Advances in Objective-C

Session 404

Doug Gregor
Senior Engineer, LLVM Frontend Team

Objective-C is on the Move

TIOBE Programming Community Index, May 2013

	Programming Language
1	C
2	Java
3	C++
4	Objective-C

Source: www.tiobe.com

Objective-C is on the Move

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Developer Productivity

Software Quality

Developer Productivity

- Eliminating boilerplate
- Simplifying common operations
- Providing great tools

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Developer Productivity

- Eliminating boilerplate
- Simplifying common operations
- Providing great tools

Software Quality

- Catching bugs early
- Automating error-prone tasks
- Encouraging best practices

Roadmap

- Modules
- Better productivity
- ARC improvements

Modules

Frameworks at the Core

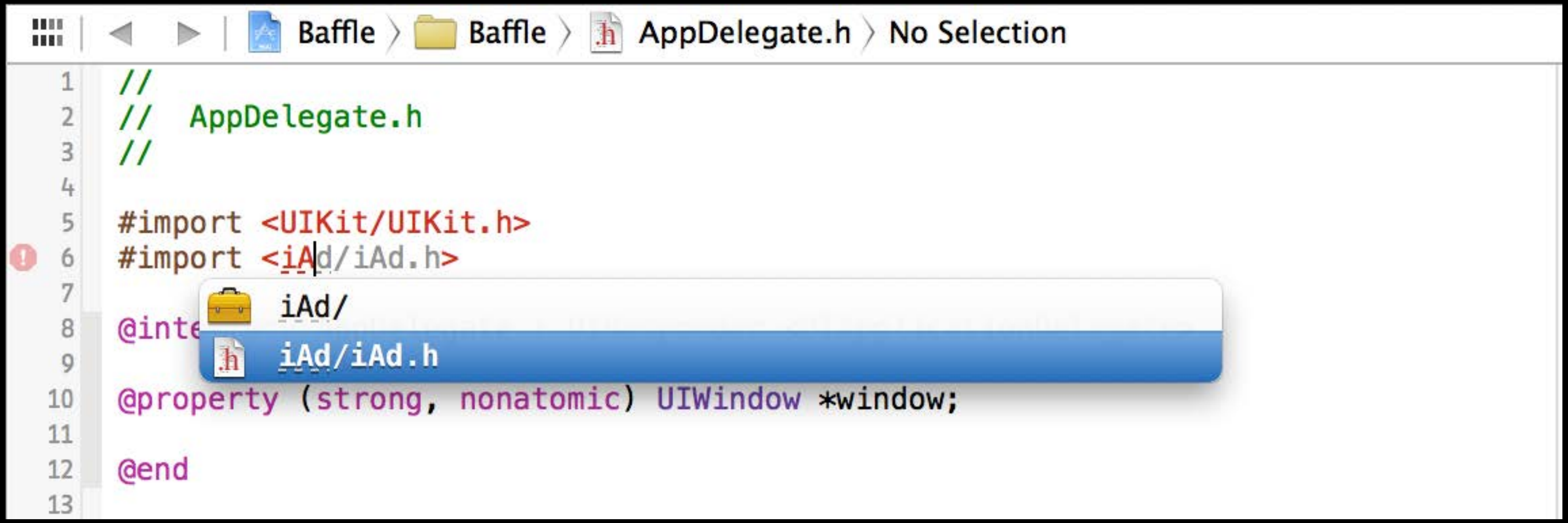
Building blocks of apps

Frameworks at the Core

Building blocks of apps

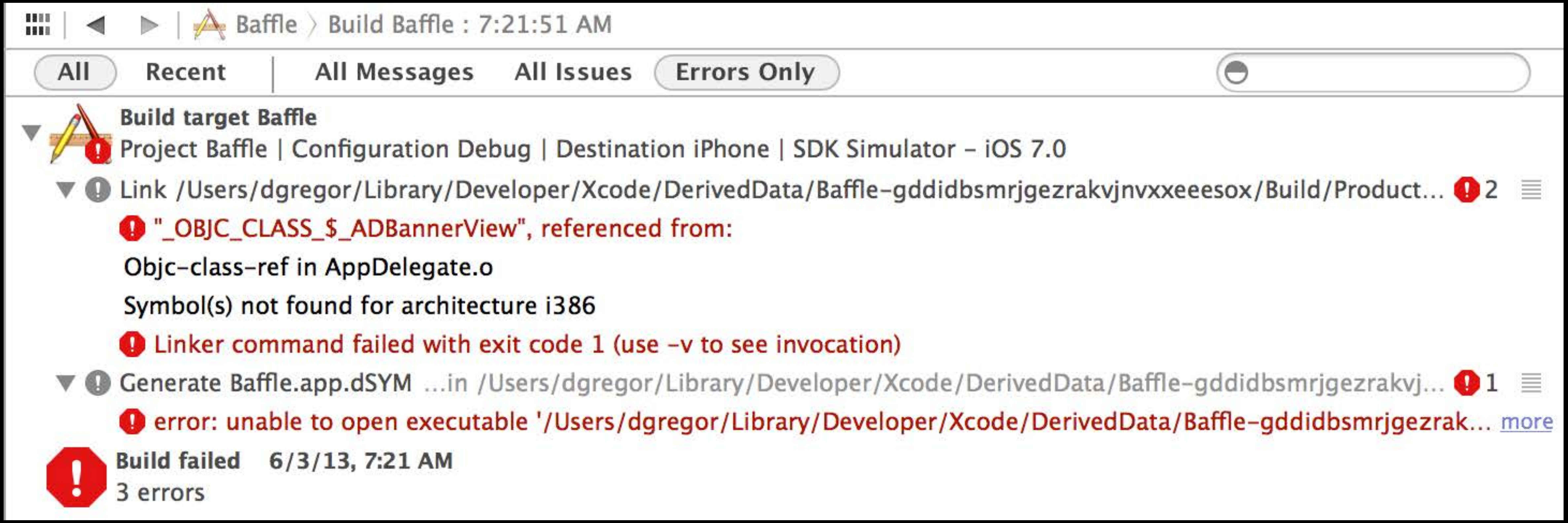
Using a Framework

Import the framework…



```
//
//  AppDelegate.h
//

#import <UIKit/UIKit.h>
#import <iAd/iAd.h>

@inte

@property (strong, nonatomic) UIWindow *window;

@end

```

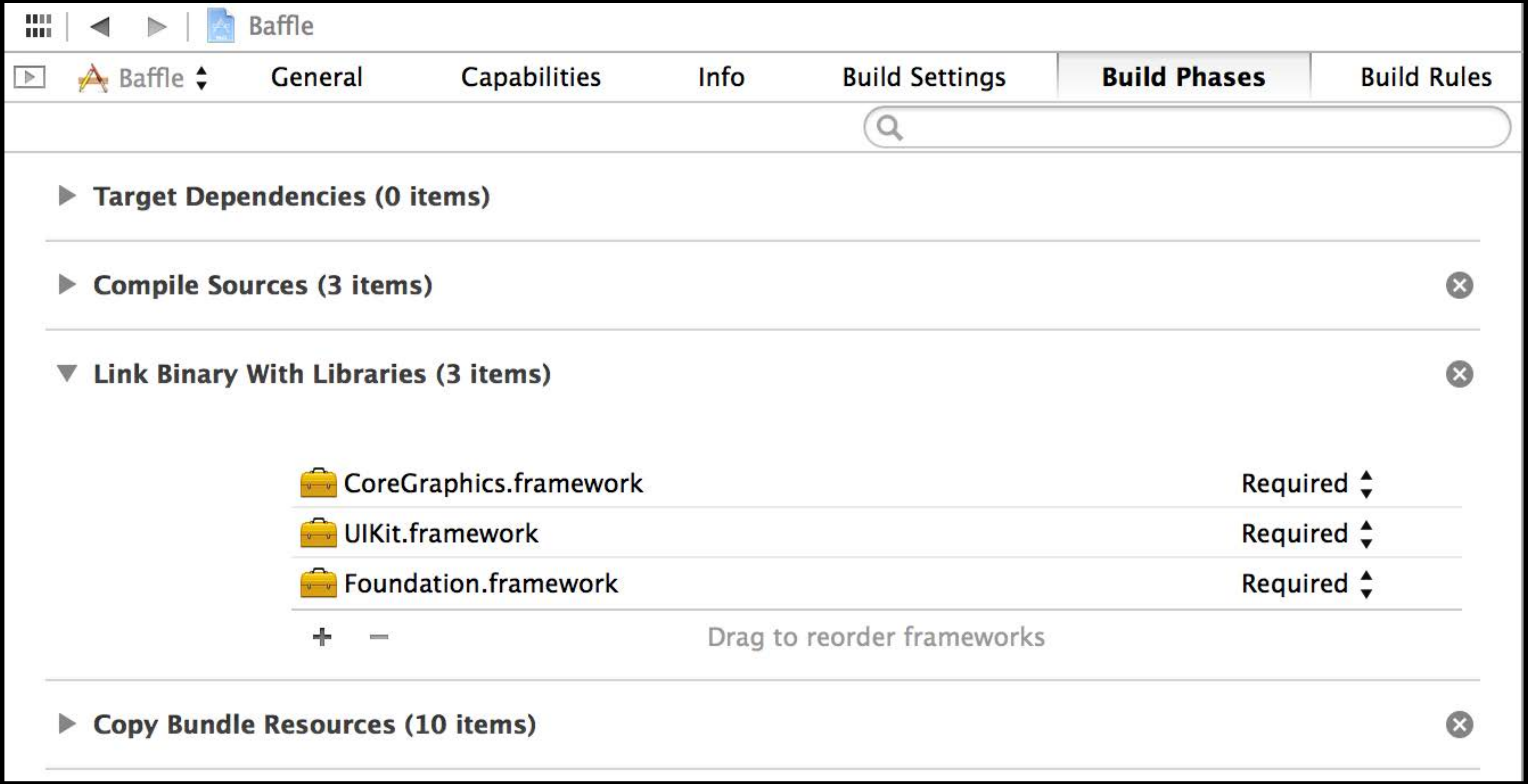
Using a Framework



```
Build target Baffle
Project Baffle | Configuration Debug | Destination iPhone | SDK Simulator - iOS 7.0
Link /Users/dgregor/Library/Developer/Xcode/DerivedData/Baffle-gddidbsmrjgezrakvjnvxxeeesox/Build/Product… 2
"_OBJC_CLASS_$_ADBannerView", referenced from:
Objc-class-ref in AppDelegate.o
Symbol(s) not found for architecture i386
Linker command failed with exit code 1 (use -v to see invocation)
Generate Baffle.app.dSYM …in /Users/dgregor/Library/Developer/Xcode/DerivedData/Baffle-gddidbsmrjgezrakvj… 1
error: unable to open executable '/Users/dgregor/Library/Developer/Xcode/DerivedData/Baffle-gddidbsmrjgezrak… more
Build failed   6/3/13, 7:21 AM
3 errors
```

Using a Framework

Import and link against the framework



▶ Target Dependencies (0 items)

▶ Compile Sources (3 items)

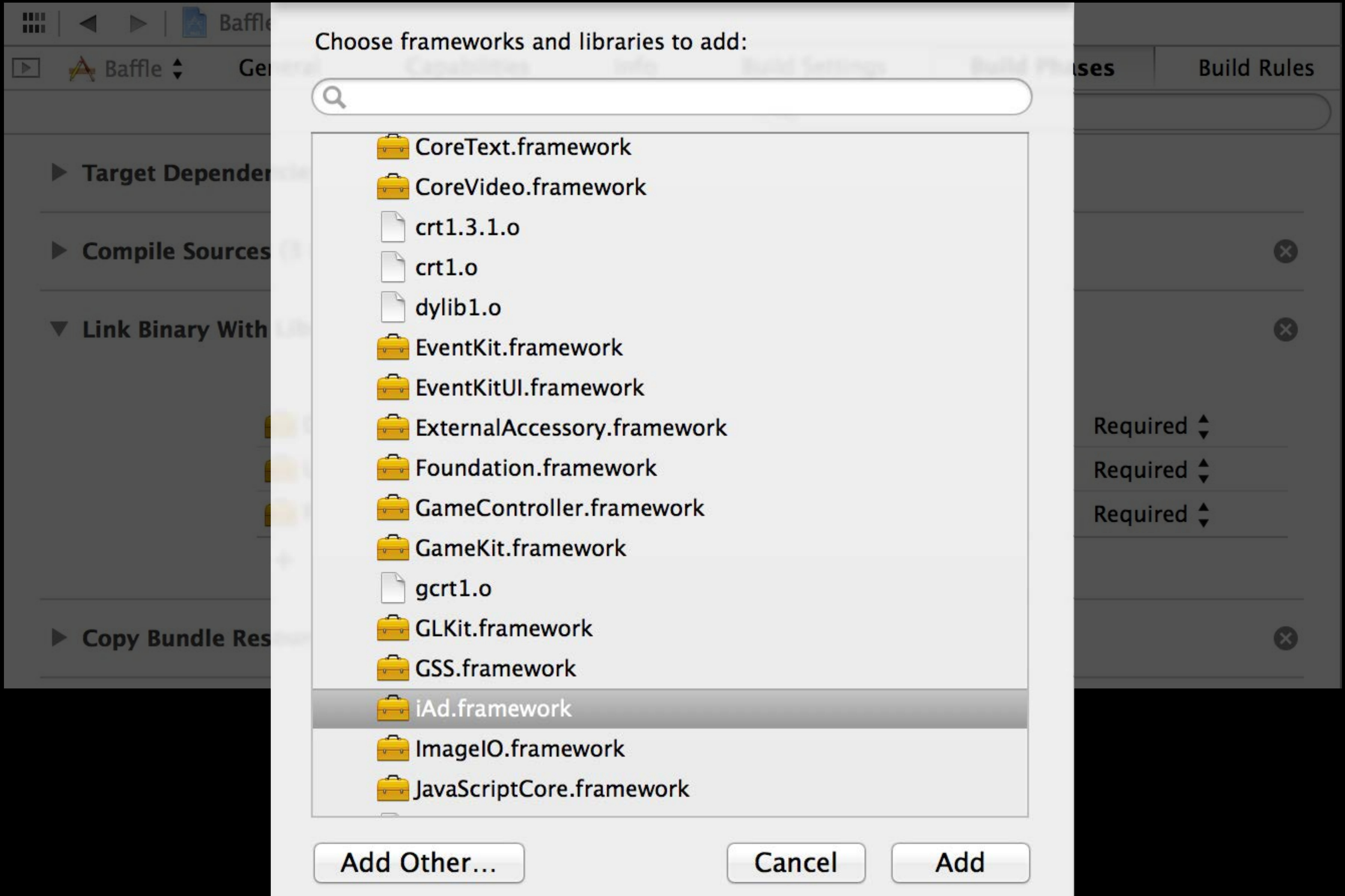
▼ Link Binary With Libraries (3 items)

CoreGraphics.framework	Required
UIKit.framework	Required
Foundation.framework	Required

▶ Copy Bundle Resources (10 items)

Using a Framework

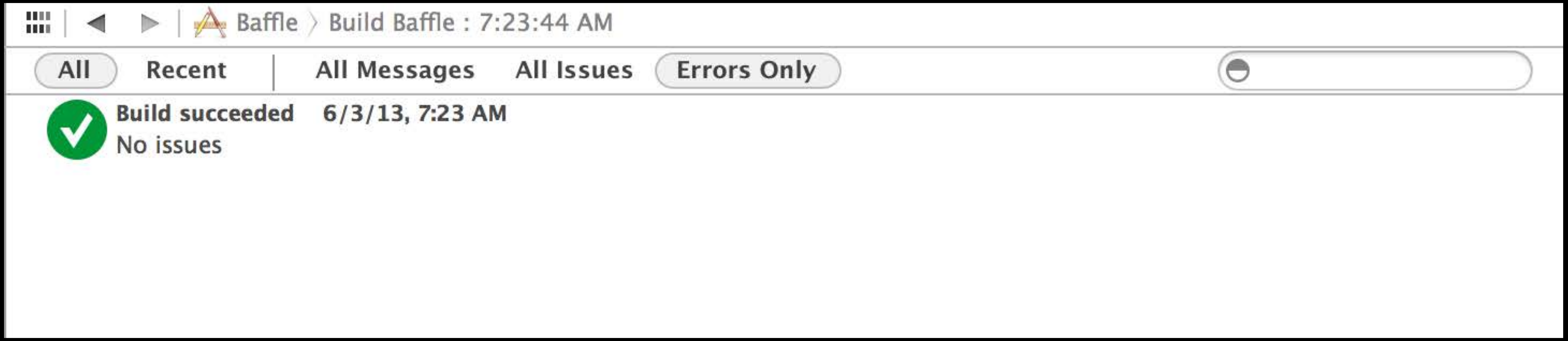
Import and link against the framework



Choose frameworks and libraries to add:

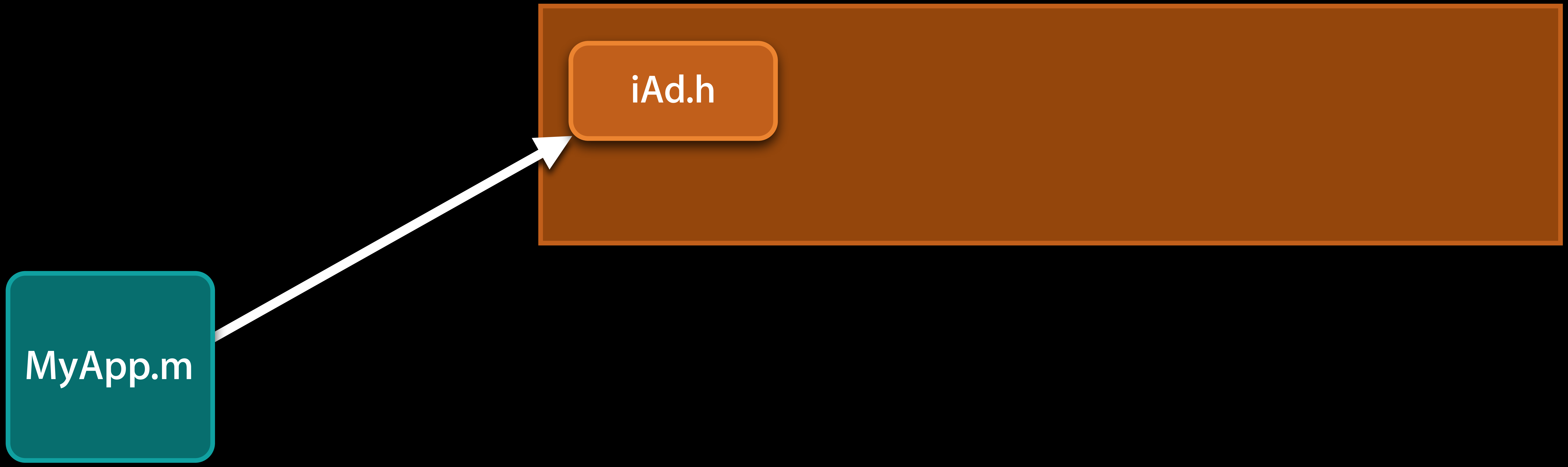
- CoreText.framework
- CoreVideo.framework
- crt1.3.1.o
- crt1.o
- dylib1.o
- EventKit.framework
- EventKitUI.framework
- ExternalAccessory.framework
- Foundation.framework
- GameController.framework
- GameKit.framework
- gcrt1.o
- GLKit.framework
- GSS.framework
- iAd.framework
- ImageIO.framework
- JavaScriptCore.framework

Using a Framework

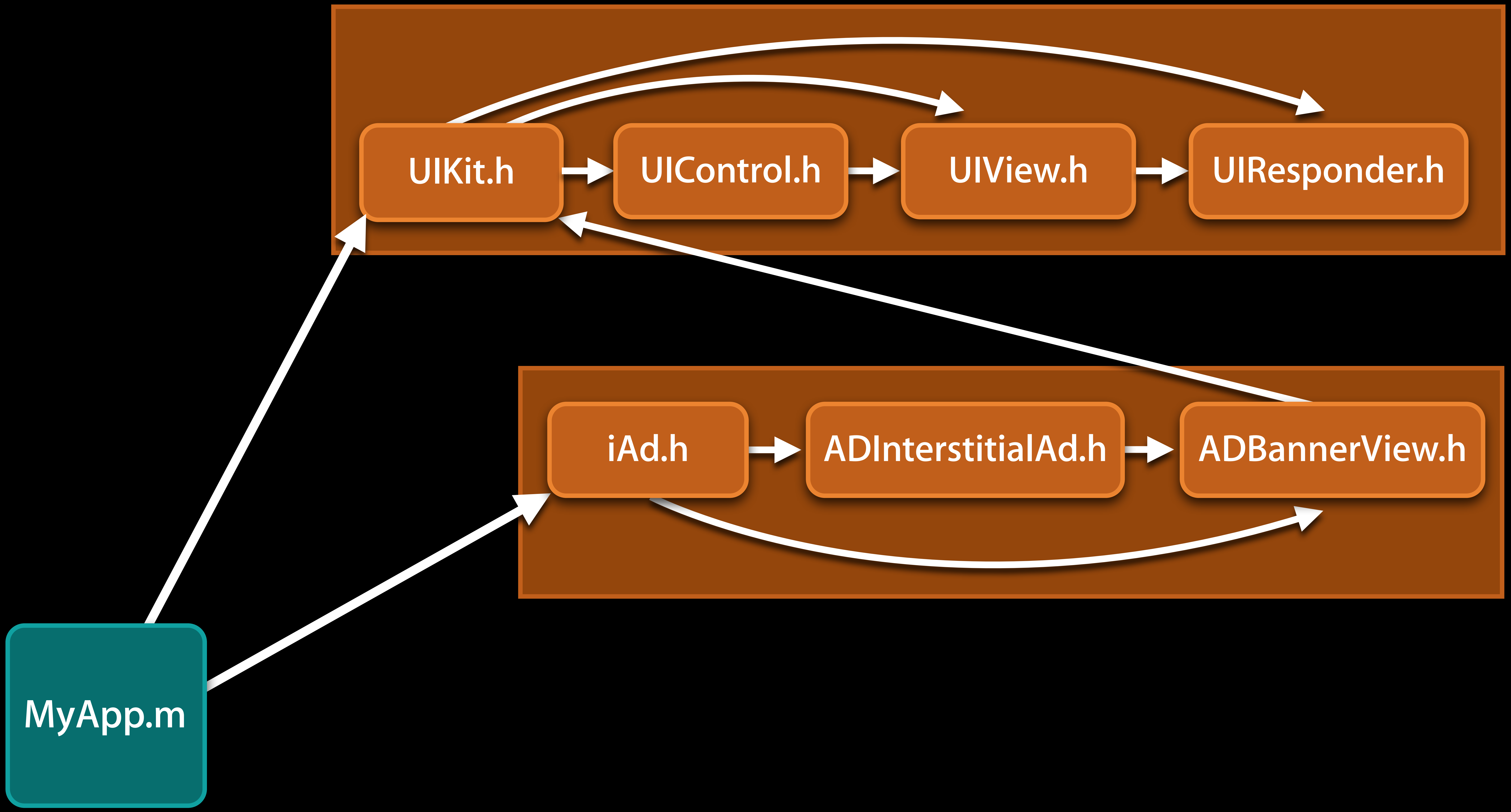


Build succeeded 6/3/13, 7:23 AM
No issues

Headers and Frameworks



Headers and Frameworks



Preprocessing and Textual Inclusion

```
#import <iAd/iAd.h>
@implementation AppDelegate
// ...
@end
```

Preprocessing and Textual Inclusion

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

@implementation AppDelegate

// ...

