#WWDC19

Binary Frameworks in Swift

Harlan Haskins, Swift Team
Jordan Rose, Swift Team

Swift Packages

Swift Packages

Swift Packages

Dependencies managed by Xcode

Swift Packages

Dependencies managed by Xcode

Versions managed by Xcode

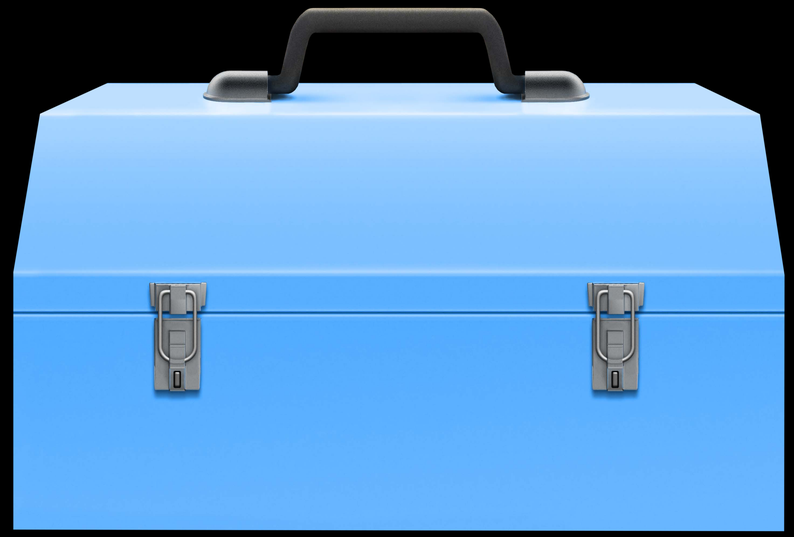
Swift Packages

Dependencies managed by Xcode

Versions managed by Xcode

No binary compatibility requirements

Swift Packages



XCFrameworks

Agenda

Agenda

Introducing XCFrameworks

Agenda

Introducing XCFrameworks

Creating an XCFramework

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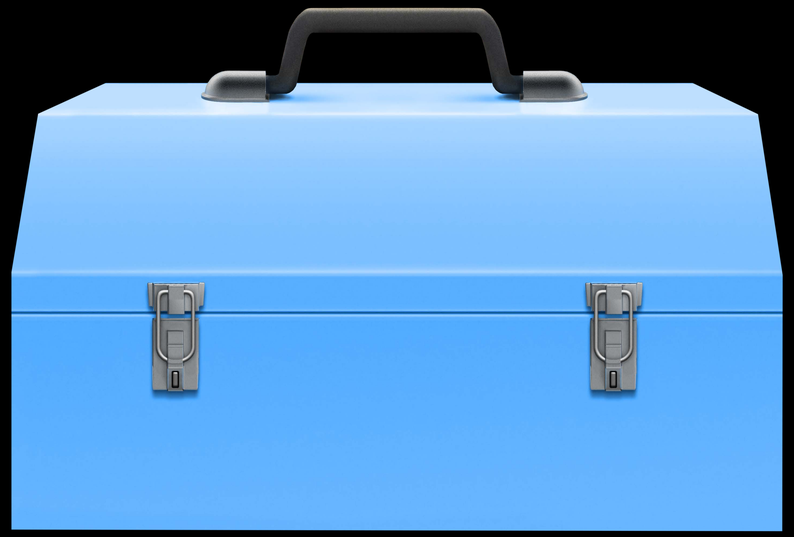
Introducing XCFrameworks

Creating an XCFramework

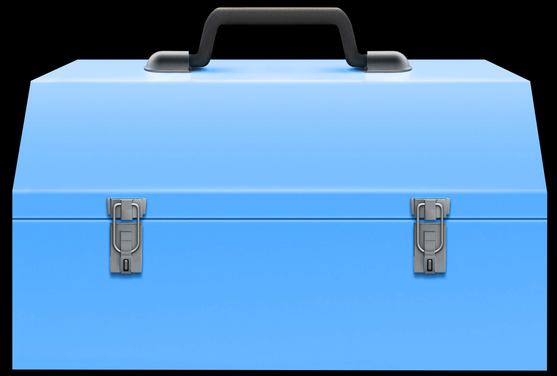
Framework author considerations

NEW



XCFramework

NEW



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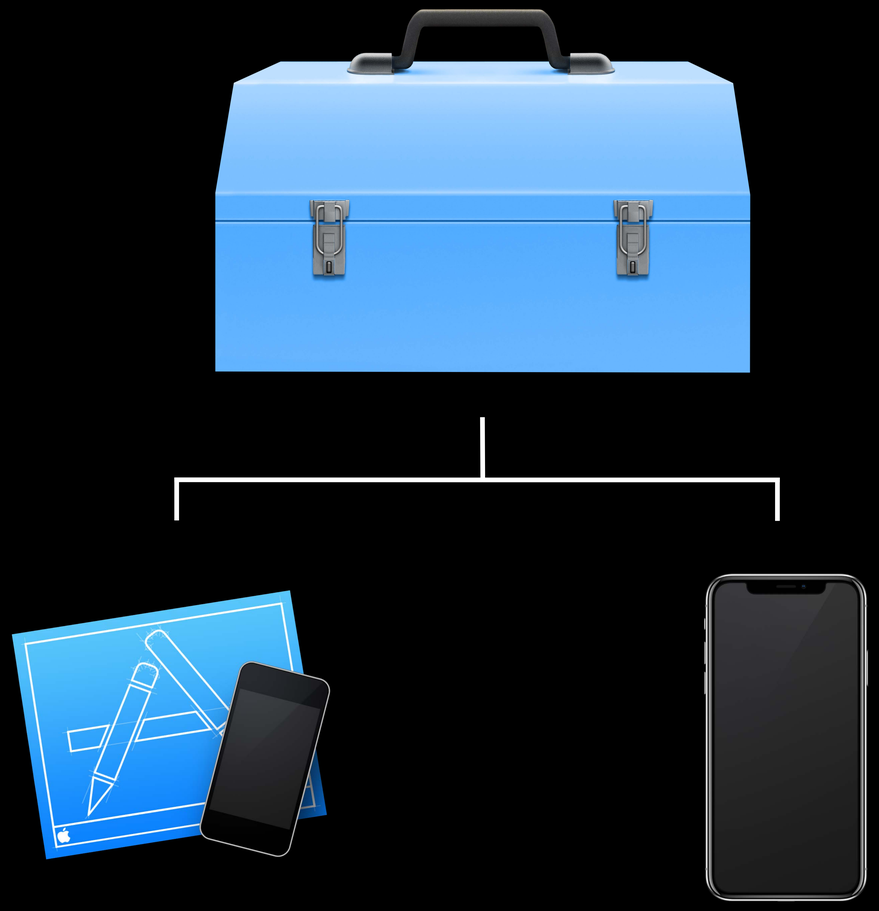

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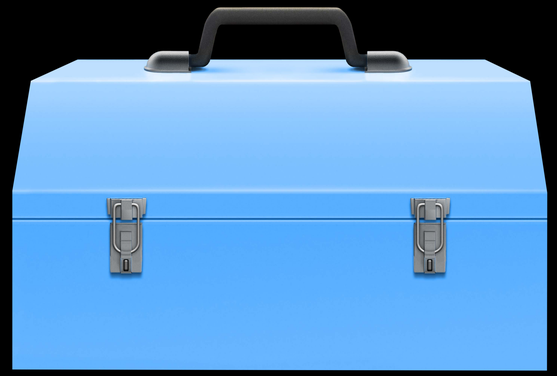

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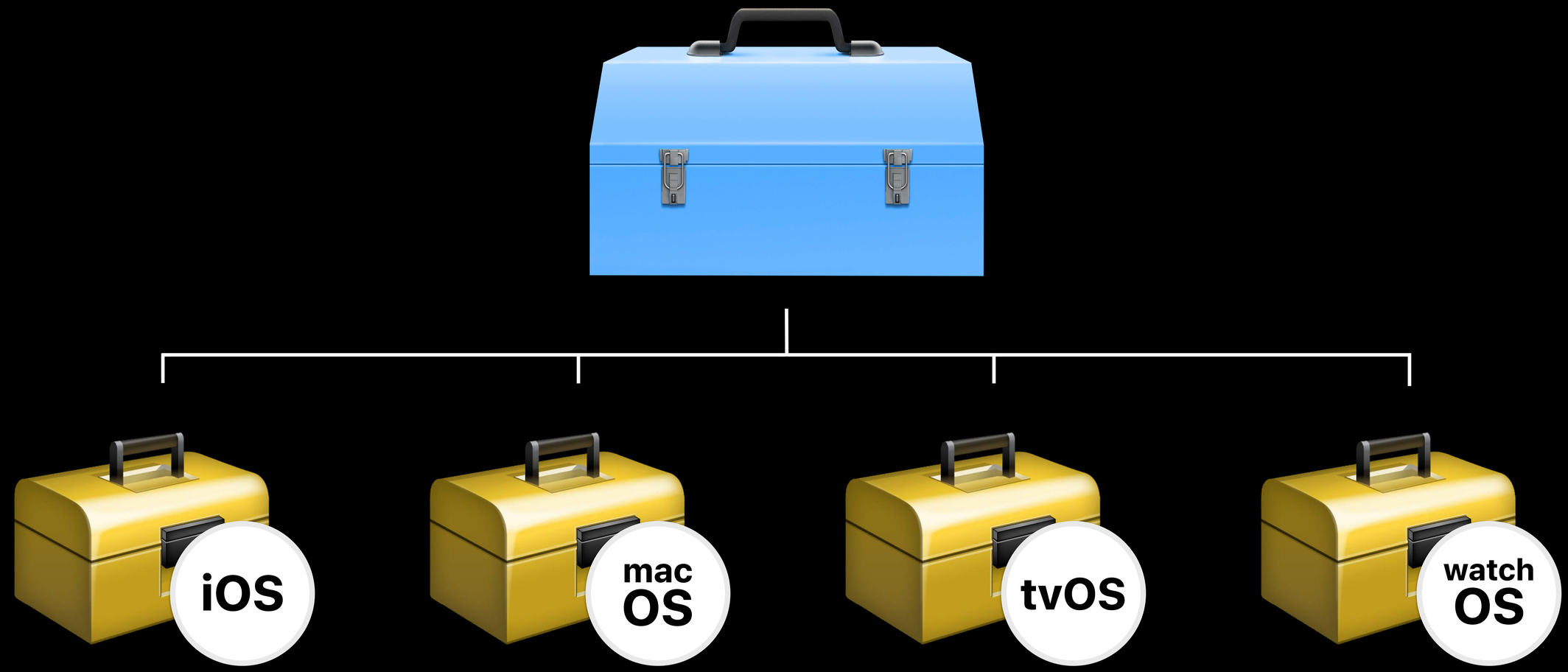

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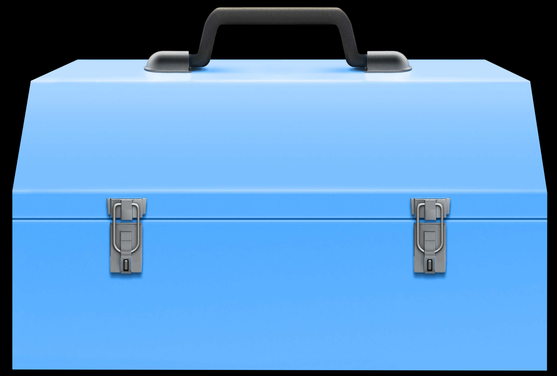

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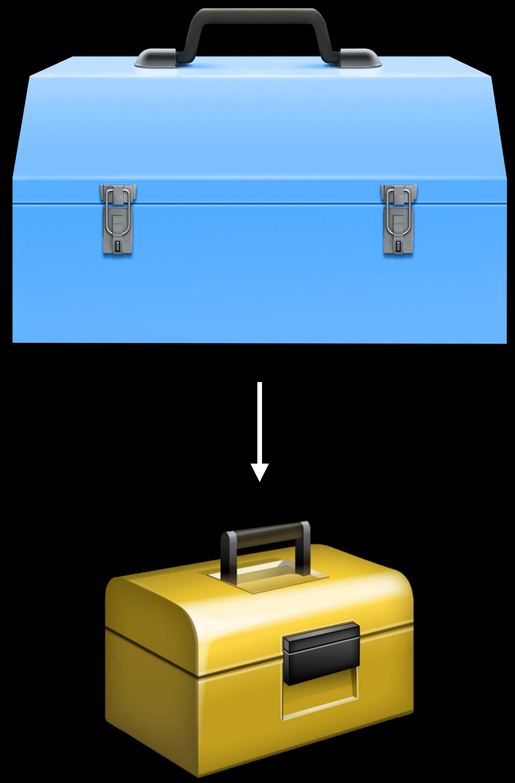

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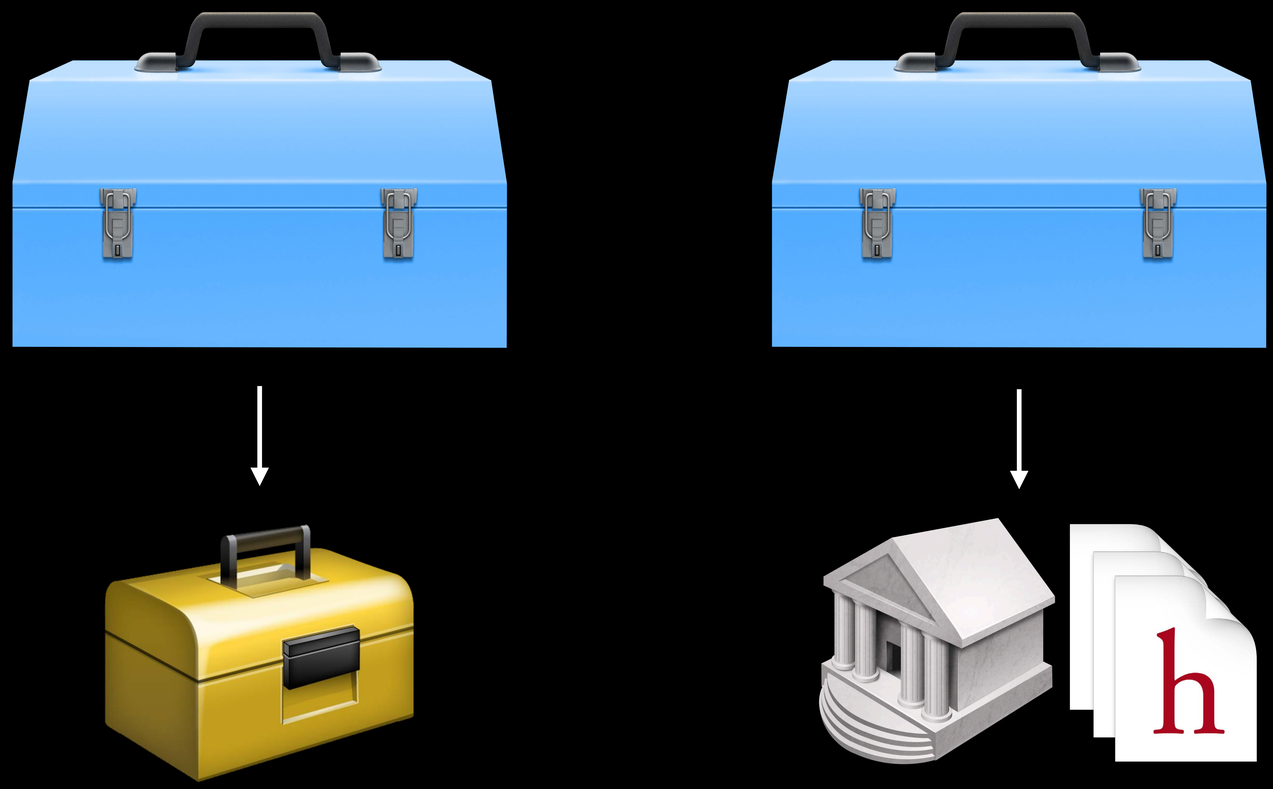

