gets the elements in `/modules/admin`. Note that the `GET` command option is not required because request options are not present.

```
GET /modules/admin/*
```

A request like the following can be used to monitor the session list:

```
GET /modules/admin/server/qtssSvrClientSessions/*
```

The response is a list of unique `qtssSvrClientSessions` session IDs. Here is an example::

```
Container="/admin/server/qtssSvrClientSessions/"
12/
2/
4/
8/
error:(0)
```

The following request gets the indexes for the `qtssCliSesStreamObjects` object, which is an indexed array of streams:

```
GET /modules/admin/server/qtssSvrClientSessions/*/qtssCliSesStreamObjects/*
```

The response might look like this:

```
Container="/admin/server/qtssSvrClientSessions/3/qtssCliSesStreamObjects/"
0/
1/
error:(0)
```

Here is another request:

```
GET /modules/admin/server/qtssSvrClientSessions/3/qtssCliSesStreamObjects/0/
*
```

And here is a typical response:

```
qtssRTPStrTrackID="4"
qtssRTPStrSSRC="683618521"
qtssRTPStrPayloadName="X-QT/600"
qtssRTPStrPayloadType="1"
qtssRTPStrFirstSeqNumber="-7111"
qtssRTPStrFirstTimestamp="433634204"
qtssRTPStrTimescale="600"
qtssRTPStrQualityLevel="0"
qtssRTPStrNumQualityLevels="3"
qtssRTPStrBufferDelayInSecs="3.000000"
qtssRTPStrFractionLostPackets="0"
qtssRTPStrTotalLostPackets="52"
qtssRTPStrJitter="0"
qtssRTPStrRecvBitRate="1526072"
qtssRTPStrAvgLateMilliseconds="501"
qtssRTPStrPercentPacketsLost="0"
```

```
qtssRTPStrAvgBufDelayInMsec="30"
qtssRTPStrGettingBetter="0"
qtssRTPStrGettingWorse="0"
qtssRTPStrNumEyes="0"
qtssRTPStrNumEyesActive="0"
qtssRTPStrNumEyesPaused="0"
qtssRTPStrTotPacketsRecv="6763"
qtssRTPStrTotPacketsDropped="0"
qtssRTPStrTotPacketsLost="0"
qtssRTPStrClientBufFill="0"
qtssRTPStrFrameRate="0"
qtssRTPStrExpFrameRate="3903"
qtssRTPStrAudioDryCount="0"
qtssRTPStrIsTCP="false”
qtssRTPStrStreamRef="18861508"
qtssRTPStrCurrentPacketDelay="-2"
qtssRTPStrTransportType="0"
qtssRTPStrStalePacketsDropped="0"
qtssRTPStrTimeFlowControlLifted="974373815109"
qtssRTPStrCurrentAckTimeout="0"
qtssRTPStrCurPacketsLostInRTCPInterval="52"
qtssRTPStrPacketCountInRTCPInterval="689"
QTSSReflectorModuleStreamCookie=(null)
qtssNextSeqNum=(null)
qtssSeqNumOffset=(null)
QTSSSplitterModuleStreamCookie=(null)
QTSSFlowControlModuleLossAboveTol="0"
QTSSFlowControlModuleLossBelowTol="3"
QTSSFlowControlModuleGettingWorses="0"
error:(0)
```

Here is an request that returns the IP addresses of connected clients:

```
GET /modules/admin/server/qtssSvrClientSessions/*/
qtssCliRTSPSessRemoteAddrStr
```

And here is a typical response:

```
Container="/admin/server/qtssSvrClientSessions/5/
"qtssCliRTSPSessRemoteAddrStr=17.221.40.1
Container="/admin/server/qtssSvrClientSessions/6/
"qtssCliRTSPSessRemoteAddrStr=17.221.40.2
```

```
Container="/admin/server/qtssSvrClientSessions/8/
"qtssCliRTSPSessRemoteAddrStr=17.221.40.3
Container="/admin/server/qtssSvrClientSessions/14/
"qtssCliRTSPSessRemoteAddrStr=17.221.40.4
error:(0)
```

Changing Server Settings

To change a server setting, the entity name and the value to be set are specified in the request body. If a match is made on the URL base and entity name at the current container level and if the setting is writable, the value is set.

```
base = /base/container
name = value
/base/container/name="value"
```

Getting and Setting Preferences

Preferences paths are useful for getting and setting a server or module preference. Setting a preference causes the preference's new value to be flushed to the server's XML preference file. The new value takes effect immediately.

Server preferences are stored in `/modules/admin/server/qtssSvrPreferences`. Module preferences are stored in `/modules/admin/server/qtssSvrModuleObjects/*/qtssModPrefs/`.

The elements defined in the `qtssSvrPreferences` object can only be modified — they cannot be deleted.

The elements defined in `qtssModPrefs` can be added to, deleted, and modified.

A module or the server can automatically restore some deleted elements if the elements are needed by a module or the server. When applied to a `qtssModPrefs` element, the `ADD`, `DEL`, and `SET` commands cause the streaming server's XML preference file to be rewritten.

Getting and Changing the Server's State

The `qtssSvrState` attribute controls the server's state. The path is `/modules/admin/server/qtssSvrState`. It can be modified as a `UInt32` with the following values.

```
qtssStartingUpState      = 0,
qtssRunningState         = 1,
qtssRefusingConnectionsState  = 2,
qtssFatalErrorState      = 3,
qtssShuttingDownState    = 4,
qtssIdleState            = 5
```

CHAPTER 4

QuickTime Streaming Server Module Reference

This chapter describes the callback routines and data types that modules use to call the QuickTime Streaming Server.

QTSS Callback Routines

This section describes the QTSS callback routines that modules call to obtain information from the server, allocate and deallocate memory, create objects, get and set attribute values, and manage client and RTSP sessions. The callbacks are organized into the following sections:

QTSS Utility Callback Routines

Modules call the following callback routines to register for roles, allocate and deallocate memory, get the value of the server's internal timer, and to convert a value from the internal timer to the current time:

- QTSS_AddRole (page 142)
- QTSS_New (page 143)
- QTSS_Delete (page 143)
- QTSS_Milliseconds (page 144)
- QTSS_MilliSecsTo1970Secs (page 144)

QTSS_AddRole

Adds a role.

```
QTSS_Error QTSS_AddRole(
   QTSS_Role inRole);
```

`inRole`

On input, a value of type `QTSS_Role` (page 185) that specifies the role that is to be added.

`result`

A result code. Possible values are `QTSS_NoErr`, `QTSS_OutOfState` if `QTSS_AddRole` is called from a role other than the Register role, `QTSS_RequestFailed` if the module is registering for the RTSP Request role and a module is already registered for that role, and `QTSS_BadArgument` if the specified role does not exist.

Discussion

The `QTSS_AddRole` callback routine tells the server that your module can be called for the role specified by `inRole`.

The `QTSS_AddRole` callback can only be called from a module's Register role. For this version of the server, you can add the following roles: `QTSS_ClientSessionClosing_Role`, `QTSS_ErrorLog_Role`, QTSS_Initialize_Role, `QTSS_OpenFilePreprocess_Role`, `QTSS_OpenFile_Role`, `QTSS_RTSPFilter_Role`,

QTSS_RTSPRoute_Role, QTSS_RTSPPreProcessor_Role, QTSS_RTSPRequest_Role, QTSS_RTSPPostProcessor_Role, QTSS_RTPSendPackets_Role, QTSS_RTCPProcess_Role, QTSS_Shutdown_Role.

QTSS_New

Allocates memory.

```
void* QTSS_New(
   FourCharCode inMemoryIdentifier,
   UInt32 inSize);
```

inMemoryIdentifier
: On input, a value of type FourCharCode that will be associated with this memory allocation. The server can track the allocated memory to make debugging memory leaks easier.

inSize
: On input, a value of type UInt32 that specifies in bytes the amount of memory to be allocated.

result
: None.

Discussion

The QTSS_New callback routine allocates memory. QTSS modules should call QTSS_New whenever it needs to allocate memory dynamically.

To delete the memory that QTSS_New allocates, call QTSS_Delete (page 143).

QTSS_Delete

Deletes memory.

```
void* QTSS_Delete(void* inMemory);
```

inMemory
: On input, a pointer to an arbitrary value that specifies in bytes the amount of memory to be deleted.

`result`
None.

Discussion
The `QTSS_Delete` callback routine deletes memory that was previously allocated by `QTSS_New` (page 143).

QTSS_Milliseconds

Gets the current value of the server's internal clock.

```
QTSS_TimeVal QTSS_Milliseconds();
```

`result`
The value of the server's internal clock in milliseconds since midnight January 1, 1970.

Discussion
The `QTSS_Milliseconds` callback routine gets the current value of the server's internal clock since midnight January 1, 1970. Unless otherwise noted, all millisecond values that the server provides in attributes are obtained from this clock.

QTSS_MilliSecsTo1970Secs

Converts a value obtained from the server's internal clock to the current time.

```
time_t QTSS_MilliSecsTo1970Secs(QTSS_TimeVal inQTSS_Milliseconds);
```

`inQTSS_Milliseconds`
On input, a value of type `QTSS_TimeVal` obtained by calling `QTSS_Milliseconds()`.

