What's New in Core Data

Session 207

Nick Gillett
Core Data Software Engineer

Road Map

Road Map

- iCloud

Road Map

- iCloud
  - Fallback Store

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- iCloud
  - Fallback Store
  - Asynchronous Setup

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  - Account Changes

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  - New API

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- Demos

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  - Asynchronous Setup
  - Account Changes
  - New API
  - Living on iCloud
- Demos
- SQLite Store Enhancements

iCloud

iCloud

- Speed

iCloud

- Speed
- Simplicity

iCloud

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- Simplicity
- Consistency

Fallback Store

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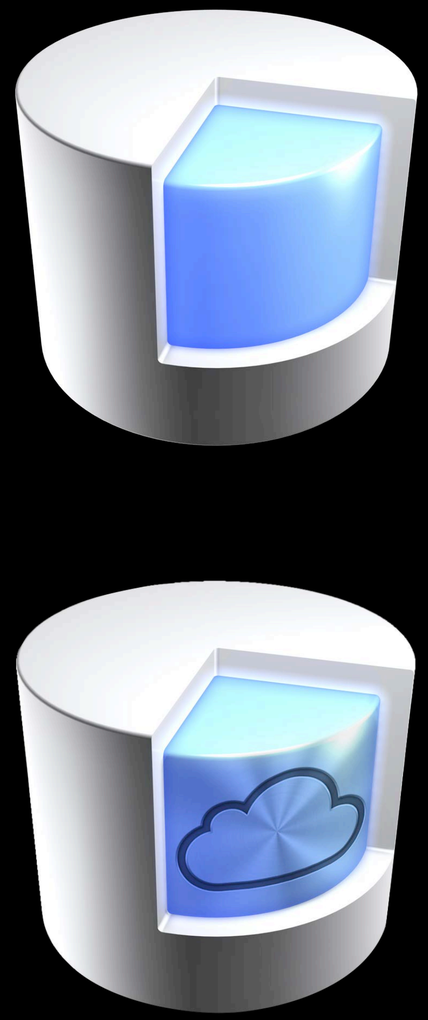
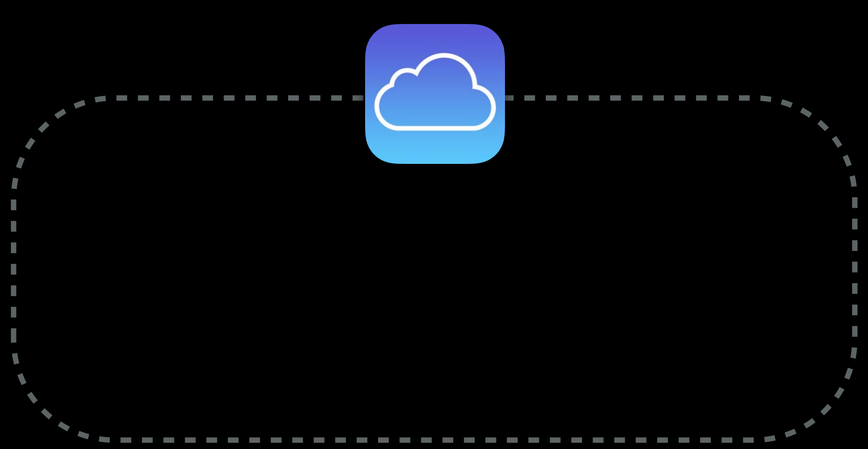
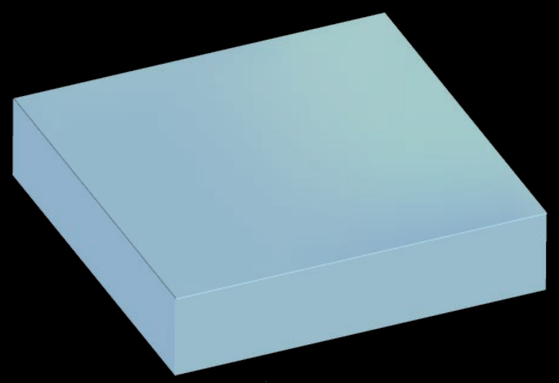
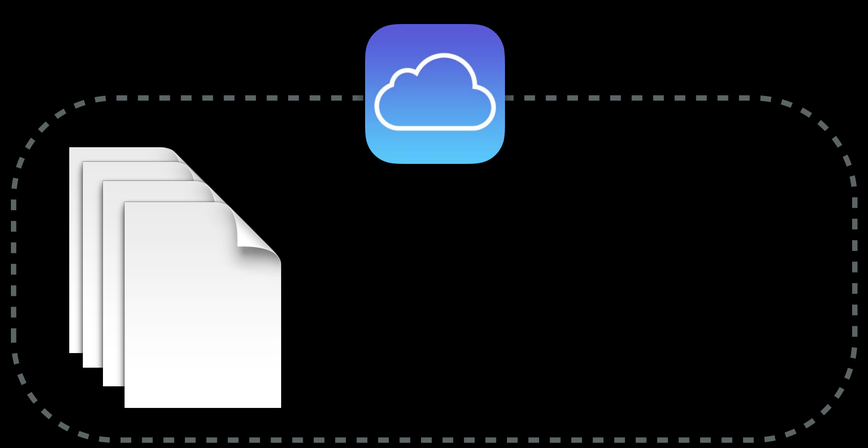