@end
```

```
/* iAd/iAd.h */
#import <iAd/ADBannerView.h>
#import <iAd/ADBannerView_Deprecated.h>
#import <iAd/ADInterstitialAd.h>
```

Preprocessing and Textual Inclusion

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Preprocessing and Textual Inclusion

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#import <iAd/ADBannerView.h>
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// ...

@end
```

```
/* iAd/ADBannerView.h */
@interface ADBannerView : UIView
@property (nonatomic,readonly) ADAdType adType;

- (id)initWithAdType:(ADAdType)type

/* ... */

@end
```

Preprocessing and Textual Inclusion

```
@interface ADBannerView : UIView
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Preprocessing and Textual Inclusion

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@implementation AppDelegate

// ...

@end
```

```
/*iAd/ADBannerView_Deprecated.h*/
```

```
/* iAd/ADInterstitialAd.h */
```

Preprocessing and Textual Inclusion

```
@interface ADBannerView : UIView
@property (nonatomic,readonly) ADAdType adType;

- (id)initWithAdType:(ADAdType)type

/* ... */

@end


@implementation AppDelegate

// ...

@end
```

Header Fragility

```
#define readonly 0x01
#import <iAd/iAd.h>


@implementation AppDelegate

// ...

@end
```

Header Fragility

```
@interface ADBannerView : UIView
@property (nonatomic,0x01) ADAdType adType;

- (id)initWithAdType:(ADAdType)type

/* ... */

@end


@implementation AppDelegate

// ...

@end
```

Header Fragility

```
@interface ADBannerView : UIView
@property (nonatomic,0x01) ADAdType adType;

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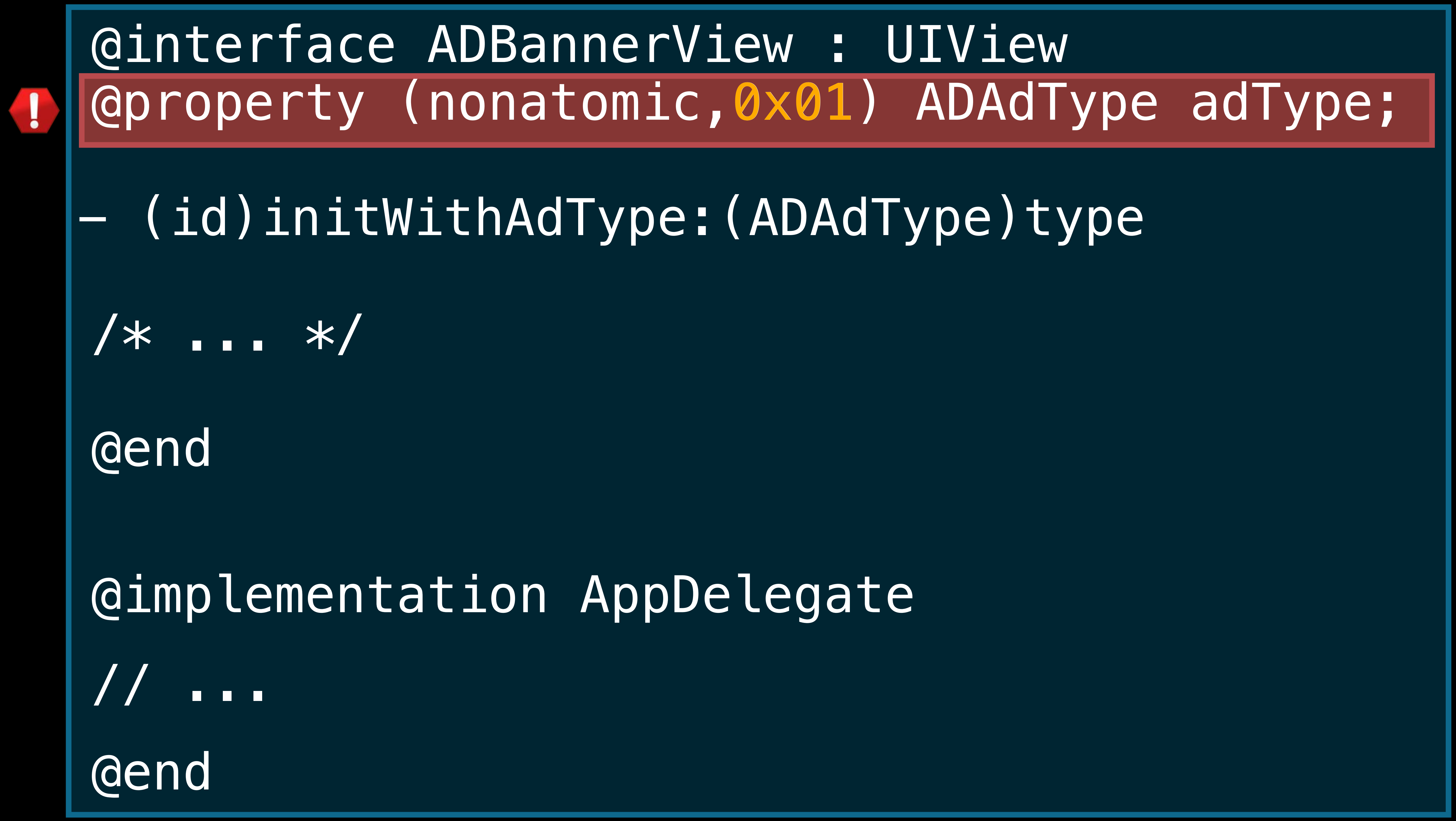
/* ... */

@end


@implementation AppDelegate
// ...
@end
```

Header Fragility



```
@interface ADBannerView : UIView
@property (nonatomic,0x01) ADAdType adType;

- (id)initWithAdType:(ADAdType)type

/* ... */

@end

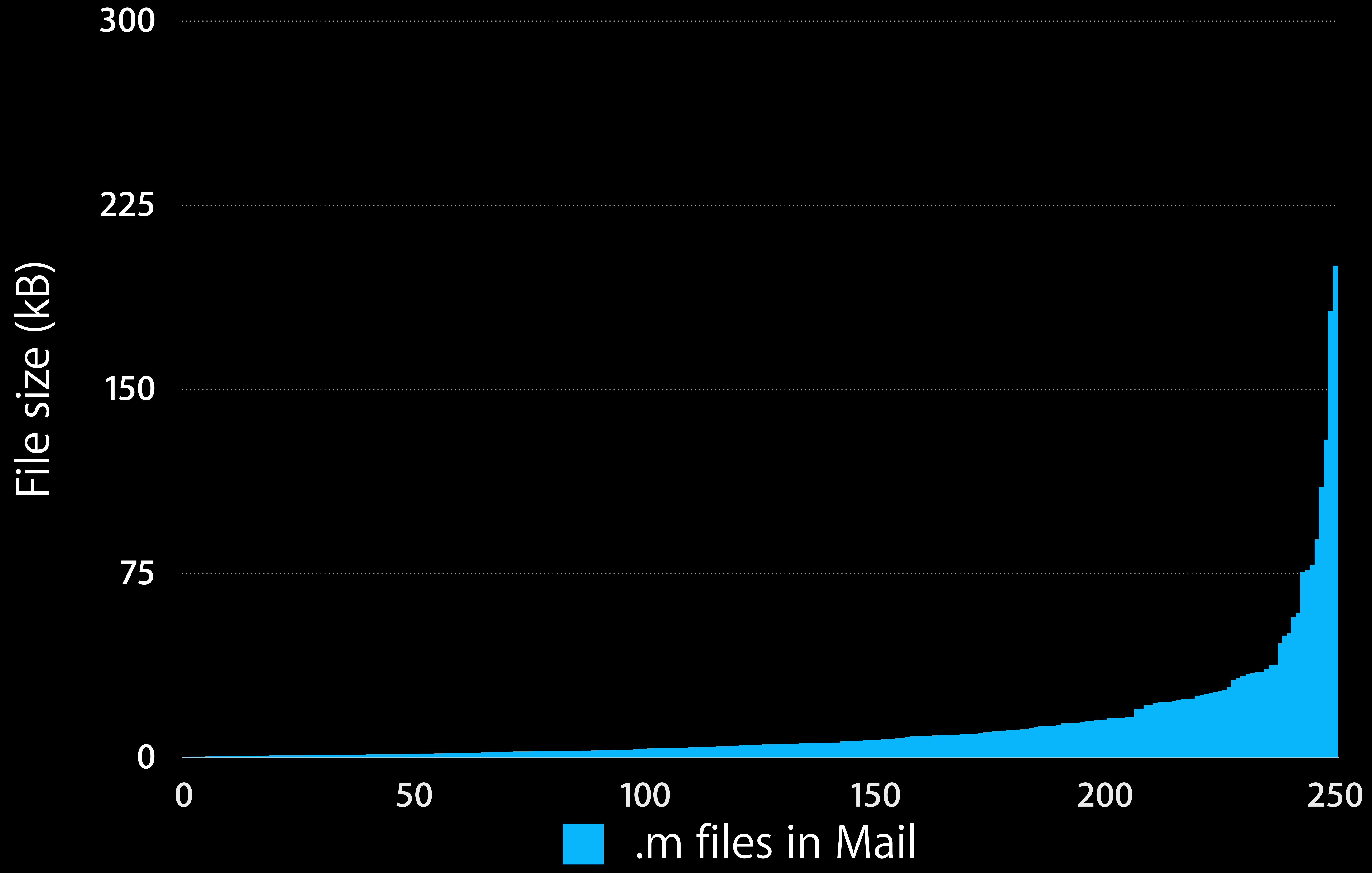
@implementation AppDelegate

// ...

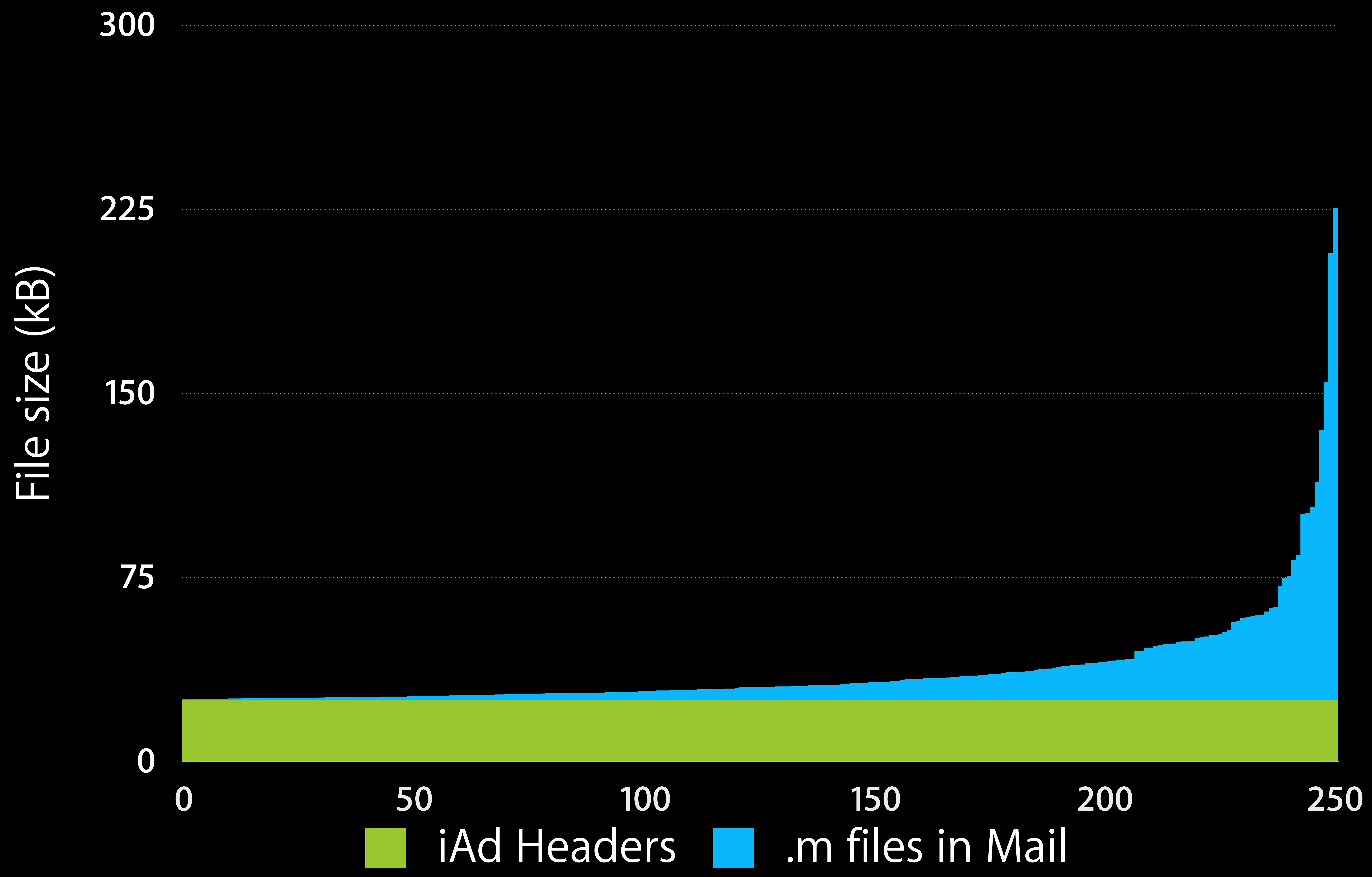
@end
```

- UPPERCASE_MACRO_NAMES
- Manifests as header ordering problems

Inherently Non-Scalable Compile Times



Inherently Non-Scalable Compile Times



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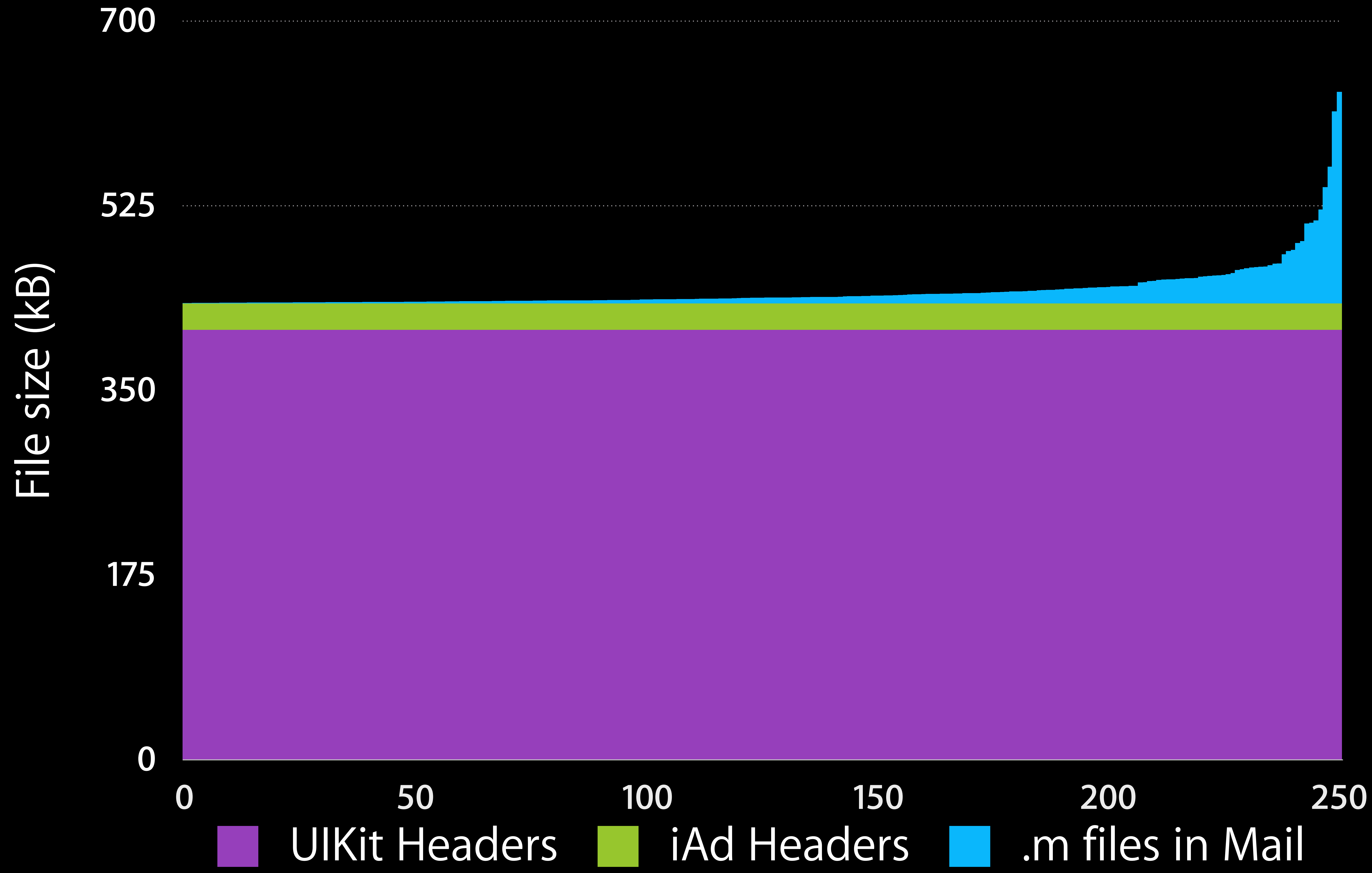
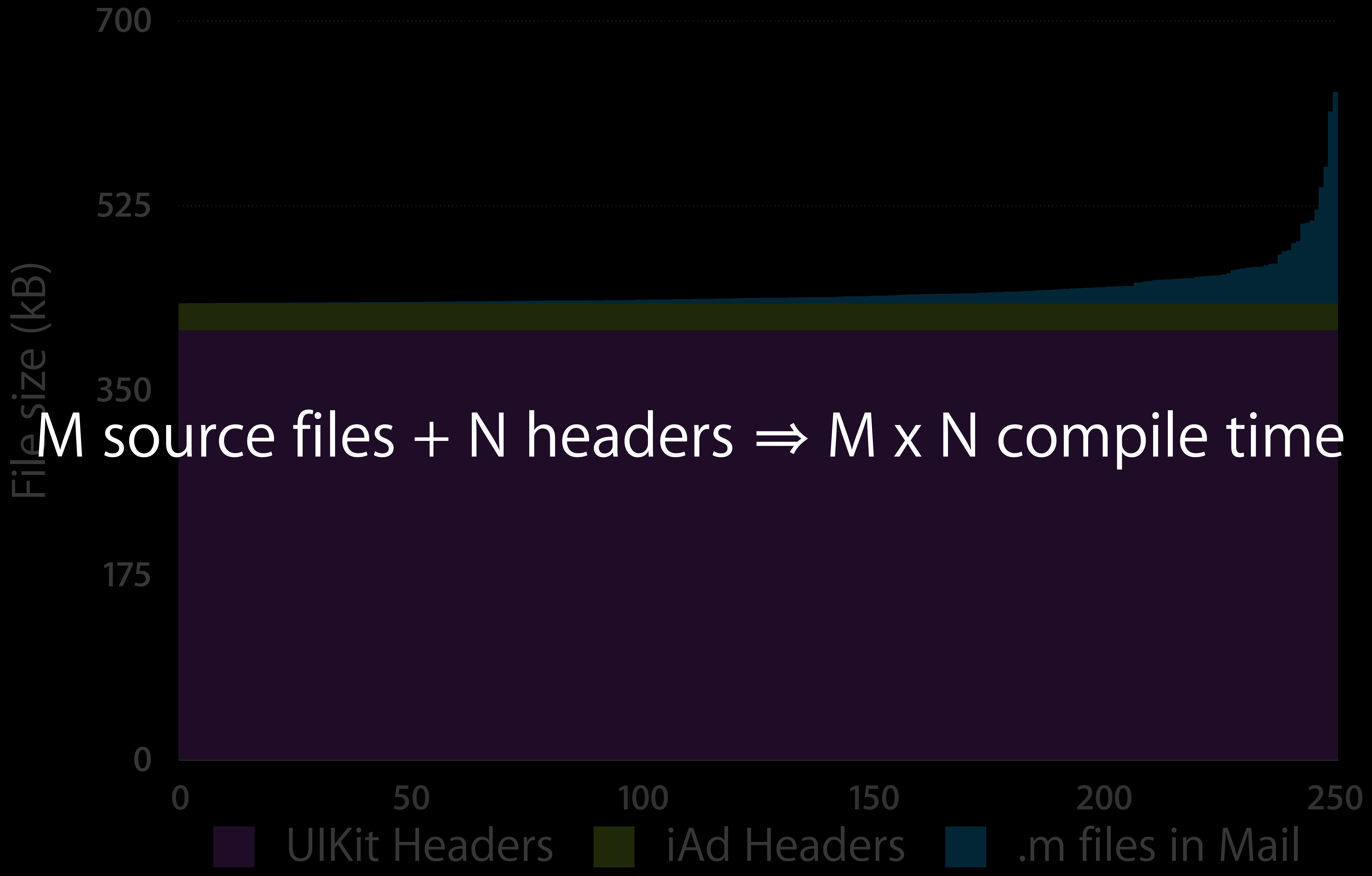


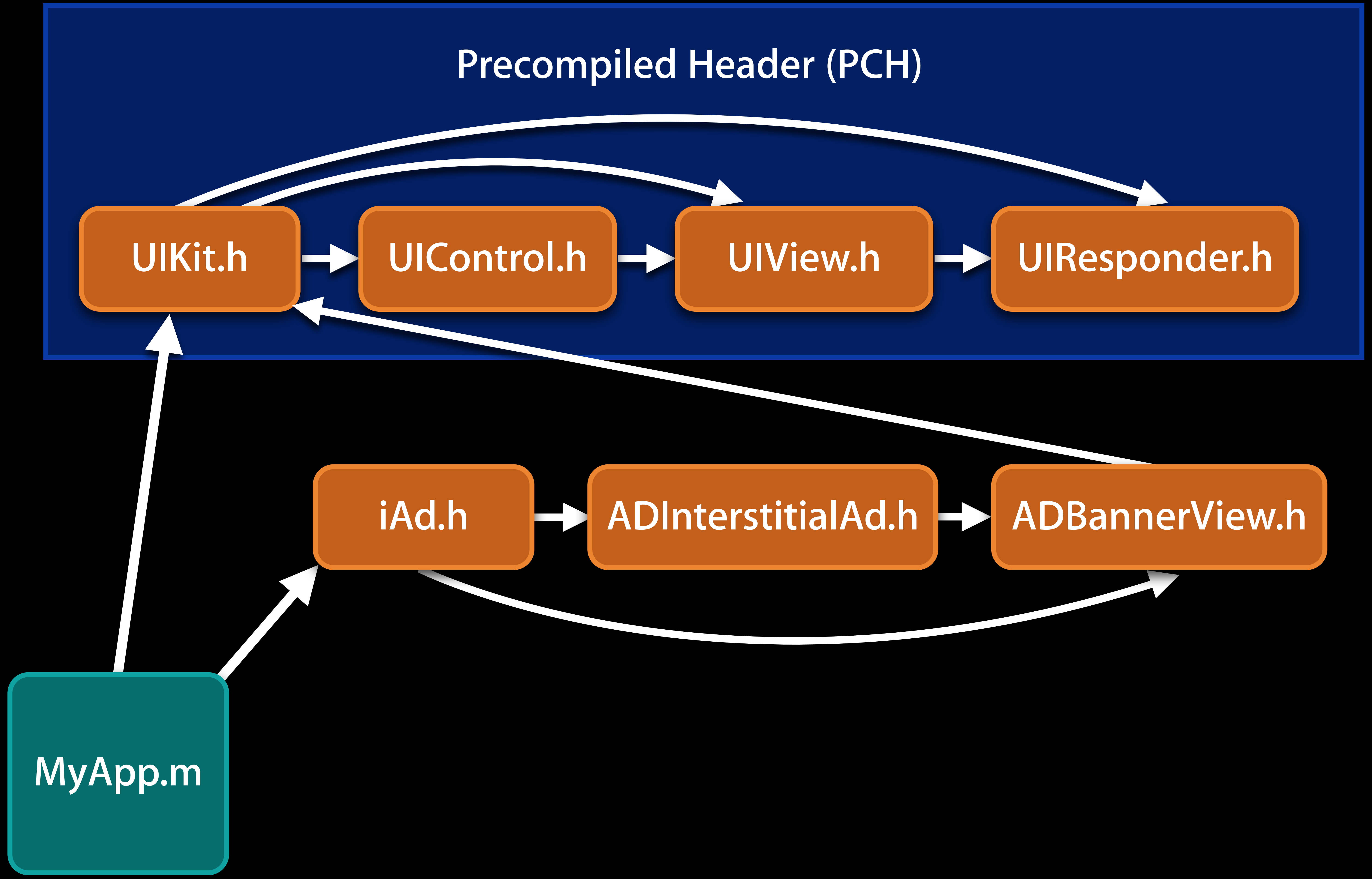
Inherently Non-Scalable Compile Times



M source files + N headers ⇒ M x N compile time

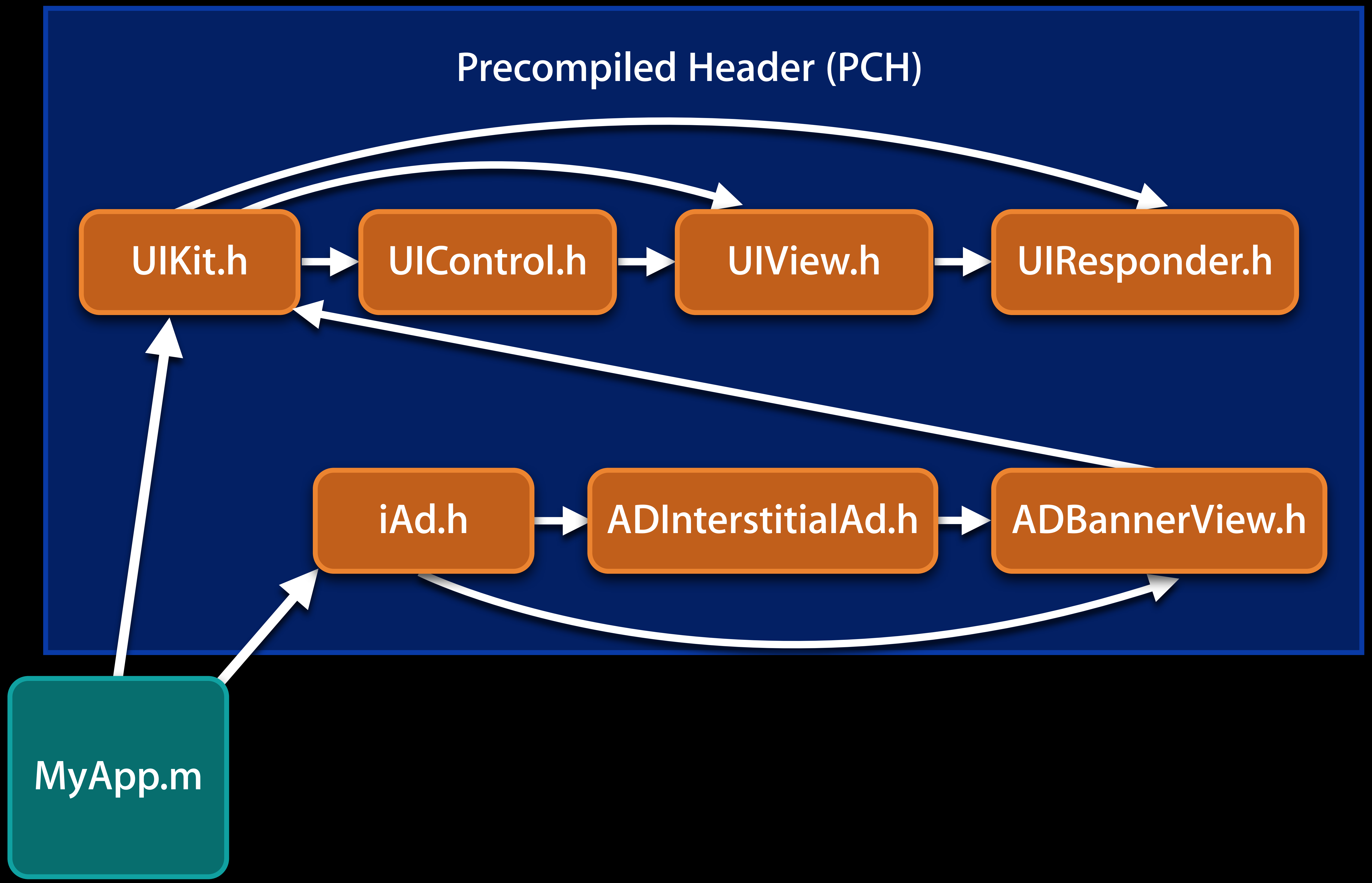
What About Precompiled Headers?