`result`
A value of type `time_t` containing the current time.

Discussion
The `QTSS_MilliSecsto1970Secs` callback routine converts a value obtained by calling `QTSS_Milliseconds` (page 144) to the current time.

QTSS Object Callback Routines

Modules call the attribute callback routines to work with attributes. The callbacks are:

- QTSS_CreateObjectType (page 145)
- QTSS_CreateObjectValue (page 146)
- QTSS_LockObject (page 147)
- QTSS_UnLockObject (page 147)

QTSS_CreateObjectType

Creates an object type.

```
QTSS_Error QTSS_CreateObjectType(
   QTSS_ObjectType* outType);
```

`outType`
On input, a pointer to a value of type QTSS_ObjectType (page 184).

`result`
A result code. Possible values are QTSS_NoErr, QTSS_FailedRequest too many object types already exist, and QTSS_OutOfState if QTSS_CreateObjectType an attribute of the specified name already exists.

Discussion

The QTSS_CreateObjectType callback routine creates a new object type and provides a pointer to it. Static attributes can be added to the object type by calling QTSS_AddStaticAttribute (page 150). Instance attributes can be added to instances of objects of the new object type.

The QTSS_AddStaticAttribute callback can only be called from the Register role. Call QTSS_SetValue (page 161) to set the value of an added attribute and QTSS_RemoveValue (page 160) to remove the value of an added attribute.

This callback may only be called from the Register role.

QTSS_CreateObjectValue

Creates a new object that is the value of another object's attribute.

```
QTSS_Error QTSS_CreateObjectValue(
   QTSS_Object inObject,
   QTSS_AttributeID inID,
   QTSS_ObjectType inType,
   UInt32* outIndex,
   QTSS_Object* outCreatedObject);
```

`inObject`
: On input, a pointer to a value of type `QTSS_ObjectType` (page 184) that specifies the object having an attribute whose value will be the created object.

`inID`
: On input, a value of type `QTSS_AttributeID` (page 183) that specifies the attribute ID of the attribute whose value will be the created object.

`inType`
: On input, a value of type `QTSS_ObjectType` (page 184) that specifies the object type of the object that is to be created.

`outIndex`
: On output, a pointer to a value of type `UInt32` that contains the index of the created object.

`outCreatedObject`
: On output, a pointer to a value of type `QTSS_ObjectType` (page 184)s that is the new object.

`result`
: A result code. Possible values are `QTSS_NoErr`, `QTSS_BadArgument` if any parameter is invalid, and `QTSS_ReadOnly` if the attribute specified by `inID` is a read-only attribute.

Discussion

The `QTSS_CreateObjectValue` callback routine creates an object that is the value of an existing object's attribute. The object specified by inObject is the "parent" object.

If the object specified by inObject is later locked by calling `QTSS_LockObject` (page 147), the object pointed to by outCreatedObject is also locked.

QTSS_LockObject

Locks an object.

```
QTSS_Error QTSS_LockObject(
   QTSS_Object inObject);
```

`inObject`
On input, a value of type `QTSS_Object` (page 183) that specifies the object that is to be locked.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if the specified object instance does not exist.

Discussion

The `QTSS_LockObject` callback routine locks the specified object so that accesses to the object's attributes from other threads will block. Call `QTSS_LockObject` before performing non-atomic updates on a variable that is pointed to by an attribute [as set by calling `QTSS_SetValuePtr` (page 162)] or before getting the value of a non-preemptive safe attribute.

Call `QTSS_UnLockObject` (page 147) to unlock the object.

Objects created by `QTSS_CreateObjectValue` (page 146) are locked when the parent object is locked.

QTSS_UnLockObject

Unlocks an object.

```
QTSS_Error QTSS_UnLockObject(
   QTSS_Object inObject);
```

`inObject`
On input, a value of type `QTSS_Object` (page 183) that is to be unlocked.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if the specified object is not a valid object.

Discussion
The `QTSS_UnLockObject` callback routine unlocks an object that was previously locked by `QTSS_LockObject` (page 147).

QTSS Attribute Callback Routines

Modules call the attribute callback routines to work with attributes. The callbacks are:

- `QTSS_AddInstanceAttribute` (page 149)
- `QTSS_AddStaticAttribute` (page 150)
- `QTSS_GetAttrInfoByID` (page 152)
- `QTSS_GetAttrInfoByIndex` (page 152)
- `QTSS_GetAttrInfoByName` (page 153)
- `QTSS_GetNumAttributes` (page 154)
- `QTSS_GetValue` (page 155)
- `QTSS_GetValueAsString` (page 156)
- `QTSS_GetValuePtr` (page 157)
- `QTSS_IDForAttr` (page 158)
- `QTSS_RemoveInstanceAttribute` (page 159)
- `QTSS_RemoveValue` (page 160)
- `QTSS_SetValue` (page 161)
- `QTSS_SetValuePtr` (page 162)
- `QTSS_StringToValue` (page 163)
- `QTSS_TypeStringToType` (page 164)
- `QTSS_TypeToTypeString` (page 164)
- `QTSS_ValueToString` (page 165)

QTSS_AddInstanceAttribute

Adds an instance attribute to the instance of an object.

```
QTSS_Error QTSS_AddInstanceAttribute(
   QTSS_Object inObject,
   char* inAttrName,
   void* inUnused,
   QTSS_AttrDataType inAttrDataType);
```

`inObject`
: On input, a value of type `QTSS_Object` (page 183) that specifies the object to which the instance attribute is to be added.

`inAttrName`
: On input, a pointer to a byte array that specifies the name of the attribute that is to be added.

`inUnused`
: Always `NULL`.

`QTSS_AttrDataType`
: On input, a value of type `QTSS_AttrDataType` (page 186) that specifies the data type of the attribute that is being added.

`result`
: A result code. Possible values are `QTSS_NoErr`, `QTSS_OutOfState` if `QTSS_AddInstanceAttribute` is called from a role other than the Register role, `QTSS_BadArgument` if the specified object type does not exist, the attribute name is too long, or a parameter is not specified, and `QTSS_AttrNameExists` if an attribute of the specified name already exists.

Discussion

The `QTSS_AddInstanceAttribute` callback routine adds an attribute to the instance of an object as specified by the `inObject` parameter. This callback can only be called from the Register role.

When adding attributes to an object that a module as created, you must lock the object first by calling `QTSS_LockObject` (page 147). Add the attributes and then call `QTSS_UnLockObject` (page 147).

All added instance attributes have values that are implicitly readable, writable, and preemptive safe, so their values can be obtained by calling QTSS_GetValueAsString (page 156) and QTSS_GetValuePtr (page 157). You can also call QTSS_GetValue (page 155) to get the value of an added static attribute, but doing so is less efficient.

Adding static attributes is more efficient than adding instance attributes, so adding static attributes instead of adding instance attributes is strongly recommended.

Typically, a module adds an instance attribute and sets its value by calling QTSS_SetValue (page 161) when it is first installed to add its default preferences to its module preferences object. On subsequent runs of the server, the preferences will already exist in the module's module preferences object, so the module only needs to call QTSS_GetValue (page 155), QTSS_GetValueAsString (page 156), or QTSS_GetValuePtr (page 157) to get the value. Calling QTSS_GetValuePtr is the most efficient and recommended way to get the value of an attribute. Calling QTSS_GetValue is less efficient than calling QTSS_GetValuePtr, and calling QTSS_GetValueAsString is less efficient than calling QTSS_GetValue.

Call QTSS_RemoveValue (page 160) to remove the value of an added attribute.

Unlike static attributes, instance attributes can be removed. To remove an instance attribute from the instance of an object, call QTSS_RemoveInstanceAttribute (page 159).

QTSS_AddStaticAttribute

Adds a static attribute to an object type.

```
QTSS_Error QTSS_AddStaticAttribute(
   QTSS_ObjectType inObjectType,
   const char* inAttributeName,
   void* inUnused,
   QTSS_AttrDataType inAttrDataType);
```

`inType`
: On input, a value of type QTSS_ObjectType (page 184) that specifies the type of object to which the attribute is to be added.

`inAttributeName`
: On input, a pointer to a byte array that specifies the name of the attribute that is to be added.

`inUnused`
: Always `NULL`.

`QTSS_AttrDataType`
: On input, a value of type `QTSS_AttrDataType` (page 186) that specifies the data type of the attribute that is being added.

`result`
: A result code. Possible values are `QTSS_NoErr`, `QTSS_OutOfState` if `QTSS_AddStaticAttribute` is called from a role other than the Register role, `QTSS_BadArgument` if the specified object type does not exist, the attribute name is too long, or a parameter is not specified, and `QTSS_AttrNameExists` if an attribute of the specified name already exists.

Discussion

The `QTSS_AddStaticAttribute` callback routine adds the specified attribute to all objects of the type specified by the `inType` parameter. This callback can only be called from the Register role. Once added, static attributes cannot be removed while the server is running.

When adding attributes to an object that a module as created, you must lock the object first by calling `QTSS_LockObject` (page 147). Add the attributes and then call `QTSS_UnLockObject` (page 147).

