

Advanced NSOperations

Exploring the WWDC app

Session 226

Philippe Hausler Foundation Engineer

Dave DeLong Frameworks Evangelist



WWDC App

WWDC App

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Exploring the WWDC App

Dave DeLong Frameworks Evangelist

Agenda

Core Concepts

Beyond the Basics

Sample Code

Core Concepts

High-level `dispatch_queue_t`

High-level `dispatch_queue_t`

Cancellation

High-level `dispatch_queue_t`

Cancellation

`maxConcurrentOperationCount`

Serial Queues

`maxConcurrentOperationCount = 1`



Serial Queues

`maxConcurrentOperationCount = 1`



Serial Queues

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Serial Queues

`maxConcurrentOperationCount = 1`



Concurrent Queues

`maxConcurrentOperationCount = Default`



Concurrent Queues

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Concurrent Queues

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Concurrent Queues

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Concurrent Queues

`maxConcurrentOperationCount = Default`



NSOperation

NSOperation

High-level `dispatch_block_t`

NSOperation

High-level `dispatch_block_t`

Long-running task

NSOperation

High-level `dispatch_block_t`

Long-running task

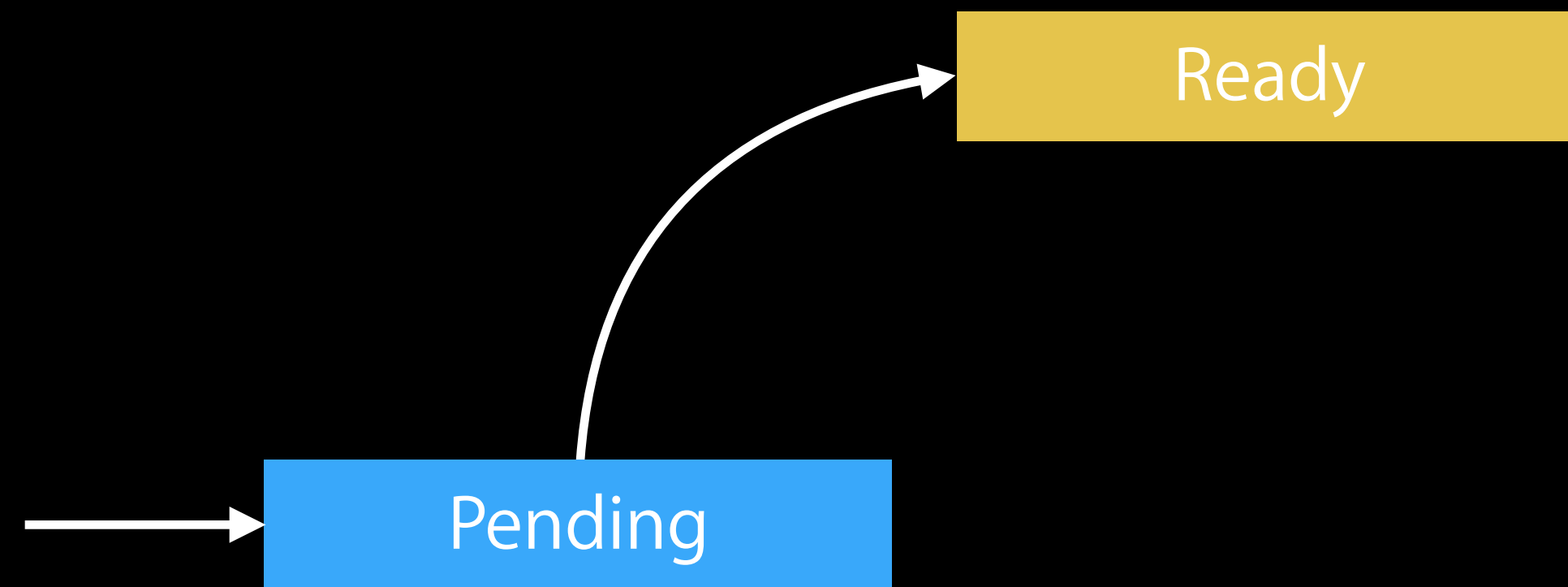
Subclassable

Lifecycle of an NSOoperation

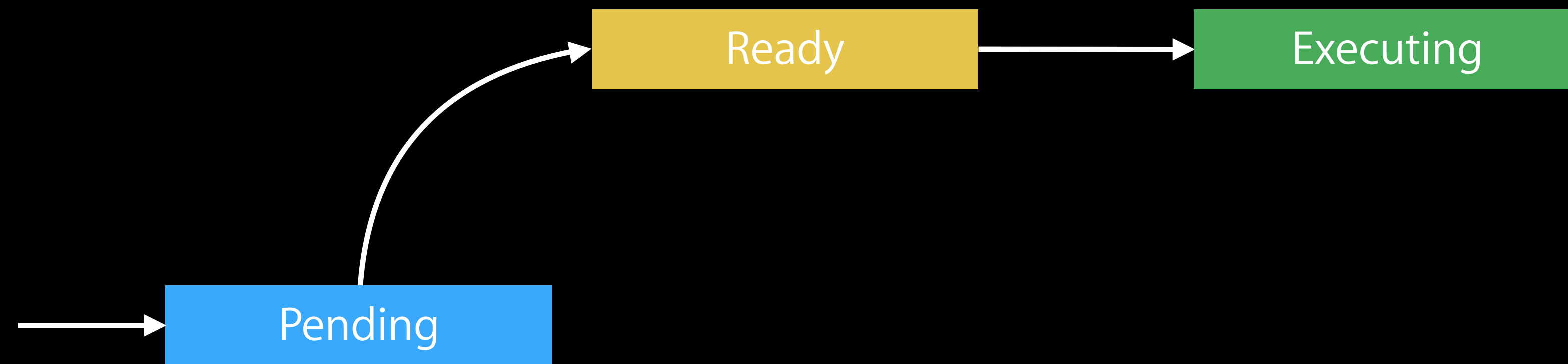
Lifecycle of an NSOperation



Lifecycle of an NSOperation



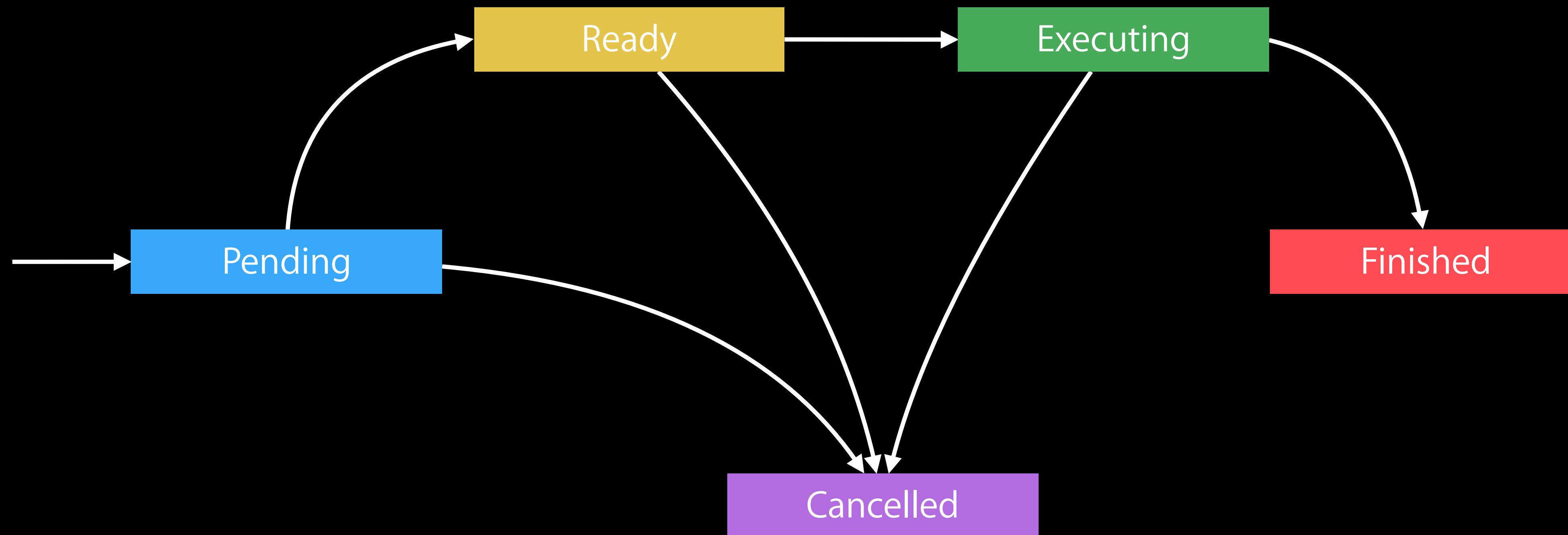
Lifecycle of an NSOperation



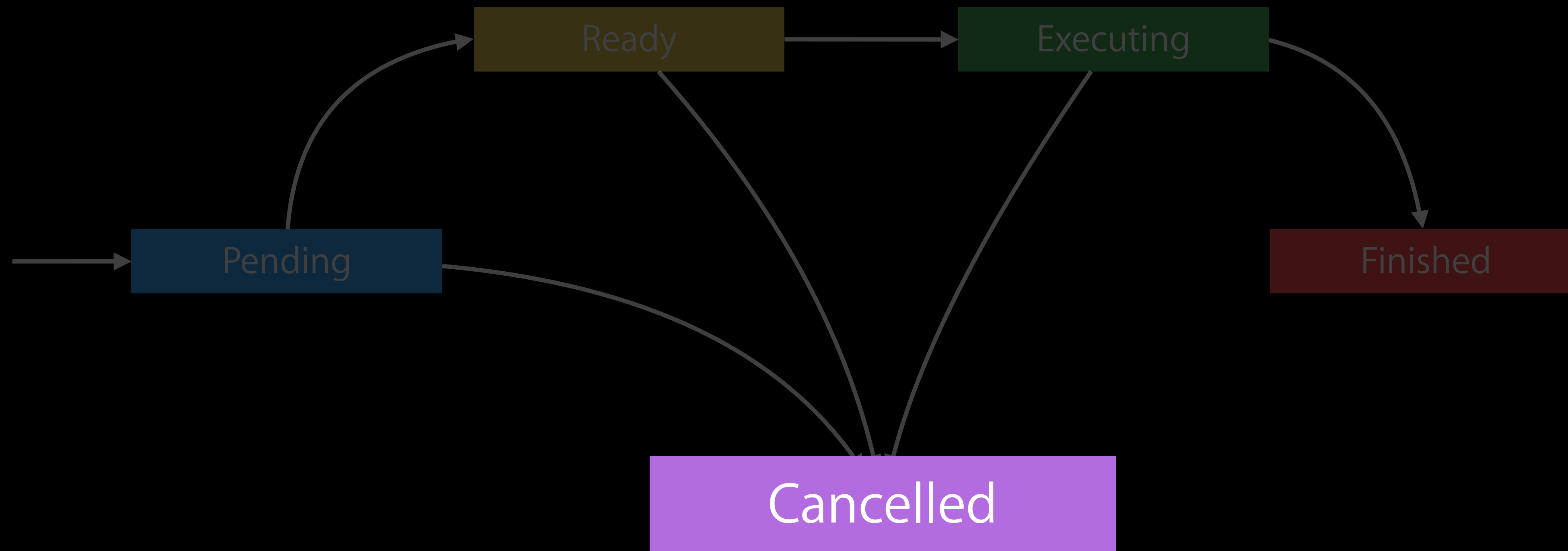
Lifecycle of an NSOperation



Lifecycle of an NSOperation



Lifecycle of an NSOperation



Cancellation

Cancellation

```
var cancelled: Bool { get }
```

Cancellation

```
var cancelled: Bool { get }
```

Only changes state

Cancellation

```
var cancelled: Bool { get }
```

Only changes state

Subclasses dictate meaning

Cancellation

```
var cancelled: Bool { get }
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Only changes state

Subclasses dictate meaning

Susceptible to race conditions

Cancellation

```
var cancelled: Bool { get }
```

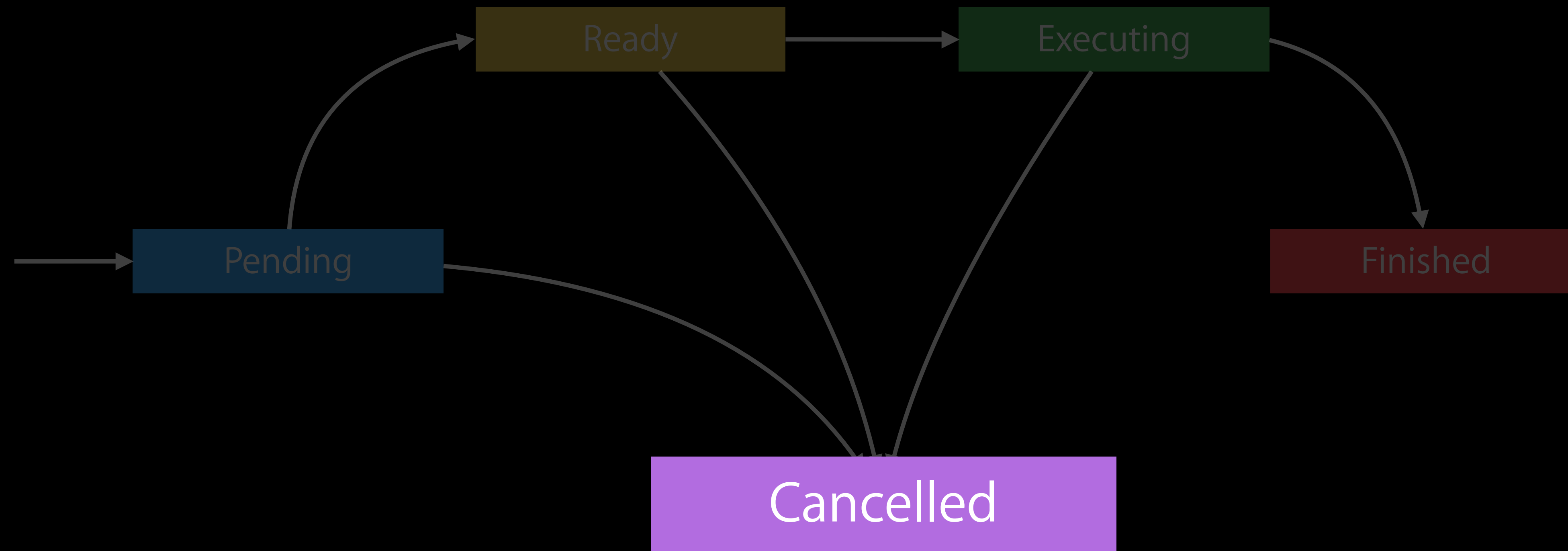
Only changes state

Subclasses dictate meaning

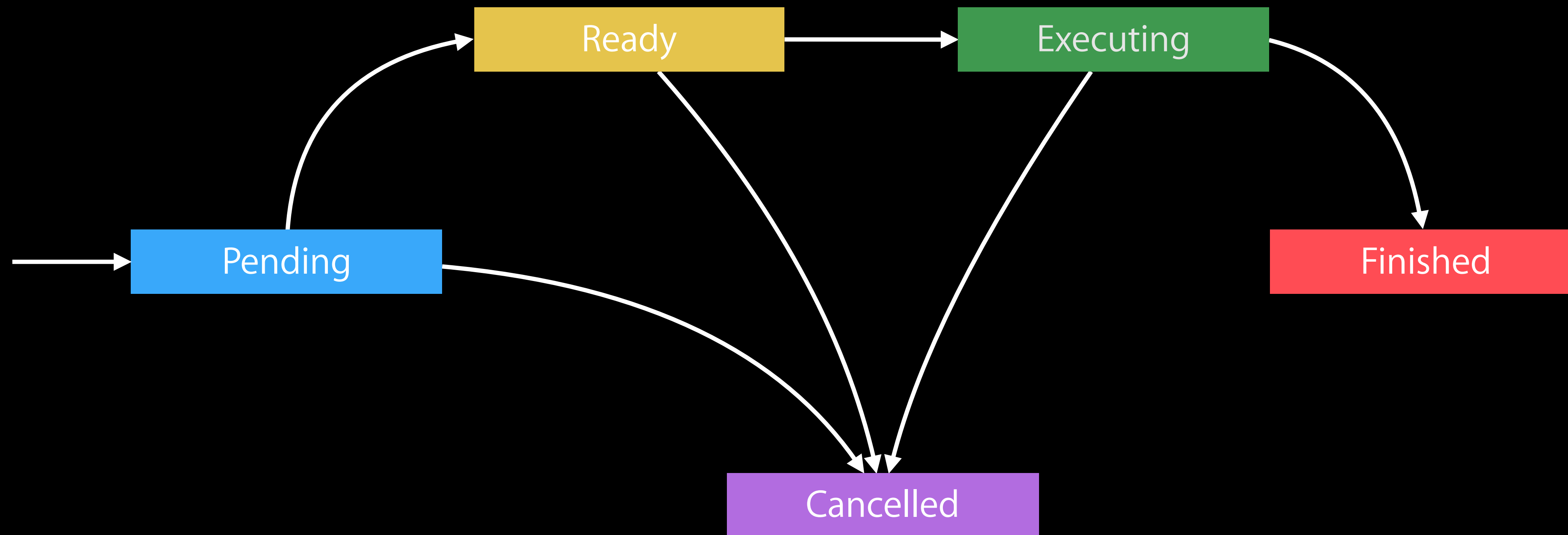
Susceptible to race conditions

```
operationA.cancel()
```

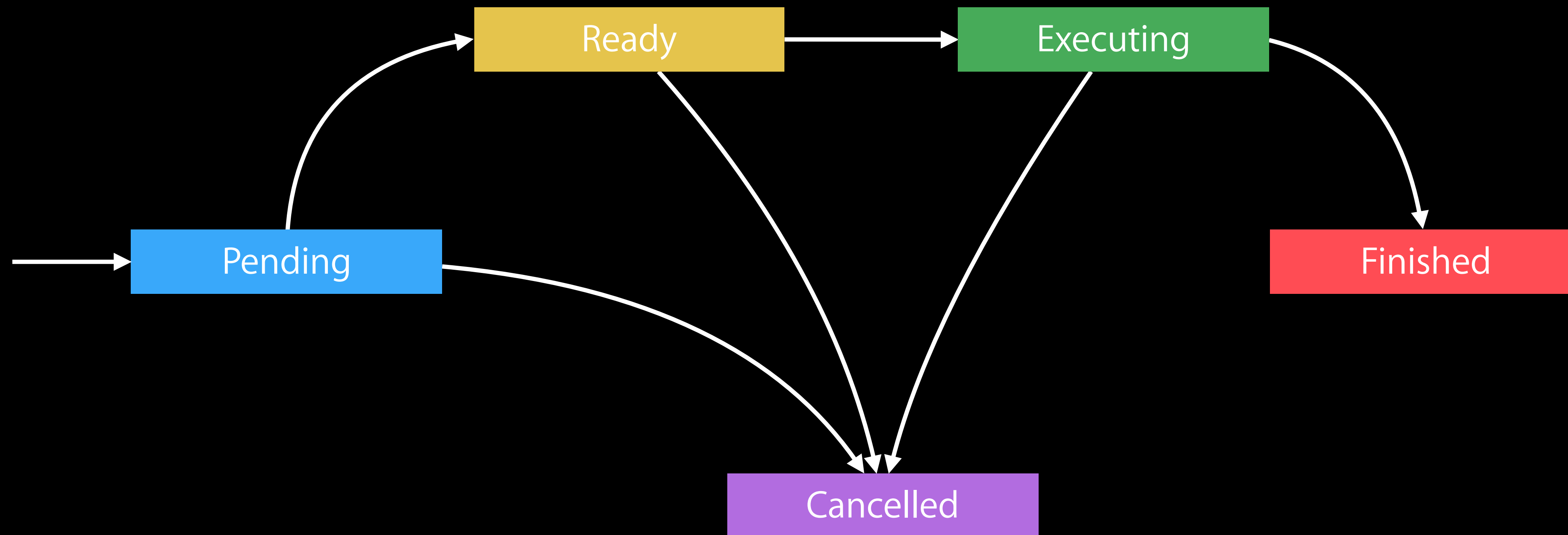

Lifecycle of an NSOperation



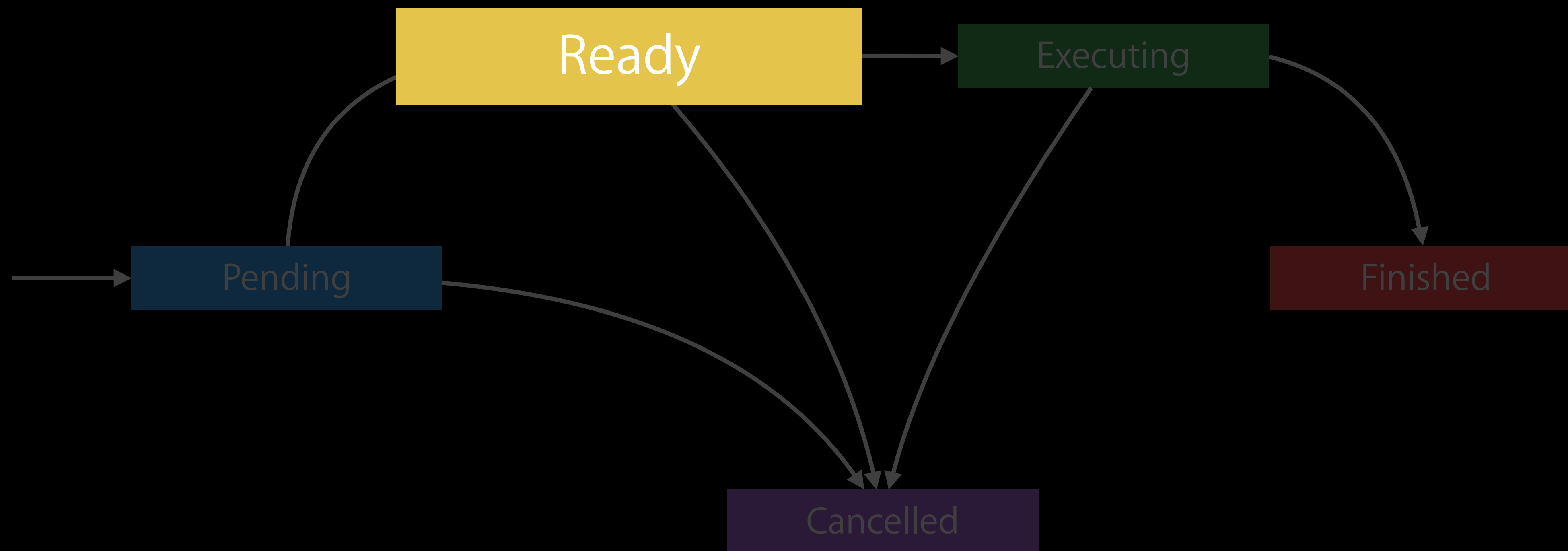
Lifecycle of an NSOperation



Lifecycle of an NSOperation



Lifecycle of an NSOperation



Readiness

Readiness