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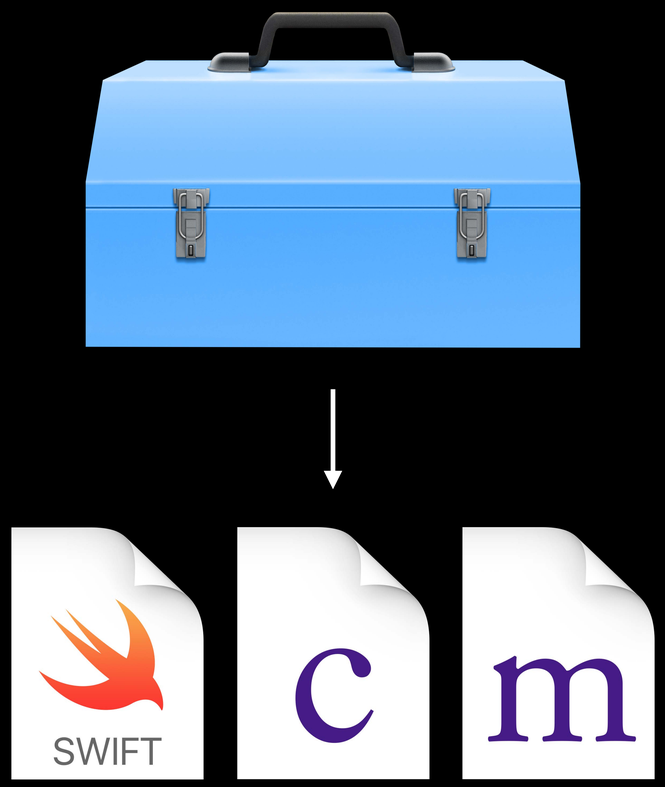
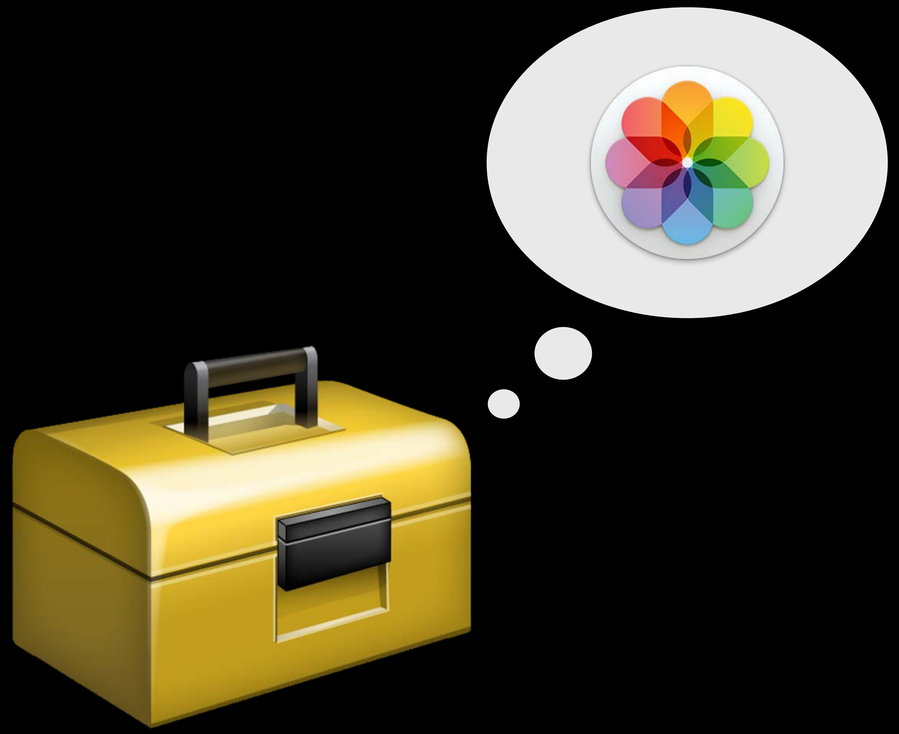


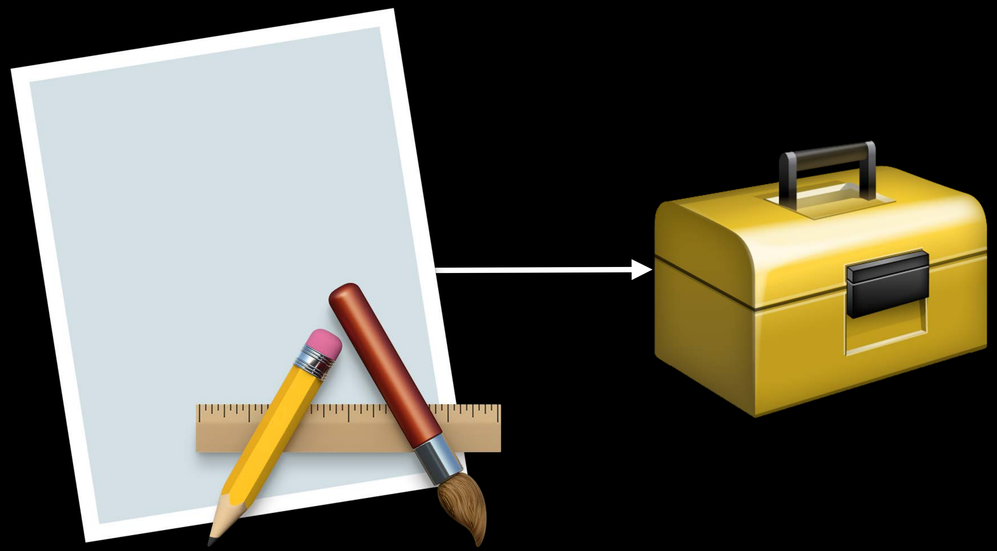
Demo

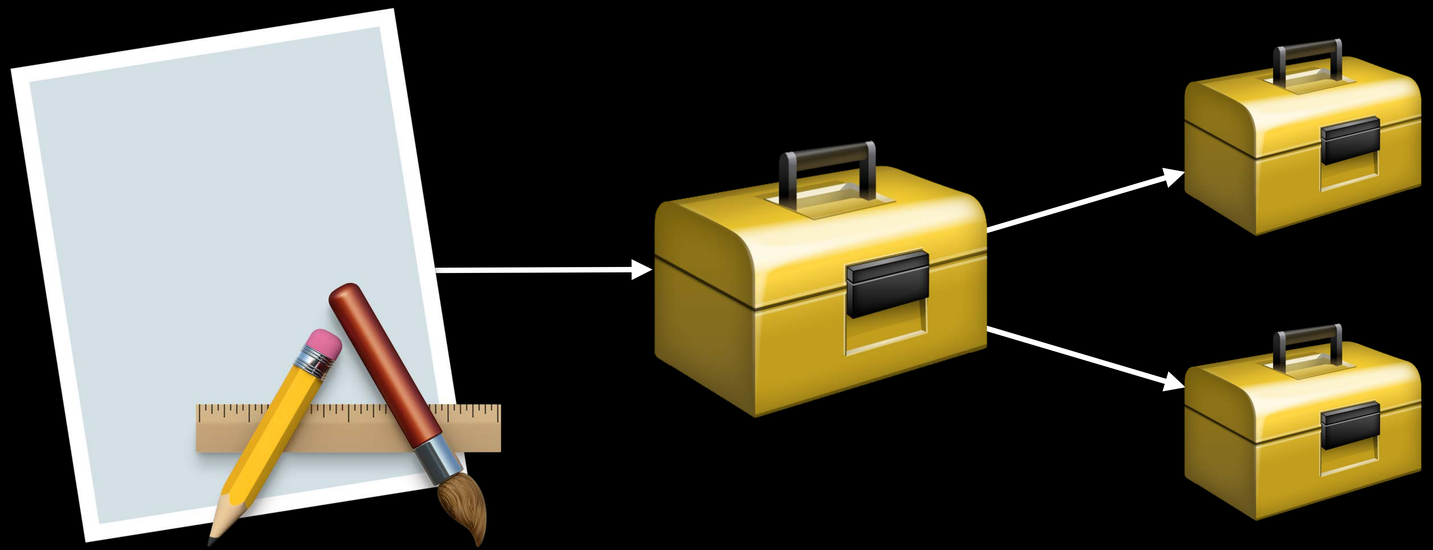
Using an XCFramework

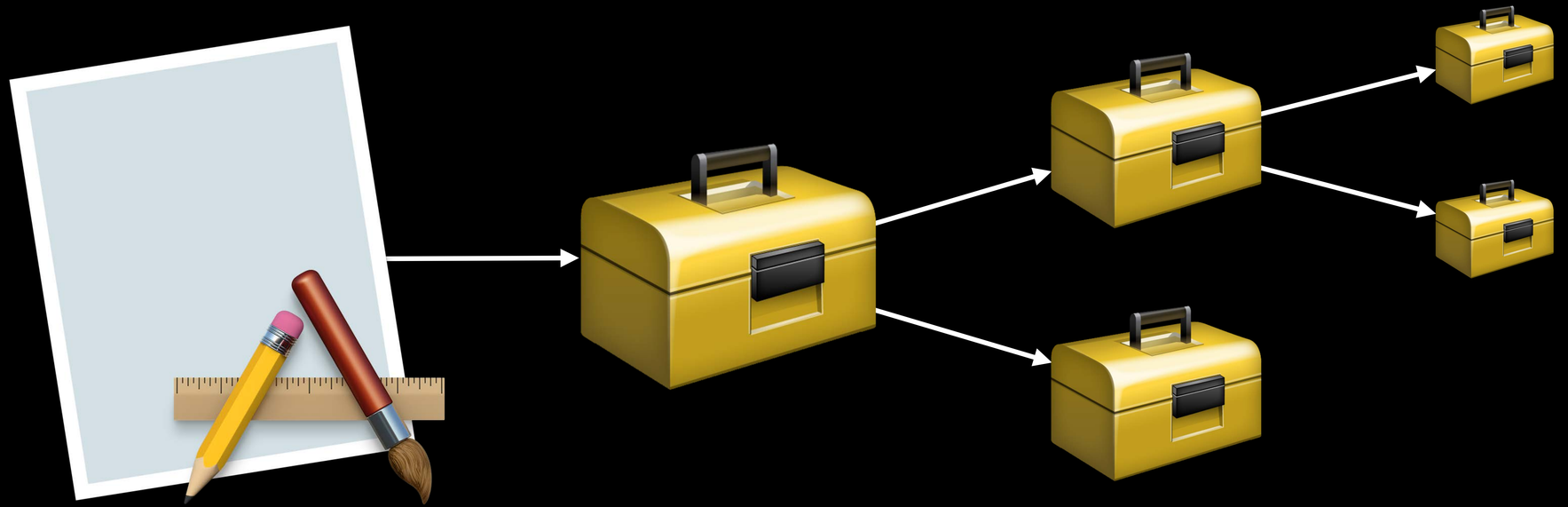
Using Frameworks

Trust









Adopting Swift Packages in Xcode	WWDC 2019
Creating Swift Packages	WWDC 2019


XCODE

Creating an XCFramework

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import UIKit

public class Spaceship {
  public let name: String
  private var currentLocation: Location

  public init(name: String) {
    self.name = name
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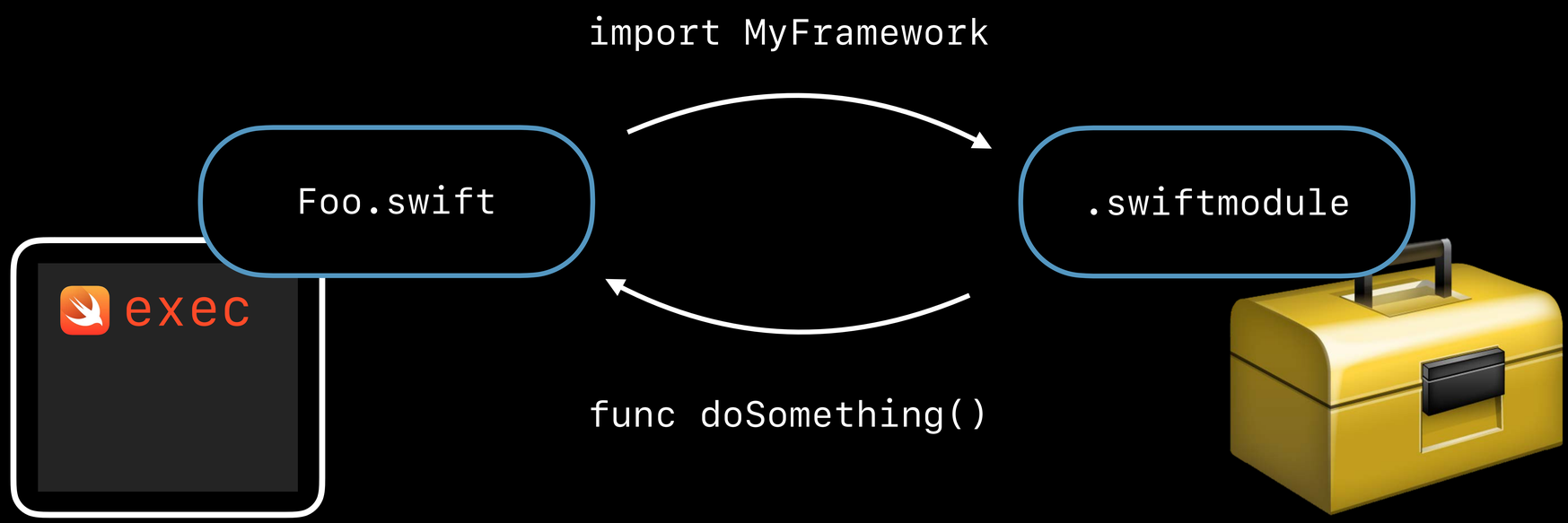
New Build Setting in Xcode 11

NEW

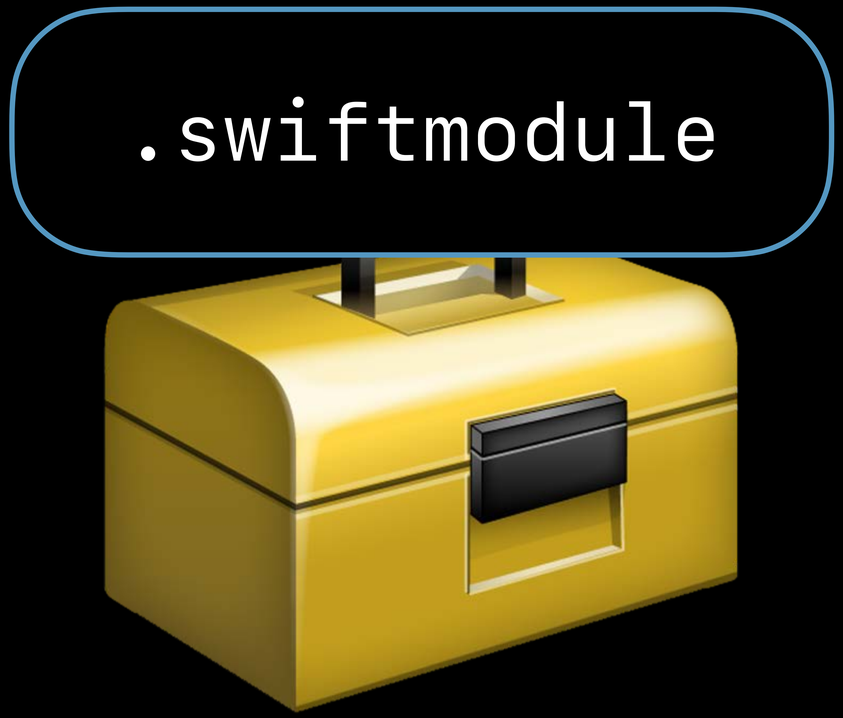
Compiled module was created by a newer version of the compiler