Adding static attributes is more efficient than adding instance attributes, so adding static attributes instead of instance attributes is strongly recommended.

The values of all added static attributes are implicitly readable, writable, and preemptive safe. Call `QTSS_SetValue` (page 161) or `QTSS_SetValuePtr` (page 162) to set the value of an added attribute.

Call `QTSS_GetValuePtr` (page 157), `QTSS_GetValue` (page 155) or `QTSS_GetValueAsString` (page 156) to get the value of a static attribute that has been added. Calling `QTSS_GetValuePtr` is the most efficient and recommended way to get the value of an attribute. Calling `QTSS_GetValue` is less efficient than calling `QTSS_GetValuePtr`, and calling `QTSS_GetValueAsString` is less efficient than calling `QTS_GetValue`.

Call `QTSS_RemoveValue` (page 160) to remove the value of an added static attribute.

QTSS_GetAttrInfoByID

Uses an attribute ID to get information about an attribute.

```
QTSS_Error QTSS_GetAttrInfoByID(
   QTSS_Object inObject,
   QTSS_AttributeID inAttrID,
   QTSS_AttrInfoObject* outAttrInfoObject);
```

`inObject`
On input, a value of type `QTSS_Object` (page 183) that specifies the object having the attribute for which information is to be obtained.

`inAttrID`
On input, a value of type `QTSS_AttributeID` (page 183) that specifies the attribute for which information is to be obtained.

`outAttrInfoObject`
On output, a pointer to a value of type `QTSS_AttrInfoObject` that can be used to get information about the attribute specified by `inAttrID`.

`result`
A result code. Possible values are `QTSS_NoErr`, `QTSS_BadArgument` if the specified object does not exist, and `QTSS_AttrDoesntExist` if the attribute doesn't exist.

Discussion

The `QTSS_GetAttrInfoByID` callback routine uses an attribute ID to get an `QTSS_AttrInfoObject` that can be used to get the attribute's name, its data type, permissions for reading and writing the attribute's value, and whether getting the attribute's value is preemptive safe.

QTSS_GetAttrInfoByIndex

Gets information about all of an object's attributes by iteration.

```
QTSS_Error QTSS_GetAttrInfoByIndex(
   QTSS_Object inObject,
   UInt32 inIndex,
   QTSS_AttrInfoObject* outAttrInfoObject);
```

inObject
: On input, a value of type QTSS_Object (page 183) that specifies the object having the attribute for which information is to be obtained.

inIndex
: On input, a value of type UInt32 that specifies the index of the attribute for which information is to be obtained. Start by setting inIndex to zero. For the next call to QTSS_GetAttrInfoByIndex, increment inIndex by one to get information for the next attribute. Call QTSS_GetNumAttributes (page 154) to get the number of attributes that inObject has.

outAttrInfoObject
: On output, a pointer to a value of type QTSS_AttrInfoObject that can be used to get information about the attribute specified by inAttrName.

result
: A result code. Possible values are QTSS_NoErr, QTSS_BadArgument if the specified object does not exist, and QTSS_AttrDoesntExist if the attribute doesn't exist.

Discussion

The QTSS_GetAttrInfoByIndex callback routine uses an attribute ID to get an QTSS_AttrInfoObject that can be used to get the attribute's name and ID, its data type and permissions for reading and write the attribute's value.

The QTSS_GetAttrInfoByIndex callback routine returns a QTSS_AttrInfoObject for both static and instance attributes.

QTSS_GetAttrInfoByName

Uses an attribute's name to get information about an attribute.

```
QTSS_Error QTSS_GetAttrInfoByName(
   QTSS_Object inObject,
   char* inAttrName,
   QTSS_AttrInfoObject* outAttrInfoObject);
```

inObject
: On input, a value of type QTSS_Object (page 183) that specifies the object having the attribute for which information is to be obtained.

`inAttrName`
On input, a pointer to a C string containing the name of the attribute for which information is to be obtained.

`outAttrInfoObject`
On output, a pointer to a value of type `QTSS_AttrInfoObject` that can be used to get information about the attribute specified by `inAttrName`.

`result`
A result code. Possible values are `QTSS_NoErr`, `QTSS_BadArgument` if the specified object does not exist, and `QTSS_AttrDoesntExist` if the attribute doesn't exist.

Discussion

The `QTSS_GetAttrInfoByName` callback routine uses an attribute ID to get an `QTSS_AttrInfoObject` that can be used to get the attribute's ID, its data type, and permissions for reading and writing the attribute's value, and whether getting the attribute's value is preemptive safe.

The `QTSS_GetAttrInfoByName` callback routine returns a `QTSS_AttrInfoObject` for both static and instance attributes.

QTSS_GetNumAttributes

Gets a count of an object's attributes.

```
QTSS_Error QTSS_GetNumAttributes(
   QTSS_Object inObject,
   UInt32* outNumAttributes);
```

`inObject`
On input, a value of type `QTSS_Object` (page 183) that specifies the object whose attributes are to be counted.

`outNumAttributes`
On output, a pointer to a value of type `UInt32` that contains the count of the object's attributes.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if the specified object does not exist.

Discussion

The `QTSS_GetNumAttributes` callback routine gets the number of attributes for the object specified by `inObject`. Having the number of attributes lets you know how often to call `QTSS_GetAttrInfoByIndex` (page 152) when getting information about each of an object's attributes.

QTSS_GetValue

Copies the value of an attribute into a buffer.

```
QTSS_Error QTSS_GetValue (
   QTSS_Object inObject,
   QTSS_AttributeID inID,
   UInt32 inIndex,
   void* ioBuffer,
   UInt32* ioLen);
```

`inObject`

On input, a value of type `QTSS_Object` (page 183) that specifies the object that contains the attribute whose value is to be obtained.

`inID`

On input, a value of type `QTSS_AttributeID` (page 183) that specifies the ID of the attribute whose value is to be obtained.

`inIndex`

On input, a value of type `UInt32` that specifies which attribute value to get (if the attribute can have multiple values) or zero for single-value attributes.

`ioBuffer`

On input, a pointer to a buffer. On output, `ioBuffer` contains the value of the attribute specified by `inID`. If the buffer is too small to contain the value, `ioBuffer` is empty.

`ioLen`

On input, a pointer to a value of type `UInt32` that specifies the length of `ioBuffer`. On output, `ioLen` contains the length of the valid data in `ioBuffer`.

result

A result code. Possible values include QTSS_NoErr, QTSS_BadArgument if a parameter is invalid, QTSS_BadIndex of the index specified by inIndex does not exist, QTSS_NotEnoughSpace if the attribute value is longer than the value specified by ioLen, and QTSS_AttrDoesntExist if the attribute doesn't exist.

Discussion

The QTSS_GetValue callback routine copies the value of the specified attribute into the provided buffer.

Calling QTSS_GetValue is slower and less efficient than calling QTSS_GetValuePtr (page 157).

QTSS_GetValueAsString

Gets the value of an attribute as a C string.

```
QTSS_Error QTSS_GetValueAsString (
   QTSS_Object inObject,
   QTSS_AttributeID inID,
   UInt32 inIndex,
   char** outString);
```

inObject

On input, a value of type QTSS_Object (page 183) that specifies the object that contains the attribute whose value is to be obtained.

inID

On input, a value of type QTSS_AttributeID (page 183) that specifies the ID of the attribute whose value is to be obtained.

inIndex

On input, a value of type UInt32 that specifies which attribute value to get (if the attribute can have multiple values) or zero for single-value attributes.

outString

On input, a pointer to an address in memory. On output, outString points to the value of the attribute specified by inID in string format.

`result`

A result code. Possible values include `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is invalid, and `QTSS_BadIndex` of the index specified by `inIndex` does not exist.

Discussion

The `QTSS_GetValueAsString` callback routine gets the value of the specified attribute converts it to C string format and stores it at the location in memory pointed to by the `outString` parameter.

When you no longer need `outString`, call `QTSS_Delete` to free the memory that has been allocated for it.

The `QTSS_GetValueAsString` callback routine can be called to get the value of preemptive safe attributes as well as attributes that are not preemptive safe. However, calling `QTSS_GetValueAsString` is less efficient than calling `QTSS_GetValue` (page 155), and calling `QTSS_GetValue` is less efficient than calling `QTSS_GetValuePtr` (page 157).

Calling `QTSS_GetValue` is the recommended way to get the value of an attribute that is not preemptive safe and calling `QTSS_GetValuePtr` is the recommended way to get the value of an attribute that is preemptive safe.

QTSS_GetValuePtr

Gets a pointer to an attribute's value.

```
QTSS_Error QTSS_GetValuePtr (
   QTSS_Object inObject,
   QTSS_AttributeID inID,
   UInt32 inIndex,
   void** outBuffer,
   UInt32* outLen);
```

`inObject`

On input, a value of type `QTSS_Object` (page 183) that specifies the object containing the attribute whose value is to be obtained.

`inID`

On input, a value of type `QTSS_AttributeID` (page 183) that specifies the ID of an attribute.

`inIndex`

On input, a value of type `UInt32` that specifies which attribute value to get (if the attribute can have multiple values) or zero for single-value attributes.