```
var ready: Bool { get }
```

Readiness

```
var ready: Bool { get }
```

Execute when ready

Serial Operation Queues

Readiness



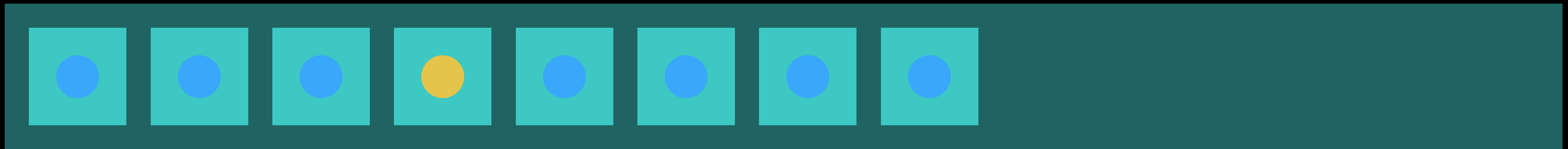
Serial Operation Queues

Readiness



Serial Operation Queues

Readiness



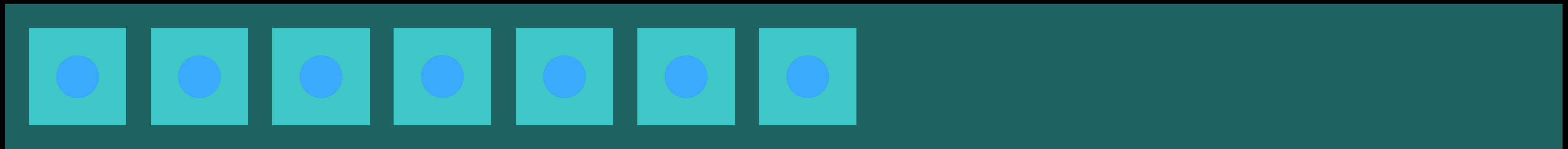
Serial Operation Queues

Readiness



Serial Operation Queues

Readiness



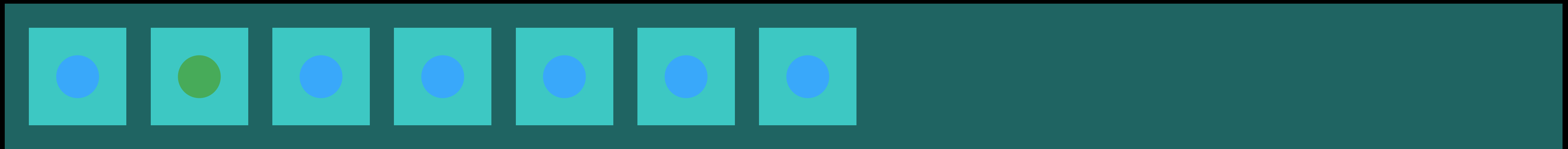
Serial Operation Queues

Readiness



Serial Operation Queues

Readiness



Serial Operation Queues

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Serial Operation Queues

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Serial Operation Queues

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Serial Operation Queues

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Serial Operation Queues

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Serial Operation Queues

Readiness



Serial Operation Queues

Readiness



Serial Operation Queues

Readiness



Serial Operation Queues

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Serial Operation Queues

Readiness



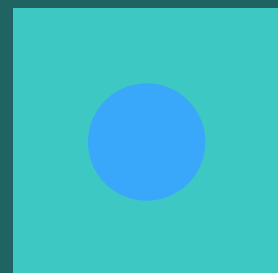
Serial Operation Queues

Readiness



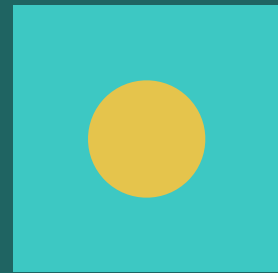
Serial Operation Queues

Readiness



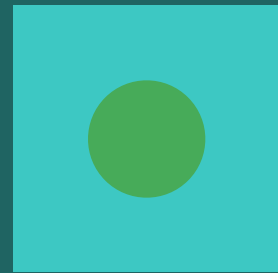
Serial Operation Queues

Readiness



Serial Operation Queues

Readiness



Serial Operation Queues

Readiness



Dependencies

Dependencies

“First this, then that”

Dependencies

“First this, then that”

Strict ordering

Dependencies

“First this, then that”

Strict ordering

Implemented via readiness

Dependencies

“First this, then that”

Strict ordering

Implemented via readiness

Not limited by queues

Dependencies

“First this, then that”

Strict ordering

Implemented via readiness

Not limited by queues