Importing a Module

Importing a Module

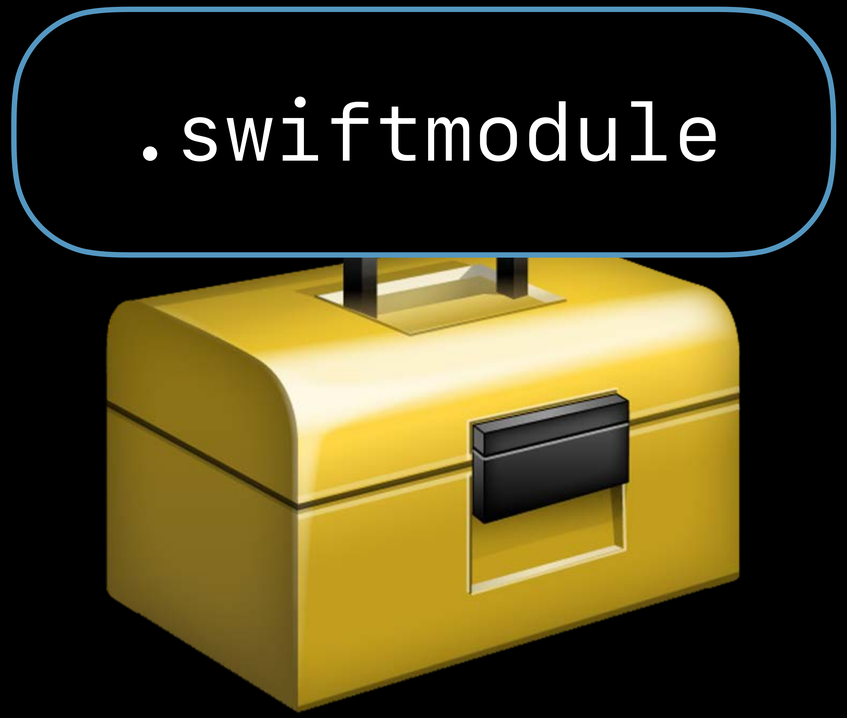


Compiled Module Format



Compiled Module Format

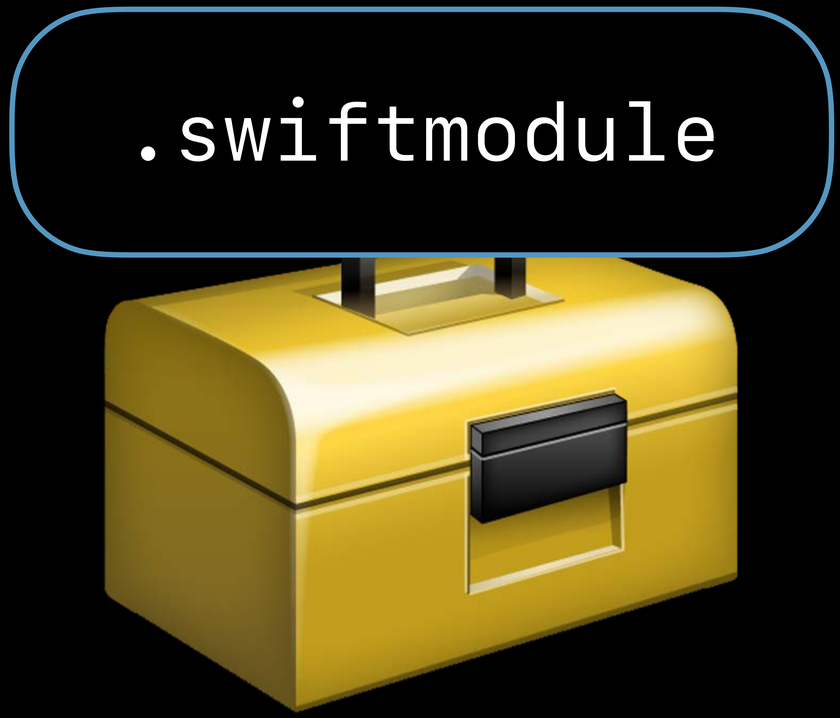
Serialized, binary format



Compiled Module Format

Serialized, binary format

Internal compiler data structures



Compiled Module Format

Serialized, binary format

Internal compiler data structures

Changes between compiler versions

Swift Module Interfaces

NEW

Swift Module Interfaces

NEW

Textual listing of public API

Swift Module Interfaces

NEW

Textual listing of public API

Compatible across compiler versions

Swift Module Interfaces

NEW

Textual listing of public API

Compatible across compiler versions

Enabled with “Build Libraries for Distribution”

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import UIKit

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```swift
// swift-interface-format-version: 1.0
// swift-compiler-version: Swift version 5.1
// swift-module-flags: -target arm64-apple-ios13.0
                       -enable-library-evolution
                       -swift-version 5 -O
                       -module-name FlightKit

import Swift
import UIKit

public class Spaceship {
  public let name: Swift.String

  public init(name: Swift.String)
  public func fly(
    to destination: FlightKit.Location,
    speed: FlightKit.Speed)

  @objc deinit
}

public enum Speed: Swift.Hashable {
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  public static func ==(
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public struct Location {
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-module-name FlightKit

import Swift
import UIKit

public class Spaceship {
  public let name: Swift.String

  public init(name: Swift.String)
  public func fly(
    to destination: FlightKit.Location,
    speed: FlightKit.Speed)

  @objc deinit
}

public enum Speed: Swift.Hashable {
  case leisurely
  case fast

  public static func ==(
    a: FlightKit.Speed,
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  public func hash(
    into hasher: inout Swift.Hasher)
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}

public struct Location {
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}
```

```swift
// swift-interface-format-version: 1.0
// swift-compiler-version: Swift version 5.1
// swift-module-flags: -target arm64-apple-ios13.0
                       -enable-library-evolution
                       -swift-version 5 -O
                       -module-name FlightKit

import Swift
import UIKit

public class Spaceship {
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    a: FlightKit.Speed,
```
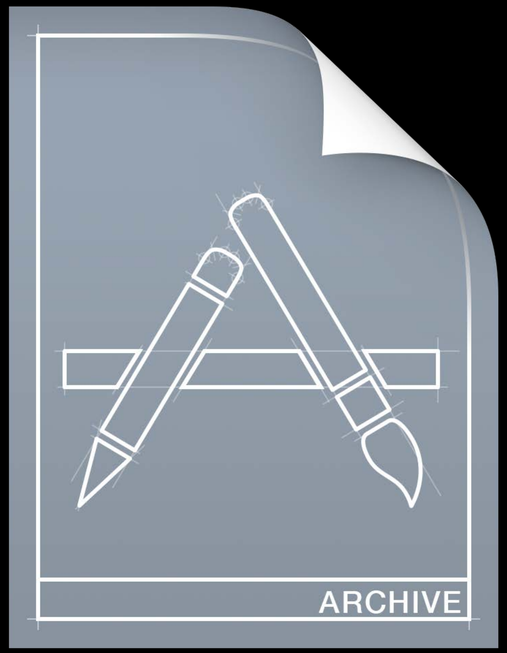
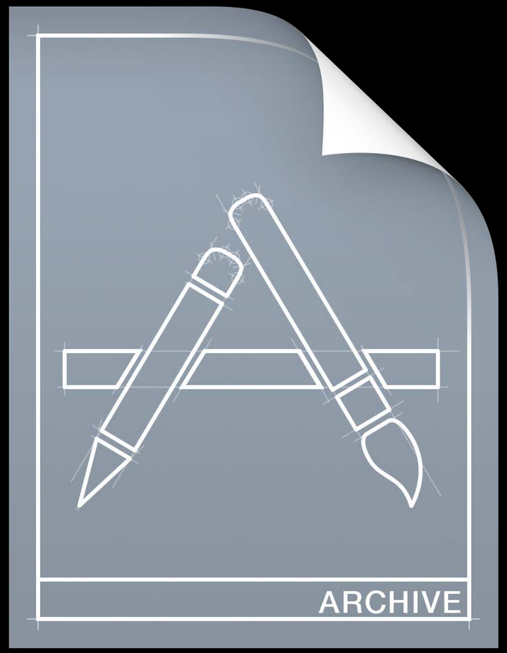

Building an XCFramework

Archiving Your Framework



Archiving Your Framework

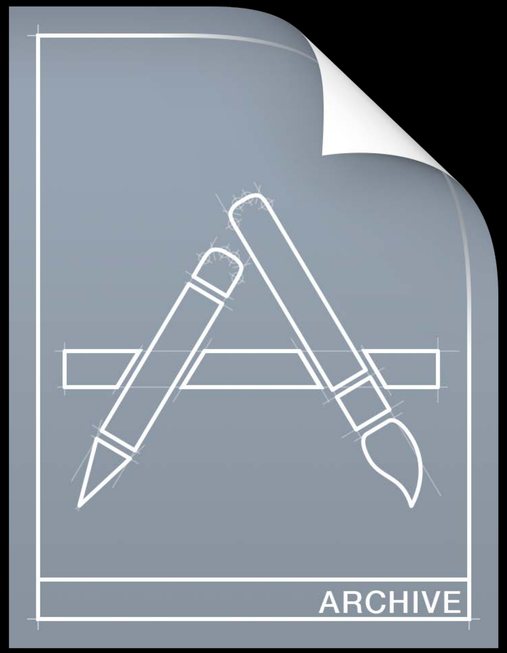
Builds framework in Release



Archiving Your Framework

Builds framework in Release

Available in Xcode Organizer

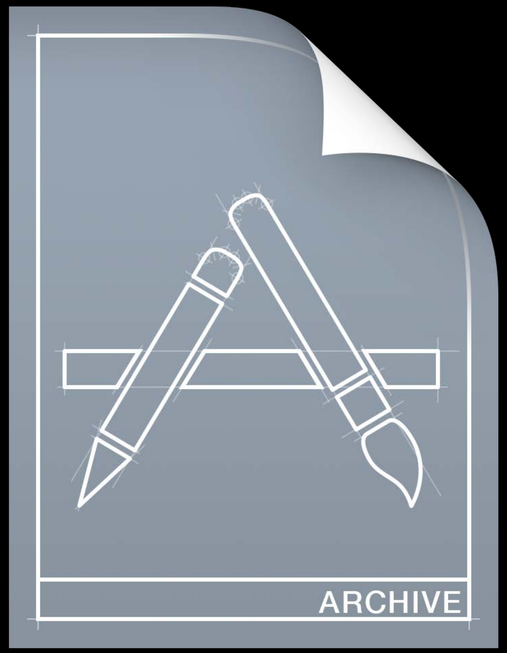


Archiving Your Framework

Builds framework in Release

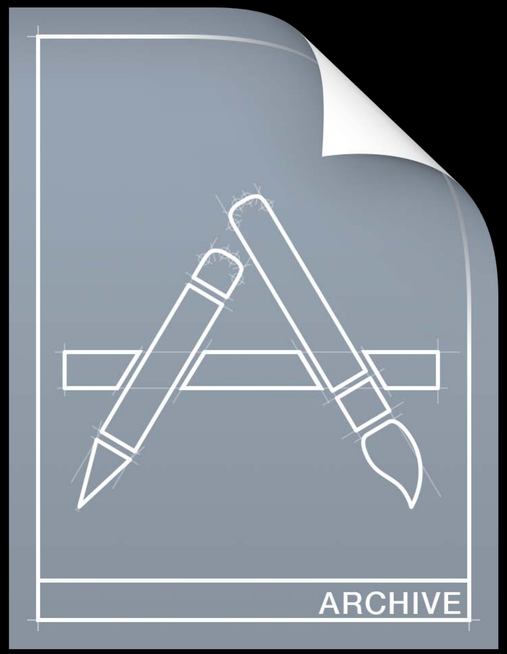
Available in Xcode Organizer

Keeps track of dSYMs



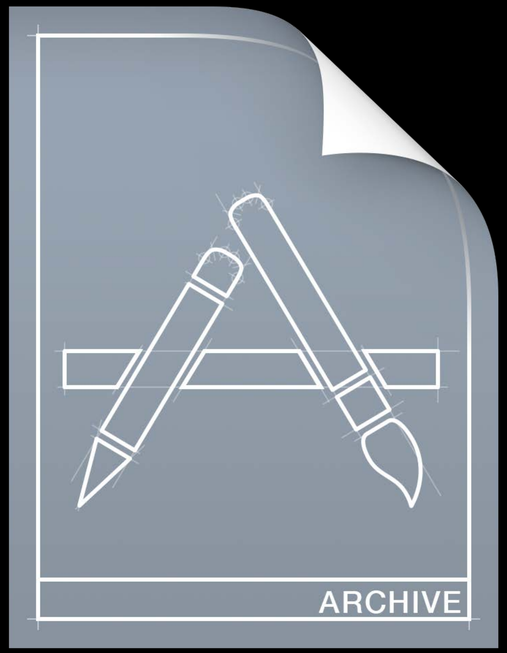
Archiving Your Framework

```
xcodebuild archive
```



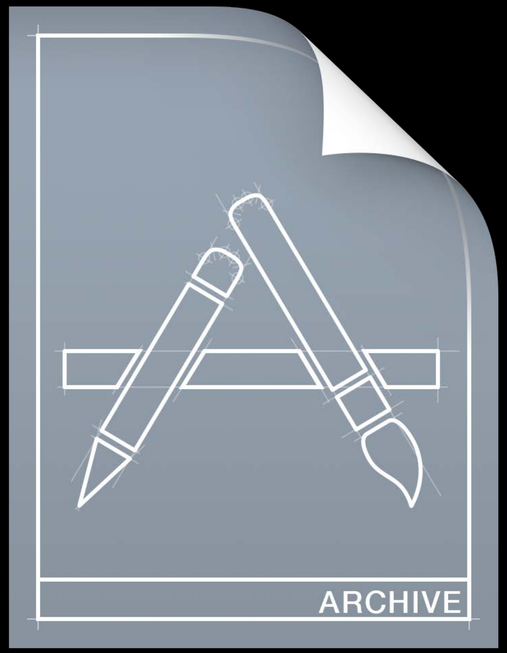
Archiving Your Framework

```
xcodebuild archive
   -scheme FlightKit
```



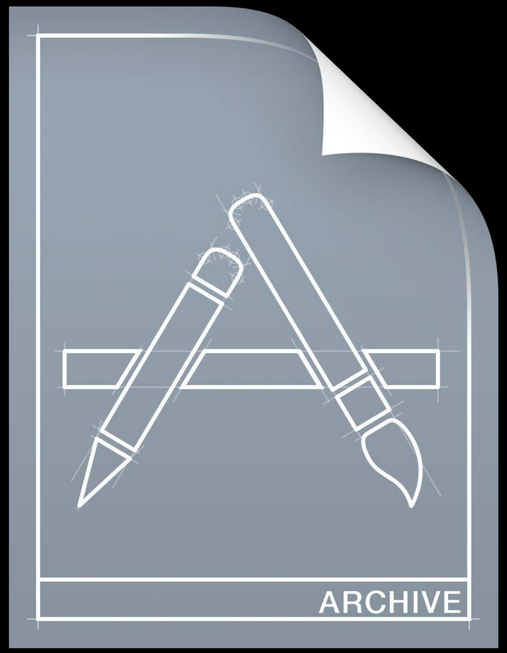
Archiving Your Framework

```
xcodebuild archive
   -scheme FlightKit
   -destination "…"
   -destination "…"
         …
   -destination "…"
```



Archiving Your Framework

