

Effective HTTP Live Streaming

Review and best practices

Session 502

These are confidential sessions—please refrain from streaming, blogging, or taking pictures

Introduction

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Effective HTTP Live Streaming

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What Makes a Great Streaming App?

- High performance
- Great navigation
- Client gets the right stream
- Localized content

What Makes a Great Streaming App?

- High performance
 - Great navigation
 - Client gets the right stream
 - Localized content
-
- Everything you need is in iOS 5!

HTTP Live Streaming Basics

A Simple Idea

- Divide the video into small pieces
- Keep a list of the pieces
- Update the list as needed

Two Types of Playlists

- Media playlist
- Master playlist

Media Playlists

```
#EXTM3U
#EXT-X-VERSION:3
#EXT-X-TARGETDURATION:10
#EXT-X-MEDIA-SEQUENCE:0
#EXT-X-PLAYLIST-TYPE:VOD
#EXTINF:9.7,
movie1/fileSequenceA.ts
#EXTINF:9.2,
movie1/fileSequenceB.ts
#EXTINF:8.6,
movie1/fileSequenceC.ts
#EXTINF:9.7,
movie1/fileSequenceD.ts
#EXT-X-ENDLIST
```

Master Playlists

#EXTM3U

#EXT-X-STREAM-INF:PROGRAM-ID=1,BANDWIDTH=1280000

low/prog.m3u8

#EXT-X-STREAM-INF:PROGRAM-ID=1,BANDWIDTH=2560000

mid/prog.m3u8

#EXT-X-STREAM-INF:PROGRAM-ID=1,BANDWIDTH=7680000

hi/prog.m3u8

#EXT-X-STREAM-INF:PROGRAM-ID=1,BANDWIDTH=64000

audio-only/prog.m3u8

High Performance

What Is High Performance?

- Fast startup and fast seek
- No playback stalls
- Fast stream switching

Fast Startup and Seek

- Make a good initial choice of variant
- Serve playlists using gzip
- At least one IDR-frame per segment
 - Preferably at the start
- Minimize TS structural overhead
 - Should be $< 10\%$ even at low bit rates
- Target duration affects startup, but...

No Stalls

- Use 10 second target durations
 - Too small a target duration can lead to stalls
 - CDNs impose additional propagation delay
 - Cellular networks have high latencies
- Don't under-report bit rate in master playlist
- Don't use a separate player for ads

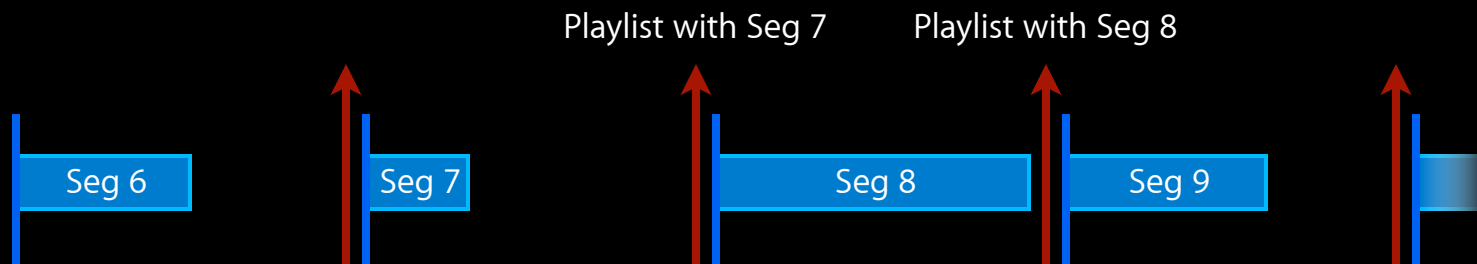
Updating Live Playlists

- Playlist must become available after segment
- Keep playlist updates as regular as possible



Updating Live Playlists

- Playlist must become available after segment
- Keep playlist updates as regular as possible



Fast Stream Switching

- Again, IDR placement is important
 - They form the switch positions
- Really long segments (over 20s) will hurt

Essentials of High Performance

- Use 10 second target durations
- Serve playlists using gzip
- At least one IDR-frame per segment

Great Navigation

What Makes for Great Navigation?