Fallback Store

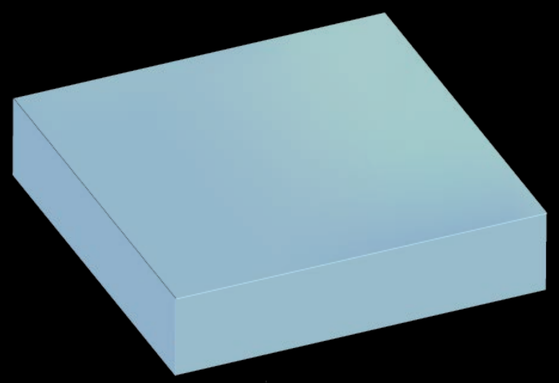


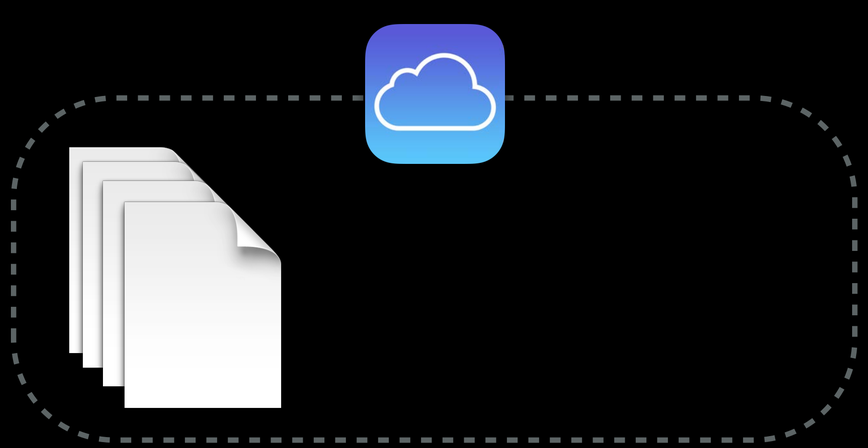
Fallback Store





Fallback Store





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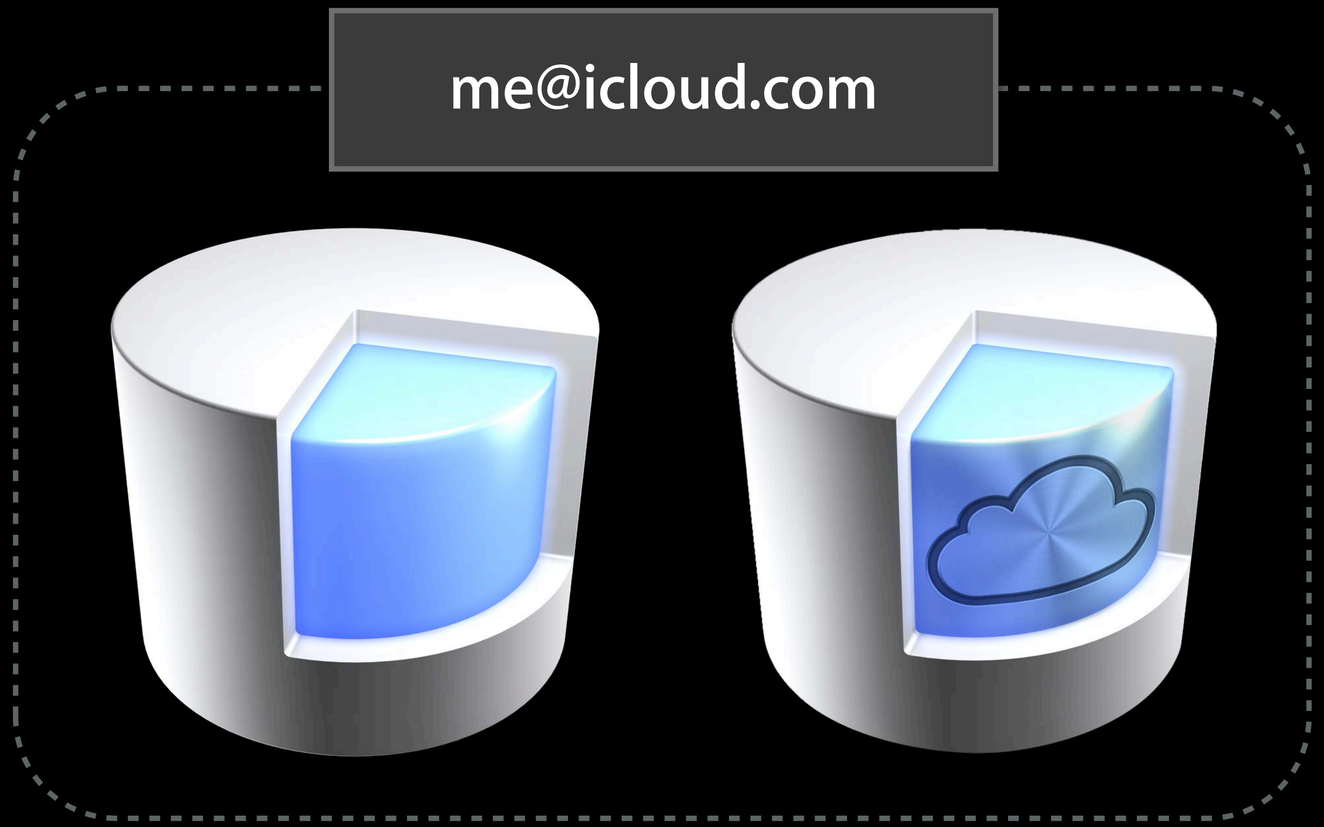
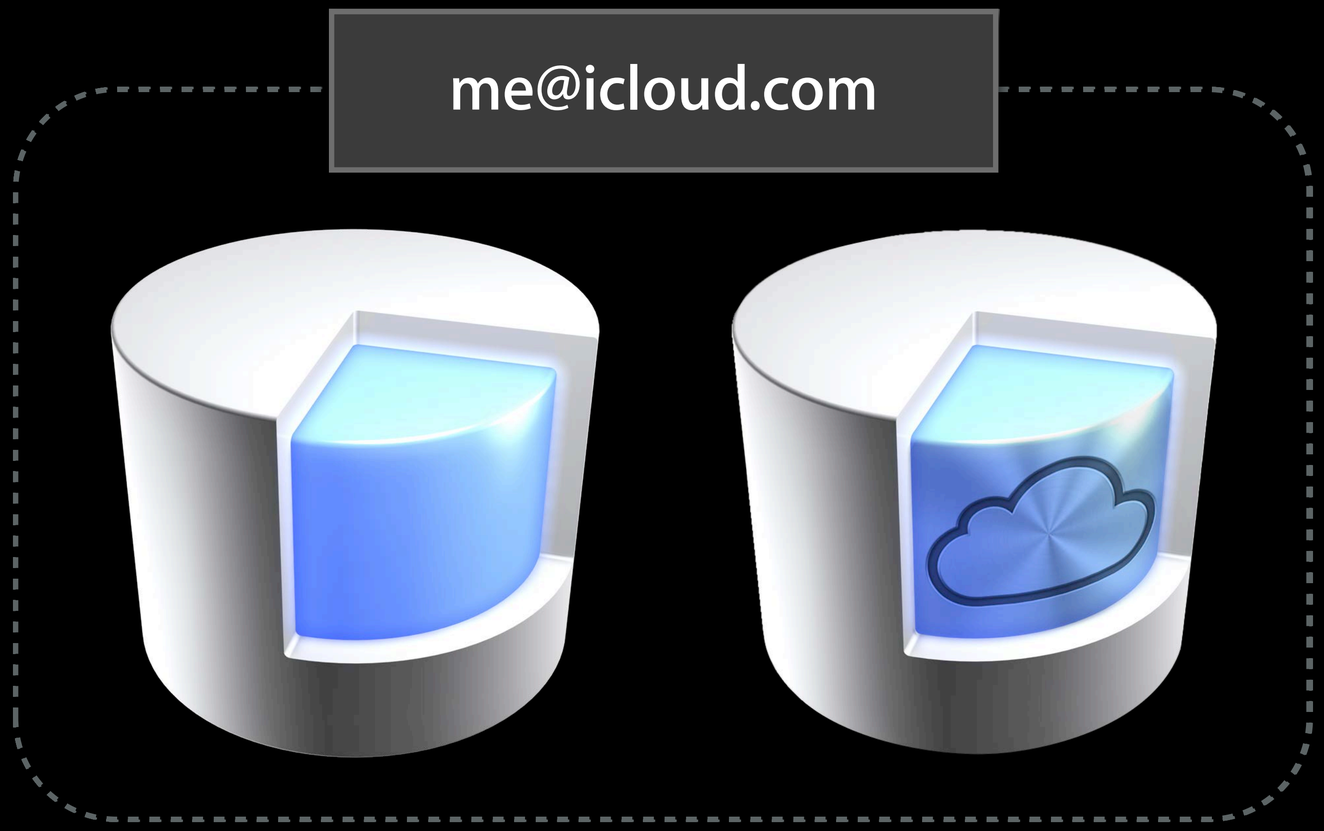


Fallback Store



Fallback Store

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- Entirely managed by Core Data

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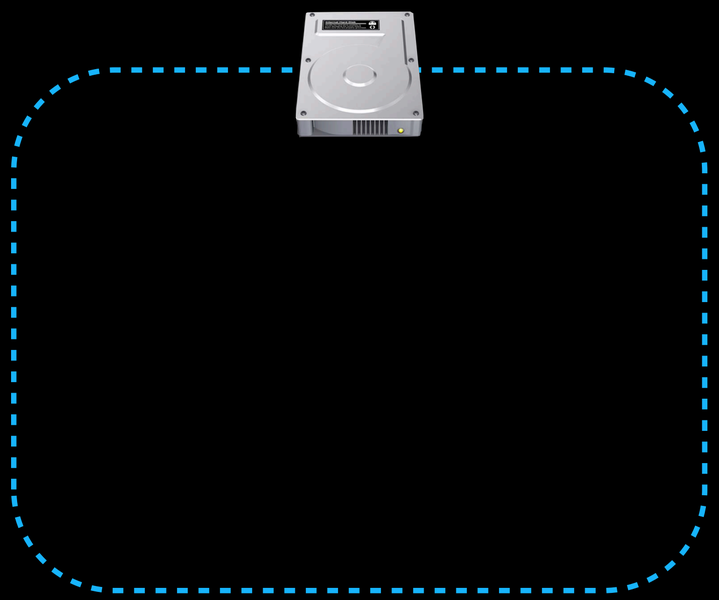
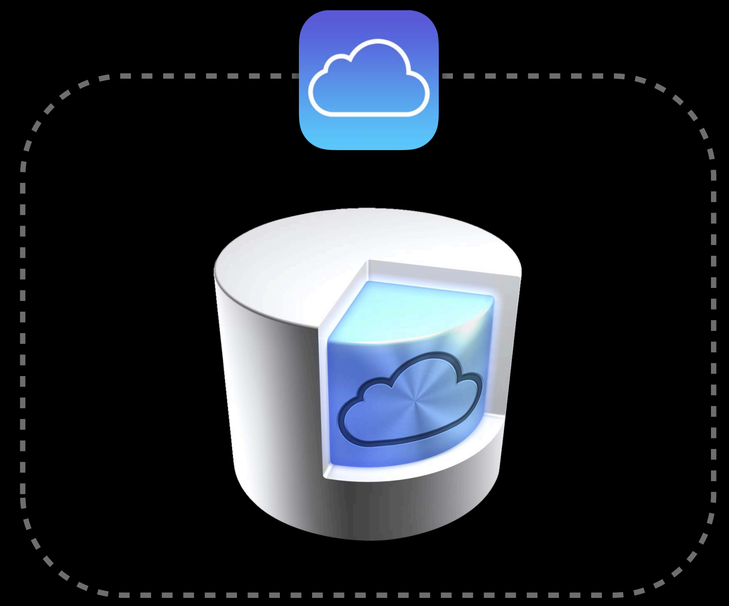
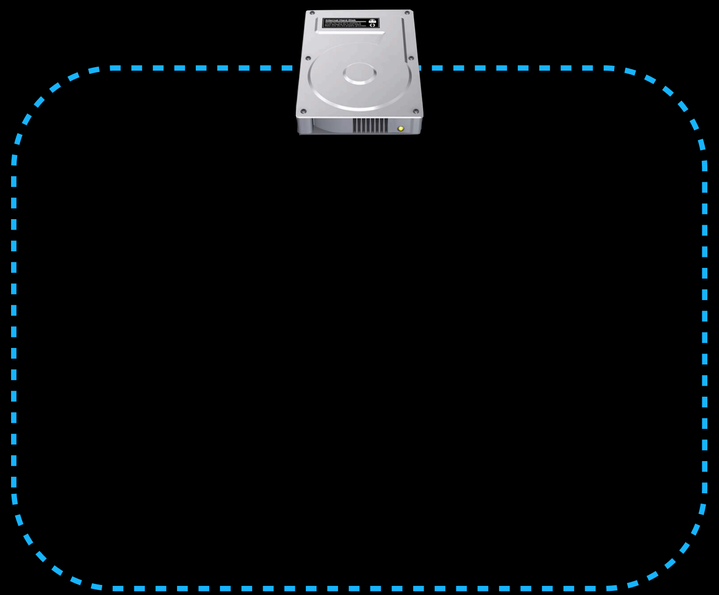