```
xcodebuild archive
   -scheme FlightKit
   -destination "…"
   -destination "…"
         …
   -destination "…"
   SKIP_INSTALL=NO
```



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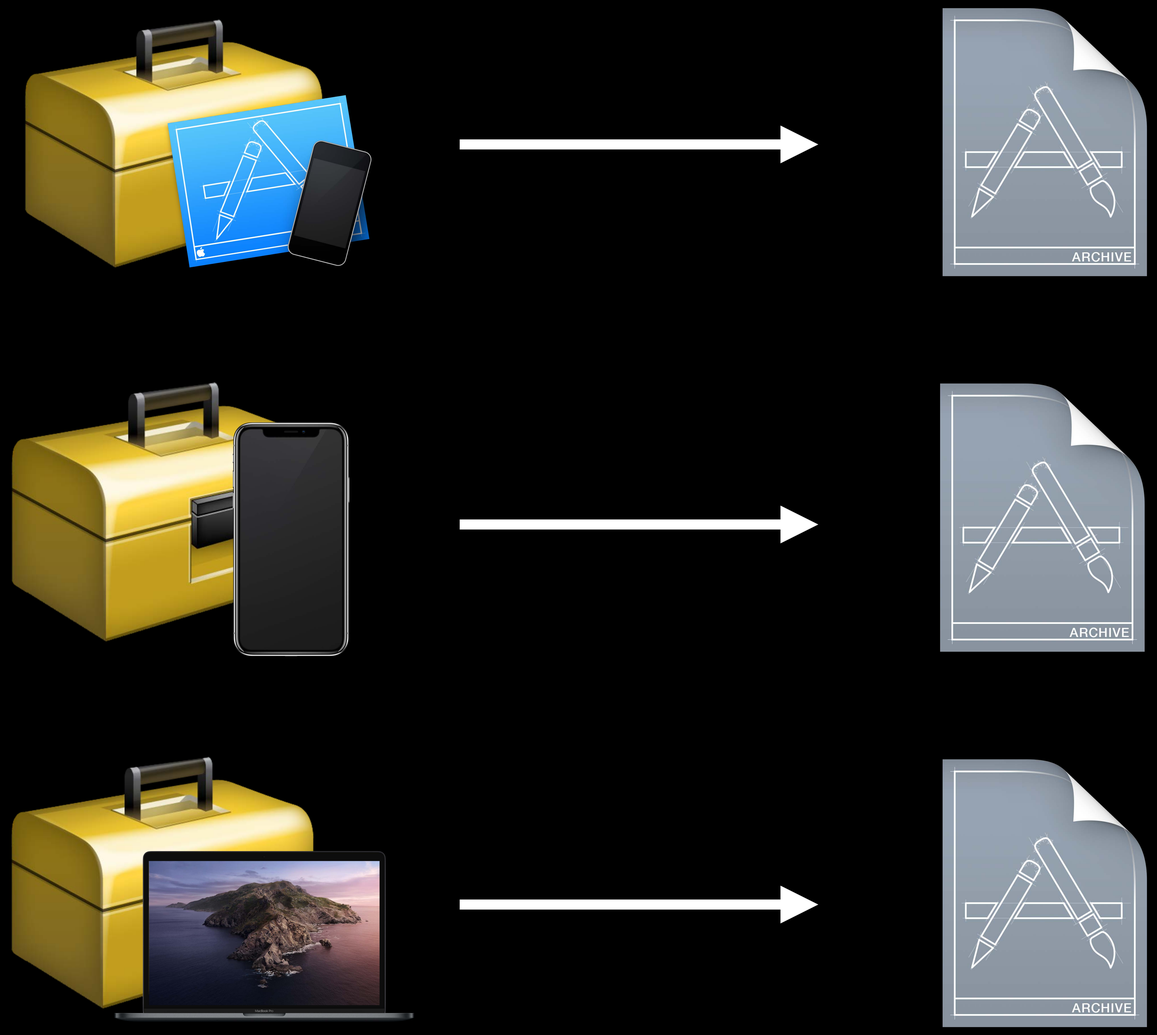

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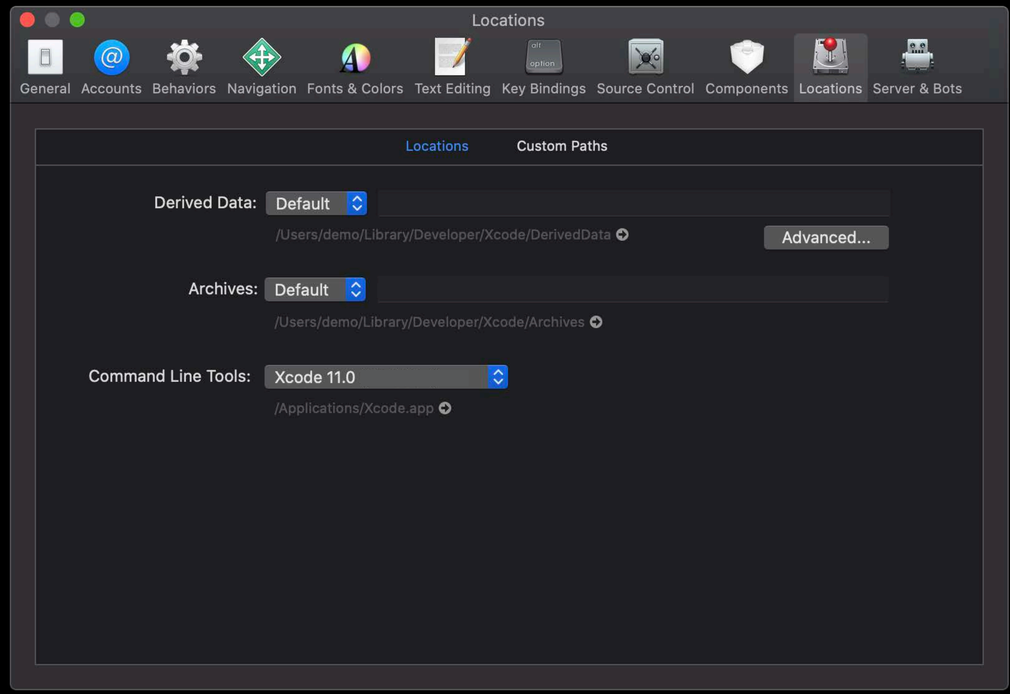

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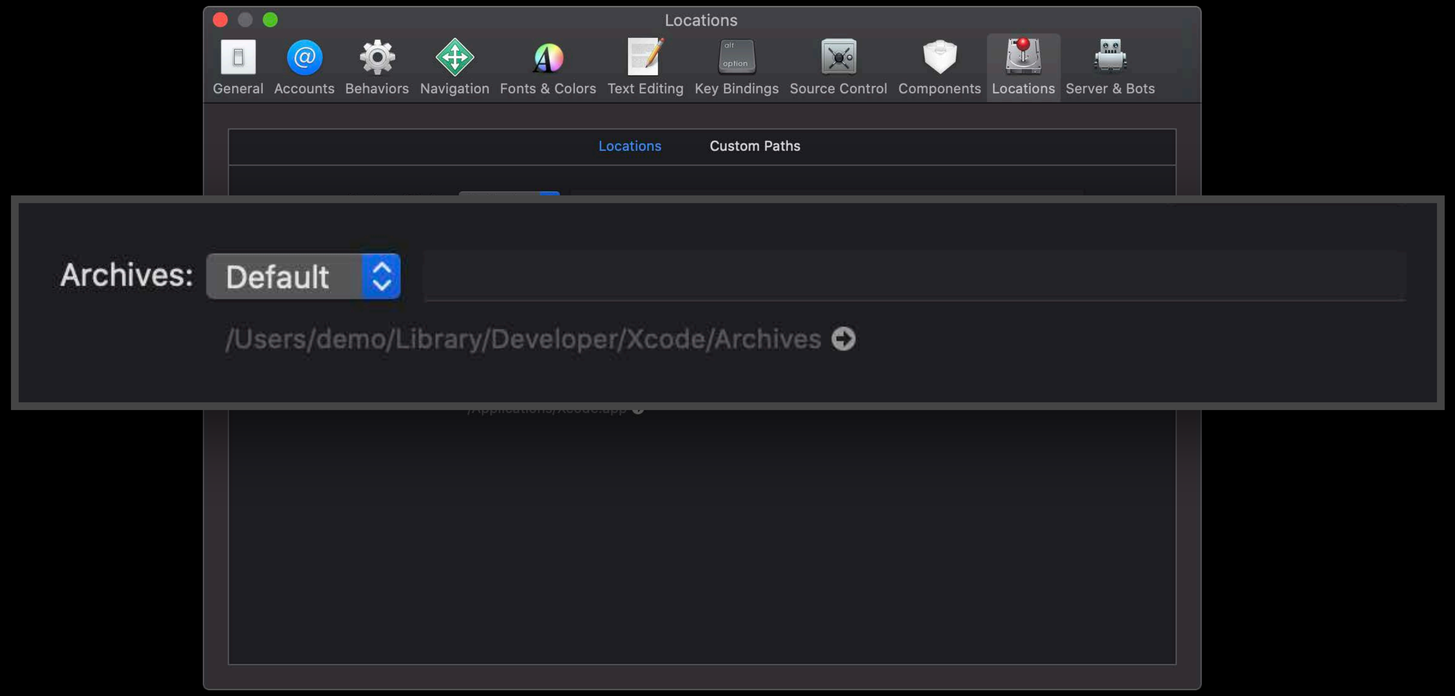
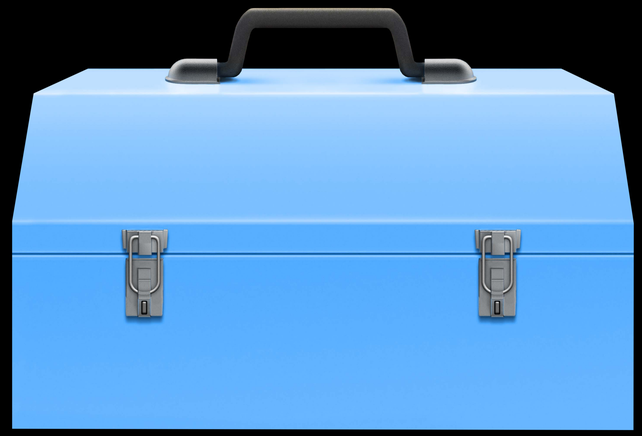


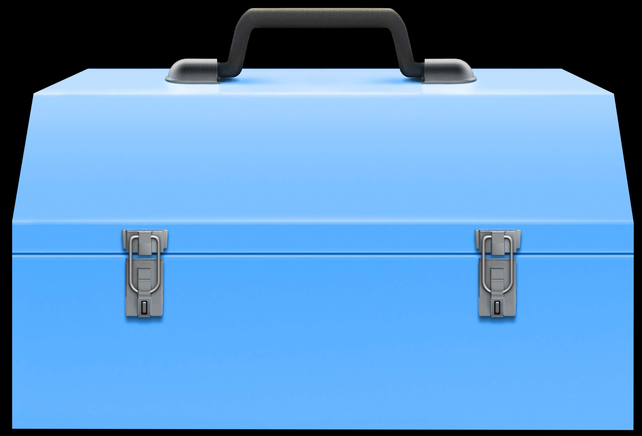
Building an XCFramework

NEW



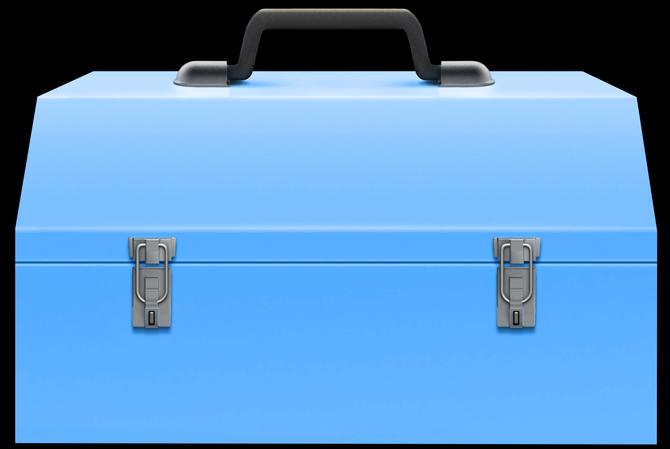
Building an XCFramework

NEW



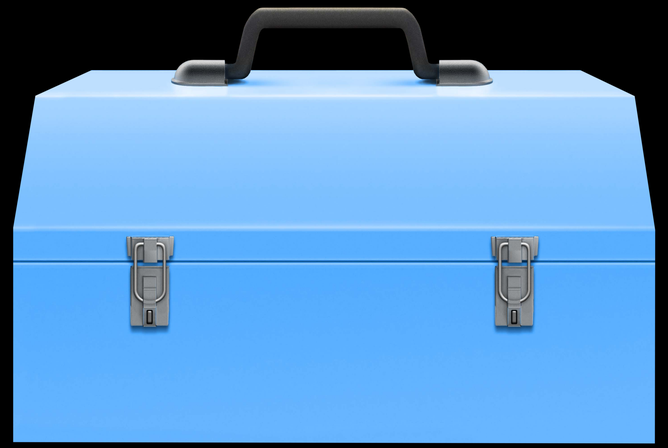
Building an XCFramework

