Penthera Cache & Carry™

Client Developer Guide (MacOS)

This document describes integrating and using the **Penthera Cache & Carry MacOS SDK**.

The SDK is the client piece of Penthera's Cache & Carry (C&C) platform, a software system that manages download, storage, and playback of videos on mobile devices. We assume that you will integrate the SDK into your own streaming video app that handles all UI/UX, user authentication, DRM, and video playout.

This document is a how-to guide. It will teach you to:

1. compile and run a sample Mac app using the SDK
2. import the SDK embedded framework into your own Mac app
3. perform common functions using the SDK: enqueue, play, expire, configure, etc.

We assume you are an experienced Mac developer who knows your way around XCode and related Mac development tools.

The SDK communicates with a server, the **C&C Backplane,** using an internal, proprietary web services protocol. This communication occurs via regular client-server syncs and via server-to-client APN messages. Penthera hosts a developer server instance, at `demo.penthera.com` which you may use to build a proof-of-concept app.

Internally, the SDK is code-named "Virtuoso." You'll notice this a lot in the headers.

We're here to help! Email `support@penthera.com` if you run into any problems.

NOTE: This document contains method signatures and reference source code. We try to keep this document up-to-date, but you'll find the **authoritative** header files and reference source in the MacOS developer package.

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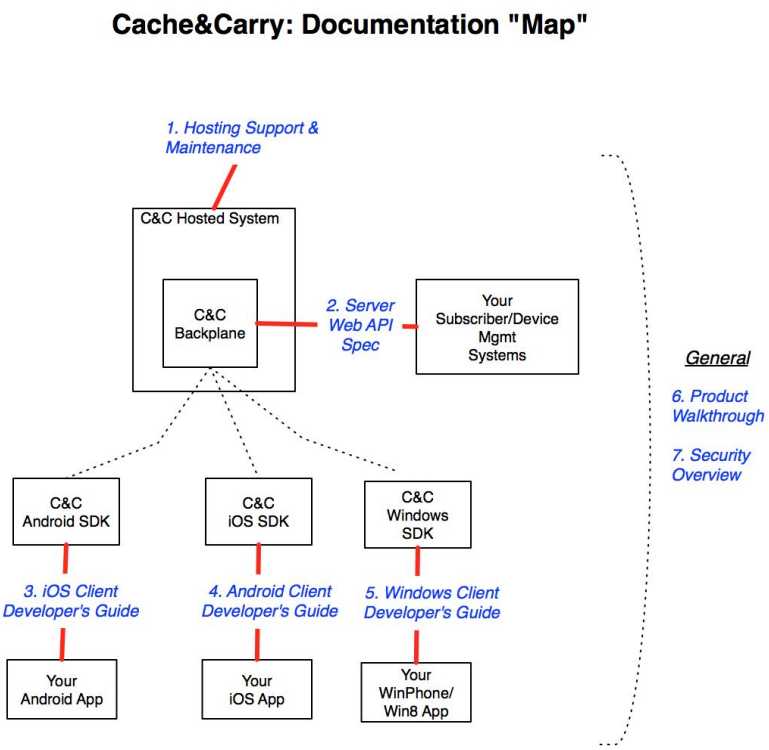
Other Documentation

This document is part of a family of documents covering Cache & Carry:



Let's Get Started

We'll provide you access to a private github repository where you can access the MacOS developer package. You'll discover two pieces in the package:

- **VirtuosoClientEngine:** The libraries and supporting files that you'll include in your own Mac project
- **VirtuosoClientEngineDemo:** A standalone Mac app that includes the VirtuosoClientEngine.

We provide the latter as a convenience, so you can see how to use the SDK in a real app. The demo uses public-domain videos (HLS and mp4), hosted by Penthera on Amazon AWS.

To build and run the demo app:

1. Open the project. Make sure the provisioning profiles are set correctly. The SDK currently supports MacOS 10.9 and later, so ensure that your build settings are configured for an appropriate deployment target. The demo application uses some newer UI components, and supports MacOS 10.11 and later.
2. Add the public/private key that Penthera gave you. (If we didn't, then just ask!) Look for the placeholder at the top of `AppDelegate.m` where you need to include these keys. If you forget this step, the app will not properly function.
3. Compile and run the app from XCode.

Congratulations! You've now got a video-downloading app up and running. You're ready to

develop your own apps with the SDK.

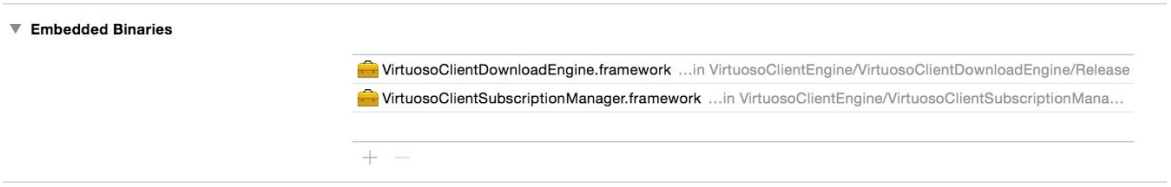
Add the framework to your project

The SDK is packaged as a Mac framework. This allows XCode to automatically access header and resource files that it needs. To include the SDK in your project, navigate to the SDK `VirtuosoClientEngine` directory and drag both the `VirtuosoClientDownloadEngine.framework` and `VirtuosoClientSubscriptionManager.framework` directories into your XCode project.