Fallback Store



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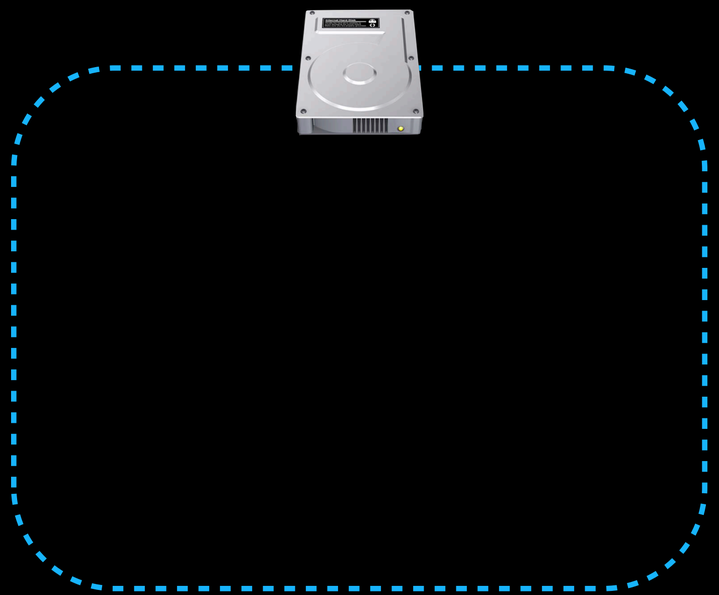

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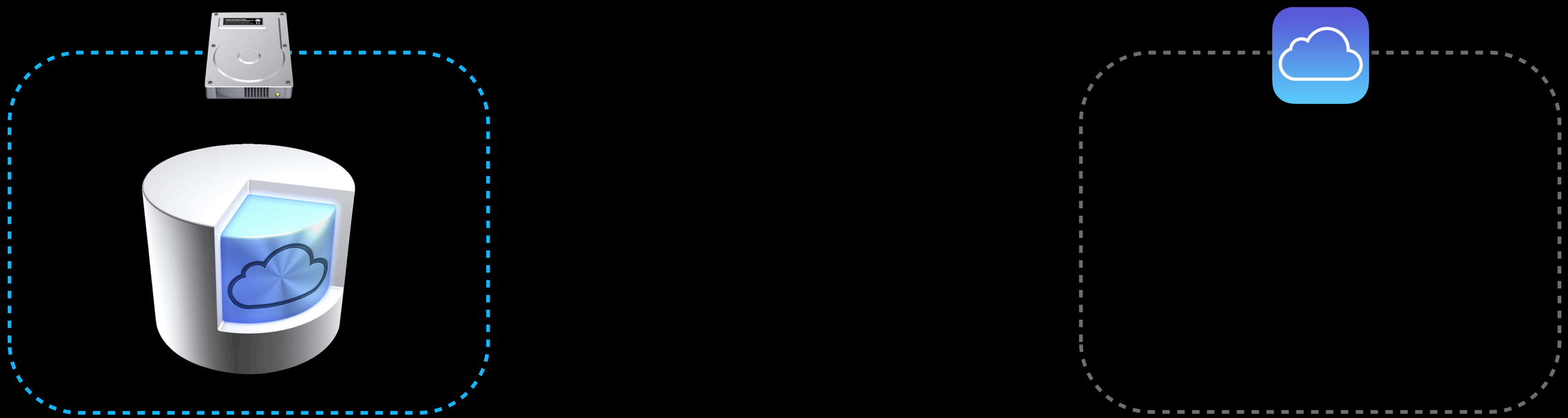

Fallback Store

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```
Core Data: Ubiquity: peerID:StoreName – Using local storage: 1
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Core Data: Ubiquity: peerID:StoreName - Using local storage: 0
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```
Core Data: Ubiquity: peerID:StoreName – Using local storage: 1
Core Data: Ubiquity: peerID:StoreName – Using local storage: 0
```

Asynchronous Setup

Asynchronous Setup