- Precompiled headers help significantly
  - UIKit / Cocoa come for free



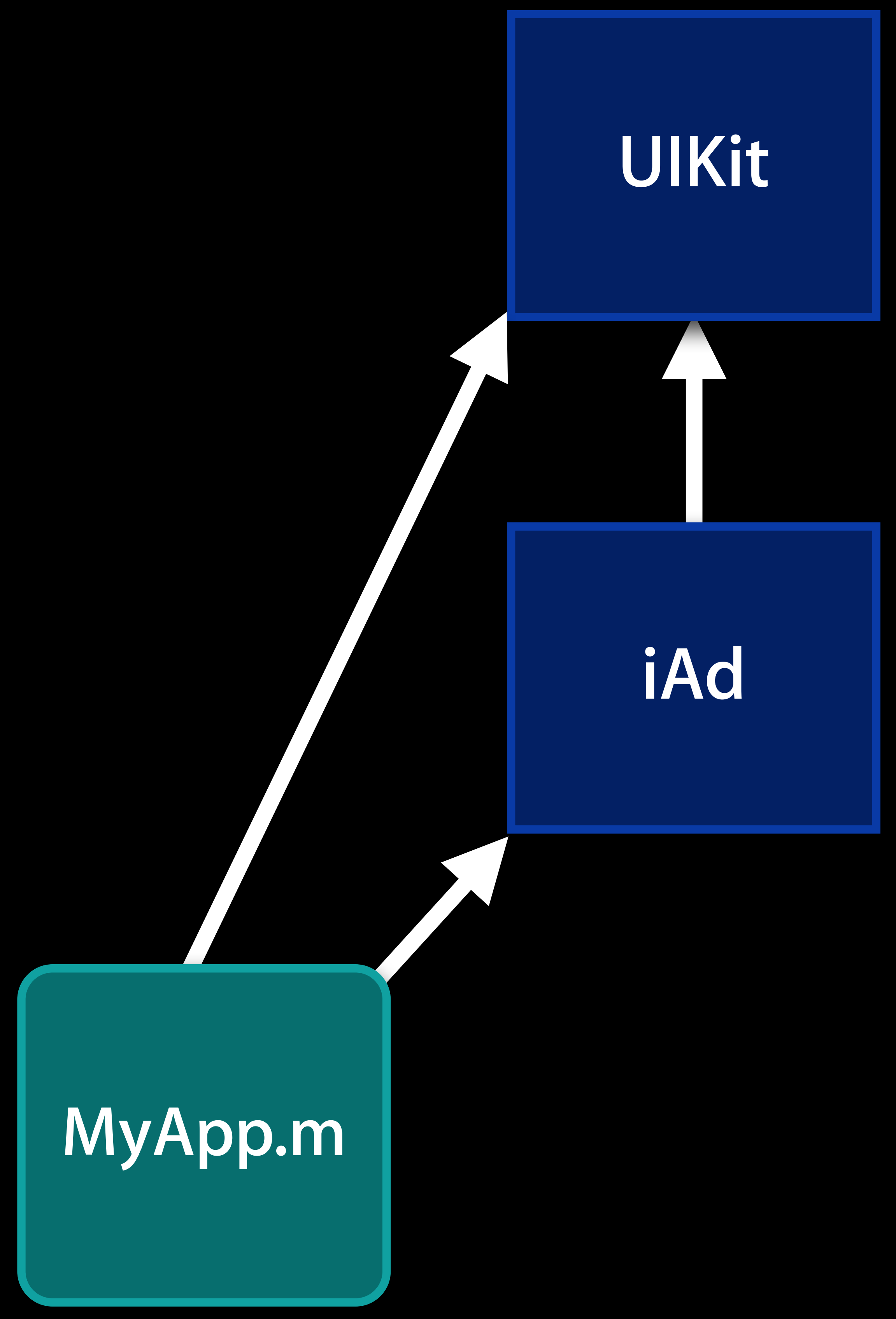
What About Precompiled Headers?

- Precompiled headers help significantly
  - UIKit / Cocoa come for free
- Maintenance burden
- Namespace pollution



Modules

- Modules encapsulate a framework
  - Interface (API)
  - Implementation (dylib)
- Separately compiled

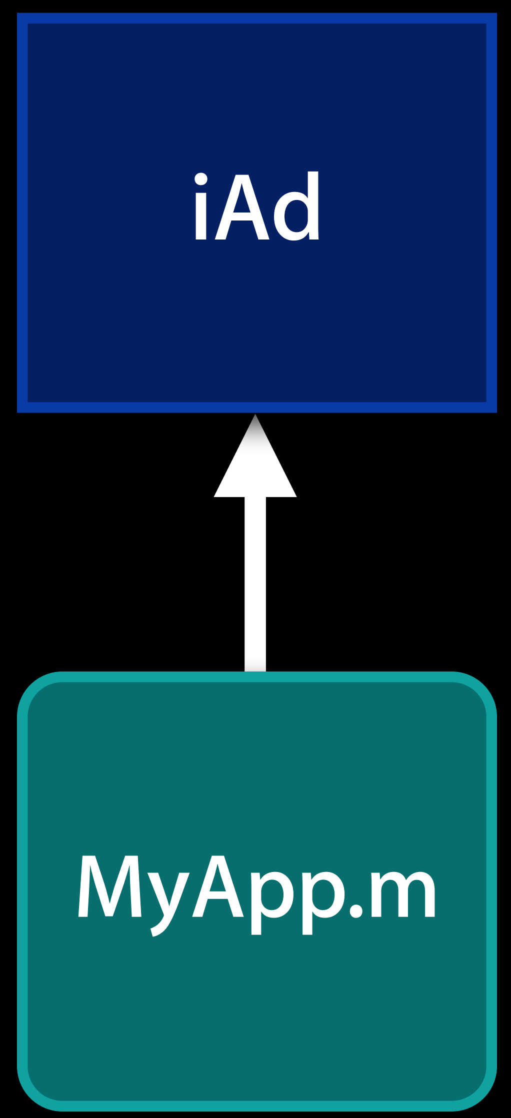


Semantic Import

- New `@import` declaration accesses framework API

```
@import iAd;
```

- Imports complete semantic description of a framework
  - Doesn’t need to parse the headers
  - Local macro definitions have no effect on framework API



Semantic Import

- New `@import` declaration accesses framework API

```
#define readonly 0x01
@import iAd;
```

- Imports complete semantic description of a framework
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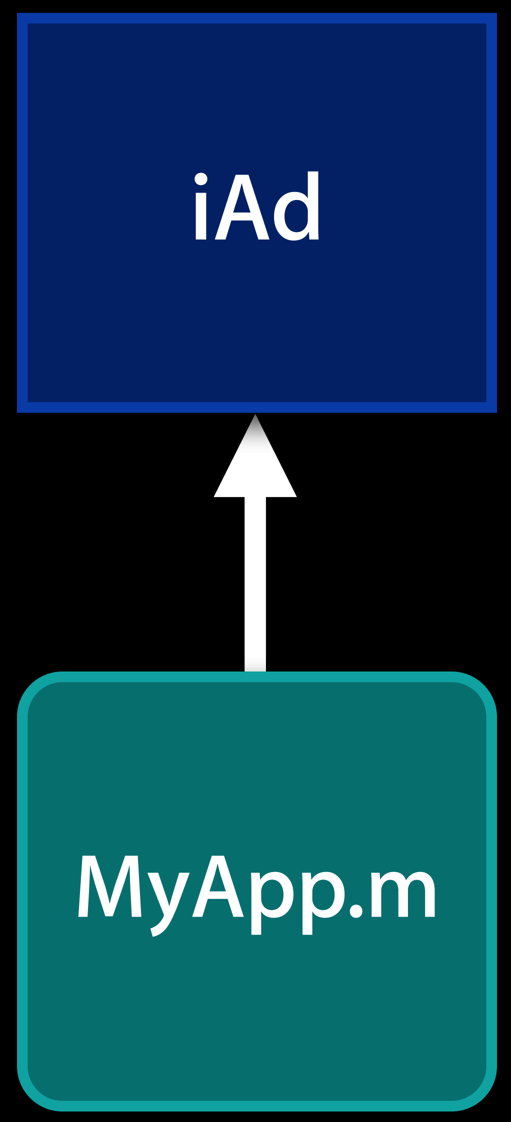
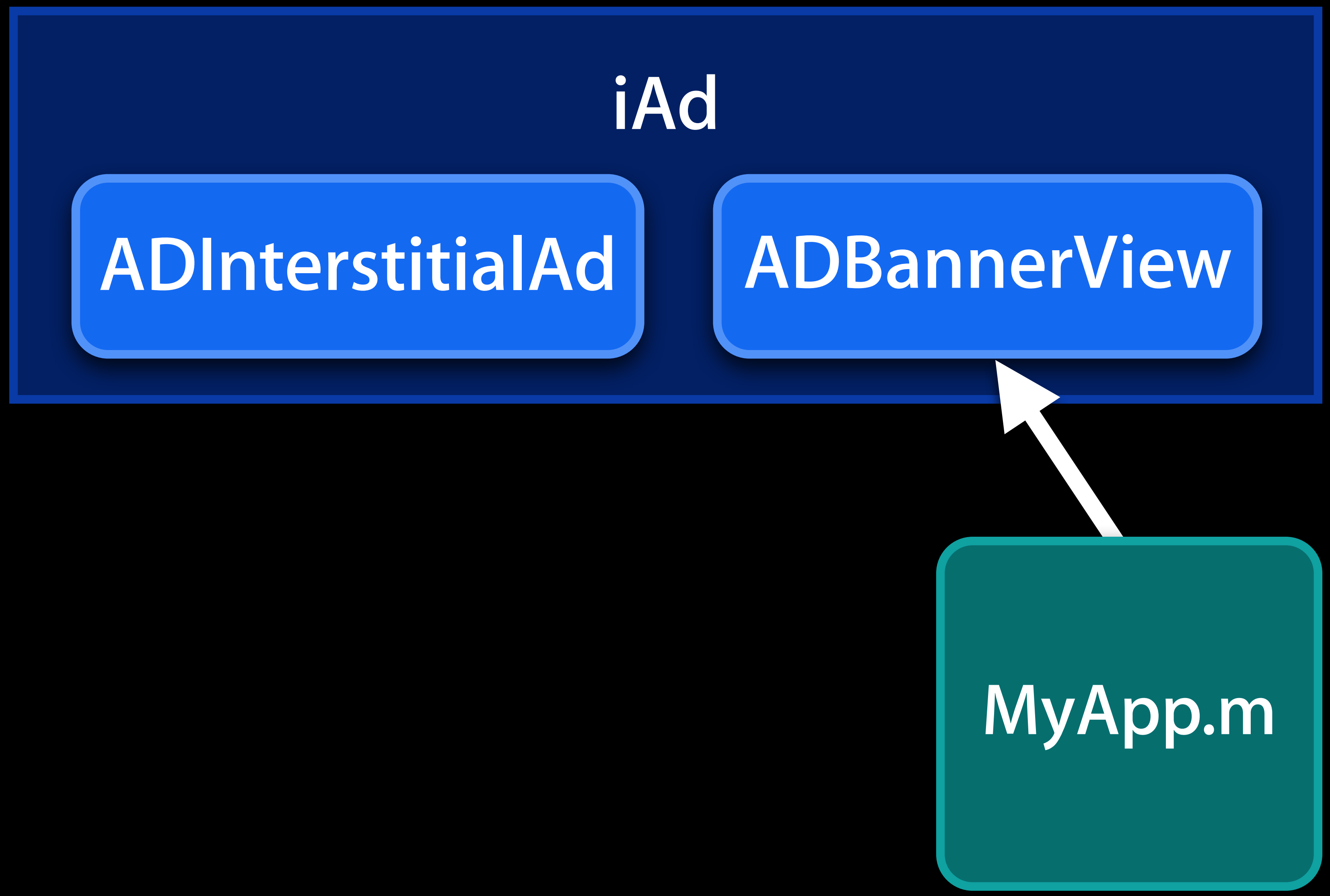


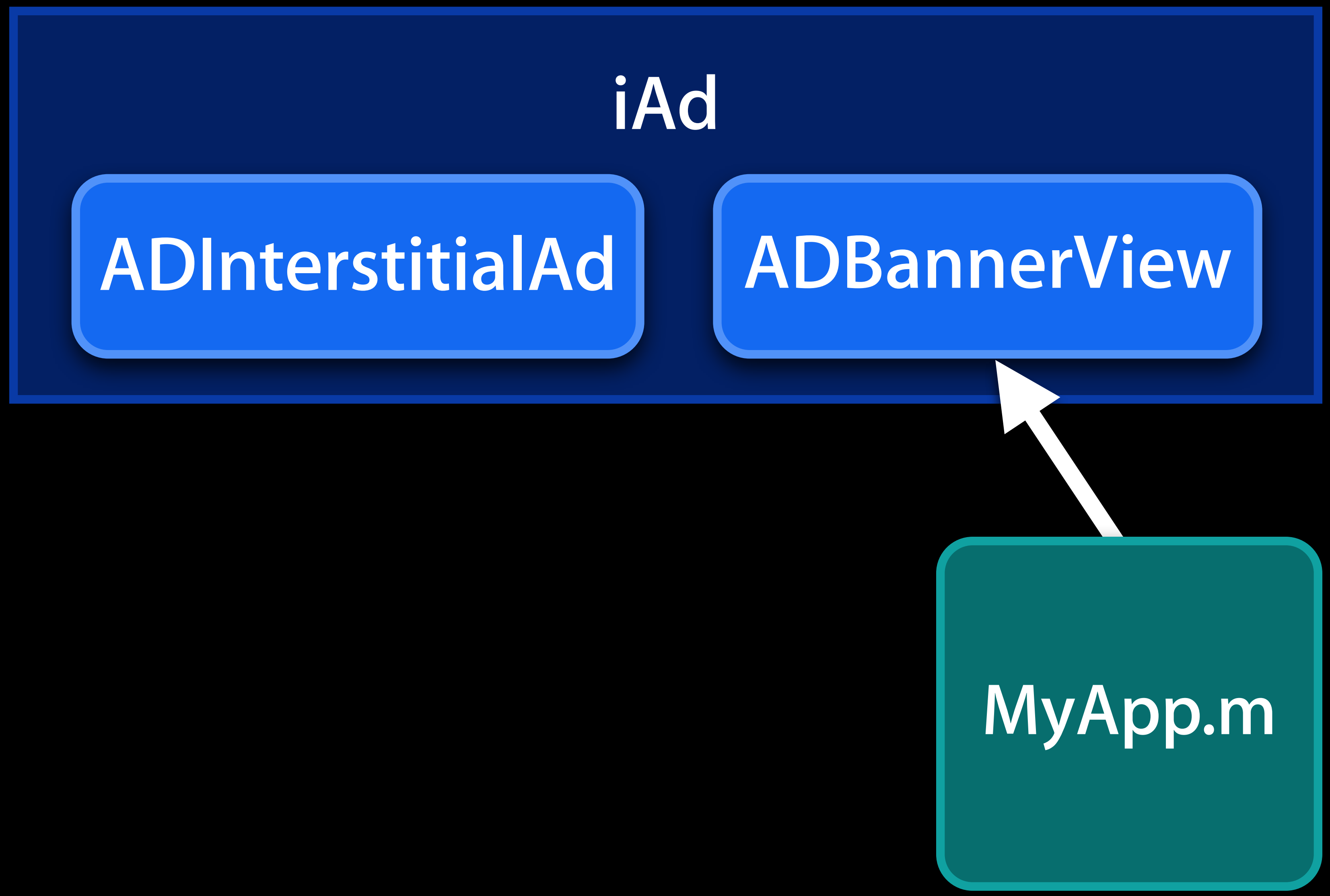
Selective Import



Selective Import

- Import part of a framework

```
@import iAd.ADBannerView;
```



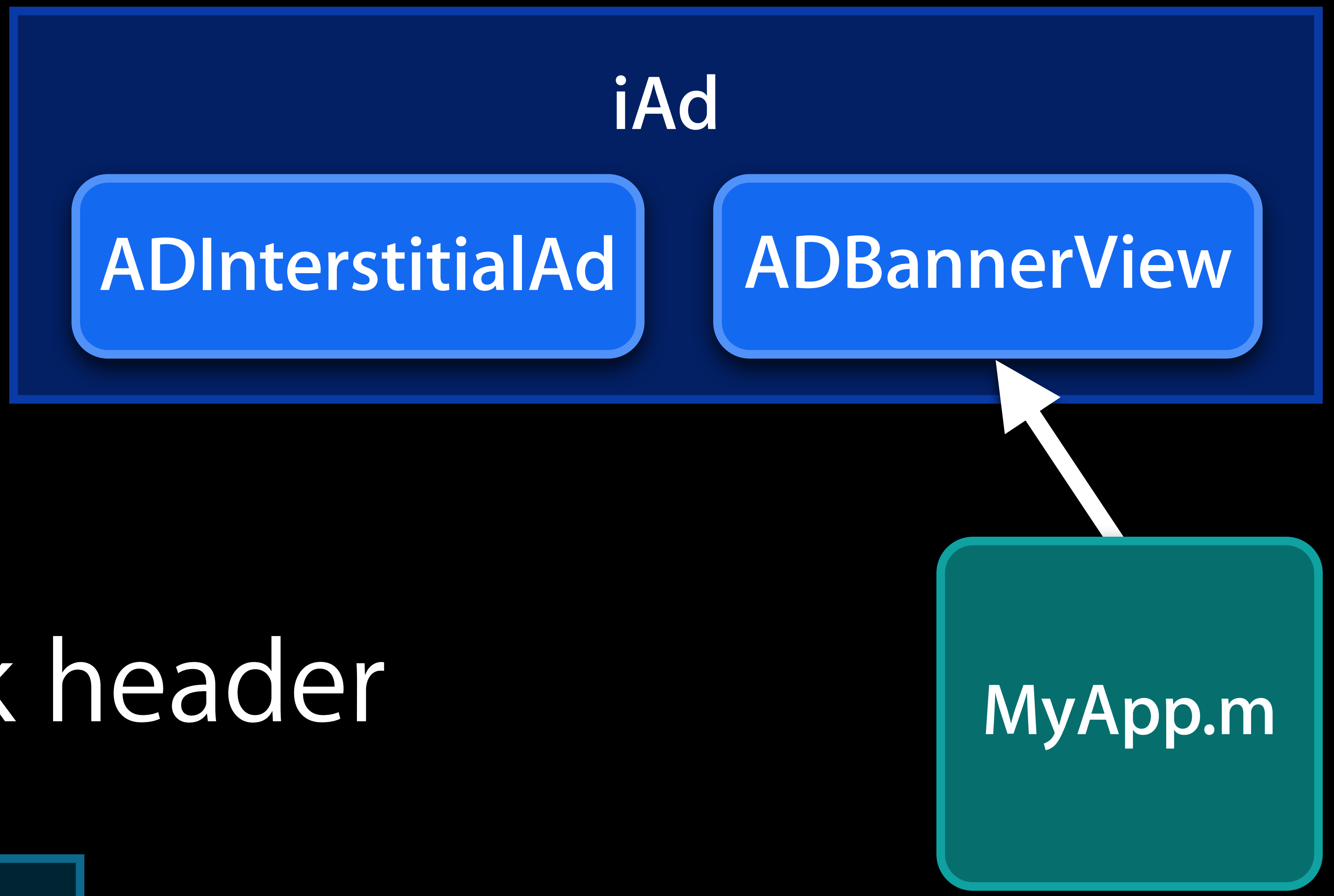
Selective Import

- Import part of a framework

```
@import iAd.ADBannerView;
```

- Similar to importing a specific framework header

```
#import <iAd/ADBannerView.h>
```