```
let operationA = ...  
let operationB = ...  
operationB.addDependency(operationA)
```

Dependencies

Operation deadlock

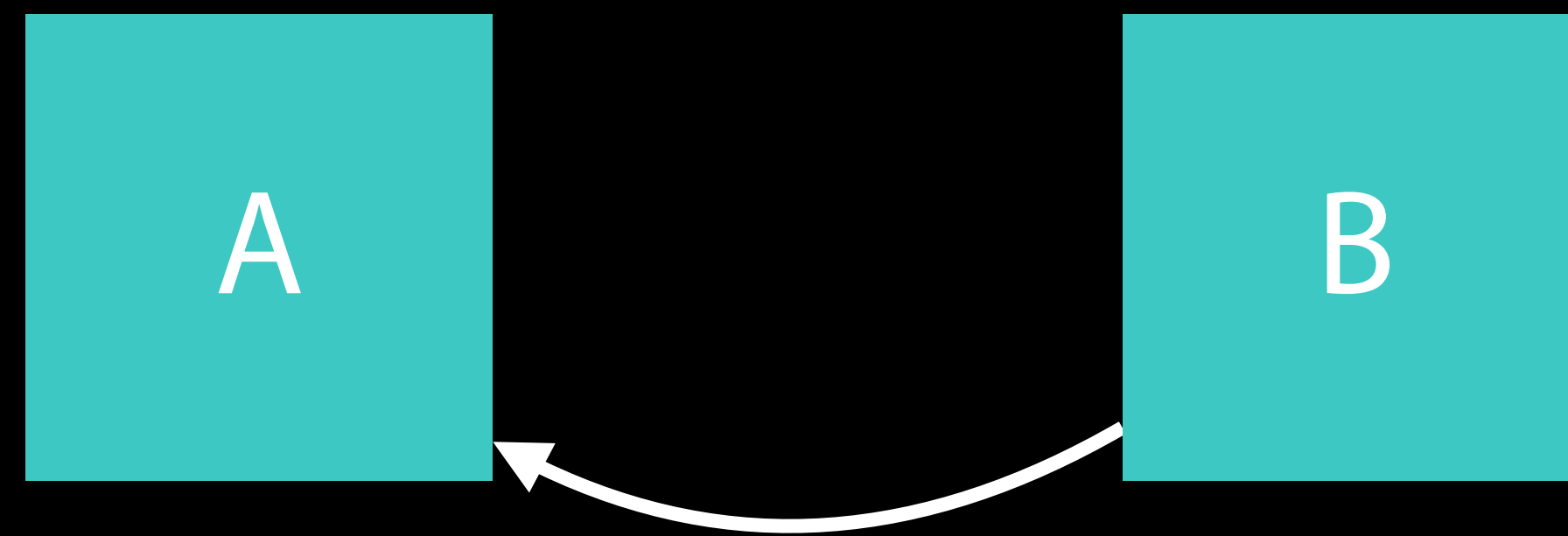
Dependencies

Operation deadlock



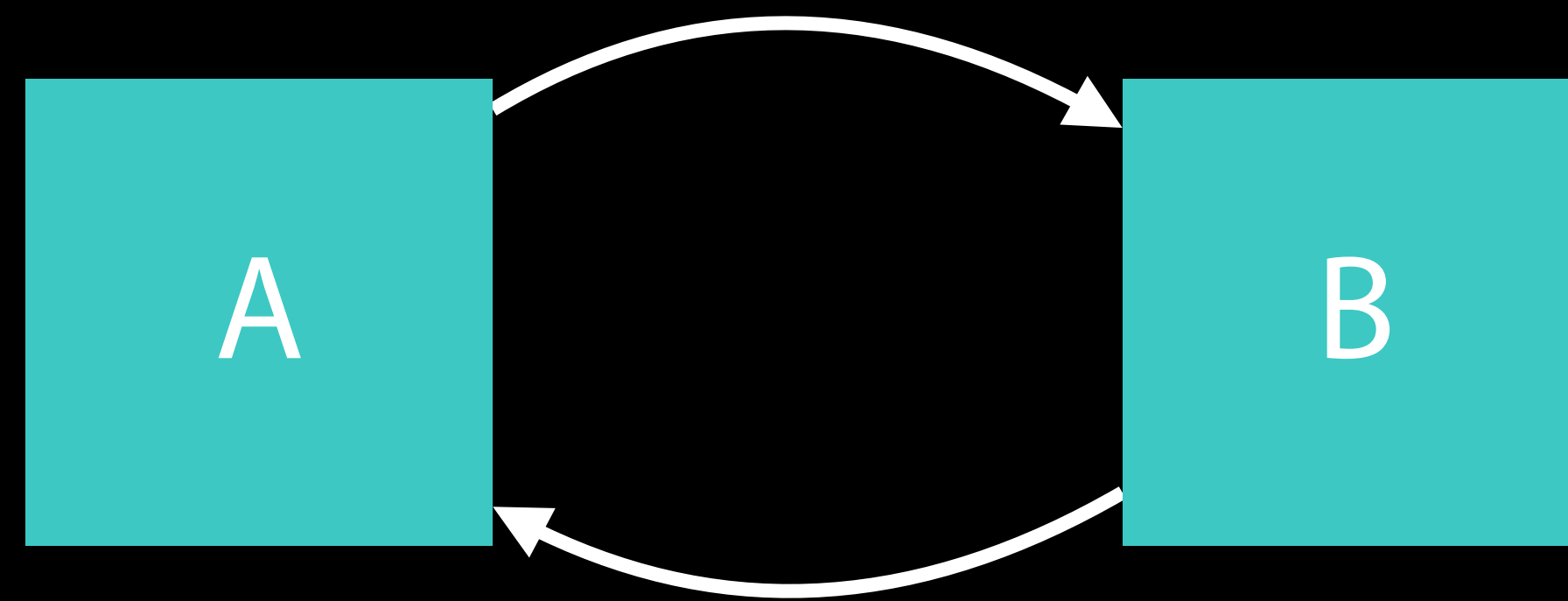
Dependencies

Operation deadlock



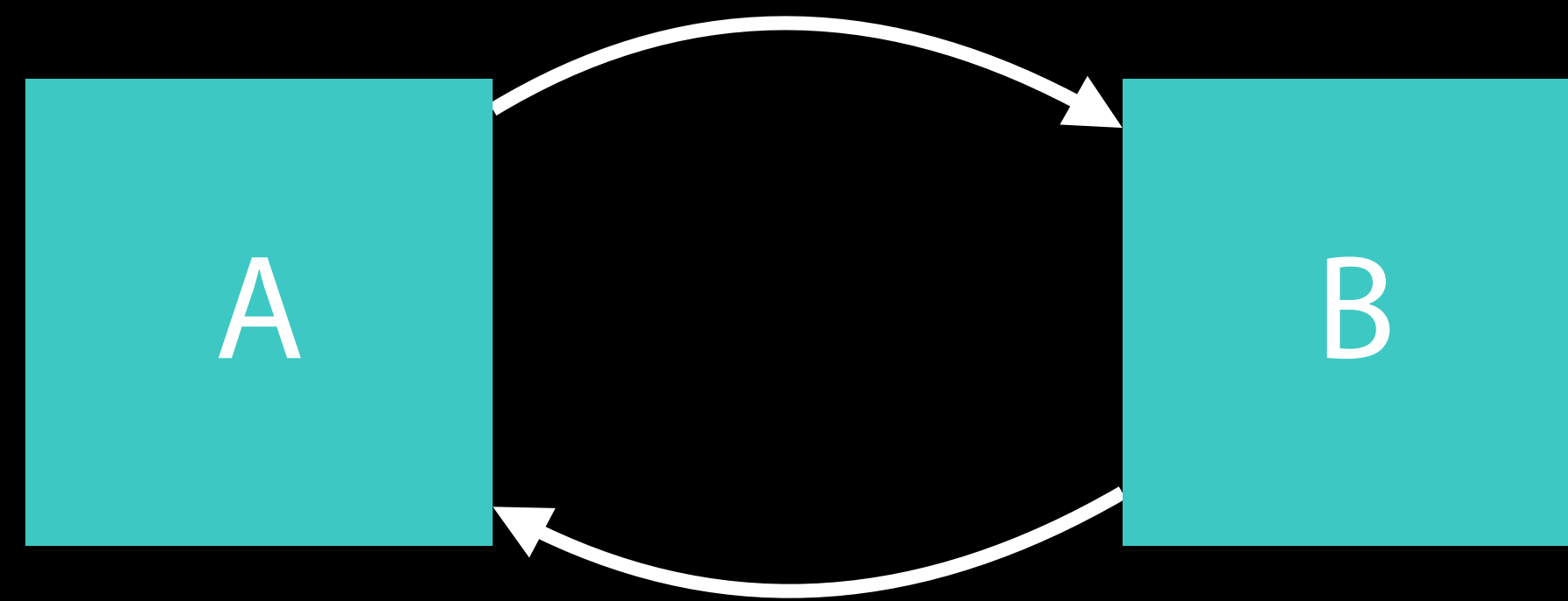
Dependencies

Operation deadlock



Dependencies

Operation deadlock



WWDC App Favorites

Operation dependencies

WWDC App Favorites

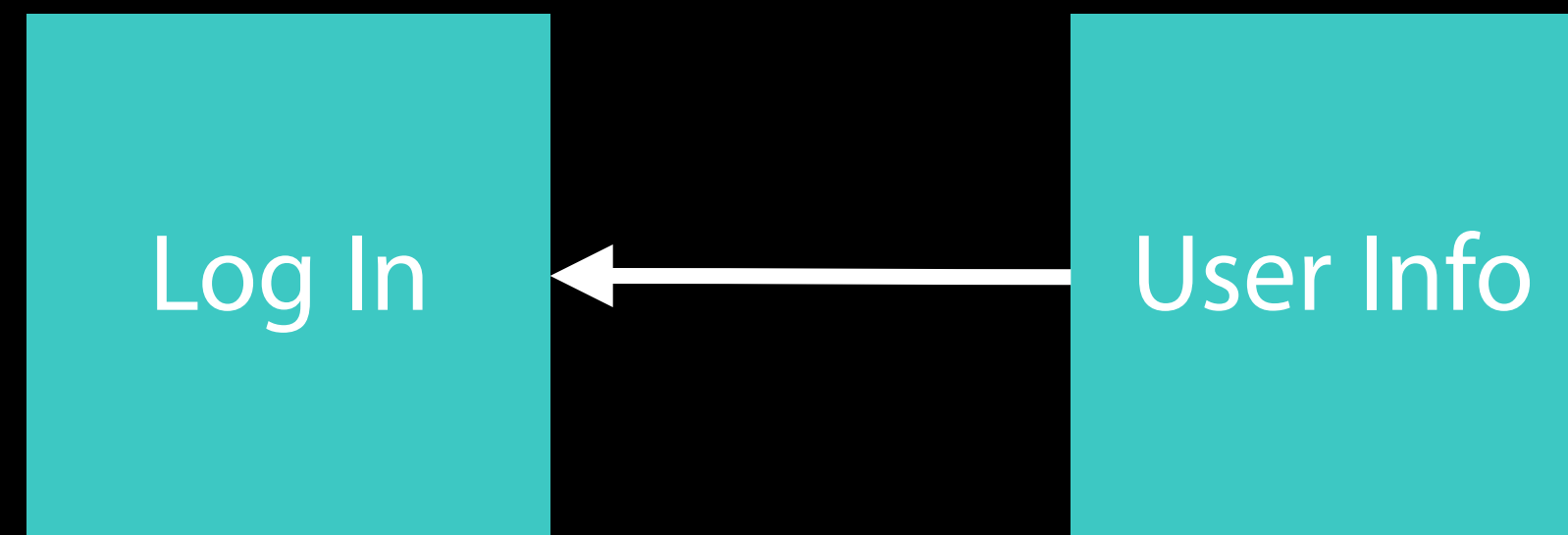
Operation dependencies



Log In

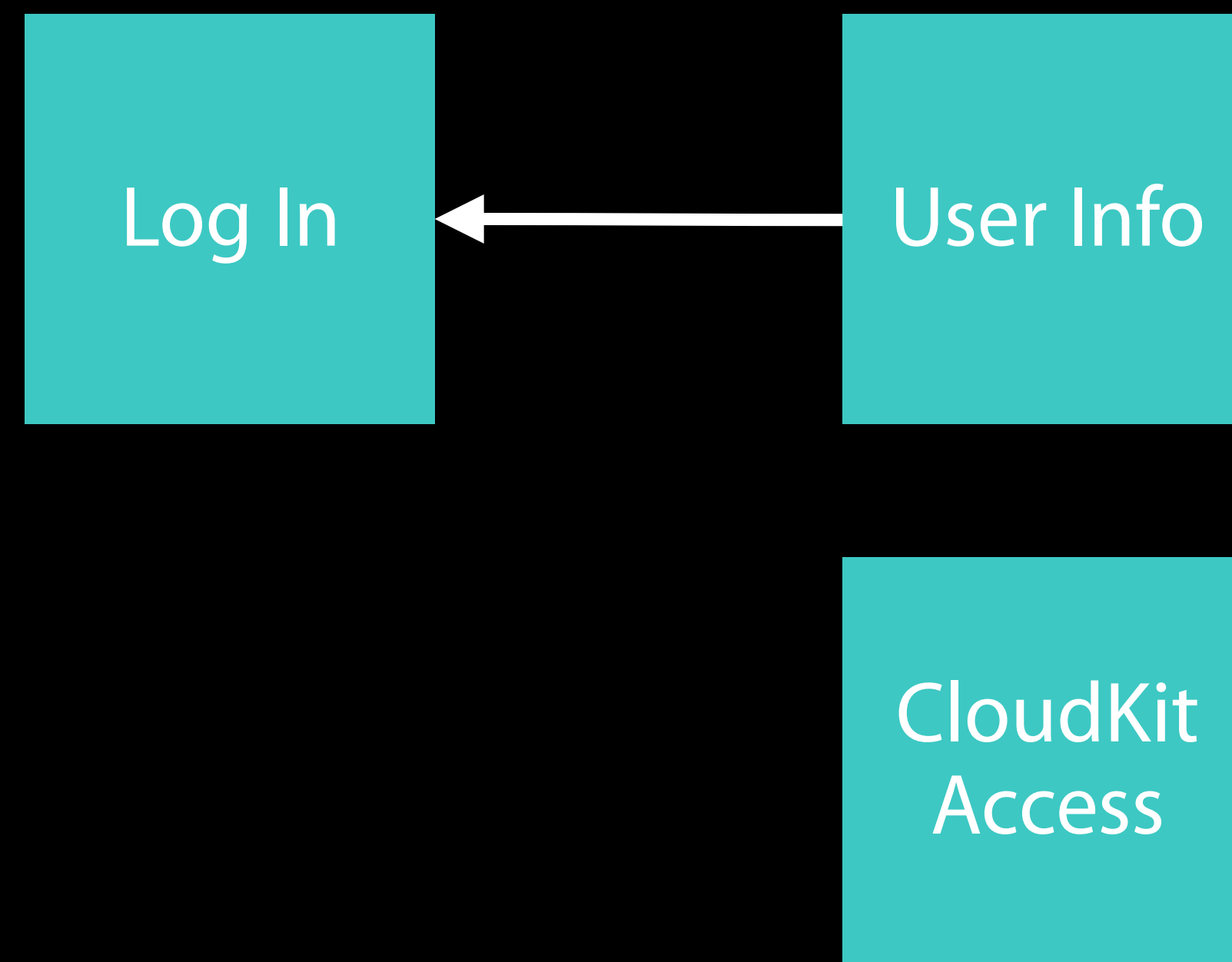
WWDC App Favorites

Operation dependencies



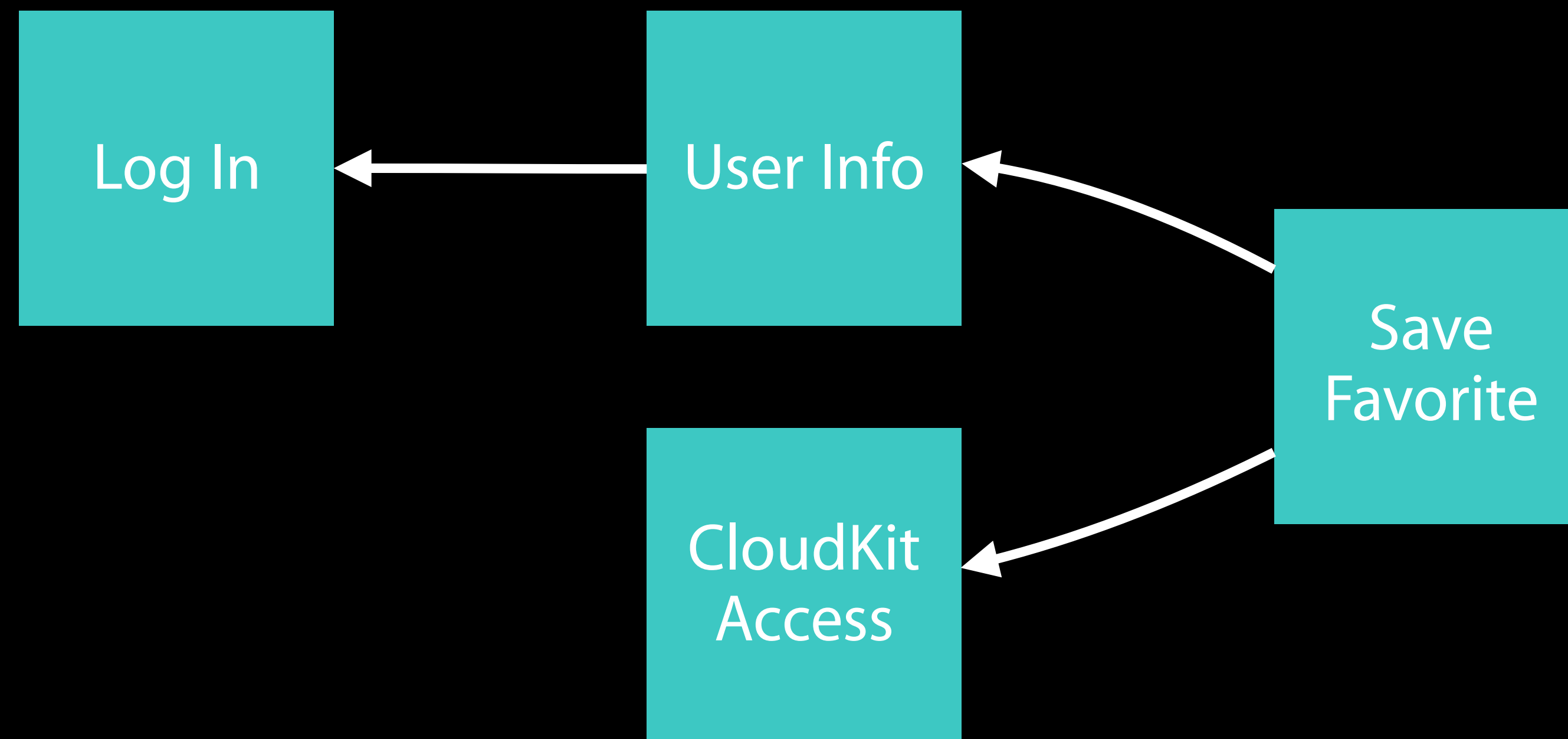
WWDC App Favorites

Operation dependencies



WWDC App Favorites

Operation dependencies



WWDC App Startup

Operation dependencies

WWDC App Startup

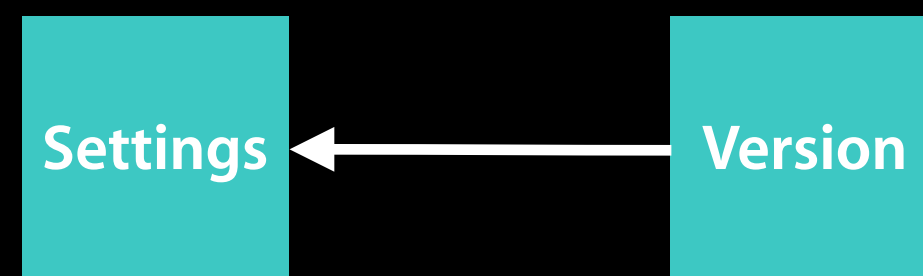
Operation dependencies



Settings

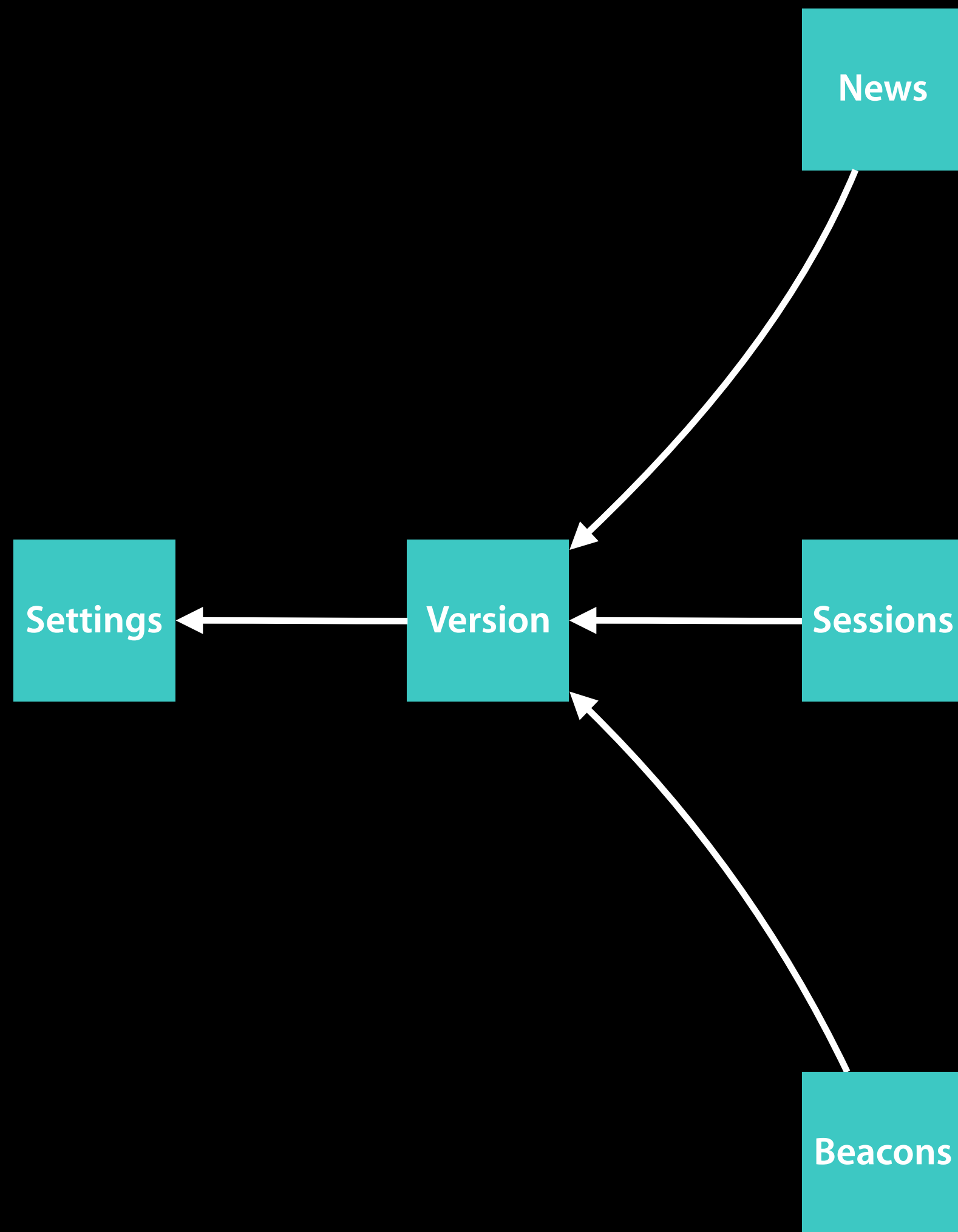
WWDC App Startup

Operation dependencies



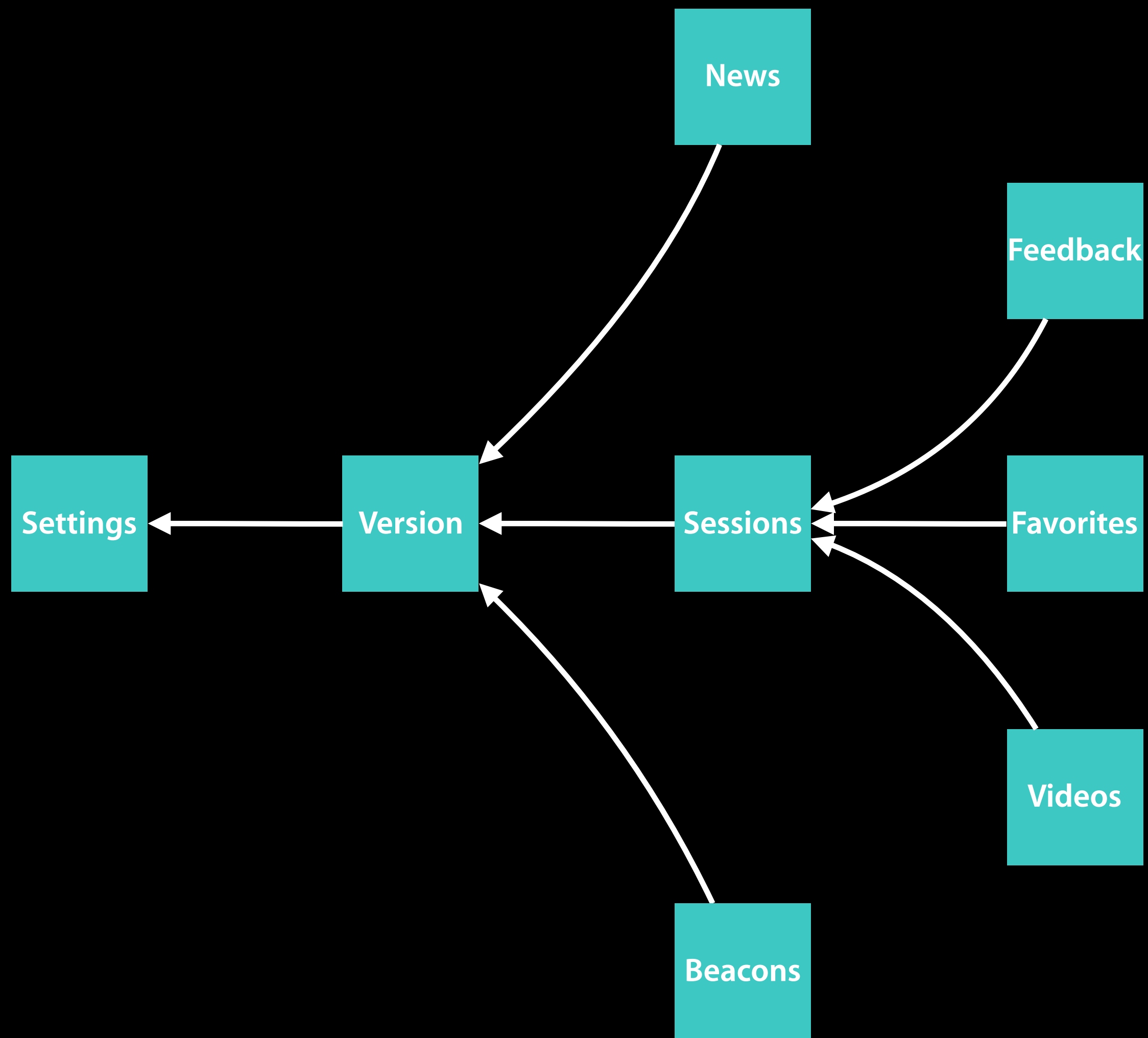
WWDC App Startup

Operation dependencies



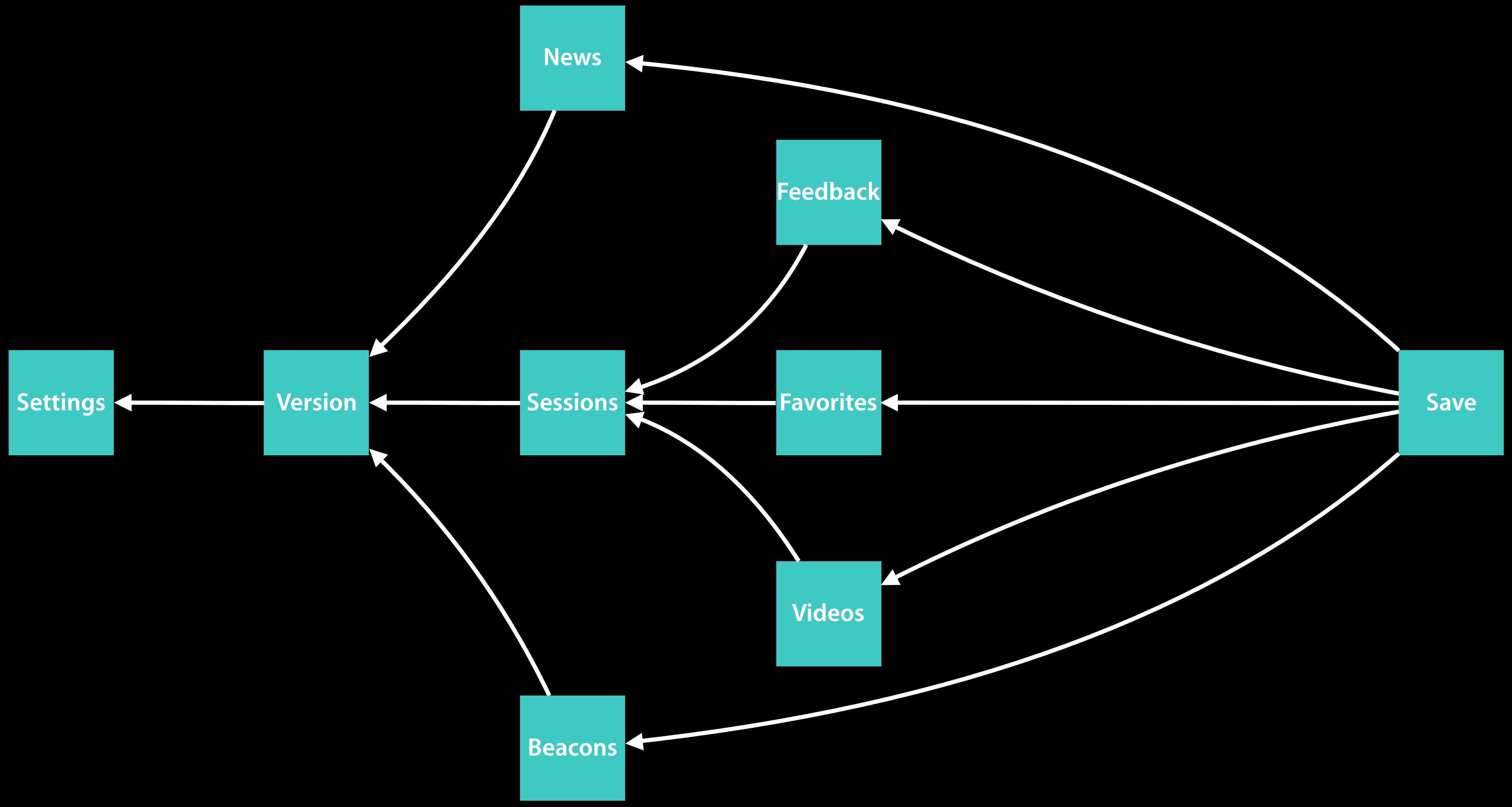
WWDC App Startup

Operation dependencies



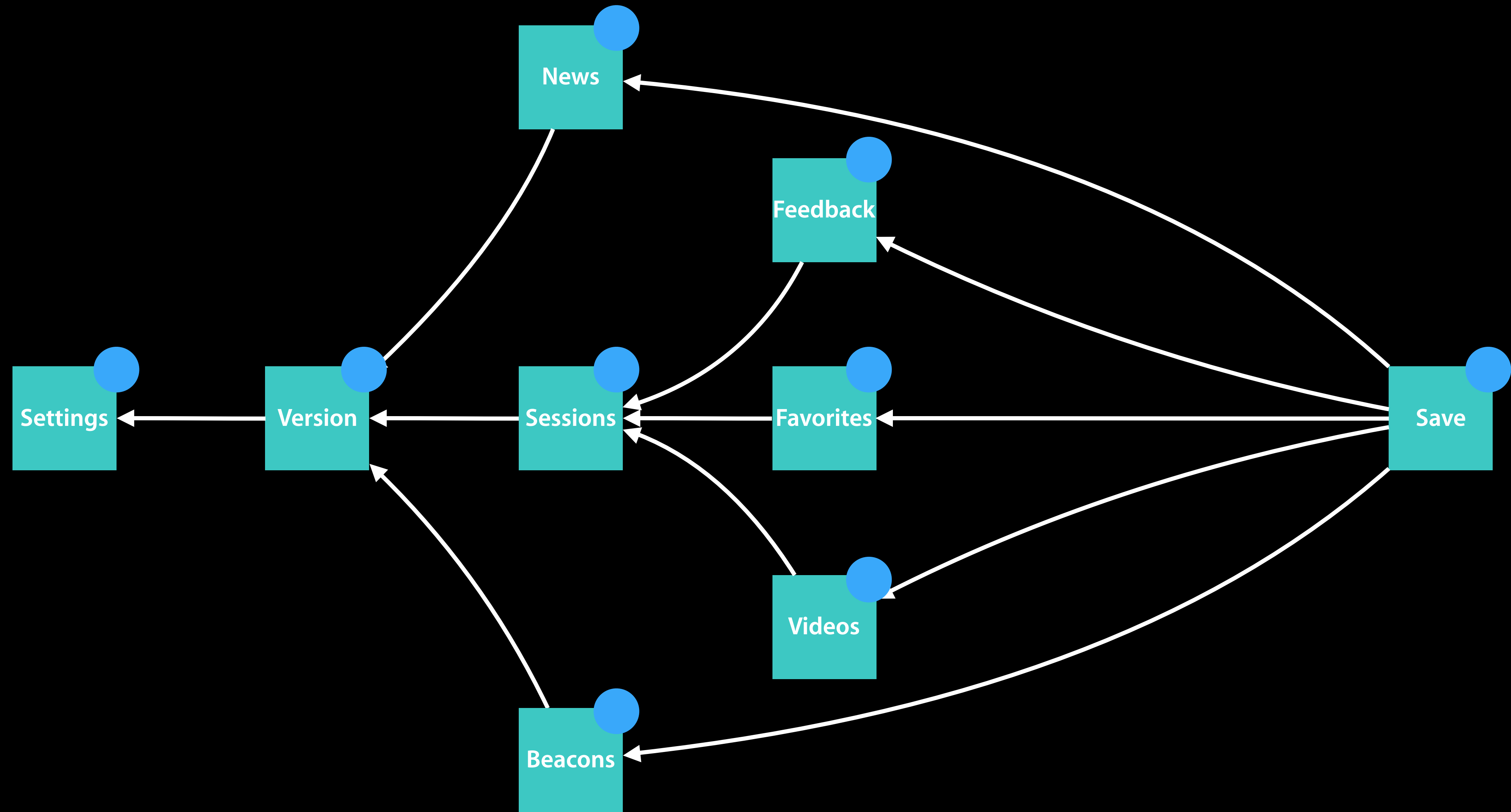
WWDC App Startup

Operation dependencies



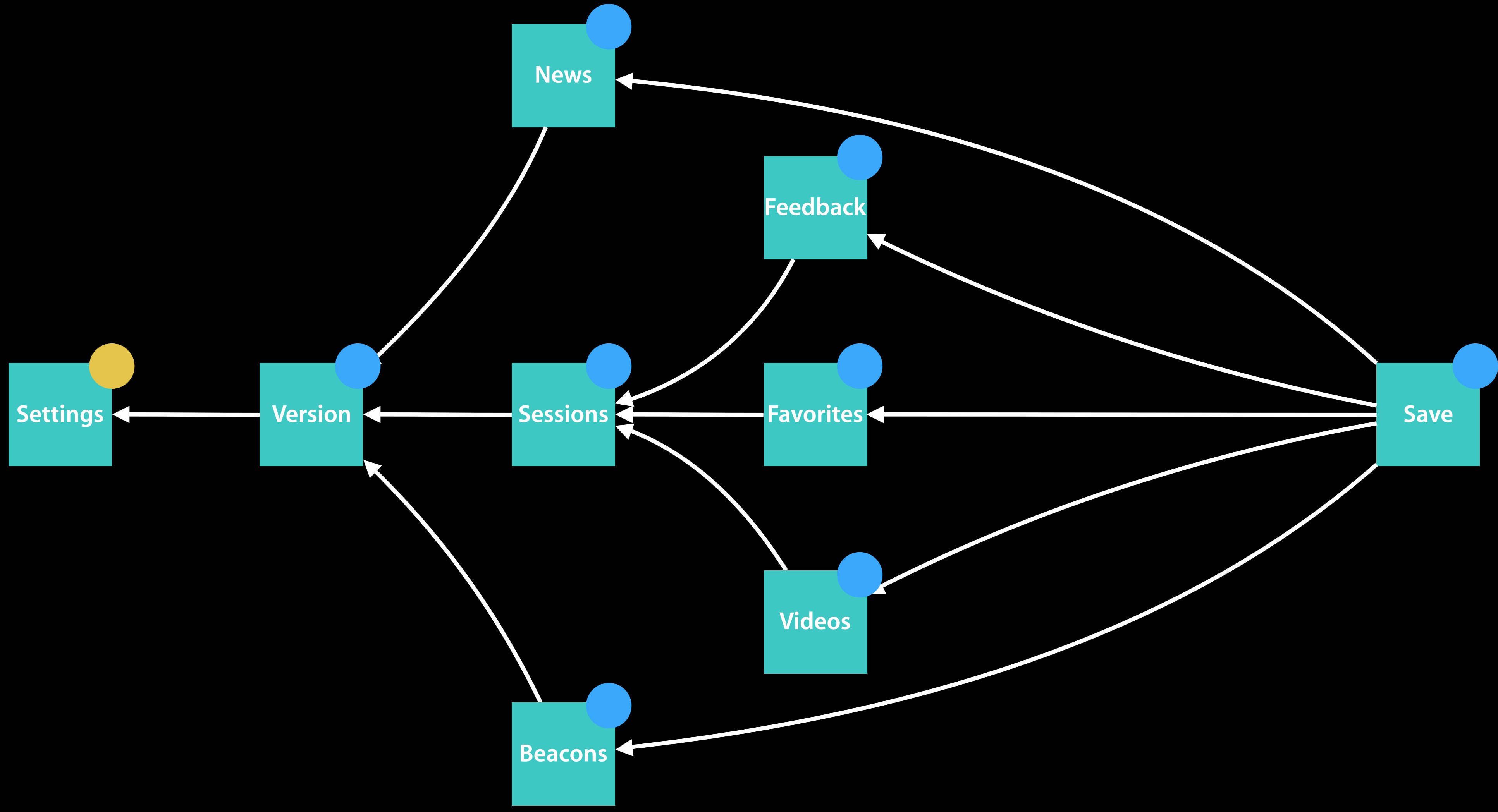
WWDC App Startup

Operation dependencies



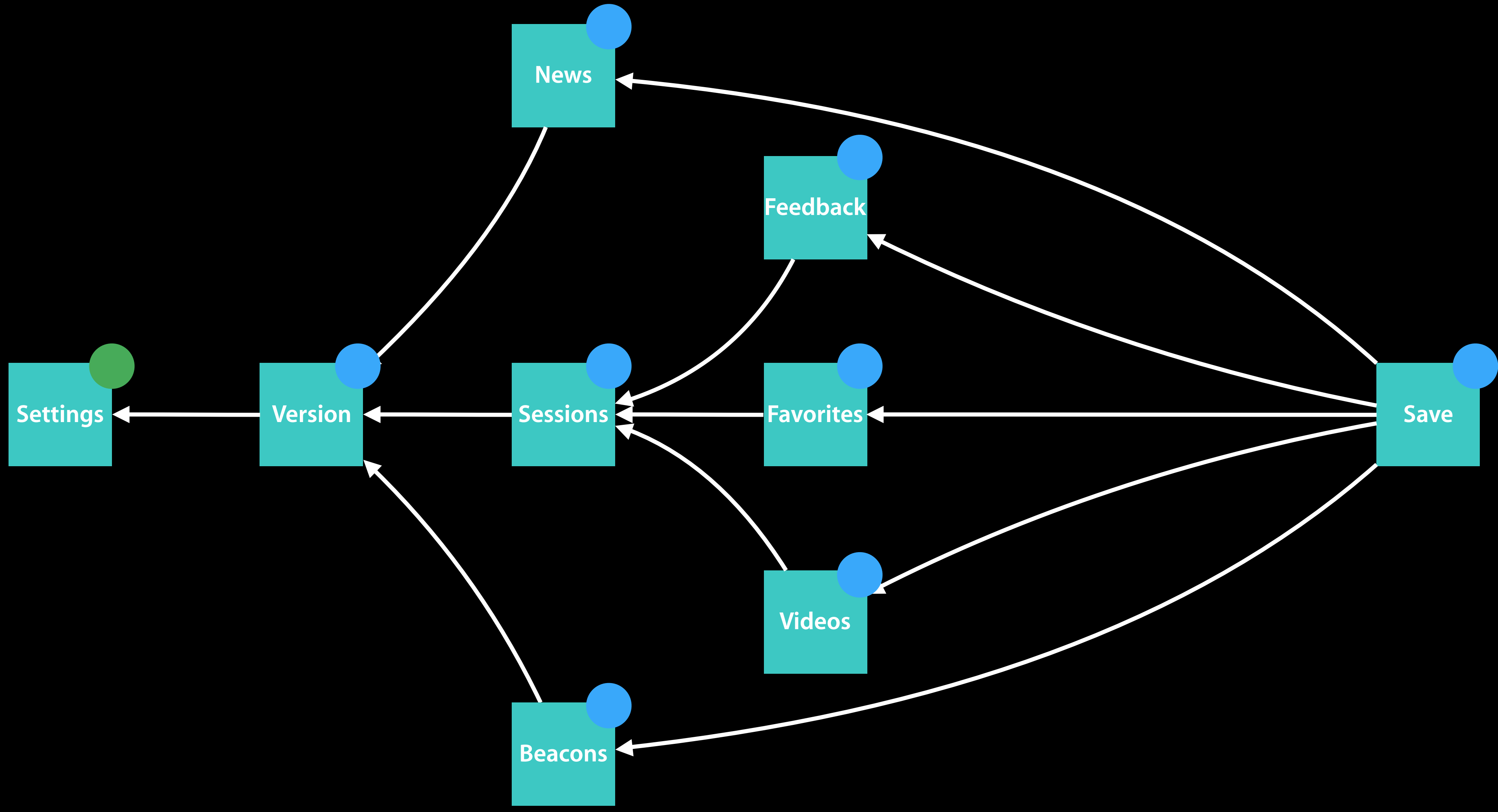
WWDC App Startup

Operation dependencies



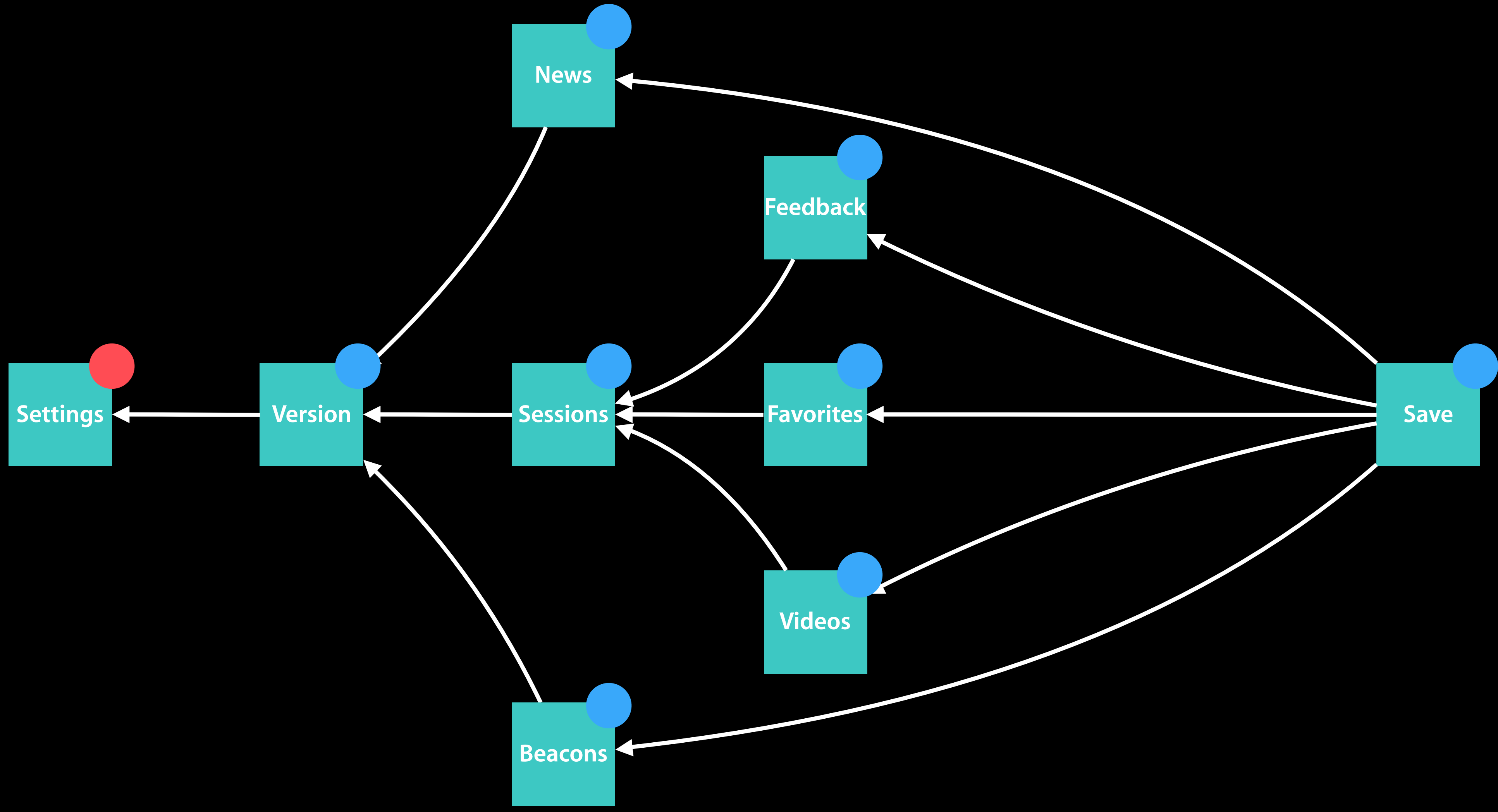
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Operation dependencies



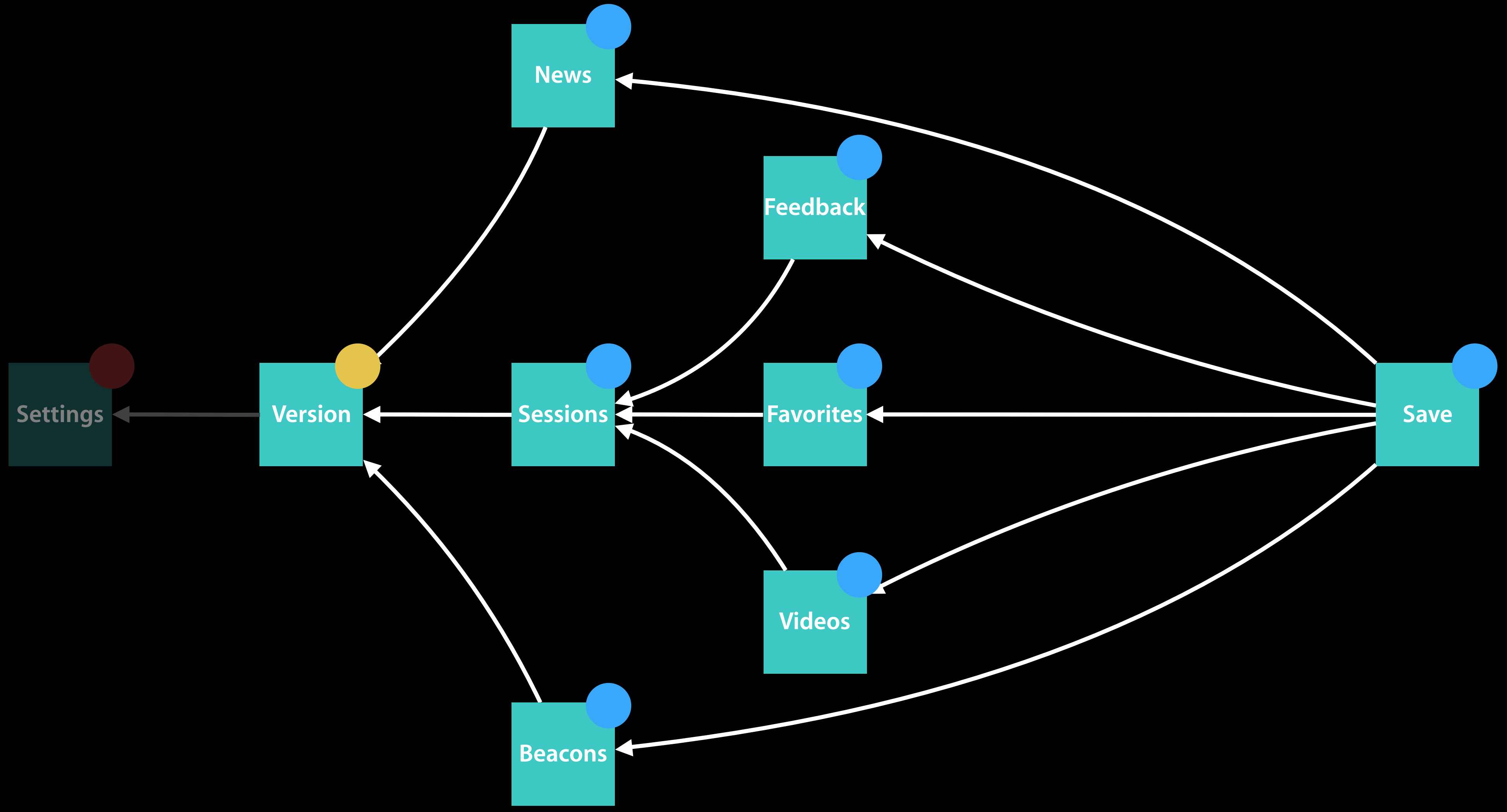
WWDC App Startup

Operation dependencies



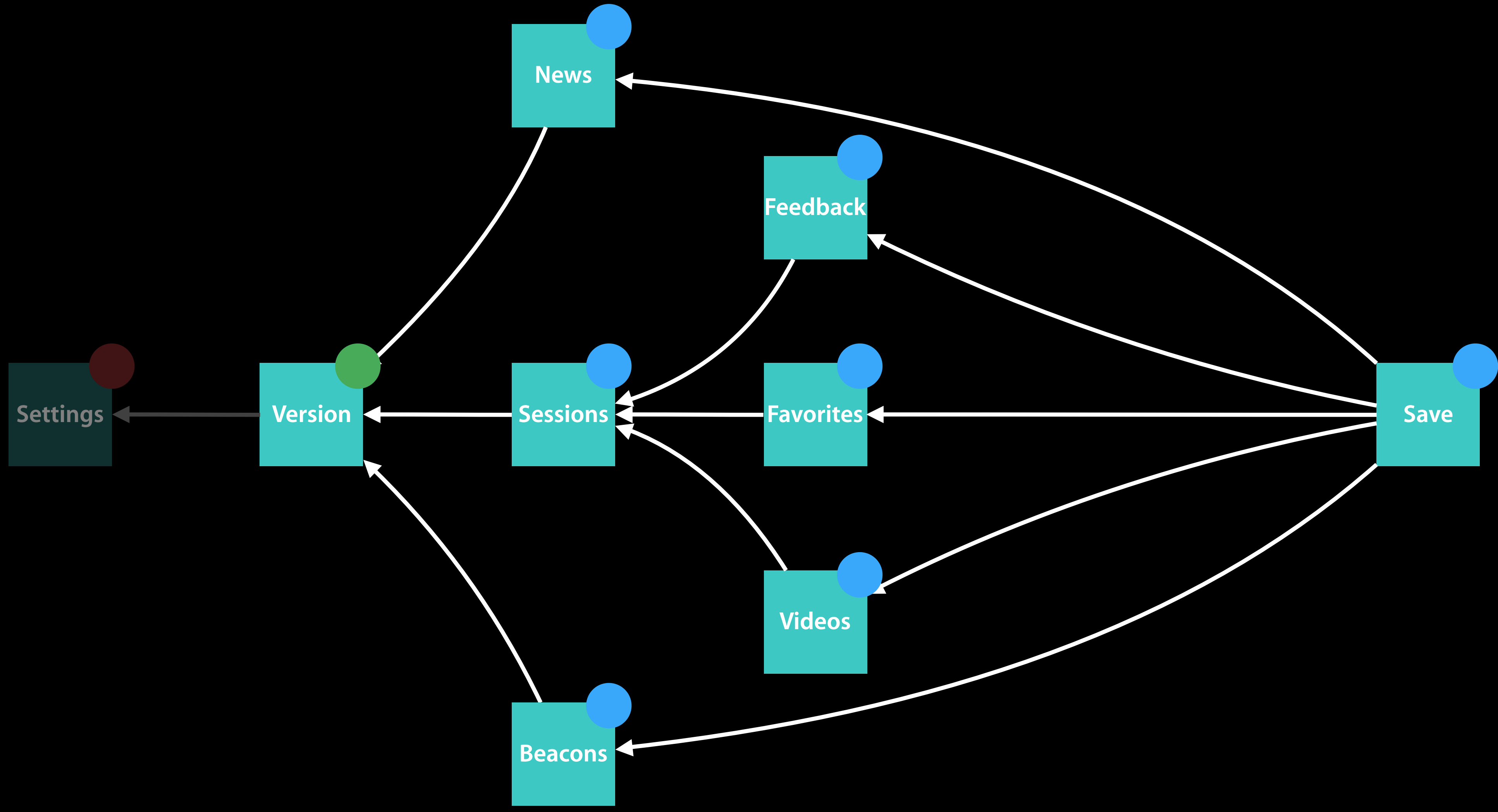