```
[psc addPersistentStoreWithType:NSSQLiteStoreType
                  configuration:nil
                            URL:url
                        options:options
                          error:&error];
```

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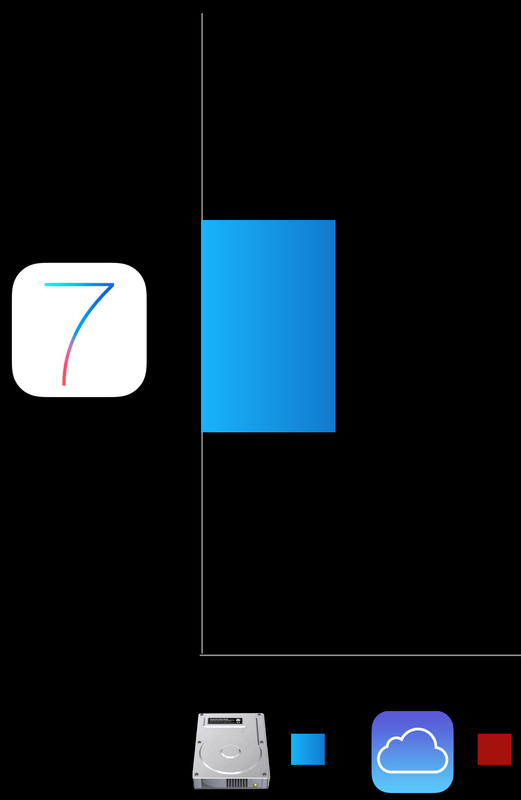

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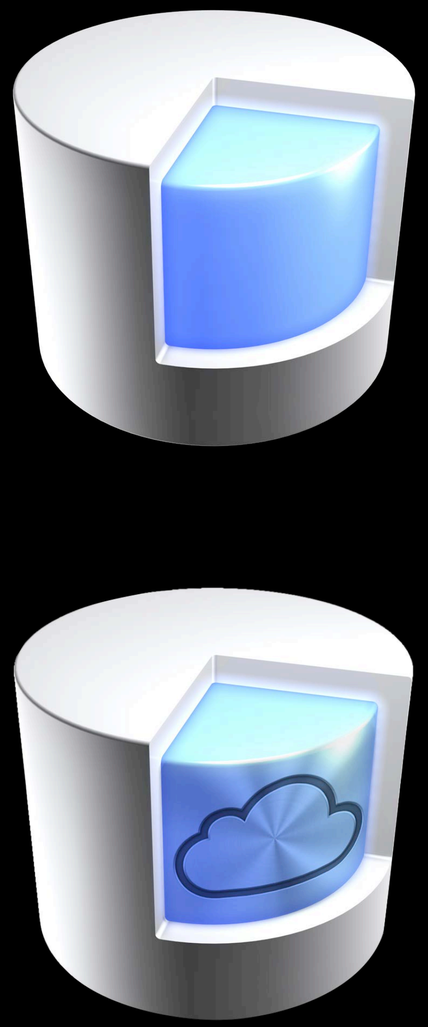

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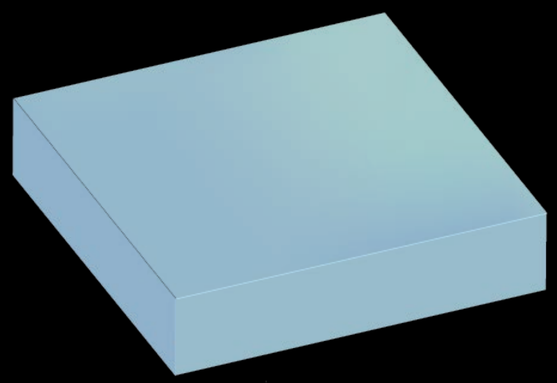
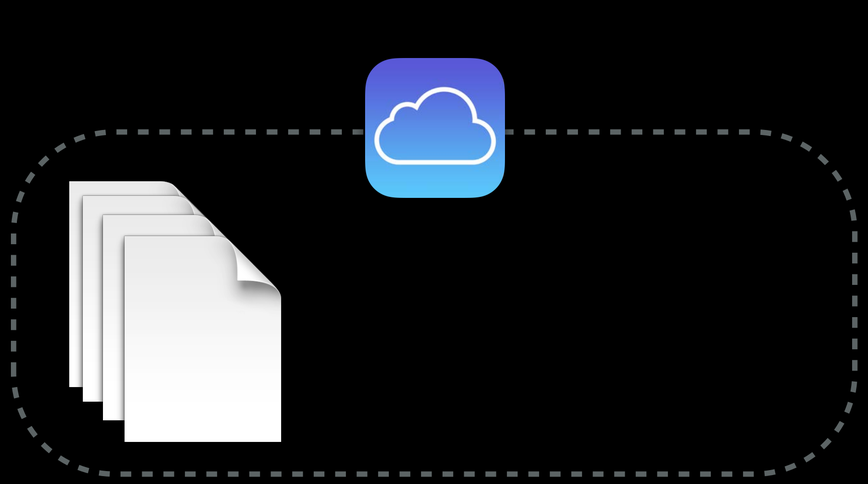
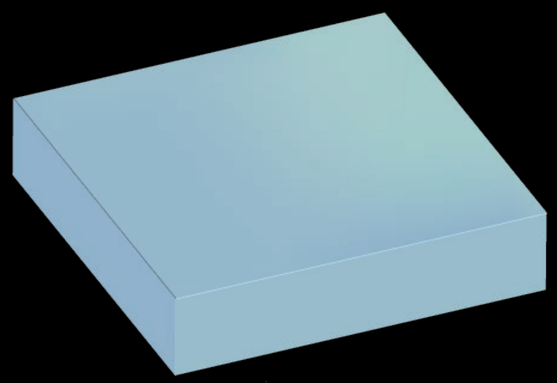
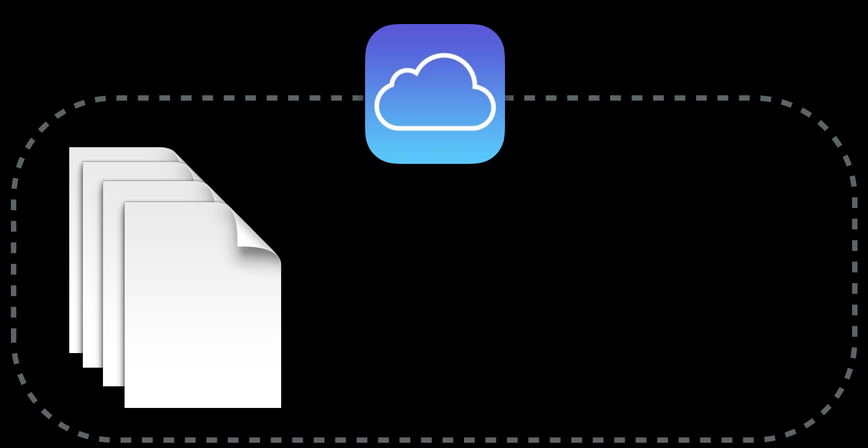




Asynchronous Setup





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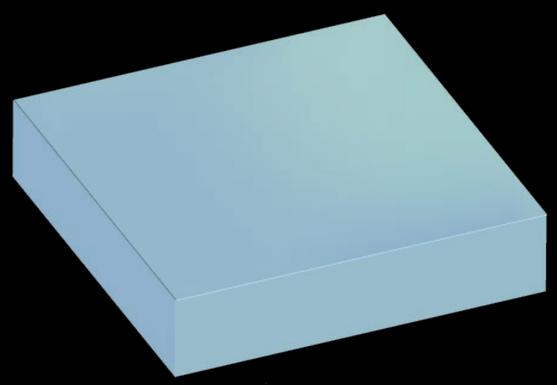

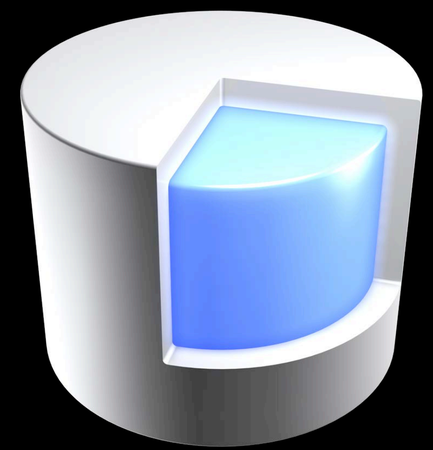

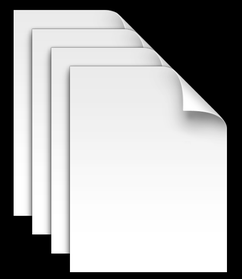

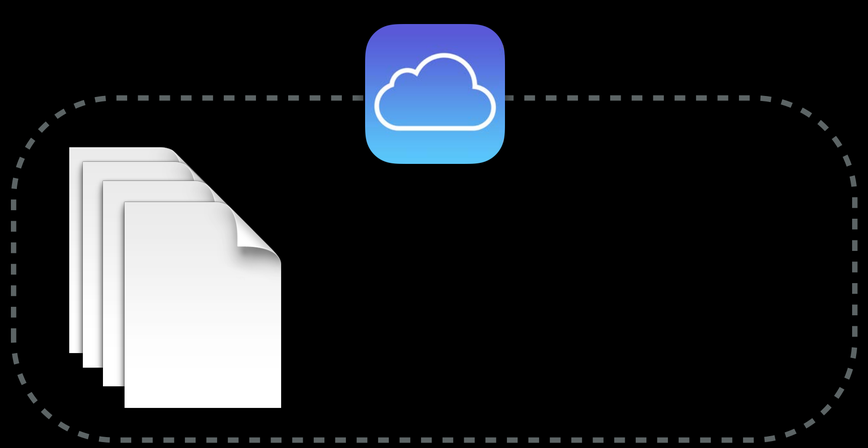

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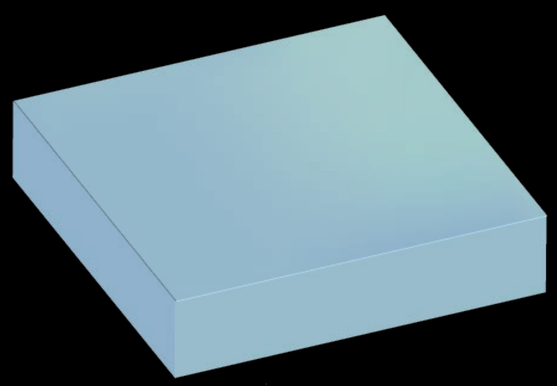

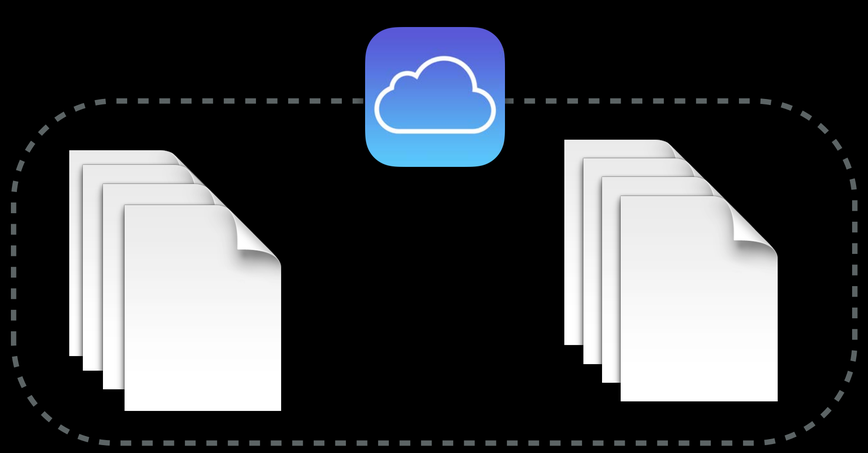

Asynchronous Setup

`NSPersistentStoreCoordinatorStoresWillChangeNotification`

Asynchronous Setup

NSPersistentStoreCoordinatorStoresWillChangeNotification

- -[NSManagedObjectContext save:]
- -[NSManagedObjectContext reset:]

Asynchronous Setup

```
NSPersistentStoreCoordinatorStoresWillChangeNotification

  -[NSManagedObjectContext save:]
  -[NSManagedObjectContext reset:]

Store Removed by Core Data
```

Asynchronous Setup

NSPersistentStoreCoordinatorStoresWillChangeNotification

- -[NSManagedObjectContext save:]
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Store Removed by Core Data

NSPersistentStoreCoordinatorStoresDidChangeNotification

Asynchronous Setup

NSPersistentStoreCoordinatorStoresWillChangeNotification

- -[NSManagedObjectContext save:]
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Store Removed by Core Data

NSPersistentStoreCoordinatorStoresDidChangeNotification

- -[NSManagedObjectContext save:]

Asynchronous Setup

Asynchronous Setup

```
NSPersistentStoreDidImportUbiquitousContentChangesNotification

  -[NSManagedObjectContext mergeChangesFromContextDidSaveNotification:]
```

Account Changes

Handling Account Changes

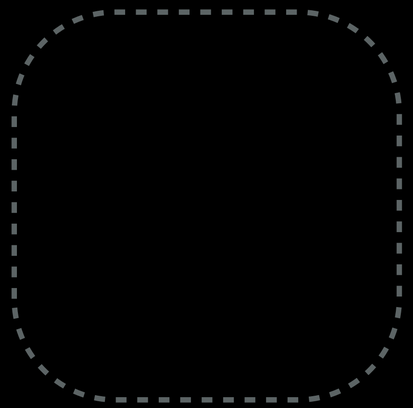
me@icloud.com

Handling Account Changes

```
NSUbiquityIdentityTokenDidChangeNotification
```

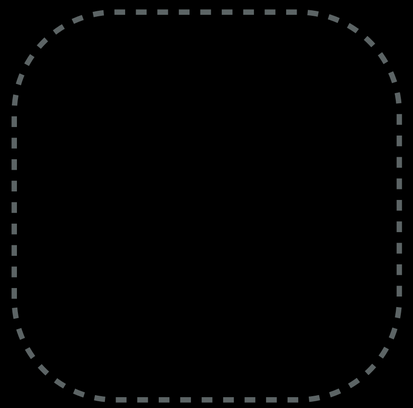
Handling Account Changes

```
NSUbiquityIdentityTokenDidChangeNotification
```



Handling Account Changes

```
NSUbiquityIdentityTokenDidChangeNotification
```



Handling Account Changes

notme@icloud.com

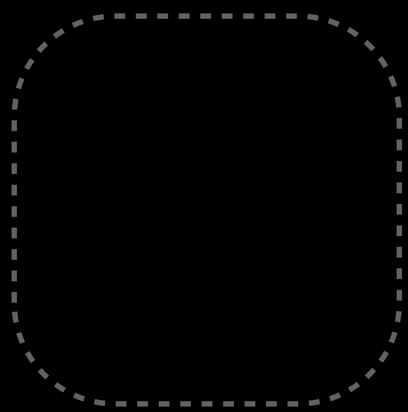
Handling Account Changes