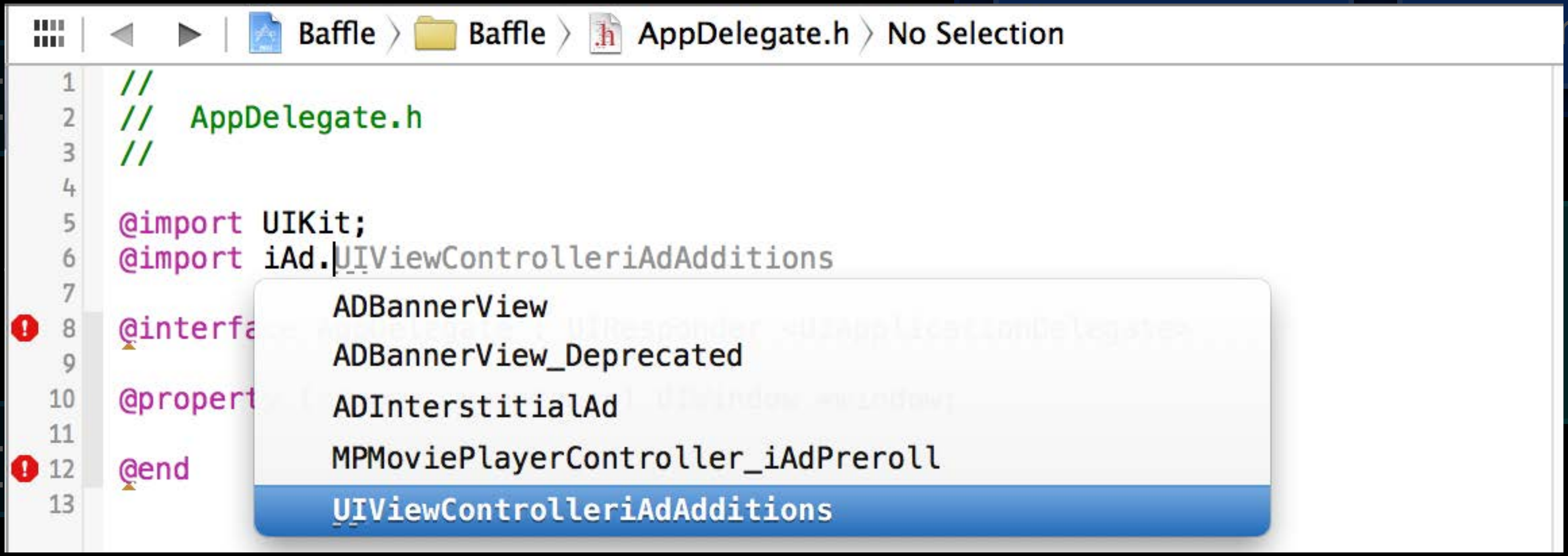
Selective Import

- Import part of a framework

```
@import
```

- Similar to

```
#import
```



```
//
//  AppDelegate.h
//

@import UIKit;
@import iAd.UIViewControlleriAdAdditions

@interface AppDelegate : UIResponder <UIApplicationDelegate>

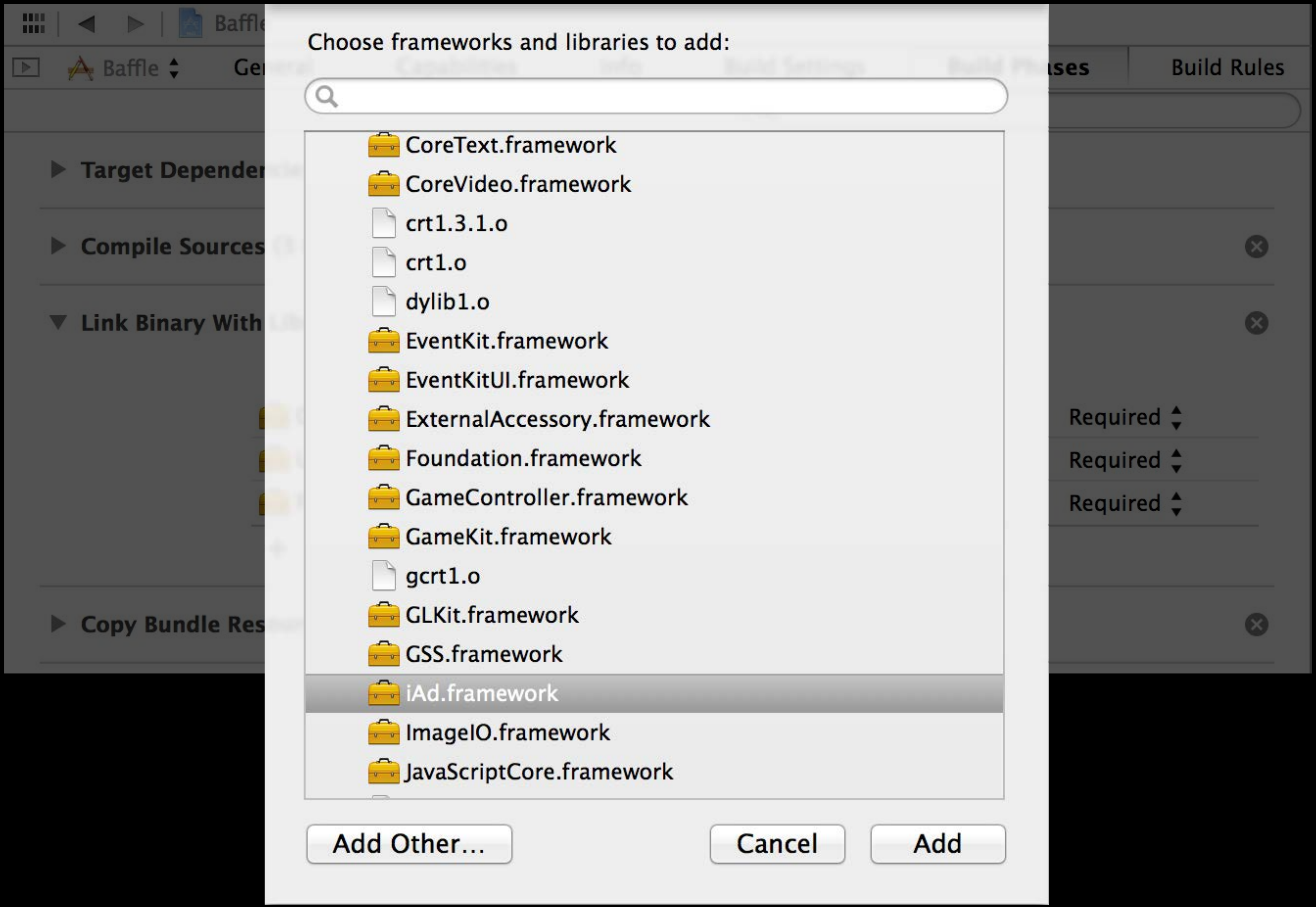
@property (strong, nonatomic) UIWindow *window;

@end

```

```
ADBannerView
ADBannerView_Deprecated
ADInterstitialAd
MPMoviePlayerController_iAdPreroll
UIViewControlleriAdAdditions
```

Autolinking



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- GameController.framework
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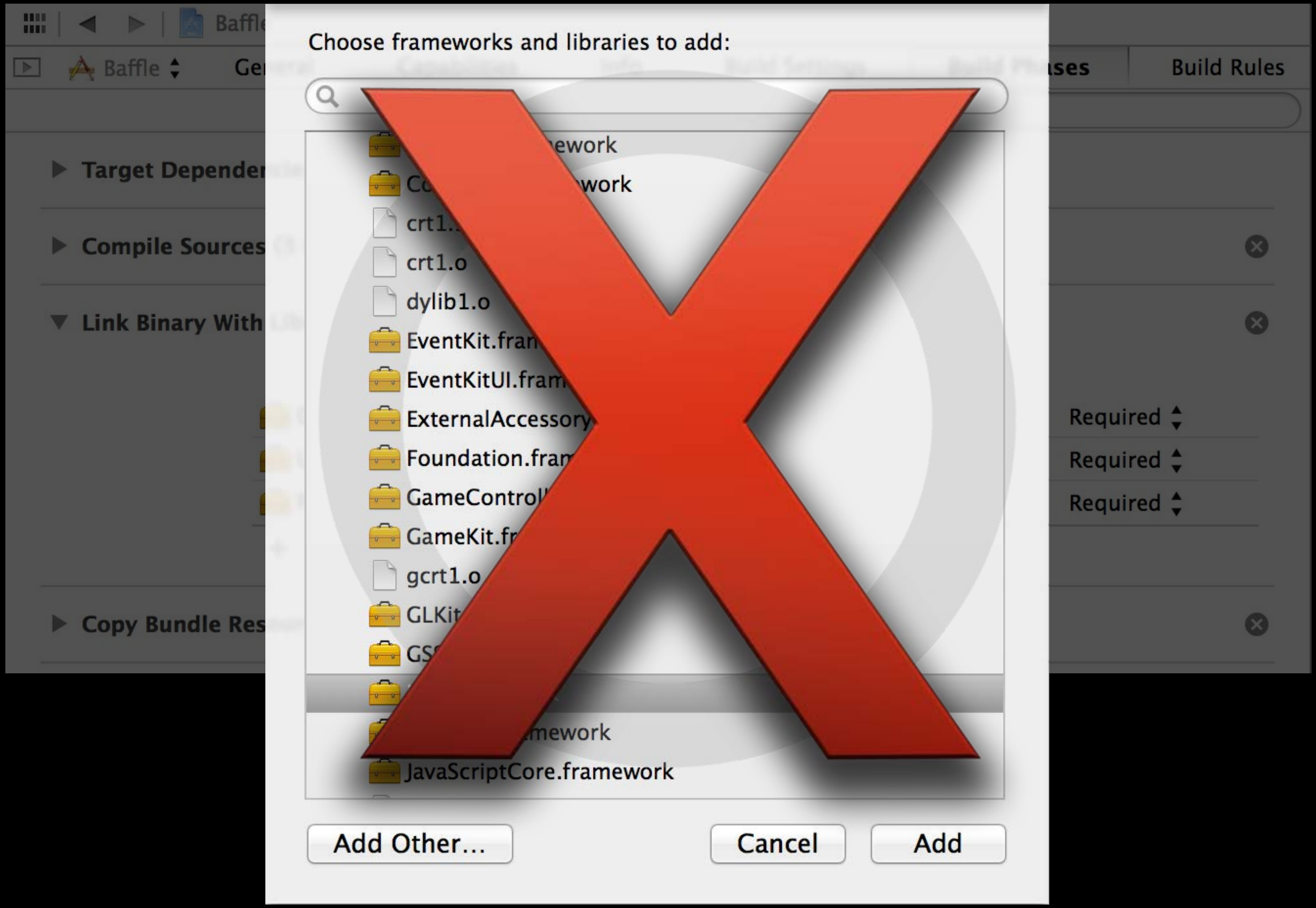
- gcrt1.o
- GLKit.framework
- GSS.framework
- iAd.framework
- ImageIO.framework
- JavaScriptCore.framework

Autolinking

- Eliminates the need to “link binary with libraries”



Using Modules

- Opt in via build settings

Using Modules

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- `#import` and `#include` automatically mapped to `@import`

```
#import <UIKit/UIKit.h>      → @import UIKit;
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Using Modules

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- No source changes required

Using Modules

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```
#import <UIKit/UIKit.h>        → @import UIKit;
#import <iAD/ADBannerView.h>   → @import iAd.ADBannerView;
```

- No source changes required
- System frameworks available as modules with iOS 7 / OS X 10.9 SDK

Module Maps

A quick peek under the hood

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A quick peek under the hood

- Module maps establish relationship between headers and modules:

```
framework module UIKit {
  umbrella header "UIKit.h"
  module * { export * }
  link framework "UIKit"
}
```

Module Maps

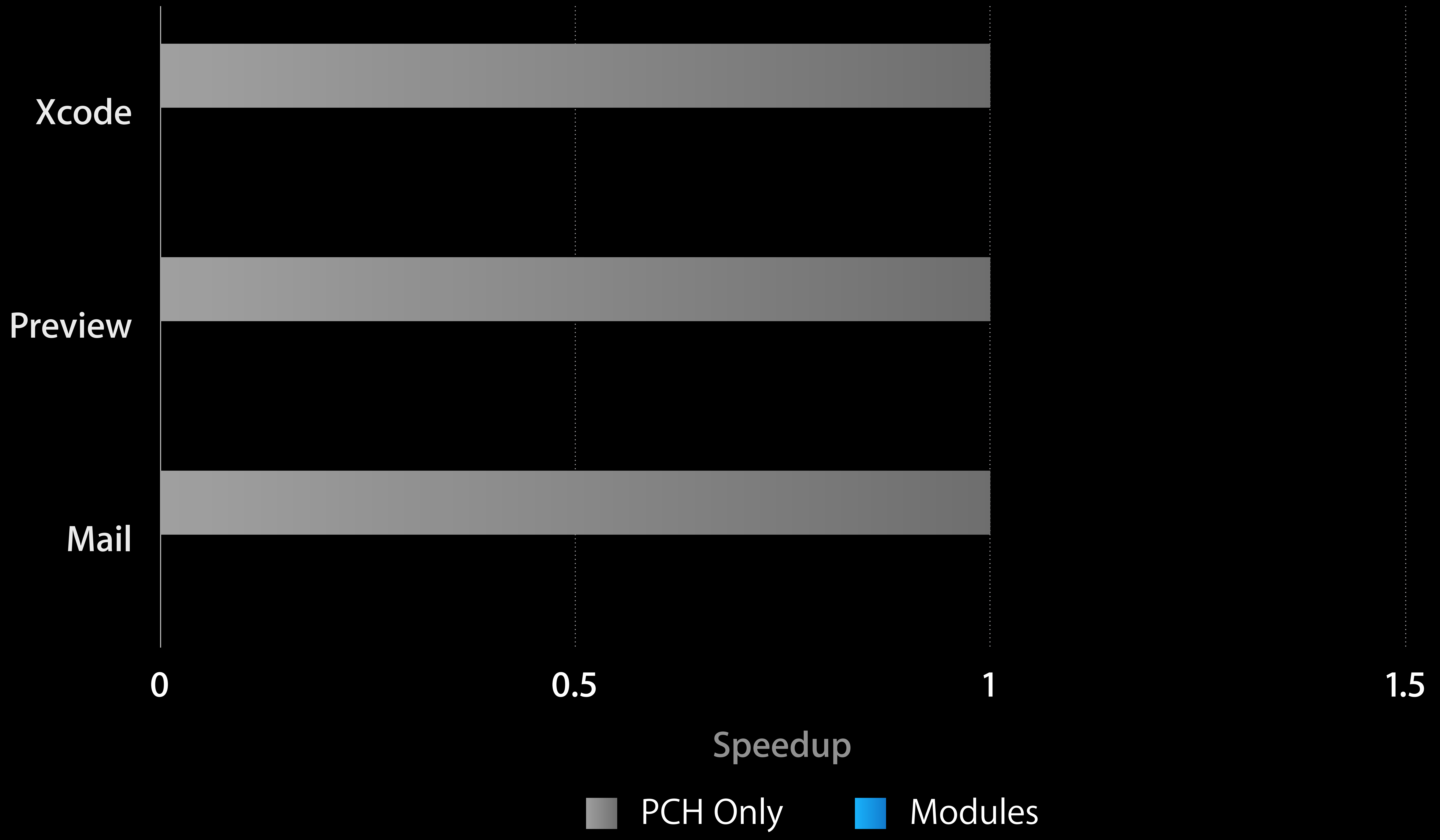
A quick peek under the hood

- Module maps establish relationship between headers and modules:

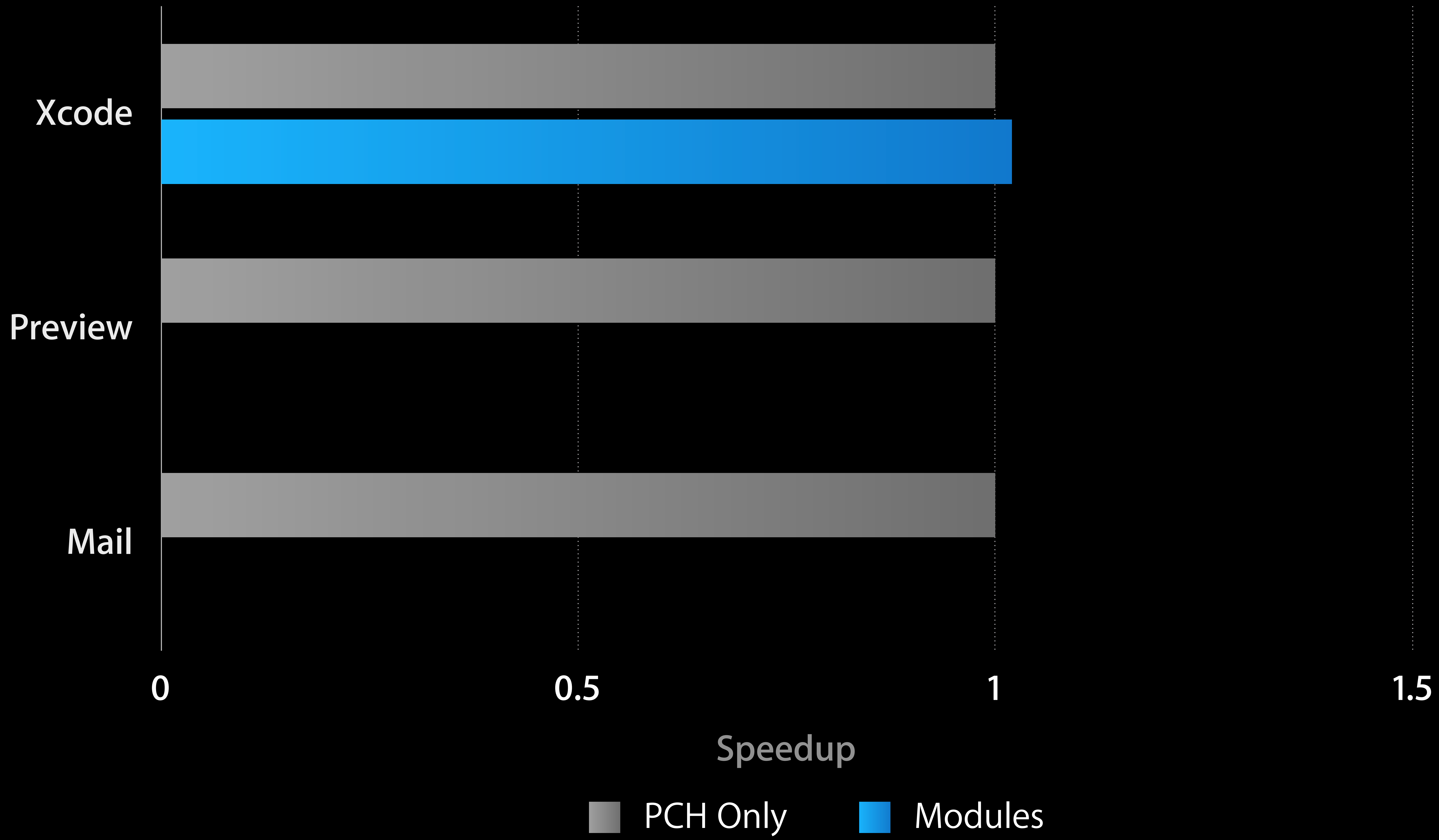
```
framework module UIKit {
  umbrella header "UIKit.h"
  module * { export * }
  link framework "UIKit"
}
```

- Modules automatically built from headers

Build Time Improvements



Build Time Improvements



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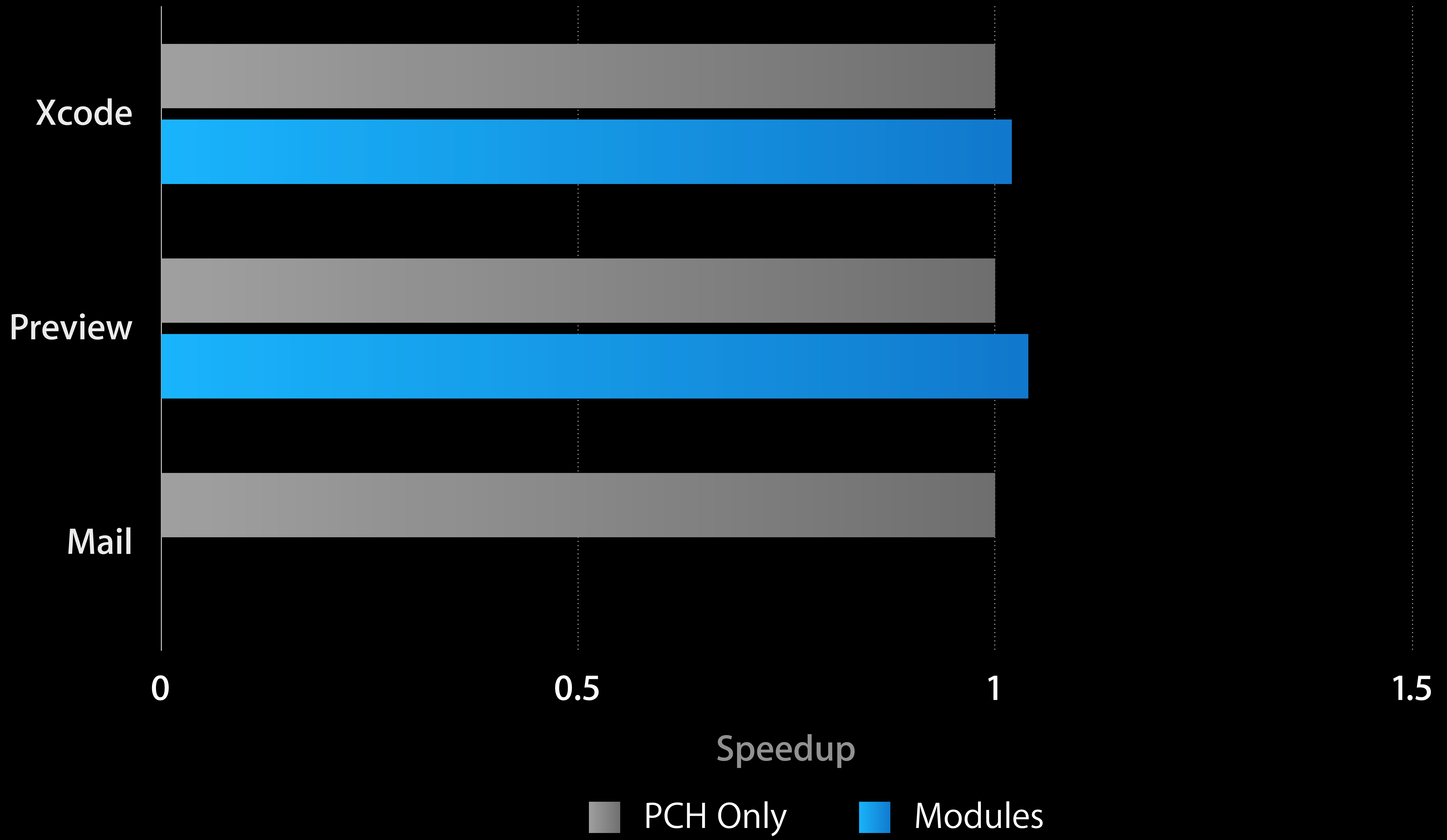
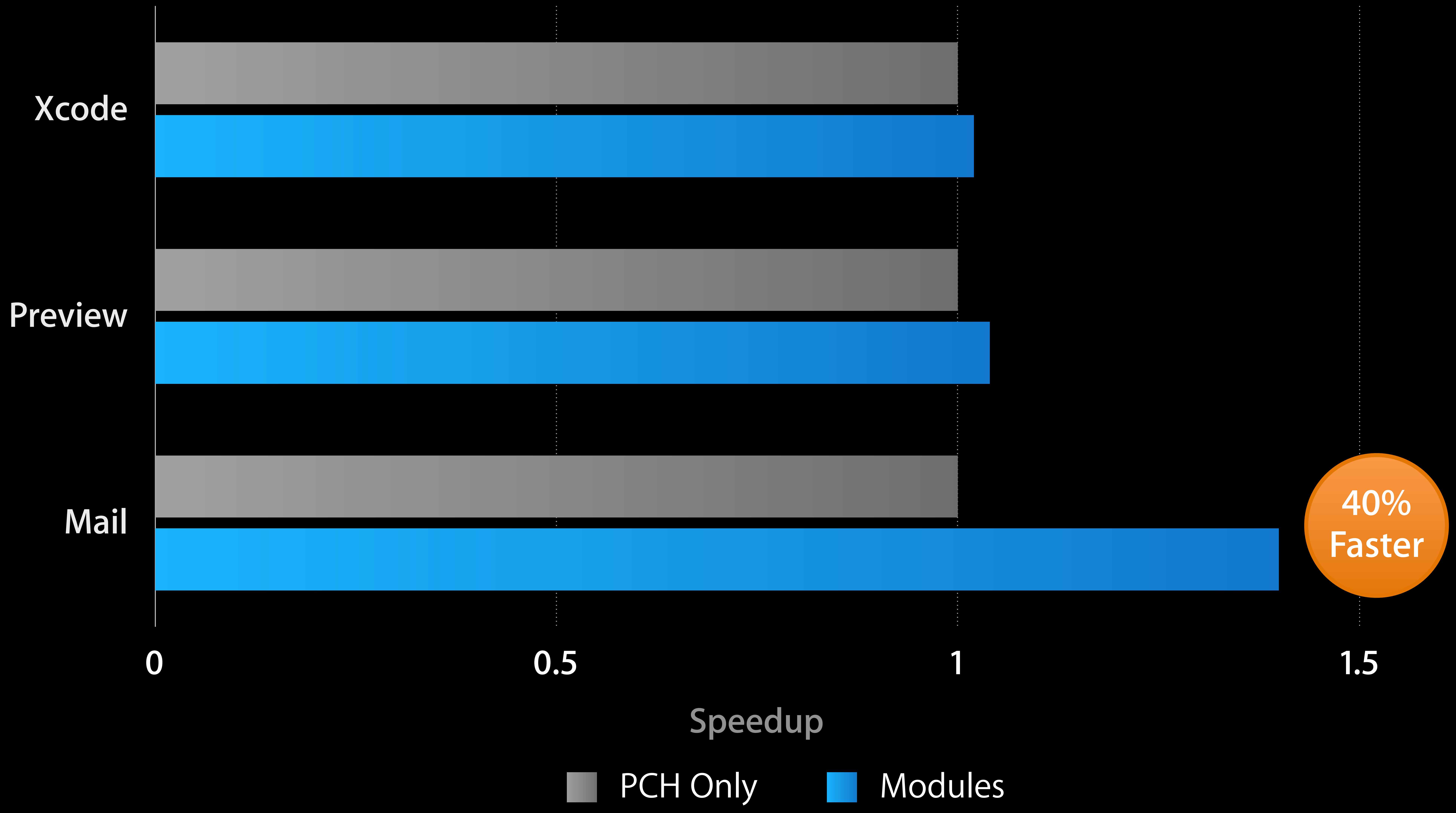
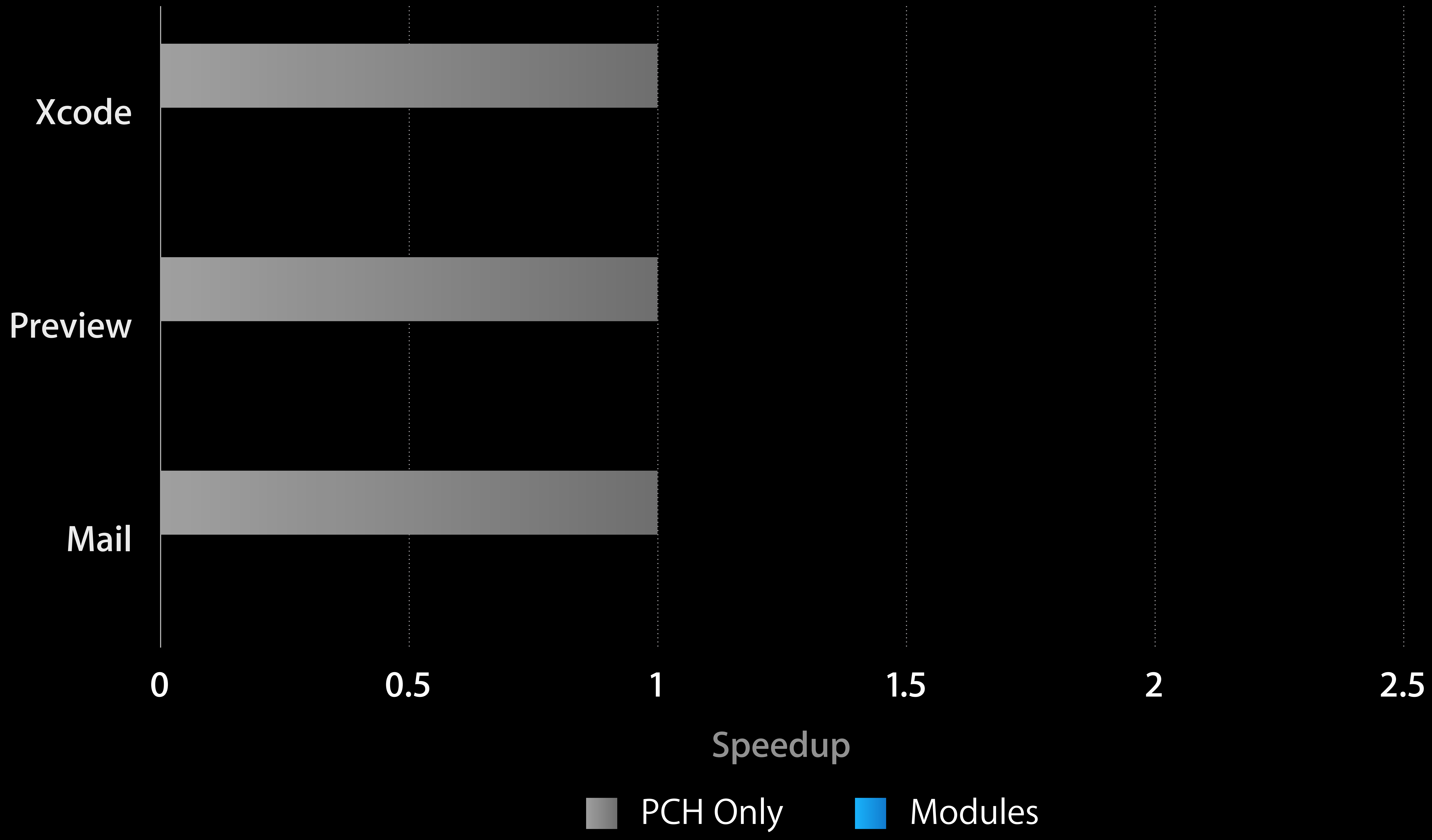


