Camera Capture: Manual Controls

Power to the people

Session 508
Brad Ford
Camera Software

Past Sessions

developer.apple.com

WWDC 2011 Session 419—Capturing from the Camera on iOS 5

WWDC 2011 Session 417—Introducing AV Foundation Capture for Lion

WWDC 2012 Session 520—What's New in Camera Capture (iOS 6)

WWDC 2013 Session 610—What's New in Camera Capture (iOS 7)

Appetizer

AVCaptureView on Yosemite
iOS Screen Recording
Barcode Update

Main Course

Manual Camera Controls
Focus / Exposure / White Balance

Dessert

Bracketed Capture

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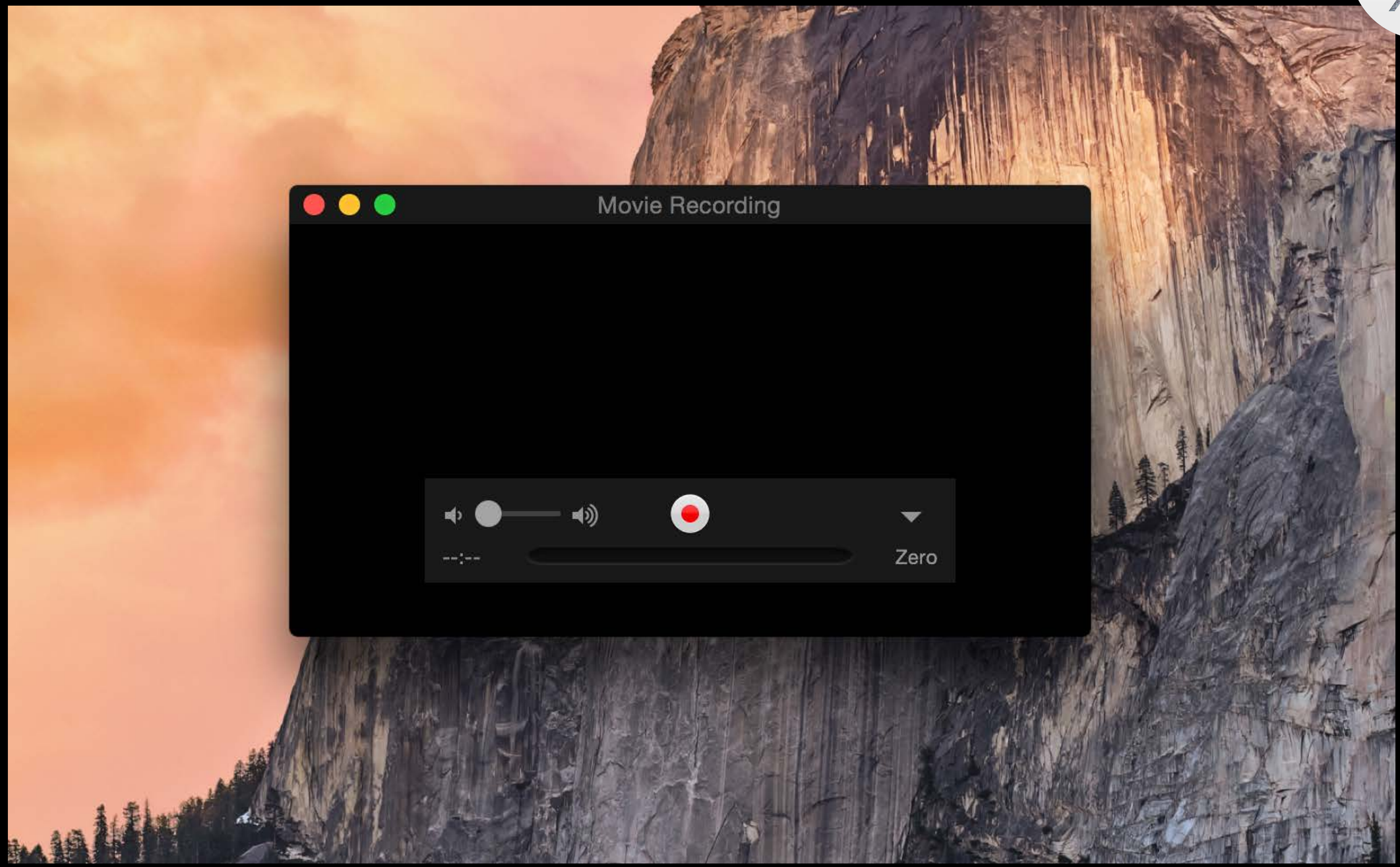
Capture in AVKit

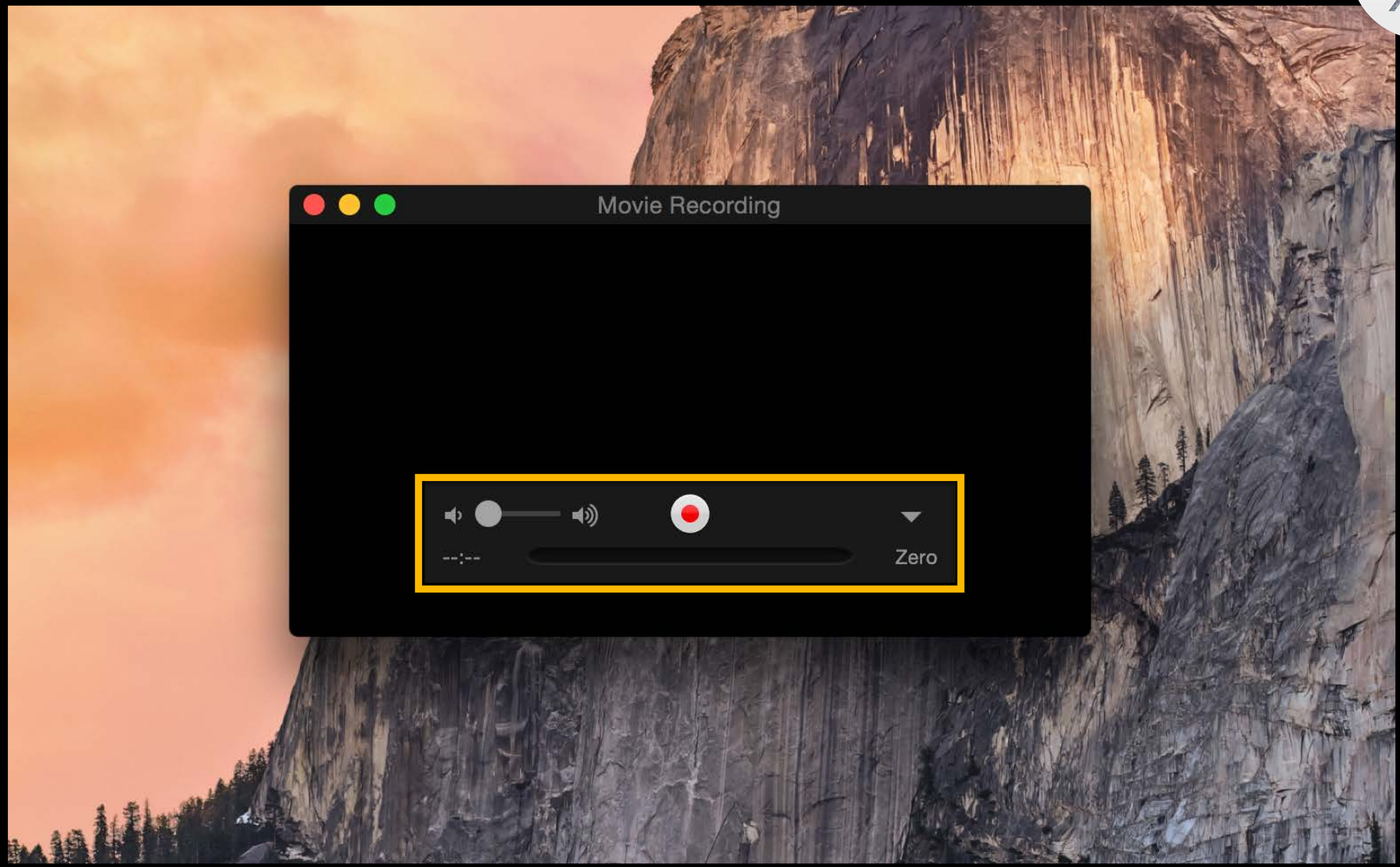
Standard user interface for capture on Yosemite