`outBuffer`

On input, a pointer to an address in memory. On output, `outBuffer` points to the value of the attribute specified by `inID`.

`outLen`

On output, a pointer to a value of type `UInt32` that contains the number of valid bytes pointed to by `outBuffer`.

`result`

A result code. Possible values include `QTSS_NoErr`, `QTSS_NotPreemptiveSafe` if `inID` is an attribute that is not preemptive safe, `QTSS_BadArgument` if a parameter is invalid, `QTSS_BadIndex` if the index specified by `inIndex` does not exist, and `QTSS_AttrDoesntExist` if the attribute doesn't exist.

Discussion

The `QTSS_GetValuePtr` callback routine gets a pointer to an attribute's value. Calling QTSS_GetValuePtr is the fastest and most efficient way to get the value of an attribute, and it is less likely to generate an error.

Before calling QTSS_GetValuePtr to get the value of an attribute that is not preemptive safe, you must lock the object by calling `QTSS_LockObject` (page 147). After getting the value, unlock the object by calling `QTSS_UnLockObject` (page 147).

If you don't want to lock and unlock the object to get the value of an attribute that is not preemptive safe, get the value by calling `QTSS_GetValue` (page 155) or `QTSS_GetValueAsString` (page 156).

QTSS_IDForAttr

Gets the ID of a static attribute.

```
QTSS_Error QTSS_IDForAttr(
   QTSS_ObjectType inType,
   const char* inAttributeName,
   QTSS_AttributeID* outID);
```

`inType`
: On input, a value of type `QTSS_ObjectType` (page 184) that specifies the type of object for which the ID is to be obtained.

`inAttributeName`
: On input, a pointer to a byte array that specifies the name of the attribute whose ID is to be obtained.

`outID`
: On input, a pointer to a value of type `QTSS_AttributeID` (page 183). On output, `outID` contains the ID of the attribute specified by `inAttributeName`.

`result`
: A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if a parameter is invalid.

Discussion

The `QTSS_IDForAttr` callback routine obtains the attribute ID for the specified static attribute in the specified object type. The attribute ID is used to when calling `QTSS_GetValue` (page 155), `QTSS_GetValueAsString` (page 156), and `QTSS_GetValuePtr` (page 157) get the attribute's value.

To get the ID of an instance attribute, call `QTSS_GetAttrInfoByName` (page 153) or `QTSS_GetAttrInfoByIndex` (page 152).

QTSS_RemoveInstanceAttribute

Remove an instance attribute from the instance of an object.

```
QTSS_Error QTSS_RemoveInstanceAttribute(
   QTSS_Object inObject,
   QTSS_AttributeID inID);
```

`inObject`
: On input, a value of type `QTSS_Object` (page 183) that specifies the object from which the instance attribute is to be removed.

`inID`
: On input, a value of type`QTSS_AttributeID` (page 183) that specifies the ID of the attribute that is to be removed.

result

A result code. Possible values are QTSS_NoErr, QTSS_BadArgument if the specified object instance does not exist, and QTSS_AttrDoesntExist if the attribute doesn't exist.

Discussion

The QTSS_RemoveInstanceAttribute callback routine removes the attribute specified by the inID parameter from the instance of an object specified by the inObject parameter.

The QTSS_RemoveInstanceAttribute callback can be called from any role.

QTSS_RemoveValue

Removes the specified value from an attribute.

```
QTSS_Error QTSS_RemoveValue (
   QTSS_Object inObject,
   QTSS_AttributeID inID,
   UInt32 inIndex);
```

inObject

On input, a value of type QTSS_Object (page 183) having an attribute whose value is to be removed.

inValueLen

On input, a value of type QTSS_AttributeID (page 183) containing the attribute ID of the attribute whose value is to be removed.

inIndex

On input, a value of type UInt32 that specifies the attribute value that is to be removed. Attribute value indexes are numbered starting from zero.

result

A result code. Possible values include QTSS_NoErr, QTSS_BadArgument if InObject, inID, or inIndex do not contain valid values, QTSS_ReadOnly if the attribute is read-only, and QTSS_BadIndex if the specified index does not exist.

Discussion

The QTSS_RemoveValue callback routine removes the value of the specified attribute. After the value is removed, the attribute values are renumbered.

QTSS_SetValue

Sets the value of an attribute.

```
QTSS_Error QTSS_SetValue (
   QTSS_Object inObject,
   QTSS_AttributeID inID,
   UInt32 inIndex,
   const void* inBuffer,
   UInt32 inLen);
```

`inObject`
: On input, a value of type `QTSS_Object` (page 183) that specifies the object containing the attribute whose value is to be set.

`inID`
: On input, a value of type `QTSS_AttributeID` (page 183) that specifies the ID of the attribute whose value is to be set.

`inIndex`
: On input, a value of type `UInt32` that specifies which attribute value to set (if the attribute can have multiple values) or zero for single-value attributes.

`inBuffer`
: On input, a pointer to a buffer containing the value that is to be set. When `QTSS_SetValue` returns, you can dispose of `inBuffer`.

`inLen`
: On input, a pointer to a value of type `UInt32` that specifies the length of valid data in `inBuffer`.

`result`
: A result code. Possible values are `QTSS_NoErr`, `QTSS_BadIndex` if the index specified by `inIndex` does not exist, `QTSS_BadArgument` if a parameter is invalid, `QTSS_ReadOnly` if the attribute is read-only, and `QTSS_AttrDoesntExist` if the attribute doesn't exist.

Discussion

The `QTSS_SetValue` callback routine explicitly sets the value of the specified attribute. Another way to set the value of an attribute is to call `QTSS_SetValuePtr` (page 162).

QTSS_SetValuePtr

Sets an existing variable as the value of an attribute.

```
QTSS_Error QTSS_SetValue (
   QTSS_Object inObject,
   QTSS_AttributeID inID,
   const void* inBuffer,
   UInt32 inLen);
```

`inObject`
: On input, a value of type `QTSS_Object` (page 183) that specifies the object containing the attribute whose value is to be set.

`inID`
: On input, a value of type `QTSS_AttributeID` (page 183) that specifies the ID of the attribute whose value is to be set.

`inBuffer`
: On input, a pointer to a buffer containing the value that is to be set.

`inLen`
: On input, a pointer to a value of type `UInt32` that specifies the length of valid data in `inBuffer`.

`result`
: A result code. Possible values are `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is invalid, and `QTSS_ReadOnly` if the attribute is a read-only attribute.

Discussion

The `QTSS_SetValuePtr` callback routine allows modules to set an attribute that its value is the value of a module's variable. This callback is an alternative to the `QTSS_SetValue` (page 161) callback.

After calling `QTSS_SetValuePtr`, the module must insure that the buffer pointed to by `inBuffer` exists as long as the attribute specified by `inID` exists.

If the buffer pointed to by `inBuffer` is not updated atomically, updating the value of inBuffer should be protected by calling `QTSS_LockObject` (page 147) before an update.callback

QTSS_StringToValue

Converts an attribute data type in C string format to a value in `QTSS_AttrDataType` format.

```
QTSS_Error QTSS_StringToValue(
   const char* inValueAsString,
   const QTSS_AttrDataType inType,
   void* ioBuffer,
   UInt32* ioBufSize);
```

`inValueAsString`
: On input, a pointer to a character array containing the value that is to be converted.

`inType`
: On input, a value of type `QTSS_AttrDataType` (page 186) that specifies the attribute data type to which the value pointed to by `inValueAsString` is to be converted.

`ioBuffer`
: On input, a pointer to a buffer. On output, the buffer contains the attribute data type to which inValueAsString has been converted. The calling module must allocate `ioBuffer` before calling `QTSS_StringToValue`.

`ioBufSize`
: On input, a pointer to a value of type `UInt32 that specifies the length of the buffer pointed to by ioBuffer`. On output, `ioBufSize` points to the length of data in `ioBuffer`.

`result`
: A result code. Possible values are `QTSS_NoErr`, `QTSS_BadArgument` if `inValueAsString` or `inType` do not contain valid values, and `QTSS_NotEnoughSpace` if the buffer pointed to by `ioBuffer` is too small to contain the converted value.

Discussion

The `QTSS_StringToValue` callback routine converts an attribute data type that is in C string format to a value that is in `QTSS_AttrDataType` format.

When the memory allocated for the buffer pointed to by `ioBuffer` is no longer needed, you should deallocate the memory.

QTSS_TypeStringToType

Gets the attribute data type of a data type string that is in C string format.

```
QTSS_Error QTSS_TypeStringToType(
   const char* inTypeString,
   QTSS_AttrDataType* outType);
```

`inTypeString`
On input, a pointer to a character array containing the attribute data type in C string format.

`outType`
On output, a pointer to a value of type `QTSS_AttrDataType` (page 186) containing the attribute data type.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if `inTypeString` does not contain a value for which an attribute data type can be returned.

Discussion

The `QTSS_TypeStringToType` callback routine gets the attribute data type of a data type string that is in C string format.

QTSS_TypeToTypeString

Gets the name in C string format of an attribute data type.

```
QTSS_Error QTSS_TypeToTypeString(
   const QTSS_AttrDataType inType,
   char** outTypeString);
```

`inType`
On input, a pointer to a value of type `QTSS_AttrDataType` (page 186) containing the attribute data type that is to be returned in C string format.