```
xcodebuild -create-xcframework
```



Building an XCFramework

```
xcodebuild -create-xcframework
   -framework [path]
   -framework [path]
         …
   -framework [path]
   -output FlightKit.xcframework
```



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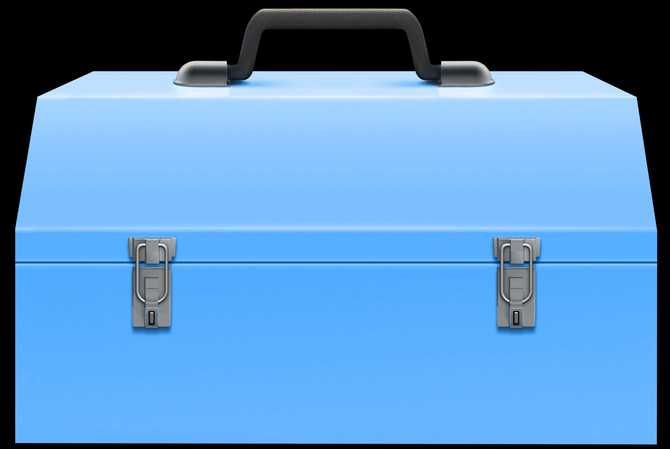
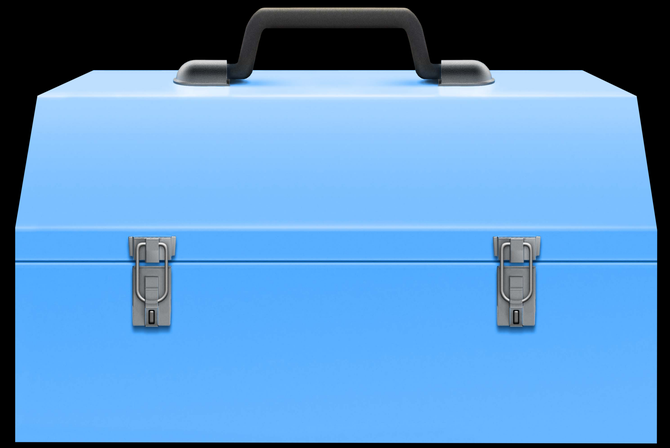


Building an XCFramework

1. Enable “Build Libraries for Distribution”



Building an XCFramework

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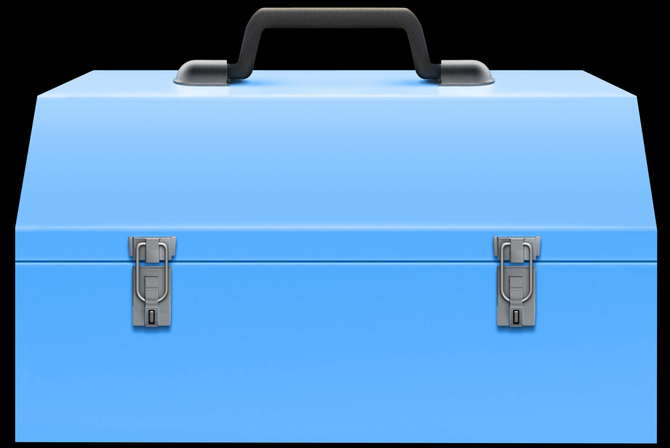

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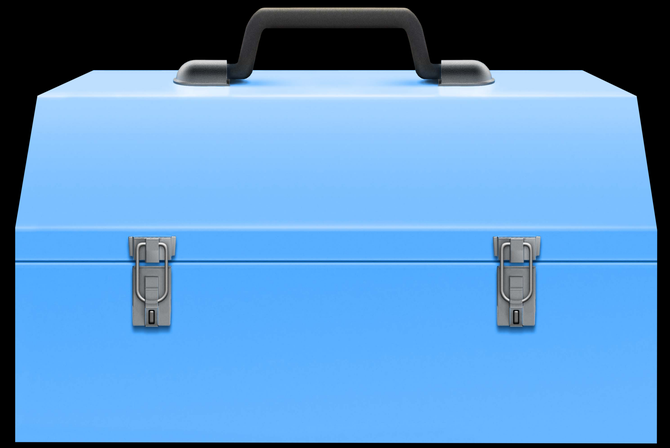


Framework Author Considerations

Jordan Rose, Swift Team

Evolving your framework

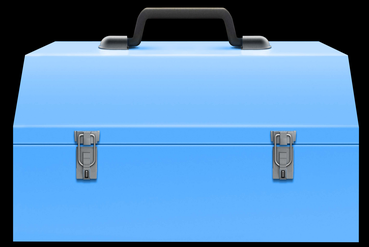
Trading flexibility for optimizability

Helping your clients

Evolving Your Framework

Evolving Your Framework

Why Is Binary Compatibility Important?



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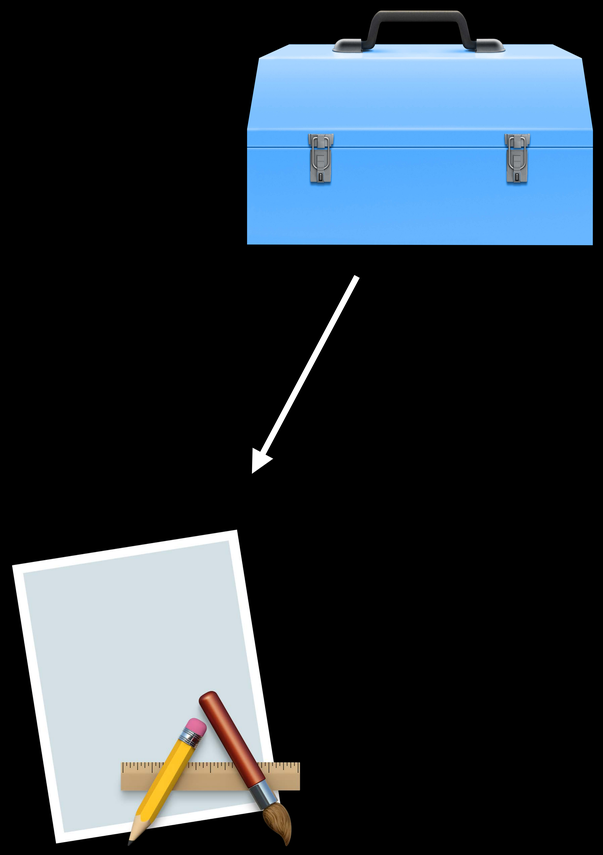

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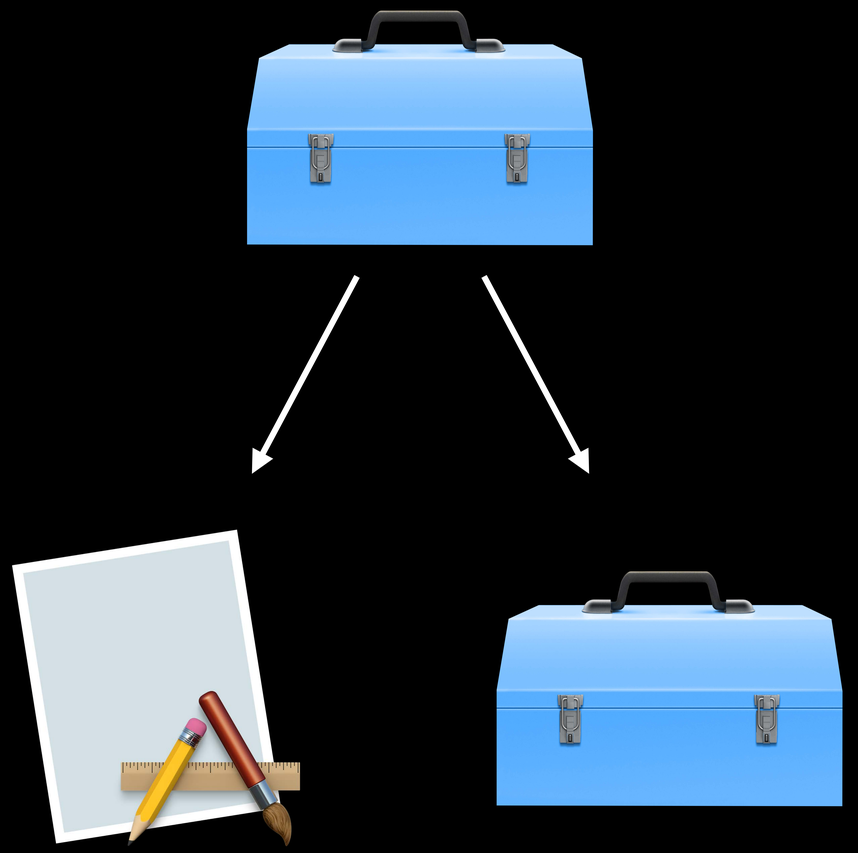

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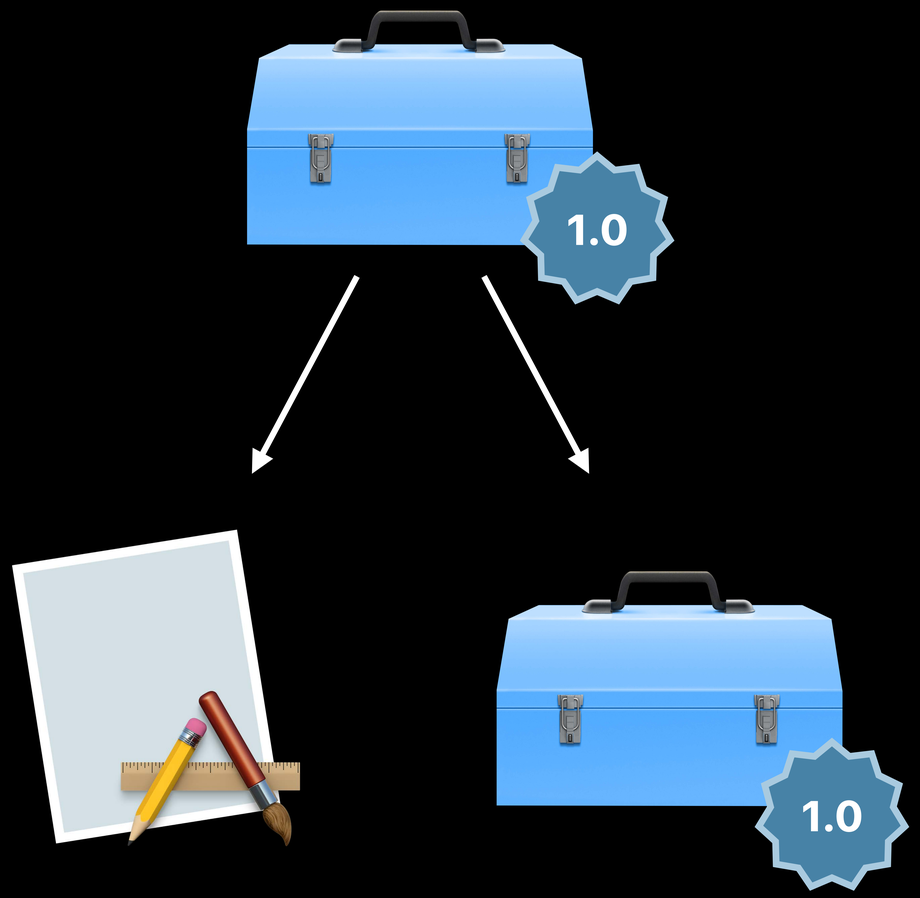

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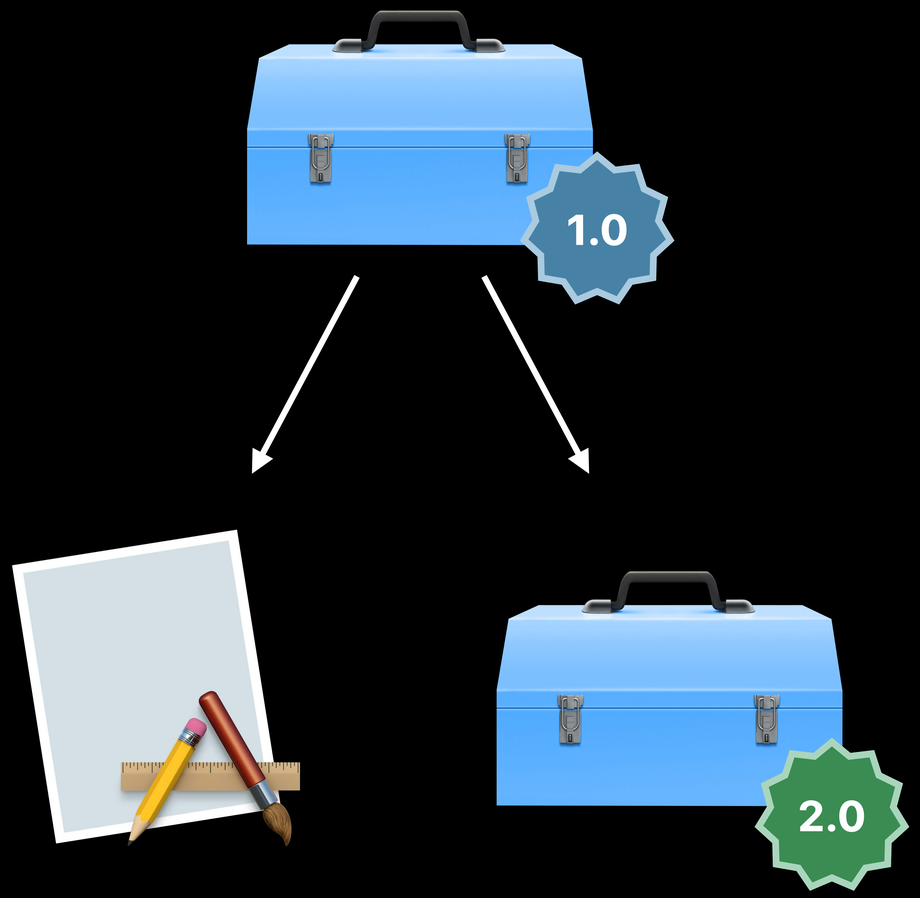

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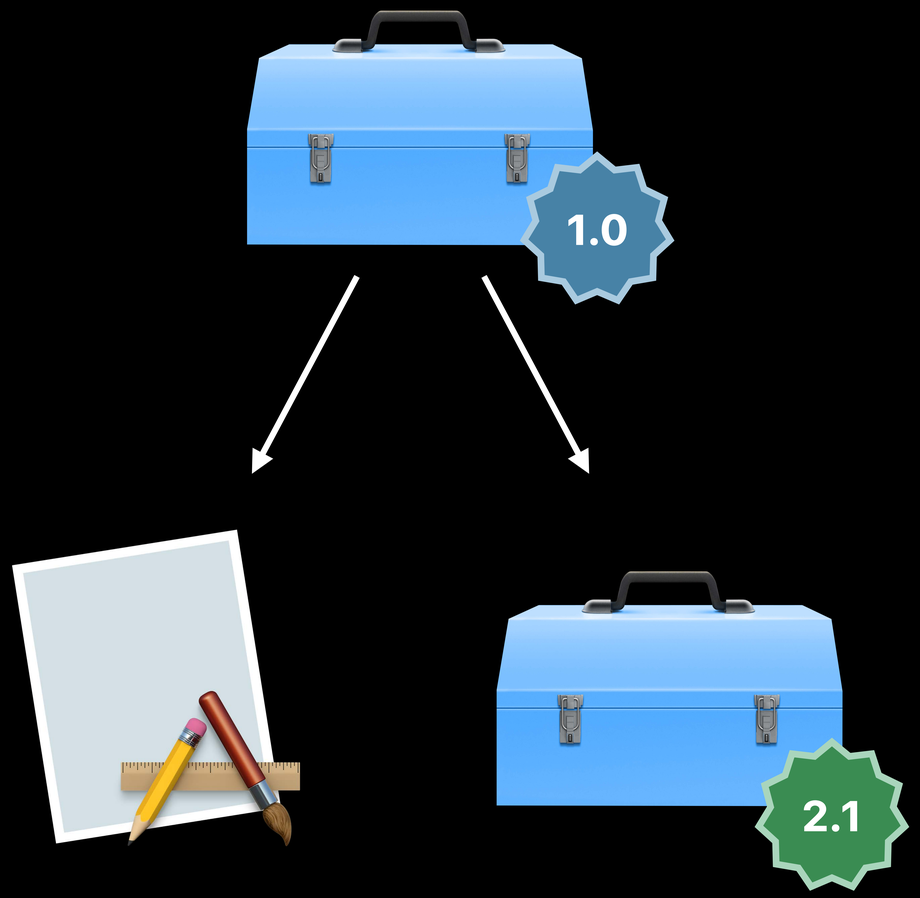

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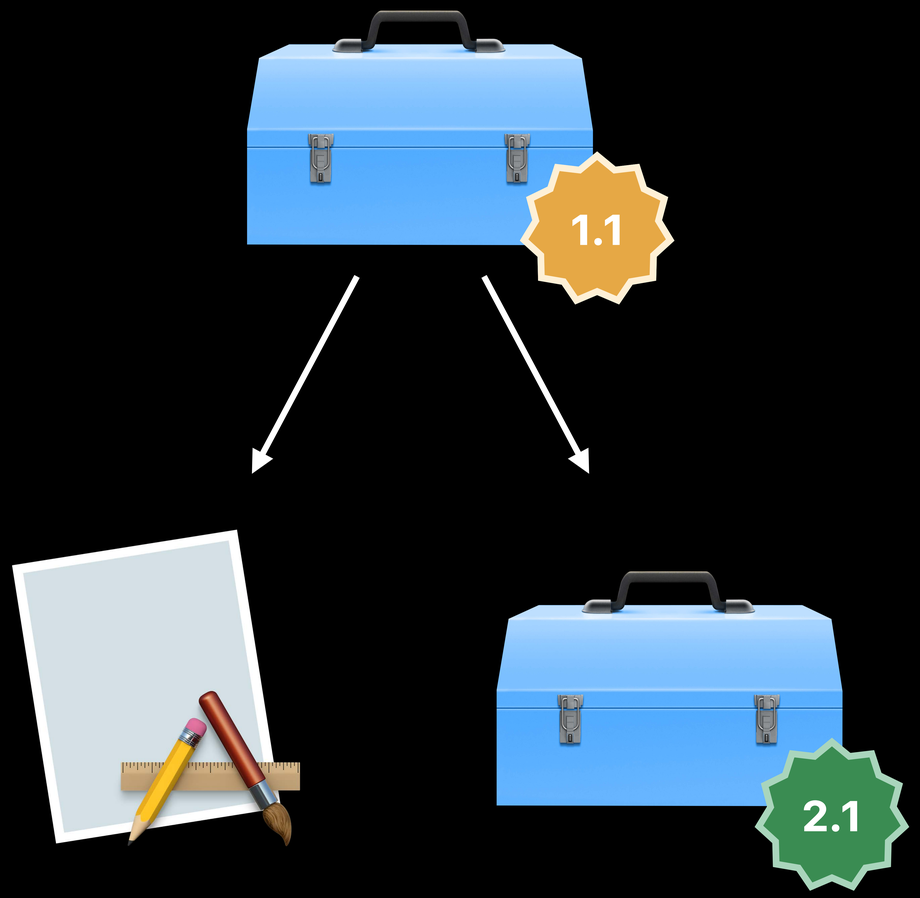

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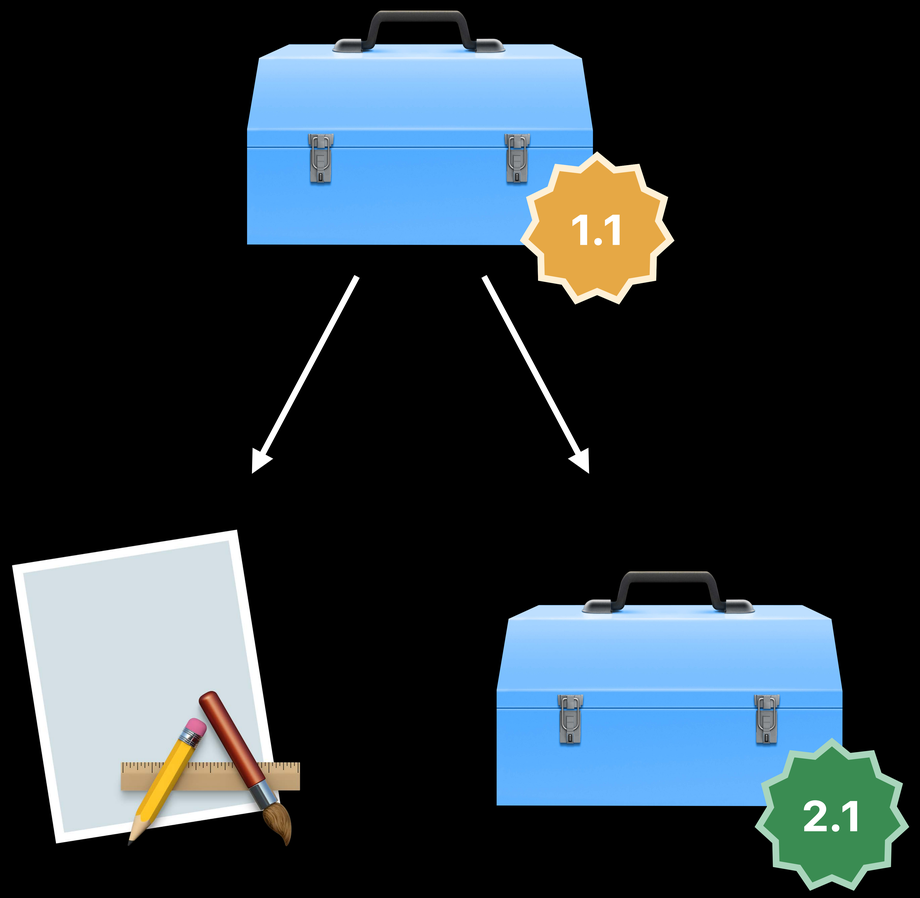

Framework Versions

Framework Versions

Key	Type	Value
▼ Information Property List	Dictionary	(8 items)
Localization native development re...	String	$(DEVELOPMENT_LANGUAGE)
Executable file	String	$(EXECUTABLE_NAME)
Bundle identifier	String	$(PRODUCT_BUNDLE_IDENTIFIER)
InfoDictionary version	String	6.0
Bundle name	String	$(PRODUCT_NAME)
Bundle OS Type code	String	$(PRODUCT_BUNDLE_PACKAGE_TYPE)
Bundle versions string, short	String	1.0
Bundle version	String	$(CURRENT_PROJECT_VERSION)

Semantic Versioning

semver.org

1.2.4

Patch Version
Bug fixes

1.2.4

Minor Version
Compatible additions

1.2.4

Major Version
Breaking changes (source, binary, semantic)