AVKit

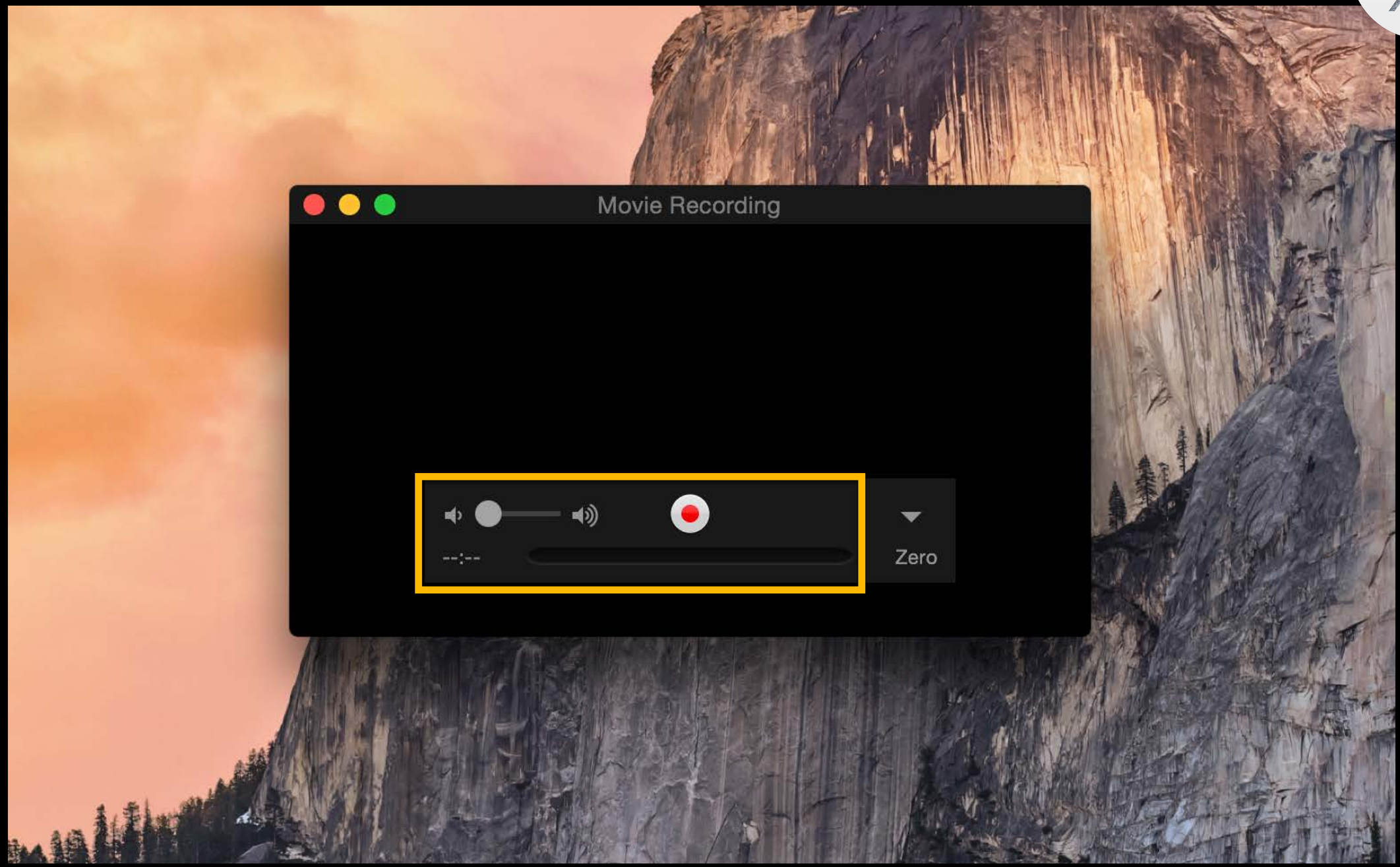
AVCaptureView



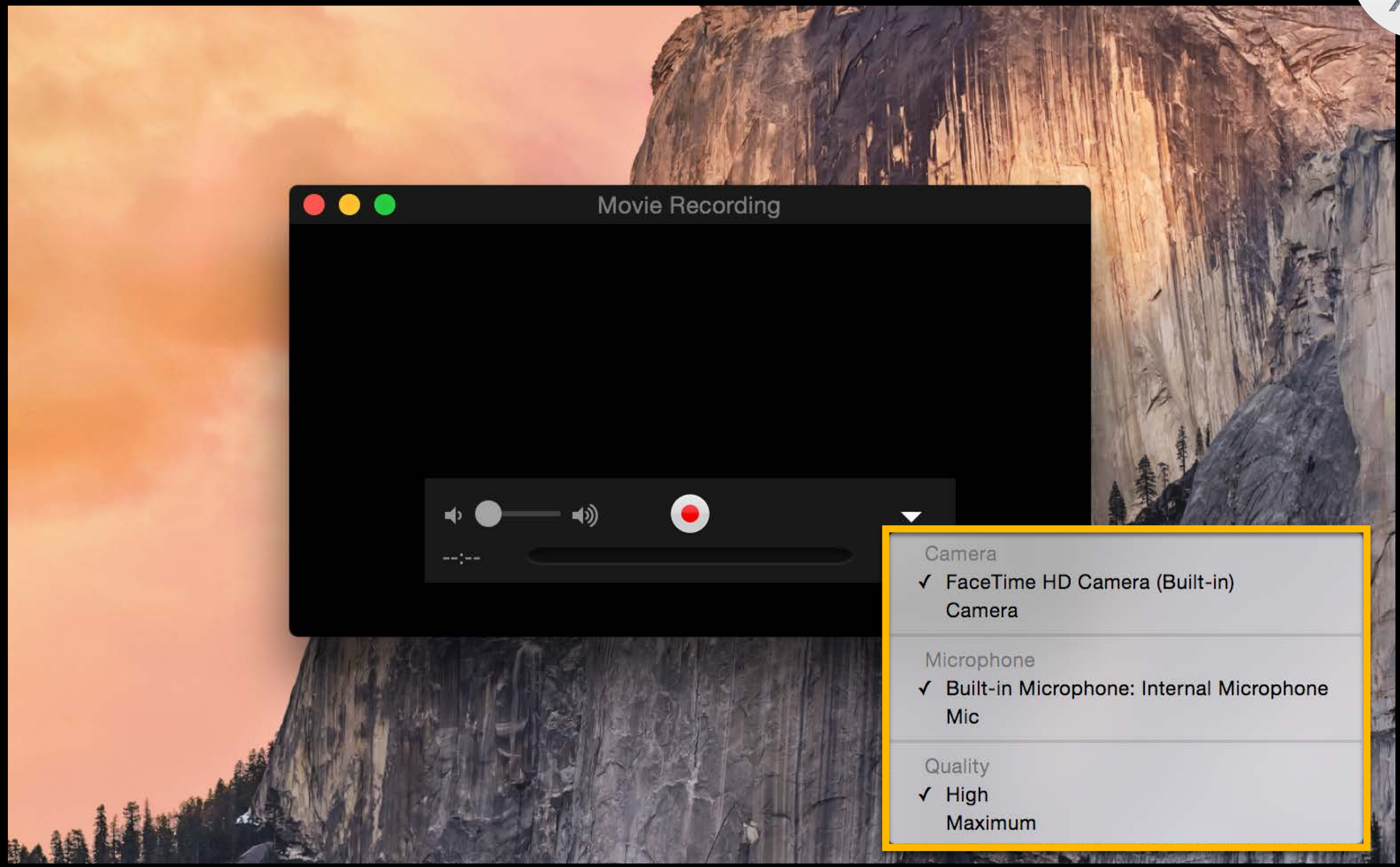
AVCaptureView



AVCaptureView



AVCaptureView

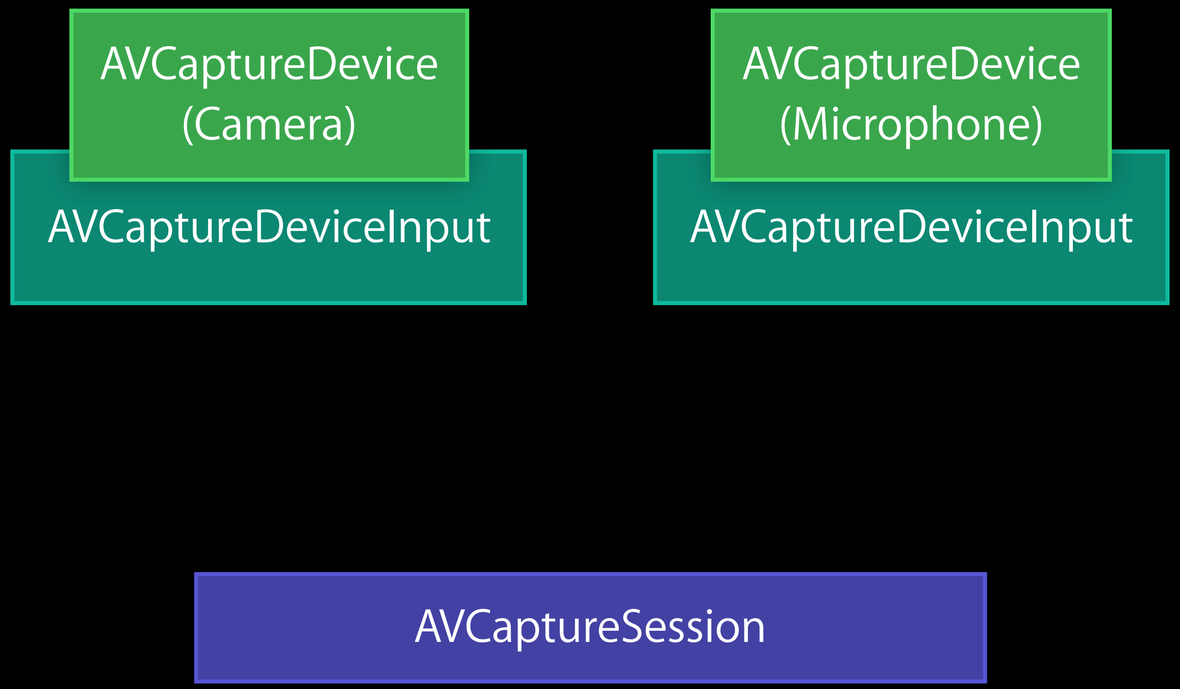


AVFoundation Capture Objects

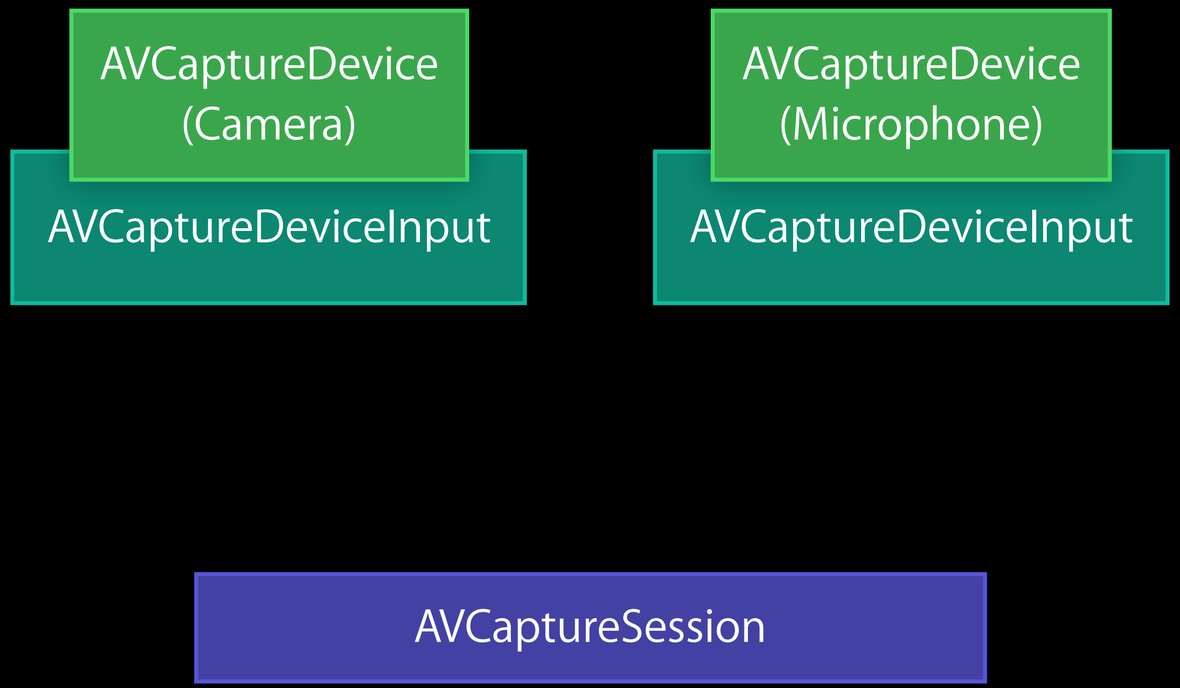
AVFoundation Capture Objects

AVCaptureSession

AVFoundation Capture Objects



AVFoundation Capture Objects



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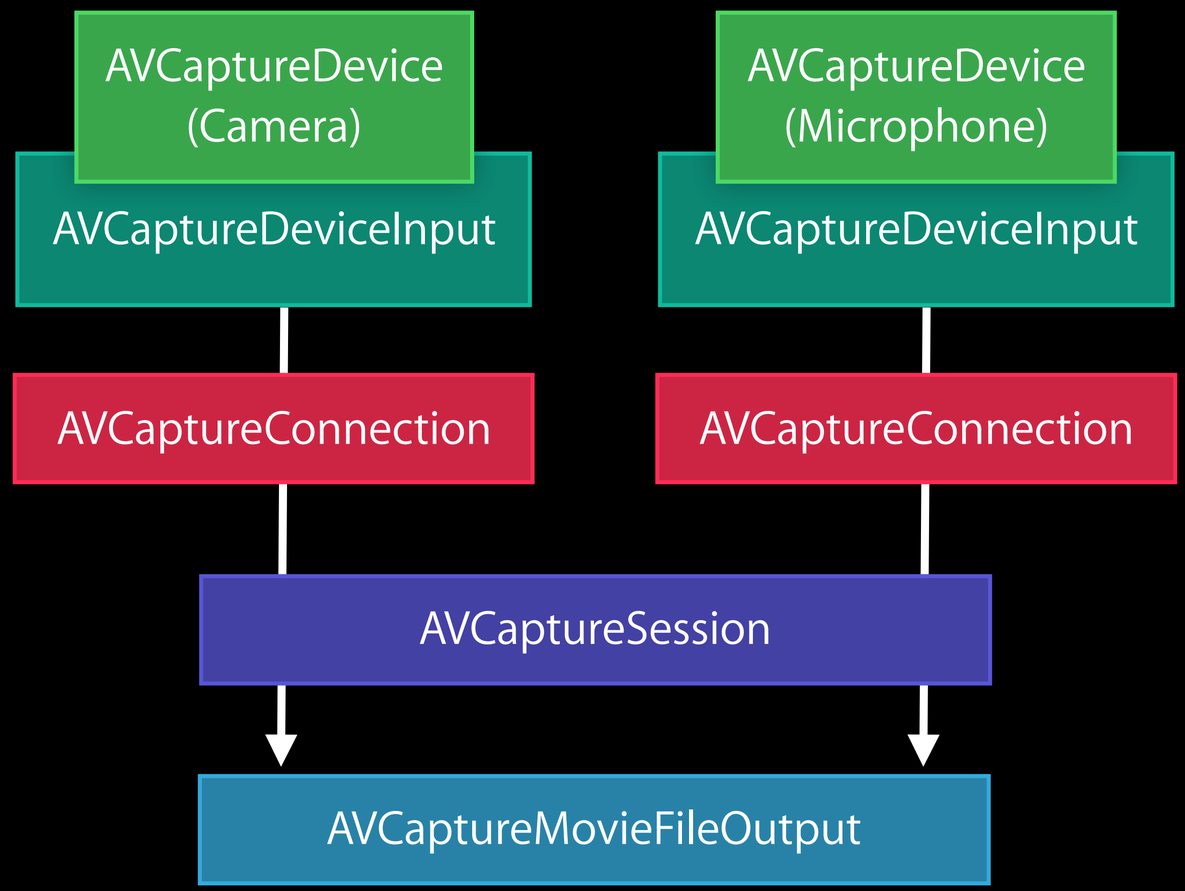
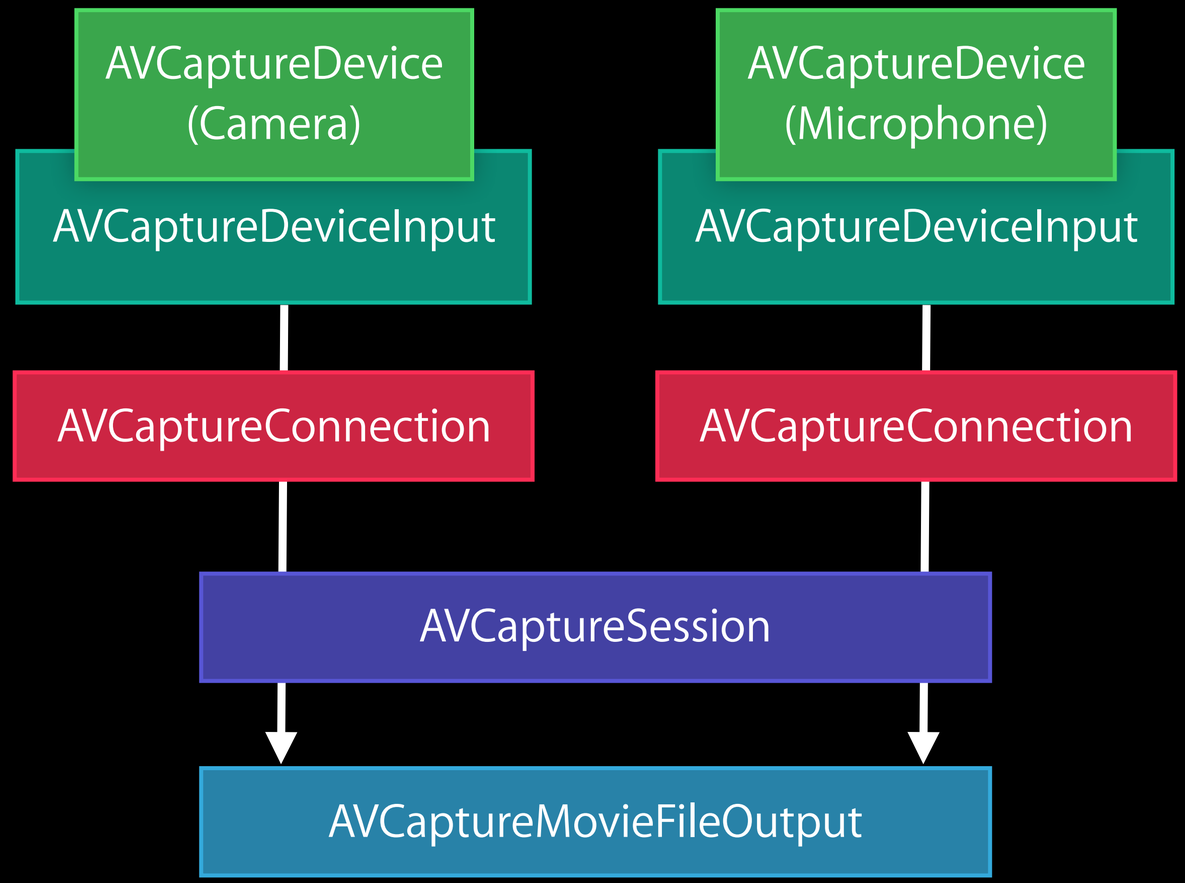


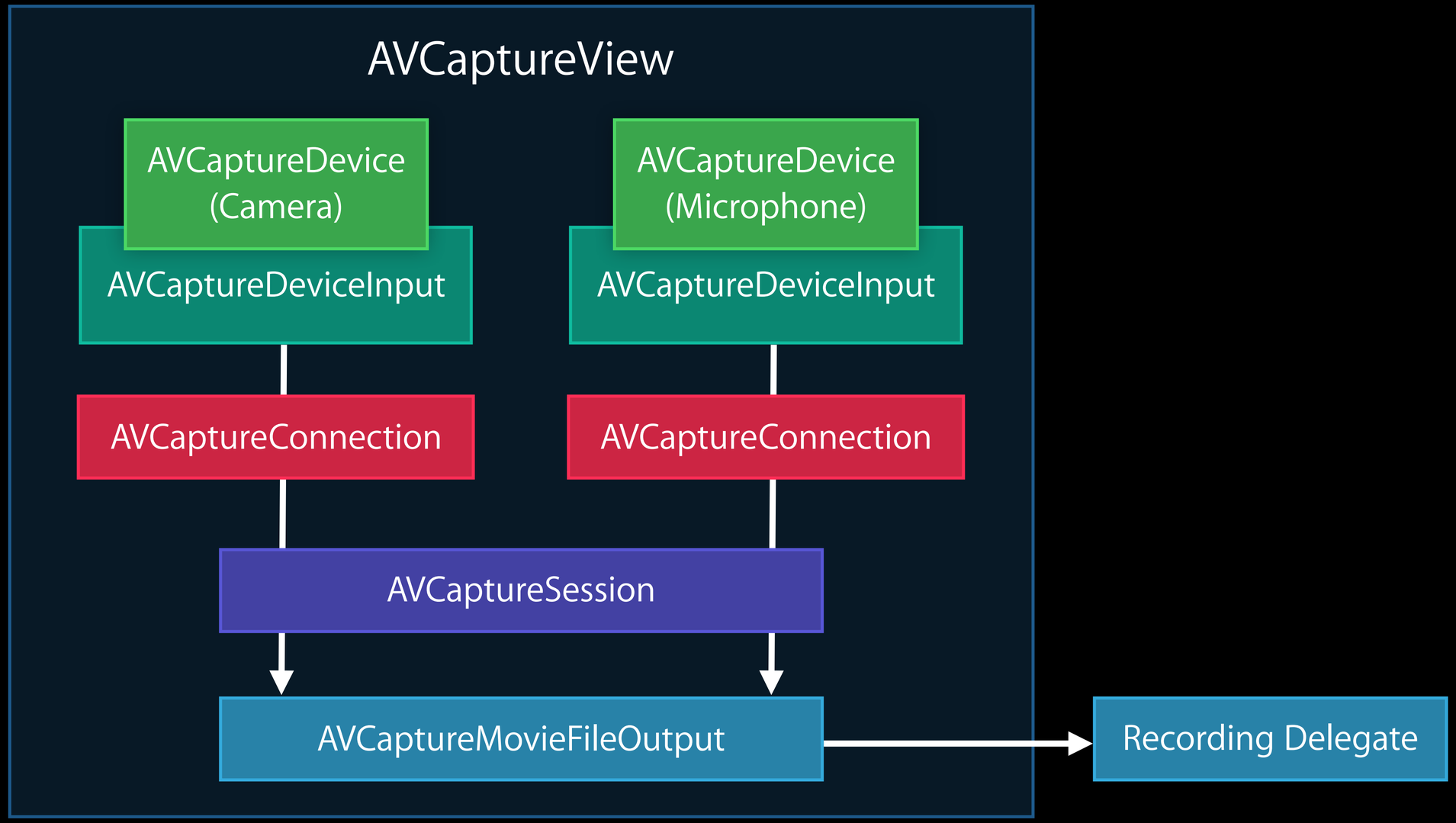
AVCaptureView

Default AVCaptureSession



AVCaptureView

Default AVCaptureSession



AVCaptureView

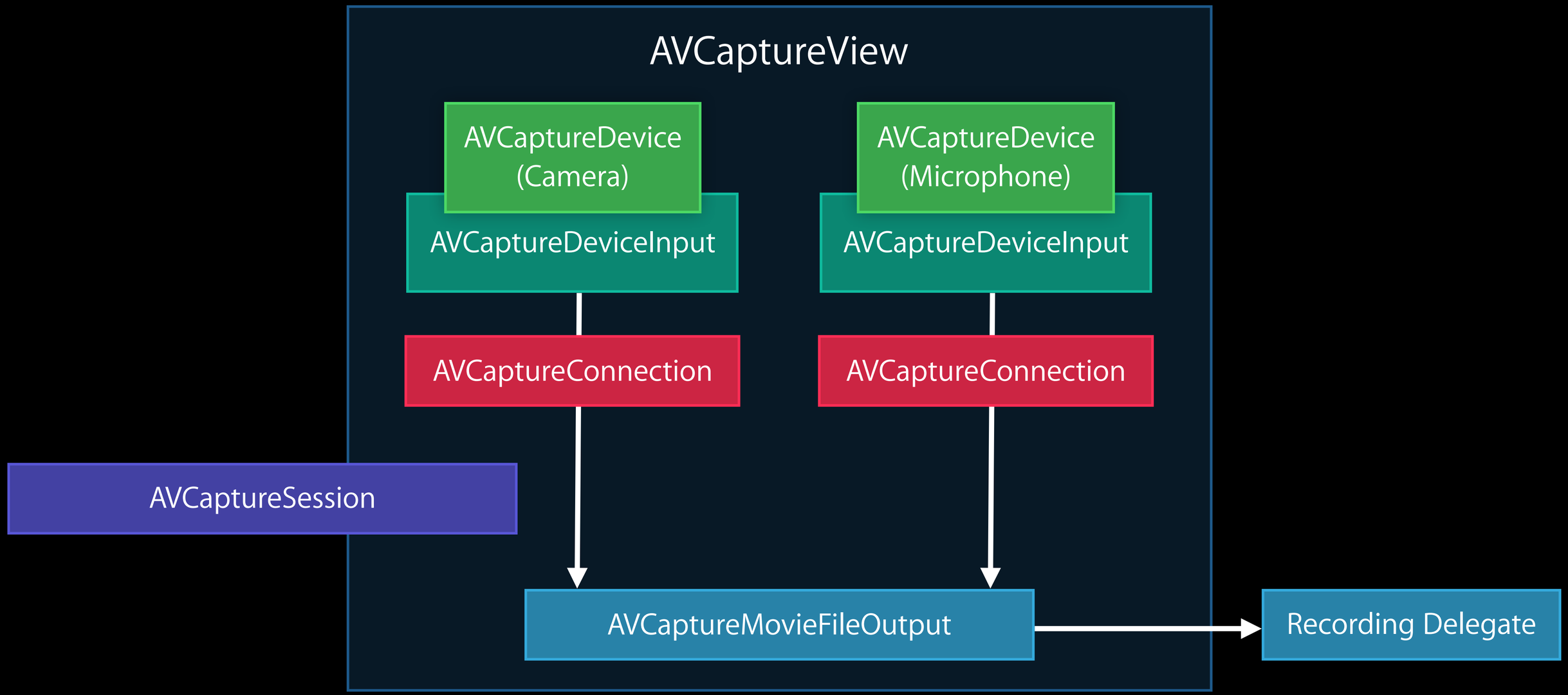
Default AVCaptureSession

```
// Need to be delegate of AVCaptureView to start recording
@interface MyClass : NSObject <AVCaptureViewDelegate>
@end

// When user clicks record button, tell the file output to start recording
- (void)captureView:(AVCaptureView *)view startRecordingToFileOutput:
(AVCaptureFileOutput *)fileOutput
{
    [fileOutput startRecordingToOutputFile:URL recordingDelegate:self];
}
```