`outType`
On input, a pointer to an address in memory. On output, `outType` points to a C string containing the attribute data type.

result

A result code. Possible values are QTSS_NoErr and QTSS_BadArgument if inType does not contain a valid attribute data type.

Discussion

The QTSS_TypeToTypeString callback routine gets the name in C string format of a value that is in QTSS_AttrDataType format.

QTSS_ValueToString

Converts an attribute data type in QTSS_AttrDataType format to a value in C string format.

```
QTSS_Error QTSS_ValueToString(
   const void* inValue,
   const UInt32 inValueLen,
   const QTSS_AttrDataType inType,
   char** outString);
```

inValue

On input, a pointer to a buffer containing the value that is to be converted from QTSS_AttrDataType format.

inValueLen

On input, a value of type UInt32 that specifies the length of the value pointed to by inValue.

inType

On input, a value of type QTSS_AttrDataType (page 186) that specifies the attribute data type of the value pointed by inValue.

outString

On output, a pointer to a location in memory containing the attribute data type in C string format.

result

A result code. Possible values are QTSS_NoErr and QTSS_BadArgument if inValue, inValueLen, or inType do not contain valid values.

Discussion

The QTSS_ValueToString callback routine converts an attribute data type in QTSS_AttrDataType format to a value in C string format.

Stream Callback Routines

This section describes the callback routines that modules call to perform I/O on streams. Internally, the server performs I/O asynchronously, so QTSS stream callback routines do not block and, unless otherwise noted, return the error `QTSS_WouldBlock` if data cannot be written. The stream callback routines are:

QTSS_Advise

Advises that the specified section of the stream will soon be read.

```
QTSS_Error QTSS_Advise(QTSS_StreamRef inRef,
   UInt64 inPosition,
   UInt32 inAdviseSize);
```

`inRef`
On input, a value of type `QTSS_StreamRef` (page 185) obtained by calling `QTSS_OpenFileObject` (page 173) that specifies the stream.

`inPosition`
On input, the offset in bytes from the beginning of the stream that marks the beginning of the advise section.

`inAdviseSize`
On input, the size in bytes of the advise section.

`result`
A result code. Possible values include `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is invalid, and `QTSS_RequestFailed`.

Discussion
The QTSS_Advise callback routine tells a file system module that the specified section of a stream will be read soon. The file system module may read ahead in order to respond more quickly to future calls to QTSS_Read for the specified stream.

QTSS_Read

Reads data from a stream.

```
QTSS_Error QTSS_Read(QTSS_StreamRef inRef,
   void* ioBuffer,
   UInt32 inBufLen,
   UInt32* outLengthRead);
```

`inRef`
: On input, a value of type QTSS_StreamRef (page 185) that specifies the stream from which data is to be read. Call QTSS_OpenFileObject to obtain a stream reference for the file you want to read.

`ioBuffer`
: On input, a pointer to a buffer in which data that is read is to be placed.

`inBufLen`
: On input, a value of type UInt32 that specifies the length of the buffer pointed to by ioBuffer.

`outLenRead`
: On output, a pointer to a value of type UInt32 that contains the number of bytes that were read.

`result`
: A result code. Possible values include QTSS_NoErr, QTSS_BadArgument if a parameter is invalid, QTSS_WouldBlock if the read operation would block, or QTSS_RequestFailed if the read operation failed.

Discussion
The QTSS_Read callback routine reads a buffer of data from a stream.

QTSS_Seek

Sets the position of a stream.

```
QTSS_Error QTSS_Seek(QTSS_StreamRef inRef,
   UInt64 inNewPosition);
```

`inRef`
: On input, a value of type `QTSS_StreamRef` (page 185) `QTSS_StreamRef` that specifies the stream whose position is to be set. Call `QTSS_OpenFileObject` to obtain stream reference.

`inNewPosition`
: On input, the offset in bytes from the start of the stream to which the position is to be set.

`result`
: A result code. Possible values include `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is invalid, and `QTSS_RequestFailed` if the seek operation failed.

Discussion

The `QTSS_Seek` callback routine sets the stream position to the value specified by `inNewPosition`.

QTSS_RequestEvent

Requests notification of specified events.

```
QTSS_Error QTSS_RequestEvent(QTSS_StreamRef inStream,
   QTSS_EventType inEventMask);
```

`inStream`
: On input, a value of type `QTSS_StreamRef` (page 185) that specifies the stream for which event notifications are requested.

`inEventMask`
: On input, a value of type `QTSS_EventType` (page 189) specifying a mask that represents the events for which notifications are requested.

result

A result code. Possible values include QTSS_NoErr, QTSS_BadArgument if a parameter is invalid, and QTSS_RequestFailed if the call failed.

Discussion

The QTSS_RequestEvent callback requests that the caller be notified when the specified events occur on the specified stream. After calling QTSS_RequestEvent, the calling module should return as soon as possible from its current module role. The server preserves the calling module's current state and, when the event occurs, calls the module in the role the module was in when it called QTSS_RequestEvent.

QTSS_SignalStream

Notifies the recipient of events that a stream has become available for I/O.

```
QTSS_Error QTSS_RequestEvent(QTSS_StreamRef inStream,
   QTSS_EventType inEventMask);
```

inStream

On input, a value of type QTSS_StreamRef (page 185) specifying the stream that has become available for I/O.

inEventMask

On input, a value of type QTSS_EventType (page 189) containing a mask that represents whether the stream has become available for reading, writing, or both.

result

A result code. Possible values include QTSS_NoErr, QTSS_BadArgument if a parameter is invalid, QTSS_OutOfState if this callback is made from a role that does not allow asynchronous events, and QTSS_RequestFailed if the call failed.

Discussion

The QTSS_SignalStream callback routine tells the server that the stream represented by inStream has become available for I/O. Currently only file system modules have reason to call QTSS_SignalStream.

QTSS_Write

Writes data to a stream.

```
QTSS_Error QTSS_Write(
   QTSS_StreamRef inRef,
   void* inBuffer,
   UInt32 inLen,
   UInt32* outLenWritten,
   UInt32 inFlags);
```

`inRef`
On input, a value of type `QTSS_StreamRef` (page 185) that specifies the stream to which data is to be written.

`inBuffer`
On input, a pointer to a buffer containing the data that is to be written.

`inLen`
On input, a value of type `UInt32` that specifies the length of the data in the buffer pointed to by `ioBuffer`.

`outLenWritten`
On output, a pointer to a value of type `UInt32` that contains the number of bytes that were written.

`inFlags`
On input, a value of type `UInt32`. See the Discussion section for possible values.

`result`
A result code. Possible values include `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is invalid, `QTSS_NotConnected` if the stream receiver is no longer connected, and `QTSS_WouldBlock` if the stream cannot be completely flushed at this time.

Discussion

The `QTSS_Write` callback routine writes a buffer of data to a stream.

The following enumeration defines constants for the `inFlags` parameter:

```
enum
{
    qtssWriteFlagsIsRTP = 0x00000001,
    qtssWriteFlagsIsRTCP= 0x00000002
};
```

These flags are relevant when writing to an RTP stream reference and tell the server whether the data written should be sent over the RTP channel (`qtssWriteFlagsIsRTP`) or over the RTCP channel of the specified RTP stream (`qtssWriteFlagsIsRTCP`).

QTSS_WriteV

Writes data to a stream using an iovec structure.

```
QTSS_Error QTSS_WriteV(
   QTSS_StreamRef inRef,
   iovec* inVec,
   UInt32 inNumVectors,
   UInt32 inTotalLength,
   UInt32* outLenWritten);
```

`inRef`
: On input, a value of type `QTSS_StreamRef` (page 185) that specifies the stream to which data is to be written.

`inVec`
: On input, a pointer to an `iovec` structure. The first member of the `iovec` structure must be empty.

`inNumVectors`
: On input, a value of type `UInt32` that specifies the number of vectors.

`inTotalLength`
: On input, a value of type `UInt32` specifying the total length of `inVec`.

`outLenWritten`
: On output, a pointer to a value of type `UInt32` containing the number of bytes that were written.

`result`
: A result code. Possible values include `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is `NULL`, and `QTSS_WouldBlock` if the write operation would block.

Discussion
The `QTSS_WriteV` callback routine writes a data to a stream using an `iovec` structure in a way that is similar to the POSIX `writev` call.

QTSS_Flush

Forces an immediate write operation.

```
QTSS_Error QTSS_Flush(QTSS_StreamRef inRef);
```

`inRef`
On input, a value of type `QTSS_StreamRef` (page 185) that specifies the stream for which buffered data is to be written.

`result`
A result code. Possible values include `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is `NULL`, and `QTSS_WouldBlock` if the stream cannot be flushed completely at this time.

Discussion
The `QTSS_Flush` callback routine forces the stream to immediately write any data that has been buffered. Some QTSS stream references, such as `QTSSRequestRef`, buffer data before sending it.

File System Callback Routines

Modules use the callback routines described in this section to open and close a file object.