```
public class Spaceship {
  public let name: String
  private var currentLocation: Location

  public init(name: String) {
    self.name = name
    currentLocation = .launchpad
  }

  public func fly(
    to destination: Location,
    speed: Speed) {
    currentLocation = destination
  }
}

public enum Speed {
  case leisurely
  case fast
}

public struct Location {
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}
```

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```
public class Spaceship {
  public let name: String
  private static var defaultLocation: Location?
  private var currentLocation: Location

  public init(name: String) {
    self.name = name
    currentLocation =
      Spaceship.defaultLocation ?? .launchpad
  }

  public func doABarrelRoll() {
    // …
  }

  public func fly(
    to destination: Location,
    speed: Speed,
    stealthily: Bool = false) {
    currentLocation = destination
  }
}

public enum Speed {
  case leisurely
  case fast
  case ludicrous
```

```
public class Spaceship {
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1.0.0

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1.0.0

```
public class Spaceship {
  public let name: String

  private var currentLocation: Location

  public init(name: String) {
    self.name = name
    currentLocation = .launchpad
  }

  public func fly(
    to destination: Location,
    speed: Speed) {
    currentLocation = destination
  }
}

public enum Speed {
```

1.0.0

```
public class Spaceship {
  public let name: String
  private static var defaultLocation: Location?
  private var currentLocation: Location

  public init(name: String) {
    self.name = name
    currentLocation =
      Spaceship.defaultLocation ?? .launchpad
  }

  public func doABarrelRoll() {
    // …
  }

  public func fly(
    to destination: Location,
    speed: Speed,
    stealthily: Bool = false) {
    currentLocation = destination
  }
}

public enum Speed {
```

1.0.0

```
public class Spaceship {
  public let name: String

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  public init(name: String) {
    self.name = name
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    to destination: Location,
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public class Spaceship {
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public enum Speed {
```

1.0.0

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public class Spaceship {
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  }

  public func fly(
    to destination: Location,
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    currentLocation = destination
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}

public enum Speed {
```

1.0.1

```
public class Spaceship {
  public let name: String
  private static var defaultLocation: Location?
  private var currentLocation: Location

  public init(name: String) {
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      Spaceship.defaultLocation ?? .launchpad
  }

  public func doABarrelRoll() {
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  public func fly(
    to destination: Location,
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    currentLocation = destination
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}

public enum Speed {
```

1.0.0

```
public class Spaceship {
  public let name: String

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```

1.0.1

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  public let name: String
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      Spaceship.defaultLocation ?? .launchpad
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  public func doABarrelRoll() {
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  }

  public func fly(
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public enum Speed {
```

1.0.0

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public class Spaceship {
  public let name: String

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public enum Speed {
```

1.1.0

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public class Spaceship {
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public enum Speed {
```

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public class Spaceship {
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  public init(name: String) {
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  }

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public enum Speed {
```

1.1.0

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public enum Speed {
```

2.0.0

```
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  private static var defaultLocation: Location?
  private var currentLocation: Location

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    currentLocation =
      Spaceship.defaultLocation ?? .launchpad
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  public func doABarrelRoll() {
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  public func fly(
    to destination: Location,
    speed: Speed,
    stealthily: Bool = false) {
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  }
}


public enum Speed {
```

1.0.0

```
    to destination: Location,
    speed: Speed) {
    currentLocation = destination
  }
}


public enum Speed {
  case leisurely
  case fast

}

public struct Location {
  public var coordinates: Coordinates

}
```

2.0.0

```
    to destination: Location,
    speed: Speed,
    stealthily: Bool = false) {
    currentLocation = destination
  }
}

public enum Speed {
  case leisurely
  case fast
  case ludicrous
}

public struct Location: Hashable {
  public var coordinates: Coordinates
  public var label: String
}
```

1.0.0

```
    to destination: Location,
    speed: Speed) {
    currentLocation = destination
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Implications for API Design

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Keep your interface small — easy to add, hard to remove!

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Choose names and requirements carefully

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Keep your interface small — easy to add, hard to remove!

Choose names and requirements carefully

Avoid unnecessary extensibility (open classes, arbitrary callbacks, etc.)

Behind the Scenes

Extra indirection at module boundaries

```
public class Spaceship {
  public init()
  public func fly(
    to destination: Location,
    speed: Speed)
}
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Behind the Scenes

Extra indirection at module boundaries

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public class Spaceship {
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spaceship.fly(to: home, speed: .fast)
```

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Extra indirection at module boundaries

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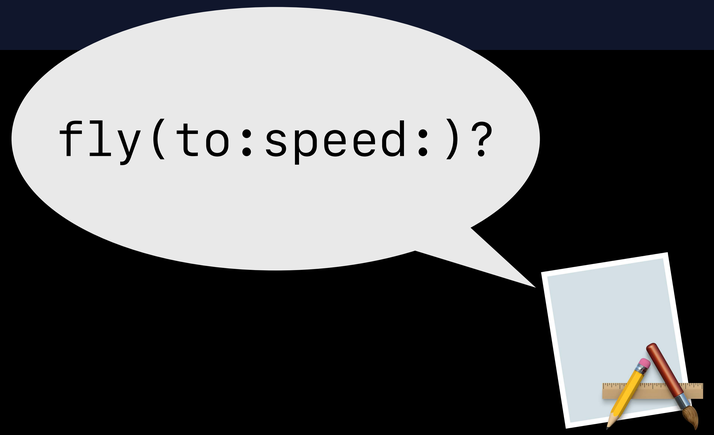

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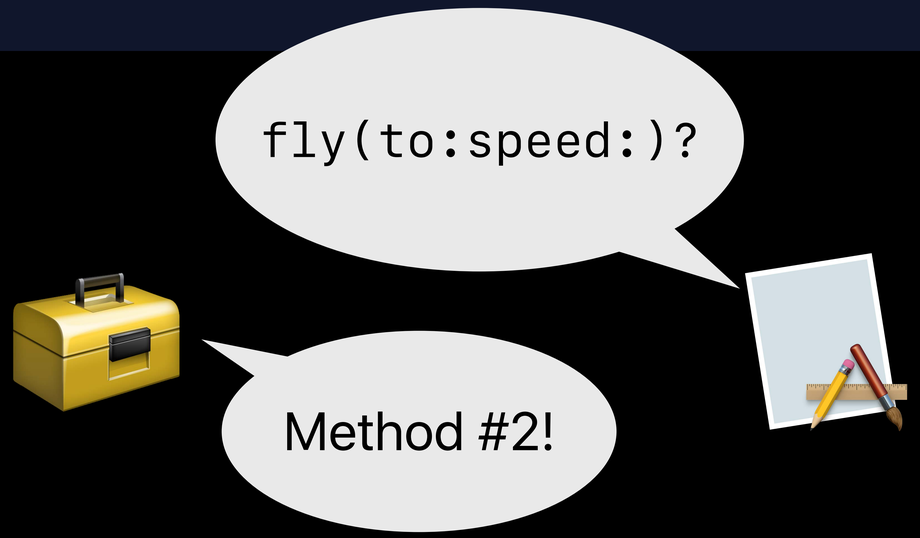

Behind the Scenes

Extra indirection when clients use the framework’s structs and enums

```
public enum Speed {
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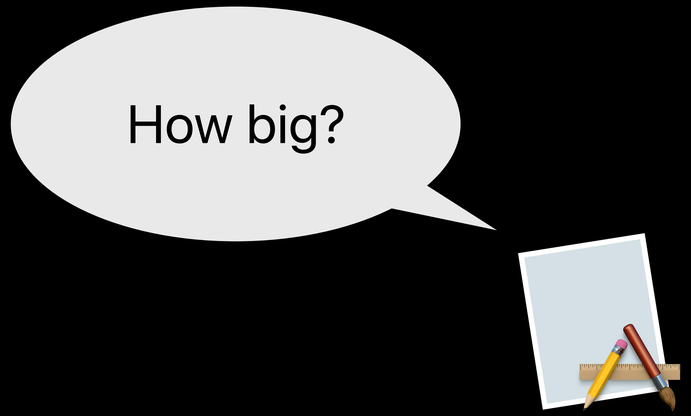

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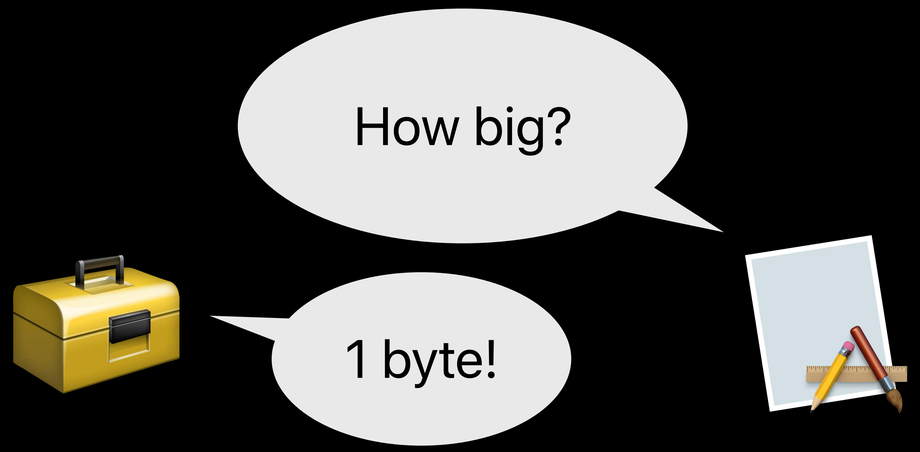

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Trading Flexibility for Optimizability


Flexibility
Optimizability

Flexibility

Optimizability


Flexibility
Optimizability


Build Options
Setting
FlightKit
Build Libraries for Distribution
Yes


Flexibility
Optimizability


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Flexibility
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Build Options
Setting
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Yes

Flexibility

Optimizability

`@inlinable` functions

`@frozen` enums

`@frozen` structs

```
public class CargoShip: Spaceship {
  @inlinable
  public func canCarry(
    _ cargo: Cargo) -> Bool {
    return cargo.mass <= self.capacity
  }

  @usableFromInline
  internal var capacity: Measurement<UnitMass>

  internal var currentCargo: Cargo?
}
```

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public class CargoShip: Spaceship {
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// swift-interface-format-version: 1.0
// swift-compiler-version: Swift version 5.1
// swift-module-flags: -target arm64-apple-ios13.0
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                       -swift-version 5 -O
                       -module-name FlightKit
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```

cargo.mass <= self.capacity

“But what happens if I change it?”

```swift
public class CargoShip: Spaceship {
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  }

  @usableFro
  internal va                rement<UnitMass>
}
```

cargo.mass <= self.capacity

```swift
public class CargoShip: Spaceship {
  @inlinable
  public func canCarry(
    _ cargo: Cargo) -> Bool {
    return cargo.mass <= self.capacity &&
           !cargo.isRadioactive
  }

  @usableFromInline
  internal var capacity: Measurement<UnitMass>

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```