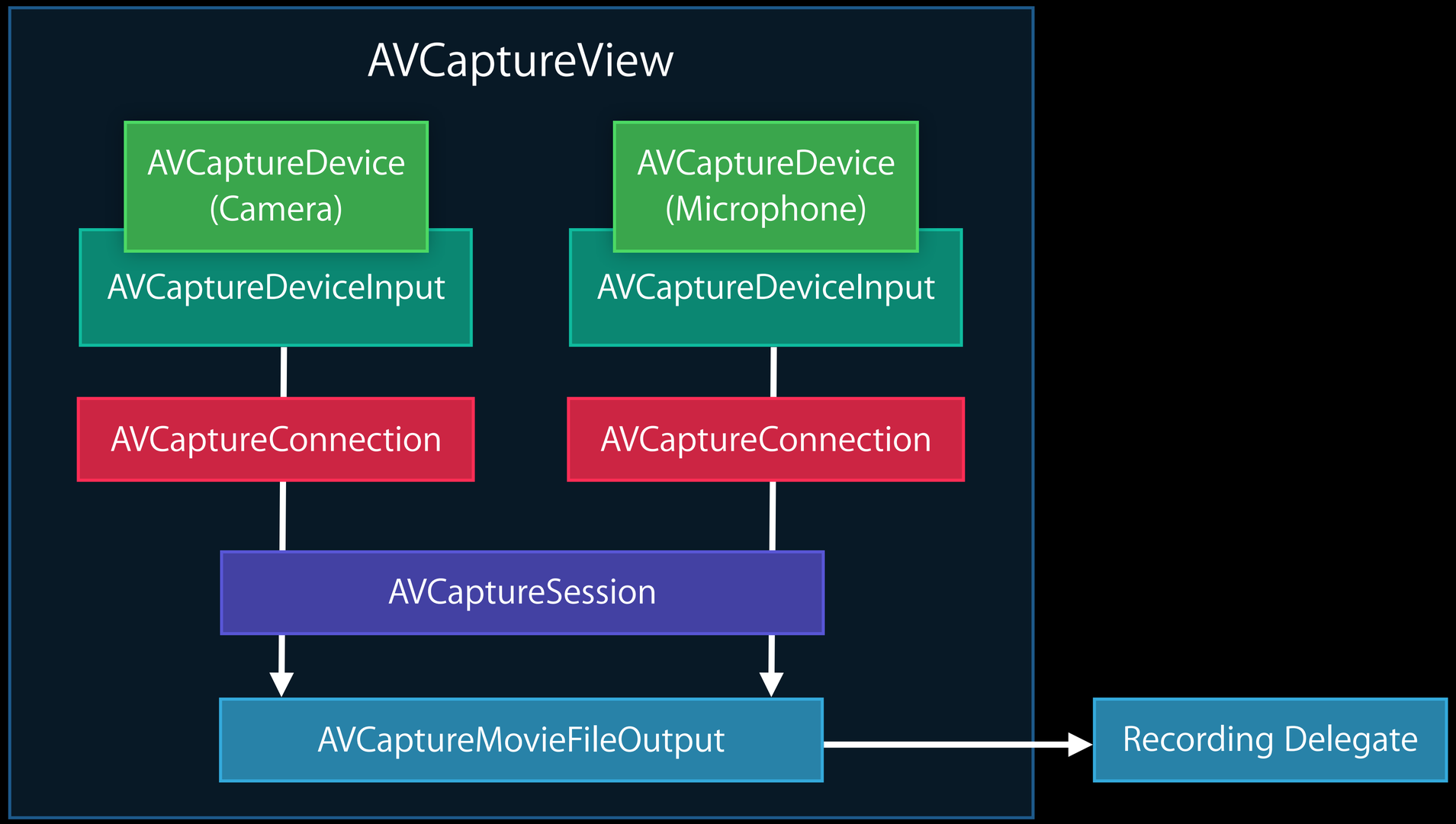
AVCaptureView

Custom AVCaptureSession



AVCaptureView

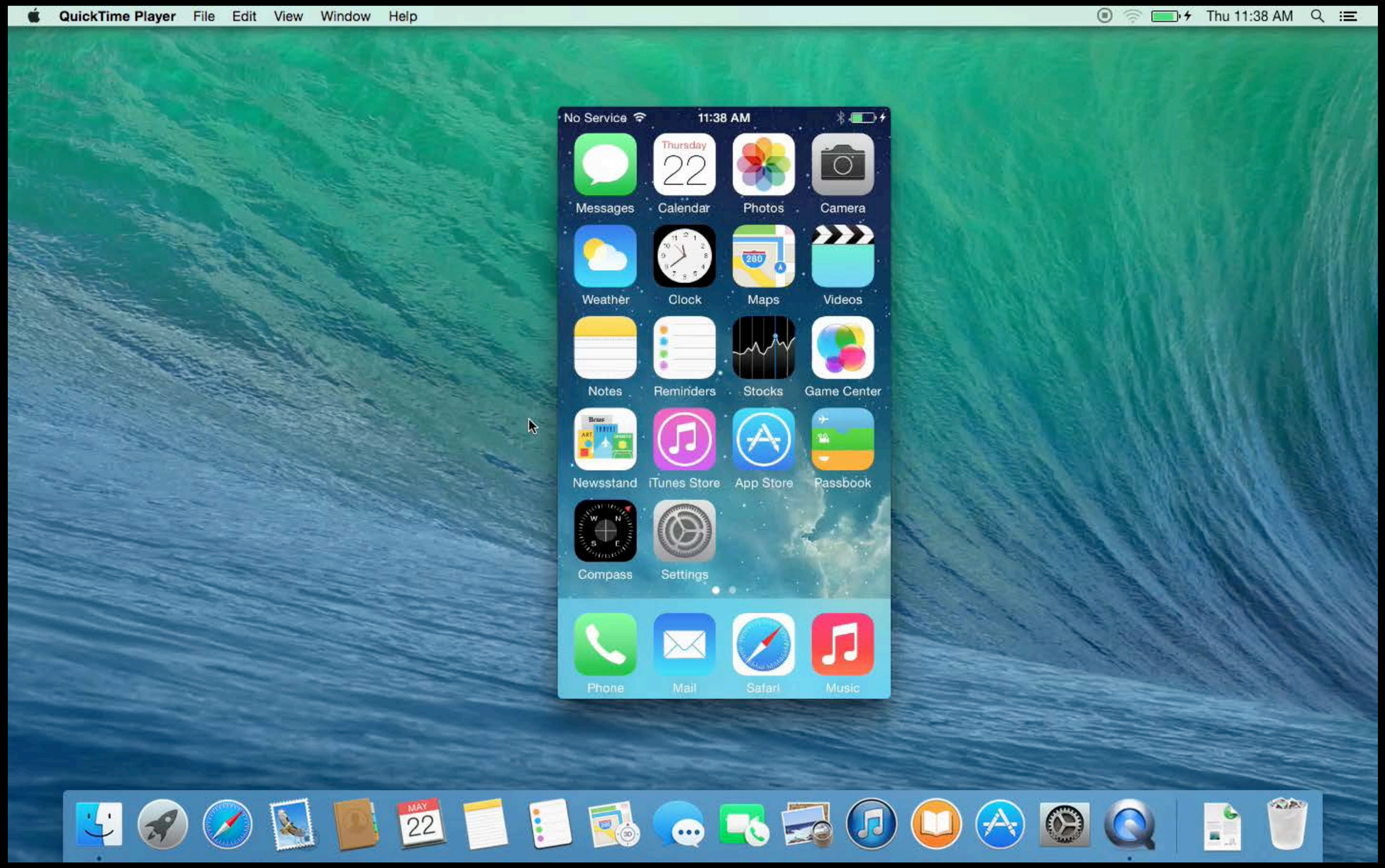
Custom AVCaptureSession



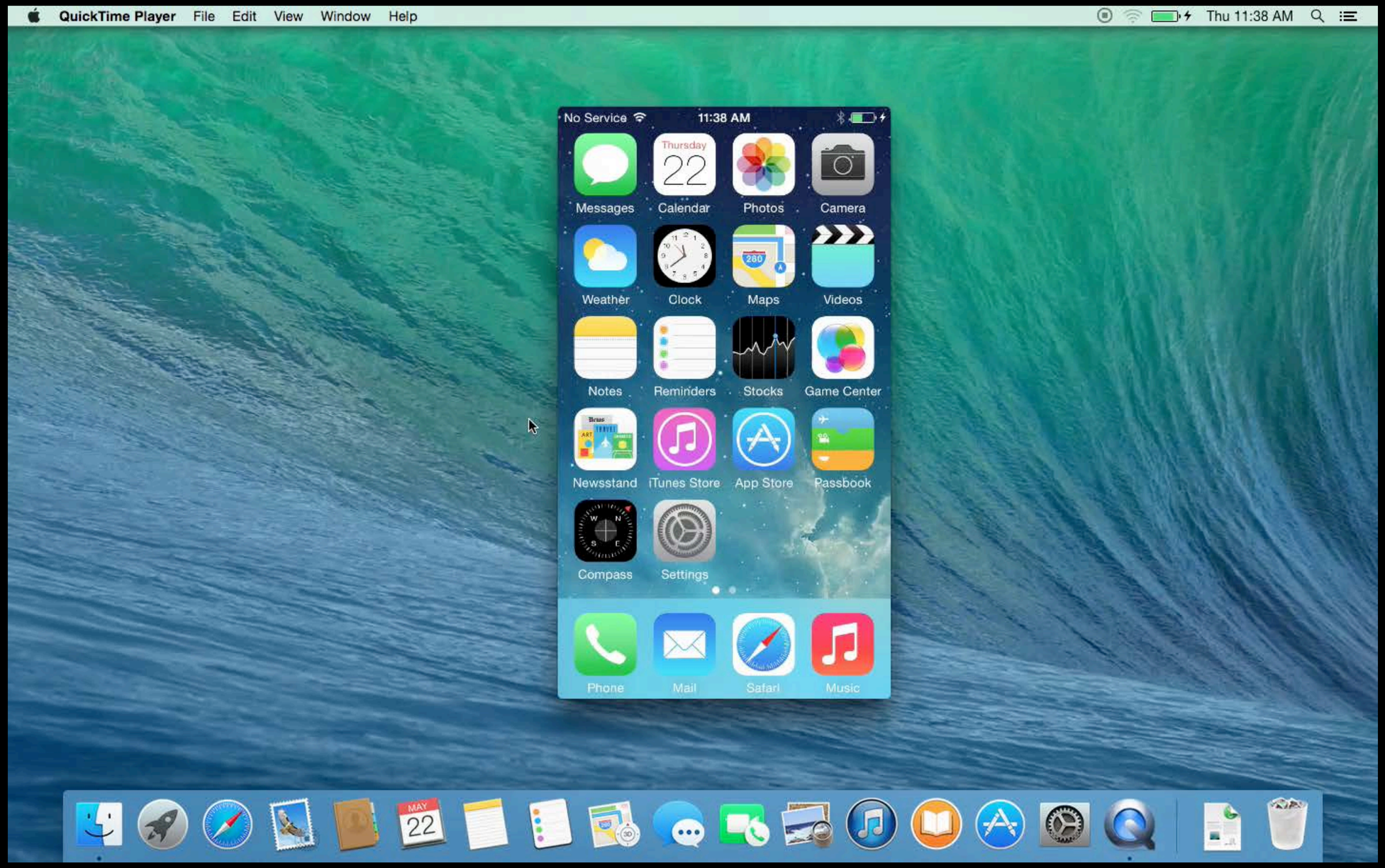
iOS Screen Recording on OS X

App previews and more

iOS Screen Recording



iOS Screen Recording



iOS Screen Recording

Special considerations

iOS Screen Recording

Special considerations

iOS devices are presented as CoreMedia IO “DAL” plug-ins

iOS Screen Recording

Special considerations

iOS devices are presented as CoreMedia IO “DAL” plug-ins

You must opt in to see iOS screen devices in your OS X app

```
CMIOObjectPropertyAddress prop =
                            { kCMIOHardwarePropertyAllowScreenCaptureDevices,
                              kCMIOObjectPropertyScopeGlobal,
                              kCMIOObjectPropertyElementMaster };
UInt32 allow = 1;
CMIOObjectSetPropertyData( kCMIOObjectSystemObject,
                           &prop, 0, NULL,
                           sizeof(allow), &allow );
```

Related Sessions

• Creating Great App Previews	Russian Hill	Thursday 3:15PM

iOS 8 Capture Enhancements

Machine-Readable Codes

iOS 7 support

UPC-E

Code 39 and Code 39 mod 43

EAN-13 (including UPC-A)

EAN-8

Code 93

Code 128

PDF417

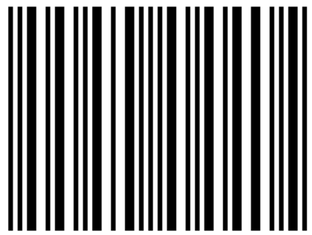
QR

Aztec

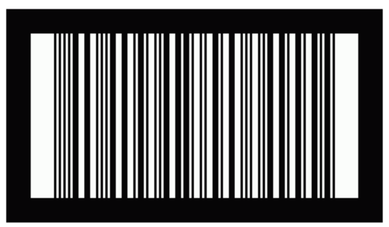
New Machine-Readable Codes

NEW

Data Matrix



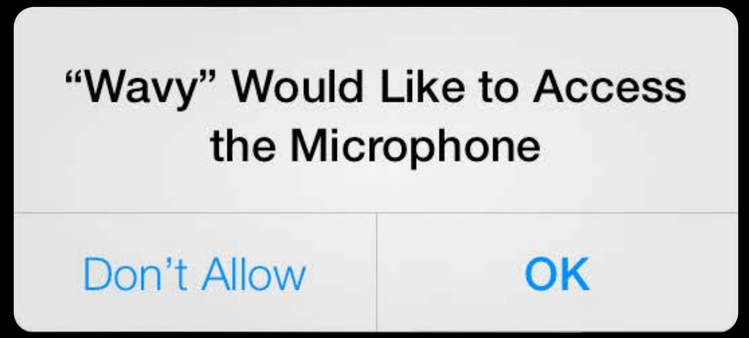
Interleaved
2 of 5

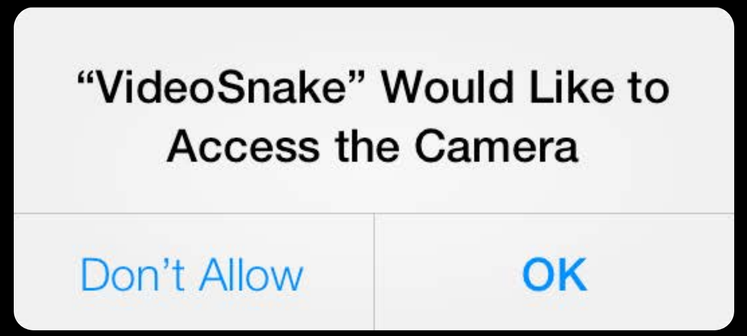


ITF14

Greater Transparency for Users

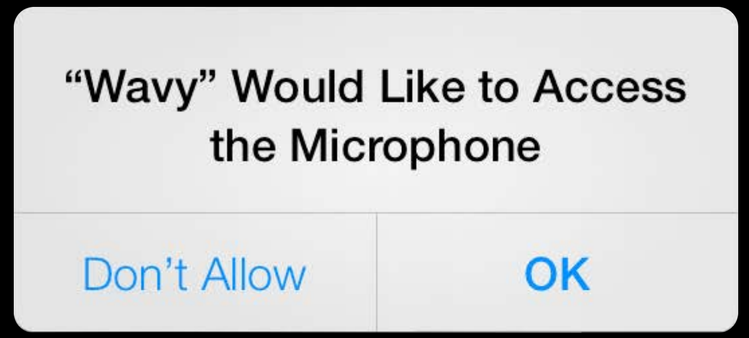
Greater Transparency for Users

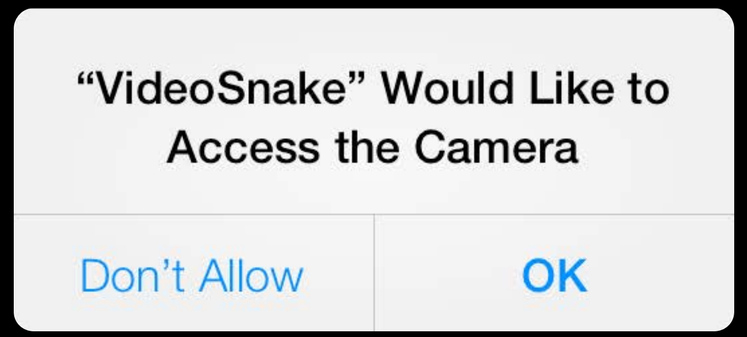




Greater Transparency for Users

User consent to use the camera or mic extends to all regions

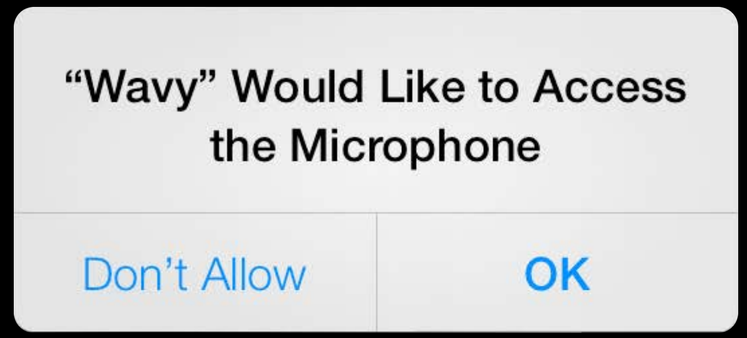


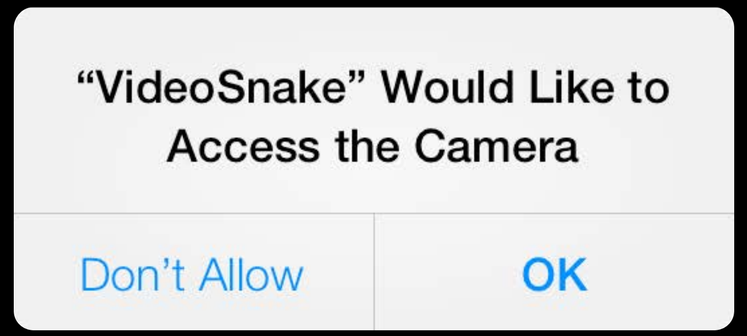


Greater Transparency for Users

User consent to use the camera or mic extends to all regions

Refer to WWDC 2013 Session 610 for coding examples





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ID: 10071195

Title: Expose VTDecompressionSession and VTCompressionSession on iOS

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Title: [API] Request for bracketed capture API for HDR

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Title: Feature Request: Support Compressed Frames from AVCaptureVideoDataOutput

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Title: ER: AWB support for neutral/grey/white object or grey-card

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Title: AVCaptureVideoDataOutput should have an option to output compressed samples

ID: 10344301

Title: support for querying and setting integration time

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Related Problems: 89 — Is blocking 1, Original of 41, Parent of 4 (2 Unresolved)

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Your Top Two Feature Requests

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Direct access to the H.264 video encoder/decoder

Your Top Two Feature Requests

Direct access to the H.264 video encoder/decoder

Manual camera controls for focus, white balance, and exposure

Access to H.264 Video Encoder

Real-time capture

Access to H.264 Video Encoder

Real-time capture

AVCaptureVideoDataOutput buffers may be compressed in real time

- I-frame insertion
- Bitrate adjustment
- I-frame only, I-P, or I-P-B GOP support
- And more