WWDC App Startup

Operation dependencies



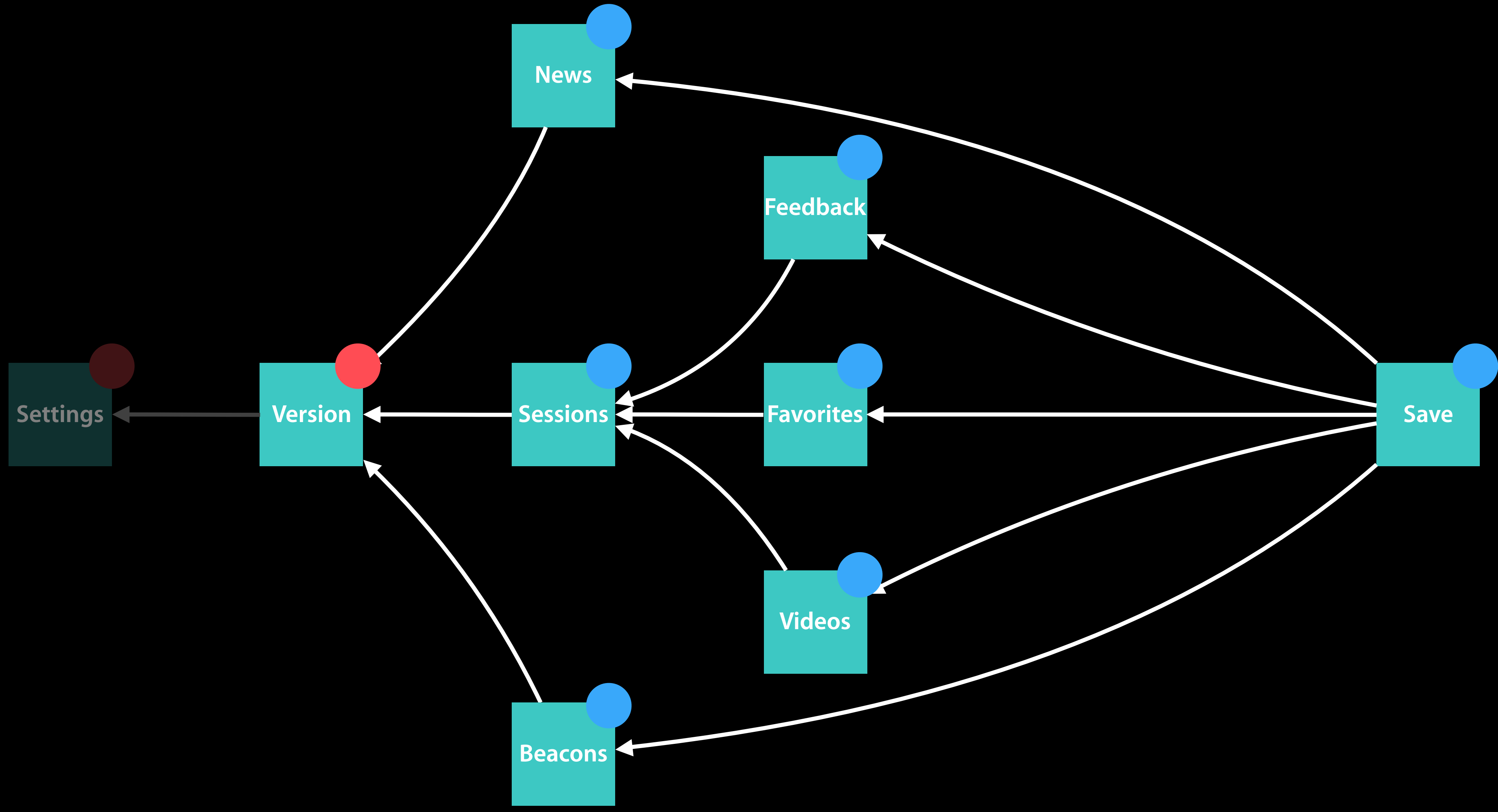
WWDC App Startup

Operation dependencies



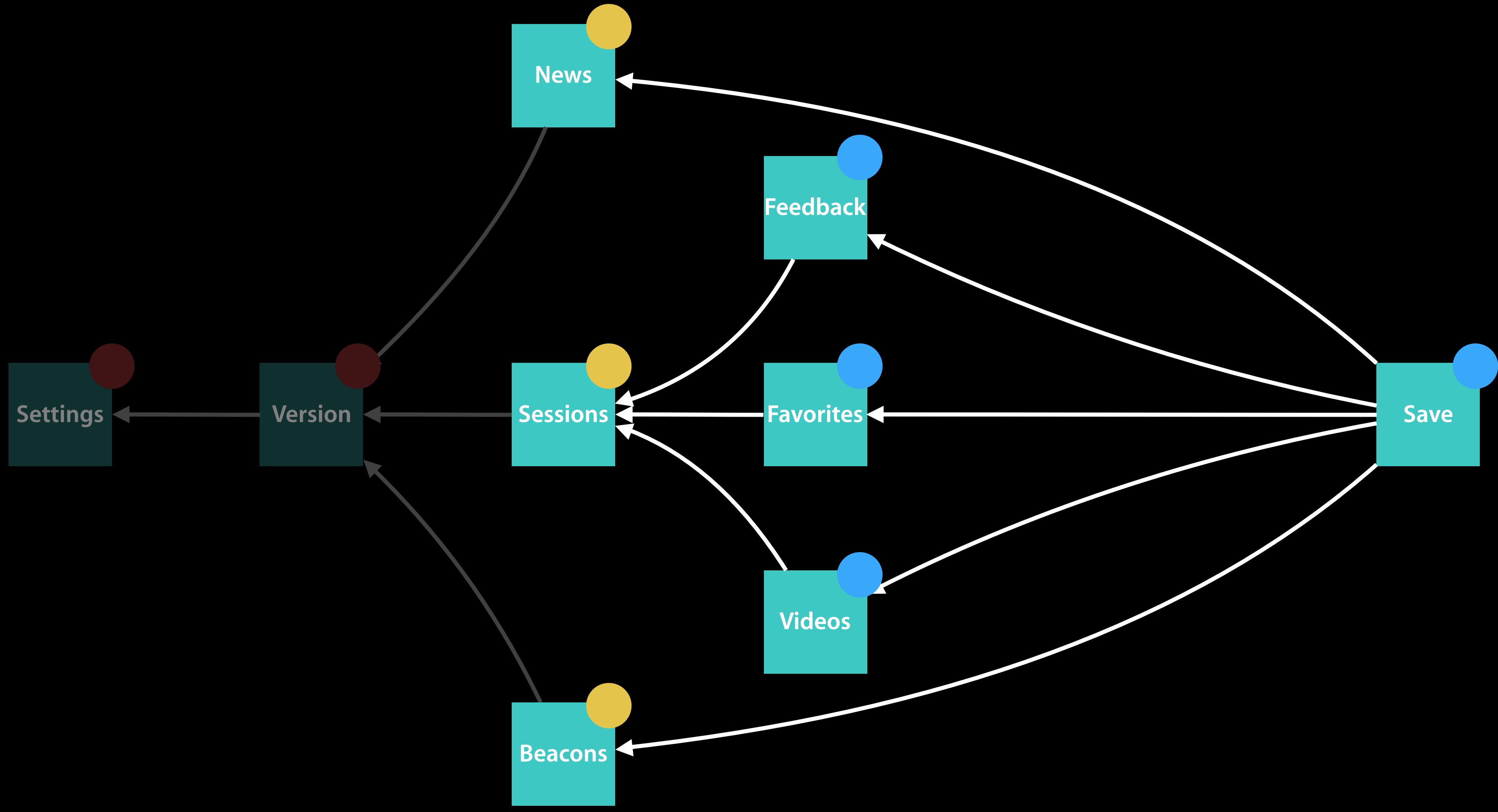
WWDC App Startup

Operation dependencies



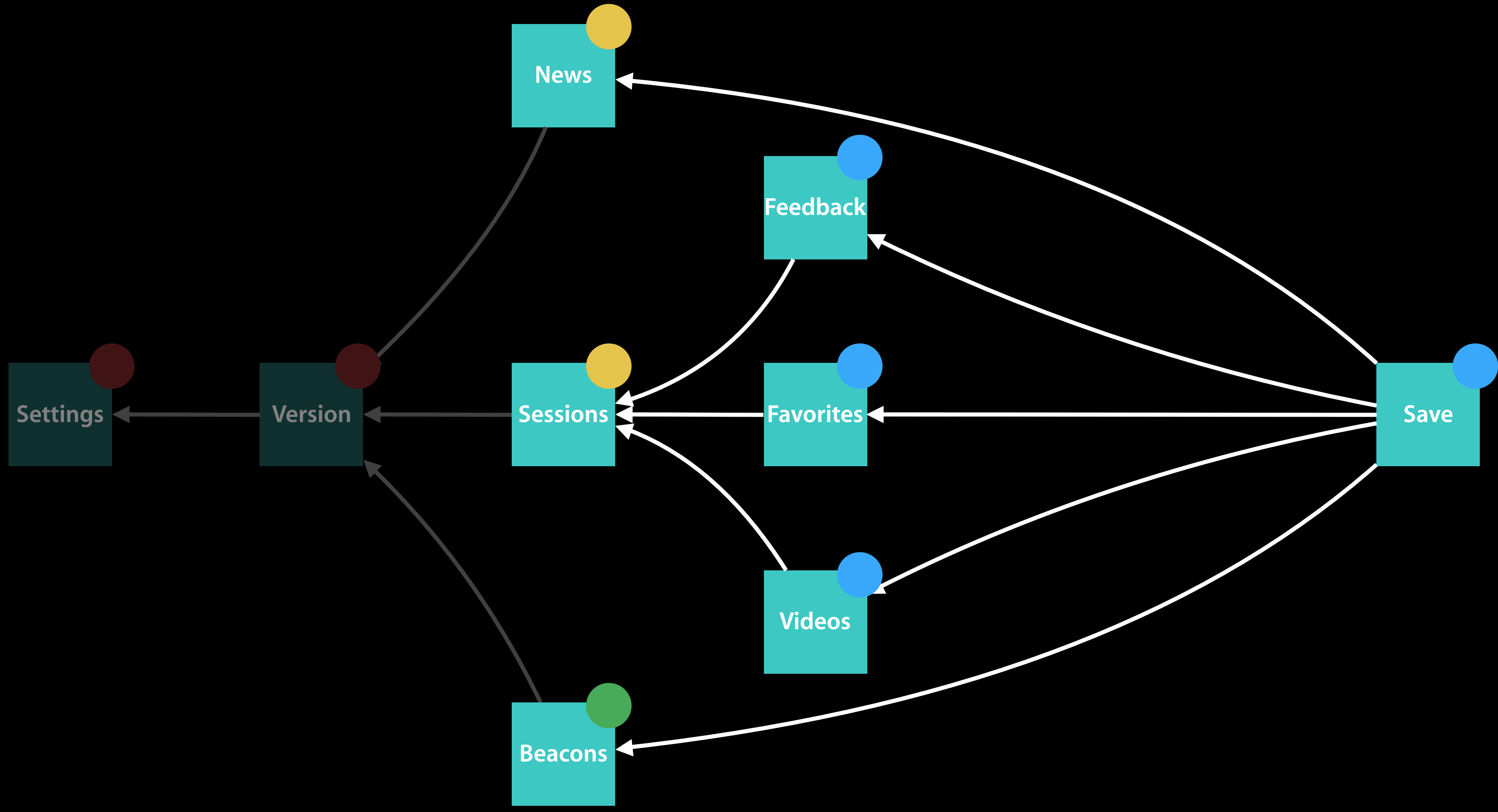
WWDC App Startup

Operation dependencies



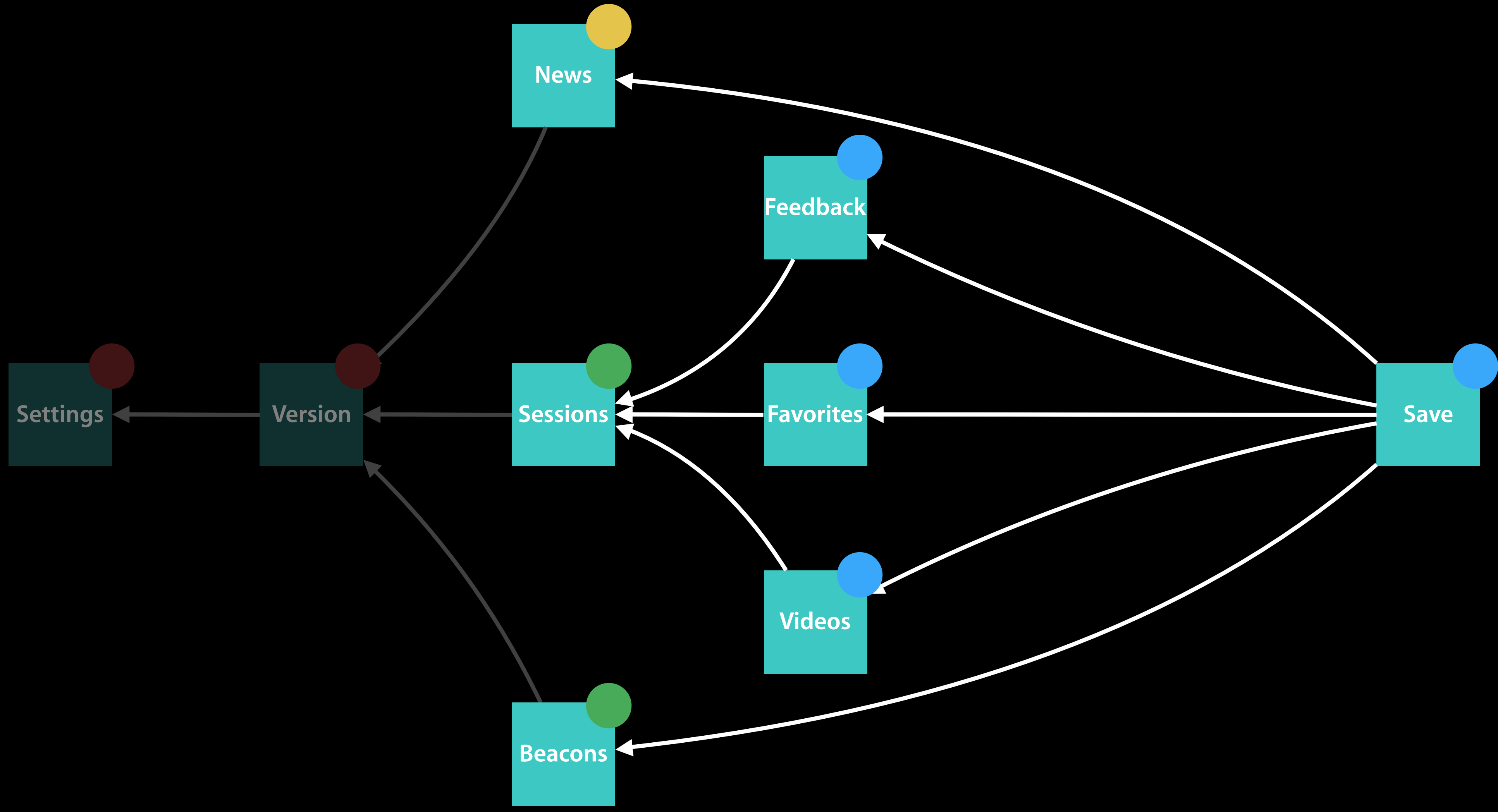
WWDC App Startup

Operation dependencies



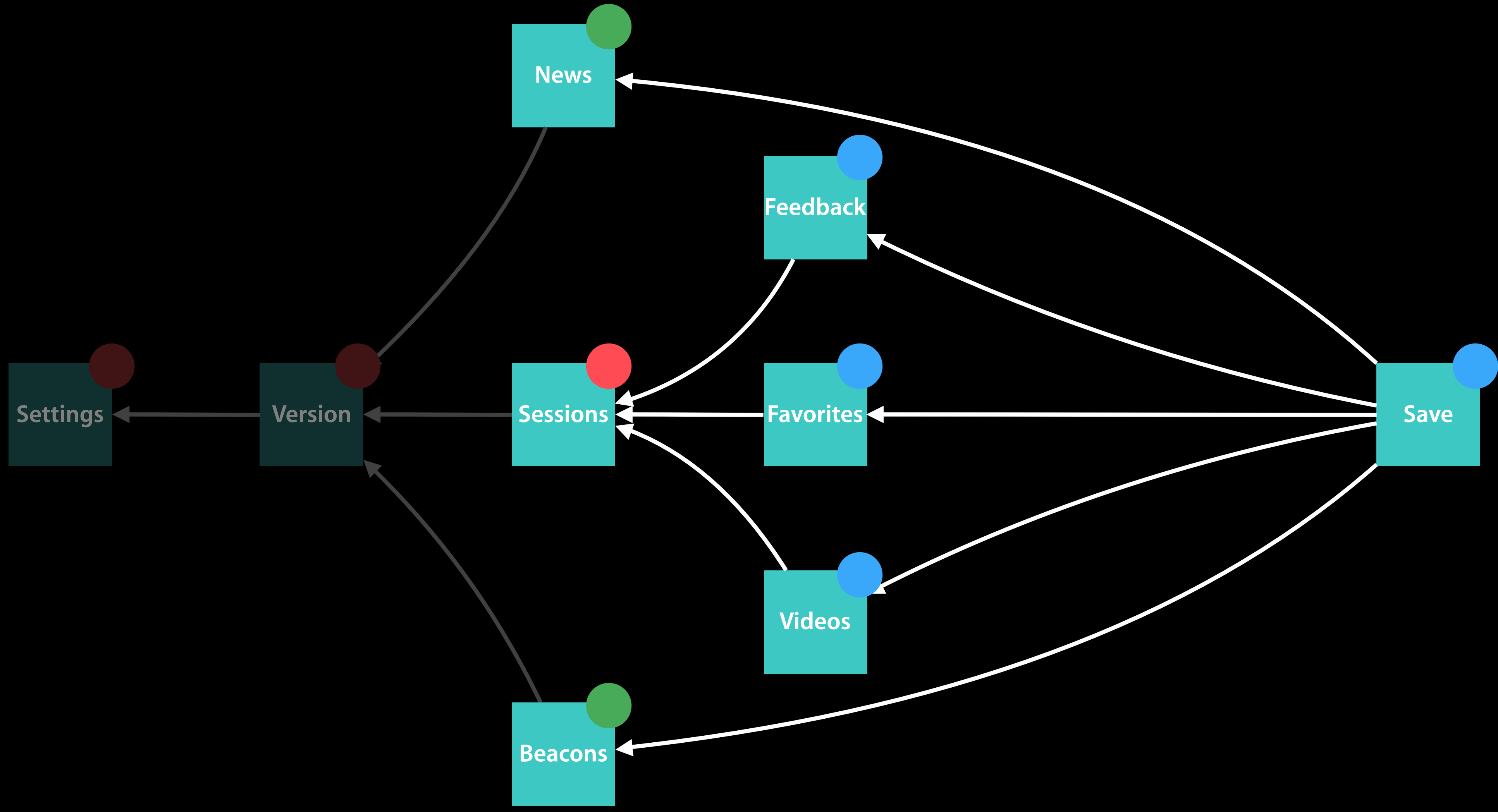
WWDC App Startup

Operation dependencies



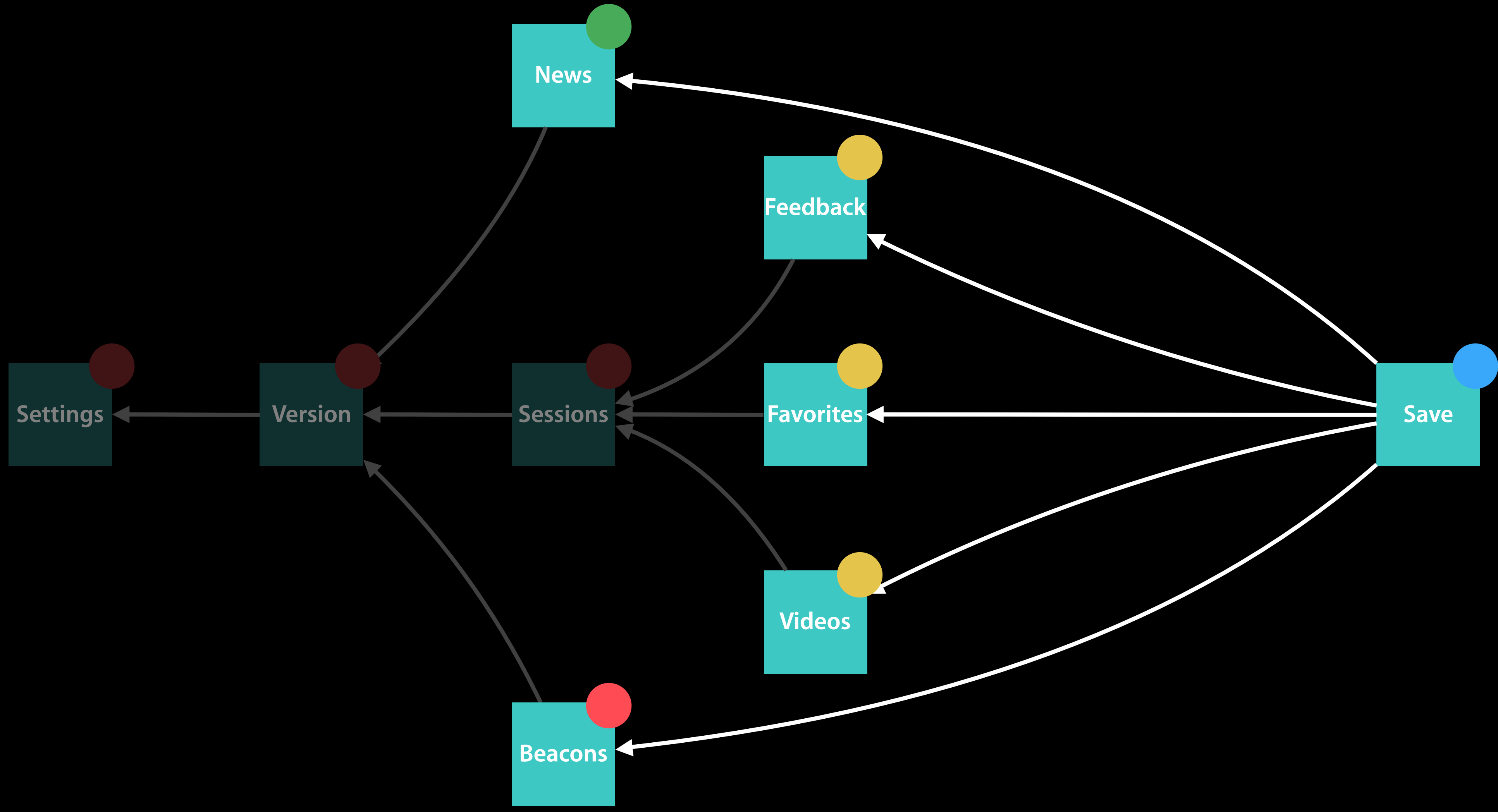
WWDC App Startup

Operation dependencies



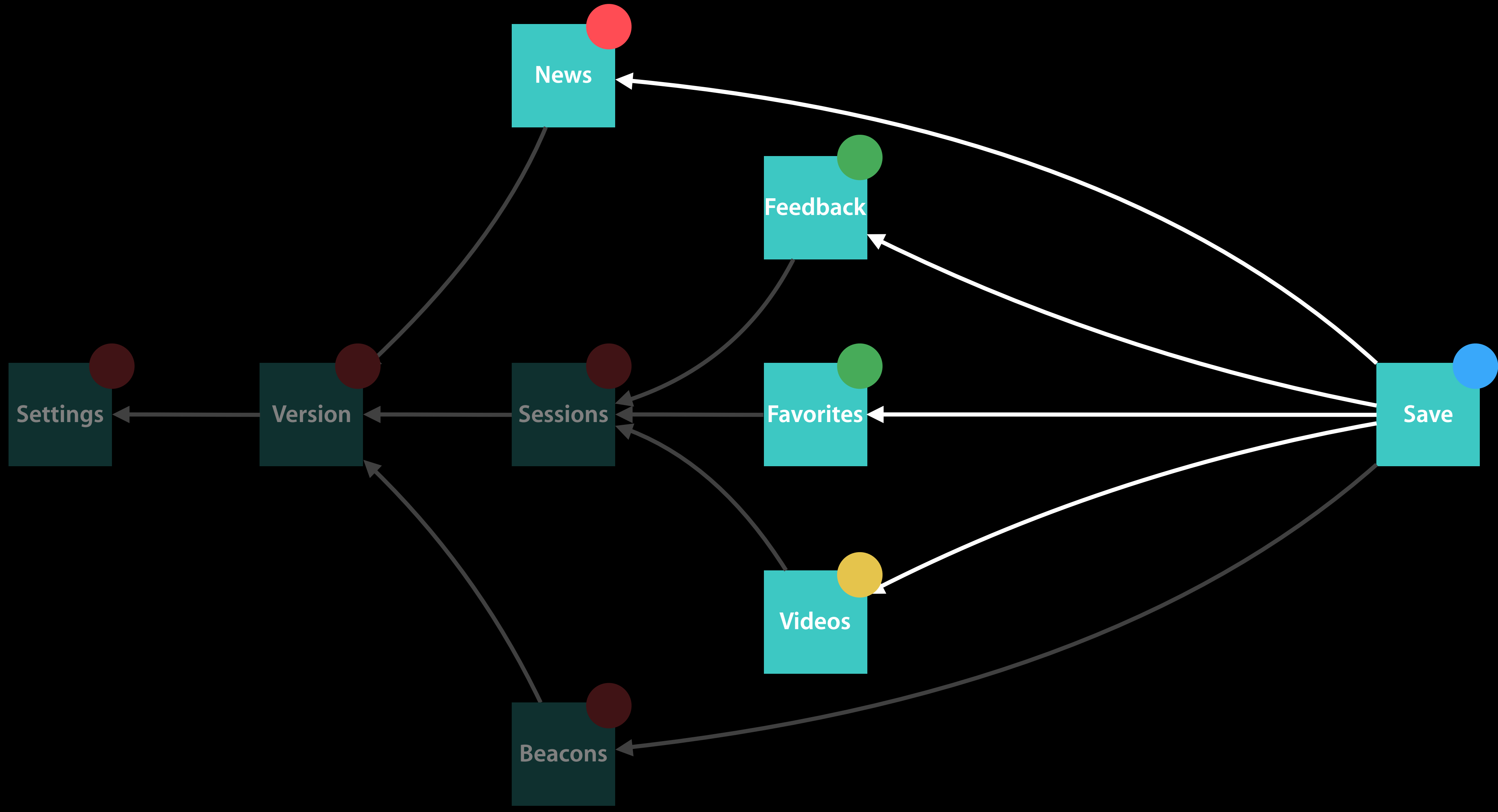
WWDC App Startup

Operation dependencies



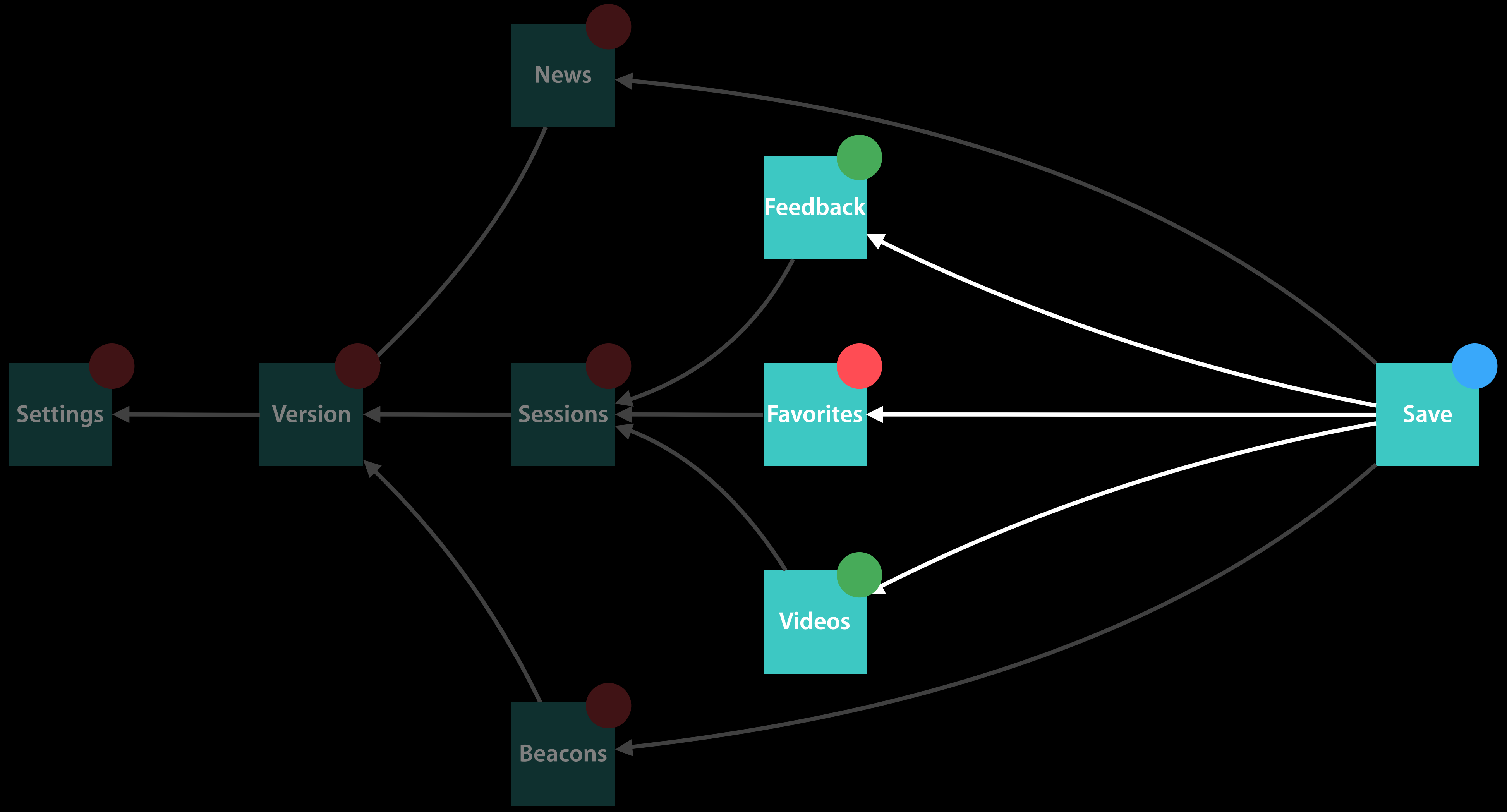
WWDC App Startup

Operation dependencies



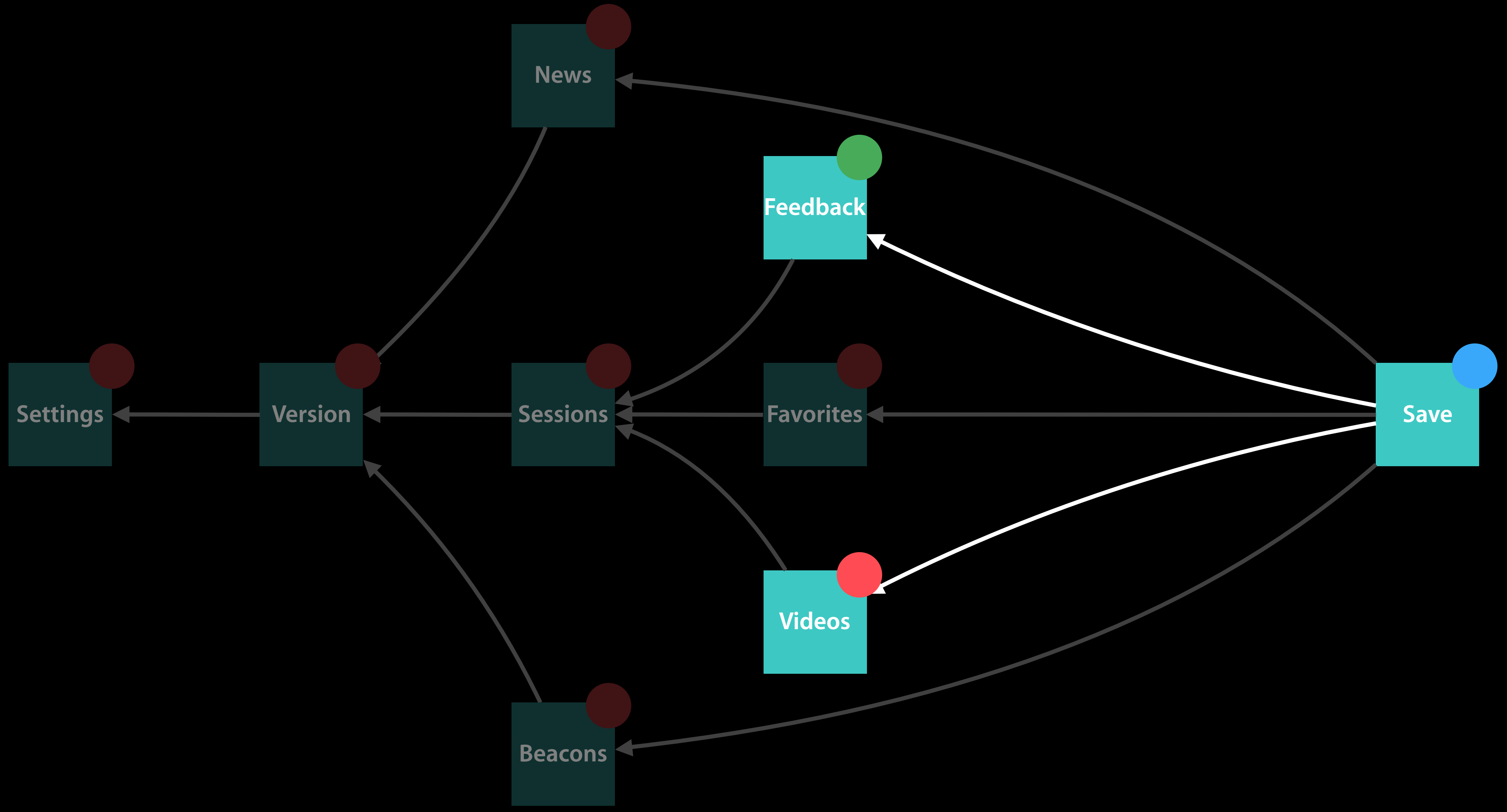
WWDC App Startup

Operation dependencies



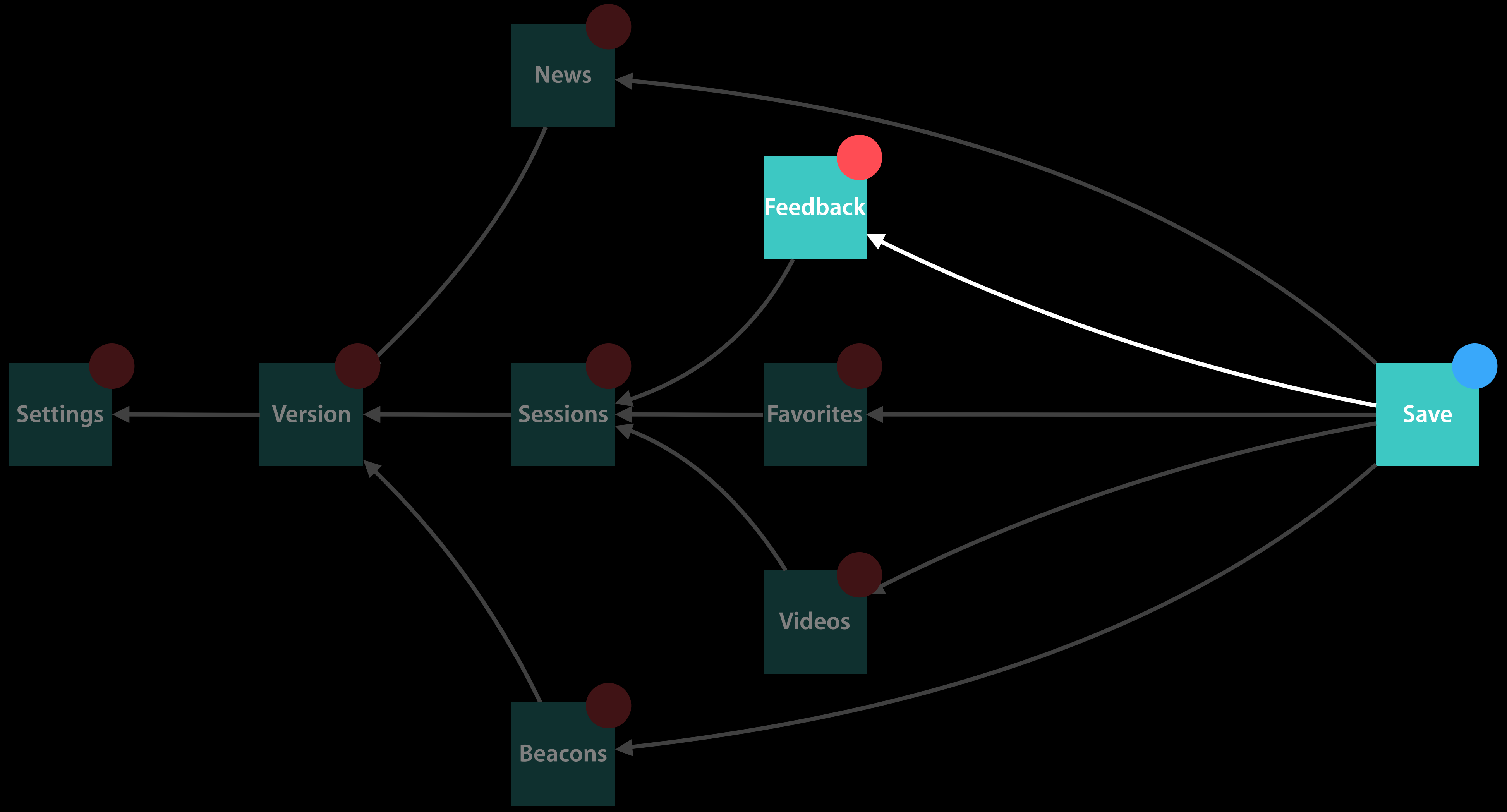
WWDC App Startup

Operation dependencies



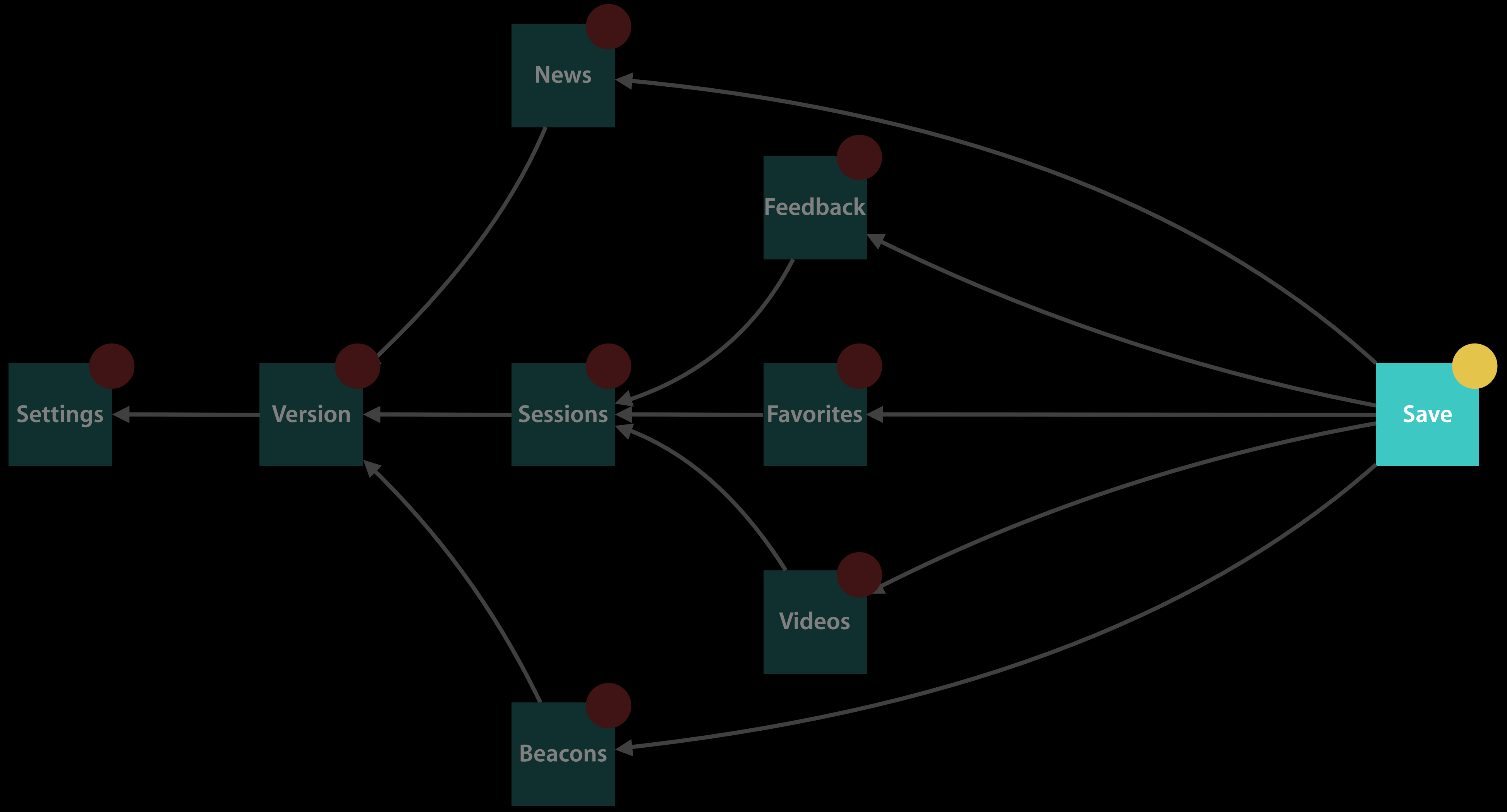
WWDC App Startup

Operation dependencies



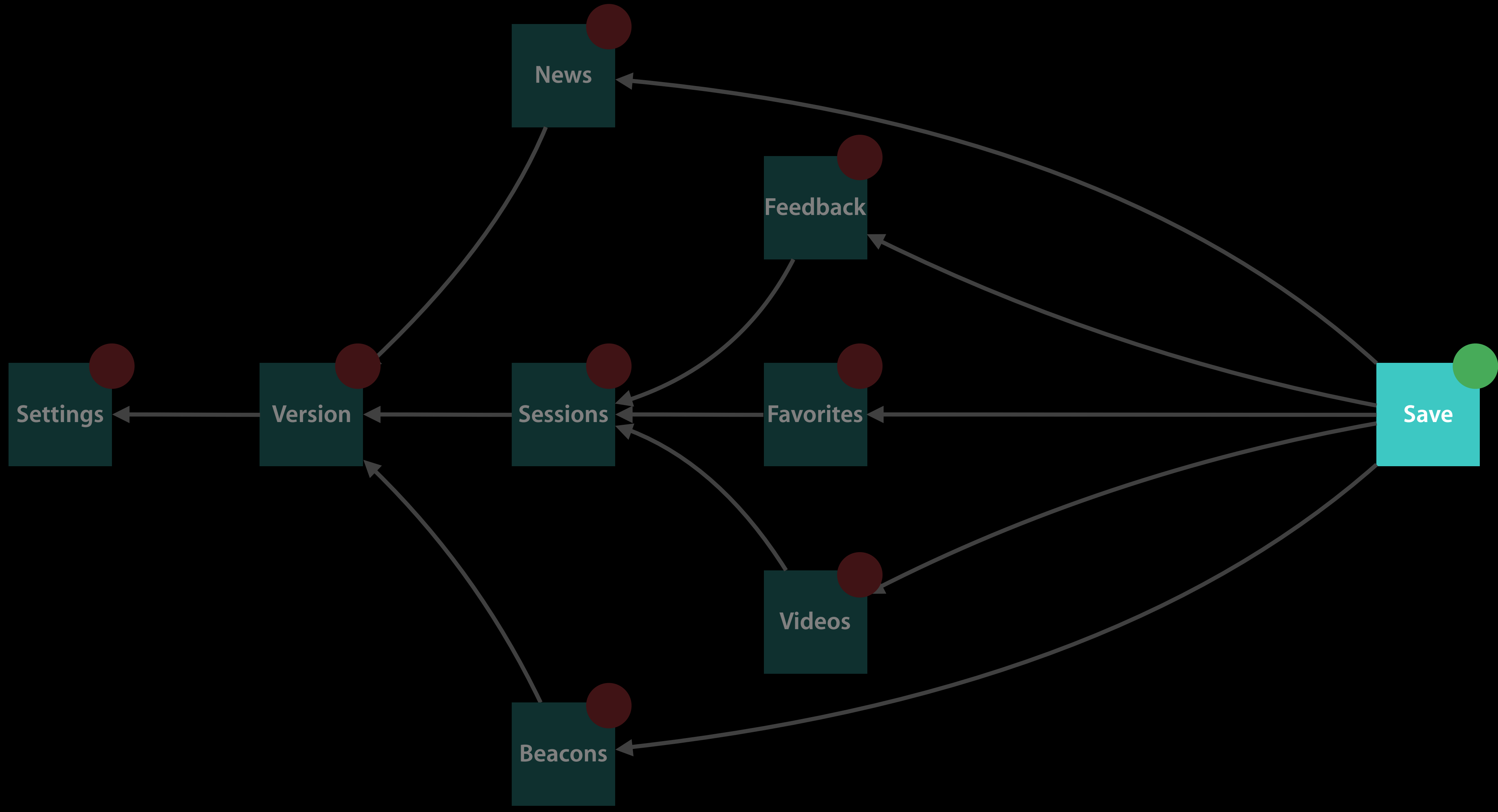
WWDC App Startup

Operation dependencies



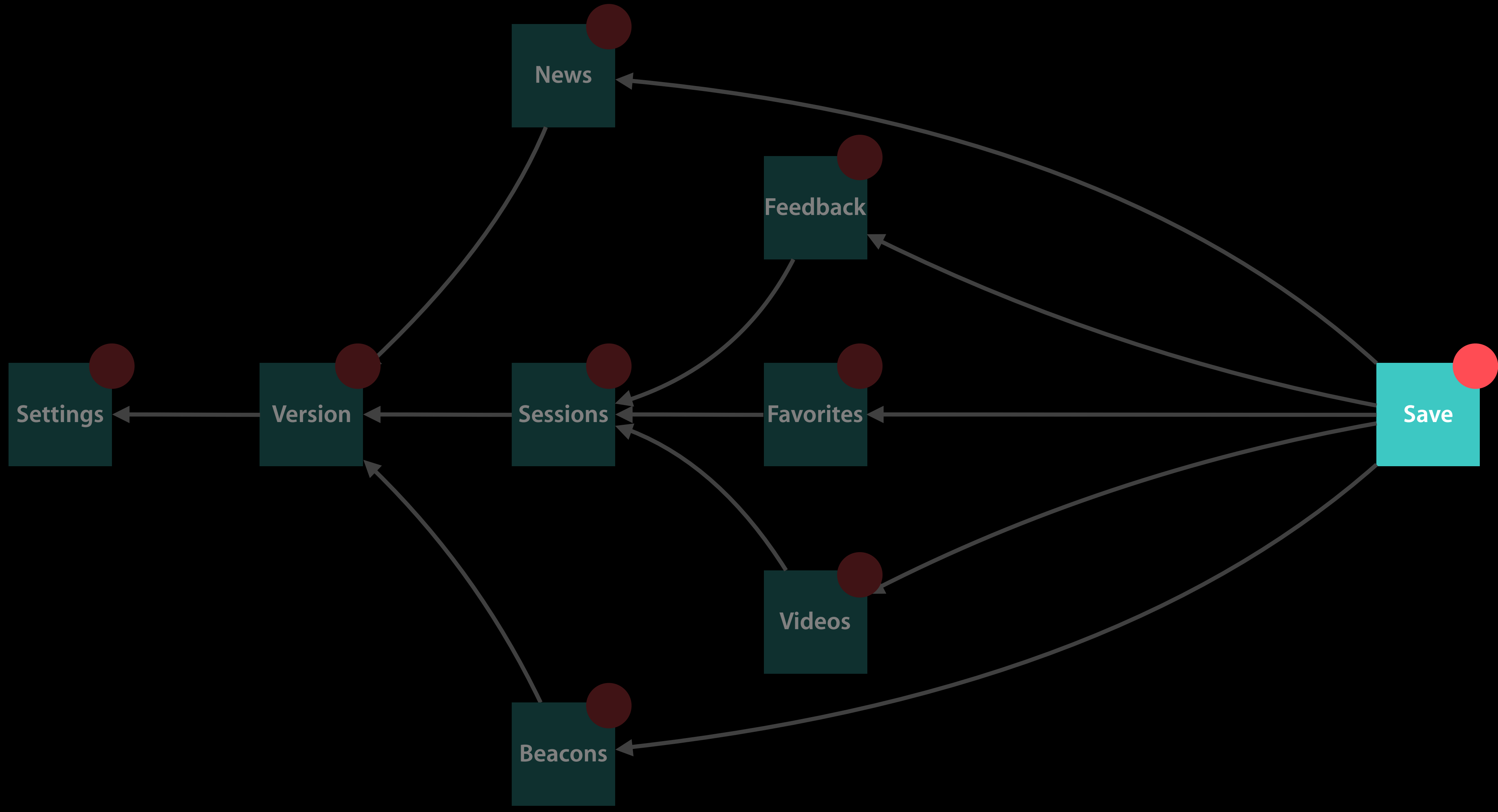
WWDC App Startup

Operation dependencies



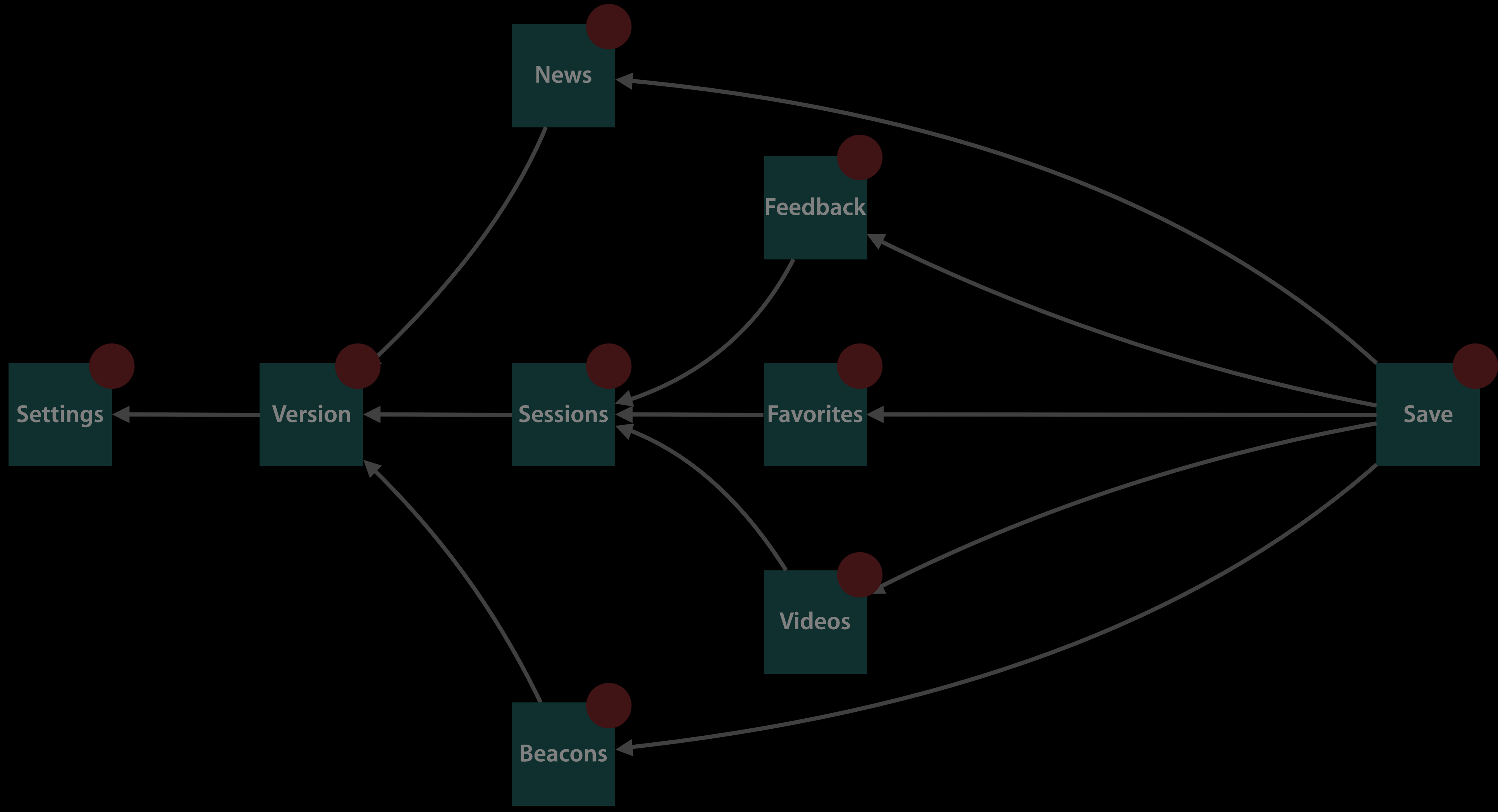
WWDC App Startup

Operation dependencies



WWDC App Startup

Operation dependencies



Abstraction

Abstraction

Operations abstract logic

Abstraction

Operations abstract logic

Simplifies logic changes

Abstraction

Operations abstract logic

Simplifies logic changes

WWDC app

Abstraction

Operations abstract logic

Simplifies logic changes

WWDC app

- Custom backend → CloudKit

Abstraction

Operations abstract logic