- Generous live content window
- Seeking works well
- Fast forward and reverse playback

Generous Window for Live Content

- At least 3 target-durations of content required for Live
- Longer window means more control for the user

Small Content Window

Can't pause playback



Small Content Window

Can't pause playback



Small Content Window

Can't pause playback



Small Content Window

Can't pause playback



Bigger Content Window

Allows pauses and seeks

Seg 09 Seg 10 Seg 11 Seg 12 Seg 13



Bigger Content Window

Allows pauses and seeks



Bigger Content Window

Allows pauses and seeks



Bigger Content Window

Allows pauses and seeks



Bigger Content Window

Allows pauses and seeks



Bigger Content Window

Allows pauses and seeks



Seeking Works Well

- Floating-point durations

- Required to prevent accumulated drift while seeking

```
[ AVPlayerItem currentTime ]
```

- Fast vs. Precise

```
[ AVPlayerItem seekToTime: ]
```

```
[ AVPlayerItem seekToTime: toleranceBefore: toleranceAfter: ]
```

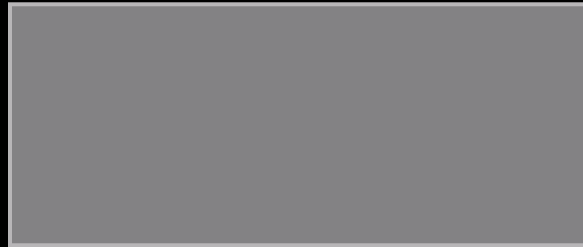
- Sufficient I-frames

Fast Forward and Reverse Playback

- Uses I-frame playlists
- Essential for AirPlay and AppleTV
- The higher the I-frame frequency, the smoother the playback