Related Sessions

• Direct Access to Video Encoding and Decoding	Nob Hill	Thursday 11:30AM

Manual Camera Controls

Making iOS the premiere platform
for computational and pro photography


FIRE
FIRE
FIRE
FIRE
APU
FIRE
GREEN
YELLOW
ERASE


1 3 5
2 4 R


P
R
N
D
M/S
+

Manual Camera Controls

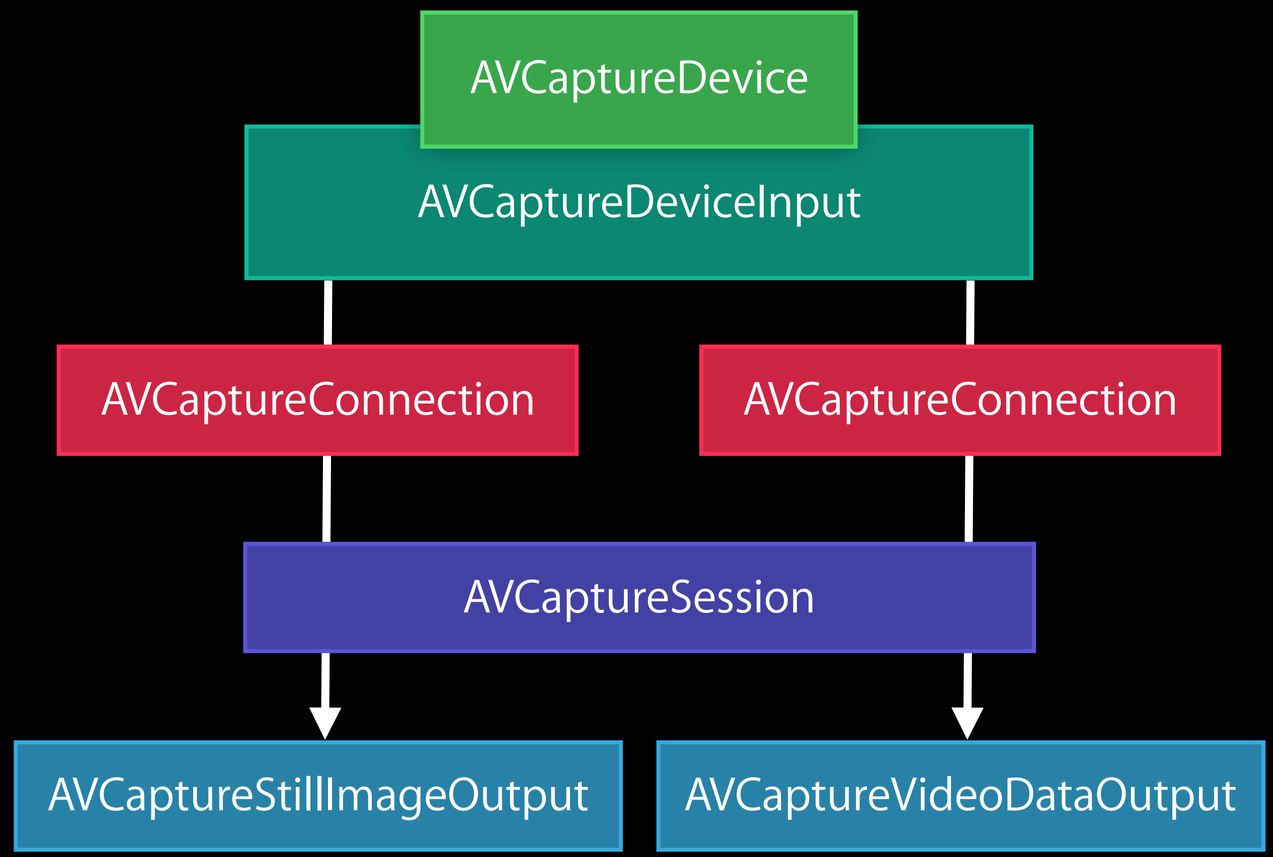
Manual focus

Manual exposure

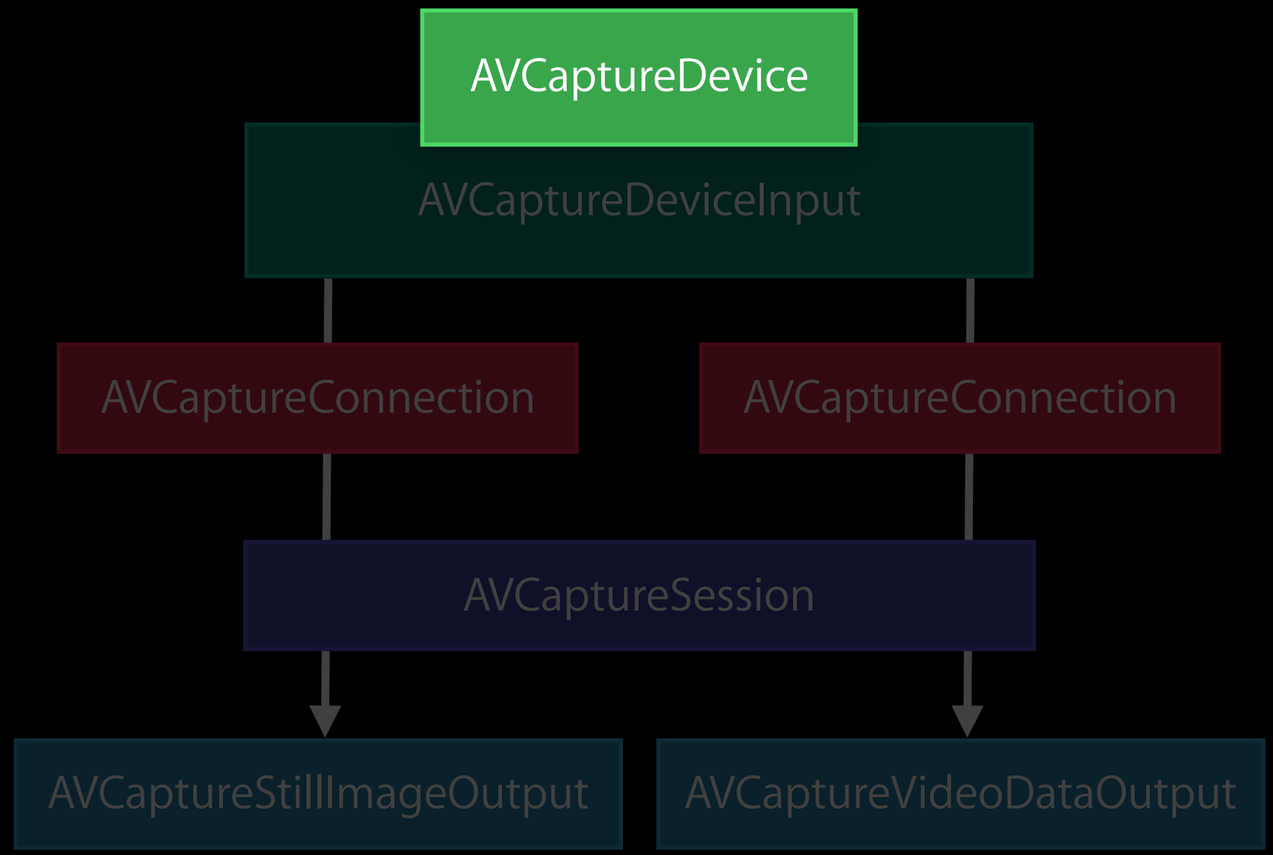
Exposure compensation

Manual white balance

AVFoundation Capture Objects

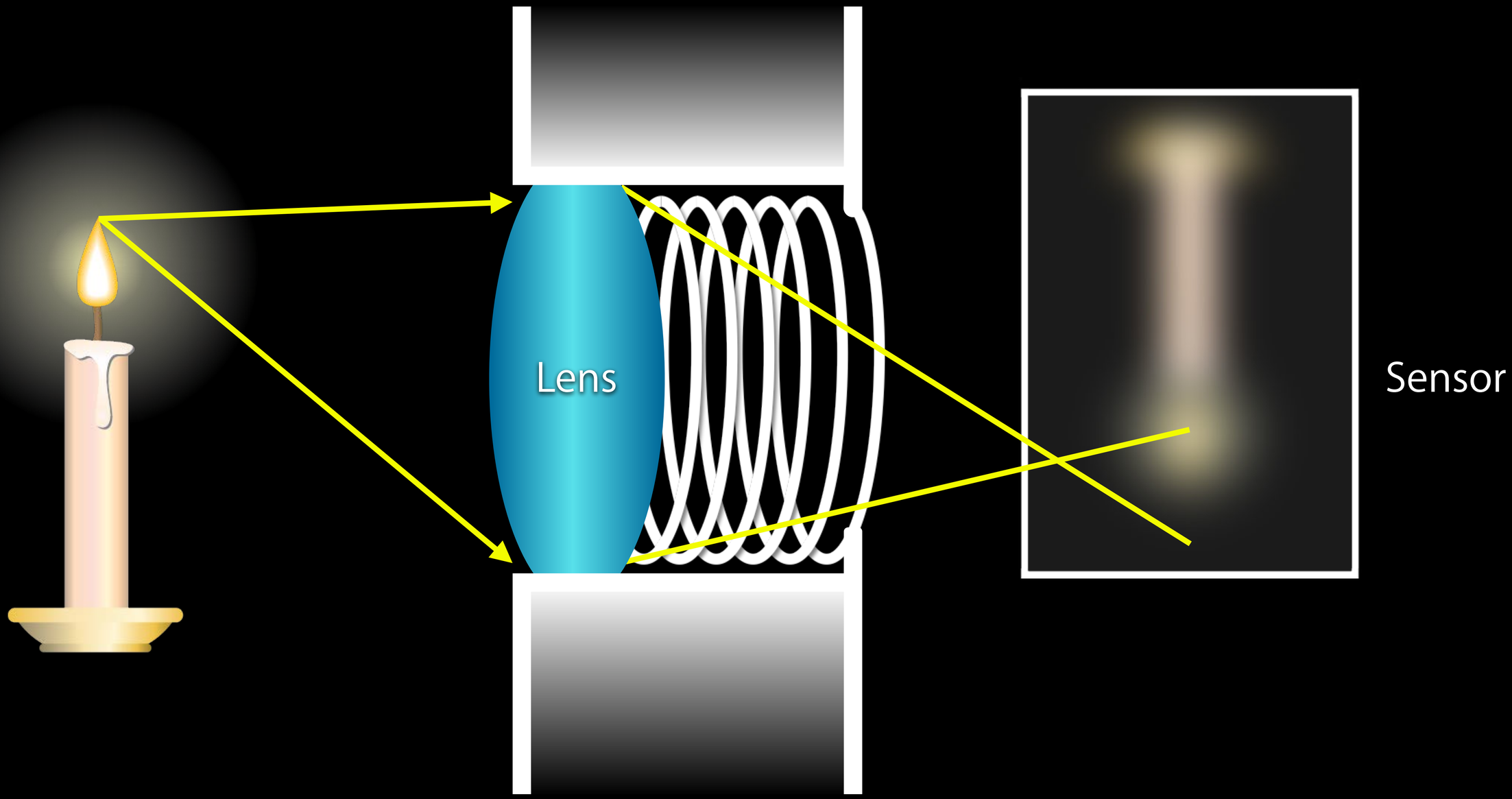


AVFoundation Capture Objects

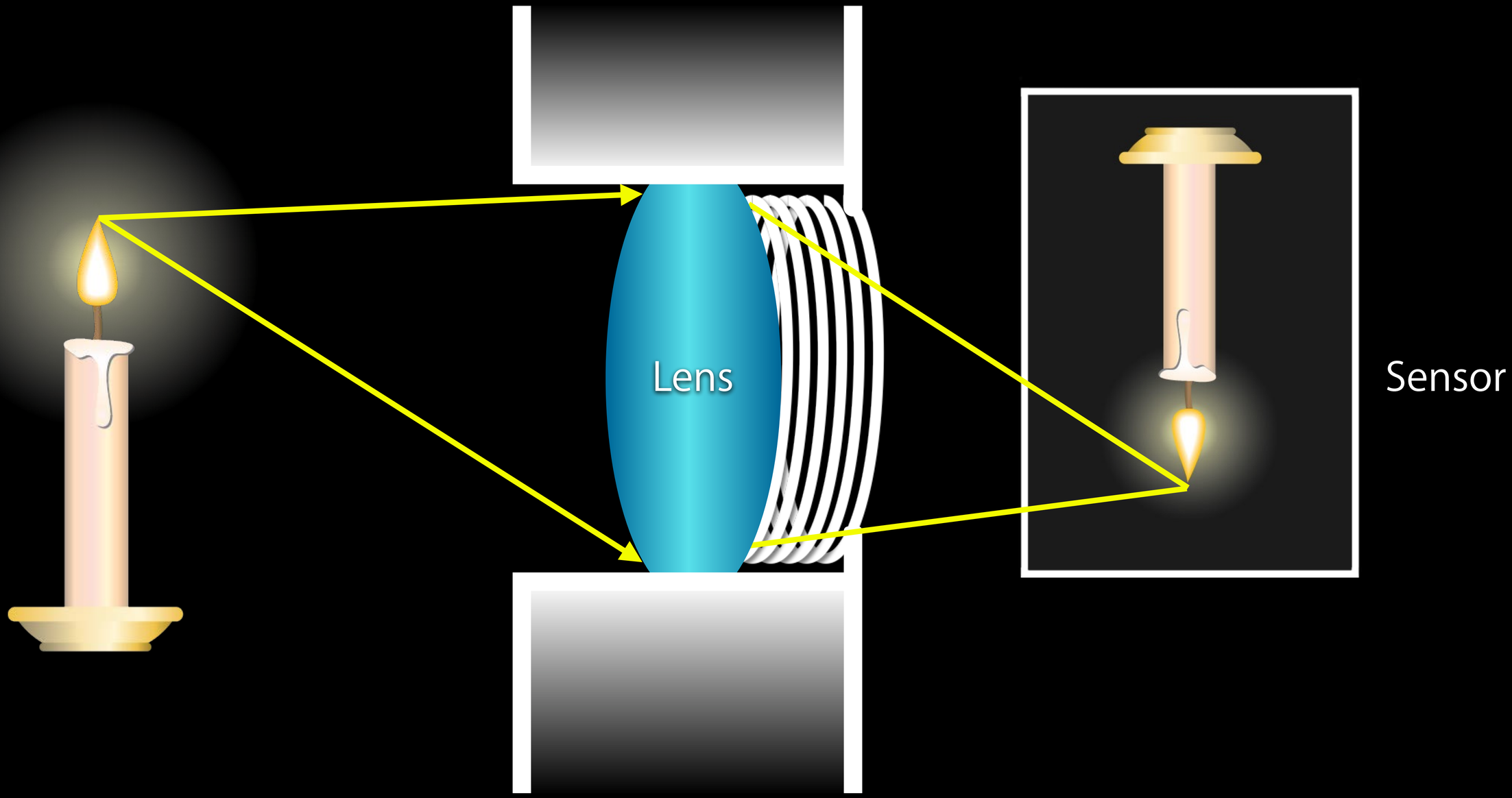


Manual Focus

Focus 101



Focus 101



Focus Terms

Focus Terms

Depth of field

Focus Terms

Depth of field

Macro

Focus Terms

Depth of field

Macro

Infinity

Focus Terms

Depth of field

Macro

Infinity

Hyperfocal distance

Focus Terms

Depth of field

Macro

Infinity

Hyperfocal distance

Lens position

What Can You Do Already?

AVCaptureDevice Focus APIs

```
@property AVCaptureFocusMode focusMode;
```

AVCaptureDevice Focus APIs

```
@property AVCaptureFocusMode focusMode;
    AVCaptureFocusModeLocked
```

AVCaptureDevice Focus APIs

```
@property AVCaptureFocusMode focusMode;
    AVCaptureFocusModeLocked
    AVCaptureFocusModeAutoFocus
```

AVCaptureDevice Focus APIs

```
@property AVCaptureFocusMode focusMode;
    AVCaptureFocusModeLocked
    AVCaptureFocusModeAutoFocus
    AVCaptureFocusModeContinuousAutoFocus
```

AVCaptureDevice Focus APIs

```
@property AVCaptureFocusMode focusMode;
    AVCaptureFocusModeLocked
    AVCaptureFocusModeAutoFocus
    AVCaptureFocusModeContinuousAutoFocus
@property CGPoint focusPointOfInterest;
```

AVCaptureDevice Focus APIs

```
@property AVCaptureFocusMode focusMode;
    AVCaptureFocusModeLocked
    AVCaptureFocusModeAutoFocus
    AVCaptureFocusModeContinuousAutoFocus
@property CGPoint focusPointOfInterest;
@property(readonly) BOOL adjustingFocus;
```

AVCaptureDevice Focus APIs

```
@property AVCaptureAutoFocusRangeRestriction autoFocusRangeRestriction;
```

AVCaptureDevice Focus APIs

```
@property AVCaptureAutoFocusRangeRestriction autoFocusRangeRestriction;
    AVCaptureAutoFocusRangeRestrictionNear
```

AVCaptureDevice Focus APIs

```
@property AVCaptureAutoFocusRangeRestriction autoFocusRangeRestriction;
    AVCaptureAutoFocusRangeRestrictionNear
    AVCaptureAutoFocusRangeRestrictionFar
```

AVCaptureDevice Focus APIs

```
@property AVCaptureAutoFocusRangeRestriction autoFocusRangeRestriction;
    AVCaptureAutoFocusRangeRestrictionNear
    AVCaptureAutoFocusRangeRestrictionFar
@property BOOL smoothAutoFocusEnabled;
```

AVCaptureDevice Focus APIs

AVCaptureDevice Focus APIs

Manual control of the lens position when locking focus

AVCaptureDevice Focus APIs

Manual control of the lens position when locking focus

Key-value observation of the lens position in any focus mode

Demo

Manual Focus in AVCam

Aparna Bhatnagar
Camera Software

Manual Focus


```
@property(readonly) float lensPosition;
```

Manual Focus


```
@property(readonly) float lensPosition;
```

Read or key-value observe

Manual Focus


```
@property(readonly) float lensPosition;
```

Read or key-value observe

Scalar values from 0.0 to 1.0

Manual Focus


```
@property(readonly) float lensPosition;
```

Read or key-value observe

Scalar values from 0.0 to 1.0

Smaller values approach macro

Manual Focus

NEW

```
@property(readonly) float lensPosition;
```

Read or key-value observe

Scalar values from 0.0 to 1.0

Smaller values approach macro

Larger values approach infinity

Manual Focus


```
- (void)setFocusModeLockedWithLensPosition:(float)lensPosition
                         completionHandler:(void (^)(CMTime syncTime))handler;
```

Manual Focus


```
- (void)setFocusModeLockedWithLensPosition:(float)lensPosition
                         completionHandler:(void (^)(CMTime syncTime))handler;
```

Locks focus at an explicit lens position

Manual Focus


```
- (void)setFocusModeLockedWithLensPosition:(float)lensPosition
                         completionHandler:(void (^)(CMTime syncTime))handler;
```

Locks focus at an explicit lens position

Calls you back when the command has completed

Manual Focus


```
- (void)setFocusModeLockedWithLensPosition:(float)lensPosition
                         completionHandler:(void (^)(CMTime syncTime))handler;
```

Locks focus at an explicit lens position

Calls you back when the command has completed

syncTime == PTS of the first video frame to which your change was applied

Manual Focus


```
- (void)setFocusModeLockedWithLensPosition:(float)lensPosition
                         completionHandler:(void (^)(CMTime syncTime))handler;
```

Locks focus at an explicit lens position

Calls you back when the command has completed

syncTime == PTS of the first video frame to which your change was applied

syncTime is on the AVCaptureDevice clock's timeline

Manual Focus

AVCaptureVideoDataOutput buffers are synced to the session's master clock

Manual Focus

AVCaptureVideoDataOutput buffers are synced to the session's master clock

Manual Focus

NEW

AVCaptureVideoDataOutput buffers are synced to the session's master clock

```
[device setFocusModeLockedWithLensPosition:lensPosition
                         completionHandler:^(CMTime syncTime {
    // Convert to master clock time
    CMClock masterClock = session.masterClock;
    CMTime convertedTime = CMSyncConvertTime( syncTime,
                                              _deviceClock,
                                              masterClock );
}];
```

Manual Focus

Special lensPosition parameter `AVCaptureLensPositionCurrent`

Manual Focus

Special lensPosition parameter `AVCaptureLensPositionCurrent`

Locks the focus mode at the current position, avoiding race conditions

Manual Focus

Special lensPosition parameter `AVCaptureLensPositionCurrent`

Locks the focus mode at the current position, avoiding race conditions

The following are equivalent—

Manual Focus

NEW

Special lensPosition parameter `AVCaptureLensPositionCurrent`

Locks the focus mode at the current position, avoiding race conditions

The following are equivalent—

```
[device setFocusModeLockedWithLensPosition:AVCaptureLensPositionCurrent
                         completionHandler:nil];

device.focusMode = AVCaptureFocusModeLocked;
```

Manual Focus

Why unit-less lensPosition values?

Manual Focus

Why unit-less lensPosition values?

Lens is moved with a spring and magnet

Manual Focus

Why unit-less lensPosition values?

Lens is moved with a spring and magnet

Hysteresis prevents precise, repeatable positioning

Manual Focus

Why unit-less lensPosition values?

Lens is moved with a spring and magnet

Hysteresis prevents precise, repeatable positioning

Gravity affects spring stretch as well

Manual Focus

Why unit-less lensPosition values?

Lens is moved with a spring and magnet

Hysteresis prevents precise, repeatable positioning

Gravity affects spring stretch as well

Lens position distance varies by device

Manual Focus

Help users achieve sharp focus

Manual Focus

Help users achieve sharp focus

AVCaptureVideoPreviewLayer is screen resolution

Manual Focus

Help users achieve sharp focus

AVCaptureVideoPreviewLayer is screen resolution

Possible techniques—

Manual Focus

Help users achieve sharp focus

AVCaptureVideoPreviewLayer is screen resolution

Possible techniques—

- AVCaptureDevice zoom

Manual Focus

Help users achieve sharp focus

AVCaptureVideoPreviewLayer is screen resolution

Possible techniques—

- AVCaptureDevice zoom
- Compute your own focus score using AVCaptureVideoDataOutput buffers

Manual Focus

Help users achieve sharp focus

AVCaptureVideoPreviewLayer is screen resolution

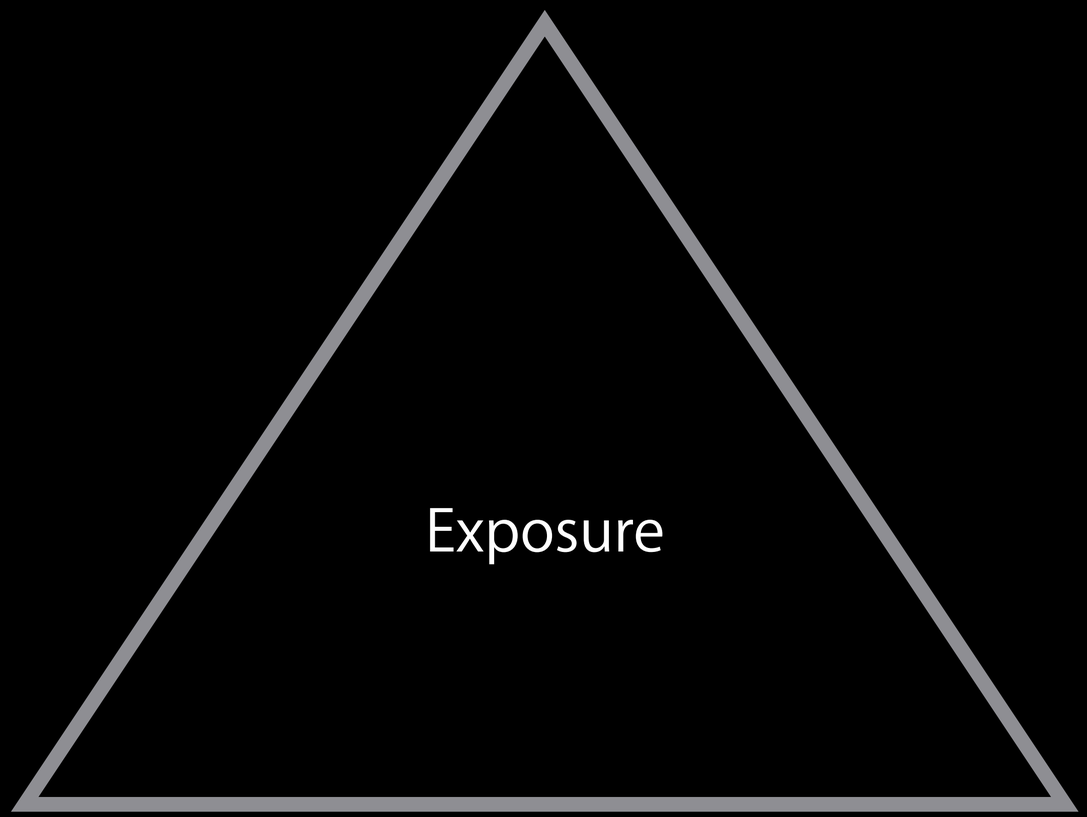
Possible techniques—

- AVCaptureDevice zoom
- Compute your own focus score using AVCaptureVideoDataOutput buffers
- Highlight sharp areas (focus peaking)