Simplifies logic changes

WWDC app

- Custom backend → CloudKit

Grand Central Dispatch?

Beyond the Basics

UI Operations

Not just the background

UI Operations

Not just the background

Authentication

UI Operations

Not just the background

Authentication

Videos

UI Operations

Not just the background

Authentication

Videos

Alerts

UI Operations

Not just the background

Authentication

Videos

Alerts

“Modal” UI



9:41 AM

100%

Filter

All

Favorites

Now

Search Schedule

MONDAY 11:00 AM

Keynote

11:00 AM - 1:00 PM - Presidio

MON

Platf

3:30 -

MON

App

5:30 -

TUE

Pins

10:00

What's New in Web Development in WebKi...

10:00 - 10:40 AM - Mission

Patience is a virtue.

10:00 - 10:40 AM - Nob Hill

iOS Accessibility



Schedule



Maps



News



Videos

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Automatically Send



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Cancel

WWDC 2015

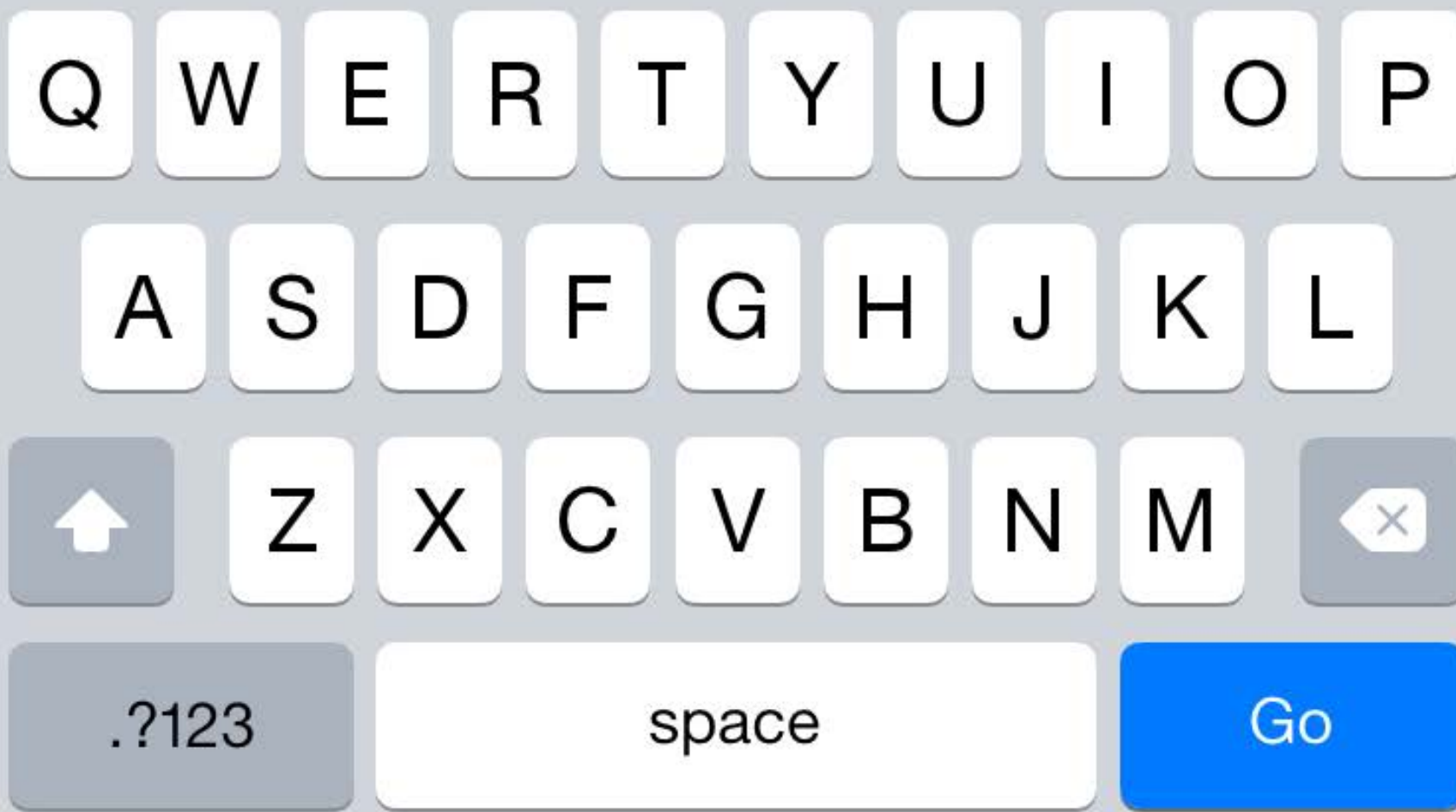
Sign In

Apple ID j.appleseed@icloud.com

Password ●●●●●●●●



Access limited to Registered Apple Developers.



Block Operations

It's blocks all the way down

Block Operations

It's blocks all the way down

NSOperation to execute a block

Block Operations

It's blocks all the way down

NSOperation to execute a block

Dependencies for blocks

Block Operations

It's blocks all the way down

NSOperation to execute a block

Dependencies for blocks

Leaving feedback

WWDC App

Block operations

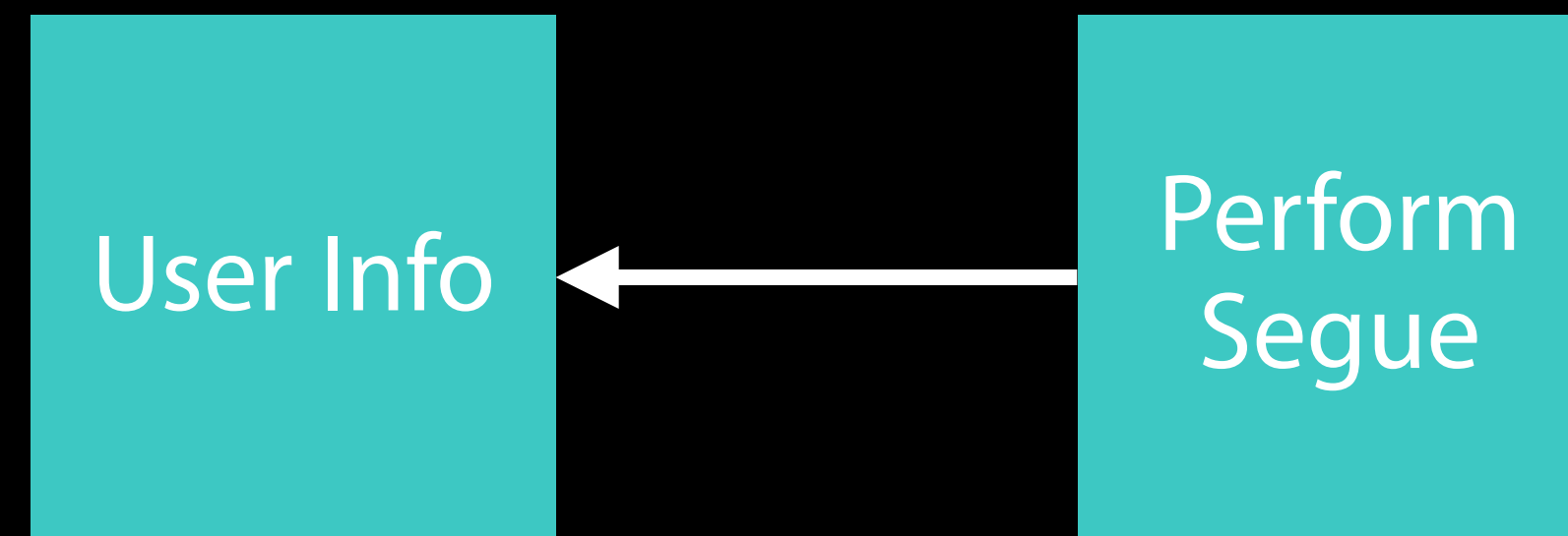
WWDC App

Block operations

Perform
Segue

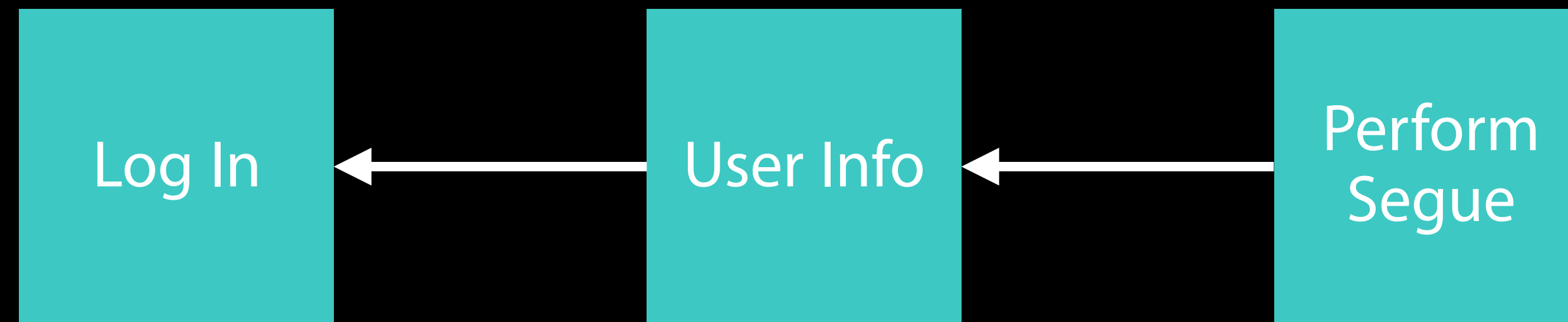
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Block operations