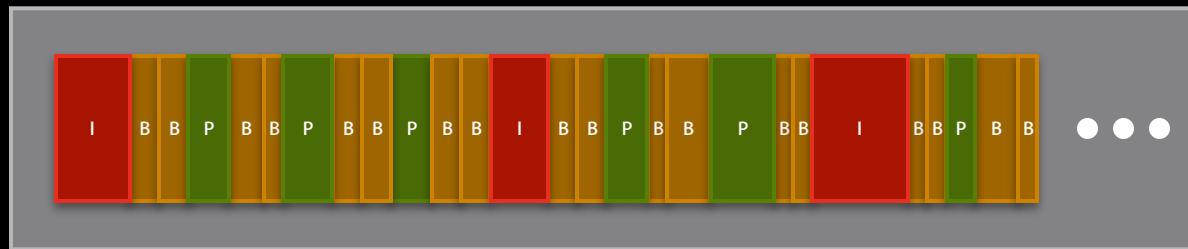
I-frame Playlists

Can reuse existing media files



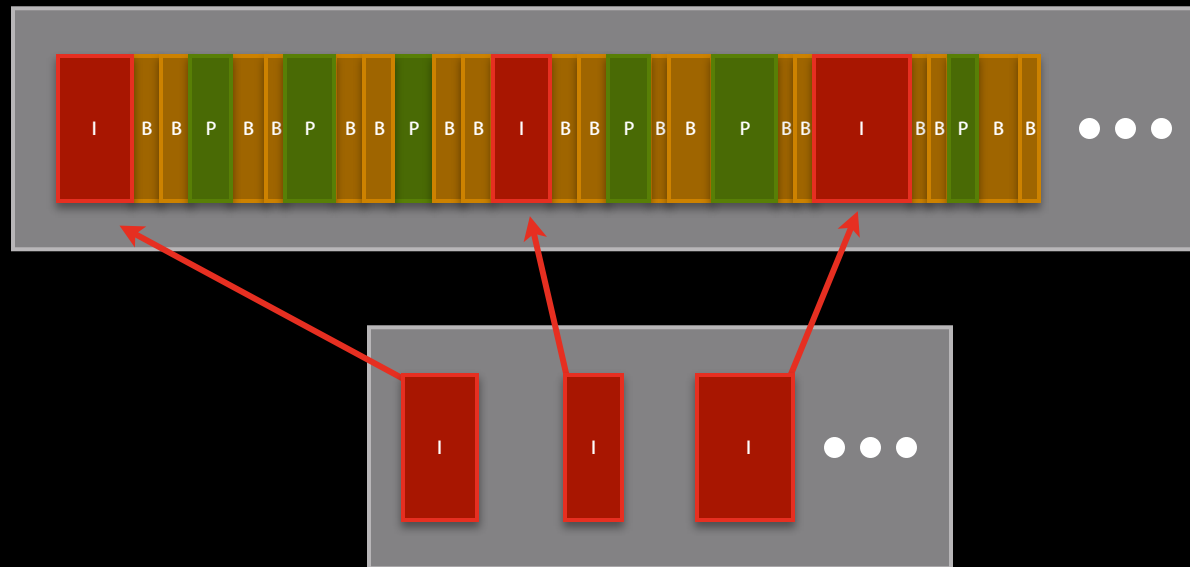
I-frame Playlists

Can reuse existing media files



I-frame Playlists

Can reuse existing media files



I-frame

Syntax—master playlist

```
#EXTM3U
```

```
#EXT-X-STREAM-INF:BANDWIDTH=1280000
```

```
low/audio-video.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=2560000
```

```
mid/audio-video.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=7680000
```

```
hi/audio-video.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=64000
```

```
audio-only.m3u8
```

```
#EXT-X-I-FRAME-STREAM-INF:BANDWIDTH=86000,URI="low/iframe.m3u8"
```

```
#EXT-X-I-FRAME-STREAM-INF:BANDWIDTH=150000,URI="mid/iframe.m3u8"
```

```
#EXT-X-I-FRAME-STREAM-INF:BANDWIDTH=550000,URI="hi/iframe.m3u8"
```

Essentials for Great Navigation

- Generous live content window
- Floating-point durations
- I-frame playlists

Getting the Right Stream

Getting the Right Stream to the Right Device

- Choose your bit rates carefully
- Know your client
- Special considerations for cellular

Bit Rate Recommendations

- Adjacent bit rates should be a factor of 1.5 to 2 apart
 - Keyframes—no more than 3 seconds apart
 - First bit rate should be one that most clients can sustain
-
- **Technical Note TN2224** "Best Practices for Creating and Deploying HTTP Live Streaming Media for the iPhone and iPad"

When Choosing Bit Rates

- Constraints you should consider
 - Encoding hardware
 - Upload budget
 - Ability to switch

Verify Your Assumptions

- Track client performance in the field
 - Using access logs and error logs
 - Don't forget to get permission
- Look at
 - Which streams
 - How long they play
 - Stream switches
 - Etc.

Know Your Clients

- Device capabilities
 - Resolution
 - Decoder
 - Model
- Network capabilities

Select Based on Device Resolution

- Add RESOLUTION attribute to the master playlist

```
#EXT-X-STREAM-INF: BANDWIDTH=1280000, RESOLUTION=640x360
```

```
#EXT-X-STREAM-INF: BANDWIDTH=1700000, RESOLUTION=1280x720
```

```
#EXT-X-STREAM-INF: BANDWIDTH=3500000, RESOLUTION=1920x1080
```