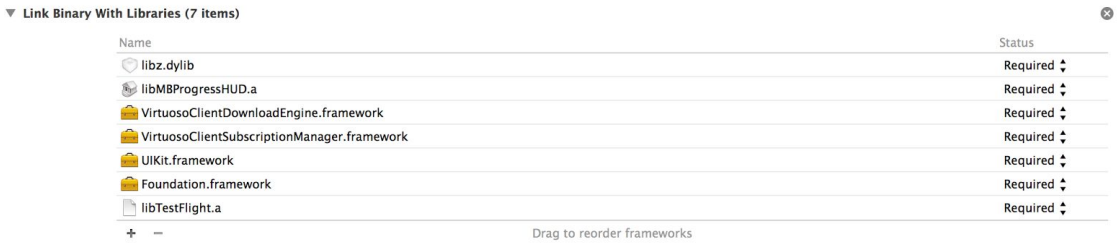
Note: As of XCode 6, Apple requires that frameworks be signed. Generally, unless there's a specific reason to do so, Penthera recommends that you always build with the release version of the SDK framework, regardless of the type of build you are creating in your own project. XCode will automatically resign imported frameworks with your own profile configuration, unless you configure it to do otherwise.

Change your build settings

Under the General section in "Embedded Binaries", add the `VirtuosoClientDownloadEngine.framework` and the `VirtuosoClientSubscriptionManager.framework`:



In the "Link Binary With Libraries" build phase, ensure that both Virtuoso frameworks are included, and add the stock library, `libz.tbd`:



Modify your app's Capabilities list

Under the Capabilities project tab:

1. Turn on the App Sandbox and enable both the Incoming Connections (Server) and Outgoing Connections (Client) checkboxes. Under the File Access section, choose Read/Write permissions for the Downloads Folder.

2. Turn on the Push Notifications capability.

You should now be able to compile your project successfully with no build errors.

A note about Apple's Application Transport Security

Apple added "Application Transport Security" (ATS), which causes non-SSL connections to be rejected in apps built with recent versions of the MacOS SDK. Apple has also announced that all apps will be required to use ATS by 2017. All Penthera Backplane communications are SSL enabled. Originally, the ATS system also disallowed non-SSL connections to localhost. If you are supporting older versions of MacOS, for video playback to function, you need to add an ATS exception for "localhost" into your info.plist NSAppTransportSecurity key, as follows:

```
<key>NSAppTransportSecurity</key>
<dict>
    <key>NSExceptionDomains</key>
    <dict>
        <key>localhost</key>
        <dict>
            <key>NSExceptionAllowsInsecureHTTPLoads</key>
            <true/>
        </dict>
    </dict>
</dict>
```

In MacOS 10.12, Apple allows connections to localhost without any ATS exceptions, and the Cache & Carry SDK will fully function without any security exceptions.

Include Header

Anywhere you want to access SDK classes or methods, you must import the main header:

```
#import <VirtuosoClientDownloadEngine/VirtuosoClientDownloadEngine.h>
```

We'll assume this line is included in all the examples below. If you have enabled precompiled headers for your project, we suggest you include this import in your app's `.pch` prefix file. This will automatically import the `.h` file in all your code by default.

Initialize the Engine

`VirtuosoDownloadEngine` is the main SDK class. It is a singleton. Call the `instance` method to initialize the object and get a pointer to the valid instance:

```
VirtuosoDownloadEngine* engine = [VirtuosoDownloadEngine instance];
```

`VirtuosoDownloadEngine` automatically cleans itself up upon receiving critical system events, like app termination or low memory conditions.

Startup

Penthera will provide you the URL of your Backplane instance, along with an app-specific public/private key pair that allows your SDK instances to authenticate to your Backplane instance.

To prepare the SDK for use, call `startupWithBackplane`, and provide this URL. Invoke this method as early on in the startup process as possible.

Sample Startup Code

Insert the following code inside your `application:didFinishLaunchingWithOptions` `AppDelegate` method:

```
- (BOOL)application:(UIApplication *)application
           didFinishLaunchingWithOptions:(NSDictionary *) launchOptions {

  // Configure logger delegate messages
  [VirtuosoLogger addDelegate:self];

  // Configure logging
  [VirtuosoLogger setLogLevel:kVL_LogWarning];
  [VirtuosoLogger enableLogsToFile:NO];
```

```
  // Initialize engine and fetch a handle to the singleton instance
  VirtuosoDownloadEngine* engine = [VirtuosoDownloadEngine instance];

  // Global "on switch" for downloading
  [engine setEnabled:YES];

  [engine startupWithBackplane:@"https://penthera.provided.url"
                          user:@"an_id_you_assign_for_this_user"
              externalDeviceID:@"an_id_you_assign_for_this_device"
                    privateKey:@"penthera_provided_private_key"
                     publicKey:@"penthera_provided_public_key"];
    ...
}
```

It's your responsibility to supply a unique user ID to the SDK when you call `startupWithBackplane`. The SDK uses this user ID in reporting, and to enforce business rules (such as "max number of download-enabled devices per user"). If you don't know the user ID by the time `didFinishLaunchingWithOptions` executes, you'll need to delay calls to `startup` until you know the user ID, such as after an opening user login dialog. You'll also need to delay registering for push notices in your app until after the engine has been started. For an example, see the SDK Demo app.

For more details on UserID, DeviceID, and related topics, see the FAQ at the end of this document.

Enabling Push Messages

The C&C Backplane sends APN (push messages) to the SDK to trigger certain actions, e.g. download and delete. To send a push message to a device, the Backplane needs a push token from your app on the device. Within your app, you need to feed this push token to the SDK, so the SDK can upload it to the Backplane.