```
NSUbiquityIdentityTokenDidChangeNotification
```

Handling Account Changes

NSUbiquityIdentityTokenDidChangeNotification

- -[NSManagedObjectContext reset:]
- -[NSPersistentStoreCoordinator removePersistentStore:]



Handling Account Changes

```
NSUbiquityIdentityTokenDidChangeNotification

    -[NSManagedObjectContext reset:]
    -[NSPersistentStoreCoordinator removePersistentStore:]

    -[NSPersistentStoreCoordinator addPersistentStore:]
```

Handling Account Changes

Account Changes Now

Account Changes Now

```
NSPersistentStoreCoordinatorStoresWillChangeNotification
```

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NSPersistentStoreCoordinatorStoresWillChangeNotification

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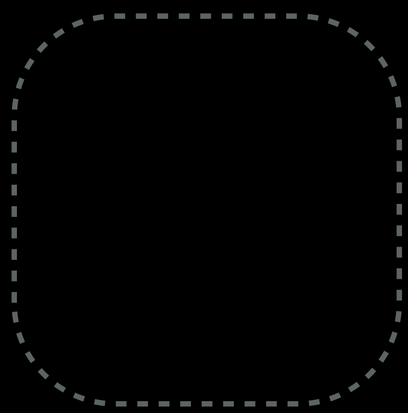
Store Removed by Core Data
```



Account Changes Now

NSPersistentStoreCoordinatorStoresWillChangeNotification

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Store Removed by Core Data

NSPersistentStoreCoordinatorStoresDidChangeNotification

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Store Removed by Core Data

NSPersistentStoreCoordinatorStoresDidChangeNotification

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Accounts and Stores

Accounts and Stores

- Provide Store URL inside App Sandbox

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- Provide Store URL inside App Sandbox
- Core Data creates an opaque container

Accounts and Stores

- Provide Store URL inside App Sandbox
- Core Data creates an opaque container

me@icloud.com

notme@icloud.com

Local

Accounts and Stores

Accounts and Stores

file://sandbox/store.sqlite

Accounts and Stores

file://sandbox/store.sqlite

file://sandbox/CoreDataUbiquitySupport/[Core Data Directories]/store.sqlite

Accounts and Stores

- Provide Store URL inside App Sandbox
- Core Data creates an opaque container

me@icloud.com

notme@icloud.com

Local

Accounts and Stores

- Provide Store URL inside App Sandbox
- Core Data creates an opaque container
- Store URL tied to a single iCloud account

me@icloud.com

notme@icloud.com

Local

Accounts and Stores

- Provide Store URL inside App Sandbox
- Core Data creates an opaque container
- Store URL tied to a single iCloud account
- Automatically removed by Core Data

New API

iCloud Options

iCloud Options

```
NSFileManager *fm = [NSFileManager defaultManager];
NSURL *url = [fm URLForUbiquitousContainerIdentifier:nil];

NSDictionary *options = @{
    NSPersistentStoreUbiquitousContentNameKey: @”Store”,
    NSPersistentStoreUbiquitousContentURLKey: url
};
```

iCloud Options

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NSFileManager *fm = [NSFileManager defaultManager];
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};

NSDictionary *options = @{
    NSPersistentStoreUbiquitousContentNameKey: @”Store”
};

NSDictionary *options = @{
    NSPersistentStoreUbiquitousContentNameKey: @”Store”,
    NSPersistentStoreUbiquitousContentURLKey: @”Subdir”
};
```

iCloud Options

iCloud Options

- NSPersistentStoreUbiquitousContainerIdentifierKey
  - Passed directly to -[NSFileManager URLForUbiquitousContainerIdentifier:]
  - For apps that have multiple iCloud entitlements, nil will elect the first one by default

iCloud Options

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```
NSDictionary *options = @{
    NSPersistentStoreUbiquitousContentNameKey: @”Store”,
    NSPersistentStoreUbiquitousContentURLKey: @”Subdir”,
    NSPersistentStoreUbiquitousContainerIdentifierKey: @”com.myapp.bundleID”
};
```

Managing iCloud Content

Managing iCloud Content

- NSPersistentStoreRebuildFromUbiquitousContentOption
  - Deletes the store file and rebuilds it from the iCloud content
  - -addPersistentStore will return an empty store

Managing iCloud Content

- NSPersistentStoreRebuildFromUbiquitousContentOption
  - Deletes the store file and rebuilds it from the iCloud content
  - -addPersistentStore will return an empty store

```
NSDictionary *options = @{
    NSPersistentStoreUbiquitousContentNameKey: @”Store”,
    NSPersistentStoreUbiquitousContentURLKey: @”Subdir”,
    NSPersistentStoreRebuildFromUbiquitousContentOption: @YES
};
```

Managing iCloud Content

Managing iCloud Content

- NSPersistentStoreRemoveUbiquitousMetadataOption
  - Removes all iCloud associated metadata

Managing iCloud Content

- NSPersistentStoreRemoveUbiquitousMetadataOption
  - Removes all iCloud associated metadata

```
NSDictionary *options = @{
    NSPersistentStoreRemoveUbiquitousMetadataOption: @YES
};

[psc migratePersistentStore:iCloudStore
                      toURL:url
                    options:options
                   withType:NSSQLiteStoreType
                      error:&error];
```

Managing iCloud Content

Managing iCloud Content

```
+ (BOOL)removeUbiquitousContentAndPersistentStoreAtURL:(NSURL *)storeURL
                                               options:(NSDictionary *)options
                                                 error:(NSError**)error;
```

- Deletes ubiquitous content and persistent store file

Managing iCloud Content

```
+ (BOOL)removeUbiquitousContentAndPersistentStoreAtURL:(NSURL *)storeURL
                                               options:(NSDictionary *)options
                                                 error:(NSError**)error;
```

- Deletes ubiquitous content and persistent store file

```
NSDictionary *options = @{
    NSPersistentStoreUbiquitousContentNameKey: @”Store”,
    NSPersistentStoreUbiquitousContentURLKey: @”Subdir”
};

BOOL success = [NSPersistentStoreCoordinator
                   removeUbiquitousContentAndPersistentStoreAtURL:storeURL
                                                          options:options
                                                            error:&error];
```

Managing iCloud Content

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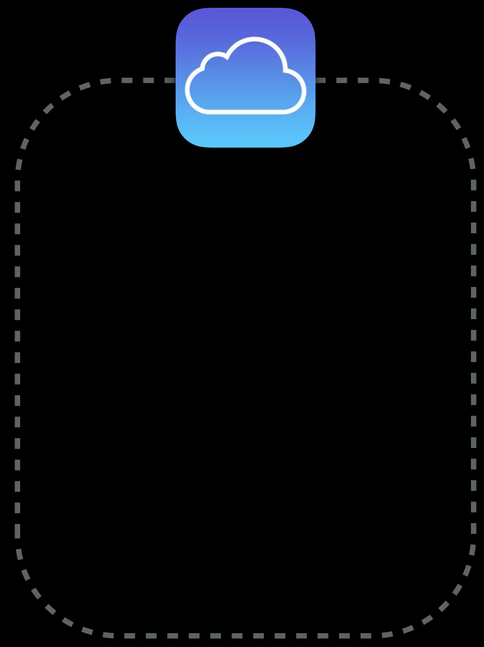


NSPersistentStoreCoordinator Notifications

- NSPersistentStoreCoordinatorStoresWillChangeNotification
  - Only posted for iCloud Stores

NSPersistentStoreCoordinator Notifications

- NSPersistentStoreCoordinatorStoresWillChangeNotification
  - Only posted for iCloud Stores

```
NSDictionary *userInfo = @{
    NSAddedPersistentStoresKey: @[store],
    NSRemovedPersistentStoresKey: @[store]
};
```

NSPersistentStoreCoordinator Notifications

NSPersistentStoreCoordinator Notifications

```
NSNotificationCenter *dc = [NSNotificationCenter defaultCenter];
[dc addObserver:self
       selector:@selector(storesWillChange:)
           name:NSPersistentStoreCoordinatorStoresWillChangeNotification
         object:pscOrNil];
```

NSPersistentStoreCoordinator Notifications

```
NSNotificationCenter *dc = [NSNotificationCenter defaultCenter];
[dc addObserver:self
       selector:@selector(storesWillChange:)
           name:NSPersistentStoreCoordinatorStoresWillChangeNotification
         object:pscOrNil];

[dc addObserver:self
       selector:@selector(storesDidChange:)
           name:NSPersistentStoreCoordinatorStoresDidChangeNotification
         object:pscOrNil];
```

NSPersistentStoreCoordinator Notifications

NSPersistentStoreCoordinator Notifications

```
NSManagedObjectContext *moc = nil;
- (void)storesWillChange:(NSNotification *)n {
    if ([moc hasChanges]) {
        [moc save:&error];
    }

    [moc reset];
    //reset user interface
}
```