WWDC App

Block operations



Generating Dependencies

When two operations love each other...

Generating Dependencies

When two operations love each other...

“Never execute this until after executing that”

Generating Dependencies

When two operations love each other...

“Never execute this until after executing that”

Saving a favorite

Generating Dependencies

When two operations love each other...

“Never execute this until after executing that”

Saving a favorite

Downloading pass

Generating Dependencies

When two operations love each other...

“Never execute this until after executing that”

Saving a favorite

Downloading pass

Anything requiring login

Generating Dependencies

WWDC app favorites

Generating Dependencies

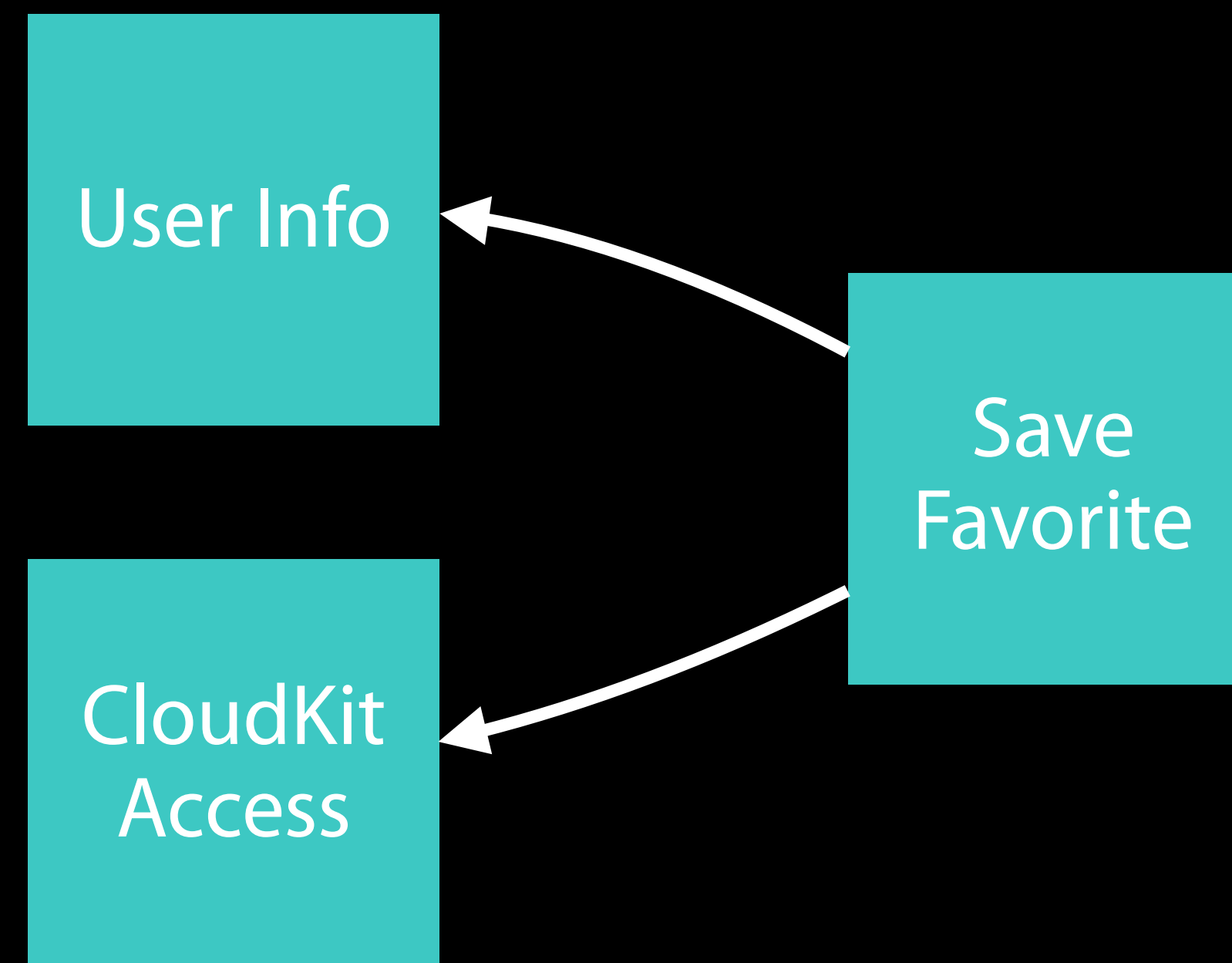
WWDC app favorites



Save
Favorite

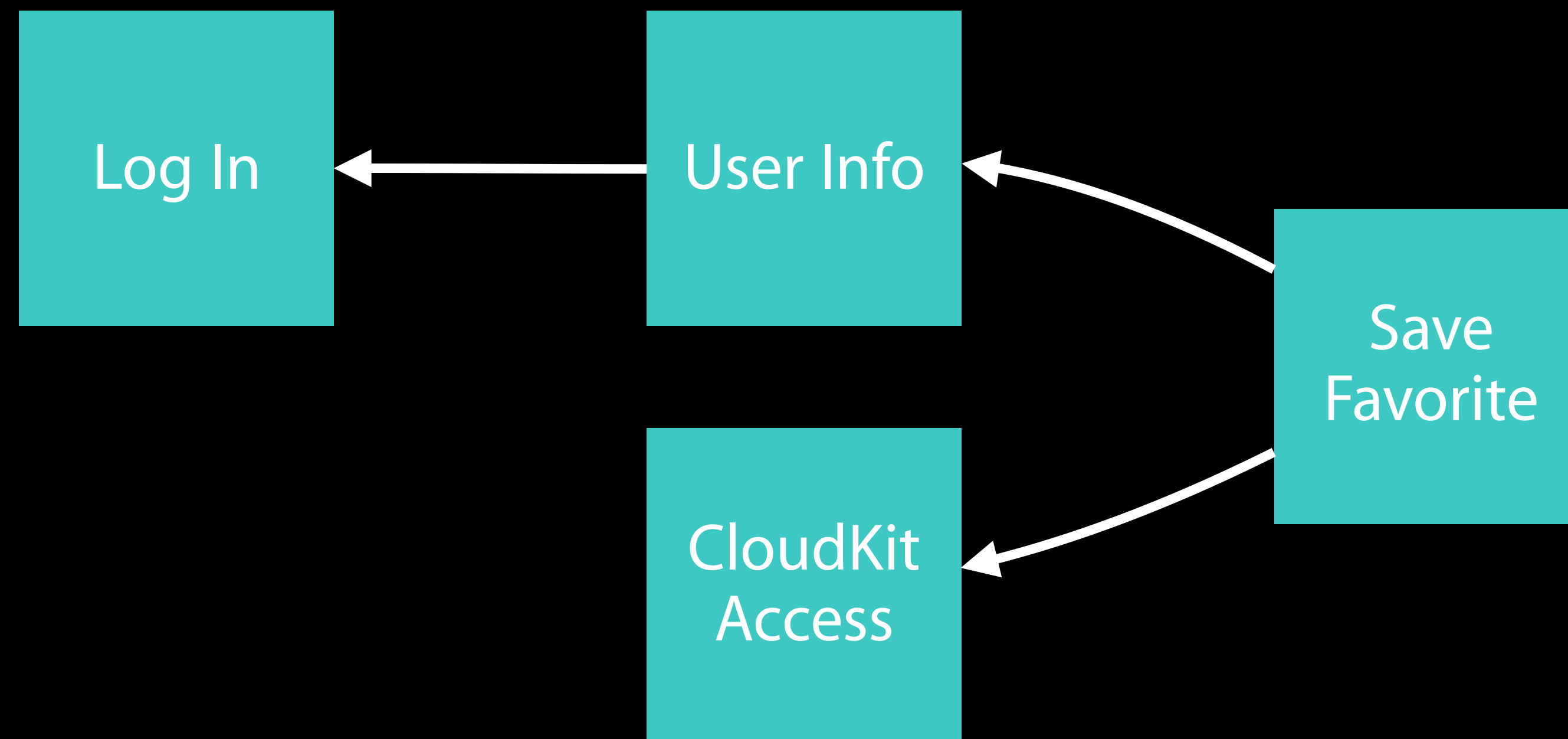
Generating Dependencies

WWDC app favorites



Generating Dependencies

WWDC app favorites



Extending Readiness

Adding requirements

Extending Readiness

Adding requirements

“Only execute this if...”

Extending Readiness

Adding requirements

“Only execute this if...”

Examples

Extending Readiness

Adding requirements

“Only execute this if...”

Examples

- Network is reachable

Extending Readiness

Adding requirements

“Only execute this if...”

Examples

- Network is reachable
- Access to user location

Extending Readiness

Adding requirements

“Only execute this if...”

Examples

- Network is reachable
- Access to user location
- User is “logged in”



9:41 AM

100%

[Schedule](#)

Session



Advanced NSOperations