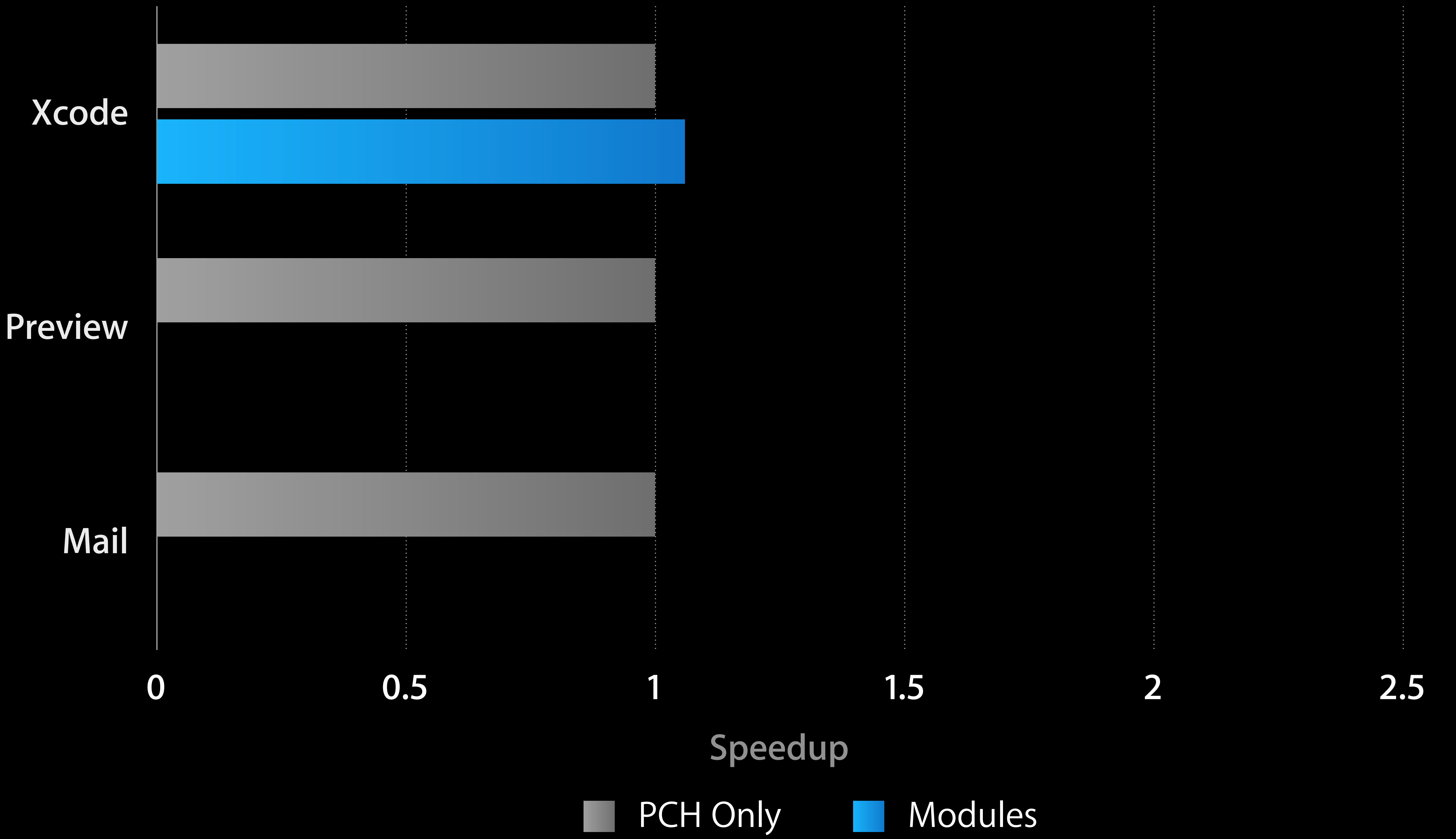
Build Time Improvements



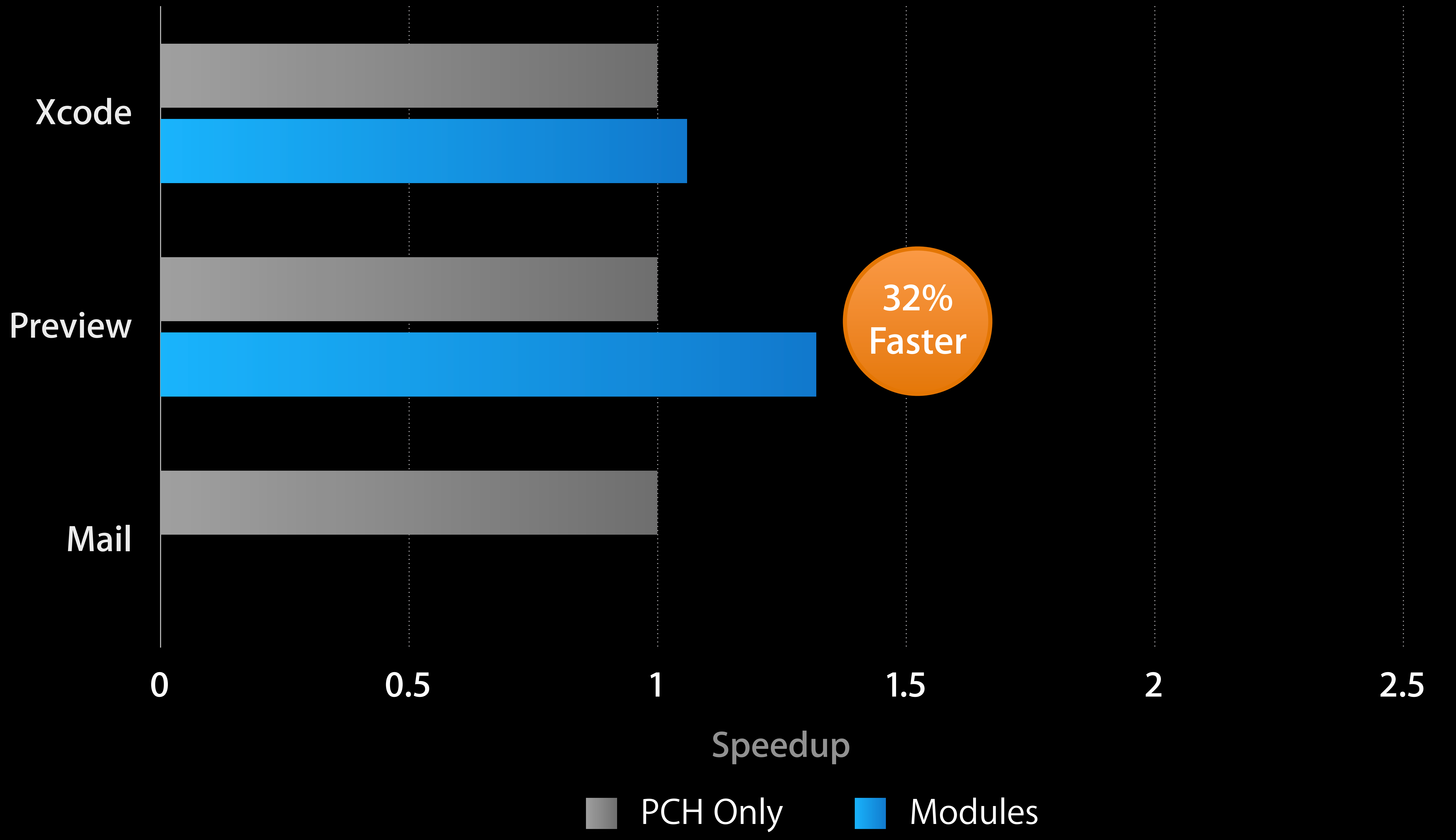
Indexing Time Improvements



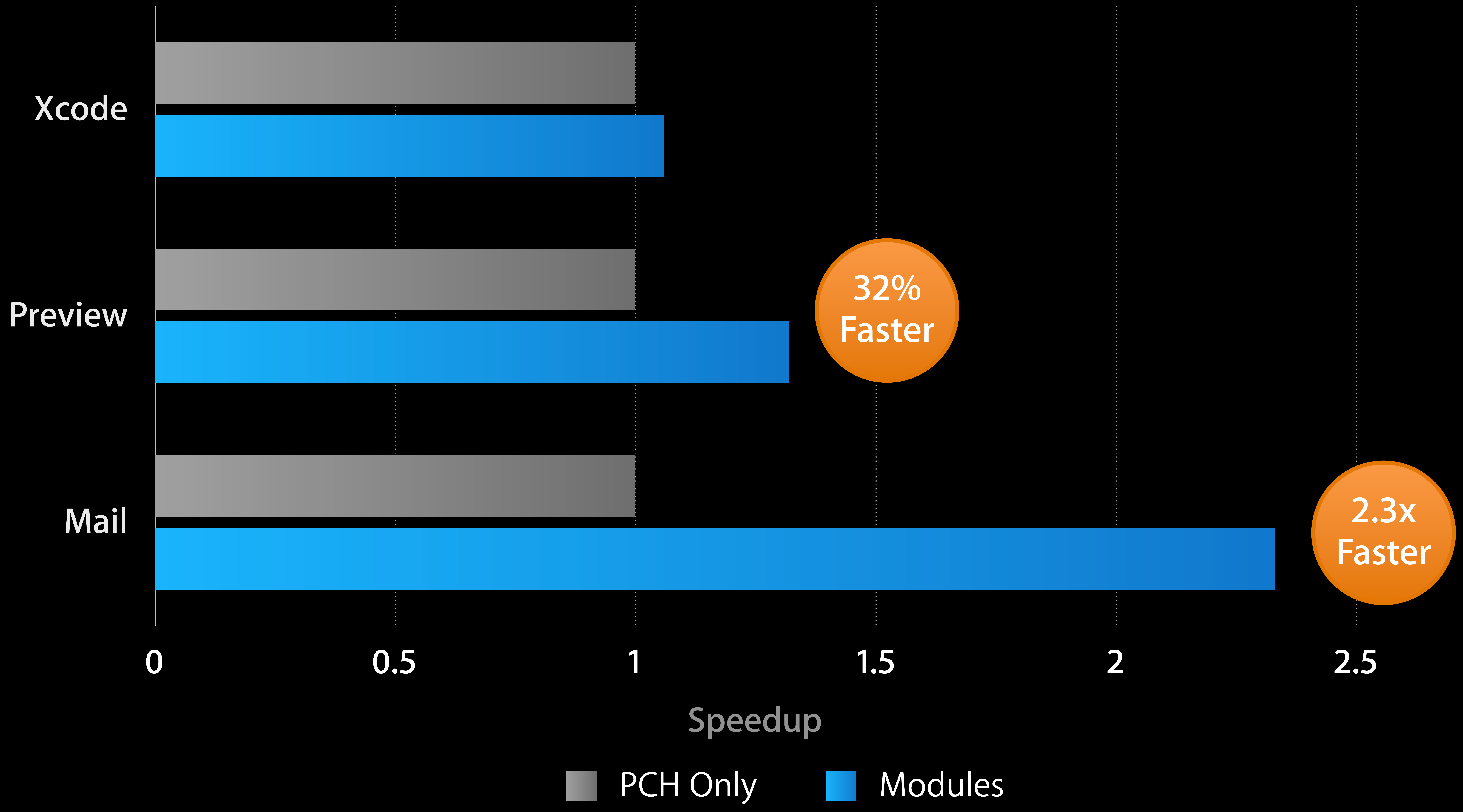
Indexing Time Improvements



Indexing Time Improvements

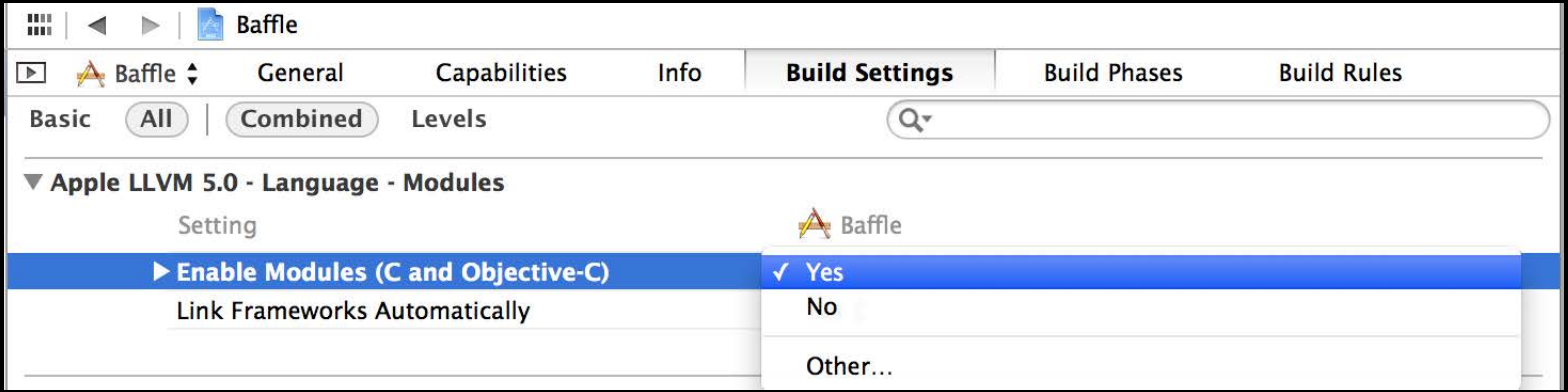


Indexing Time Improvements



Enabling Modules

- Enabled by default in new projects



Apple LLVM 5.0 - Language - Modules

Setting	Baffle
Enable Modules (C and Objective-C)	✓ Yes No Other...
Link Frameworks Automatically	

Enabling Modules

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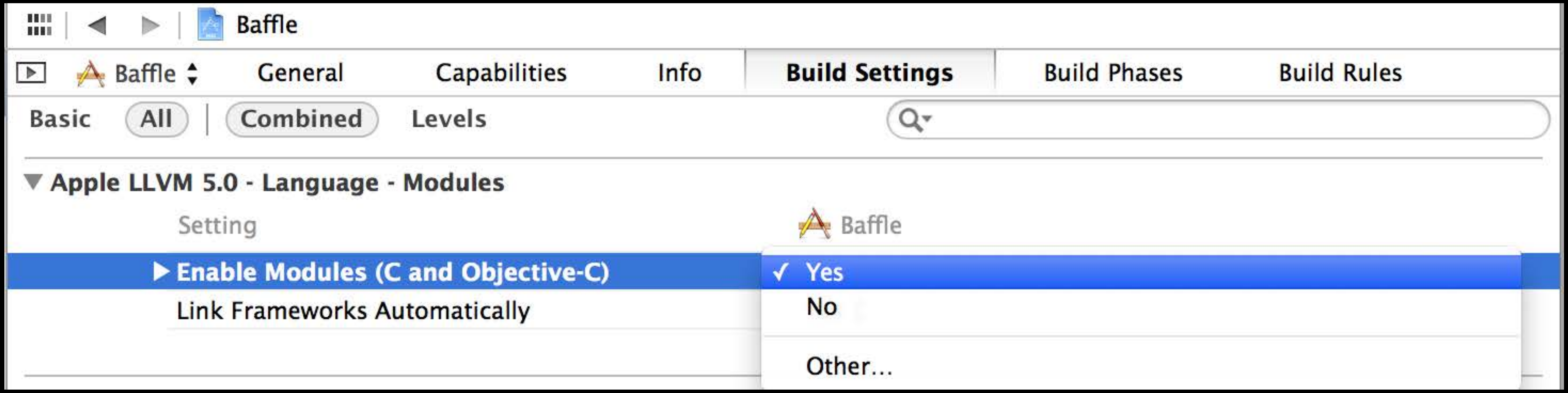


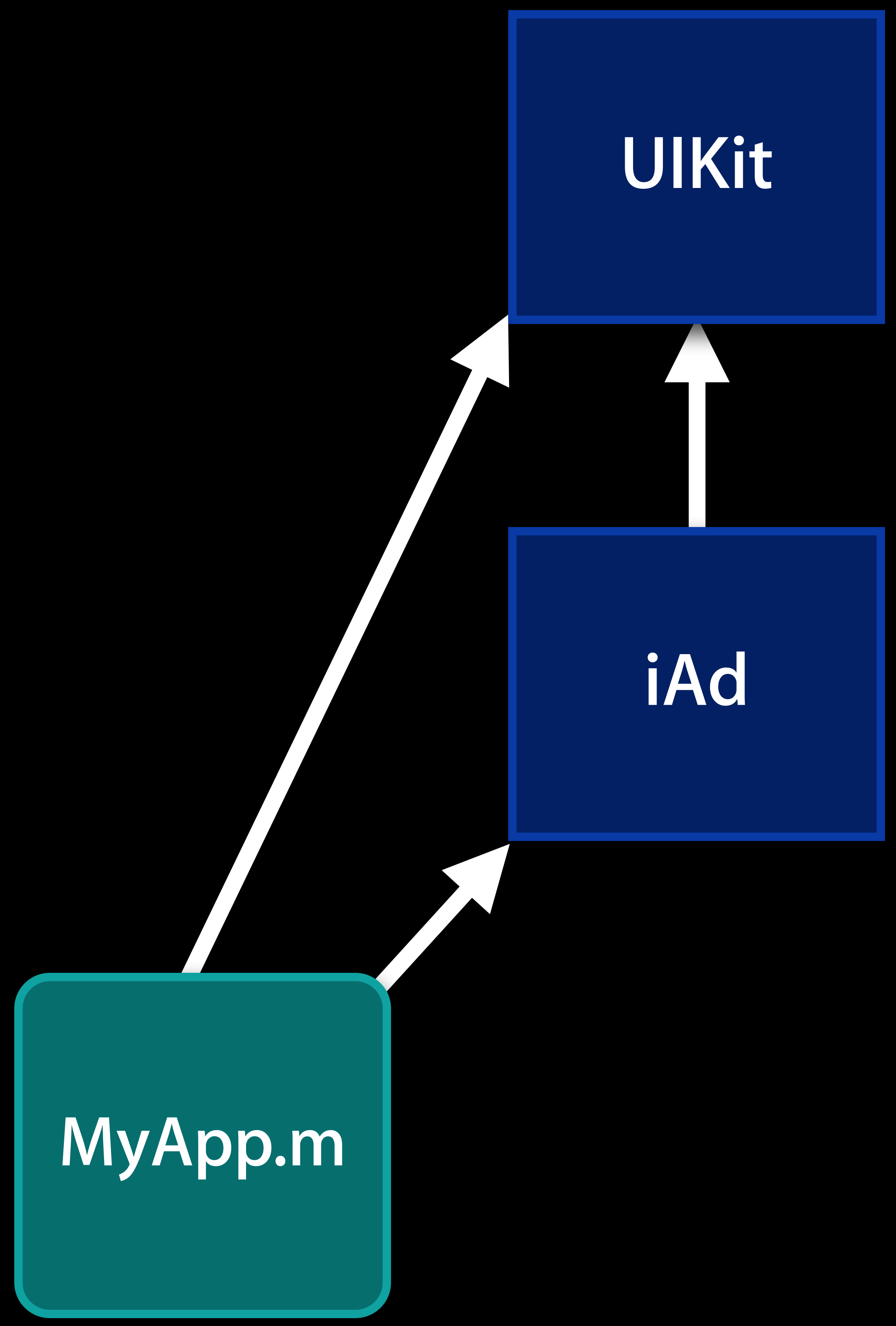
▼ Apple LLVM 5.0 - Language - Modules

Setting	Baffle
▶ Enable Modules (C and Objective-C)	✓ Yes
Link Frameworks Automatically	No
	Other...