Here's how:

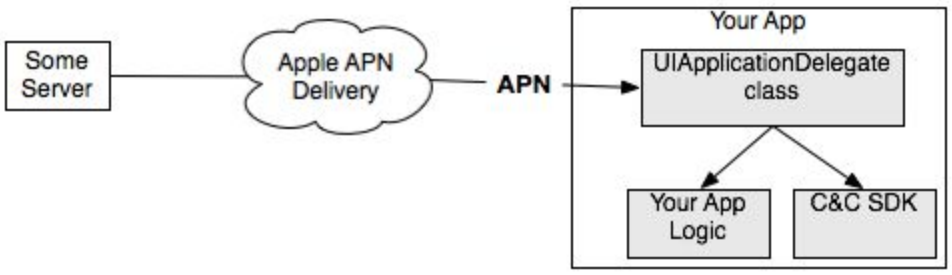
```
// At this point, tokenString should contain the app-specific push token
- (void)application:(UIApplication *)application
didRegisterForRemoteNotificationsWithDeviceToken:(NSData *)deviceToken {
    [VirtuosoSettings instance].devicePushToken = [deviceToken description];
}

- (void)application:(UIApplication *)application
didFailToRegisterForRemoteNotificationsWithError:(NSError *)error {
    // oops, something went wrong with the token
    [VirtuosoSettings instance].devicePushToken = nil;
}
```

Handling SDK-Related Events

Push Notices

From time to time, a server (the C&C Backplane or another server associated with your app) may send your app an APN signal.

The signal will land in your `UIApplicationDelegate` class. From there, you need to dispatch the signal to whoever it belongs to: either the C&C SDK or your own code.



If you drop the following method into your `UIApplicationDelegate` class, the APN messages will go where they're supposed to:

```
- (void)application:(UIApplication *)application didReceiveRemoteNotification:(NSDictionary
*)userInfo fetchCompletionHandler:(void (^)(UIBackgroundFetchResult))completionHandler {
    if( [VirtuosoEventHandler processRemotePushNotice:userInfo
                              withCompletionHandler:completionHandler] ) {
        // SDK handled the push signal. No action required.
    }
    else {
        // SDK did not handle the push signal.
       // Handle the signal yourself - call your handler code or insert it here
    }
}
```

Listening for the SDK's NSNotification messages

The SDK sends out various NSNotification messages to let your app know about changes in SDK status. Make sure your app registers to receive whichever notifications you care about:

```
extern NSString* kDownloadEngineStatusDidChangeNotification;
extern NSString* kDownloadEngineDidStartDownloadingAssetNotification;
extern NSString* kDownloadEngineProgressUpdatedForAssetNotification;
extern NSString* kDownloadEngineProgressUpdatedForAssetProcessingNotification;
extern NSString* kDownloadEngineInternalQueueUpdateNotification;
extern NSString* kDownloadEngineDidFinishDownloadingAssetNotification;
extern NSString* kDownloadEngineDidEncounterErrorNotification;
extern NSString* kDownloadEngineDidEncounterWarningNotification;
extern NSString* kDownloadEngineIsEnteringBackgroundNotification;
extern NSString* kBackplaneDidUnregisterDeviceNotification;
extern NSString* kBackplaneDeviceLimitReachedNotification;
extern NSString* kBackplaneInvalidCredentialsNotification;
extern NSString* kBackplaneDeviceAlreadyRegisteredNotification;
extern NSString* kBackplaneCommunicationsFailureNotification;
extern NSString* kBackplaneSyncResultNotification;
extern NSString* kBackplaneDeviceSaveResultNotification;
extern NSString* kBackplaneLogsSentNotification;
extern NSString* kBackplaneRemoteKillNotification;
extern NSString* kProxyDidEncounterErrorNotification;
extern NSString* kDownloadEngineDidResetExpiredAssetsNotification;
extern NSString* kDownloadEngineDidBeginDataStoreUpgradeNotification;
extern NSString* kDownloadEngineDidFinishDataStoreUpgradeNotification;
```

Look for the latest set of these notifications in `VirtuosoNotifications.h`. Implementing any of these notifications will give you the appropriate status update.

Common Functions

Here we list common ways to use the SDK. This is just a sliver of the overall SDK functionality; after you're done here, have a look at the API to see what else is available.

Enqueue an Item

In the SDK, every downloadable object is a `VirtuosoAsset`. You may enqueue a `VirtuosoAsset` by calling one of the below methods:

Enqueue a Single (Flat) File (e.g. mp4)

To enqueue a single file, create an instance of `VirtuosoAsset`, then add the asset to the SDK's queue after the completion block is invoked:

```
[VirtuosoAsset
   assetWithRemoteURL:@"http://path/to/file.mp4" // downloaded file
              assetID:@"your_unique_asset_id"
          description:@"Test File"       // not used by the SDK
          publishDate:nil                // available immediately
           expiryDate:nil                // don't ever expire
   permittedMimeTypes:@[@"video/mp4"]    // for validation
             userInfo:nil                // your own info; not used by SDK
   onReadyForDownload:^(VirtuosoAsset* parsedAsset)
   {
     [[VirtuosoDownloadEngine instance] addToQueue:parsedAsset atIndex:NSUIntegerMax];
   }
     onParseComplete:^(VirtuosoAsset* parsedAsset)
     {

     }];
```

Refer to the SDK header files for a full description of the behavior and syntax of every parameter.