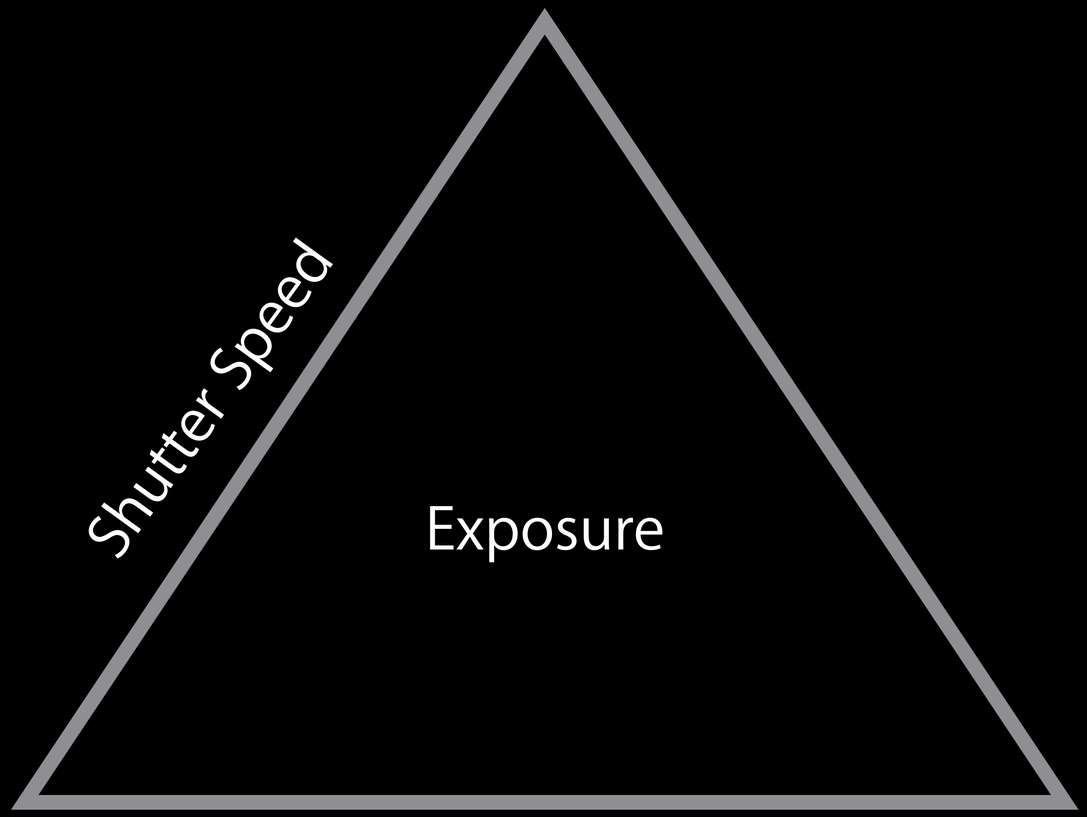
Manual Exposure

Exposure 101

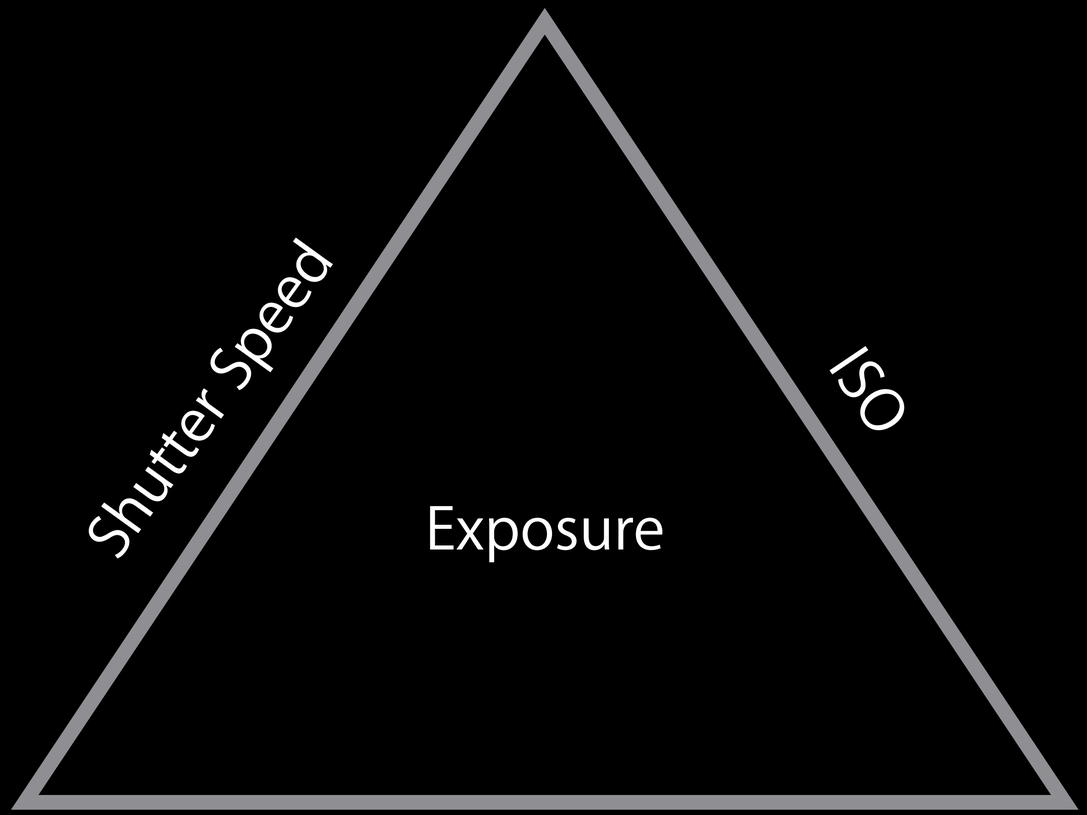
Exposure 101



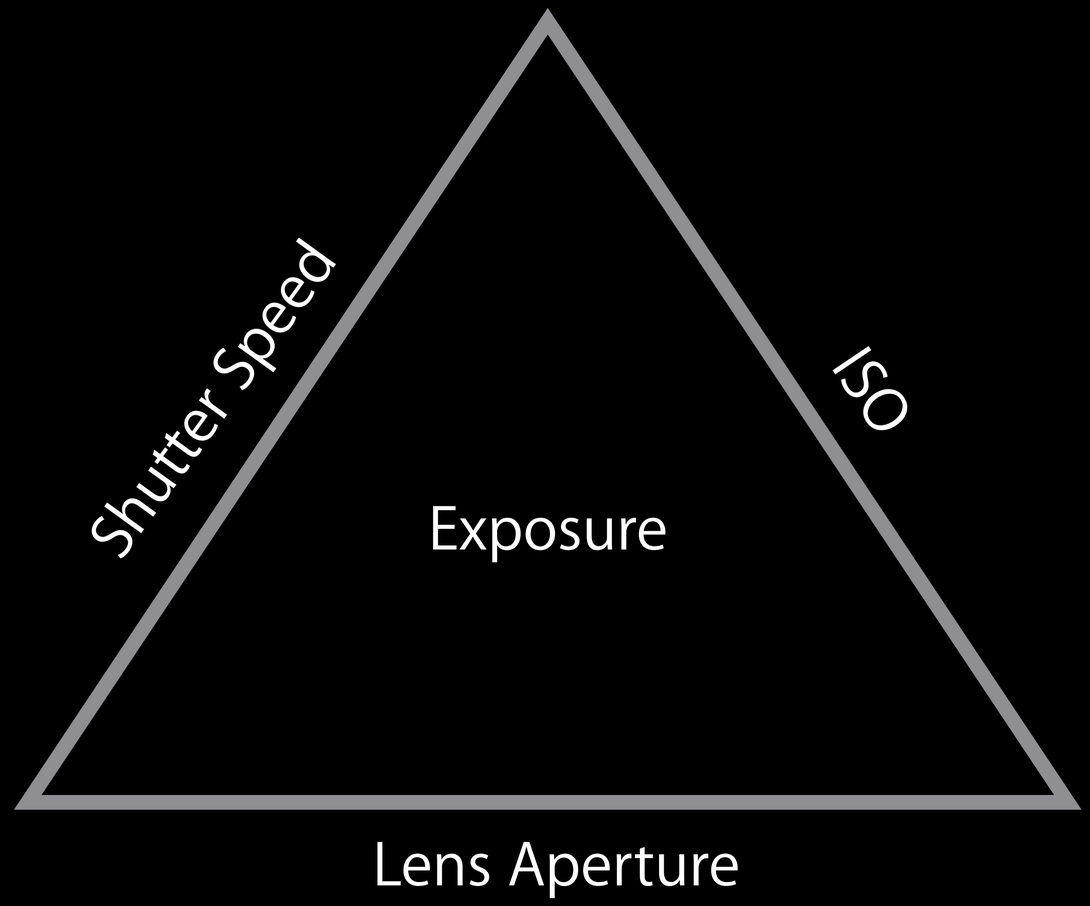
Exposure 101



Exposure 101



Exposure 101



Shutter Speed (Exposure Duration)

Short
Less Light
Less Motion Blur

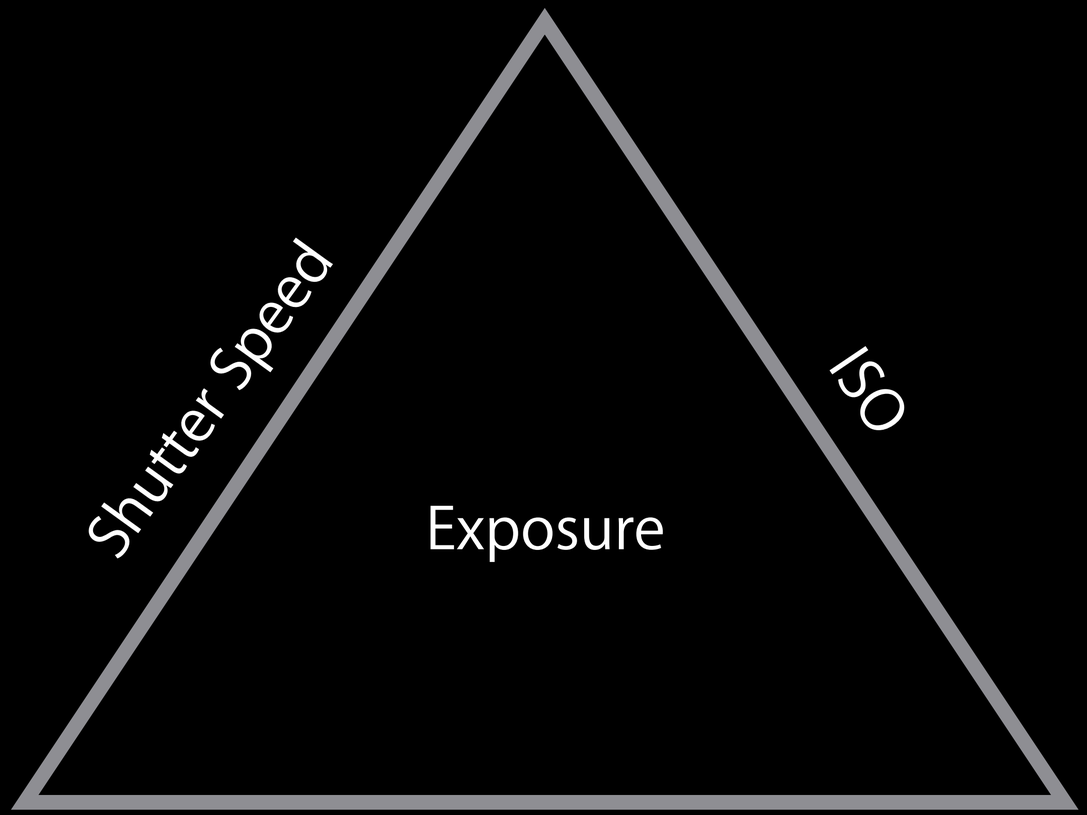
Long
More Light
More Motion Blur

ISO

Low ISO
Darker
Less Noise

High ISO
Brighter
More Noise

Exposure 101



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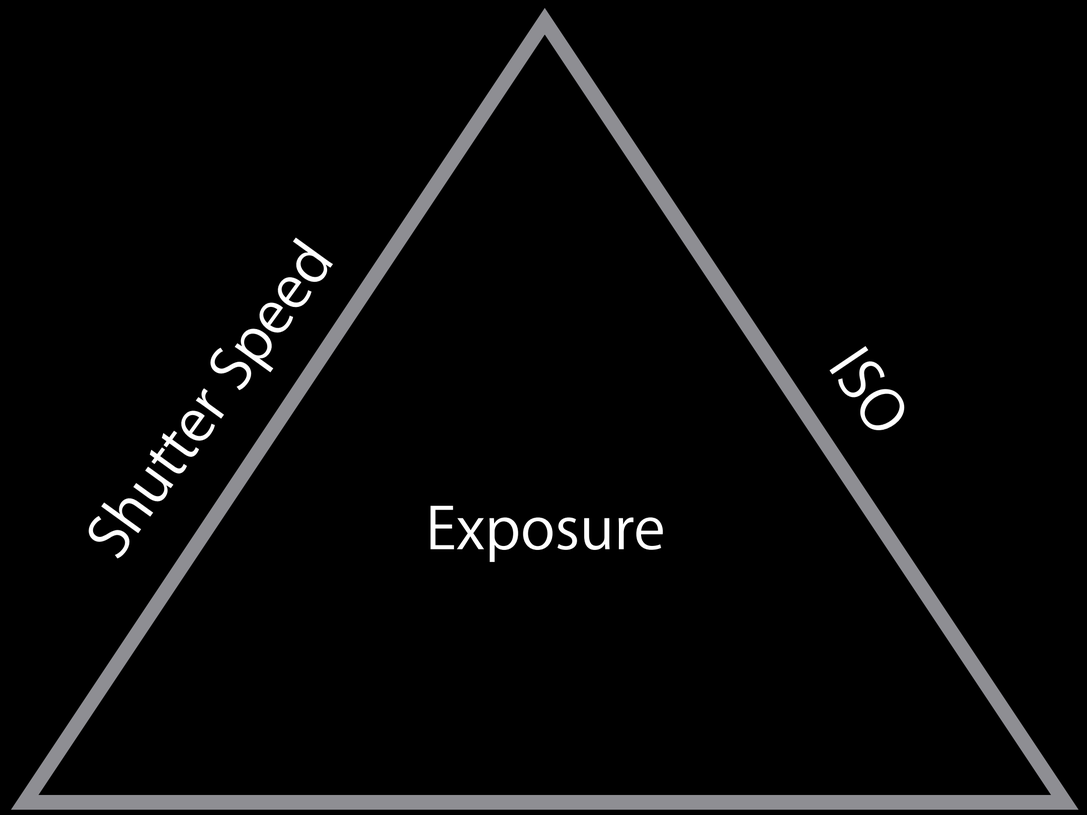


AVCaptureDevice Exposure APIs

```
@property AVCaptureExposureMode exposureMode;
```

AVCaptureDevice Exposure APIs

```
@property AVCaptureExposureMode exposureMode;
    AVCaptureExposureModeLocked
```

AVCaptureDevice Exposure APIs

```
@property AVCaptureExposureMode exposureMode;
    AVCaptureExposureModeLocked
    AVCaptureExposureModeContinuousAutoExposure
```

AVCaptureDevice Exposure APIs

```
@property AVCaptureExposureMode exposureMode;
    AVCaptureExposureModeLocked
    AVCaptureExposureModeContinuousAutoExposure
@property CGPoint exposurePointOfInterest;
```

AVCaptureDevice Exposure APIs

```
@property AVCaptureExposureMode exposureMode;
    AVCaptureExposureModeLocked
    AVCaptureExposureModeContinuousAutoExposure
@property CGPoint exposurePointOfInterest;
@property(readonly) BOOL adjustingExposure;
```

AVCaptureDevice Exposure APIs

AVCaptureDevice Exposure APIs

Fully manual (custom) exposure

AVCaptureDevice Exposure APIs

Fully manual (custom) exposure

Set, get, and key-value observe ISO and duration (shutter speed)

Demo

Manual Exposure in AVCam

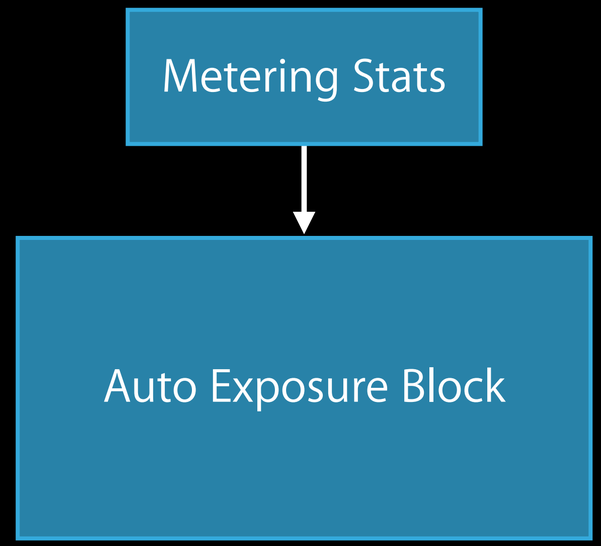
Matthew Calhoun
Camera Software

How Continuous Auto Exposure Works

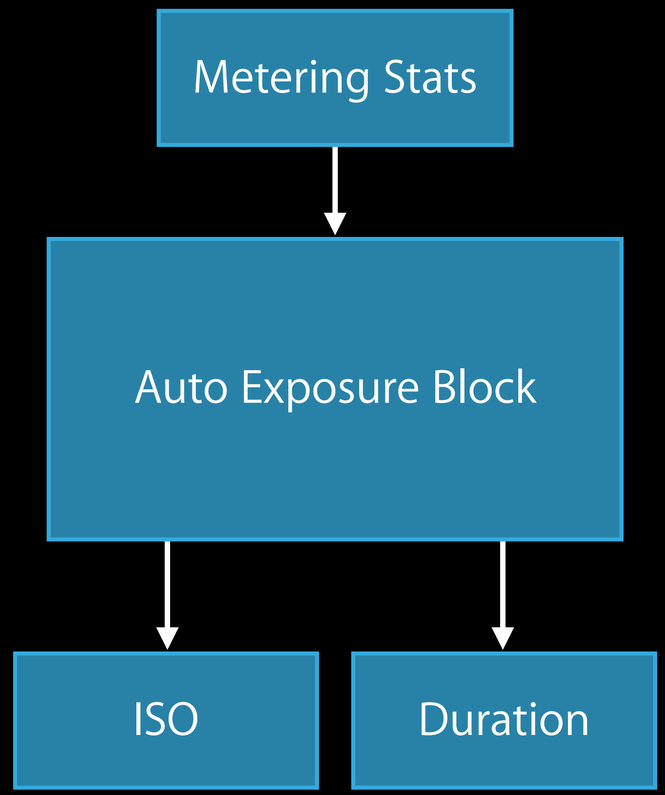
How Continuous Auto Exposure Works

Auto Exposure Block

How Continuous Auto Exposure Works



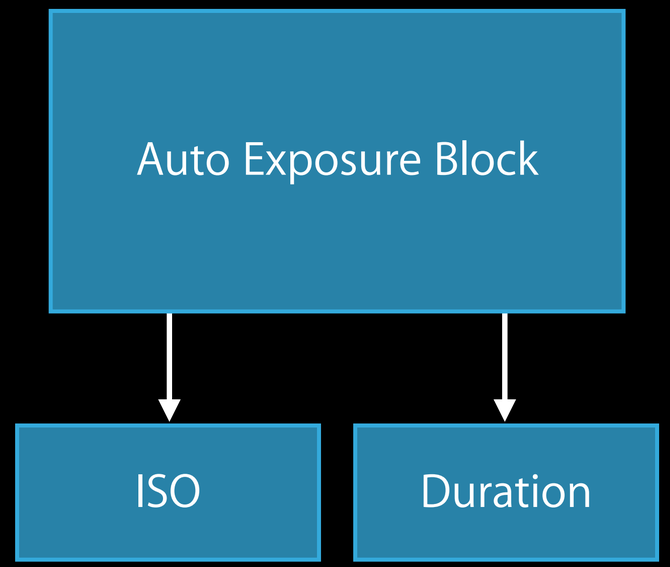
How Continuous Auto Exposure Works



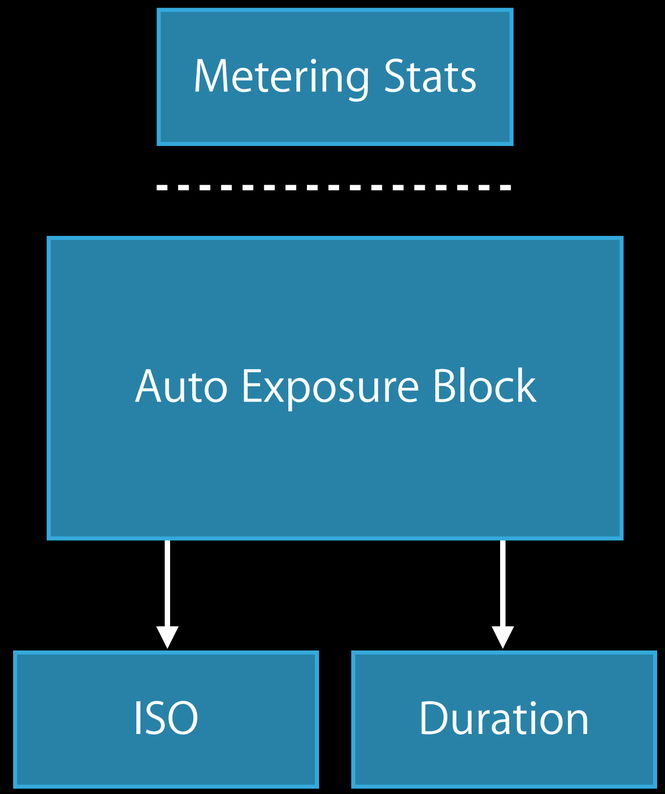
How Locked Exposure Works

Auto Exposure Block

How Locked Exposure Works



How Locked Exposure Works



Custom Exposure

New exposure mode `AVCaptureExposureModeCustom`

Custom Exposure

New exposure mode `AVCaptureExposureModeCustom`

```
- (void)setExposureModeCustomWithDuration:(CMTime)duration
                                      ISO:(float)ISO
                        completionHandler:(void (^)(CMTime syncTime))handler;
```

Custom Exposure

New exposure mode `AVCaptureExposureModeCustom`

```
- (void)setExposureModeCustomWithDuration:(CMTime)duration
                                      ISO:(float)ISO
                        completionHandler:(void (^)(CMTime syncTime))handler;
```

Special parameters—

Custom Exposure

New exposure mode `AVCaptureExposureModeCustom`

```
- (void)setExposureModeCustomWithDuration:(CMTime)duration
                                      ISO:(float)ISO
                        completionHandler:(void (^)(CMTime syncTime))handler;
```

Special parameters—

```
const CMTime AVCaptureExposureDurationCurrent;
```

Custom Exposure

New exposure mode `AVCaptureExposureModeCustom`

```
- (void)setExposureModeCustomWithDuration:(CMTime)duration
                                      ISO:(float)ISO
                        completionHandler:(void (^)(CMTime syncTime))handler;
```

Special parameters—

```
const CMTime AVCaptureExposureDurationCurrent;
const float AVCaptureISOCurrent;
```

Custom Exposure

AVCaptureDeviceFormat supported ranges—

Custom Exposure

AVCaptureDeviceFormat supported ranges—

```
@property(readonly) float minISO;
@property(readonly) float maxISO;
```

Custom Exposure

AVCaptureDeviceFormat supported ranges—

```
@property(readonly) float minISO;
@property(readonly) float maxISO;
@property(readonly) CMTime minExposureDuration;
@property(readonly) CMTime maxExposureDuration;
```

Custom Exposure

NEW

AVCaptureDeviceFormat supported ranges—

```
@property(readonly) float minISO;
@property(readonly) float maxISO;
@property(readonly) CMTime minExposureDuration;
@property(readonly) CMTime maxExposureDuration;
```

AVCaptureDevice observable properties—

Custom Exposure

AVCaptureDeviceFormat supported ranges—

```
@property(readonly) float minISO;
@property(readonly) float maxISO;
@property(readonly) CMTime minExposureDuration;
@property(readonly) CMTime maxExposureDuration;
```

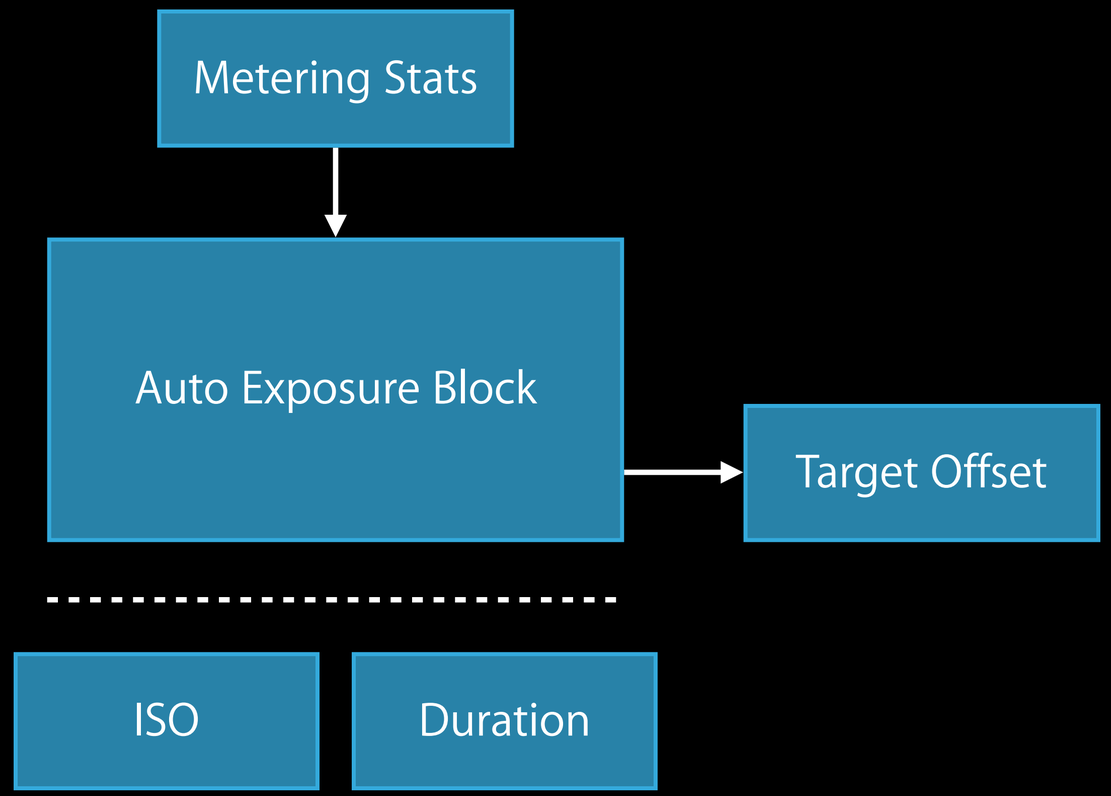
AVCaptureDevice observable properties—

```
@property(readonly) float ISO;
@property(readonly) CMTime exposureDuration;
@property(readonly) float lensAperture;
```