- Caveats:
  - Requires iOS 7 / OS X 10.9 SDK
  - Modules implicitly disabled for C++ sources
  - Modules not available for user frameworks

Modules Summary

- Simplify the use of frameworks
    - Semantic import rather than textual inclusion
    - Eliminate separate "link with libraries" step
- Improve performance of source tools
- No source changes required



Advances in Objective-C

Dave Zarzycki
Compiler Runtime Manager

Advances in Objective-C

Advances in Objective-C

- Better productivity
  - Tools support for modernization
  - SDK improvements
  - Block return-type safety
  - The runtime and you

Advances in Objective-C

- Better productivity
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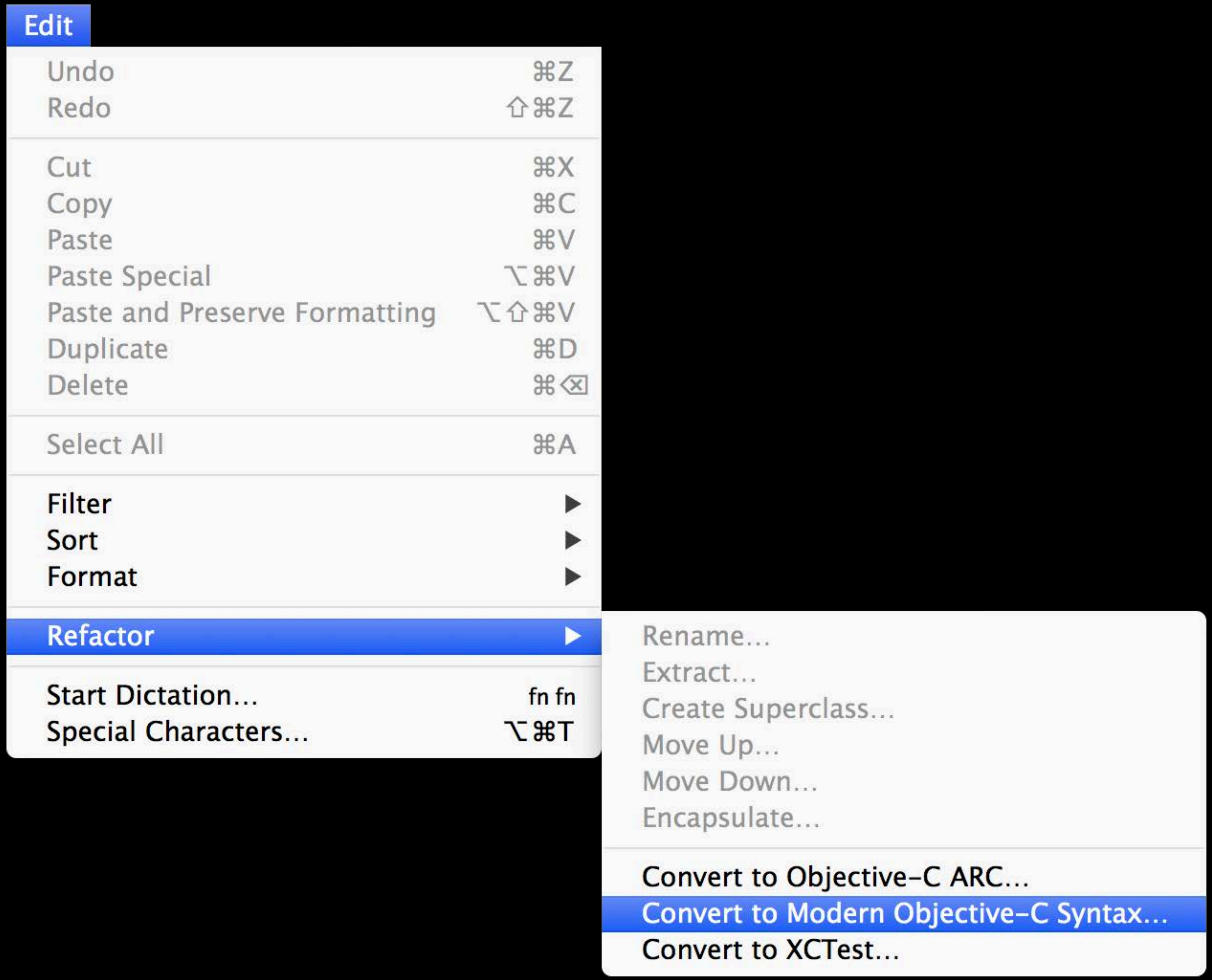
  - The runtime and you
- ARC
  - Updates
  - Improvements

Tools Support for Modernization

Easiest change you can make today!



Reducing Boilerplate

- Object literals
- Container literals
- Subscripting
- Covered in depth during WWDC 2012
    - See talk 405—Modern Objective-C

Literals Before Modern Syntax

```
-(NSDictionary *)example {
    return [NSDictionary dictionaryWithObjectsAndKeys:
       @"Willie",   @"PreferredName",
       @"The Lion", @"NickName",
       @"Smith",    @"LastName",
       @"William",  @"FirstName",
       [NSArray arrayWithObjects: @"Henry", @"Joseph", @"Bonaparte",
          @"Bertholoff", nil], @"MiddleNames",
       [NSNumber numberWithInt: 79],   @"Age",
       [NSNumber numberWithInt: 1893], @"BirthYear",
       [NSNumber numberWithInt: 1973], @"DeathYear",
       [NSNumber numberWithBool: YES], @"Male",
       nil];
}
```

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-(NSDictionary *)example {
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        @"FirstName":     @"William",

        @"MiddleNames":   @[ @"Henry", @"Joseph", @"Bonaparte", @"Bertholoff" ],
        @"Age":           @79,
        @"BirthYear":     @1893,
        @"DeathYear":     @1973,
        @"Male":          @YES
    };
}
```

Containers Before Modern Syntax

```
-(NSString *)swap1:(NSString *)arg {
  NSString *tmp = [_dict objectForKey: @"key"];
  [_dict setObject: arg forKey: @"key"];
  return tmp;
}

-(NSString *)swap2:(NSString *)arg {
  NSString *tmp = [_array objectAtIndex: 0];
  [_array replaceObjectAtIndex: 0 withObject: tmp];
  return tmp;
}
```

Containers Before Modern Syntax

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Containers After Modern Syntax

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-(NSString *)swap1:(NSString *)arg {
   NSString *tmp = _dict[@"key"];
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   return tmp;
}

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   return tmp;
}
```

More to Modern Syntax

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- Boxed expressions via @()

More to Modern Syntax

- Boxed expressions via @()
- Full interaction with C types

More to Modern Syntax

- Boxed expressions via @()
- Full interaction with C types
- How to implement subscripting for your objects

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- Full interaction with C types
- How to implement subscripting for your objects
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  - See 405—Modern Objective-C

SDK Improvements

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- Leveraging the improving compiler
  - Better correctness
  - Better safety
  - Better compile-time error detection

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- Leveraging the improving compiler
  - Better correctness
  - Better safety
  - Better compile-time error detection
- New features and you
  - The “instancetype” keyword
  - Explicitly-typed enums

Return Type Correctness

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```
-(NSDictionary *)exampleFactoryUsage {
    NSDictionary *var = [NSArray array];
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-(NSDictionary *)exampleFactoryUsage {
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}
```

```
warning: incompatible pointer types initializing
'NSDictionary *' with an expression of type 'NSArray
*' [-Wincompatible-pointer-types]
    NSDictionary *var = [NSArray array];
                  ^     ~~~~~~~~~~~~~~~
```

How Does the Compiler Know?

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```
+(id)array;
```

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- Implicitly converts to any object type

How Does the Compiler Know?

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+(instancetype)array;
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How Does the Compiler Know?

```
+(instancetype)array;
```

- A contextual keyword
- Only for return types
- Subclasses do not need to redeclare “instancetype” methods
- The compiler contextually matches the return type to the receiver

Subclasses and “instancetype”

Implicitly does what you want

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```
@interface Foobar : NSArray
@end
// ...
NSDictionary *var = [Foobar array];
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Subclasses and “instancetype”

Implicitly does what you want

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Explicitly-Typed Enums

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NSURLHandleStatus status = NSURLSessionTaskStateRunning;
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Explicitly-Typed Enums

```
NSURLHandleStatus status = NSURLSessionTaskStateRunning;
```

- Copy-and-paste errors are easy
- Refactoring errors are easy
- Enums are global integers

Explicitly-Typed Enums

```
NSURLHandleStatus status = NSURLSessionTaskStateRunning;
```

```
warning: implicit conversion from enumeration type 'enum
NSURLSessionTaskState' to different enumeration type
'NSURLHandleStatus' (aka 'enum NSURLHandleStatus')
[-Wenum-conversion]
NSURLHandleStatus status = NSURLSessionTaskStateRunning;
                  ~~~~~~   ^~~~~~~~~~~~~~~~~~~~~~~~~~~
```

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```
enum { ABC, JKL, XYZ };
typedef NSUInteger MyEnum;
```

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- Traditional C enums are implicitly “int”

How Does the Compiler Know?

```
enum MyEnum : NSUInteger { ABC, JKL, XYZ };
typedef MyEnum MyEnum;
```

- Traditional C enums are implicitly “int”
- Enums now support a fixed underlying type
- Covered in depth during WWDC 2012
    - See talk 405—Modern Objective-C

Convenient Foundation Macros

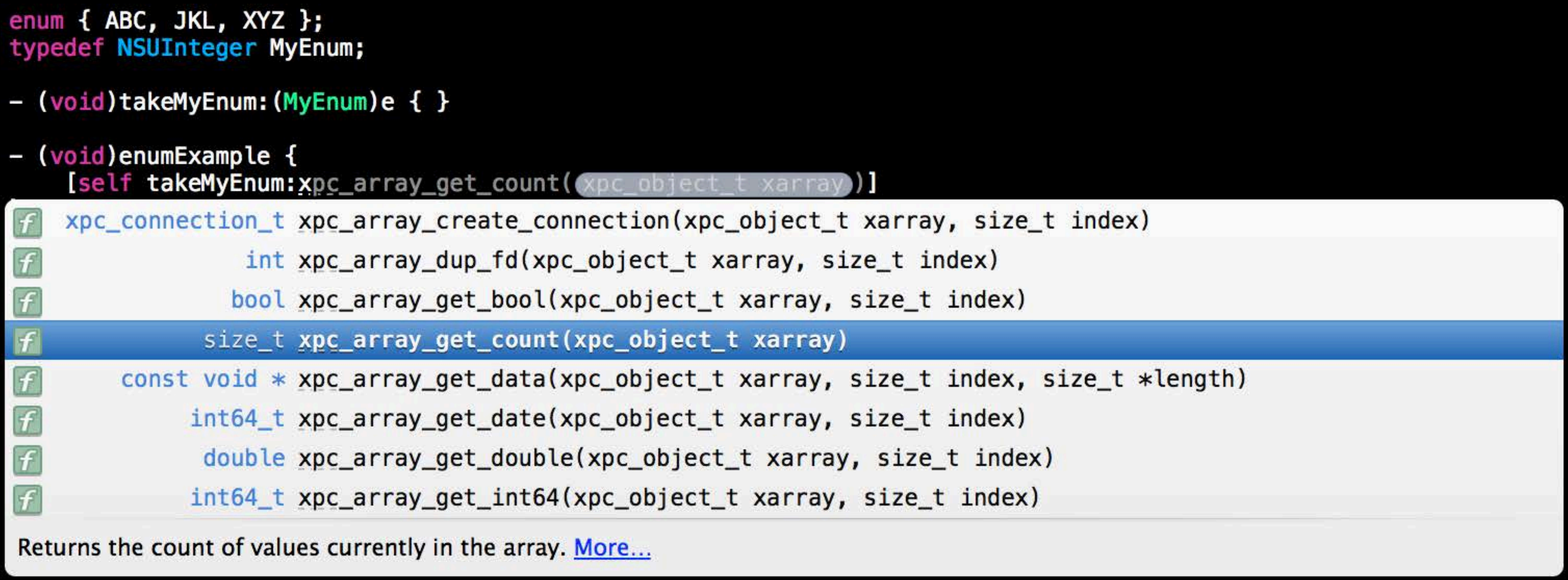
Convenient Foundation Macros

```
typedef NS_ENUM(NSUInteger, MyEnum) { ABC, JKL, XYZ };

typedef NS_OPTIONS(NSUInteger, MyOptions) {
    kFaster  = (1 << 3),
    kBetter  = (1 << 4),
    kAwesome = (1 << 5)
};
```

Code Completion Before NS_ENUM()

Code Completion Before NS_ENUM()



```
enum { ABC, JKL, XYZ };
typedef NSUInteger MyEnum;

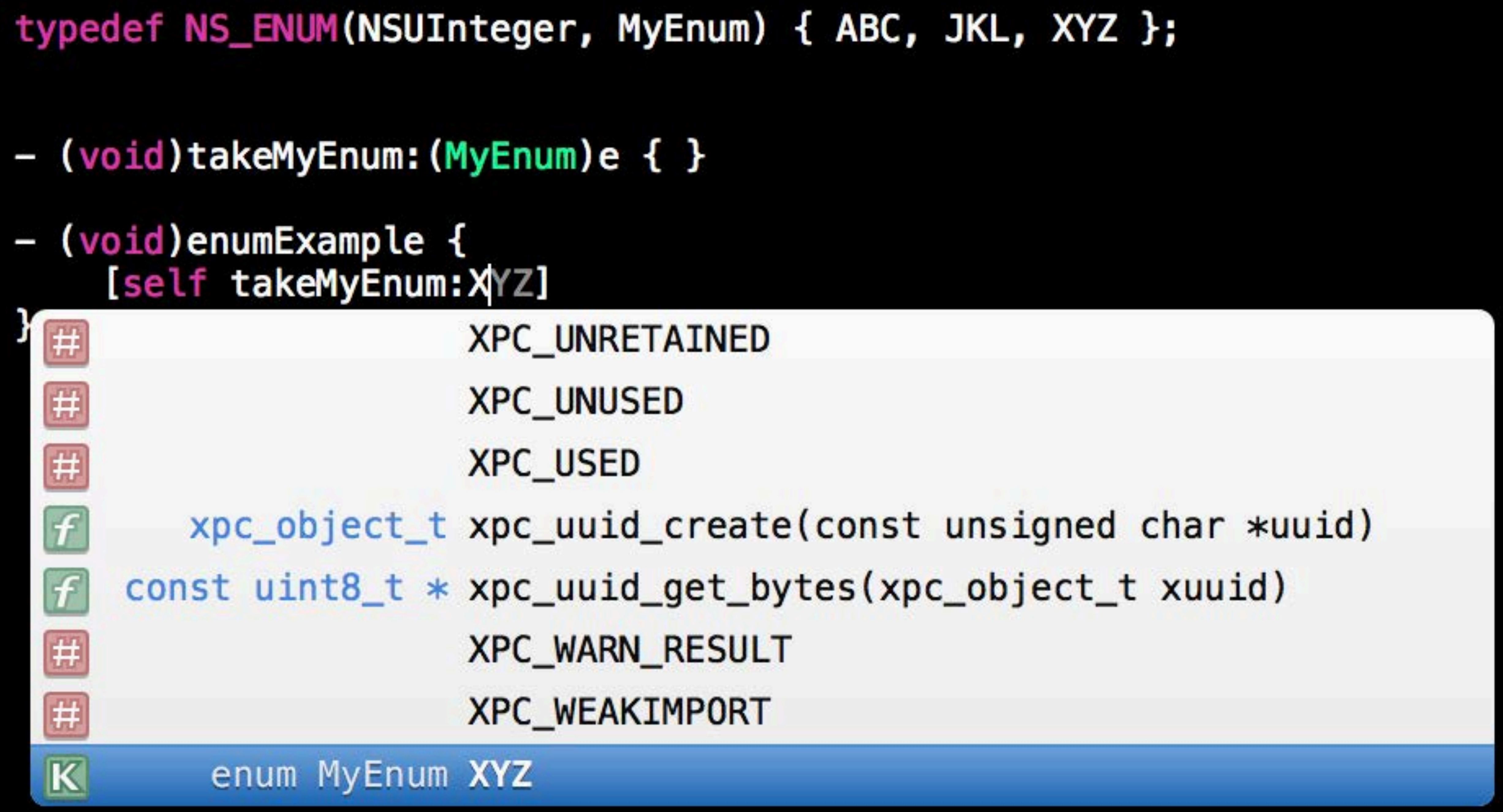
- (void)takeMyEnum:(MyEnum)e { }

- (void)enumExample {
    [self takeMyEnum:xpc_array_get_count(xpc_object_t xarray)]
```

```
f xpc_connection_t xpc_array_create_connection(xpc_object_t xarray, size_t index)
f              int xpc_array_dup_fd(xpc_object_t xarray, size_t index)
f             bool xpc_array_get_bool(xpc_object_t xarray, size_t index)
f           size_t xpc_array_get_count(xpc_object_t xarray)
f     const void * xpc_array_get_data(xpc_object_t xarray, size_t index, size_t *length)
f          int64_t xpc_array_get_date(xpc_object_t xarray, size_t index)
f           double xpc_array_get_double(xpc_object_t xarray, size_t index)
f          int64_t xpc_array_get_int64(xpc_object_t xarray, size_t index)
```

Returns the count of values currently in the array. More...

Code Completion After NS_ENUM()



```
typedef NS_ENUM(NSUInteger, MyEnum) { ABC, JKL, XYZ };

- (void)takeMyEnum:(MyEnum)e { }

- (void)enumExample {
    [self takeMyEnum:XYZ]
}
```

```
#                     XPC_UNRETAINED
#                     XPC_UNUSED
#                     XPC_USED
f        xpc_object_t xpc_uuid_create(const unsigned char *uuid)
f   const uint8_t *   xpc_uuid_get_bytes(xpc_object_t xuuid)
#                     XPC_WARN_RESULT
#                     XPC_WEAKIMPORT
K         enum MyEnum XYZ
```

Return-type Inference

```
myNSArray = [myNSArray sortedArrayUsingComparator: ^(id lhs, id rhs) {
     if (...) {
       return NSOrderedAscending;
     } else {
       return NSOrderedDescending;
     }
}
```

Return-type Inference

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}
```

```
error: incompatible block pointer types sending 'int (^)(id, id)' to
parameter of type 'NSComparator' (aka 'NSComparisonResult (^)(id, id)')
myNSArray = [myNSArray sortedArrayUsingComparator: ^(id lhs, id rhs) {
                                                   ^
```

Return-type Inference

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myNSArray = [myNSArray sortedArrayUsingComparator: ^(id lhs, id rhs) {
     if (...) {
       return (NSComparisonResult)NSOrderedAscending;
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}
```

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myNSArray = [myNSArray sortedArrayUsingComparator: ^(id lhs, id rhs) {
                                                   ^
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- Implicitly typed enums can require more casting
- NS_ENUM() helps you avoid casting

Return-type Inference

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- Implicitly typed enums can require more casting
- NS_ENUM() helps you avoid casting

Return-type Inference

```
-(void)returnInference:(BOOL)arg {
    someAPI(^{
        if (arg) return NSURLHandleLoadSucceeded;
        else return NSURLSessionTaskStateRunning;
    });
}
```

Return-type Inference

```
-(void)returnInference:(BOOL)arg {
    someAPI(^{
        if (arg) return NSURLHandleLoadSucceeded;
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    });
}
```

- Implicit enums create silent bugs
- NS_ENUM() helps the compiler produce an error

Return-type Inference

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-(void)returnInference:(BOOL)arg {
    someAPI(^{
        if (arg) return NSURLHandleLoadSucceeded;
        else return NSURLSessionTaskStateRunning;
    });
}
```

```
error: return type 'NSURLSessionTaskState' must match previous return type
'NSURLHandleStatus' when block literal has unspecified explicit return type
                else NSURLSessionTaskStateRunning;
                     ^
```

The Objective-C Runtime

The core of the language

The Objective-C Runtime

The core of the language

- Enables dynamic behavior
- Method dispatch
- Object introspection
- Object proxies
- Dynamic class construction and replacement

The Runtime Enables Innovation

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- Many features have been added over the years
- The heart of these features are in the runtime
- Examples:
    - Key-Value observing
    - Associated objects
    - @synchronized
    - Weak references
    - Tagged pointers
    - etc.

Tagged Pointers

Example innovation

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- Added to 64-bit Cocoa
  - For small value-like objects
  - NSNumber, NSDate, etc.

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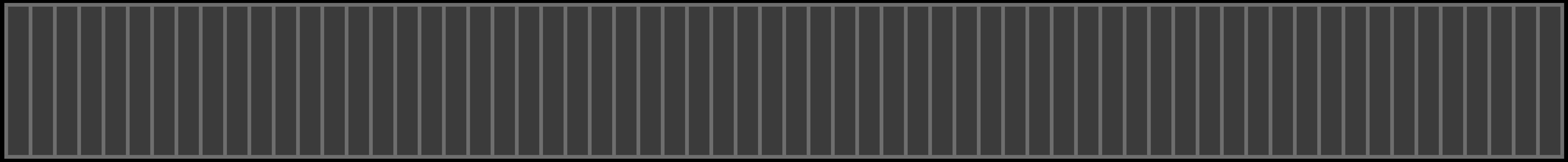
Tagged Pointers

Example innovation

- Added to 64-bit Cocoa
    - For small value-like objects
    - NSNumber, NSDate, etc.
- Stores object in the pointer itself
    - No malloc/free overhead
- Performance
    - Three times more space efficient!
    - 106 times faster to allocate/destroy!

How Tagged Pointers Work

Optimizing bits

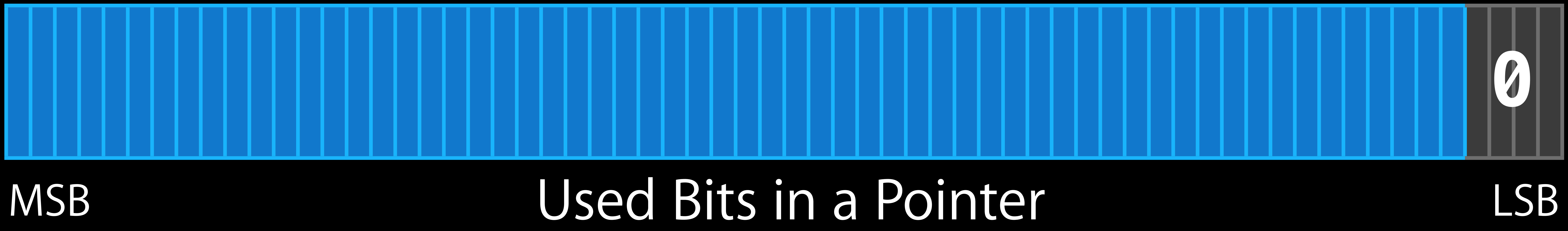


MSB

LSB

How Tagged Pointers Work

Optimizing bits



How Tagged Pointers Work

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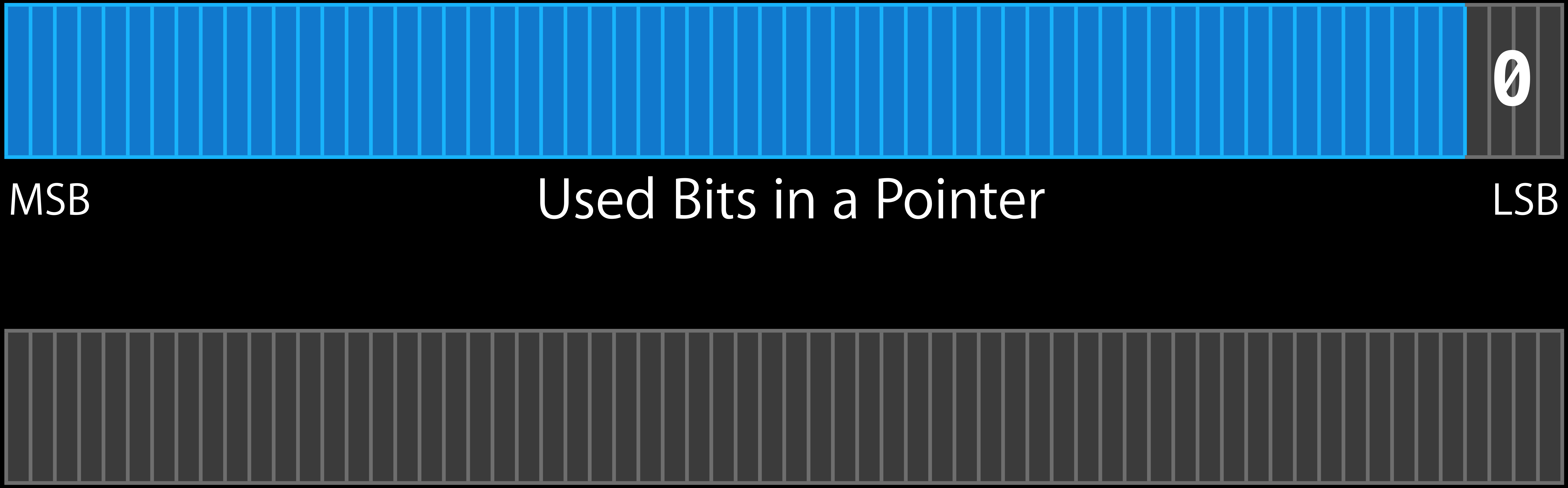