Enqueue an HLS Video

The SDK treats HLS videos as a special case. The SDK can automatically configure and download all the required HLS fragments from an `m3u8` manifest.
To enqueue an HLS manifest, create an instance of `VirtuosoAsset`, then add the asset to the SDK's queue after the completion block is invoked:

```
[VirtuosoAsset
        assetWithAssetID:@"your_unique_asset_id"
             description:@"Test HLS Video"
             manifestUrl:@"http://path/to/main/manifest.m3u8"
          protectionType:kVDE_AssetProtectionTypePassthrough
   includeEncryptionKeys:YES
          maximumBitrate:INT_MAX     // i.e. use the highest available profile
             publishDate:nil
              expiryDate:nil
                userInfo:nil
    onReadyForDownload:^(VirtuosoAsset* parsedGroup)
    {
      [[VirtuosoDownloadEngine instance] addToQueue:parsedAsset atIndex:NSUIntegerMax];
    }
    onParseComplete:^(VirtuosoAsset* parsedAsset)
    {

    }];
```

Note: `maximumBitrate` specifies which HLS profile the SDK should select for download, from among the HLS profiles available in the manifest. The SDK will download the the highest bitrate not exceeding `maximumBitrate`. If no profile exists lower than the provided maximum, then Virtuoso will select the lowest bitrate profile. Set `maximumBitrate=0` to force the SDK to use the lowest profile, or to INT_MAX to use the highest profile.

Note: You should set `protectionType` to be `kVDE_AssetProtectionTypePassthrough if you are not using DRM, or if you are using a DRM type that is not built-into Cache & Carry.` If you are using DRM protection, you should most likely set includeEncryptionKeys to NO. Take a look at the definition of `kVDE_AssetProtectionType` in VirtuosoConstants.h for a list of built-in DRM systems.

Enqueue an HSS Video
HSS works similarly to HLS:

```
[VirtuosoAsset
        assetWithAssetID:@"your_unique_asset_id"
             description:@"Test HSS Video"
             manifestUrl:@"http://path/to/main/video.ism/Manifest"
     maximumVideoBitrate:INT_MAX     // i.e. use highest available video profile
     maximumAudioBitrate:INT_MAX     // i.e. use highest available audio profile
             publishDate:nil
              expiryDate:nil
                userInfo:nil
   onReadyForDownload:^(VirtuosoAsset* parsedAsset) {
      [[VirtuosoDownloadEngine instance] addToQueue:parsedAsset atIndex:NSUIntegerMax];
   }
   onParseComplete:^(VirtuosoAsset* parsedAsset) {
   }];
```

Unlike HLS, the HSS format uses a separate audio and video data stream. So instead of specifying `maximumBitrate`, you need to specify both `maximumVideoBitrate` and `maximumAudioBitrate.` As above, the SDK will select and download the profile with the highest bitrate not exceeding the values you specify.

Working With DRM

Most Penthera customers use Cache & Carry in conjunction with a commercial DRM system. Cache & Carry for MacOS will automatically encrypt HLS encryption keys with a device-specific encryption key as they are stored to disk. Support for offline playback using Widevine or FairPlay does not currently exist in MacOS.

If you are integrating with a different DRM system, you must handle DRM license management youself. We recommend that you fetch the DRM license before you call a C&C "enqueue" method. That way, you can be sure the DRM license is on the device when the video download finishes.

If you wait until the video download finishes before fetching the license, you may run into trouble. If the download finishes while the app is in the background, your app may not receive a 'download-finished' notification from the SDK until the user re-opens the app. At this point, the device may be offline and the app can't fetch the license.

Pause/Resume Downloading

Use the '`enabled`' flag to start and pause downloads:

Pause: `[[VirtuosoDownloadEngine instance]setEnabled:NO];`
Resume: `[[VirtuosoDownloadEngine instance]setEnabled:YES];`

Cancel Downloads

To cancel one download:

```
[[VirtuosoDownloadEngine instance] removeFromQueue:asset];
```

To cancel *all* downloads:

```
[[VirtuosoDownloadEngine instance] flushQueue];
```

Clear SDK State

If the enclosing app were to de-authenticate a user, the app may at the same time also wish to delete all downloaded videos:

```
[VirtuosoAsset deleteAll];
```

In addition, the administrator may choose to schedule a remote wipe of any device. See the Backplane documentation for additional details.

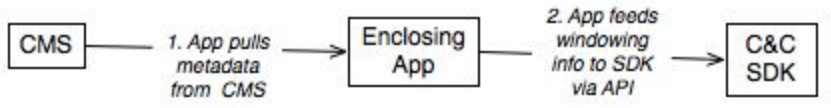
Set Availability Window for an Item

The 'Availability Window' governs when the video is actually available for playout by the user. The SDK enforces several windowing parameters on each video:

Windowing Parameter	Description
Publish Date	The SDK will download the video as soon as possible, but will not make the video available through any of its APIs until after this date.
Expiry Date	The SDK will automatically delete the video as soon as possible after this date.
Expiry After Download (EAD)	The duration a video is accessible after download has completed. As soon as possible after this time period has elapsed, the SDK will automatically delete this video.
Expiry After Play (EAP)	The duration a video is accessible after first play. As soon as possible after this time period has elapsed, the SDK will delete this video. To enforce this rule, the SDK has to know when the video is played, so be sure to register a `play-start` event when the video is played.

The Backplane stores a global default value for EAP and EAD. You may set these values through the Backplane web API. The Backplane transmits these default values to all SDK instances.

Typically, a Content Management System (CMS) stores the windowing information for an item, and communicates it through a web API to the enclosing app. The app then feeds this windowing information to the SDK:



Step 2 in the above diagram occurs when you create the `VirtuosoAsset` object. You can also modify the values later, via the appropriate class properties.

```
[VirtuosoAsset
    assetWithRemoteURL:@"http://path/to/your/asset.mp4"
               assetID:@"your_unique_asset_id"
           description:@"Test Video"
           publishDate:[NSDate date]        // Available now
            expiryDate:[NSDate dateWithTimeIntervalSinceNow:604800] // Expires in 7d
   expiryAfterDownload:86400         // Expires 24h after download
       expiryAfterPlay:43200         // Expires 12h after play
    permittedMimeTypes:nil
              userInfo:nil
    onReadyForDownload:^(VirtuosoAsset* parsedAsset)
{
     [[VirtuosoDownloadEngine instance] addToQueue:parsedAsset atIndex:NSUIntegerMax];
}
    onParseComplete:^(VirtuosoAsset* parsedAsset)
{
}];
```

Each of the API's content lookup methods (e.g. `assetsWithAvailabilityFilter:`) contains an `availabilityFilter` parameter. Set this parameter to YES to filter for only items still valid given

windowing constraints. Set the parameter to NO to list all items, regardless of windowing.