[App Frameworks](#) | [Session 226](#)

Operations are a flexible way to model your app's business logic, but they can do so much more. See how NSOperation forms the heart of the WWDC app, and how using features like dependencies, readiness, and composition allow you to quickly and easily build dynamic and complex apps.

Friday

[Add](#)

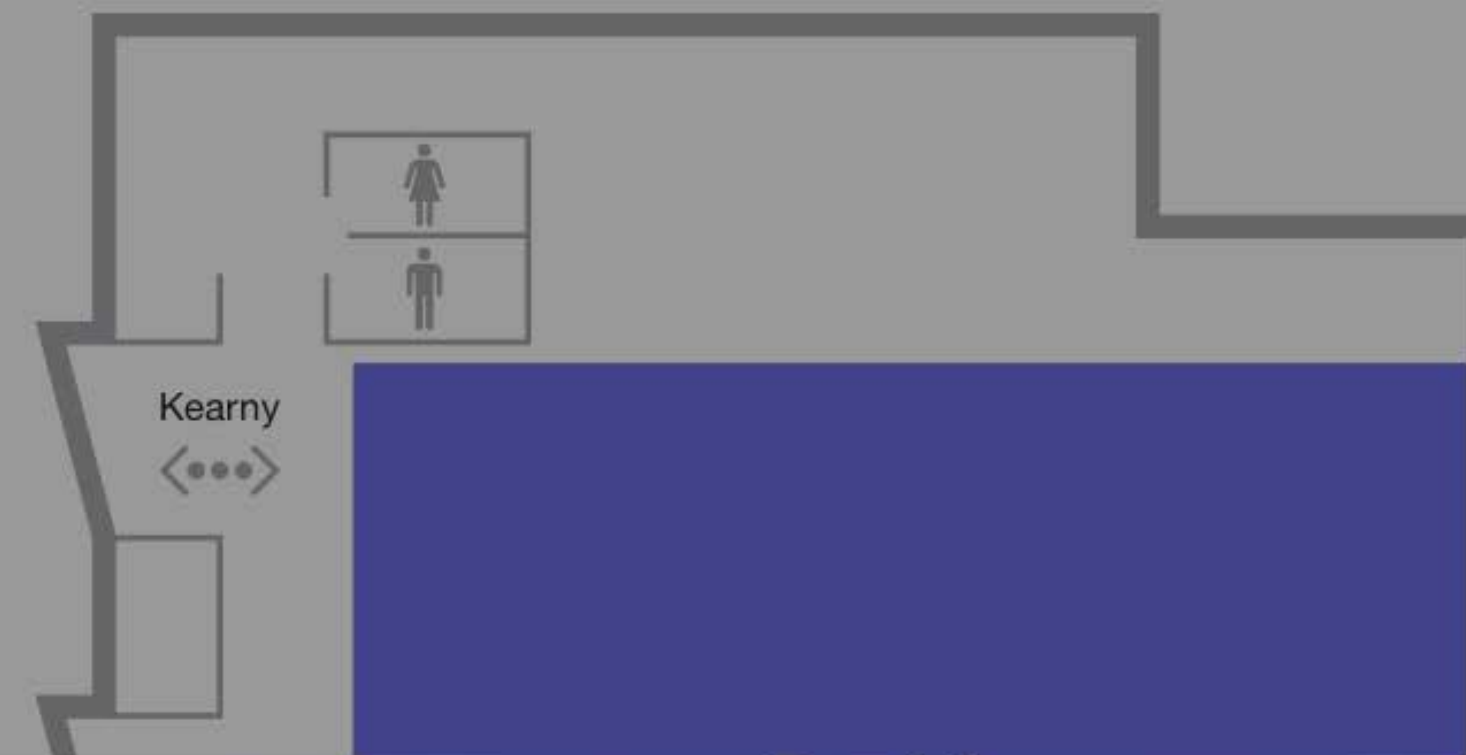
[Rem](#)

Network error

Unable to connect to server.

[OK](#)

Moscone 3rd Floor



Schedule



Maps



News



Videos

Composing Operations

I heard you like operations...

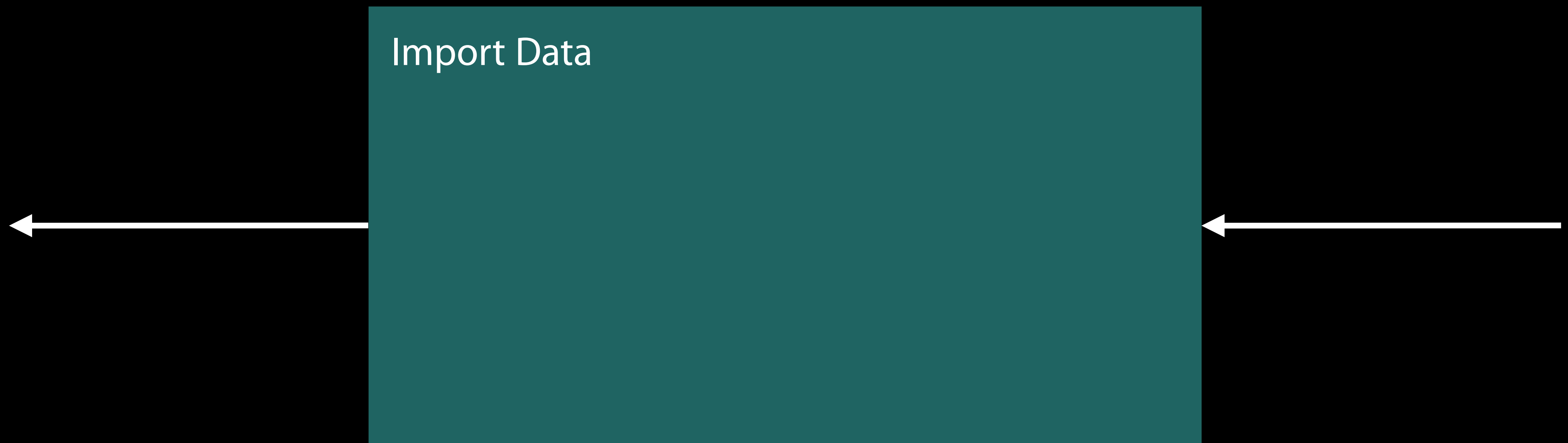
Composing Operations

I heard you like operations...

Downloading and parsing

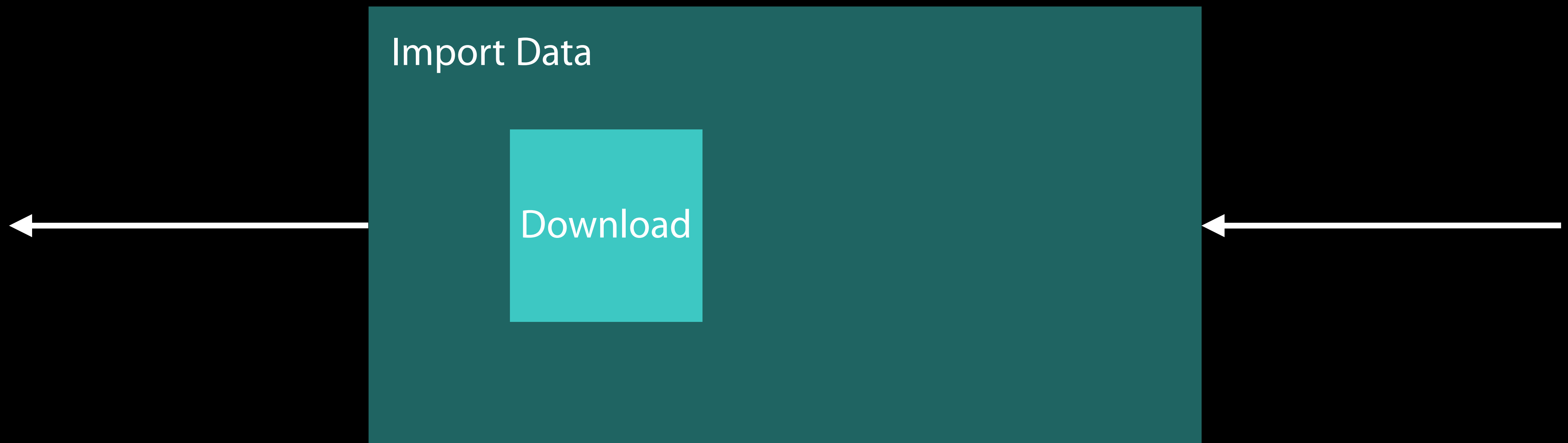
Composing Operations

Downloading and parsing



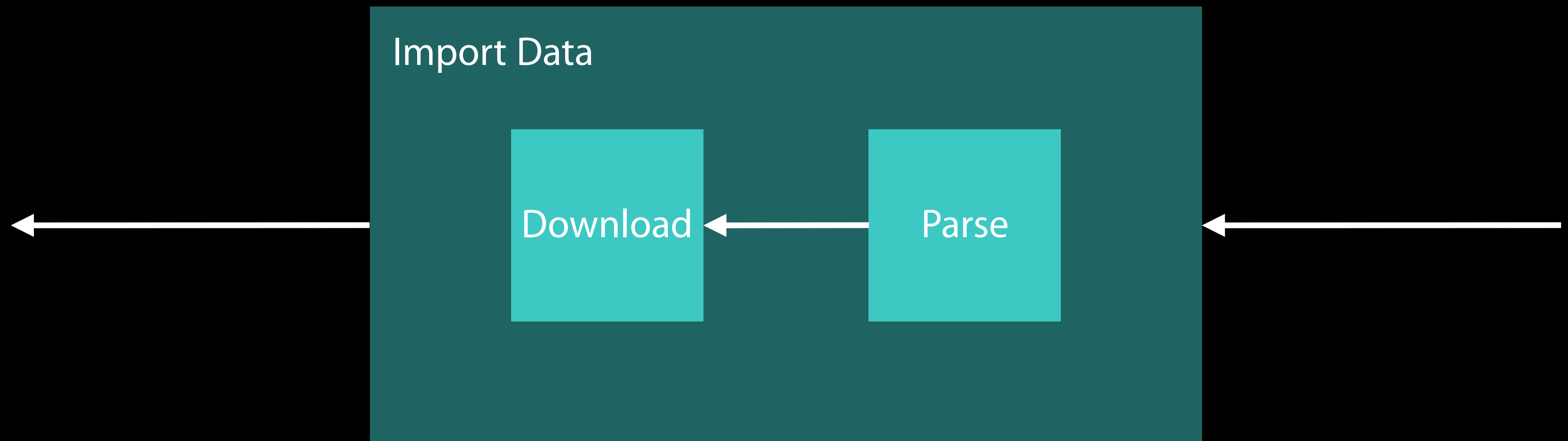
Composing Operations

Downloading and parsing



Composing Operations

Downloading and parsing



Composing Operations

I heard you like operations...

Downloading and parsing

Composing Operations

I heard you like operations...

Downloading and parsing

Fetching favorites

WWDC App

Fetching favorites

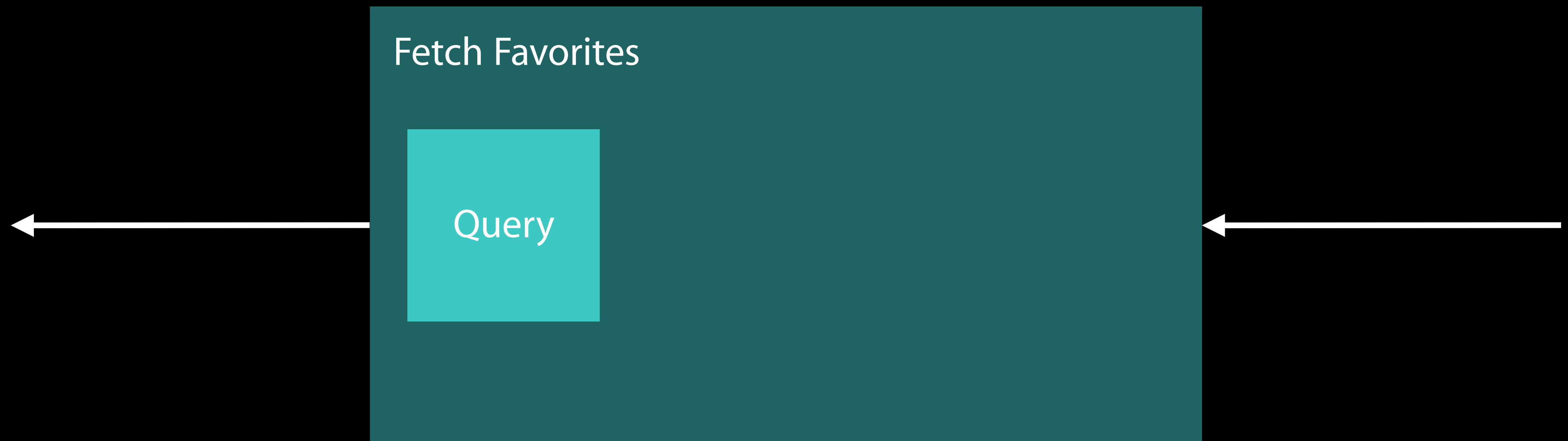


Fetch Favorites

The diagram shows a teal-colored rectangular box with the text "Fetch Favorites" in the top-left corner. Two white arrows point horizontally towards the box from the left and right sides, indicating that data is being passed into the task from both directions.

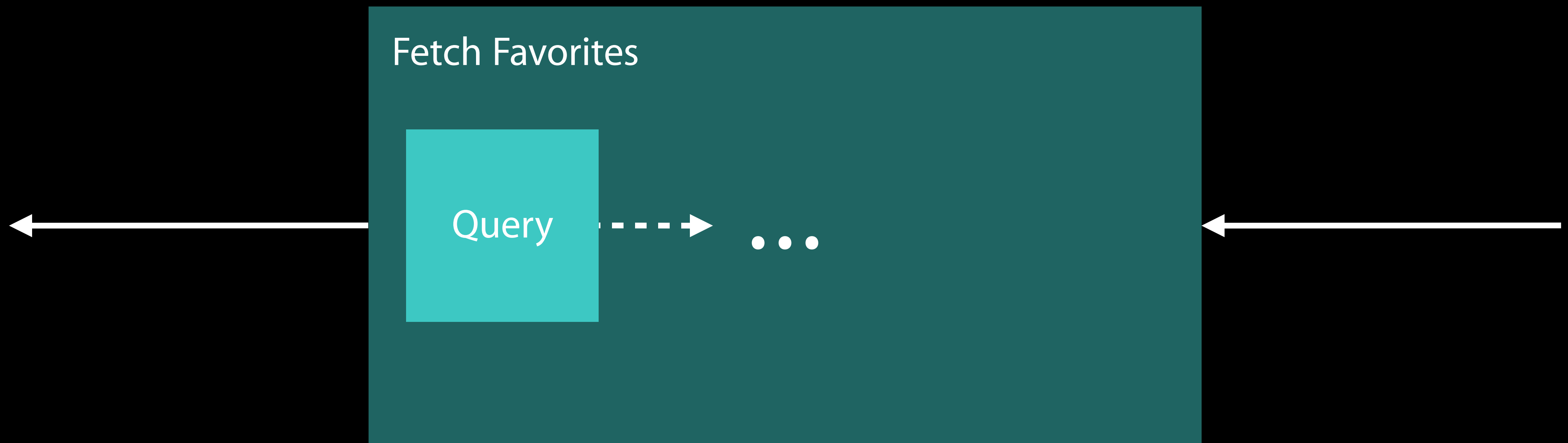
WWDC App

Fetching favorites



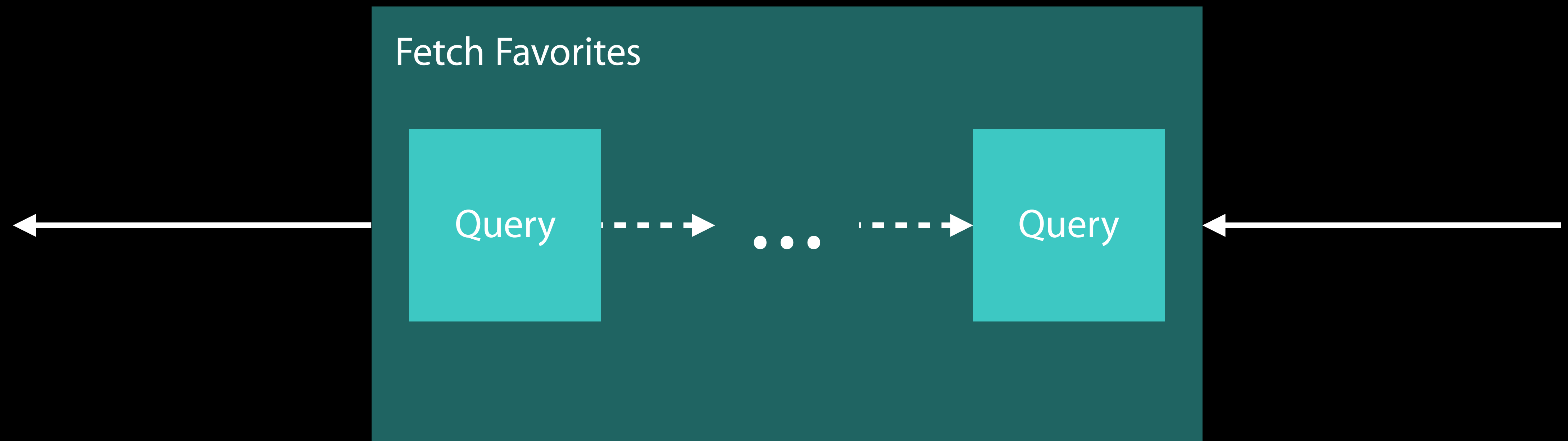
WWDC App

Fetching favorites



WWDC App

Fetching favorites



WWDC App

Fetching favorites