How Tagged Pointers Work

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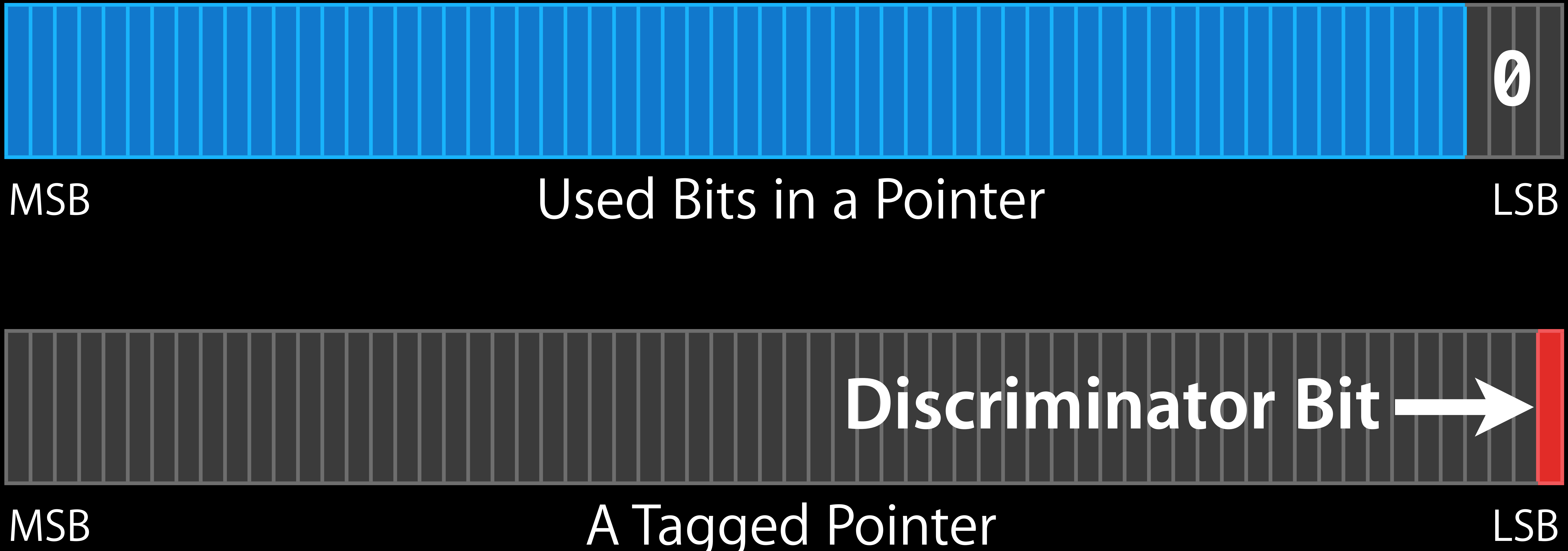

How Tagged Pointers Work

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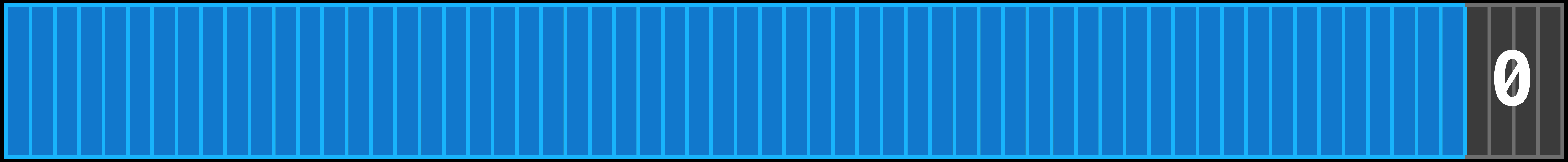
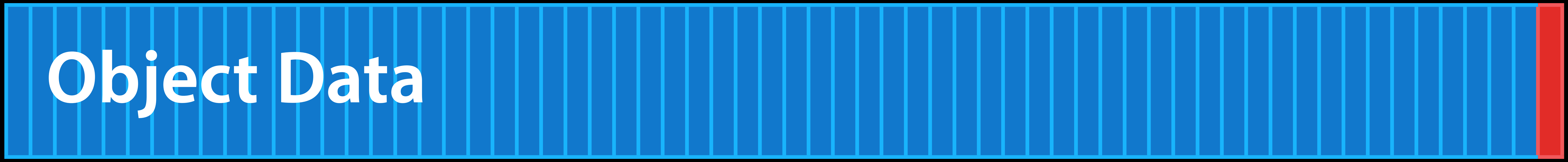


MSB Used Bits in a Pointer LSB



MSB A Tagged Pointer LSB

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An implementation detail

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- Most apps are well behaved
    - Use API to introspect or update
    - This lets us innovate considerably!

Tagged Pointers and You

An implementation detail

- The runtime data is almost all private
  - The remaining public data structures are becoming private
- Most apps are well behaved
  - Use API to introspect or update
  - This lets us innovate considerably!
- New warnings
  - Tagged pointers
  - Raw ‘isa’ access

New Tagged Pointer and Raw ISA Warnings

```
-(BOOL)exampleTagUsage:(NSObject *)arg {
    if (((long)arg & 1) == 0) return arg->isa == cachedValue;
    else return [arg isKindOfClass: cachedValue];
}
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             ~~~~~~~~~ ^
error: direct access to Objective-C's isa is deprecated in favor of
object_getClass() [-Werror,-Wdeprecated-objc-isa-usage]
        if (((long)arg & 1) == 0) return arg->isa == cachedValue;
                                              ^
```

New Tagged Pointer and Raw ISA Warnings

```
-(BOOL)exampleTagUsage:(NSObject *)arg {
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}
```

- We want to unlock the next level of innovation
- Please use `-isKindOfClass:` or `object_getClass()`
- Failure to do so may break your code in the future!

Garbage Collection

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- Only available on the Mac

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- Not supported by new frameworks
  - AVKit, Accounts, GameController, GameKit, MapKit, Social, SpriteKit, etc.
- *Please* use the ARC migrator to transition off GC

Automatic Reference Counting

Updates and improvements

ARC Update

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- Cocoa is designed with reference counting semantics
    - Deterministic object destruction order is important!
    - Great for debugging too

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- Cocoa is designed with reference counting semantics
    - Deterministic object destruction order is important!
    - Great for debugging too
- ARC helps you write great Cocoa code
    - Allows you to focus on what matters, your app
- Majority of new app store submissions use ARC

ARC and Xcode 5.0

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- Xcode now uses ARC
  - Was a large GC app

ARC and Xcode 5.0

- Xcode now uses ARC
  - Was a large GC app
- Better developer experience
  - Determinism
  - Debugging
  - Performance

ARC and Performance

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- __weak references are about 2x faster on iOS 7.0 and OSX 10.9
- More predictable memory usage in debug builds
- Lifetime of autoreleased objects is more like release builds

ARC Migrator

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- The migrator does the “heavy lifting”
    - Removes retain/release/autorelease
    - Removes empty dealloc methods
    - Converts NSAutoreleasePool to @autoreleasepool

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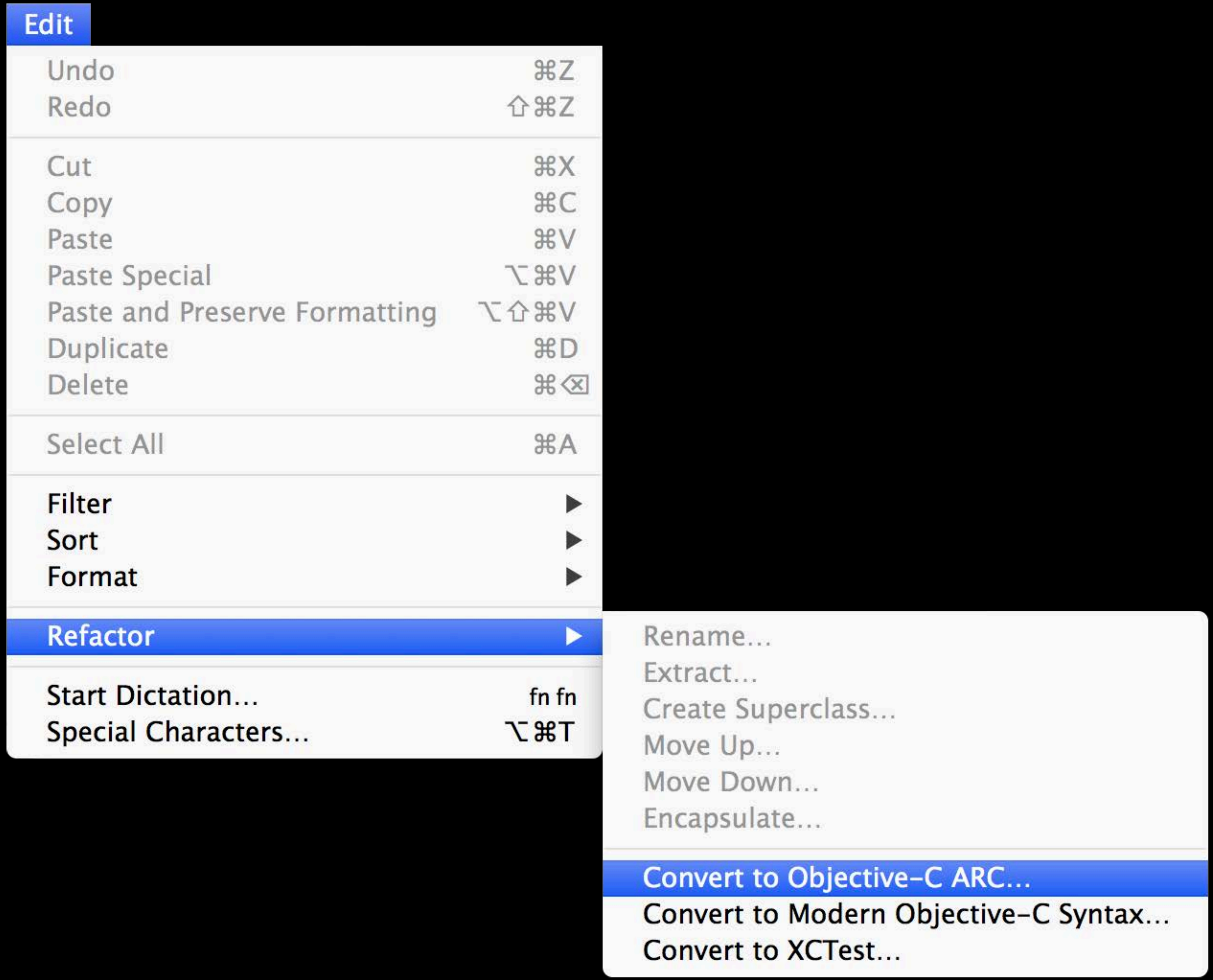
  - “id” in structs (rare)
  - Atypical uses of memory management API
- Covered in depth during WWDC 2012

ARC Migrator



ARC and Your App

ARC and Your App

- Switch to ARC by default
  - Can opt out specific files

ARC and Your App

- Switch to ARC by default
  - Can opt out specific files
- The ARC migrator supports
  - Manual retain/release code
  - Garbage-collected code

New Memory Management Warnings

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- Help you reason about object lifetime

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New Memory Management Warnings

NEW

- Help you reason about object lifetime
- Implicit retain of 'self' within blocks
- Repeatedly using a __weak reference
- Sending messages to __weak pointers

Understanding Retain Cycles

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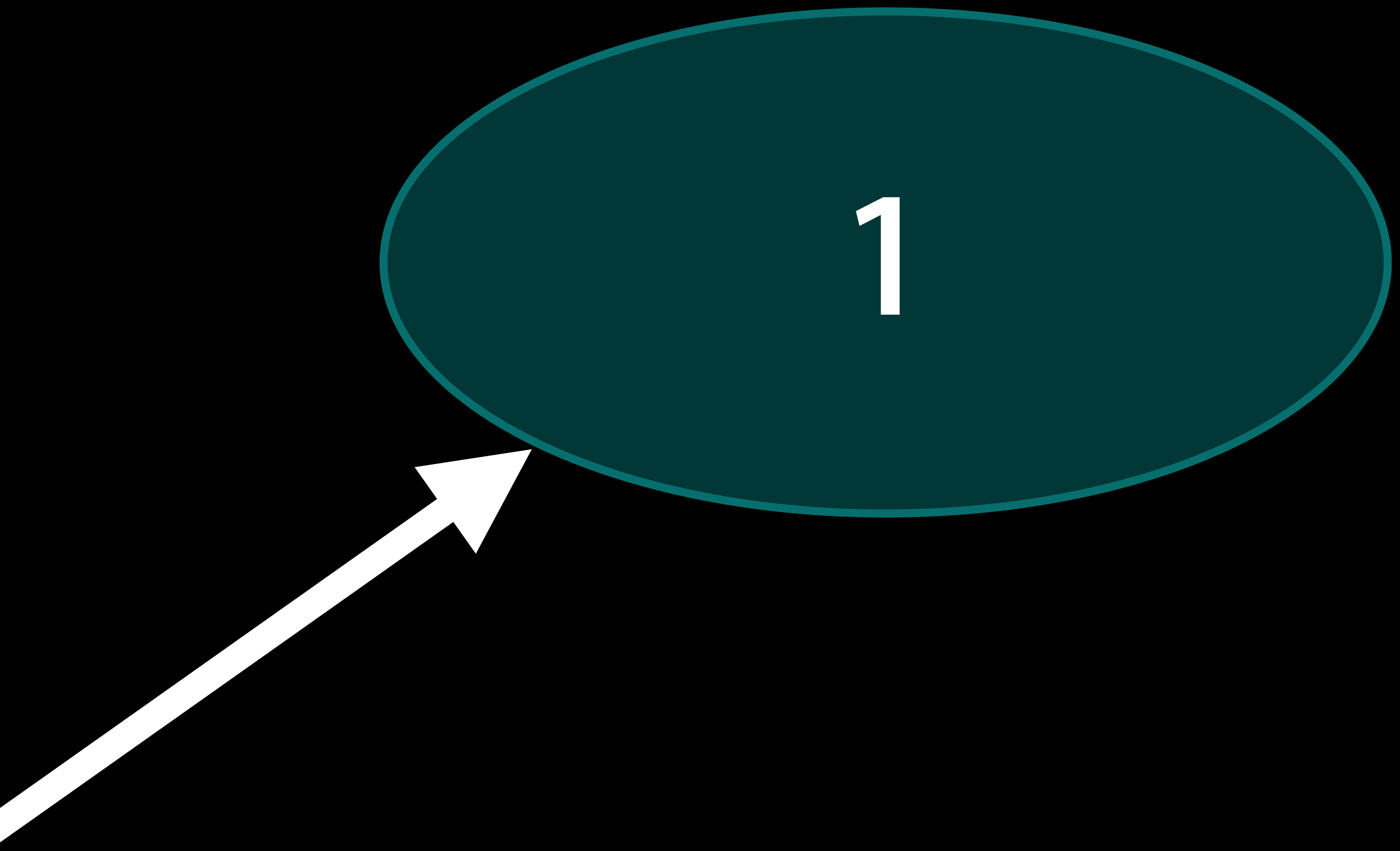
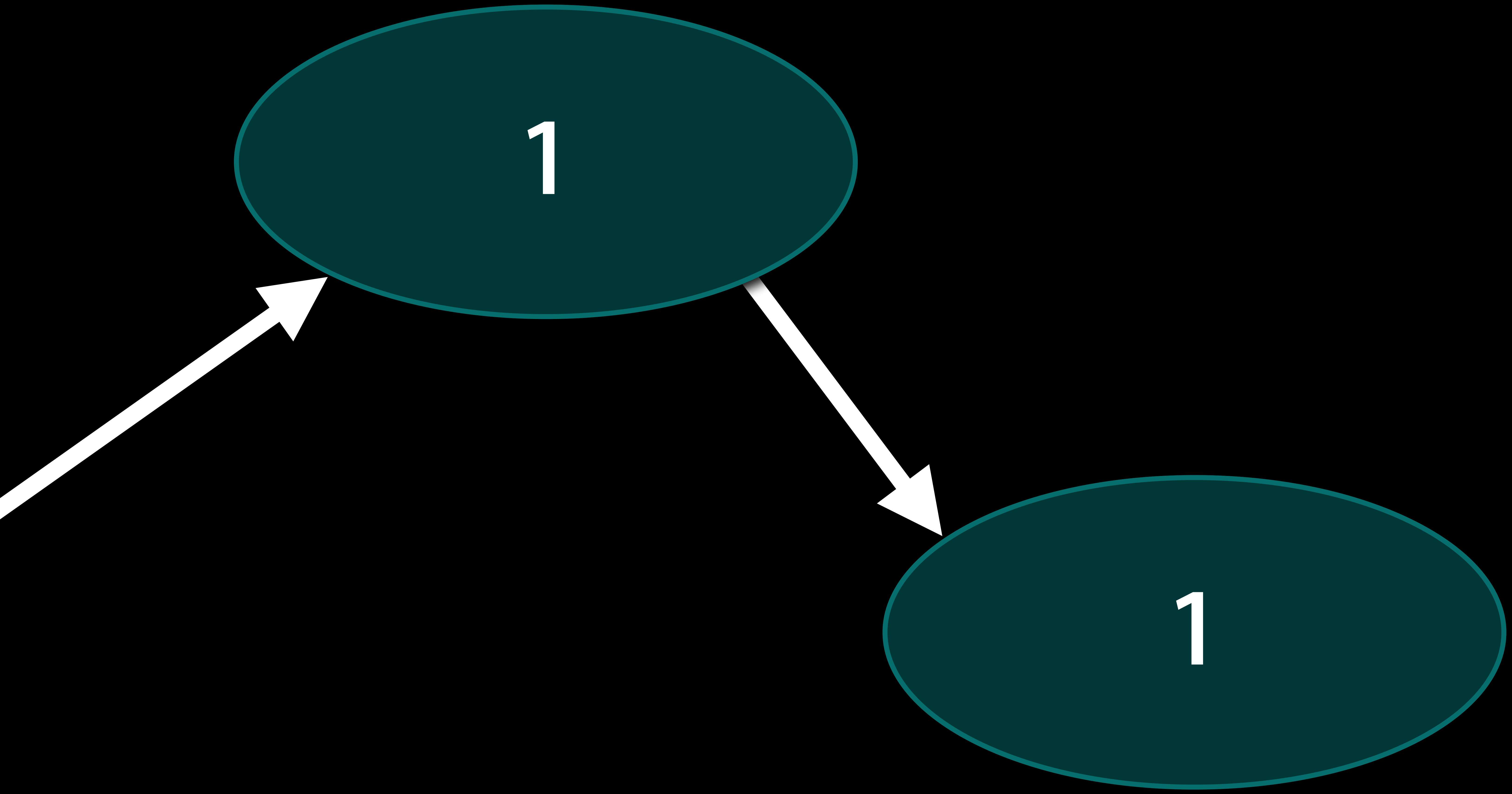
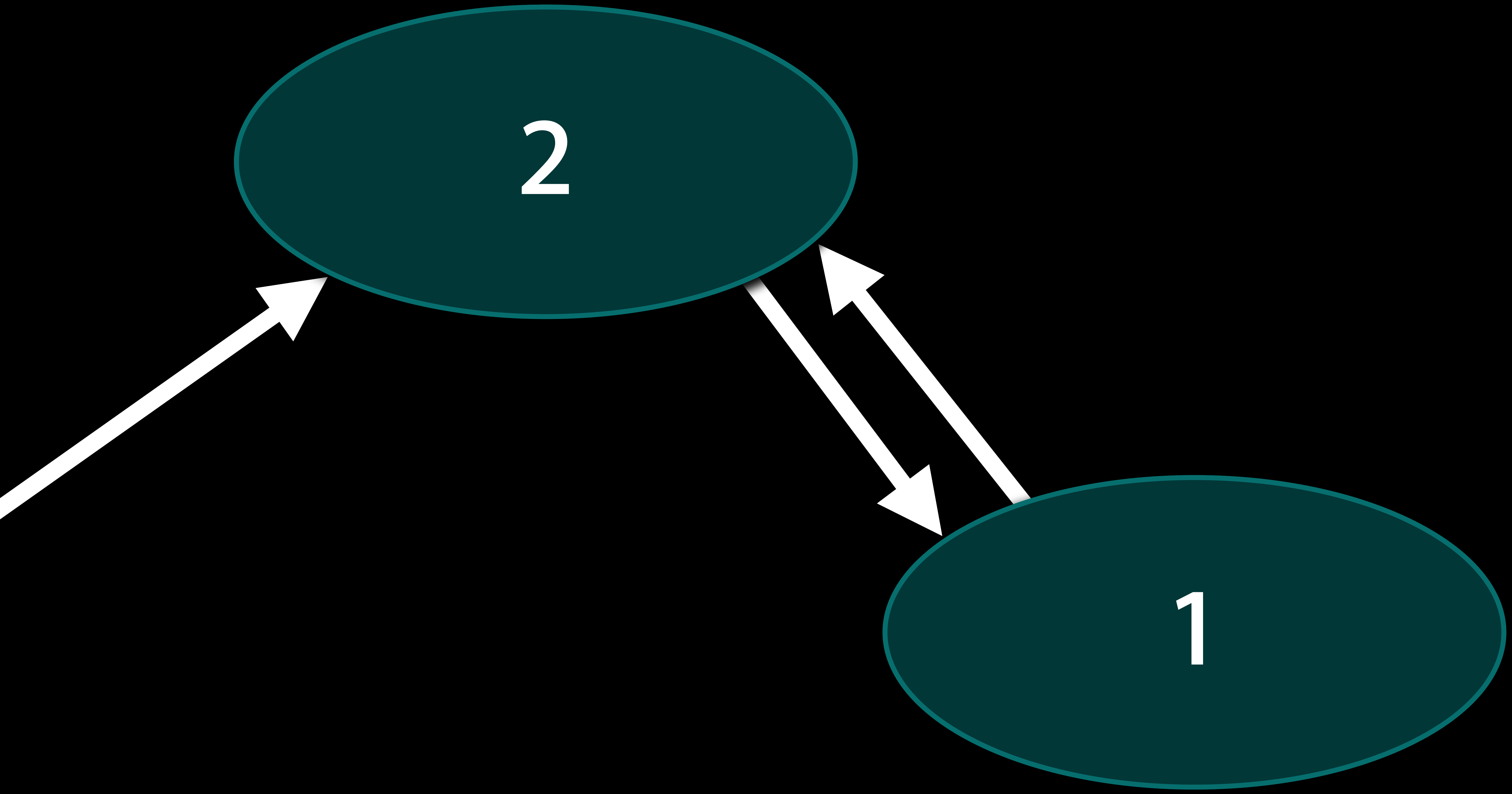


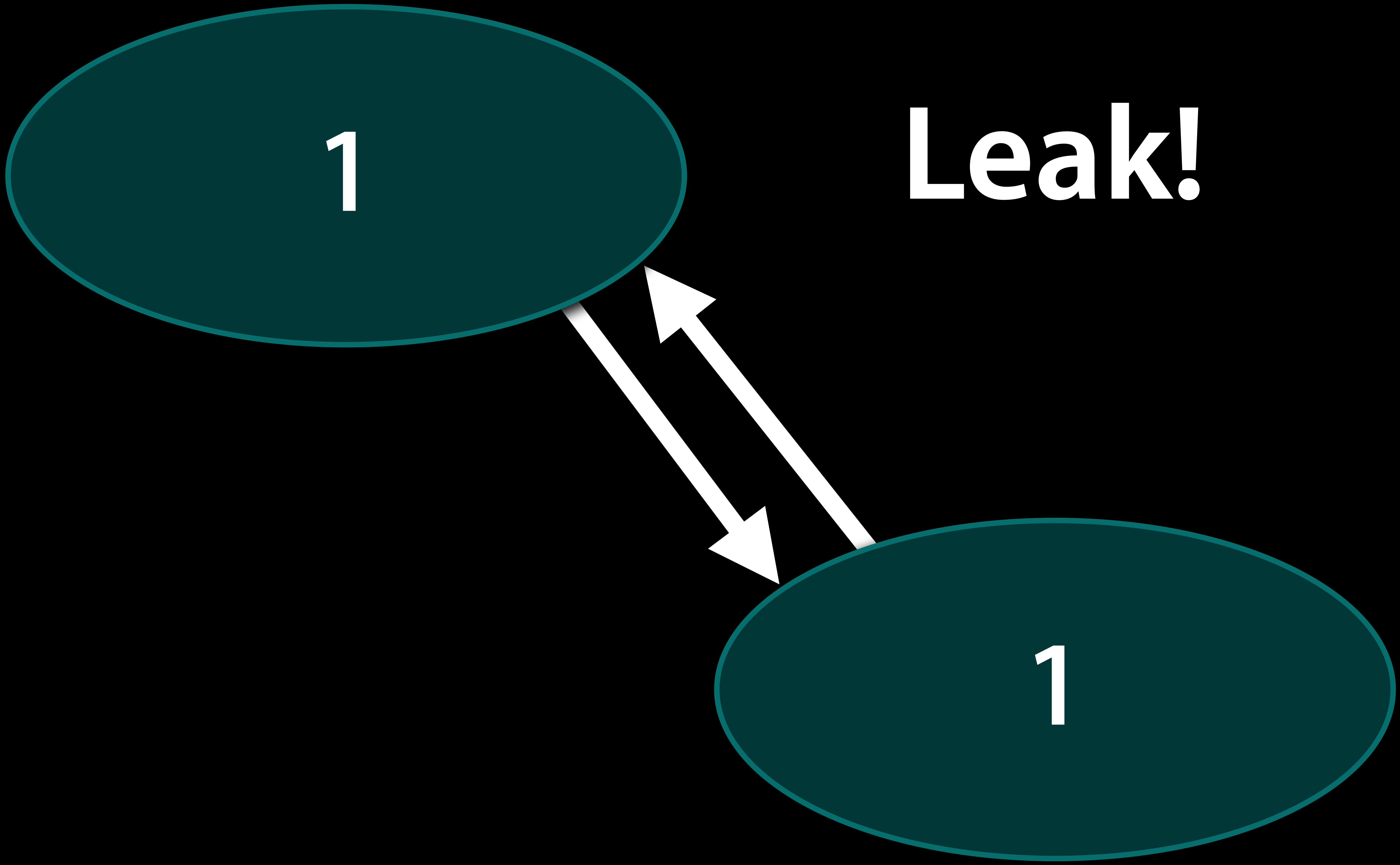
Understanding Retain Cycles



Understanding Retain Cycles



Understanding Retain Cycles



Leak!