The SDK will delete a video as soon as possible after the video expires. Also, when a caller tries to access an expired item via the API, any downloaded files associated with that item will be auto-deleted from disk, calls to play the item via the `VirtuosoClientHTTPServer` will fail, and any attempts to access the local file URLs will return nil.

Enable/Disable Downloading

C&C provides two switches that control download. They have different purposes. The SDK only downloads if both toggles are 'on'.

SDK "Master Switch": A Boolean property on the VirtuosoSDK instance in the SDK that you can set to toggle downloading. Use this to disable downloads, for example, when your app is streaming video and you don't want to share bandwidth between streaming and download. **Be careful: this value persists across app restarts**.

```
@property (nonatomic,assign) Boolean enabled;
```

Backplane-Enforced Toggle: The Backplane enforces a limit on the number of Devices that each User may have enabled for download. To do so, the Backplane maintains, for each known Device, a flag indicating whether the Device is permitted to download. If new devices are created in a user account, and the limit hasn't yet been reached, then the new devices are automatically enabled on the Backplane. If the limit has been reached, then newly-added Devices are disabled from downloading via the device property:

```
@property (nonatomic,readonly) Boolean downloadEnabled;
```

You can request a change to this flag by calling the following method. The device needs to be online and able to connect to the Backplane for this to succeed.

```
- (void) updateDownloadEnabled:(Boolean)enabled
onComplete:(DeviceUpdateResultBlock)onComplete;
```

NOTE: The Backplane also offers a web API to do this; see the server documentation.

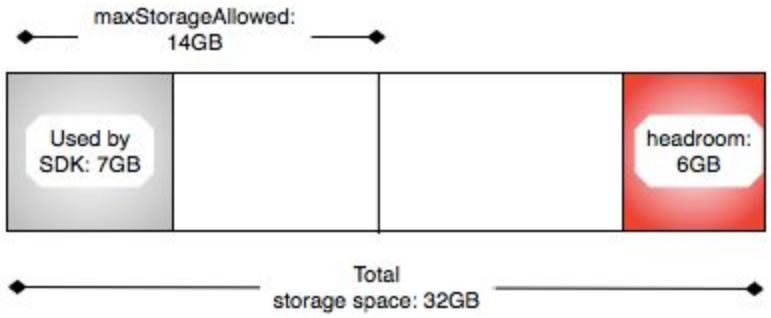
Configure Download Rules

Several behavioral properties control the SDK's behavior:

`int` **`maxDownloadedAssets`** (default=100): maximum number of assets that may be downloaded at any given time. Any assets added to the queue beyond this limit will be blocked until existing assets are deleted.

`long long` **`maxStorageAllowed`** (in MB; default=LONG_LONG_MAX): disk space that the SDK will download and manage on the device. While downloading in the foreground, the SDK will continue to download until it reaches `maxStorageAllowed`, even if that means stopping with a partially-completed file. While downloading in the background, the SDK will not initiate a download unless, after downloading that item, the total device storage used by the SDK will still be under `maxStorageAllowed`.

`long long` **`headroom`** (in MB; default=1024): disk space that the SDK will leave available on the device. While downloading with the app in the foreground, the SDK will continue to download until `headroom` space is left on the device, even if that means stopping with a partially downloaded item. When downloading in the background, the SDK will not initiate a download unless, after downloading that item, at least `headroom` space will still be free on the device.



Visualizing `maxStorageAllowed` *and* `headroom` *parameters. Here the device has 32GB disk space. The SDK will always preserve 6GB free space on disk. Currently, the SDK is using 7GB, and will never use more than 14GB total.*

Boolean **`downloadOverCellular`** (default: false): whether the SDK is permitted to download over a cellular network. This value is a **permission**, and does not guarantee that downloads **will** continue on a cellular network. It only indicates the the SDK **may** download over cellular, should internal business rules allow it. If this value is NO, downloads will never happen over a cellular connection.

`NSString` **`destinationPath`:** an additional relative path component added to the enclosing app's Documents directory. The SDK will store all downloaded files here. By default, the SDK stores all downloads in the `Documents` directory itself, under appropriate sub-directories.

Set up Logging

There's two separate logging paths in the SDK:

Event Logging

The SDK can capture many different events of potential business value, e.g. when a download starts and stops, offline playout, etc.

You can configure which of these events the SDK uploads to the Backplane. By default, most events are enabled; you should choose which events you want to enable or disable. Available events are listed in the `kVL_LogEvent` enumeration.

Use the `setLoggingEnabled:forEvent:` or `setLoggingEnabledForAllEvents:` methods to enable event logging. We suggest you do this prior to the logger startup call.

Note: *You can't disable the "download queued", "download start", "download complete", "download error", "max errors reset", or "reset" events. Attempts to do so will have no effect.*

Debug Logging

The SDK generates lots of developer-friendly debug information. You can send this to various locations (console, log file) or you can implement a logger delegate and handle it manually.