- "QTSS_OpenFileObject" (page 173)
- "QTSS_CloseFileObject" (page 173)

QTSS_OpenFileObject

Opens a file.

```
QTSS_Error QTSS_OpenFileObject(
   char* inPath,
   QTSS_OpenFileFlags inFlags,
   QTSS_Object* outFileObject);
```

`inPath`
: On input, a pointer to a null-terminated C string containing the full path to the file in the local file system that is to be opened.

`inFlags`
: On input, a value of type `QTSS_OpenFileFlags` (page 190) specifying flags that describe how the file is to be opened.

`outFileObject`
: On output, a pointer to a value of type `QTSS_Object` (page 183) in which the file object for the opened file is to be placed.

`result`
: A result code. Possible values include `QTSS_NoErr`, `QTSS_BadArgument` if a parameter is invalid, and `QTSS_FileNotFound` if the specified file does not exist.

Discussion

The `QTSS_OpenFileObject` callback routine opens the specified file and returns a file object for it. One of the attributes of the file object is a stream reference that is passed to QTSS stream callback routines to read and write data to the file and to perform other file operations.

QTSS_CloseFileObject

Closes a file.

```
QTSS_Error QTSS_CloseFileObject(QTSS_Object inFileObject);
```

`inFileObject`
: On input, a value of type `QTSS_Object` (page 183) that represents the file that is to be closed.

`result`
A result code. Possible values include `QTSS_NoErr` and `QTSS_BadArgument` if a parameter is invalid.

Discussion
The `QTSS_CloseFileObject` callback routine closes the specified file.

Service Callback Routines

Modules use the callback routines described in this section to register and invoke services. The service callback routines are:

- `QTSS_AddService` (page 174)
- `QTSS_IDForService` (page 175)
- `QTSS_DoService` (page 175)

QTSS_AddService

Adds a service.

```
QTSS_Error QTSS_AddService(
   const char* inServiceName,
   QTSS_ServiceFunctionPtr inFunctionPtr);
```

`inServiceName`
On input, a pointer to a string containing the name of the service that is being added.

`inFunctionPtr`
On input, a pointer to the module that provides the service that is being added.

`result`
A result code. Possible values include `QTSS_NoErr`, `QTSS_OutOfState` if `QTSS_AddService` is not called from the Register role, and `QTSS_BadArgument` if `inServiceName` is too long or if a parameter is `NULL`.

Discussion

The QTSS_AddService callback routine makes the specified service available for other modules to call.

This callback can only be called from the Register role.

QTSS_IDForService

Resolves a service name to a service ID.

```
QTSS_Error QTSS_IDForService(
   const char* inTag,
   QTSS_ServiceID* outID);
```

`inTag`

On input, a pointer to a string containing the name of the service that is to be resolved.

`outID`

On input, a pointer to a value of type QTSS_ServiceID (page 185). On output, QTSS_ServiceID contains the ID of the service specified by inTag.

`result`

A result code. Possible values are QTSS_NoErr and QTSS_BadArgument if a parameter is invalid.

Discussion

The QTSS_IDForService callback routine returns in the outID parameter the service ID of the service specified by the inTag parameter. You can use the service ID to call QTSS_DoService (page 175) to invoke the service that serviceID represents.

QTSS_DoService

Invokes a service.

```
QTSS_Error QTSS_DoService(
   QTSS_ServiceID inID,
   QTSS_ServiceFunctionArgsPtr inArgs);
```

`inID`

On input, a value of type `QTSS_ServiceID` (page 185) that specifies the service that is to be invoked. Call `QTSS_IDForAttr` (page 158) to get the service ID of the service you want to invoke.

`inArgs`

On input, a value of type `QTSS_ServiceFunctionArgsPtr` that points to the arguments that are to be passed to the service.

`result`

A result code returned by the service or `QTSS_IllegalService` if `inID` is invalid.

Discussion

The `QTSS_DoService` callback routine invokes the service specified by `inID`.

RTSP Header Callback Routines

As a convenience to modules that want to send RTSP responses, the server provides the utilities described in this section for formatting RTSP responses properly. The RTSP header callback routines are:

- `QTSS_AppendRTSPHeader` (page 176)
- `QTSS_SendRTSPHeaders` (page 177)
- `QTSS_SendStandardRTSPResponse` (page 178)

QTSS_AppendRTSPHeader

Appends information to an RTSP header.

```
QTSS_Error QTSS_AppendRTSPHeader(
   QTSS_RTSPRequestObject inRef,
   QTSS_RTSPHeader inHeader,
   const char* inValue,
   UInt32 inValueLen);
```

`inRef`

On input, a value of type `QTSS_RTSPRequestObject` for the RTSP stream.

`inHeader`
On input, a value of type `QTSS_RTSPHeader`.

`inValue`
On input, a pointer to a byte array containing the header that is to be appended.

`inValueLen`
On input, a value of type `UInt32` containing the length of valid data pointed to by `inValue`.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if a parameter is invalid.

Discussion

The `QTSS_AppendRTSPHeader` callback routine appends headers to an RTSP header. After calling `QTSS_AppendRTSPHeader`, call `QTSS_SendRTSPHeaders` (page 177) to send the entire header.

QTSS_SendRTSPHeaders

Sends an RTSP header.

```
QTSS_Error QTSS_SendRTSPHeaders(
   QTSS_RTSPRequestOjbect inRef);
```

`inRef`
On input, a value of type QTSS_RTSPRequestObject for the RTSP stream.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if a parameter is invalid.

Discussion

The `QTSS_SendRTSPHeaders` callback routine sends an RTSP header. When a module calls `QTSS_SendRTSPHeaders`, the server sends a proper RTSP status line, using the request's current status code. The server also sends the proper `CSeq` header, session ID header, and connection header.

QTSS_SendStandardRTSPResponse

Sends an RTSP response to a client.

```
QTSS_Error QTSS_SendStandardRTSPResponse(
   QTSS_RTSPRequestObject inRTSPRequest,
   QTSS_Object inRTPInfo,
   UInt32 inFlags);
```

`inRTSPRequest`
On input, a value of type QTSS_RTSPRequestObject for the RTSP stream.

`inRTPInfo`
On input, a value of type `QTSS_Object` (page 183). This parameter is a `QTSS_ClientSessionObject` or a `QTSS_RTPStreamObject`, depending the response that is sent.

`inFlags`
On input, a value of type `UInt32`. Set `inFlags` to `qtssPlayRespWriteTrackInfo` if you want the server to append the seq number, a timestamp, and SSRC information to RTP-Info headers.

`result`
A result code. Possible values include `QTSS_NoErr` and `QTSS_BadArgument` if a parameter is invalid.

Discussion

The `QTSS_SendStandardRTSPResponse` callback routine writes a standard response to the stream specified by the inRTSPRequest parameter. The actual response that is sent depends on the method.

The following enumeration defines the `qtssPlayRespWriteTrackInfo` constant for the `inFlags` parameter:

```
enum
{
    qtssPlayRespWriteTrackInfo = 0x00000001
};
```

This function supports the following response methods:

- DESCRIBE. This response method writes status line, CSeq, SessionID, Connection headers as determined by the request. Writes a Content-Base header with the content base being the URL provided. Writes a Content-Type header of `application/sdp`. The `inRTPInfo` parameter must be a `QTSS_ClientSessionObject`.
- ANNOUNCE. This response method writes status line, CSeq, and Connection headers as determined by the request. The `inRTPInfo` parameter must be a `QTSS_ClientSessionObject`.
- SETUP. This response method writes status line, CSeq, SessionID, Connection headers as determined by the request. Writes a Transport header with client and server ports (if the connection is over UDP). The `inRTPInfo` parameter must be a `QTSS_RTPStreamObject`.
- PLAY. This response method writes status line, CSeq, SessionID, Connection headers as determined by the request. The `inRTPInfo` parameter must be a `QTSS_ClientSessionObject`. Set the `inFlags` parameter to `qtssPlayRespWriteTrackInfo` to specify that you want the server to append the sequence number, timestamp, and SSRC information to the RTP-Info header.
- PAUSE. This response method writes status line, CSeq, SessionID, Connection headers as determined by the request. The `inRTPInfo` parameter must be a `QTSS_ClientSessionObject`.
- TEARDOWN. This response method writes status line, CSeq, SessionID, Connection headers as determined by the request. The `inRTPInfo` parameter must be a `QTSS_ClientSessionObject`.

RTP Callback Routines

QTSS modules can generate and send RTP packets in response to an RTSP request. Typically RTP packets are sent in response to a SETUP request from the client. Currently, only one module can generate packets for a particular session. The RTP callback routines are:

- `QTSS_AddRTPStream` (page 180)
- `QTSS_Play` (page 181)
- `QTSS_Pause` (page 182)
- `QTSS_Teardown` (page 182)

QTSS_AddRTPStream

Enables a module to send RTP packets to a client.

```
QTSS_Error QTSS_AddRTPStream(
   QTSS_ClientSessionObject inClientSession,
   QTSS_RTSPRequestObject inRTSPRequest,
   QTSS_RTPStreamObject* outStream,
   QTSS_AddStreamFlags inFlags);
```

`inClientRequest`
: On input, a value of type `QTSS_ClientSessionObject` identifying the client session for which the sending of RTP packets is to be enabled.