```swift
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```

cargo.mass <= self.capacity

```
cargo.mass <=
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```

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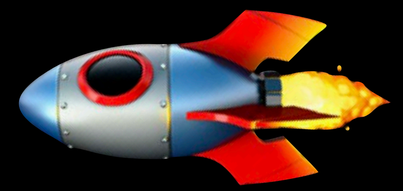

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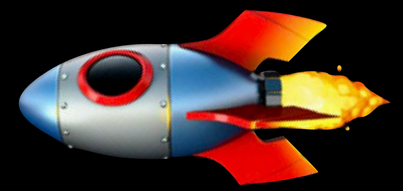

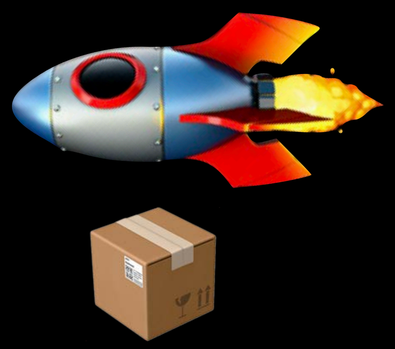

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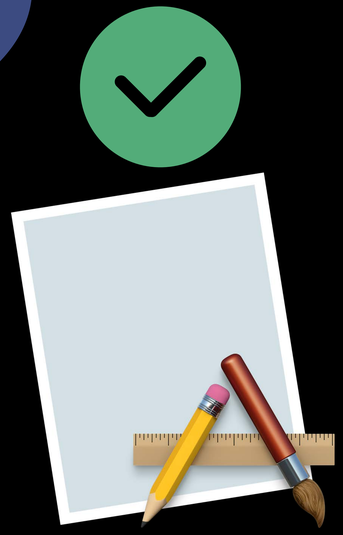

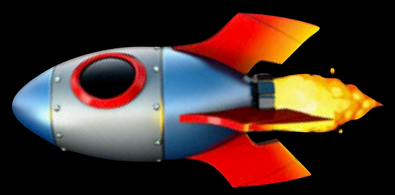

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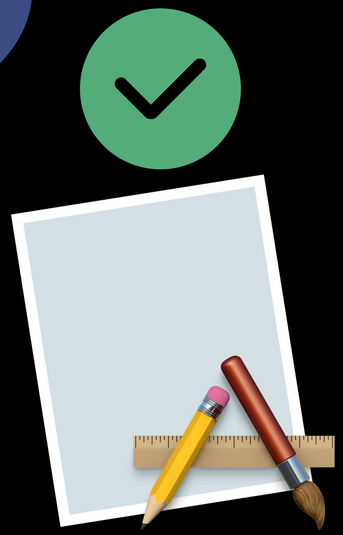

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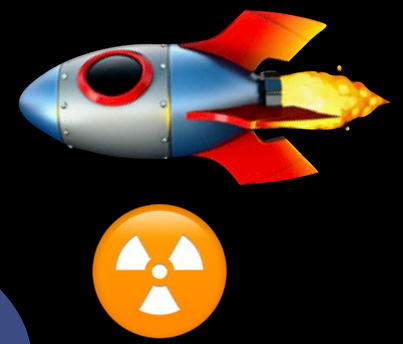

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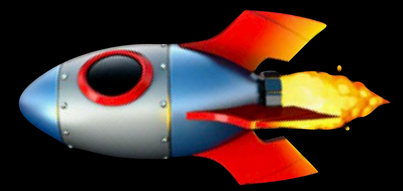

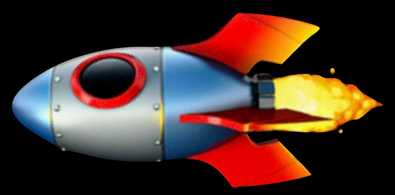

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cargo.mass <=
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```

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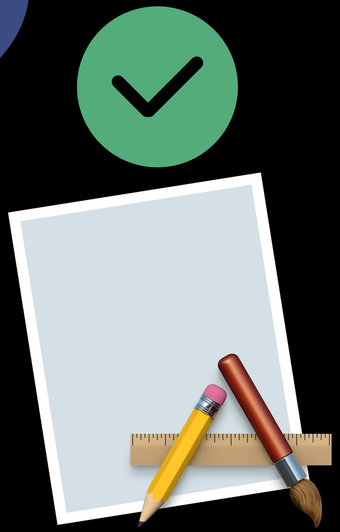

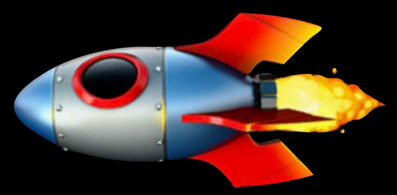

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Changing an `@inlinable` Function

Rule of thumb — don’t change the output or observable behavior

- Better algorithms are okay

`@frozen` Enums

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public enum FlightPlanKind {
  case oneWay
  case roundTrip
}
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switch kind {
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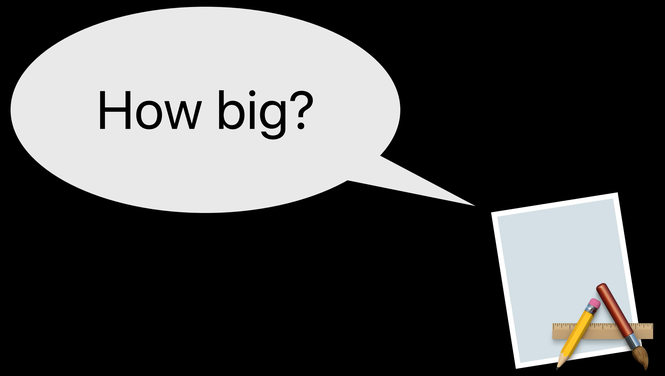


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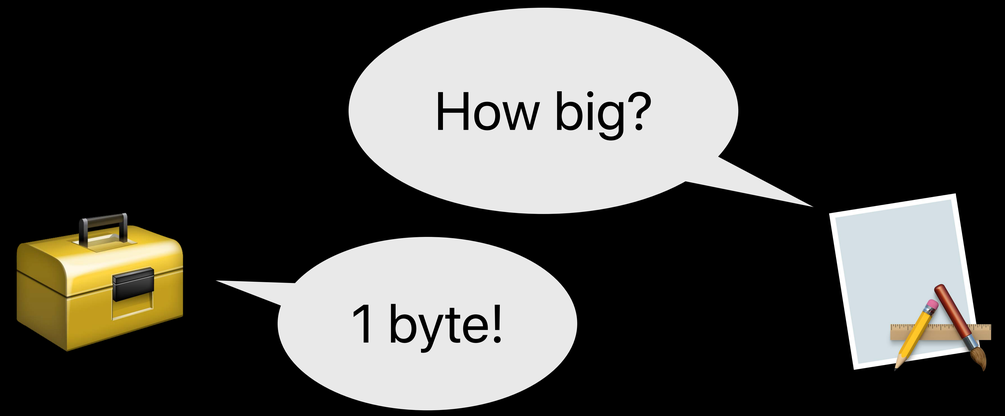


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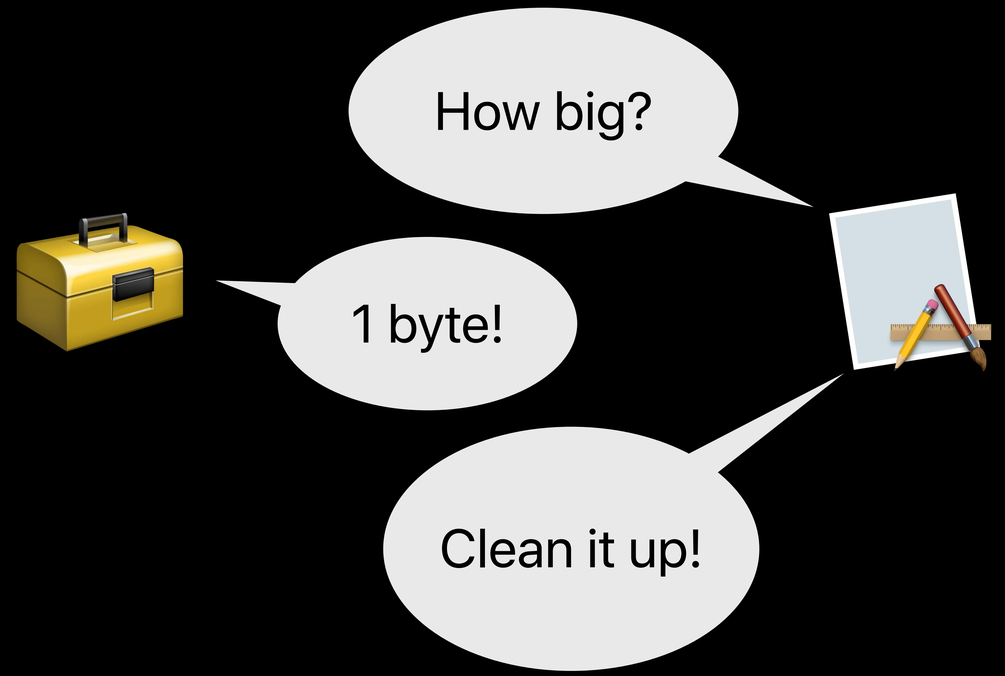


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Promise not to add new cases

Clients won’t write `default` in switches

Better performance, especially when no cases have associated values

Changing `@frozen` Enums

```
@frozen public enum FlightPlanKind {
  case oneWay
  case roundTrip
  case multiHop([Location])
}
```

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2.1.0

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`@frozen` Structs

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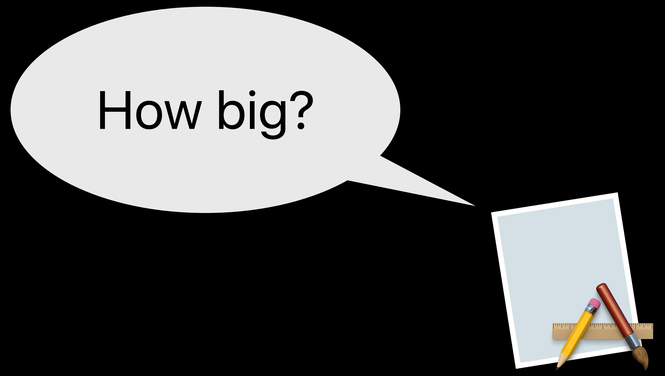

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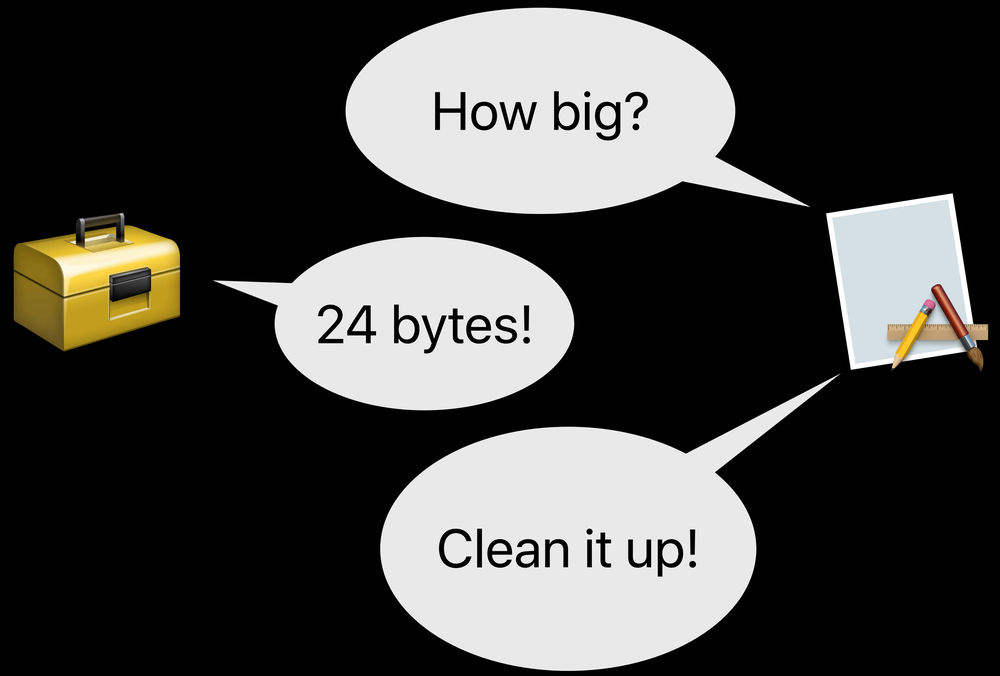

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Promise not to add or reorder stored properties

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@frozen public struct Coordinates {
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```

Promise not to add or reorder stored properties

Types of stored properties must be public or `@usableFromInline`

`@frozen` Structs

NEW

