Error Handling Best Practices for HTTP Live Streaming

Session 514

Shravya Kunamalla, AVFoundation Engineer
Introduction to HLS Error Handling
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Multiple complex delivery scenarios
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Multiple complex delivery scenarios

Possibly millions of simultaneous viewers
Introduction to HLS Error Handling

Multiple complex delivery scenarios
Possibly millions of simultaneous viewers
Bound to run into errors
Introduction to HLS Error Handling

Multiple complex delivery scenarios
Possibly millions of simultaneous viewers
Bound to run into errors
Best practices for handling errors for both server and app
Overview of HLS Delivery
Overview of HLS Delivery

Master Playlist
Overview of HLS Delivery

Master Playlist

Video 6Mbit
Overview of HLS Delivery

Master Playlist

- Video 6Mbit
- Video 2Mbit
Overview of HLS Delivery

Master Playlist

- Video 6Mbit
- Video 2Mbit
- Audio English
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- Video 6Mbit
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Segments
1 2 3 4 5 6
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Keys
- EXT-X-KEY

Segments
- 1
- 2
- 3
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- 6
Overview of HLS Delivery

- **Master Playlist**
  - Video 6Mbit
  - Video 2Mbit
  - Audio English
  - Audio French
  - Subtitles English
  - Subtitles French
  - Session Data

- **Media Playlists**
  - Subtitles English
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Session Data
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Server Error Handling
How to handle content and delivery errors
Server Goals

General expectations
Server Goals

General expectations

Should deliver the expected resources in time
Server Goals
General expectations

Should deliver the expected resources in time

In case of error, communicate the correct error code
Server Goals
General expectations

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Server errors when it fails to fulfill a valid request
Server Goals

General expectations

Should deliver the expected resources in time

In case of error, communicate the correct error code

Server errors when it fails to fulfill a valid request
  • Encountered an error
Server Goals

General expectations

Should deliver the expected resources in time

In case of error, communicate the correct error code

Server errors when it fails to fulfill a valid request
  • Encountered an error
  • Incapable of performing the request
## Expected Failures and Error Codes

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#EXTM3U
#EXT-X-TARGETDURATION:10
#EXT-X-VERSION:2
#EXT-X-MEDIA-SEQUENCE:0
#EXTINF:10,
fileSequence0.ts
#EXT-X-GAP
#EXTINF:10,
fileSequence1.ts
#EXT-X-GAP
#EXTINF:10,
fileSequence2.ts
GAP Tag

Applied to one or more segments

#EXTM3U
#EXT-X-TARGETDURATION:10
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GAP Tag

Applied to one or more segments

Put this tag in sample timeline to indicate gap

#EXTM3U
#EXT-X-TARGETDURATION:10
#EXT-X-VERSION:2
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GAP Tag

Applied to one or more segments

Put this tag in sample timeline to indicate gap

AVPlayer could switch down to a variant without gap if possible
GAP Tag

Applied to one or more segments

Put this tag in sample timeline to indicate gap

AVPlayer could switch down to a variant without gap if possible

Play silence if nothing else available
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Expected Error Codes and Behavior
Expected Error Codes and Behavior

Send 404 to indicate stale playlist
Expected Error Codes and Behavior

Send 404 to indicate stale playlist

Send 501 for Unsupported features for example BYTE-RANGES not supported
Expected Error Codes and Behavior

Send 404 to indicate stale playlist

Send 501 for Unsupported features for example BYTE-RANGES not supported

Send 401 for authentication failures
Example Scenario Live Playback

Encoder/Packager 6Mbit

Encoder/Packager 2Mbit

Server

App
Example Scenario Live Playback

Encoder/Packager 6Mbit

Encoder/Packager 2Mbit

Server

App

Video6Mbit

200 ok
Example Scenario Live Playback

- Encoder/Packager 6Mbit
- Encoder/Packager 2Mbit
- Server
- App

Connections:
- Encoder/Packager 6Mbit to Server
- Encoder/Packager 2Mbit to Server
- Server to App
  - Video6Mbit
  - 200 ok
  - Segment1
  - 200 ok
Example Scenario Live Playback

- Encoder/Packager 6Mbit
- Encoder/Packager 2Mbit

Server:
- Video6Mbit
- Segment1
- Refresh Video6Mbit
- 200 ok
- 200 ok with GAP

App:
- 200 ok
- 200 ok with GAP
Example Scenario Live Playback

- Encoder/Packager 6Mbit
  - Video 6Mbit
    - 200 ok
    - Refresh Video 6Mbit
      - 200 ok with GAP
      - Video 2Mbit
        - 200 ok

- Encoder/Packager 2Mbit
  - Segment 1
    - 200 ok
Example Scenario Live Playback

Encoder/Packager 6Mbit

Encoder/Packager 2Mbit

Video 6Mbit
200 ok
Segment 1
200 ok
Refresh Video 6Mbit
200 ok with GAP
Video 2Mbit
200 ok
Segment 2
200 ok

Server

App
Failover
Failover

A method of protecting systems from failure, in which standby system takes over when the main system fails
Failover

Master Playlist

- Video 6Mbit
- Video 2Mbit
- Audio English
- Audio French
- Subtitles English
- Subtitles French
- Session Data
Have variants on different servers with same bandwidth and include them in master playlist.
Failover

Have variants on different servers with same bandwidth and include them in master playlist

- Video 6Mbit
- Video 2Mbit
- BackupVideo 6Mbit
- Audio English
- Audio French
- Subtitles English
- Subtitles French
- Session Data
Failover

Have variants on different servers with same bandwidth and include them in master playlist

- Master Playlist
  - Video 6Mbit
  - Video 2Mbit
  - BackupVideo 6Mbit
  - BackupVideo 2Mbit
  - Audio English
  - Audio French
  - Subtitles English
  - Subtitles French
  - Session Data
Failover

Have variants on different servers with same bandwidth and include them in master playlist.