`inRTSPRequest`
: On input, a value of type `QTSS_RTSPRequestObject`.

`outStream`
: On output, a pointer to a value of type `QTSS_RTPStreamObject`, containing the newly created stream.

`inFlags`
: On input, a value of type `QTSS_AddStreamFlags` (page 188) that specifies stream options.

`result`
: A result code. Possible values are `QTSS_NoErr`, `QTSS_RequestFailed` if the QTSS_RTPStreamObject couldn't be created, and `QTSS_BadArgument` if a parameter is invalid.

Discussion

The `QTSS_AddRTSPStream` callback routine enables a module to send RTP packets to a client in response to an RTSP request. Call `QTSS_AddRTSPStream` multiple times in order to add more than one stream to the session.

To start playing a stream, call `QTSS_Play` (page 181).

QTSS_Play

Starts playing streams associated with a client session.

```
QTSS_Error QTSS_Play(
   QTSS_ClientSessionObject inClientSession,
   QTSS_RTSPRequestObject inRTSPRequest,
   QTSS_PlayFlags inPlayFlags);
```

`inClientSession`
On input, a value of type QTSS_ClientSessionObject that identifies the client session for which the sending of RTP packets was enabled by previously calling `QTSS_AddRTPStream` (page 180).

`inRTSPRequest`
On input, a value of type `QTSS_RequestObject`.

`inPlayFlags`
On input, a value of type `QTSS_PlayFlags`. Set `inPlayFlags` to the constant `qtssPlaySendRTCP` to cause the server to generate RTCP sender reports automatically while playing. Otherwise, the module is responsible for generating sender reports that specify play characteristics.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if a parameter is invalid, and `QTSS_RequestFailed` if no streams have been added to the session.

Discussion

The `QTSS_Play` callback routine starts playing streams associated with the specified client session.

The module that called `QTSS_AddRTPStream` (page 180) is the only module that can call `QTSS_Play`.

Before calling `QTSS_Play`, the module should set the following attributes of the `QTSS_RTPStreamObject` object for this RTP stream:

- `qtssRTPStrFirstSeqNumber`, which should be set to the sequence number of the first packet after the last PLAY request was issued. The server uses the sequence number to generate a proper RTSP PLAY response.

- qtssRTPStrFirstTimestamp, which should be set to the timestamp of the first RTP packet generated for this stream after the last PLAY request was issued. The server uses the timestamp to generate a proper RTSP PLAY response.
- qtssRTPStrTimescale, which should be set to the timescale for the track.

After calling QTSS_Play, the module is invoked in the RTP Send Packets role.

Call QTSS_Pause (page 182) to pause playing or call QTSS_Teardown (page 182) to close the client session.

QTSS_Pause

Pauses a stream that is playing.

```
QTSS_Error QTSS_Pause(QTSS_ClientSessionObject inClientSession);
```

`inClientSession`
On input, a value of type QTSS_ClientSessionObject that identifies the client session that is to be paused.

`result`
A result code. Possible values are QTSS_NoErr and QTSS_BadArgument if a parameter is invalid.

Discussion

The QTSS_Pause callback routine pauses playing for a stream. The module that called QTSS_AddRTPStream (page 180) is the only module that can call QTSS_Pause.

QTSS_Teardown

Closes a client session.

```
QTSS_Error QTSS_Teardown(QTSS_ClientSessionObject inClientSession);
```

`inClientSession`
On input, a value of type QTSS_ClientSessionObject that identifies the client session that is to be closed.

`result`
A result code. Possible values are `QTSS_NoErr` and `QTSS_BadArgument` if a parameter is invalid.

Discussion
The `QTSS_Teardown` callback routine closes a client session.

The module that called `QTSS_AddRTPStream` (page 180) is the only module that can call `QTSS_Teardown`.

Calling `QTSS_Teardown` causes the calling module to be invoked in the Client Session Closing role for the session identified by the `inClientSession` parameter.

QTSS Data Types

QTSS_AttributeID

A `QTSS_AttributeID` is a signed 32-bit integer that uniquely identifies an attribute.

```
typedef SInt32 QTSS_AttributeID;
```

QTSS_Object

A `QTSS_Object` is a pointer to a value that identifies a particular object. The `QTSS_Object` is defined as

```
typedef void* QTSS_Object;
```

Discussion
The `QTSS_Object` is used to define other QTSS objects:

```
typedef QTSS_Object  QTSS_RTPStreamObject;
typedef QTSS_Object  QTSS_RTSPSessionObject;
typedef QTSS_Object  QTSS_RTSPRequestObject;
typedef QTSS_Object  QTSS_RTSPHeaderObject;
typedef QTSS_Object  QTSS_ClientSessionObject;
```

```
typedef QTSS_Object  QTSS_ConnectedUserObject;
typedef QTSS_Object  QTSS_ServerObject;
typedef QTSS_Object  QTSS_PrefsObject;
typedef QTSS_Object  QTSS_TextMessagesObject;
typedef QTSS_Object  QTSS_FileObject;
typedef QTSS_Object  QTSS_ModuleObject;
typedef QTSS_Object  QTSS_ModulePrefsObject;
typedef QTSS_Object  QTSS_AttrInfoObject;
```

QTSS_ObjectType

A `QTSS_ObjectType` is a value of type `UInt32` that identifies a particular QTSS object type.

```
typedef UInt32 QTSS_ObjectType;
```

Discussion

Constants for the following QTSS object types are defined:

- qtssAttrInfoObjectType — The attribute information object type. Objects of this type have attributes that describe an attribute.
- qtssClientSessionObjectType — The client session object type. Objects of this type have attributes that describe a client session.
- qtssConnectedUserObjectType — The connected user object type. Objects of this type have attributes that described connections other than those described by qtssClientSessionObjectType objects.
- qtssFileObjectType — The file object type. Objects of this type have attributes that describe an open file.
- qtssModuleObjectType — The module object type. Objects of this type have attributes that describe a QTSS module.
- qtssModulePrefsObjectType — The module preferences object type. Objects of this type have attributes that describe module preferences.
- qtssPrefsObjectType — The preferences object type. Objects of this type have attributes that describe the server's preferences.
- qtssRTPStreamObjectType — The RTPS stream object type. Objects of this type have attributes that describe an RTP stream.

- qtssRTSPHeaderObjectType — The RTSP header object type. Objects of this type have attributes that contain all of the RTSP headers associated with an individual RTSP request.
- qtssRTSPRequestObjectType — The RTSP request object type. Objects of this type have attributes that describe a particular RTSP request.
- qtssRTSPSessionObjectType — The RTSP session object type. Objects of this type have attributes that describe an RTSP client-server connection.
- qtssServerObjectType — The server object type. Objects of this type have attributes that contain global server information, such as server statistics.
- qtssTextMessagesObjectType — The text messages object type. Objects of this type have attributes that contain messages intended for display to the user.

QTSS_Role

A value of type `QTSS_Role` is an unsigned 32-bit integer used to store module roles. It is defined as

```
typedef UInt32 QTSS_Role;
```

QTSS_ServiceID

A `QTSS_ServiceID` is a signed 32-bit integer that uniquely identifies a service. It is defined as

```
typedef SInt32 QTSS_ServiceID;
```

QTSS_StreamRef

A value of type `QTSS_StreamRef` is a pointer to a value that identifies a particular stream. It is defined as

```
typedef void* QTSS_StreamRef;
```

Discussion

The `QTSS_StreamRef` is used to define other stream references:

```
typedef QTSS_StreamRef      QTSS_ErrorLogStream;
typedef QTSS_StreamRef      QTSS_FileStream;
typedef QTSS_StreamRef      QTSS_RTSPSessionStream;
typedef QTSS_StreamRef      QTSS_RTSPRequestStream;
```

```
typedef QTSS_StreamRef                  QTSS_RTPStreamStream;
typedef QTSS_StreamRef                  QTSS_SocketStr
```

QTSS_TimeVal

A value of type `QTSS_TimeVal` is a signed 64-bit integer used to store time values. It is defined as

```
typedef SInt64 QTSS_TimeVal;
```

QTSS Constants

QTSS_AttrDataType

Each QTSS attribute has an associated data type. The `QTSS_AttrDataType` enumeration defines values that describe attribute data types. Having an attribute's data type helps the server and modules handle an attribute value without having specific knowledge about the attribute.

```
typedef UInt32 QTSS_AttrDataType;
   enum
   {
       qtssAttrDataTypeUnknown      = 0,
       qtssAttrDataTypeCharArray    = 1,
       qtssAttrDataTypeBool16       = 2,
       qtssAttrDataTypeSInt16       = 3,
       qtssAttrDataTypeUInt16       = 4,
       qtssAttrDataTypeSInt32       = 5,
       qtssAttrDataTypeUInt32       = 6,
       qtssAttrDataTypeSInt64       = 7,
       qtssAttrDataTypeUInt64       = 8,
       qtssAttrDataTypeQTSS_Object  = 9,
       qtssAttrDataTypeQTSS_StreamRef= 10,
       qtssAttrDataTypeFloat32      = 11,
       qtssAttrDataTypeFloat64      = 12,
       qtssAttrDataTypeVoidPointer  = 13,
       qtssAttrDataTypeTimeVal      = 14,
```

```
        qtssAttrDataTypeNumTypes      = 15
    };
```

Constant descriptions

`qtssAttrDataTypeUnknown`
The data type is unknown.