Select Based on Device Resolution

- Add RESOLUTION attribute to the master playlist

#EXT-X-STREAM-INF: BANDWIDTH=1280000, RESOLUTION=640x360

#EXT-X-STREAM-INF: BANDWIDTH=1700000, RESOLUTION=1280x720

#EXT-X-STREAM-INF: BANDWIDTH=3500000, RESOLUTION=1920x1080

640x360



1080p



Select Based on Device Codec

- Add CODECS attribute to the master playlist

```
#EXT-X-STREAM-INF:BANDWIDTH=1280000,CODECS="avc1.42001e" // Baseline
#EXT-X-STREAM-INF:BANDWIDTH=1280000,CODECS="avc1.4d001f" // Main
#EXT-X-STREAM-INF:BANDWIDTH=1280000,CODECS="avc1.64001f" // High
```


Select Based on Device Codec

- Add CODECS attribute to the master playlist

```
#EXT-X-STREAM-INF: BANDWIDTH=1280000, CODECS="avc1.42001e" // Baseline  
#EXT-X-STREAM-INF: BANDWIDTH=1280000, CODECS="avc1.4d001f" // Main  
#EXT-X-STREAM-INF: BANDWIDTH=1280000, CODECS="avc1.64001f" // High
```

Baseline 3.0



Main 3.1



Select Based on Device Model

- Deliver different master playlist based on the User-Agent string

```
Mozilla/5.0 (iPhone; CPU iPhone OS 5_1_1 like Mac OS X) AppleWebKit/  
534.46 (KHTML, like Gecko) Version/5.1 Mobile/9B206 Safari/7534.48.3
```

```
Mozilla/5.0 (iPad; CPU OS 5_1_1 like Mac OS X) AppleWebKit/534.46  
(KHTML, like Gecko) Version/5.1 Mobile/9B206 Safari/7534.48.3
```

```
AppleCoreMedia/1.0.0.9B176 (iPhone; U; CPU OS 5_1 like Mac OS X; en_us)
```

```
AppleCoreMedia/1.0.0.9B176 (iPad; U; CPU OS 5_1 like Mac OS X; en_us)
```

Know Your Network

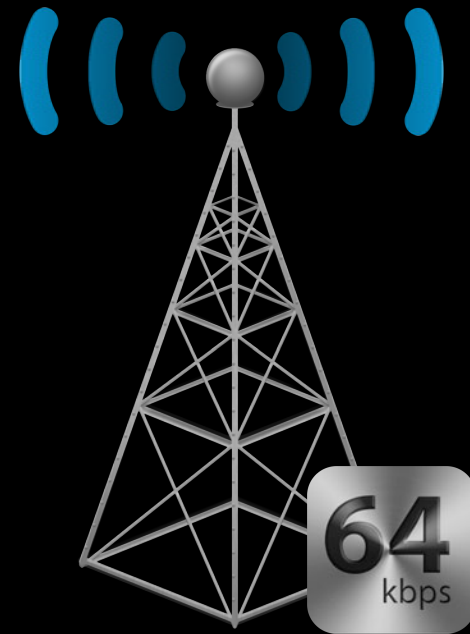
- Use reachability API (SCNetworkReachability) in your app

`kSCNetworkReachabilityFlagsIsWWAN`

- Allows you to distinguish cellular and WiFi

Special Considerations for Cellular

- Provide a 64 kbps stream
- Don't serve media segments from your app



The Right Stream to the Right Device

- Choose your bit rates carefully
- Use access logs to verify your assumptions
- Customize your master playlists