NSPersistentStoreCoordinator Notifications

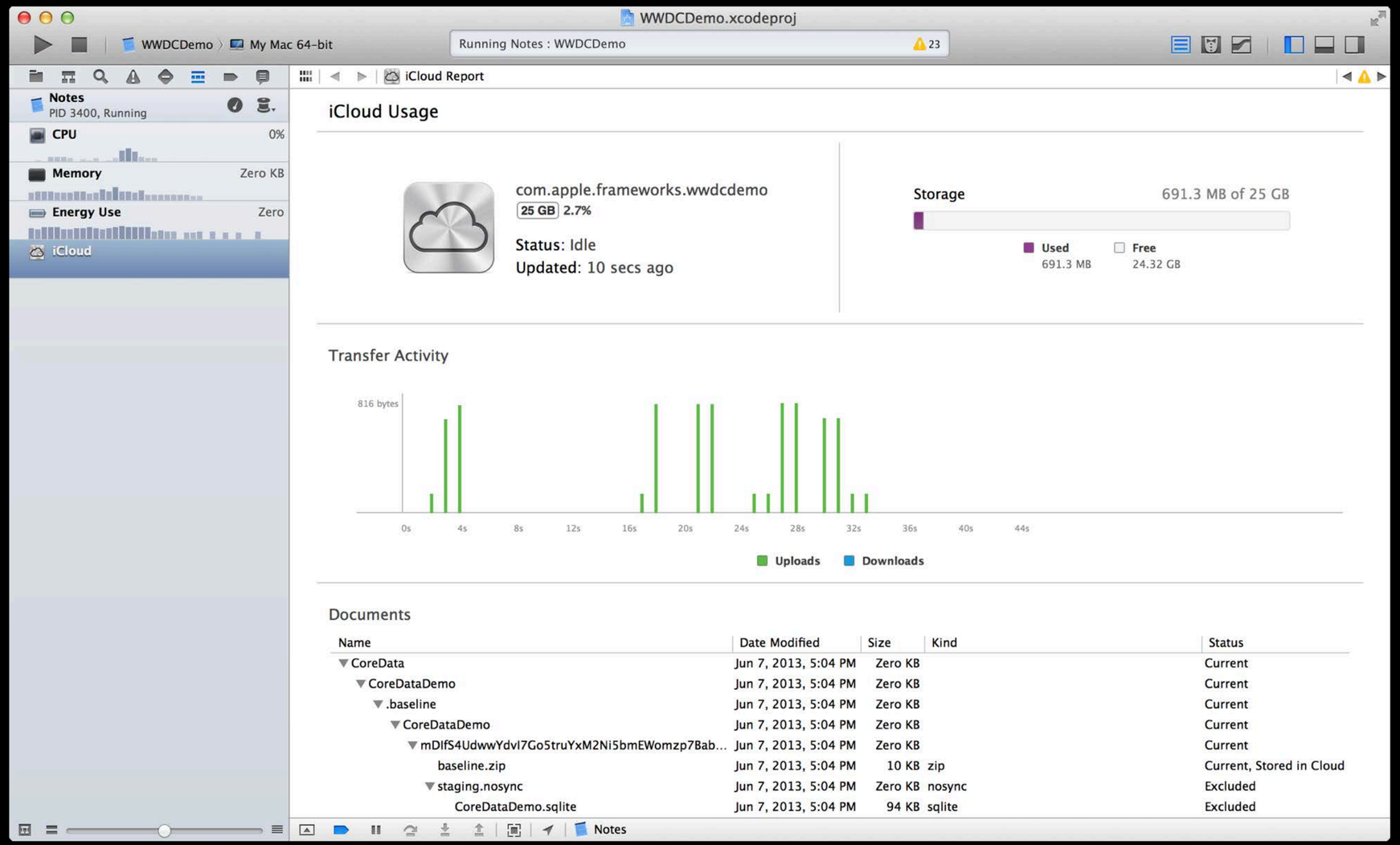
```
NSManagedObjectContext *moc = nil;
- (void)storesWillChange:(NSNotification *)n {
    if ([moc hasChanges]) {
        [moc save:&error];
    }

    [moc reset];
    //reset user interface
}

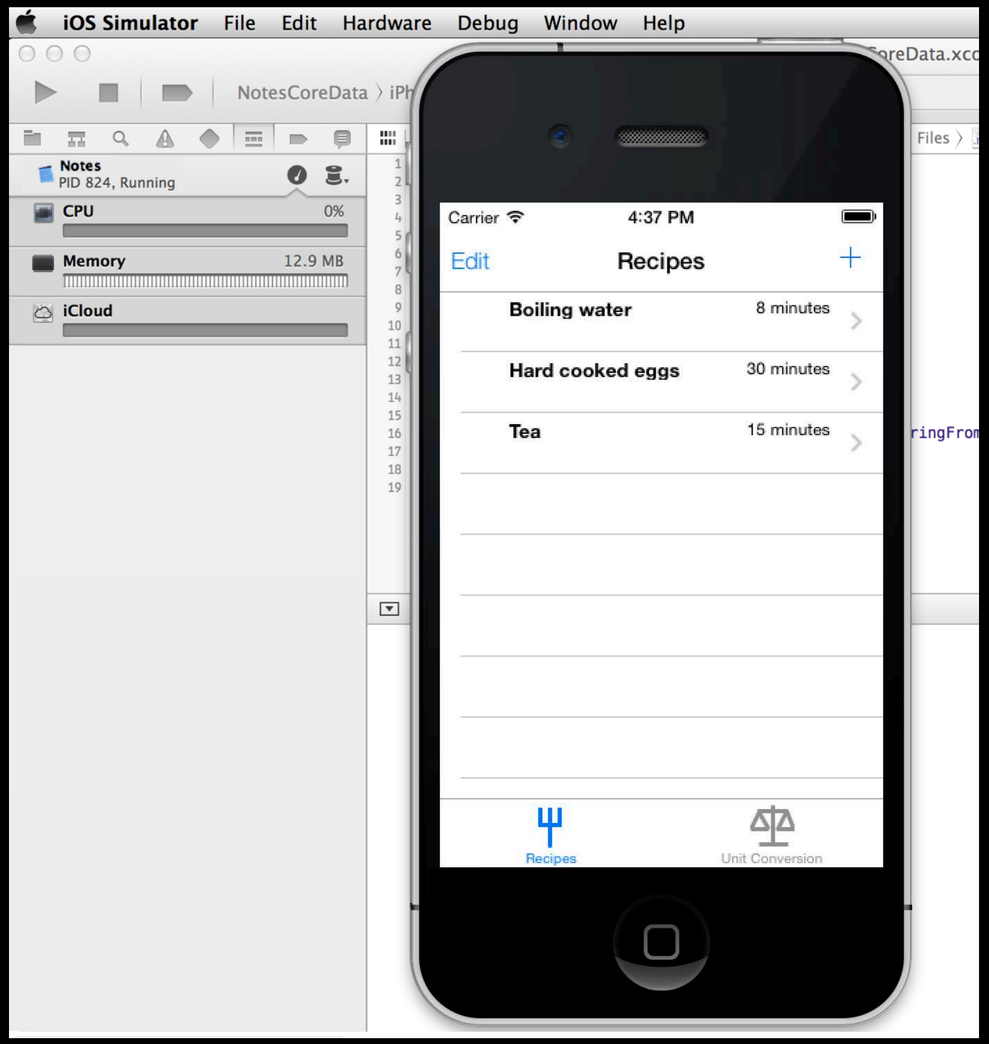
- (void)storesDidChange:(NSNotification *)n {
    //refresh user interface
}
```