By default, the SDK logging system is very quiet. To configure logging, use these just after the logger startup call:

a. `[VirtuosoLogger addDelegate:id<VirtuosoLoggerDelegate>]`: Adds the indicated delegate to the logger. Delegates must follow the `VirtuosoLoggerDelegate` protocol. Methods in the protocol can be used to receive SDK events and handle them in your own custom logging mechanisms.

b. `[VirtuosoLogger setLogLevel:kVL_LogVerbose]`: Configures verbose console logging. See SDK headers for available log levels.

c. `[VirtuosoLogger enableLogsToFile:YES]`: Enables all log output to be logged to a file in the app's `documents` directory.

Play a Downloaded Item

The SDK provides a drop-in replacement for Apple's AVPlayer class to help make playback easier. Use of this class is optional, but does provide some convenience. Using the built-in class automatically handles appropriate logging of the "play start" and "play stop" log events.

If you need to use your own closed-source player, or need more control over aspects of playback than the built-in class allows, you may also choose to use the SDK's local HTTP proxy, `VirtuosoClientHTTPServer`, that sits between a media player and downloaded HLS and HSS items.

There are three ways to play a VirtuosoAsset:

- **`filePath`:** If you have downloaded a standalone video file, such as an MP4 or ISMV file, then you can access the downloaded file directly for playback. An example of this method is shown in the SDK Demo app.

- **`VirtuosoClientHTTPServer` with `AVPlayer`:** This method automatically handles windowing and playback itself. It uses a `VirtuosoAVPlayer` for playback. Create a VirtuosoClientHTTPServer with the asset you wish to play, then use the playbackURL provided from the server to create an AVPlayerItem, and hand that to the VirtuosoAVPlayer to play. An example of this method is shown in the SDK Demo app. This method is unsupported for HSS and DASH video assets.

- **VirtuosoClientHTTPServer with cutom player:** If you need to use a custom player, you can use create an instance of VirtuosoClientHTTPServer with the asset you want to play, and then hand the playbackURL from that server instance to your custom player. This method automatically handles windowing, as the VirtuosoClientHTTPServer class disallows service creation if the asset is not playable. It is your responsibility to further configure the player, to log playback start and stop events, to start playback if necessary, and to present the player in the UI hierarchy.

NOTE: If using a custom player, be sure to set the first playback timestamp when the item starts playback, so the SDK can later enforce "expiry after playback."

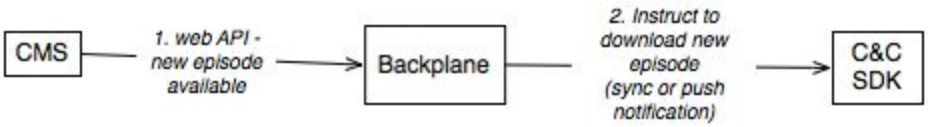
```
self.server = [[VirtuosoClientHTTPServer alloc]initWithAsset:self.asset];
NSURL* url = [NSURL URLWithString:self.server.playbackURL];

AVAsset* avAsset = [AVURLAsset assetWithURL:url];
AVPlayerItem* item = [AVPlayerItem playerItemWithAsset:avAsset];
VirtuosoAVPlayer* avPlayer = [VirtuosoAVPlayer playerWithPlayerItem:item];
avPlayer.contentURL = url;
avPlayer.asset = self.asset;
[avPlayer prepareToPlay];
[self.player setPlayer:avPlayer];
[avPlayer play];
```

Subscriptions

We've already described how you can enqueue a single video (flat file or fragmented) for download. In addition, the SDK can subscribe to a **feed** of assets, a.k.a. "episodes."

The Backplane keeps track of which SDK instance is subscribed to which feeds. The Backplane also keeps track (by communicating with your CMS) of which episodes belong to which feeds.

As new episodes in a feed become known to the Backplane, the Backplane informs the SDK, through the normal SDK-Backplane sync and/or through a push notification. In response, the SDK automatically adds the new episode to its download queue.



VirtuosoSubscriptionManager

`VirtuosoSubscriptionManager` is the main class for handling subscription logic. It interfaces with the Backplane and maintains information on feeds and episodes in those feeds.

`VirtuosoSubscriptionManager` is a singleton (i.e. one and only one instance ever exists). Calling the `instance` method will initialize the object (if needed), link to the VirtuosoDownloadEngine configuration, and return a pointer to the valid instance:

```
VirtuosoSubscriptionManager* manager = [VirtuosoSubscriptionManager instance];
```

NOTE: You need to start `VirtuosoDownloadEngine` before the above.

Receiving Updates from the Subscription Manager

To get updates from the Manager (and thus keep your views refreshed), your code must register to receive the various `NSNotification` messages sent by the Manager. The Manager provides notices when status is updated, content is reset (downloaded data deleted), content is deferred (created but not enqueued), and when items are added (created and enqueued). You register for notifications in your own code as follows:

```
[[NSNotificationCenter defaultCenter]
                 addObserverForName:kSubscriptionManagerAssetAddedNotification
                             object:nil
                              queue:[NSOperationQueue mainQueue]
                         usingBlock:^(NSNotification *note) {

               // Get list of new VirtuosoAsset objects
               NSArray* newAssets = [note.userInfo
objectForKey:kSubscriptionManagerNotificationVirtuosoAssetKey];

               // Handle new assets.
                                                          }];
```

You'll find the latest set and versions of these notifications in the `VirtuosoSubscriptionManager` header file. Registering for any of these notices will give you all the required data needed in order to update your UI.