```
@frozen public struct Coordinates {
  public var radius, azimuth, inclination: Double
  @inlinable public init(r: Double, alpha: Double, theta: Double) {…}
}
```

Promise not to add or reorder stored properties

Types of stored properties must be public or `@usableFromInline`

Allows inlinable initializers

`@frozen` Structs

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Flexibility Is the Default

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Profile before reaching for `@inlinable` or `@frozen`

Helping Your Clients

Entitlements

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Entitlements

Document your requirements

Entitlements

Document your requirements

Minimize entitlement requests

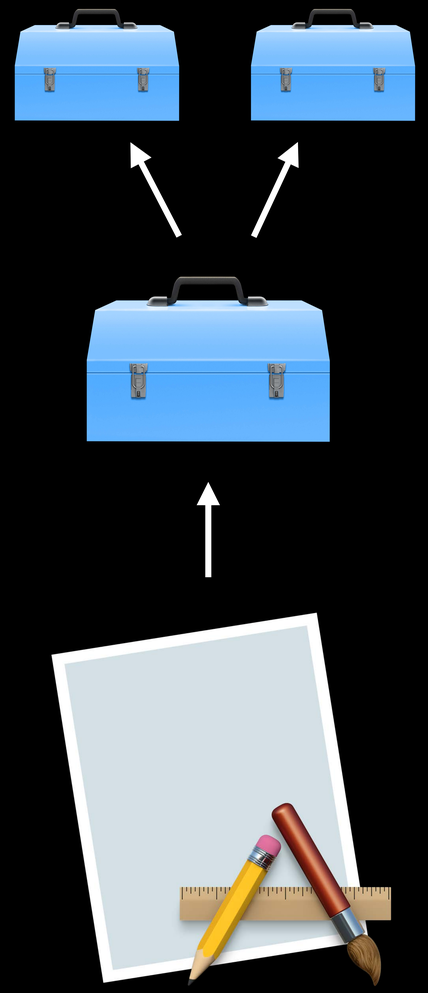
Entitlements

Document your requirements

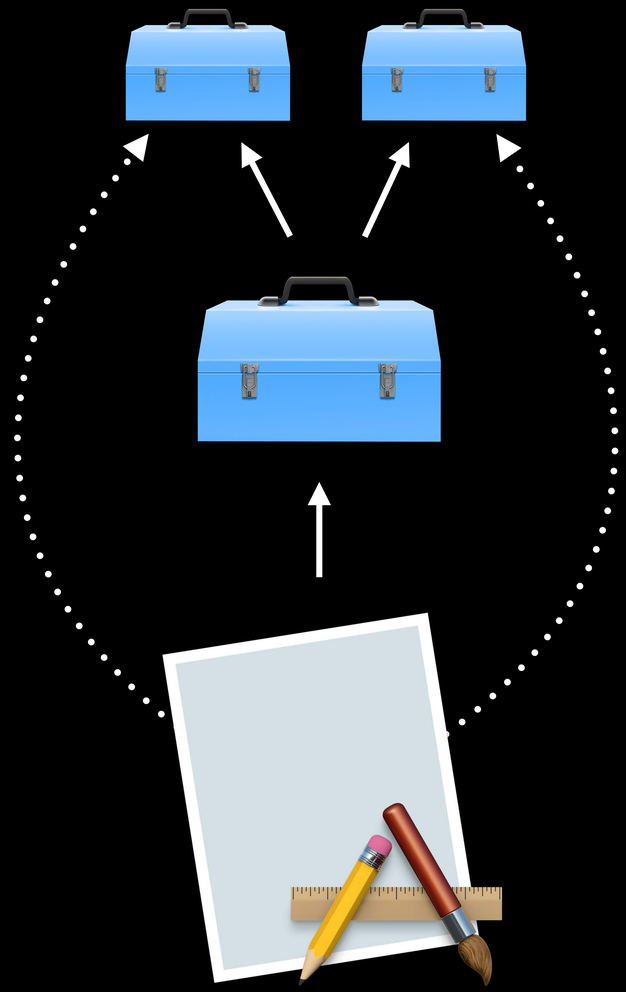
Minimize entitlement requests

Handle denial gracefully

Dependencies



Dependencies



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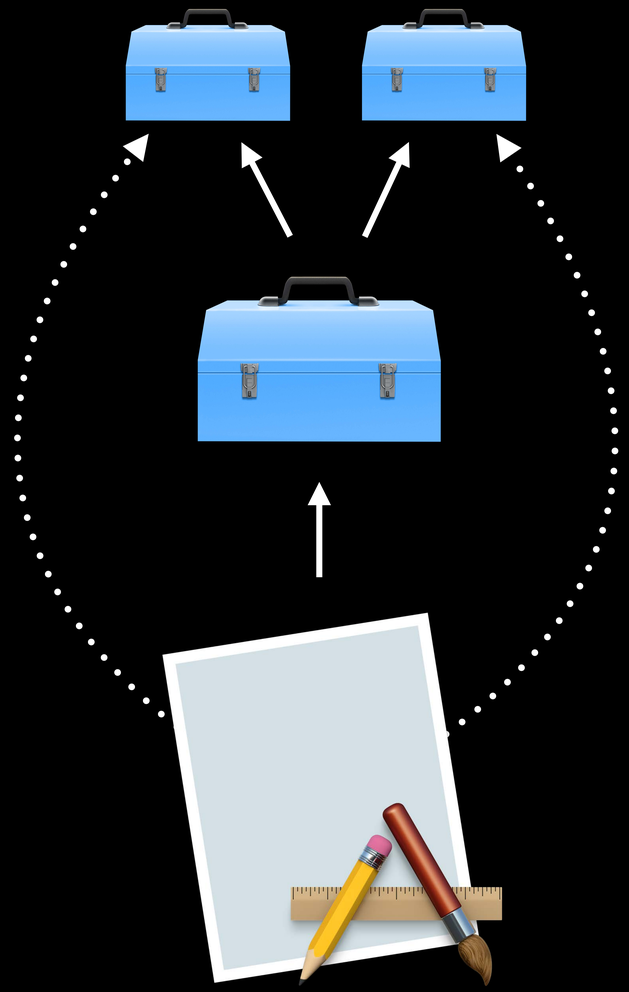

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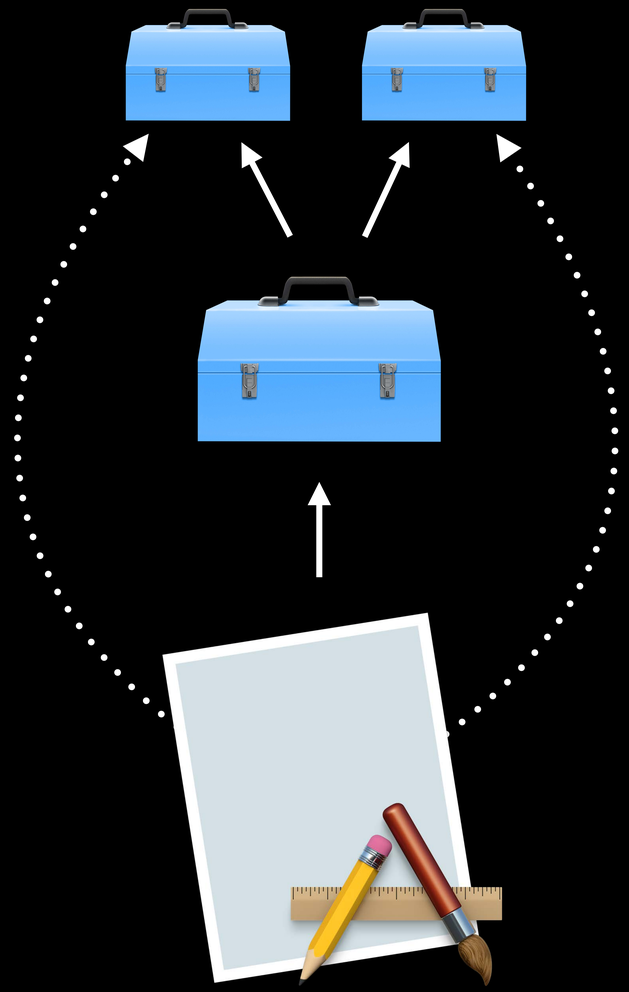
Minimize your dependencies



Dependencies

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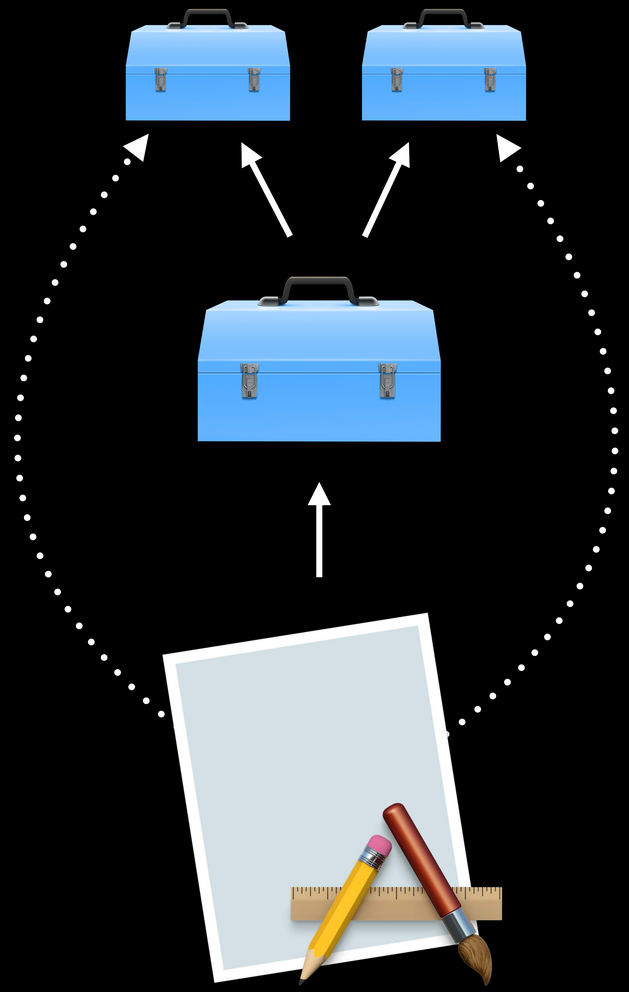
Dependencies must use
“Build Libraries for Distribution”



Binary Frameworks Cannot Depend on Packages

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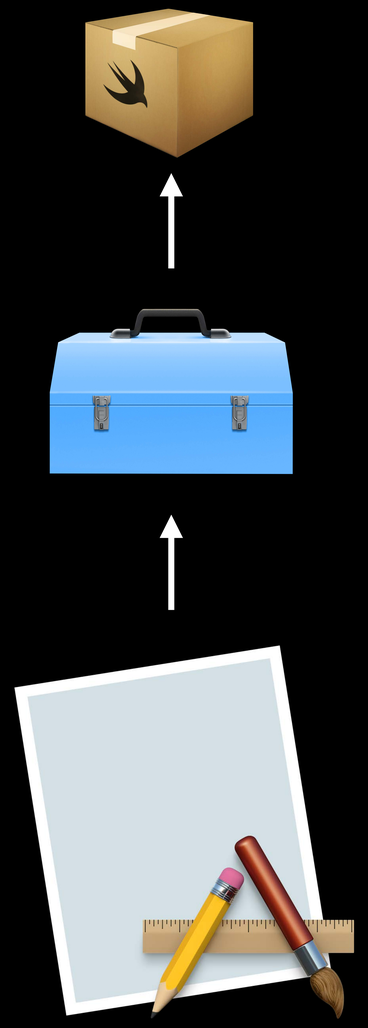

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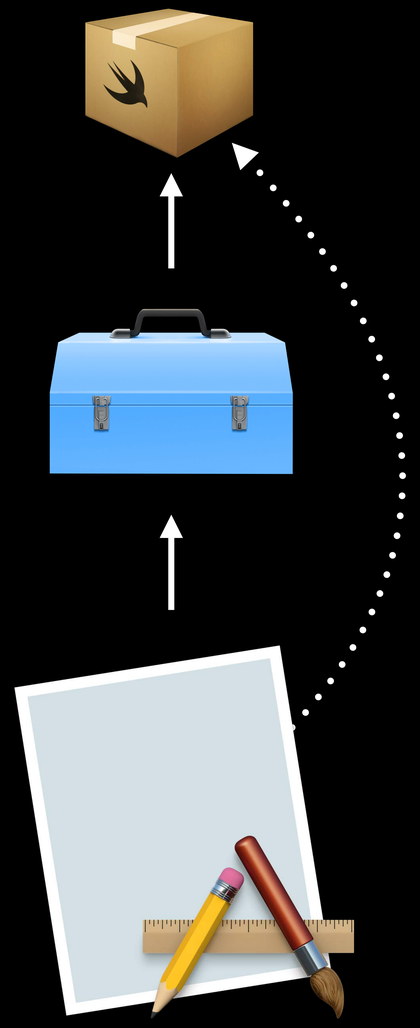

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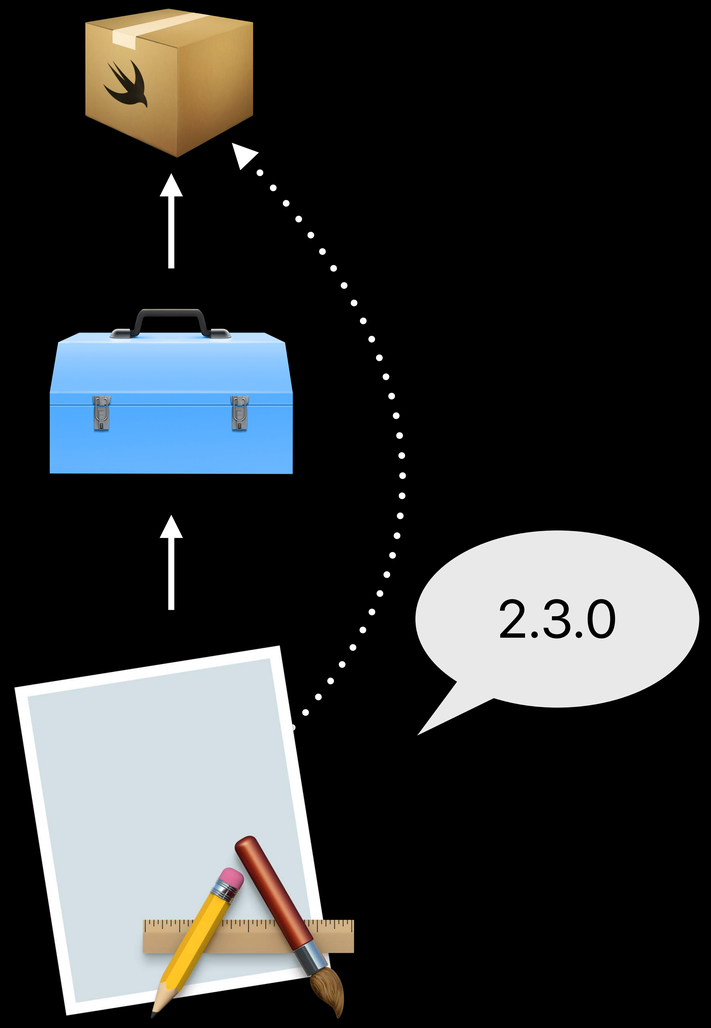

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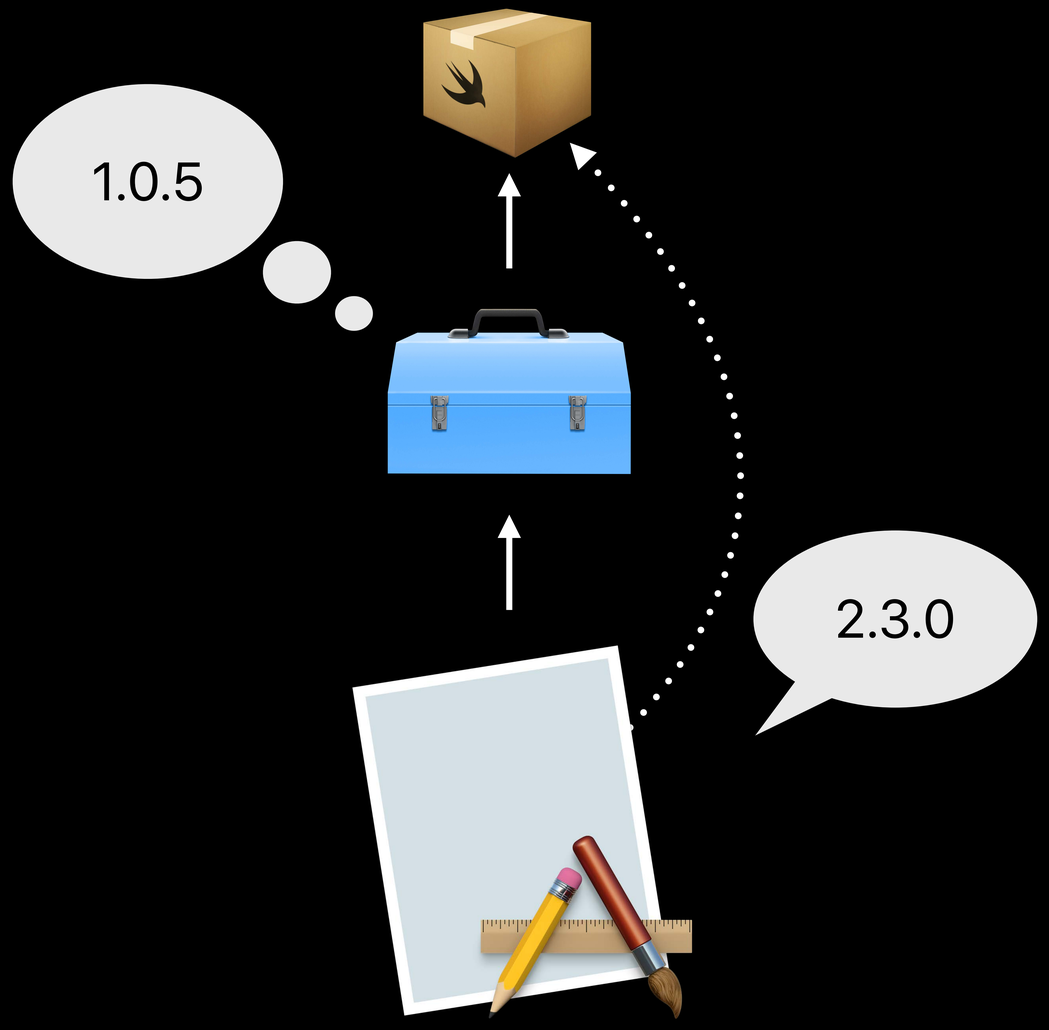

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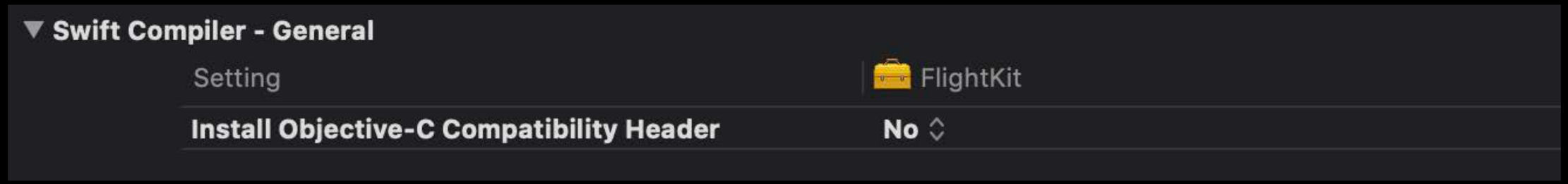

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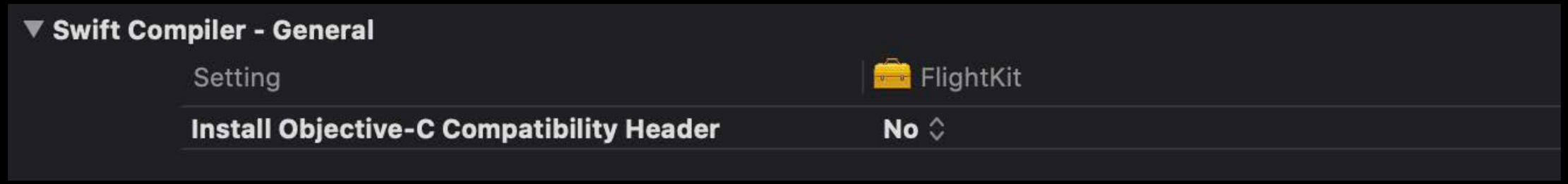

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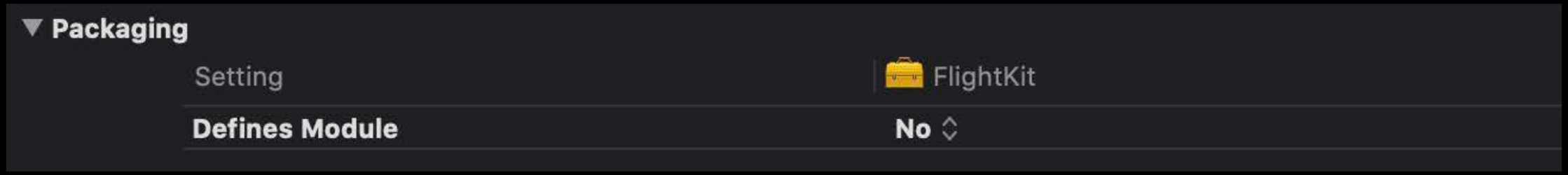

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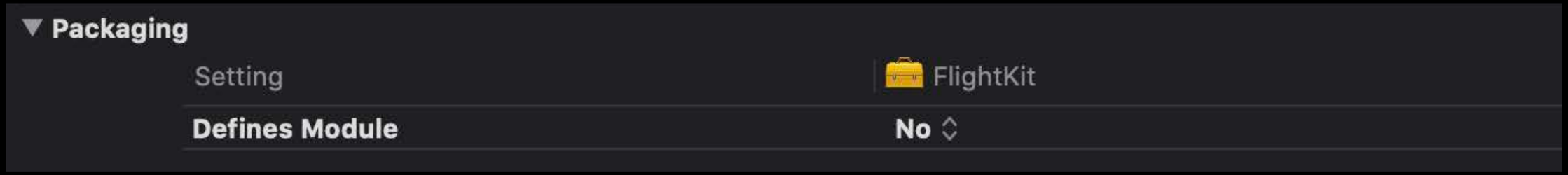

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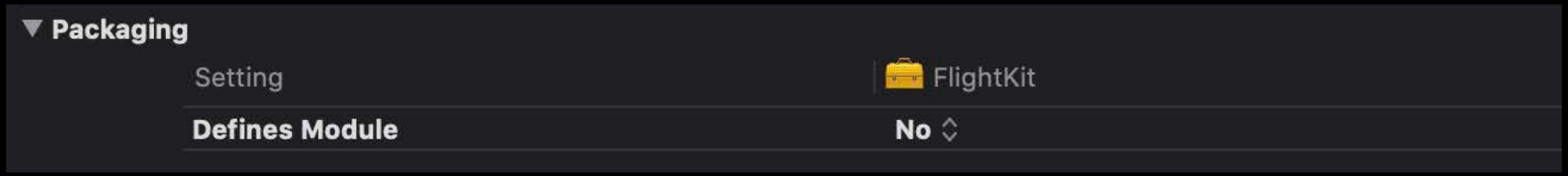

Summary

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XCFrameworks — for distributing multiple framework variants

“Build Libraries for Distribution” build setting

Framework owners — know your responsibilities

More Information

developer.apple.com/wwdc19/416

Swift Open Hours	Thursday, 3:00
Building, Signing, and Distributing Lab	Friday, 9:00


WWDC19