```
override public func execute() {  
    let userRecordID: CKRecordID = ...  
    let predicate = NSPredicate(format: "creatorUserRecordID = %@", userRecordID)  
    let query = CKQuery(recordType: "SessionFavorite", predicate: predicate)  
  
    let queryOperation = CKQueryOperation(query)  
    executeQueryOperation(queryOperation)  
}
```

WWDC App

Fetching favorites

```
private func executeQueryOperation(queryOperation: CKQueryOperation) {
    queryOperation.recordFetchedBlock = ...
    queryOperation.queryCompletionBlock = { cursor, error in
        if let error = error {
            self.finishWithError(error)
        } else if let cursor = cursor {
            let fetchMoreRecords = CKQueryOperation(cursor)
            self.executeQueryOperation(fetchMoreRecords)
        } else {
            self.processFetchedRecords()
        }
    }
}

database.addOperation(queryOperation)
}
```

WWDC App

Fetching favorites

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private func executeQueryOperation(queryOperation: CKQueryOperation) {
    queryOperation.recordFetchedBlock = ...
    queryOperation.queryCompletionBlock = { cursor, error in
        if let error = error {
            self.finishWithError(error)
        } else if let cursor = cursor {
            let fetchMoreRecords = CKQueryOperation(cursor)
            self.executeQueryOperation(fetchMoreRecords)
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WWDC App

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Mutual Exclusivity

There can be only one

Mutual Exclusivity

There can be only one

Alerts

Mutual Exclusivity

There can be only one

Alerts

Videos

Mutual Exclusivity

There can be only one

Alerts

Videos

Loading database

Mutual Exclusivity

One alert at a time

Mutual Exclusivity

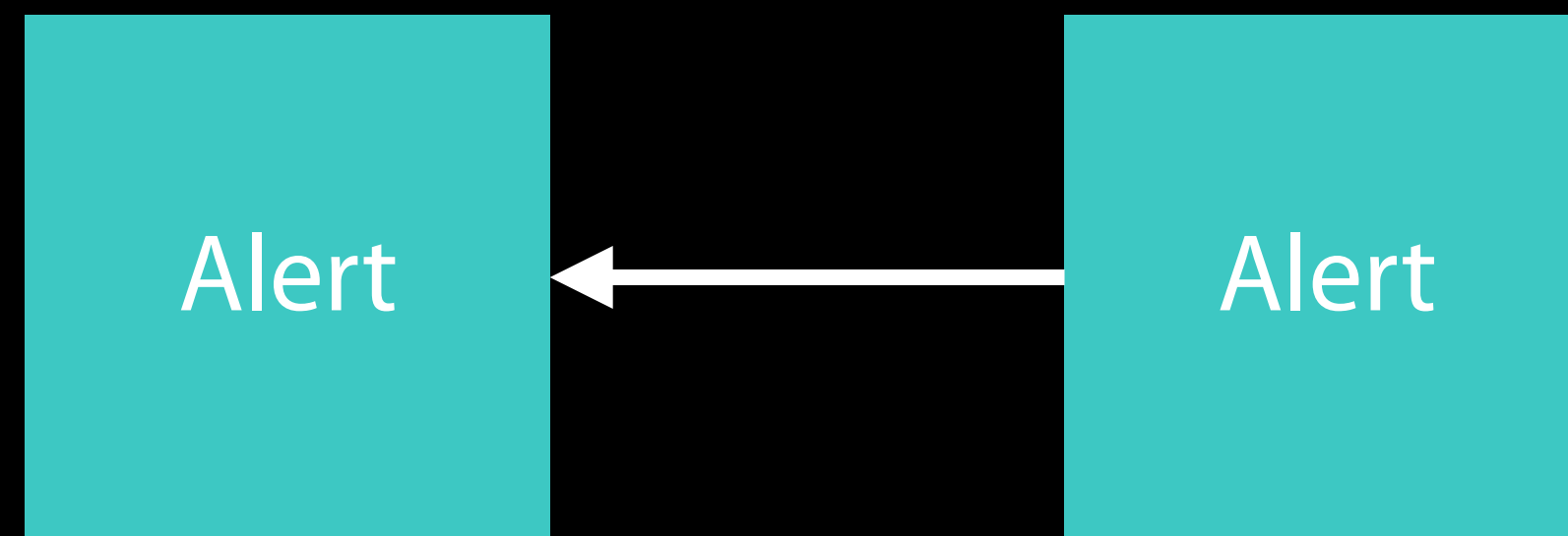
One alert at a time



Alert

Mutual Exclusivity

One alert at a time



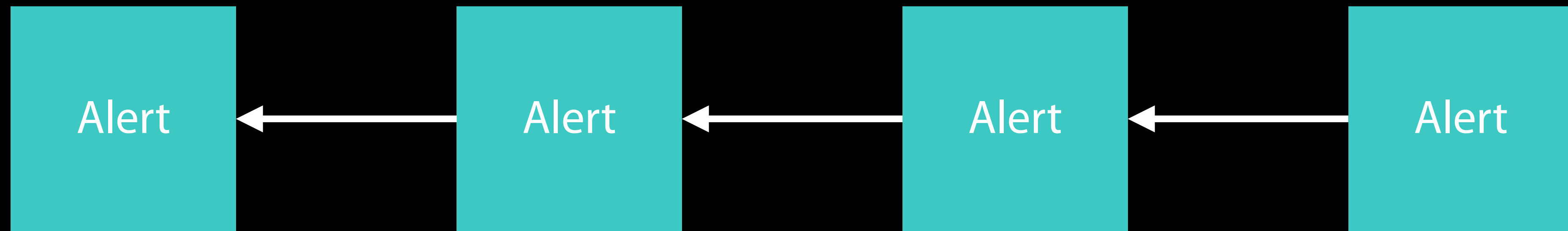
Mutual Exclusivity

One alert at a time



Mutual Exclusivity

One alert at a time



Sample Code

Earthquakes and Operations

Operation

Operation

NSOperation subclass

Operation

NSOperation subclass

Adds "conditions"

Operation

NSOperation subclass

Adds "conditions"

Adds "observers"

Operation

NSOperation subclass

Adds “conditions”

Adds “observers”

Example operations

- Groups
- URLSessionTask
- Location
- Delay

OperationCondition

OperationCondition

Generates dependencies

OperationCondition

Generates dependencies

Defines mutual exclusivity

OperationCondition

Generates dependencies

Defines mutual exclusivity

Checks for satisfied conditions

OperationCondition

Generates dependencies

Defines mutual exclusivity

Checks for satisfied conditions

Example conditions

- MutuallyExclusive<T>
- Reachability
- Permissions

OperationObserver

OperationObserver

Notified about significant events

- Operation start
- Operation end
- Operation generation

OperationObserver












Notified about significant events

- Operation start
- Operation end
- Operation generation

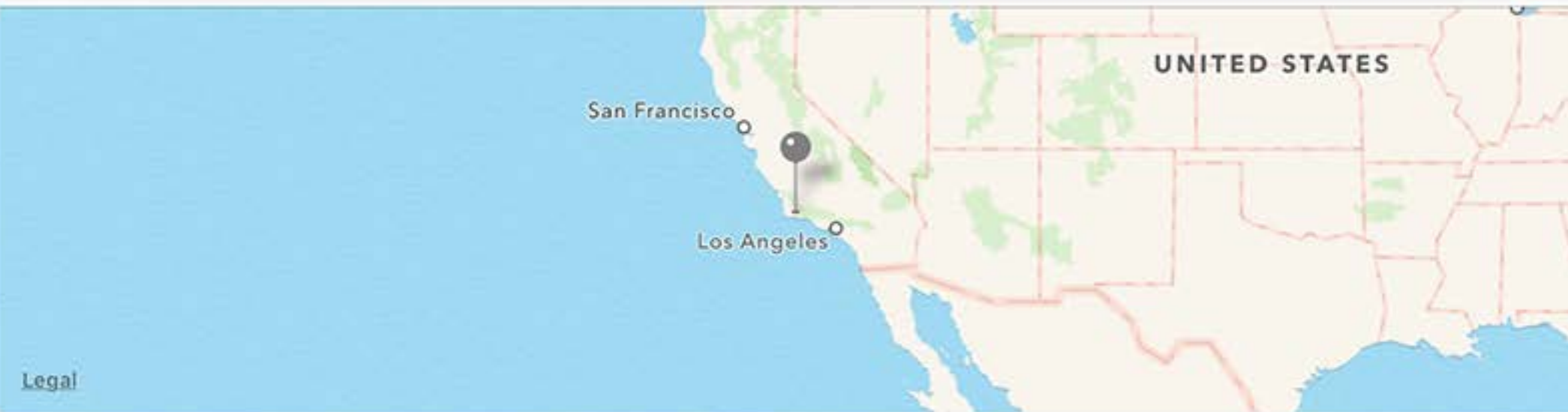
Example observers

- Timeouts
- Background tasks
- Network activity indicator

Earthquakes

- 175km WNW of Pangai, T...  5.7
May 24, 2015, 7:39:02...
- 131km SW of Kokopo, Pap...  4.6
May 24, 2015, 6:30:11 A...
- 15km NE of Los Olivos, C...  2.7
May 24, 2015, 3:37:14...
- 15km NE of Los Olivos, C...  2.7
May 24, 2015, 3:37:14...
- 167km ENE of Iquique, Ch...  4.9
May 24, 2015, 2:38:04...
- 3km S of Sultan, Washing...  2.6
May 24, 2015, 2:21:34...
- 46km N of Charlotte Amal...  3.1
May 24, 2015, 1:54:57...
- 5km NE of Edmond, Okla...  2.7
May 23, 2015, 11:54:54...
- 57km NW of Aguadilla, Pu...  2.9
May 23, 2015, 10:56:42...
- 65km NNE of Arecibo, Pu...  3.3
May 23, 2015, 10:30:16...
- 15km SSE of Ridgemark,...  3.0
May 23, 2015, 10:12:50...

Earthquake



INFORMATION

Location	15km NE of Los Olivos, California
Magnitude	2.7
Depth	3.032 mi
Time	May 24, 2015, 3:37:14 AM
Distance	210.38 mi

More Information

Summary

Summary

Operations abstract logic

Summary

Operations abstract logic

Dependencies clarify intent

Summary

Operations abstract logic

Dependencies clarify intent

Describe complex behaviors

Summary

Operations abstract logic

Dependencies clarify intent

Describe complex behaviors

Enables powerful patterns

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Friday 10:00AM

CloudKit Tips and Tricks

Pacific Heights

Thursday 4:30PM

Advanced CloudKit

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Threading Programming Guide

developer.apple.com/library

Sample Code

Advanced NSOperations

developer.apple.com/wwdc

Technical Support

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General Inquiries

Dave DeLong, Frameworks Evangelist

delong@apple.com

Developer Technical Support

developer.apple.com/support/technical

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