Backup alternate will be tried before switching down.
Failover

Have variants on different servers with same bandwidth and include them in master playlist

Backup alternate will be tried before switching down

Send 404 to trigger a failover
Summary of Server Best Practices
Summary of Server Best Practices

Notify the client of error with correct error code
Summary of Server Best Practices

Notify the client of error with correct error code

Have backup playlists on alternate servers to failover in case of server failures
Summary of Server Best Practices

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Send 501 for unsupported features
Summary of Server Best Practices

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Live
Summary of Server Best Practices

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Live

Update the playlist in time as specified by the HLS Spec
Summary of Server Best Practices

Notify the client of error with correct error code

Have backup playlists on alternate servers to failover in case of server failures

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Live

Update the playlist in time as specified by the HLS Spec

Prefer gap tag in case of temporary resource/server unavailability
Summary of Server Best Practices

Notify the client of error with correct error code

Have backup playlists on alternate servers to failover in case of server failures

Send 501 for unsupported features

Live

Update the playlist in time as specified by the HLS Spec

Prefer gap tag in case of temporary resource/server unavailability

Send 404 to indicate stale playlists
App Error Handling
How to handle AVFoundation errors
Identifying Error
Identifying Error

AVPlayer.status and AVPlayerItem.status
Changes to AVPlayerStatusFailed, AVPlayerItemStatusFailed
Identifying Error

AVPlayer.status and AVPlayerItem.status
Changes to AVPlayerStatusFailed, AVPlayerItemStatusFailed

AVPlayerItem.error
Describes what caused the item to be no longer playable
Identifying Error

AVPlayer.status and AVPlayerItem.status
Changes to AVPlayerStatusFailed, AVPlayerItemStatusFailed

AVPlayerItem.error
Describes what caused the item to be no longer playable

AVPlayerItemFailedToPlayToEndTimeNotification
AVPlayerItem.errorLog the snapshot of error log
What do the errors mean?
Possible Error Events
Possible Error Events

Network errors
Possible Error Events

Network errors

Timeouts
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Possible Error Events

- Network errors
- Timeouts
- Format errors
- Live playlist update errors
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User-info of AVPlayerItem.error contains the underlying error
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AVPlayerItem.status changes to failed only after
• We have no viable alternate to use to continue playback
• Played out what ever buffer we have
AVPlayer Error Handling
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Switch to a different variant or retry on temporary server errors (i.e. 500, 502, 503, 504, 401, 403, 404)
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On permanent failures (i.e. 410) playback is stopped only if there are no other viable variants

All session data errors are not fatal and are ignored
// Extracting the Errors

let hlsAsset = AVURLAsset(URL: assetURL as URL)
let item = AVPlayerItem(asset: hlsAsset!)
let player = AVPlayer(playerItem: item)

// Add observer for player status
addObserver(self, forKeyPath: #keyPath(AVPlayer.status), options: [.new, .initial], context: nil)

// Add observer for playerItem status
addObserver(self, forKeyPath: #keyPath(AVPlayer.currentItem.status), options: [.new, .initial], context: nil)

// Listen to notification
NotificationCenter.default.addObserver(self, selector:"failedToPlayToEndTime:",
    name: NSNotification.Name.AVPlayerItemFailedToPlayToEndTimeNotification, object: player.currentItem)
// Extracting the Errors

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// Listen to notification
NotificationCenter.default.addObserver(self, selector:"failedToPlayToEndTime:",
    name: NSNotification.Name.AVPlayerItemFailedToPlayToEndTimeNotification, object: player.currentItem)
// Observe If AVPlayerItem.status Changed to Fail

override func observeValue(forKeyPath keyPath: String?, of object: Any?, change: [NSKeyValueChangeKey: Any]?, context: UnsafeMutableRawPointer?) {
    if keyPath == #keyPath(player.currentItem.status) {
        let newStatus: AVPlayerItemStatus
        if let newStatusAsNumber = change?[NSKeyValueChangeKey.newKey] as? NSNumber {
            newStatus = AVPlayerItemStatus(rawValue: newStatusAsNumber.intValue)!
        } else {
            newStatus = .unknown
        }
        if newStatus == .failed {
            NSLog("Error: \(player.currentItem?.error?.localizedDescription), error: \(player.currentItem?.error)"")
        }
    }
}
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if newStatus == .failed {
    NSLog("Error: 
(player.currentItem?.error?.localizedDescription), error: 
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    )
}

// Getting error from Notification payload
func failedToPlayToEndTime(_ notification: Notification) {
    let error = notification.userInfo!["AVPlayerItemFailedToPlayToEndTimeErrorKey"]
    NSLog("Error: 
(error?.localizedDescription), error: 
(error)"
    )
}
if let newStatusAsNumber = change?[NSKeyValueChangeKey.newKey] as? NSNumber {
    newStatus = AVPlayerItemStatus(rawValue: newStatusAsNumber.intValue)!
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Summary App Best Practices
Monitor AVPlayer and AVPlayerItem status
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Display meaningful messages/pop-ups when failures occur
More Information