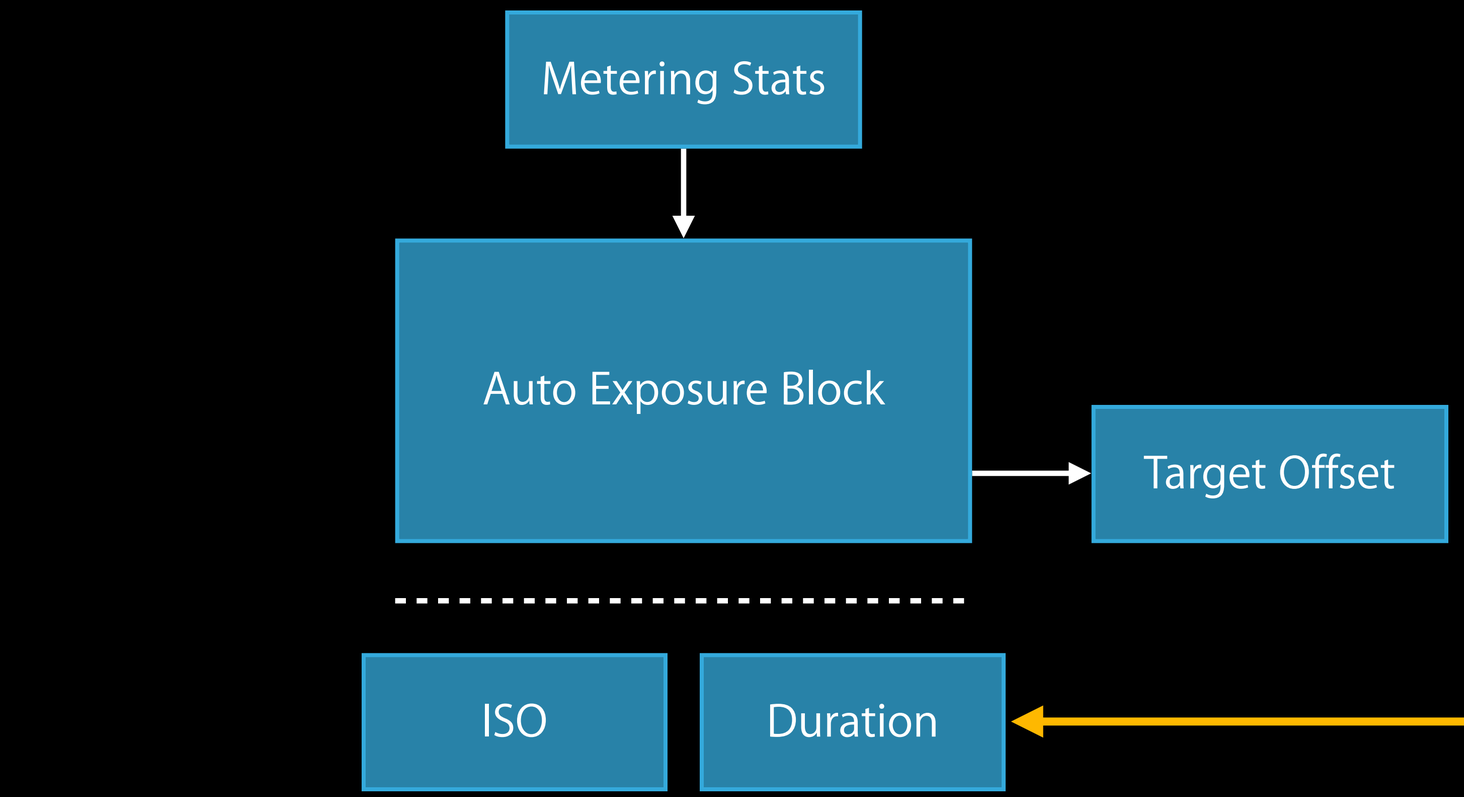
How Custom Exposure Mode Works

Auto Exposure Block

How Custom Exposure Mode Works



How Custom Exposure Mode Works




```
[device setExposureModeCustomWithDuration:duration
                                      ISO:iso
                        completionHandler:nil];
```

Exposure Compensation

Exposure Compensation

NEW

Exposure Compensation

NEW

Target bias adjustment

Exposure Compensation

Target bias adjustment

- Continuous AE

Exposure Compensation

Target bias adjustment

- Continuous AE
- Locked exposure

Exposure Compensation

Target bias adjustment

- Continuous AE
- Locked exposure

Expressed in f-stops (exposure values)

Exposure Compensation

Target bias adjustment

- Continuous AE
- Locked exposure

Expressed in f-stops (exposure values)

- +1 f-stop == double the brightness

Exposure Compensation

NEW

Target bias adjustment

- Continuous AE
- Locked exposure

Expressed in f-stops (exposure values)

- +1 f-stop == double the brightness
- -1 f-stop == half the brightness

Demo

Exposure Compensation in AVCam

Matthew Calhoun
Camera Software

Exposure Compensation

Supported in all exposure modes

```
- (void)setExposureTargetBias:(float)bias
            completionHandler:(void (^)(CMTime syncTime))handler;
```

Exposure Compensation

Supported range

```
@property(readonly) float minExposureTargetBias;
@property(readonly) float maxExposureTargetBias;
```

Exposure Compensation

Supported range

```
@property(readonly) float minExposureTargetBias;
@property(readonly) float maxExposureTargetBias;
```

Key-value observable getters

Exposure Compensation

Supported range

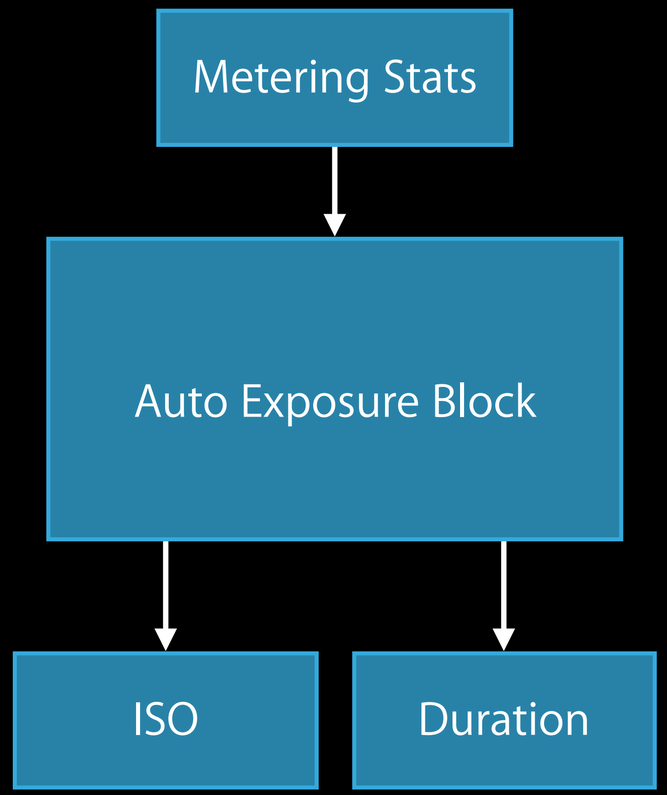
```
@property(readonly) float minExposureTargetBias;
@property(readonly) float maxExposureTargetBias;
```

Key-value observable getters

```
@property(readonly) float exposureTargetBias;
@property(readonly) float exposureTargetOffset;
```