Localized Content

Localizing Audio

- Dub audio into other languages
- Use alternate audio playlists

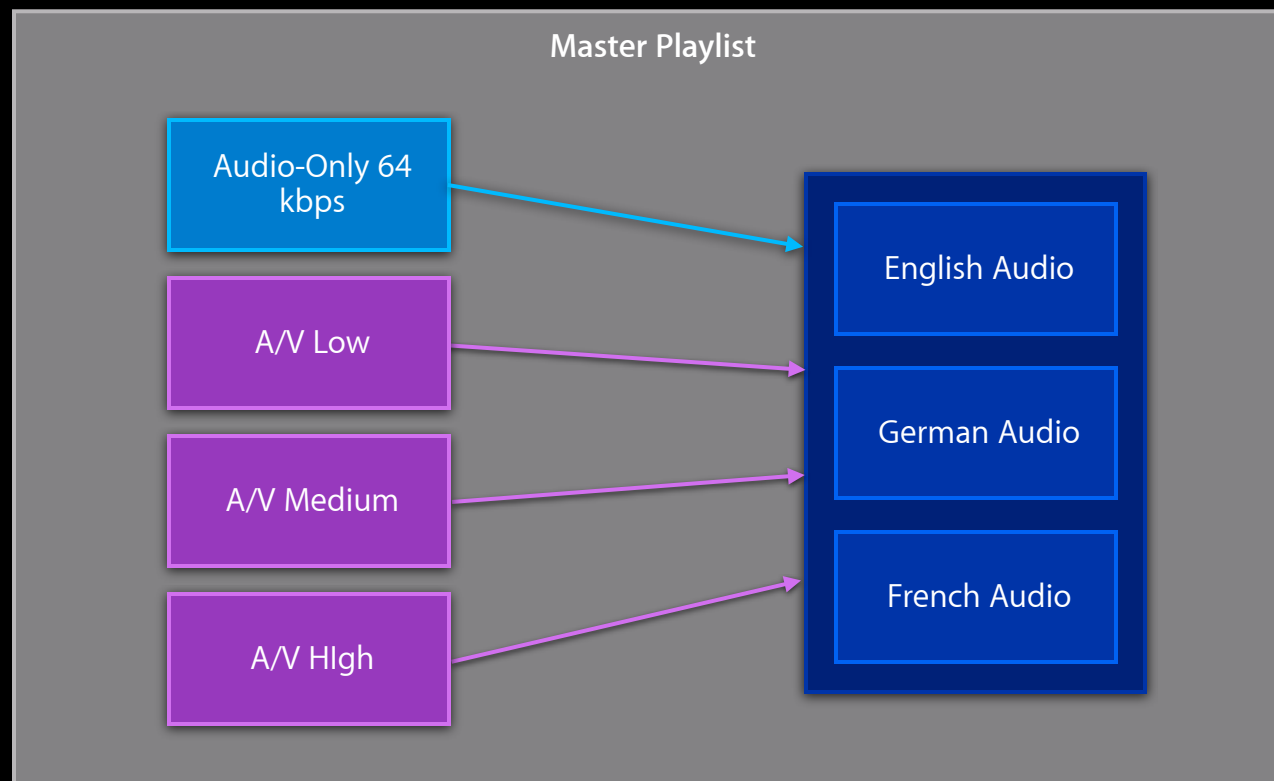
Playlist Diagram

Master with Variants



Playlist Diagram

Master with Variants and Audio Alternate



Alternate Media

Playlists

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/english-audio.m3u8",  
AUTOSELECT=YES,LANGUAGE="en",NAME="English",DEFAULT=YES
```

Alternate Media

Playlists

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/english-audio.m3u8",  
AUTOSELECT=YES,LANGUAGE="en",NAME="English",DEFAULT=YES
```

Alternate Media

Playlists

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/english-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="en",NAME="English",DEFAULT=YES  
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/german-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="de",NAME="Deutsch",DEFAULT=NO  
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/french-audio.m3u8",  
    AUTOSELECT=NO,LANGUAGE="fr",NAME="Français",DEFAULT=NO
```

Alternate Media

Playlists

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/english-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="en",NAME="English",DEFAULT=YES  
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/german-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="de",NAME="Deutsch",DEFAULT=NO  
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/french-audio.m3u8",  
    AUTOSELECT=NO,LANGUAGE="fr",NAME="Français",DEFAULT=NO
```