Living on iCloud

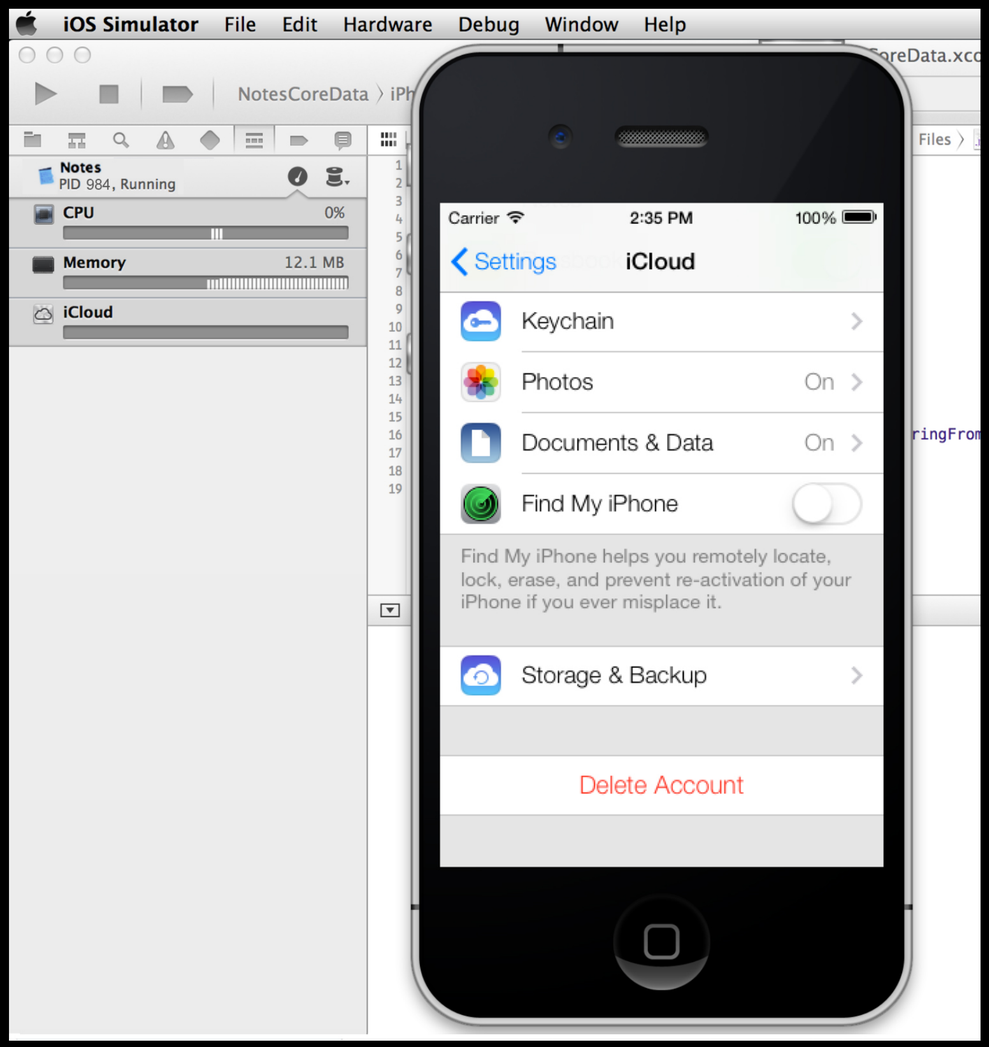
Xcode Debugging Pane



iOS Simulator Support



iOS Simulator Support



iOS Simulator Support

iOS Simulator Support

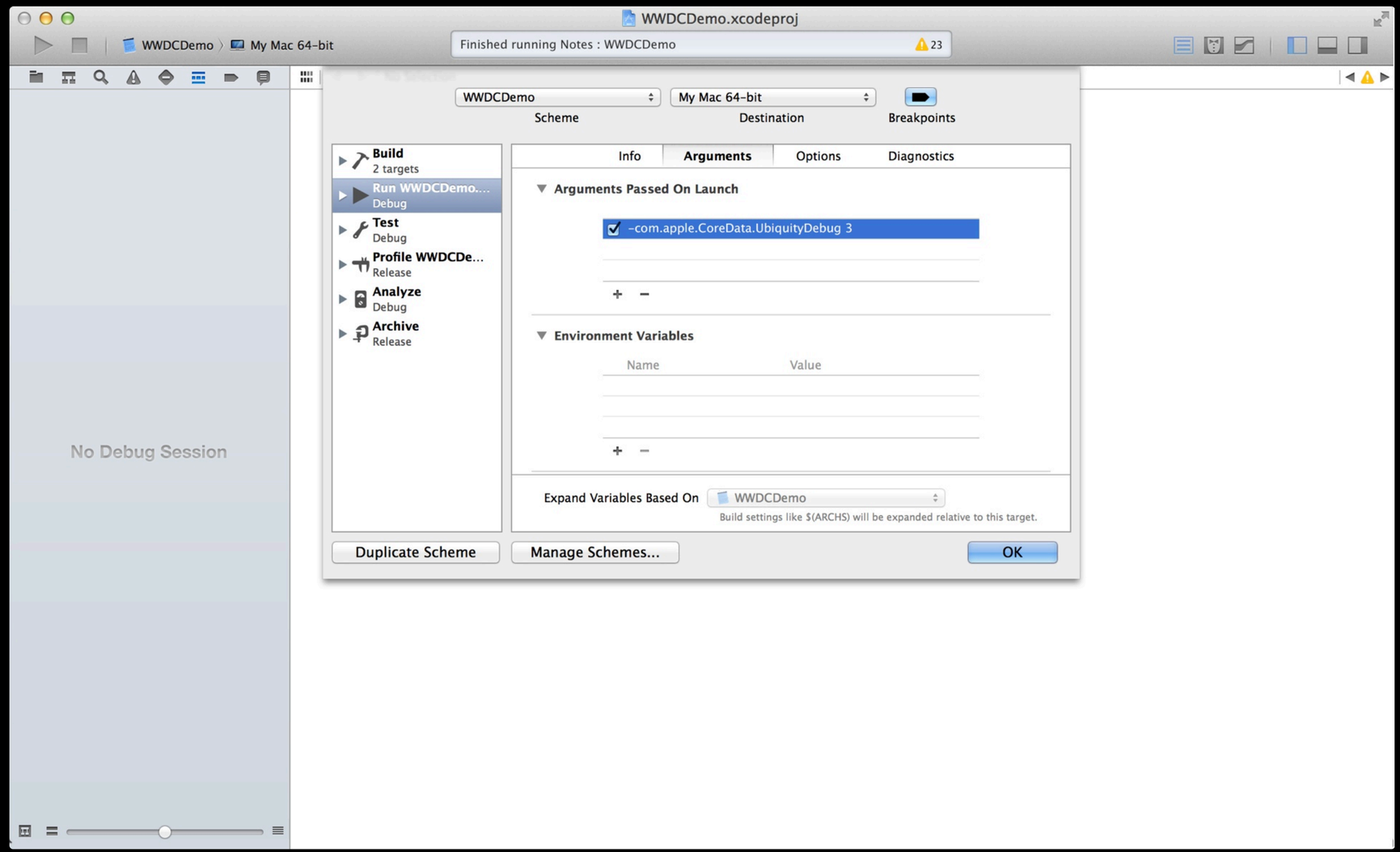
- iCloud Document Storage
- iCloud Key Value Store
- Push notifications

iCloud Logging

iCloud Logging

- Core Data Logging
  - NSUserDefaults
  - -com.apple.coredata.ubiquity.logLevel 3
  - -com.apple.CoreData.SQLDebug 1

Core Data Logging



iCloud Logging

iCloud Logging

- OS X

iCloud Logging

- OS X
  - ubcontrol tool

iCloud Logging

- OS X
  - ubcontrol tool
  - $ ubcontrol -k 7

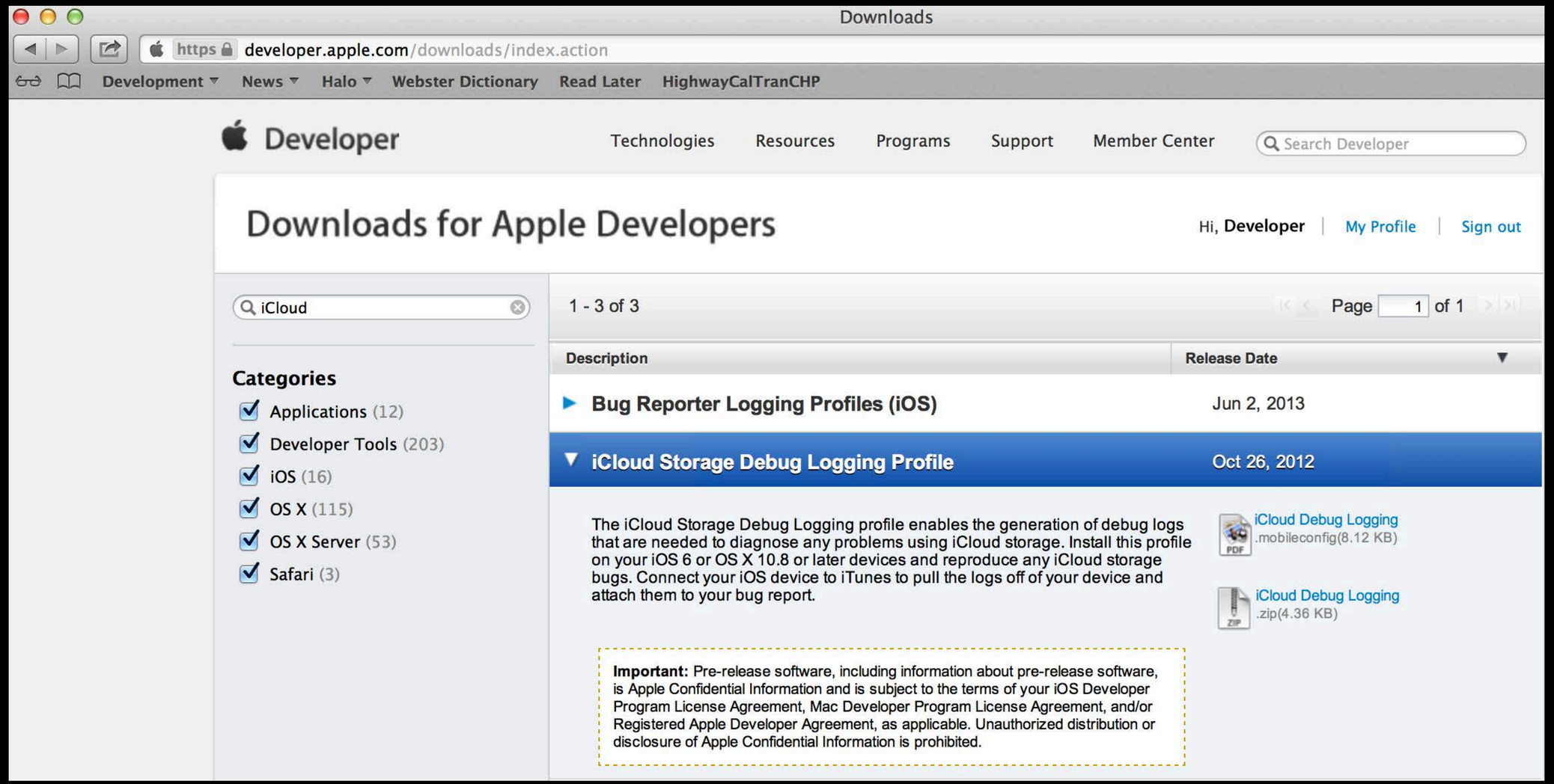
iCloud Logging

- OS X
  - ubcontrol tool
  - $ ubcontrol -k 7
- iOS

iCloud Logging

- OS X
  - ubcontrol tool
  - $ ubcontrol -k 7
- iOS
  - iCloud Debug Provisioning profile

iCloud Logging Profile



Installing Profile On iOS

Installing Profile On iOS

- Download and unzip the profile from developer.apple.com/downloads
- Email file to yourself
- On iOS
  - Tap attachment in email
  - Follow instructions to install
  - Reboot your iOS device