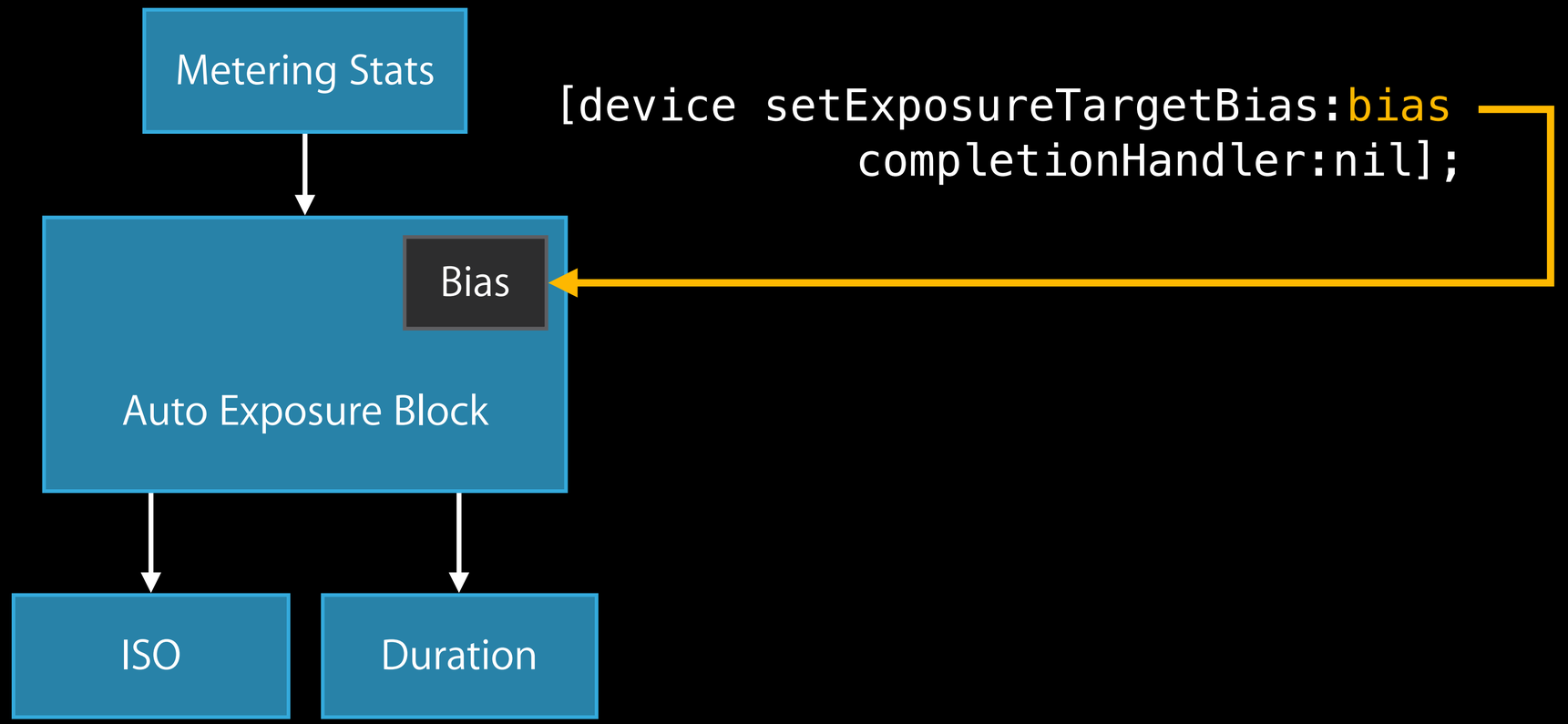
How Exposure Compensation Works

Continuous Auto Exposure



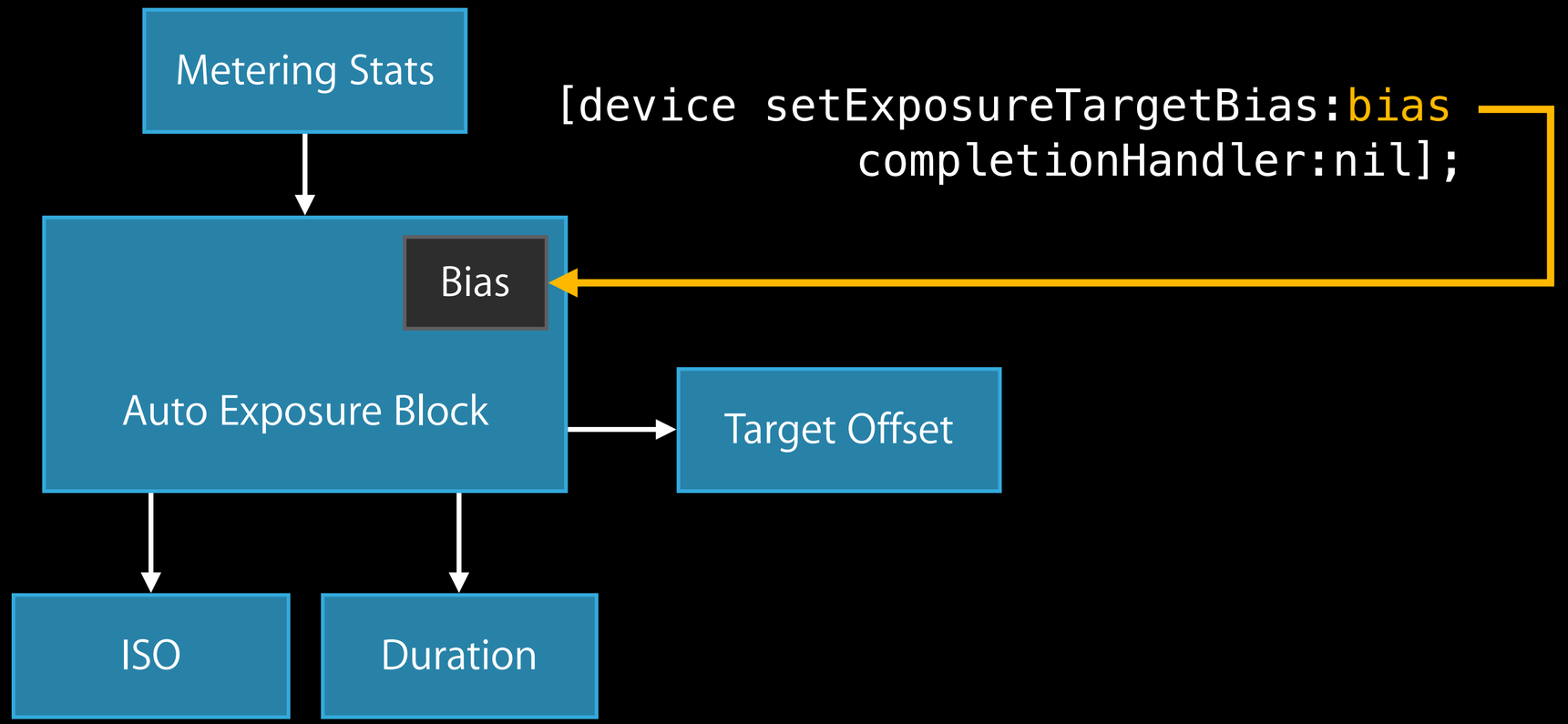
How Exposure Compensation Works

Continuous Auto Exposure



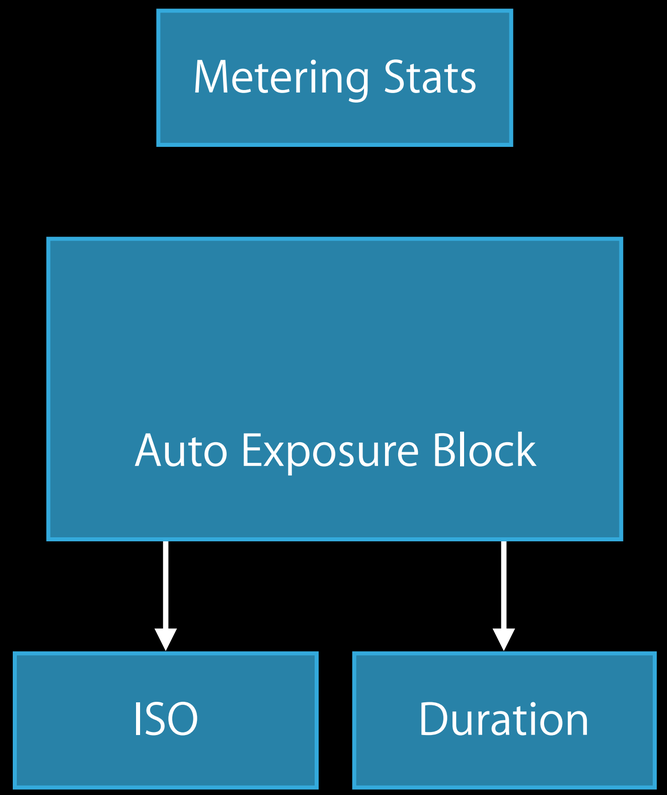
How Exposure Compensation Works

Continuous Auto Exposure



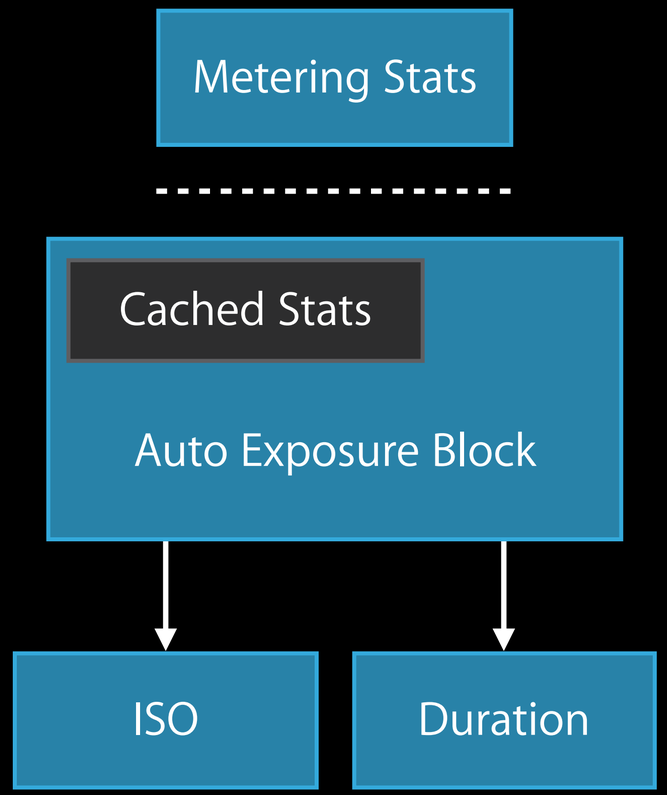
How Exposure Compensation Works

Locked Exposure Mode



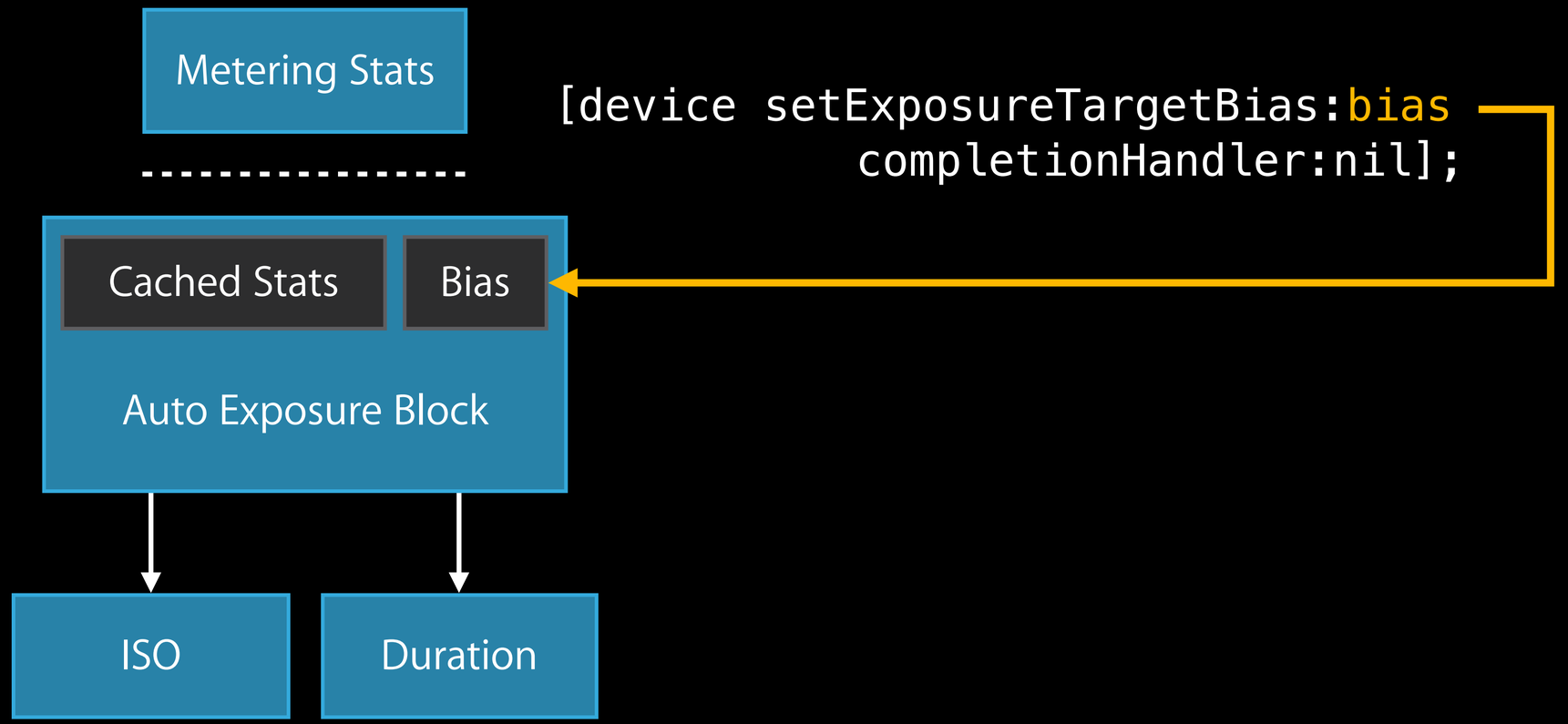
How Exposure Compensation Works

Locked Exposure Mode



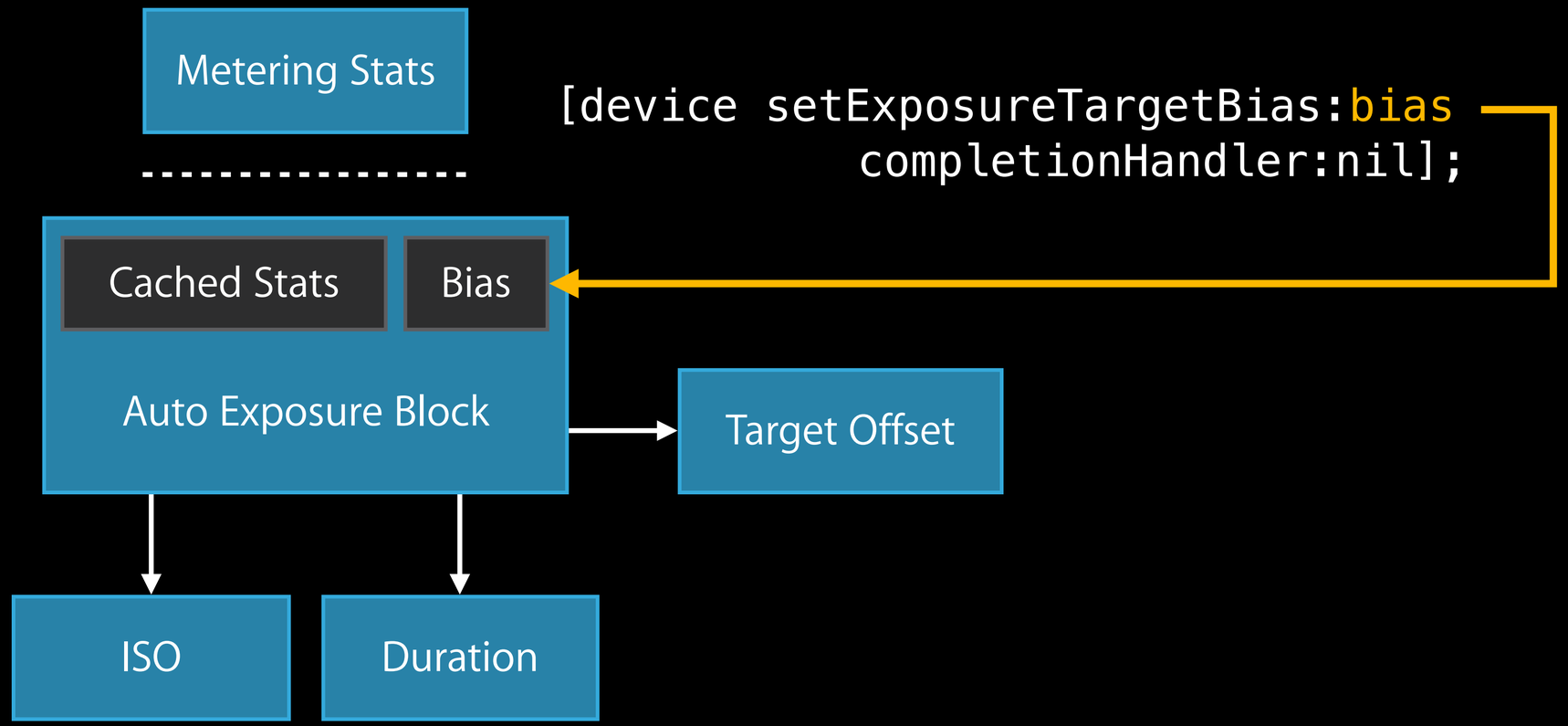
How Exposure Compensation Works

Locked Exposure Mode



How Exposure Compensation Works

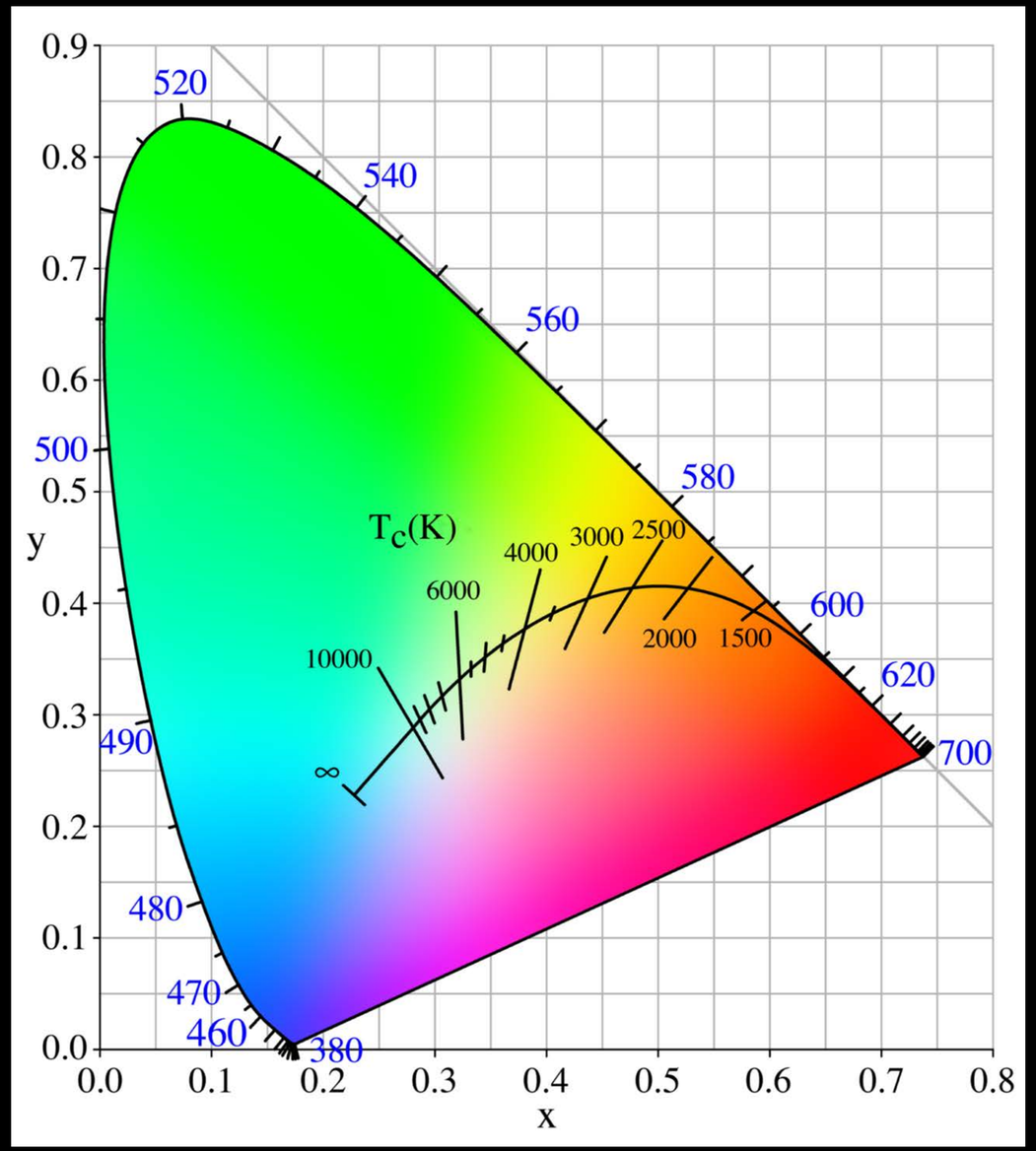
Locked Exposure Mode



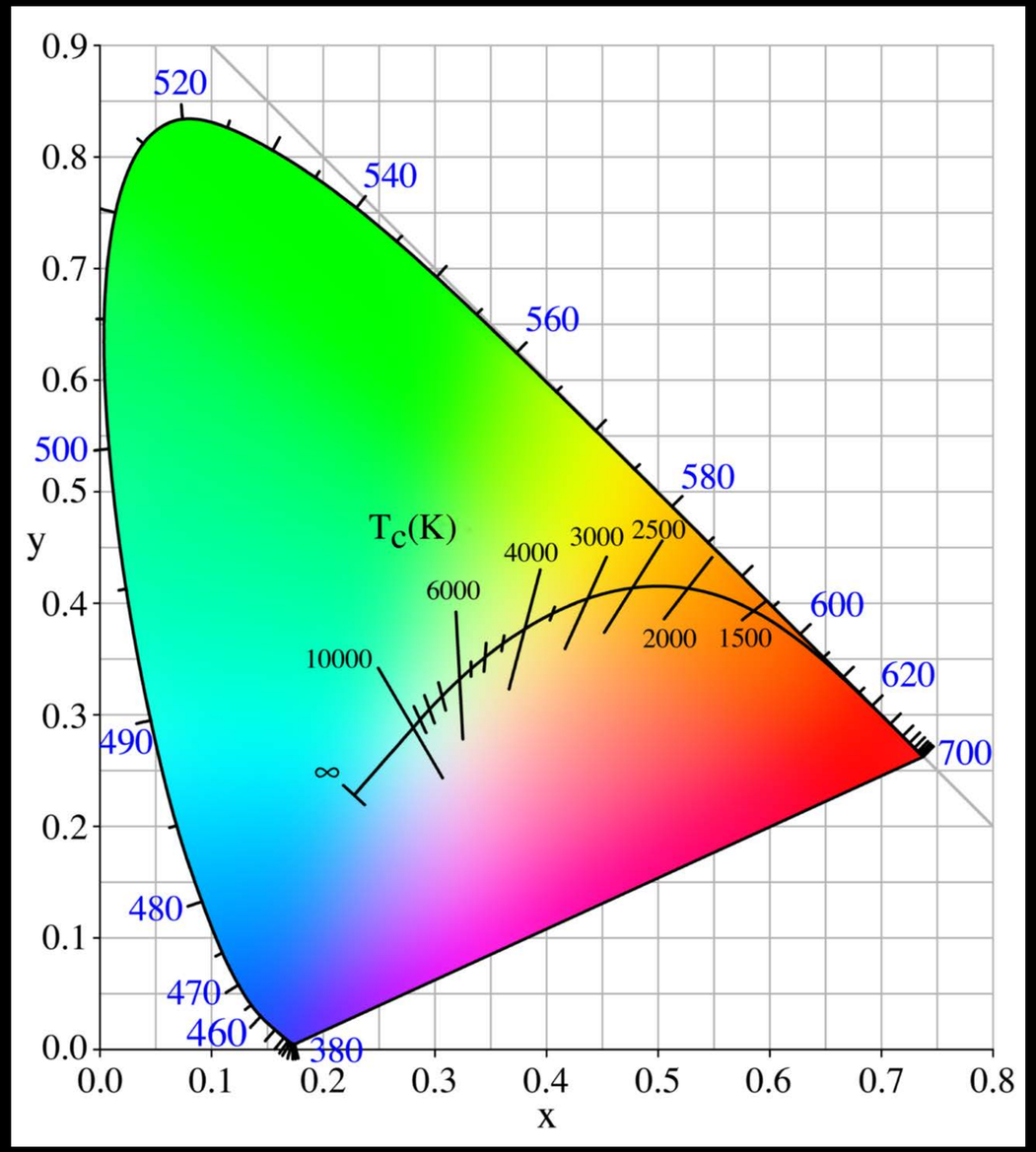

SLO-MO
VIDEO
PHOTO
SQUARE
PANO
HDR
Auto
Auto

Manual White Balance

Cooler ⟷ Warmer

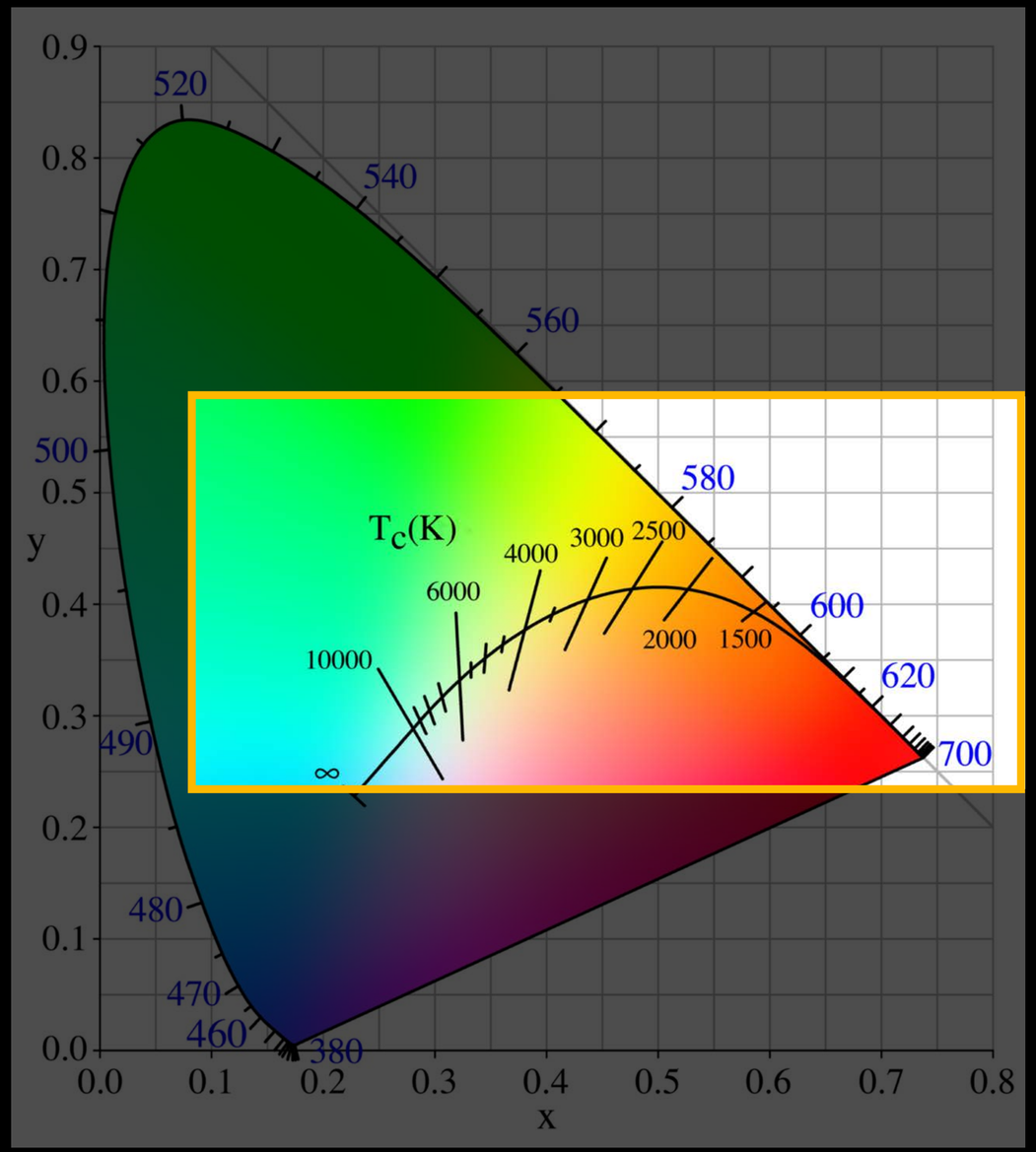

0.9
0.8
0.7
0.6
500
0.5
y
0.4
0.3
490
0.2
480
0.1
470
460
0.0
520
540
560
580
600
620
700
380
T_C(K)
6000
4000
3000
2500
2000
1500
10000
∞
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
x

y [0, 1]


0.9
0.8
0.7
0.6
500
0.5
y
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
x
520
540
560
580
600
620
700
490
480
470
460
380
T_C(K)
6000
4000
3000
2500
2000
1500
10000
∞

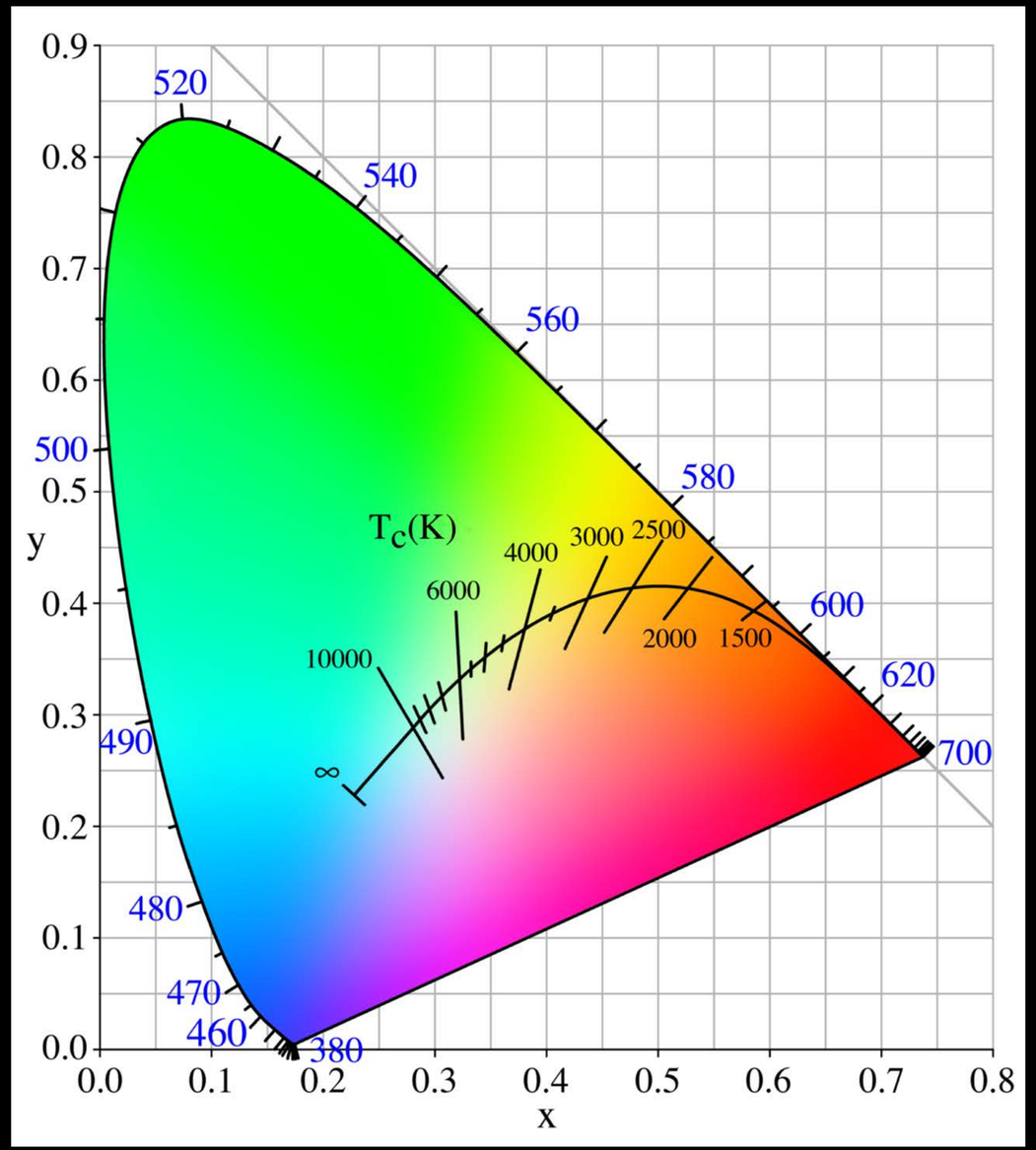
x [0, 1]

y [0, 1]


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
y
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
x
520
540
560
580
600
620
700
500
490
480
470
460
380
T_C(K)
10000
6000
4000
3000
2500
2000
1500
∞

x [0, 1]

Auto Sun Cloudy Flash Shadow Incandescent Fluorescent


0.9
0.8
0.7
0.6
500
0.5
y
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
x
520
540
560
580
600
620
700
490
480
470
460
380
T_C(K)
10000
6000
4000
3000
2500
2000
1500
∞