Register a Data Source

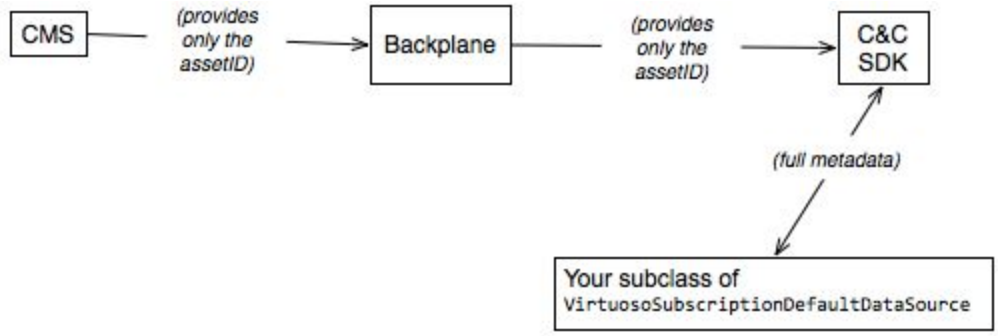
Let's say the SDK receives a push notification from the Backplane indicating a subscription update occurred. The SDK will then connect to the Backplane and retrieve a list of subscription updates. Depending on your Backplane configuration, that information may or may not contain all of the metadata required to download the new episodes. At this point, the SDK may need to request additional information about an episode (e.g. the remote URL, which profile to use, expiry rules for the episode). The enclosing app may need a title, description, an image, and other metadata for the episode. A complete list of the metadata which will be processed by the SDK is included, with detailed descriptions, in the `VirtuosoSubscriptionDataSource.h` protocol declaration.

How does the client get this metadata? There's two options:

Scenario 1: *All required item metadata is provided to the Backplane*

In this scenario, the `VirtuosoSubscriptionDefaultDataSource` class receives the metadata from the Backplane internally, automatically downloads and deletes episodes in the feed according to your defined settings, and no further configuration is required.

Scenario 2: *Only the feed item Asset UUID is provided to the Backplane via the web APIs when new feed content is announced.*



In this case, you must implement a custom data source class, which will provide metadata to the Subscription Manager. (The data source might fetch this information from anywhere, e.g. a web call to your CMS).

Penthera recommends that you subclass `VirtuosoSubscriptionDefaultDataSource` and implement at **least** `lookupMetadataForAssetID`. Once you have your custom data source, you must register it prior to calling the VirtuosoSubscriptionManager startup method:

```
[[VirtuosoSubscriptionManager instance] registerDataSource:[CustomDataSource class]];
```

When implementing the `lookupMetadataForAssetID:` method, you need to obtain all the required metadata in a synchronous manner and return that metadata via the method's return value. Review the `VirtuosoSubscriptionDataSource.h` protocol header for a complete list of required and optional metadata items. In addition to the protocol metadata items, you may return any custom metadata you wish as independent key-value pairs in the response dictionary or as serializable data in the user info dictionary metadata item.

```
- (NSDictionary*)lookupMetadataForAssetID:(NSString *)assetID
{
  // This example just returns the required metadata for a hard-coded asset.
  // Your implementation should lookup all proper metadata for the provided
  // asset ID.

    return @{SubscriptionContentDataAssetIDKey:assetID,
             SubscriptionContentDataDescriptionKey:@"my_asset_title",
             SubscriptionContentDataDownloadURLKey:@"http:download.url",
             SubscriptionContentDataCreatedDateKey:[NSDate date],
             SubscriptionContentDataMediaTypeKey:@(MediaTypeCodeVideo),
             SubscriptionContentDataUserInfoKey:@{@"arbitrary":@"info"},
             @"My_custom_metadata_key":@"my_custom_metadata_value"};
}
```

Subscribe to a Feed

Each feed is identified by an externally defined feed asset ID. To register for updates on that feed:

```
// Duplicate registrations do nothing
[[VirtuosoSubscriptionManager instance]
                registerForSubscription:@"customer_defined_feed_uuid"
                             onComplete:^(Boolean success, NSError *error) {
                    // Handle response
}];
```

Force a Sync

The Subscription Manager will automatically sync with the Backplane when the application is foregrounded, and at other opportune moments. If you would like to sync at some particular moment,

with greater frequency, or in order to retrieve information not normally fetched during a standard sync, you can call one of the sync methods. The version of the method that takes no additional parameters will perform a standard sync immediately. The version that takes additional parameters can be used to retrieve metadata information about older items or about feeds that the user is not currently subscribed to. These items will not be downloaded automatically, but will be returned in the data source, and can be used in your own internal processing.

```
// Standard sync
[[VirtuosoSubscriptionManager instance]
       syncSubscriptionsWithBackplaneNowOnComplete:^(Boolean success,
                                    NSArray *subscriptions,
                                    NSError *error) {
   // Handle response.
   // Note - Data from sync results will be sent via NSNotification
   // notices and via the data source processing methods.

 }];


// Sync retrieving all items and all feeds
[[VirtuosoSubscriptionManager instance]
 syncSubscriptionsWithBackplaneNowForDataSince:[NSDate dateWithTimeIntervalSince1970:0]
                 returningOnlySubscribedFeeds:NO
                                   onComplete:^(Boolean success,
                                                NSArray *subscriptions,
                                                NSError *error) {
   // Handle response.
   // Note - Data from sync results will be sent via NSNotification
   // notices and via the data source processing methods.
}];
```

Configure Subscription Rules

The SDK follows two behavioral settings for subscriptions. These exist as properties on `VirtuosoSubscriptionManager`, and are global defaults. You may also set a feed-unique value when registering for a new subscription.

- `int` **`maximumSubscriptionItemsPerFeed (default:0)`**: The SDK tracks how many episodes it's downloaded in each feed. When this max value is reached, the behavior is dictated by the value of `autodeleteOldItems`. A value less than or equal to 0 indicates "unlimited."