`qtssAttrDataTypeCharArray`
The data type is a character array.

`qtssAttrDataTypeBool16`
The data type is a 16-bit Boolean value.

`qtssAttrDataTypeSInt16`
The data type is a signed 16-bit integer.

`qtssAttrDataTypeUInt16`
The data type is an unsigned 16-bit integer.

`qtssAttrDataTypeSInt32`
The data type is a signed 32-bit integer.

`qtssAttrDataTypeUInt32`
The data type is an unsigned 32-bit integer.

`qtssAttrDataTypeSInt64`
The data type is a signed 64-bit integer.

`qtssAttrDataTypeQTSS_Object`
The data type is a `QTSS_Object` (page 183).

`qtssAttrDataTypeQTSS_StreamRef`
The data type is a `QTSS_ServerState` (page 193).

`qtssAttrDataTypeFloat32`
The data type is a `Float32`.

`qtssAttrDataTypeFloat64`
The data type is a `Float64`.

`qtssAttrDataTypeVoidPointer`
The data type is a pointer to a void.

`qtssAttrDataTypeTimeVal`
The data type is a `QTSS_TimeVal` (page 186).

`qtssAttrDataTypeNumTypes`
The data type is a value that describes the number of types.

QTSS_AttrPermission

The `QTSS_AttrPermission` data type is an enumeration that defines values used to indicate whether an attribute is readable, writable, or preemptive safe. The data type of the `qtssAttrPermissions` attribute of the `QTSS_AttrInfoObject` object type is of type `QTSS_AttrPermission`.

```
typedef UInt32 QTSS_AttrPermission;
   enum
   {
       qtssAttrModeRead     = 1,
       qtssAttrModeWrite    = 2,
       qtssAttrModePreempSafe= 4
   };
```

Constant descriptions

`qtssAttrModeRead`

The attribute is readable.

`qtssAttrModeWrite`

The attribute is writable.

`qtssAttrModePrempSafe`

The attribute is preemptive safe.

Discussion

Once set, attribute permissions cannot be changed.

QTSS_AddStreamFlags

The `QTSS_AddStreamFlags` enumeration defines flags that specify stream options when adding RTP streams.

```
enum
   {
       qtssASFlagsAllowDestination      = 0x00000001,
       qtssASFlagsForceInterleave       = 0x00000002
   };
   typedef UInt32 QTSS_AddStreamFlags;
```

Constant descriptions

`qtssASFlagsAllowDestination`

`qtssASFlagsForceInterleave`
: Requires interleaving.

QTSS_CliSesTeardownReason

The `QTSS_CliSesTeardownReason` enumeration defines values that describe why a session is closing. The `QTSS_RTPSessionState` enumeration is defined as

```
enum
   {
       qtssCliSesTearDownClientRequest  = 0,
       qtssCliSesTearDownUnsupportedMedia = 1,
       qtssCliSesTearDownServerShutdown = 2,
       qtssCliSesTearDownServerInternalErr = 3
   };
   typedef UInt32 QTSS_CliSesTeardownReason;
```

Constant descriptions

`qtssCliSesTearDownClientRequest`
: The client requested that the session be closed.

`qtssCliSesTearDownUnsupportedMedia`
: The session is being closed because the media is not supported.

`qtssCliSesTearDownServerShutdown`
: The server requested that the session be closed.

`qtssCliSesTearDownServerInternalErr`
: The session is being closed because of a server error.

QTSS_EventType

A `QTSS_EventType` is an unsigned 32-bit integer whose value uniquely identifies stream I/O events.

```
enum
   {
       QTSS_ReadableEvent               = 1,
       QTSS_WriteableEvent              = 2
   };
   typedef UInt32 QTSS_EventType;
```

Constant descriptions

`QTSS_ReadableEvent`
: The stream has become readable.

`QTSS_WriteableEvent`
: The stream has become writable.

QTSS_OpenFileFlags

A `QTSS_OpenFileFlags` is an unsigned 32-bit integer whose value describes how a file is to be opened.

```
enum
   {
       qtssOpenFileNoFlags  = 0,
       qtssOpenFileAsync    = 1,
       qtssOpenFileReadAhead= 2
   };
   typedef UInt32 QTSS_OpenFileFlags;
```

Constant descriptions

`qtssOpenFileNoFlags`
: No open flags are specified.

`qtssOpenFileAsync`
: The file stream will be read asynchronously. Reads may return `QTSS_WouldBlock`. Modules that open files with `qtssOpenFileAsync` should call `QTSS_RequestEvent` (page 168) to be notified when data is available for reading.

`qtssOpenReadAhead`
: The file stream will be read in order from beginning to end. The file system module may read ahead in order to respond more quickly to future read calls.

QTSS_RTPPayloadType

The `QTSS_RTPPayloadType` enumeration defines values that a module uses to specify the stream's payload type when it adds an RTP stream to a client session. The enumeration is defined as

```
enum
   {
       qtssUnknownPayloadType = 0,
       qtssVideoPayloadType = 1,
       qtssAudioPayloadType = 2
   };
   typedef UInt32 QTSS_RTPPayloadType;
```

Constant descriptions

`qtssUnknownPayloadType`
The payload type is unknown.

`qtssVideoPayloadType`
The payload type is video.

`qtssAudioPayloadType`
The payload type is audio.

QTSS_RTPNetworkMode

The `QTSS_RTPNetworkMode` enumeration defines values that describe the RTP network mode. These values are set as the value of the `qtssRTPStrNetworkMode and qtssRTSPReqNetworkMode` attributes of objects of type `qtssRTPStreamObjectType` and `qtssRTSPRequestObjectType`, respectively. The QTSS_RTPNetworkMode enumeration is defined as

```
enum
   {
       qtssRTPNetworkModeDefault = 0,
       qtssRTPNetworkModeMulticast = 1,
       qtssRTPNetworkModeUnicast= 2
   };
   typedef UInt32 QTSS_RTPNetworkModes;
```

Constant descriptions

`qtssRTPNetworkModeDefault`
The RTP network mode is not declared.

`qtssRTPNetworkModeMulticast`
The RTP network mode is multicast.

`qtssRTPNetworkModeUnicast`
The RTP network mode is unicast.

QTSS_RTPSessionState

The `QTSS_RTPSessionState` enumeration defines values that identify the state of an RTP session. The `QTSS_RTPSessionState` enumeration is defined as

```
enum
   {
       qtssPausedState  = 0,
```

```
        qtssPlayingState = 1
    };
    typedef UInt32 QTSS_RTPSessionState;
```

Constant descriptions

`qtssPausedState`
The RTP session is paused.

`qtssPlayingState`
The RTP session is playing.

QTSS_RTPTransportType

The `QTSS_RTPTransportType` enumeration defines values for RTP transports. The enumeration is defined as

```
enum
    {
        qtssRTPTransportTypeUDP      = 0,
        qtssRTPTransportTypeReliableUDP= 1,
        qtssRTPTransportTypeTCP      = 2
    };
    typedef UInt32 QTSS_RTPTransportType;
```

Constant descriptions

`qtssRTPTransportTypeUDP`
The RTP transport type is UDP.

`qtssRTPTransportTypeReliableUDP`
The RTP transport type is Reliable UDP.

`qtssRTPTransportTypeTCP`
The RTP transport type is TCP.

QTSS_RTSPSessionType

The `QTSS_RTSPSessionType` enumeration defines values that specify RTSP session types. The enumeration is defined as

```
enum
    {
        qtssRTSPSession          = 0,
        qtssRTSPHTTPSession      = 1,
```

```
        qtssRTSPHTTPInputSession = 2
    };
    typedef UInt32 QTSS_RTSPSessionType;
```

Constant descriptions

`qtssRTSPSession`
The session is an RTSP session.

`qtssRTSPHTTPSession`
The session is an RTSP session tunneled over HTTP.

`qtssRTSPHTTPInputSession`
The session is the input half of an RTSP session tunneled over HTTP.

Discussion

These session types are usually very short lived.

QTSS_ServerState

The `QTSS_ServerState` enumeration defines values that describe the server's state. Modules can set the server's state by setting the value of the `qtssSvrState` attribute in the `QTSS_ServerObject` object. The enumeration is defined as

```
enum
    {
        qtssStartingUpState      = 0,
        qtssRunningState         = 1,
        qtssRefusingConnectionsState = 2,
        qtssFatalErrorState      = 3,
        qtssShuttingDownState    = 4,
        qtssIdleState            = 5
    };
    typedef UInt32 QTSS_ServerState;
```

Constant descriptions

`qtssStartingUpState`
The server is starting up.

`qtssRunningState`
The server is running.

`qtssRefusingConnectionsState`
Setting the server to this state causes the server to refuse new connections.

`qtssFatalErrorState`
Setting the server to this state causes the server to quit.

`qtssShuttingDownState`
: Setting the server to this state causes the server to quit.

`qtssIdleState`
: Setting the server to this state causes the server to refuse new connections and disconnect existing connections.