AVCaptureDevice White Balance APIs

```
@property AVCaptureWhiteBalanceMode whiteBalanceMode;
```

AVCaptureDevice White Balance APIs

```
@property AVCaptureWhiteBalanceMode whiteBalanceMode;
    AVCaptureWhiteBalanceModeLocked
```

AVCaptureDevice White Balance APIs

```
@property AVCaptureWhiteBalanceMode whiteBalanceMode;
    AVCaptureWhiteBalanceModeLocked
    AVCaptureWhiteBalanceModeContinuousAutoWhiteBalance
```

AVCaptureDevice White Balance APIs

```
@property AVCaptureWhiteBalanceMode whiteBalanceMode;
    AVCaptureWhiteBalanceModeLocked
    AVCaptureWhiteBalanceModeContinuousAutoWhiteBalance
@property(readonly) BOOL adjustingWhiteBalance;
```

AVCaptureDevice White Balance APIs

Manual control of the device RGB gains

AVCaptureDevice White Balance APIs

Manual control of the device RGB gains

Key-value observation of device RGB gains

AVCaptureDevice White Balance APIs

Manual control of the device RGB gains

Key-value observation of device RGB gains

Support for white balance using a gray card

AVCaptureDevice White Balance APIs

Manual control of the device RGB gains

Key-value observation of device RGB gains

Support for white balance using a gray card

Conversion routines to and from device independent color spaces

AVCaptureDevice White Balance APIs

Manual control of the device RGB gains

Key-value observation of device RGB gains

Support for white balance using a gray card

Conversion routines to and from device independent color spaces

- Device RGB gains ⇄ x, y chromaticity values

AVCaptureDevice White Balance APIs

Manual control of the device RGB gains

Key-value observation of device RGB gains

Support for white balance using a gray card

Conversion routines to and from device independent color spaces

- Device RGB gains ⇄ x, y chromaticity values
- Device RGB gains ⇄ temperature and tint values

Demo

Manual White Balance in AVCam

Matthew Calhoun and Aparna Bhatnagar

Manual White Balance

NEW

Manual White Balance


```
typedef struct {
    float redGain;
    float greenGain;
    float blueGain;
} AVCaptureWhiteBalanceGains;
```

Manual White Balance

NEW

```
typedef struct {
    float redGain;
    float greenGain;
    float blueGain;
} AVCaptureWhiteBalanceGains;

@property(readonly) float maxWhiteBalanceGain;
```

Manual White Balance


```
typedef struct {
    float redGain;
    float greenGain;
    float blueGain;
} AVCaptureWhiteBalanceGains;
```

```
@property(readonly) float maxWhiteBalanceGain;
```

Legal range is [1, `maxWhiteBalanceGain`]

Manual White Balance

NEW

```
typedef struct {
    float redGain;
    float greenGain;
    float blueGain;
} AVCaptureWhiteBalanceGains;
```

```
@property(readonly) float maxWhiteBalanceGain;
```

Legal range is [1, maxWhiteBalanceGain]

```
@property(readonly) AVCaptureWhiteBalanceGains deviceWhiteBalanceGains;
```

Manual White Balance

NEW

Manual White Balance


```
- (void)setWhiteBalanceModeLockedWithDeviceWhiteBalanceGains:
                        (AVCaptureWhiteBalanceGains)whiteBalanceGains
                         completionHandler:(void (^)(CMTime syncTime))handler;
```

Special gains value `AVCaptureWhiteBalanceGainsCurrent`

Manual White Balance

Conversion routines

NEW

Manual White Balance

Conversion routines


```
typedef struct {
    float x;
    float y;
} AVCaptureWhiteBalanceChromaticityValues;
```

Manual White Balance

Conversion routines

NEW

```
typedef struct {
    float x;
    float y;
} AVCaptureWhiteBalanceChromaticityValues;
```

```
typedef struct {
    float temperature;
    float tint;
} AVCaptureWhiteBalanceTemperatureAndTintValues;
```

Manual White Balance

Conversion routines so long they need three lines

Manual White Balance

Conversion routines so long they need three lines


```
- (AVCaptureWhiteBalanceChromaticityValues)
        chromaticityValuesForDeviceWhiteBalanceGains:
                              (AVCaptureWhiteBalanceGains)whiteBalanceGains;
```

Manual White Balance

Conversion routines so long they need three lines

NEW

```
- (AVCaptureWhiteBalanceChromaticityValues)
        chromaticityValuesForDeviceWhiteBalanceGains:
                            (AVCaptureWhiteBalanceGains)whiteBalanceGains;

- (AVCaptureWhiteBalanceGains)
    deviceWhiteBalanceGainsForChromaticityValues:
          (AVCaptureWhiteBalanceChromaticityValues)chromaticityValues;
```

Manual White Balance

Conversion routines so long they need three lines

NEW

```
- (AVCaptureWhiteBalanceChromaticityValues)
        chromaticityValuesForDeviceWhiteBalanceGains:
                            (AVCaptureWhiteBalanceGains)whiteBalanceGains;

- (AVCaptureWhiteBalanceGains)
        deviceWhiteBalanceGainsForChromaticityValues:
                (AVCaptureWhiteBalanceChromaticityValues)chromaticityValues;

- (AVCaptureWhiteBalanceTemperatureAndTintValues)
        temperatureAndTintValuesForDeviceWhiteBalanceGains:
                            (AVCaptureWhiteBalanceGains)whiteBalanceGains;
```

Manual White Balance

Conversion routines so long they need three lines

NEW

```
- (AVCaptureWhiteBalanceChromaticityValues)
        chromaticityValuesForDeviceWhiteBalanceGains:
                            (AVCaptureWhiteBalanceGains)whiteBalanceGains;

- (AVCaptureWhiteBalanceGains)
        deviceWhiteBalanceGainsForChromaticityValues:
              (AVCaptureWhiteBalanceChromaticityValues)chromaticityValues;

- (AVCaptureWhiteBalanceTemperatureAndTintValues)
        temperatureAndTintValuesForDeviceWhiteBalanceGains:
                            (AVCaptureWhiteBalanceGains)whiteBalanceGains;

- (AVCaptureWhiteBalanceGains)
        deviceWhiteBalanceGainsForTemperatureAndTintValues:
          (AVCaptureWhiteBalanceTemperatureAndTintValues)tempAndTintValues;
```

Manual White Balance

Conversion routines

Manual White Balance

Conversion routines

Conversion methods faithfully convert to device RGB gains without clamping

Manual White Balance

Conversion routines

Conversion methods faithfully convert to device RGB gains without clamping

AVCaptureDevice throws an NSException if you provide out-of-range dRGB values to `-setWhiteBalanceModeLockedWithDeviceWhiteBalanceGains:completionHandler:`

Manual White Balance

Gray world

Manual White Balance

Gray world

NEW

Manual White Balance

Gray world

Auto White Balance is complicated and preferenced

Manual White Balance

Gray world

NEW

Auto White Balance is complicated and preferenced

Gray world == an alternate set of gains

Manual White Balance

Gray world

NEW

Auto White Balance is complicated and preferenced

Gray world == an alternate set of gains

- Makes white look white

Manual White Balance

Gray world

NEW

Auto White Balance is complicated and preferenced

Gray world == an alternate set of gains

- Makes white look white
- Assumes a neutral subject fills the center 50% of the frame

Manual White Balance

Gray world

Auto White Balance is complicated and preferenced

Gray world == an alternate set of gains

- Makes white look white
- Assumes a neutral subject fills the center 50% of the frame

```
@property(readonly) AVCaptureWhiteBalanceGains grayWorldDeviceWhiteBalanceGains;
```

Manual White Balance

Working with gray world gains

Manual White Balance

Working with gray world gains

Place gray card in front of the camera and wait for the white balance gains to settle

Manual White Balance

Working with gray world gains

Place gray card in front of the camera and wait for the white balance gains to settle

Sample the `grayWorldDeviceWhiteBalanceGains`

Manual White Balance

Working with gray world gains

Place gray card in front of the camera and wait for the white balance gains to settle

Sample the `grayWorldDeviceWhiteBalanceGains`

`-setWhiteBalanceModeLockedWithDeviceWhiteBalanceGains:completionHandler:`
with the sampled gray world gains

Manual Camera Controls

Where are they supported?

Manual Camera Controls

Where are they supported?

Manual Focus—All focus capable iOS cameras

Manual Camera Controls

Where are they supported?

Manual Focus—All focus capable iOS cameras

Manual Exposure—All iOS cameras

Manual Camera Controls

Where are they supported?

Manual Focus—All focus capable iOS cameras

Manual Exposure—All iOS cameras

Manual White Balance—All iOS cameras

Manual Camera Controls

Where are they supported?

Manual Focus—All focus capable iOS cameras

Manual Exposure—All iOS cameras

Manual White Balance—All iOS cameras

All AVCaptureSession presets and AVCaptureDevice formats

Appetizer

AVCaptureView on Yosemite
iOS Screen Recording
Barcode Update

Main Course

Manual Camera Controls
Focus / Exposure / White Balance

Dessert

Bracketed Capture

Appetizer

AVCaptureView on Yosemite
iOS Screen Recording
Barcode Update

Main Course

Manual Camera Controls

Focus / Exposure / White Balance

Dessert

Bracketed Capture

Bracketed Still Image Capture

A twist on manual controls

–2 · · –1 · · 0 · · +1 · · +2

–2 · · –1 · · 0 · · +1 · · +2

–2 · · –1 · · 0 · · +1 · · +2

Bracketed Capture 101

Bracketed Capture 101

A burst of still images taken with varied settings from picture to picture

Bracketed Capture 101

A burst of still images taken with varied settings from picture to picture

Exposure bracket

Bracketed Capture 101

A burst of still images taken with varied settings from picture to picture

Exposure bracket

- Auto—Exposure bias differs (e.g., -2, 0, +2)

Bracketed Capture 101

A burst of still images taken with varied settings from picture to picture

Exposure bracket

- Auto—Exposure bias differs (e.g., -2, 0, +2)
- Manual—Shutter speed and ISO differ

Bracketed Capture 101

A burst of still images taken with varied settings from picture to picture

Exposure bracket

- Auto—Exposure bias differs (e.g., -2, 0, +2)
- Manual—Shutter speed and ISO differ

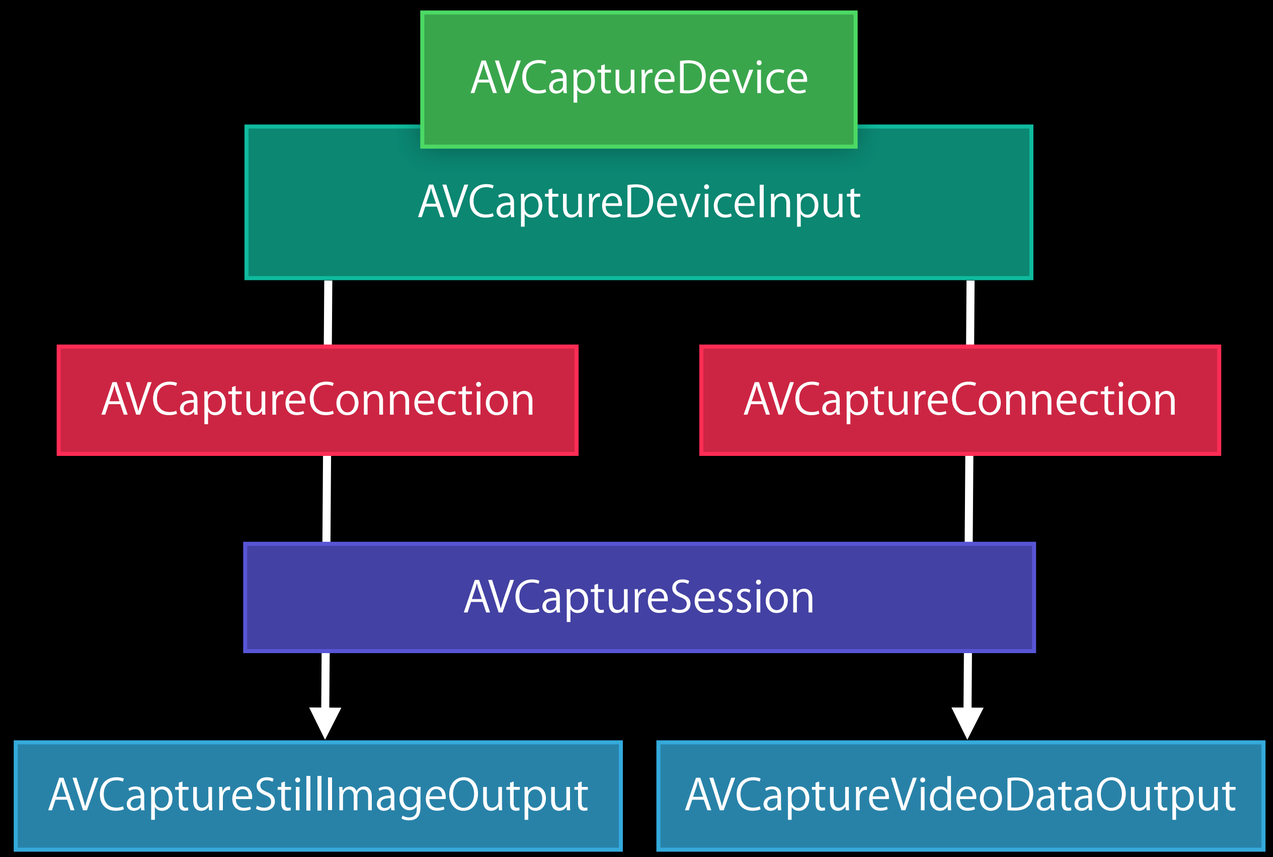
Simple burst bracket

Demo

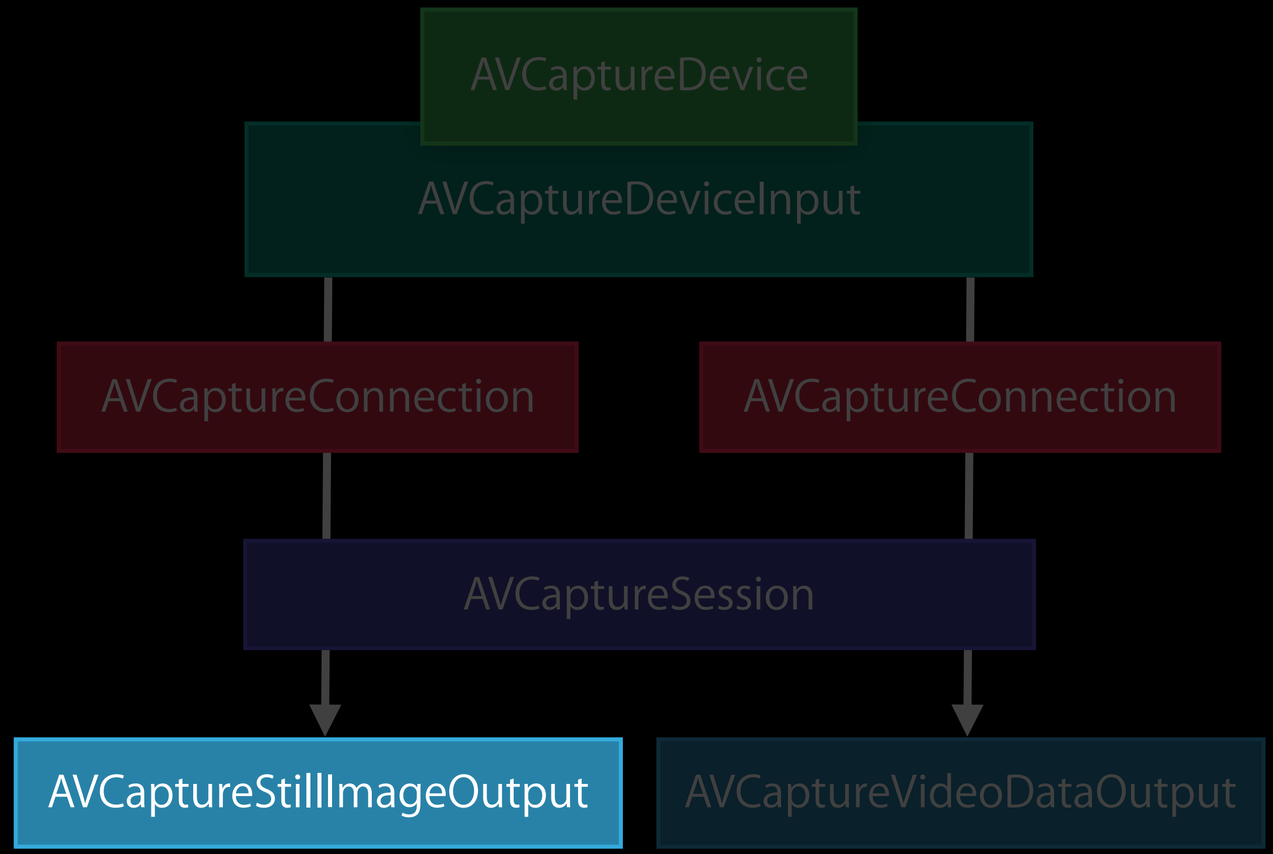
Bracketed Capture using BracketStripes

John Papandriopoulos
Camera Software

Bracketed Capture



Bracketed Capture



Bracketed Capture

AVCaptureStillImageOutput

Bracketed Capture

AVCaptureStillImageOutput

Single still image capture interface

Bracketed Capture

AVCaptureStillImageOutput

Single still image capture interface

```
- (void)captureStillImageAsynchronouslyFromConnection:
                        (AVCaptureConnection *)connection
    completionHandler:(void (^)(
            CMSampleBufferRef imageDataSampleBuffer,
            NSError *error))handler;
```

Bracketed Capture

AVCaptureStillImageOutput

Bracketed Capture

AVCaptureStillImageOutput

Bracketed capture interface

Bracketed Capture

AVCaptureStillImageOutput

Bracketed capture interface

```
- (void)captureStillImageBracketAsynchronouslyFromConnection:
                        (AVCaptureConnection *)connection
    withSettingsArray:(NSArray *)settings
    completionHandler:(void (^)(
    CMSampleBufferRef sampleBuffer,
    AVCaptureBracketedStillImageSettings *stillImageSettings,
    NSError *error))handler;
```

Bracketed Capture

Auto exposure settings

NEW

Bracketed Capture

Auto exposure settings

NEW

```
@interface AVCaptureAutoExposureBracketedStillImageSettings

+ (instancetype)autoExposureSettingsWithExposureTargetBias:
                                                    (float)exposureTargetBias;

@property(readonly) float exposureTargetBias;

@end
```

Bracketed Capture

Manual exposure settings

NEW

Bracketed Capture

Manual exposure settings


```
@interface AVCaptureManualExposureBracketedStillImageSettings

+ (instancetype)manualExposureSettingsWithExposureDuration:(CMTime)duration
                                                       ISO:(float)ISO;

@property(readonly) CMTime exposureDuration;
@property(readonly) float ISO;

@end
```

Bracketed Capture

The don’ts

Don’t mix bracket settings classes

Don’t request more than `maxBracketedCaptureStillImageCount`

Bracketed Capture

The do’s

Bracketed Capture

The do's

```
- (void)prepareToCaptureStillImageBracketFromConnection:
                                        (AVCaptureConnection *)connection
      withSettingsArray:(NSArray *)settings
      completionHandler:(void (^)(BOOL prepared, NSError *error))handler
```

Bracketed Capture

The do's

```
- (void)prepareToCaptureStillImageBracketFromConnection:
                                        (AVCaptureConnection *)connection
      withSettingsArray:(NSArray *)settings
      completionHandler:(void (^)(BOOL prepared, NSError *error))handler
```

Sample buffers may come from a shared buffer pool

Bracketed Capture

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```

Sample buffers may come from a shared buffer pool

Prepare with an array of one object to reclaim memory

Bracketed Capture

The details

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Bracketed settings temporarily override AVCaptureDevice properties

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Video preview may drop frames

Bracketed Capture

Supported on all iOS devices

Summary

AVCaptureView on Yosemite

iOS screen recording for app previews

Access to hardware video encoder on iOS 8

Powerful new camera controls APIs on iOS 8

- Manual focus
- Custom exposure
- Exposure target bias adjustment
- Manual white balance

Still image exposure bracketing

Sample Code

AVCamManual

BracketStripes

Available Now!

More Information

Evangelism
Graphics and Media Evangelism
evangelism@apple.com

Documentation
AV Foundation Programming Guide: Media Capture
http://apple.com

Apple Developer Forums
http://devforums.apple.com

Related Sessions

AVAudioEngine in Practice	Marina	Tuesday 10:15AM
Mastering Modern Media Playback	Mission	Tuesday 11:30AM
Harnessing Metadata in Audiovisual Media	Pacific Heights	Tuesday 2:00PM
Introducing the Photos Framework	Nob Hill	Thursday 10:15AM
Direct Access to Video Encoding and Decoding	Nob Hill	Thursday 11:30AM
Creating Great App Previews	Russian Hill	Thursday 3:15PM

Labs

• AV Foundation and Camera Capture Lab	Media Lab A	Wednesday 12:45PM
• Photos Framework Lab	Media Lab A	Thursday 11:30AM
• AV Foundation and Camera Capture Lab	Media Lab A	Thursday 2:00PM
• Photos Framework Lab	Media Lab B	Friday 10:15AM

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