Potential Retain Cycle Warning

```
- (void)example {
    _ivar = ^{
        [_ivar2 class];
    };
}
```

Potential Retain Cycle Warning

```
- (void)example {
    self->_ivar = ^{
        [self->_ivar2 class];
    };
}
```

Potential Retain Cycle Warning

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    self->_ivar = ^{
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```

- The compiler implicitly references ‘self’

Potential Retain Cycle Warning

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Potential Retain Cycle Warning

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}
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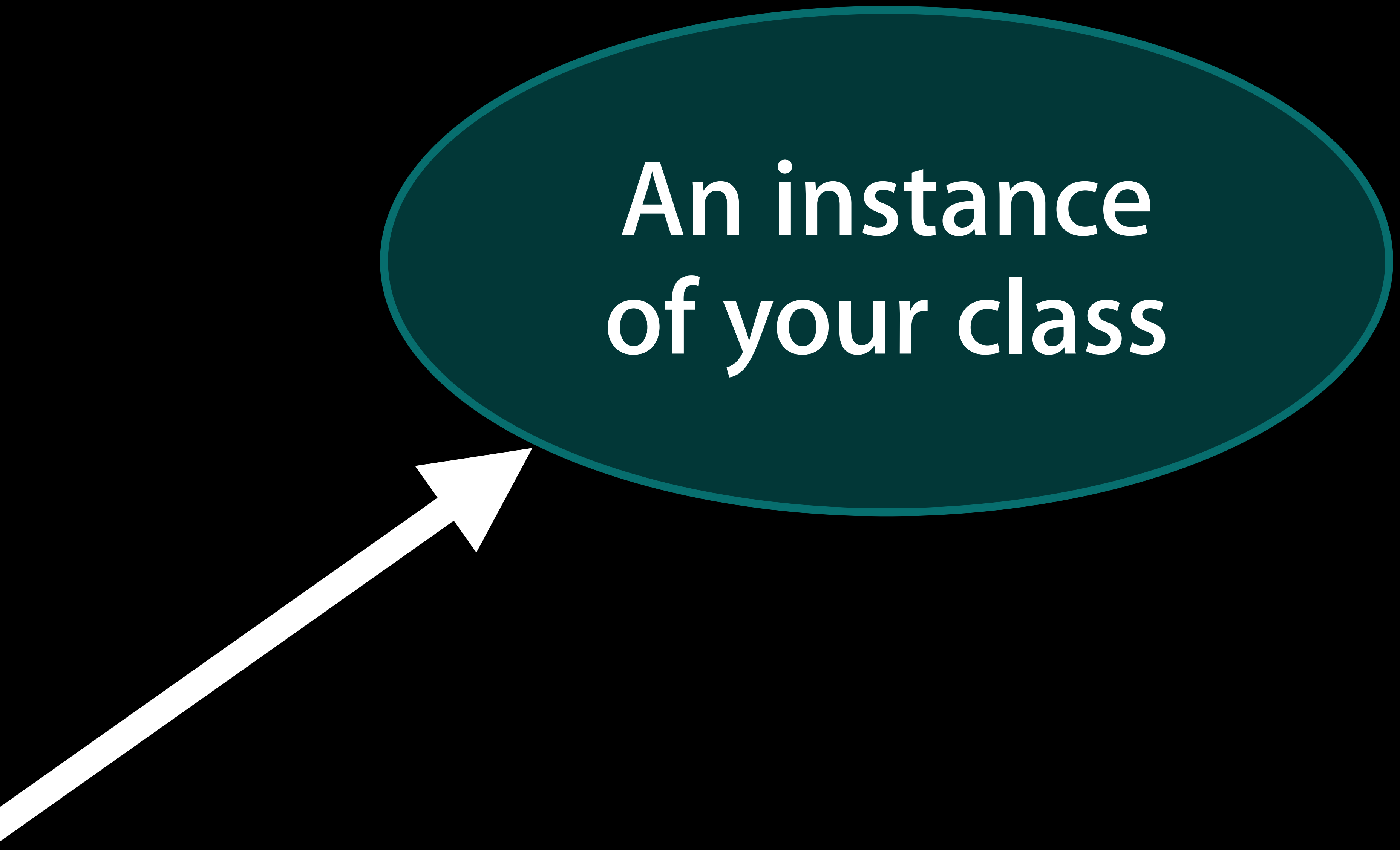
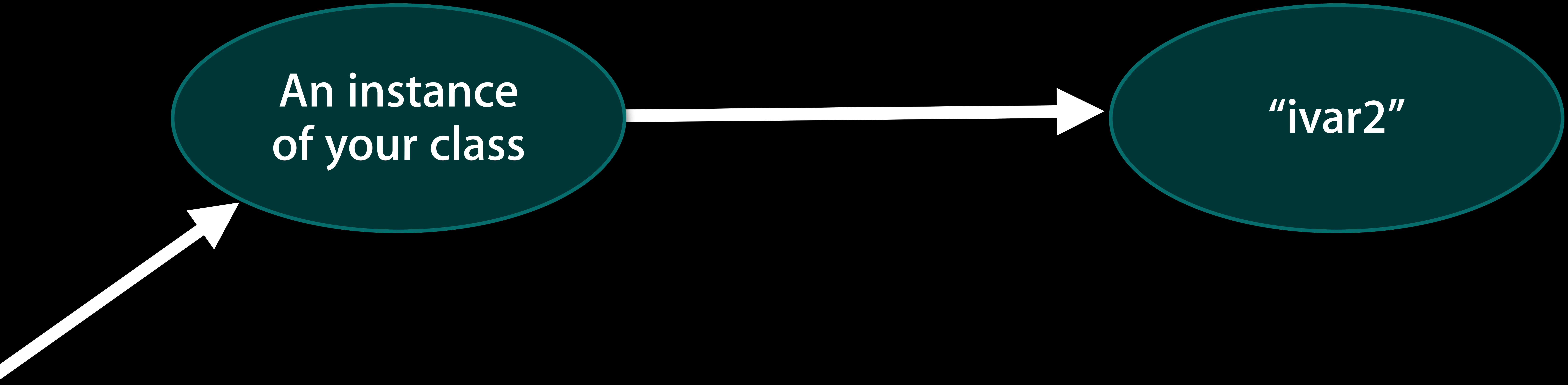
```
warning: capturing 'self' strongly in this block is likely to lead to a
retain cycle [-Warc-retain-cycles]
                [_ivar2 class];
                 ^~~~~~
note: block will be retained by an object strongly retained by the captured
object
        _ivar = ^{
        ^~~~~
```

Understanding Block Retain Cycles

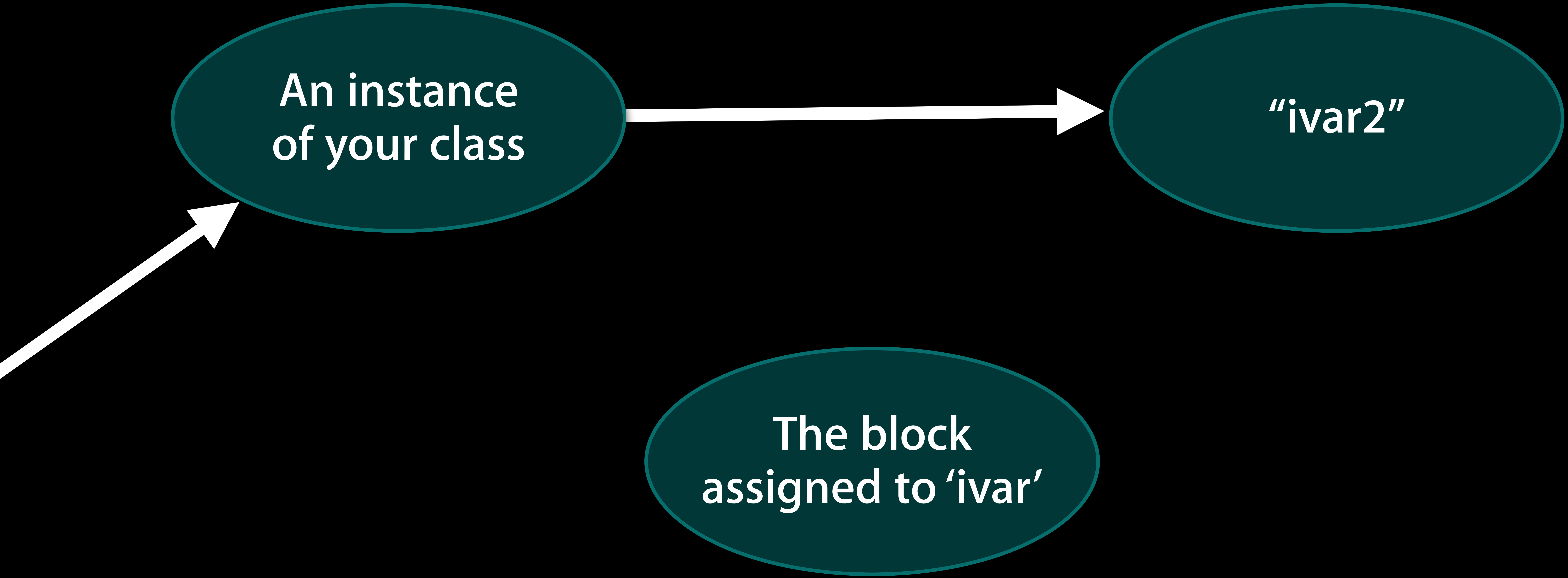


An instance of your class

Understanding Block Retain Cycles



Understanding Block Retain Cycles

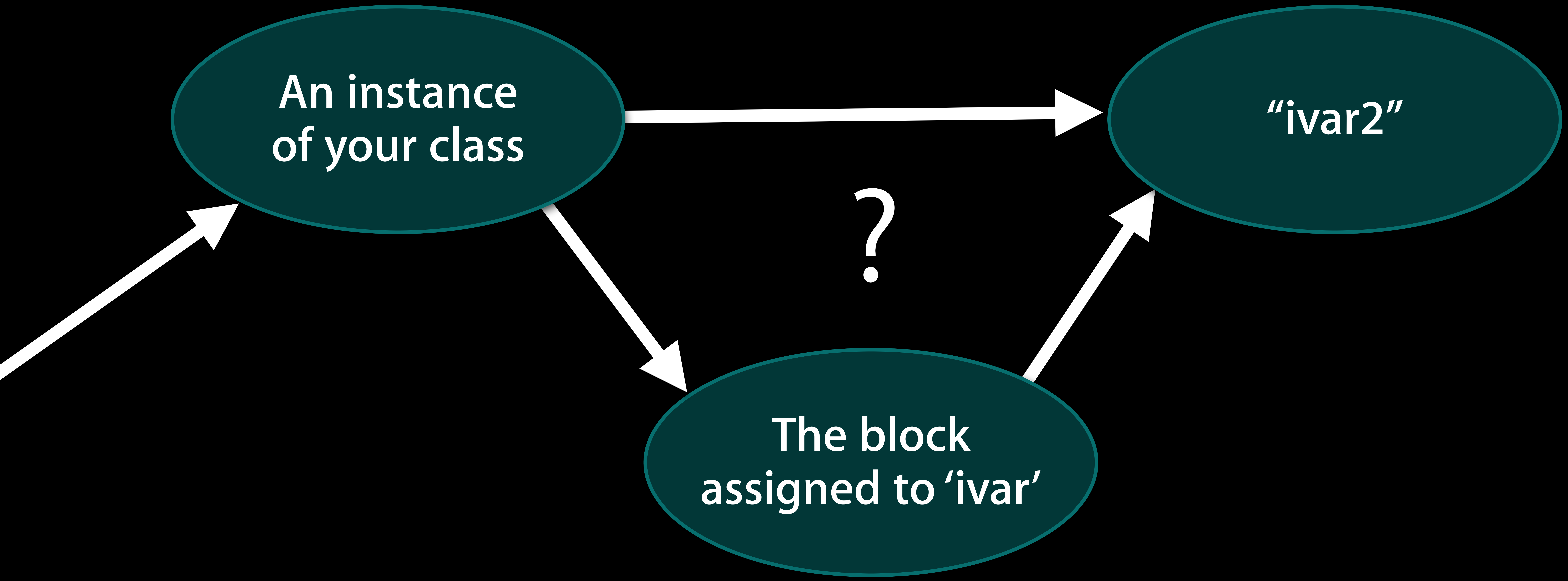


An instance of your class

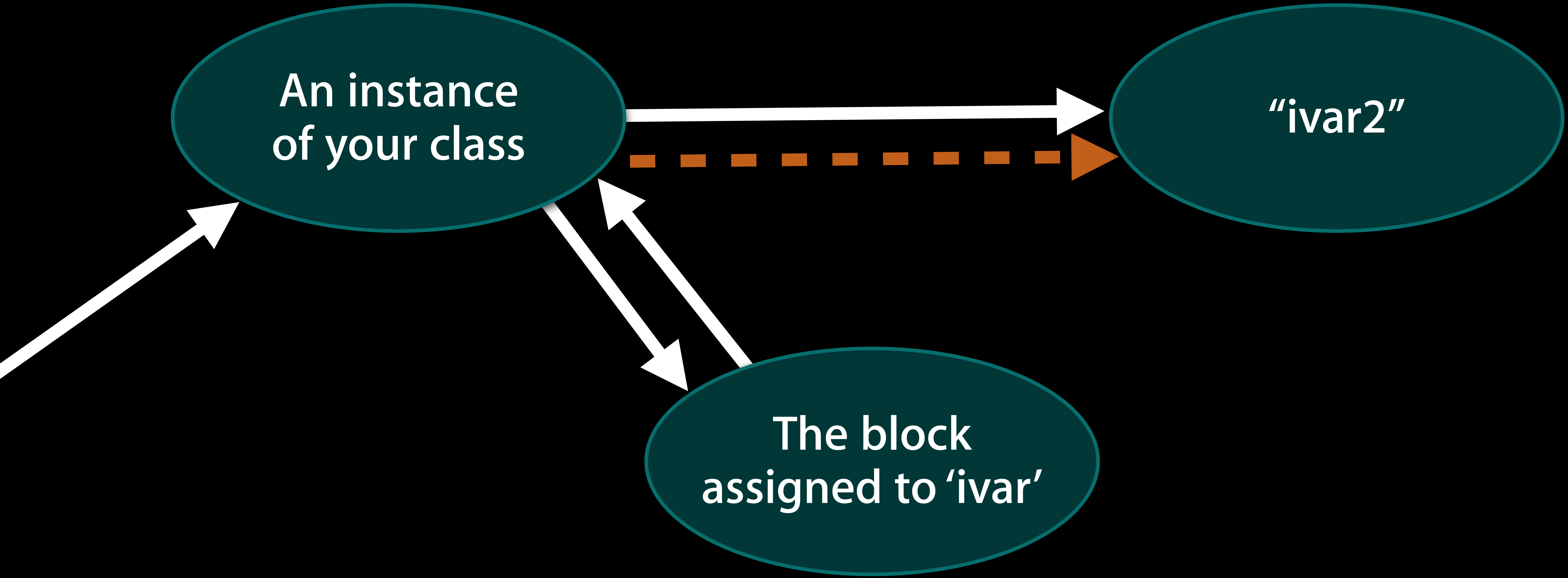
“ivar2”

The block assigned to ‘ivar’

Understanding Block Retain Cycles



Understanding Block Retain Cycles



An instance of your class

“ivar2”

The block assigned to ‘ivar’

Fixing the Retain Cycle

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    };
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retain cycle [-Warc-retain-cycles]
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note: block will be retained by an object strongly retained by the captured
object
        _ivar = ^{
        ^~~~~
```

Fixing the Retain Cycle

```
- (void)example {
    __weak MyClass *weak_self = self;
    _ivar = ^{
        [weak_self->_ivar2 class];
    };
}
```

```
warning: capturing 'self' strongly in this block is likely to lead to a
retain cycle [-Warc-retain-cycles]
                [_ivar2 class];
                 ^~~~~~

note: block will be retained by an object strongly retained by the captured
object
        _ivar = ^{
        ^~~~~
```

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- Weak variables do not extend the lifetime of objects

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- Therefore they do not create retain cycles

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- (void)example {
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- Weak variables do not extend the lifetime of objects
- Therefore they do not create retain cycles
- Weak variables safely become nil

Predictably Accessing Weak Variables

```
- (void)example {
    NSLog(@”%@”, [_weak_ivar description]);
}
```

Predictably Accessing Weak Variables

```
– (void)example {
    NSLog(@”%@”, [_weak_ivar description]);
}
```

- Does this method get called?

Predictably Accessing Weak Variables

```
- (void)example {
    NSLog(@”%@”, [_weak_ivar description]);
}
```

- Does this method get called?
- How do we reason about when ‘weak_ivar’ is nil?

Predictably Accessing Weak Variables

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- (void)example {
    NSLog(@”%@”, [_weak_ivar description]);
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```
warning: weak receiver may be unpredictably set to nil
[-Wreceiver-is-weak]
```

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note: assign the value to a strong variable to keep the object alive
during use
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- (void)example {
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- (void)example {
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- Does this method get called zero, one, or two times?

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- Does this method get called zero, one, or two times?
- How do we reason about when ‘weak_ivar’ is nil?

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- (void)example {
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}
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warning: weak instance variable '_weak_ivar' is accessed multiple
times in this method but may be unpredictably set to nil; assign to a
strong variable to keep the object alive [-Warc-repeated-use-of-weak]
```

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```
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    NSLog(@”%@”, [_weak_ivar description]);
                  ^
note: assign the value to a strong variable to keep the object alive
during use
```

Predictably Accessing Weak Variables

```
- (void)example {
    NSString *tmp = _weak_ivar;
    if (tmp) {
        NSLog(@”%@”, [tmp description]);
    }
}
```

```
warning: weak receiver may be unpredictably set to nil
[-Wreceiver-is-weak]
    NSLog(@”%@”, [_weak_ivar description]);
                  ^

note: assign the value to a strong variable to keep the object alive
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- “tmp” is valid for the scope of the ‘if’ block

Predictably Accessing Weak Variables

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- (void)example {
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}
```

- “tmp” is valid for the scope of the ‘if’ block
- Handling the “weak is nil” case is natural

Improving CoreFoundation and ARC

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```
NSString *string = (__bridge NSString *)CFDictionaryGetValue(_dict, @”key”);
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Improving CoreFoundation and ARC

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  - +1 via CFBridgingRetain()

Improving CoreFoundation and ARC

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- The ARC compiler must reason about object lifetime
- Requires retain count “bridging” between in and out of ARC
    - +1 via CFBridgingRetain()
    - –1 via CFBridgingRelease()

Improving CoreFoundation and ARC

```
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```

- The ARC compiler must reason about object lifetime
- Requires retain count “bridging” between in and out of ARC
    - +1 via CFBridgingRetain()
    - –1 via CFBridgingRelease()
    - +0 via “__bridge” casts to avoid mistakes

CoreFoundation Conventions

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NSString *string = (__bridge NSString *)CFDictionaryGetValue(_dict, @”key”);
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    - “...Create()” and “...Copy...()” return +1
    - Everything else is +0

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- Common CF functions have been audited
    - “...Create()” and “...Copy...()” return +1
    - Everything else is +0
- Compiler attributes for exceptions
    - CF_RETURNS_RETAINED and CF_RETURNS_NOT_RETAINED
    - CF_RELEASES_ARGUMENT

CoreFoundation Conventions

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- Common CF functions have been audited
  - “...Create()” and “...Copy...()” return +1
  - Everything else is +0
- Compiler attributes for exceptions
  - CF_RETURNS_RETAINED and CF_RETURNS_NOT_RETAINED
  - CF_RELEASES_ARGUMENT
- These also help the static analyzer

Improving CoreFoundation and ARC

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NSString *string = (__bridge NSString *)CFDictionaryGetValue(_dict, @”key”);
```

Improving CoreFoundation and ARC

```
NSString *string = (__bridge NSString *)CFDictionaryGetValue(_dict, @”key”);
```

- The “everything else” case is now formalized

Improving CoreFoundation and ARC

```
NSString *string = (__bridge NSString *)CFDictionaryGetValue(_dict, @”key”);
```

- The “everything else” case is now formalized
- Common CF APIs allow implicit bridging

Improving CoreFoundation and ARC

```
NSString *string = CFDictionaryGetValue(_dict, @”key”);
```

- The “everything else” case is now formalized
- Common CF APIs allow implicit bridging

Improving CoreFoundation and ARC

```
NSString *string = CFDictionaryGetValue(_dict, @”key”);
```

- The “everything else” case is now formalized
- Common CF APIs allow implicit bridging
- New macros are available for your use too

Enabling Implicit Bridging

Enabling Implicit Bridging

```
#include <CoreFoundation/CoreFoundation.h>





EXArrayRef EXFooCreateCopy(...);
const void *EXFooGetValueAtIndex(EXArrayRef theArray, CFIndex idx);
const void *EXFooRandomPlusOne(EXArrayRef theArray);
```

Enabling Implicit Bridging

```
#include <CoreFoundation/CoreFoundation.h>





EXArrayRef EXFooCreateCopy(...);  // GOOD: follows the naming convention
const void *EXFooGetValueAtIndex(EXArrayRef theArray, CFIndex idx);
const void *EXFooRandomPlusOne(EXArrayRef theArray);
```

Enabling Implicit Bridging

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EXArrayRef EXFooCreateCopy(...);
const void *EXFooGetValueAtIndex(EXArrayRef theArray, CFIndex idx);
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```

Enabling Implicit Bridging

```
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CF_IMPLICIT_BRIDGING_ENABLED

EXArrayRef EXFooCreateCopy(...);
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CF_IMPLICIT_BRIDGING_DISABLED
```

Enabling Implicit Bridging

```
#include <CoreFoundation/CoreFoundation.h>


// must be after all #includes / #imports
CF_IMPLICIT_BRIDGING_ENABLED

EXArrayRef EXFooCreateCopy(...);
const void *EXFooGetValueAtIndex(EXArrayRef theArray, CFIndex idx);
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CF_IMPLICIT_BRIDGING_DISABLED
```

Enabling Implicit Bridging

```
#include <CoreFoundation/CoreFoundation.h>
// explicitly bridged code

// must be after all #includes / #imports
CF_IMPLICIT_BRIDGING_ENABLED

EXArrayRef EXFooCreateCopy(...);
const void *EXFooGetValueAtIndex(EXArrayRef theArray, CFIndex idx);
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CF_IMPLICIT_BRIDGING_DISABLED

// explicitly bridged code
```

Wrap Up

Summary

- Modules
- Improved productivity
  - Better compiler warnings
- ARC
  - Faster, easier, safer

More Information

Dave DeLong

Developer Tools Evangelist
delong@apple.com

Documentation

Developer Tools Portal
http://developer.apple.com/xcode

Apple Developer Forums

http://devforums.apple.com

Related Sessions

What’s New in the LLVM Compiler	Pacific Heights Tuesday 2:00PM
Optimize Your Code Using LLVM	Nob Hill Wednesday 3:15PM

Labs

Objective-C and LLVM	Tools Lab B Wednesday 9AM
Objective-C and LLVM	Tools Lab C Thursday 2PM

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