Alternate Media Playlists

#EXTM3U

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/english-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="en",NAME="English",DEFAULT=YES
```

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/german-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="de",NAME="Deutsch",DEFAULT=NO
```

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/french-audio.m3u8",  
    AUTOSELECT=NO,LANGUAGE="fr",NAME="Français",DEFAULT=NO
```

```
#EXT-X-STREAM-INF:BANDWIDTH=1280000,CODECS="...",AUDIO="group1"  
low/video-only.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=2560000,CODECS="...",AUDIO="group1"  
mid/video-only.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=7680000,CODECS="...",AUDIO="group1"  
hi/video-only.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=64000,CODECS="mp4a.40.5",AUDIO="group1"  
main/english-audio.m3u8
```

Alternate Media Playlists

#EXTM3U

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/english-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="en",NAME="English",DEFAULT=YES
```

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/german-audio.m3u8",  
    AUTOSELECT=YES,LANGUAGE="de",NAME="Deutsch",DEFAULT=NO
```

```
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="group1",URI="main/french-audio.m3u8",  
    AUTOSELECT=NO,LANGUAGE="fr",NAME="Français",DEFAULT=NO
```

```
#EXT-X-STREAM-INF:BANDWIDTH=1280000,CODECS="...",AUDIO="group1"  
low/video-only.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=2560000,CODECS="...",AUDIO="group1"  
mid/video-only.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=7680000,CODECS="...",AUDIO="group1"  
hi/video-only.m3u8
```