- `Boolean` **`autodeleteOldItems (default:YES)`**: Determines how the SDK behaves when a new episode is available and the device is already storing its quota from this feed. If YES, then the Subscription Manager will call the `VirtuosoAsset reset` method on the old items. The `reset` method deletes any downloaded files from local storage and resets the objects properties and status back to a pre-download state. The SDK reports the reset items in the proper notification. If NO, then the SDK will create a `VirtuosoAsset` object for the new episode, but won't automatically download it. These deferred items are reported in the proper notification.

NOTE: Only items downloaded through a subscription automatically count towards these rules. If you enqueue an episode of a feed manually, that enqueued item will not be automatically deleted or cause new downloads to be deferred unless you call the `VirtuosoSubscriptionManager includeItem:inTrackingFeed:` method with the episode.

Appendix A: How Downloading Works

This section is for the curious developer. You don't need to understand this in order to use the SDK.

Virtuoso follows a "Rule of Threes" in downloading:

1. Proceed through the download queue in order. Virtuoso will download multiple file segments at a time (in parallel), but avoids downloading segments belonging to different assets simultaneously.
2. If Virtuoso encounters an error downloading the asset, it will try that asset two more times before moving on. (This is the "inner" three).
3. When it reaches the end of the download queue, Virtuoso will return to the beginning of the queue and make another pass, trying to download the errored files.
4. Once it has encountered an asset in three separate passes through the queue, Virtuoso will mark the asset in error and will no longer try to download the asset, until you reset that asset using the `VirtuosoAsset clearRetryCount` method. (This is the "outer" three).

In fact, the above is a slight simplification. If Virtuoso encounters a "fatal" error in step 2, it will not retry the file later. An error is fatal if there's no point retrying later (e.g. the HTTP server advertises an unexpected mime type.) Virtuoso may also choose to retry failed assets at opportune moments, such as when the user returns to the app.

Virtuoso communicates download issues to the enclosing app in two ways.

1. When the Virtuoso encounters an issue that will eventually cause the file to be marked as blocked, it issues a `kDownloadEngineDidEncounterErrorNotification`. It will send this notice even if the file download will be retried.
2. When Virtuoso determines a potential issue exists (such as when the server reported size and expected size do not match), it issues a `kDownloadEngineDidEncounterWarningNotification`. This notice indicates that something unexpected happened, but the file download will still finish and be marked as successfully completed.

In the case of both notices, the userInfo dictionary sent with the notice will contain an NSError object in the `kDownloadEngineNotificationErrorKey` that contains detailed information about the error that was encountered and the VirtuosoAsset that caused the error will be contained in the `kDownloadEngineNotificationAssetKey`.

The following chart summarizes error conditions and Virtuoso's behavior. For the most up-to-date list of errors, see the `kVDE_DownloadErrorCode` enumeration in `VirtuosoConstants.h`.

Condition	Description	Retry?
Invalid mime type	The MIME type advertised by the HTTP server for the file isn't included in the MIME types whitelist you provided earlier.	No
Final file segment size disagrees with server-provided segment size	After a segment download completes, the on-disk file size didn't match the expected size, as reported by the server.	Yes
Network error	Some network issue (HTTP 404,416, etc.) caused the download to fail.	Yes
File System Error	The OS couldn't write the file to disk. In most cases, the root cause is a full disk.	Yes

Appendix B: Upgrading

Unless the release notes indicate otherwise, SDK versions are back-compatible with older versions. If you had previously deployed a version of your app using an earlier version of the SDK, then the old data store will automatically be upgraded to the new data store. There are a few important considerations for handling of this process:

Asynchronous Update

Depending on how many assets the user has created in the app, the upgrade process may take a fair amount of time. To ensure that you can startup the engine without worrying about thread considerations, the SDK upgrades the data store in a background process. This allows your app to appear fully functional to the user, but it does mean that while the upgrade process is proceeding, previously-downloaded assets may be unavailable.

The `VirtuosoDownloadEngine` will issue two notifications via NSNotificationCenter to indicate when the upgrade process is starting and when the upgrade process has finished:

- `kDownloadEngineDidBeginDataStoreUpgradeNotification`
- `kDownloadEngineDidFinishDataStoreUpgradeNotification`

You can use these notifications as a trigger in your user interface to indicate to the user that previously downloaded assets are temporarily unavailable.

Download Continuity

All asset metadata will be fully available as soon as the data upgrade process completes. Any assets that had already been downloaded will be immediately available for offline playback. Any assets that had not started downloading yet will remain enqueued and will download normally.

Appendix C: FAQ

I'm confused about UserID, DeviceID, and External Device ID

A "User" is a person, household, or other entity that owns a device. When you call VirtuosoDownloadEngine's `startupWithBackplane` method, you must supply a **UserID**. but Meanwhile, the SDK uses its own internal logic to assign a unique **DeviceID** to the device. The SDK uploads this (UserID, DeviceID) pair to the C&C Backplane, which associates the Device with the User. The C&C Backplane only uses this (User, Device) pair to enforce the "max download-enabled Devices per User" rule.

The **External Device ID** is a field we maintain for your convenience. You can look up a device's activity on the Backplane using the external Device ID. You can perform a "remote-delete" or "remote-wipe" from the Backplane, providing it an External Device ID. The Backplane provides convenience mechanism to map an External Device ID to Penthera's internal DeviceID.

How does the SDK guarantee the DeviceID persists across installs?

In the MacOS version of the SDK, the DeviceID is an encrypted form of the device MAC address. This allows the DeviceID to persist across installs, and prevents it from changing under most conditions.

How does the SDK decide what order to download queued assets?

In general, assets will be downloaded in the order that they were added to the queue. This is not, however, guaranteed, and various internal rules may allow one asset to be downloaded before another.

**** END OF DOCUMENT ****