```
#EXT-X-STREAM-INF:BANDWIDTH=64000,CODECS="mp4a.40.5",AUDIO="group1"  
main/english-audio.m3u8
```

Alternate Media

Rules

- Alternates are constrained by the streams that use them
- Media tag is backward compatible

Localizing Text

- Translate subtitles into other languages

Localizing Text

- Translate subtitles into other languages

What's New in HTTP Live Streaming

Russian Hill
Wednesday 11:30AM

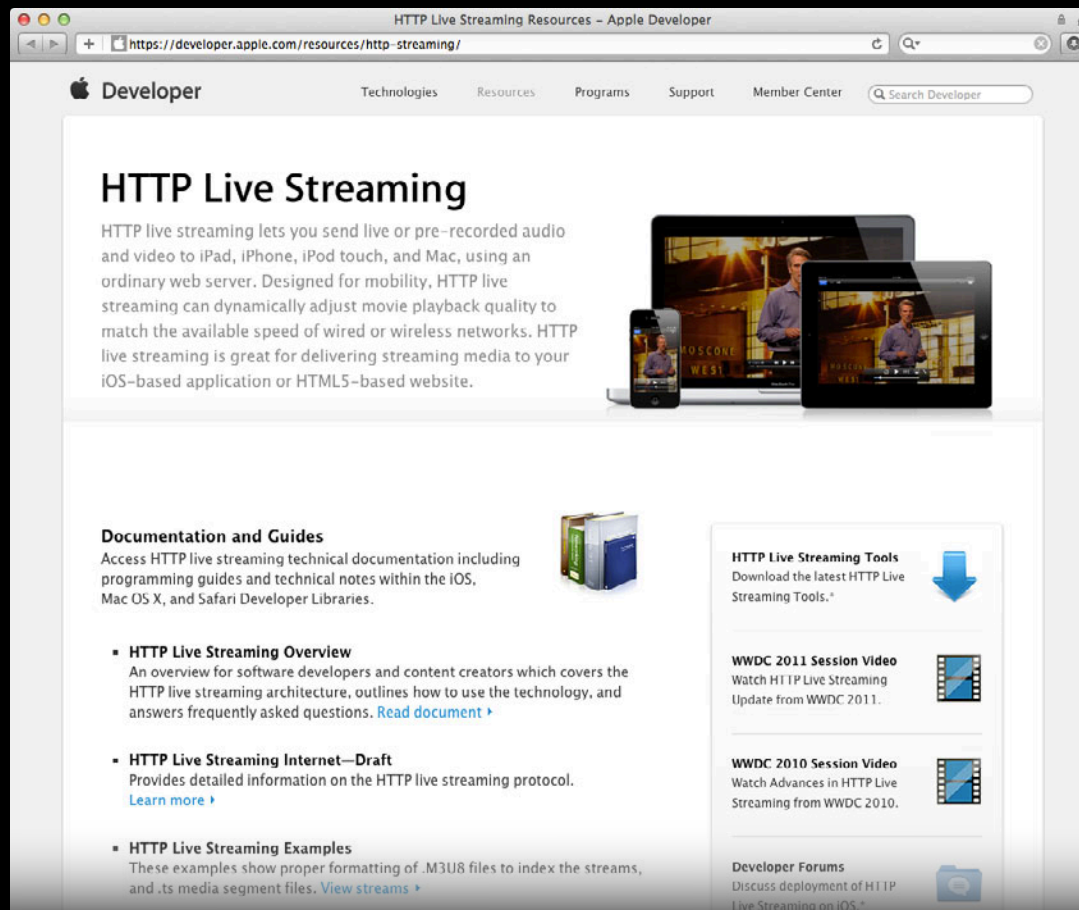
Wrap Up

There's More You Can Do

- Video alternates
- Timed metadata
- Closed captions
- Time/date marking
- Consolidating segments
- Encryption

Resources


<http://developer.apple.com/resources/http-streaming>




The screenshot shows a web browser window with the URL <https://developer.apple.com/resources/http-streaming/>. The page title is "HTTP Live Streaming Resources - Apple Developer". The navigation bar includes "Technologies", "Resources", "Programs", "Support", and "Member Center", along with a search box labeled "Search Developer".

HTTP Live Streaming


HTTP live streaming lets you send live or pre-recorded audio and video to iPad, iPhone, iPod touch, and Mac, using an ordinary web server. Designed for mobility, HTTP live streaming can dynamically adjust movie playback quality to match the available speed of wired or wireless networks. HTTP live streaming is great for delivering streaming media to your iOS-based application or HTML5-based website.





Documentation and Guides
Access HTTP live streaming technical documentation including programming guides and technical notes within the iOS, Mac OS X, and Safari Developer Libraries.




- **HTTP Live Streaming Overview**
An overview for software developers and content creators which covers the HTTP live streaming architecture, outlines how to use the technology, and answers frequently asked questions. [Read document](#) ▶
- **HTTP Live Streaming Internet—Draft**
Provides detailed information on the HTTP live streaming protocol. [Learn more](#) ▶
- **HTTP Live Streaming Examples**
These examples show proper formatting of .M3U8 files to index the streams, and .ts media segment files. [View streams](#) ▶

HTTP Live Streaming Tools
Download the latest HTTP Live Streaming Tools.* 

WWDC 2011 Session Video
Watch HTTP Live Streaming Update from WWDC 2011. 

WWDC 2010 Session Video
Watch Advances in HTTP Live Streaming from WWDC 2010. 

Developer Forums
Discuss deployment of HTTP Live Streaming on iOS.* 

Example Streams

- Byte-range access to a single media file
- Floating-point durations, CODECS attribute, RESOLUTION attribute
- Alternate audio streams
- I-frame playlists
- Timed metadata, closed captions

<https://developer.apple.com/resources/http-streaming/examples/>

More Information

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Documentation

HTTP Live Streaming resource page
<http://developer.apple.com/resources/http-streaming>

Tools

HTTP Live Streaming Tools
<http://developer.apple.com/downloads>

Apple Developer Forums

<http://devforums.apple.com>

Related Sessions

What's New in HTTP Live Streaming

Russian Hill
Wednesday 11:30AM

Labs

HTTP Live Streaming Lab

Graphics, Media & Games Lab
Wednesday 2:00PM

 WWDC2012