Retrieving Logs From iOS

Retrieving Logs From iOS

- Sync your iOS device directly with iTunes
- Gather logs from
  - ~/Library/Logs/CrashReporter/MobileDevice/device-name/DiagnosticLogs

Demo

Melissa Turner
Core Data Software Engineer

Core Data SQLite Store

Ben Trumbull
Core Data Engineering Manager

SQLite Store Database Journaling

- Core Data switched default journaling in iOS 7 and 10.9
  - Original SQLite rollback journaling
  - SQLite Write Ahead Logging (WAL)
  - WAL default for applications rebuilt on newer OS

What's the Difference?

- Rollback journaling
  - Copies original pages to -journal file
  - Updates main db file in place
  - Deletes -journal on commit

What's the Difference?

- Write ahead logging
  - Leaves main db file untouched
  - Appends transactions to -wal file
  - Uses -shm file to track which pages are in which file
  - Performs a checkpoint operation to merge the -wal into main file

Rollback Journaling Behavior

SQLite Store

main db file

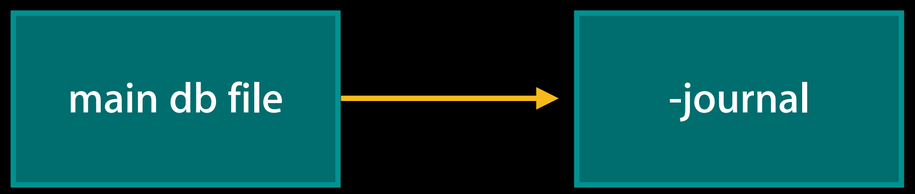
Rollback Journaling Behavior

SQLite Store

Begin Transaction

Rollback Journaling Behavior

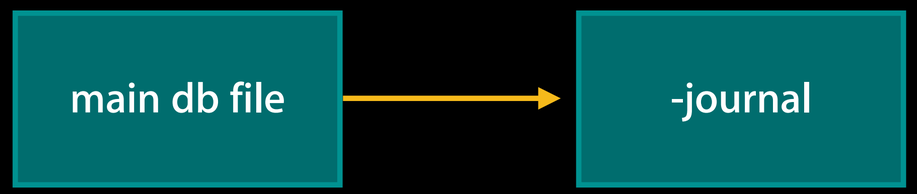
SQLite Store



Begin Transaction

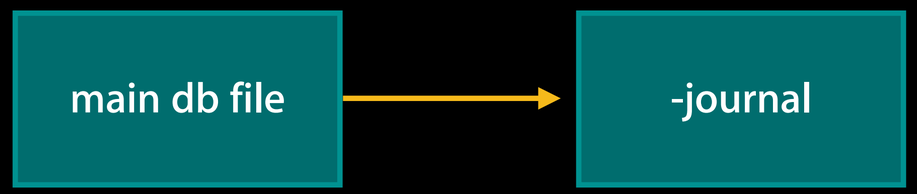
Rollback Journaling Behavior

SQLite Store



Rollback Journaling Behavior

SQLite Store



Commit Transaction

Rollback Journaling Behavior

SQLite Store

main db file

Commit Transaction

Rollback Journaling Behavior

SQLite Store

main db file

WAL Journaling Behavior

SQLite Store

main db file

-shm

-wal

WAL Journaling Behavior

SQLite Store

main db file

-shm

-wal

Begin Transaction

WAL Journaling Behavior

Begin Transaction

WAL Journaling Behavior

WAL Journaling Behavior

Commit Transaction

WAL Journaling Behavior

SQLite Store

main db file

-shm

-wal

Commit Transaction

WAL Journaling Behavior

SQLite Store

main db file

-shm

-wal

WAL Journaling Behavior

SQLite Store

main db file

-shm

-wal

Checkpoint Operation

WAL Journaling Behavior

Checkpoint Operation

WAL Journaling Behavior

SQLite Store

main db file

-shm

-wal

WAL Journaling Behavior

SQLite Store

main db file

-shm

WAL Journaling Behavior

SQLite Store

main db file

-shm

-wal

WAL Journaling Benefits

- Improved reliability across kernel panics and power loss
- Improved performance
  - Minimizes file system sync overhead, especially on iOS
- Improved concurrency
  - Multiple readers **and** one writer
- System wide adoption

Concurrency

- WAL databases support a writer concurrently with readers
- NSPersistentStoreCoordinator serializes all its requests
- Maximizing concurrency requires two Core Data stacks

Leveraging WAL Concurrency

Main UI stack

Background import stack

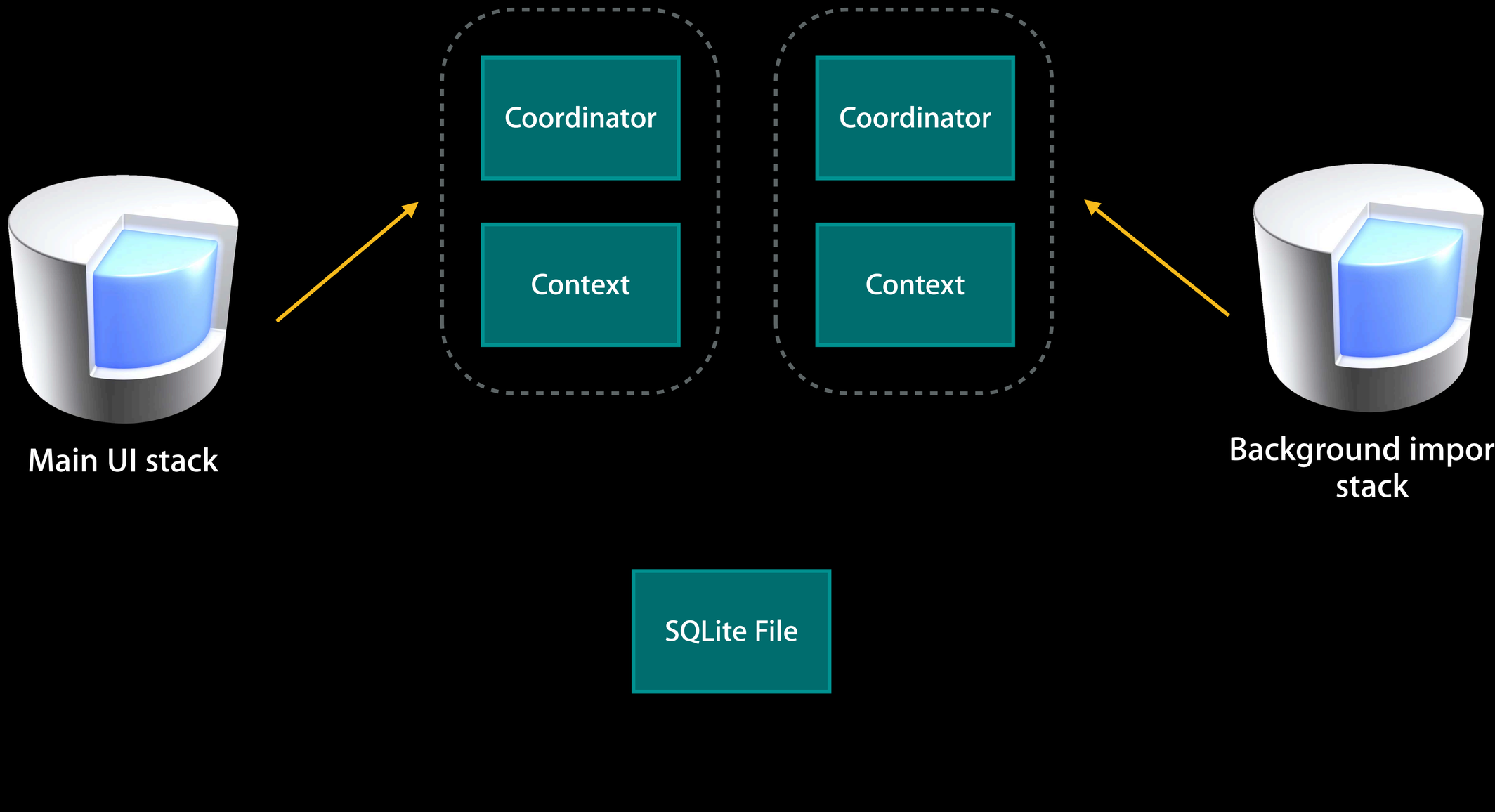
Leveraging WAL Concurrency

Main UI stack

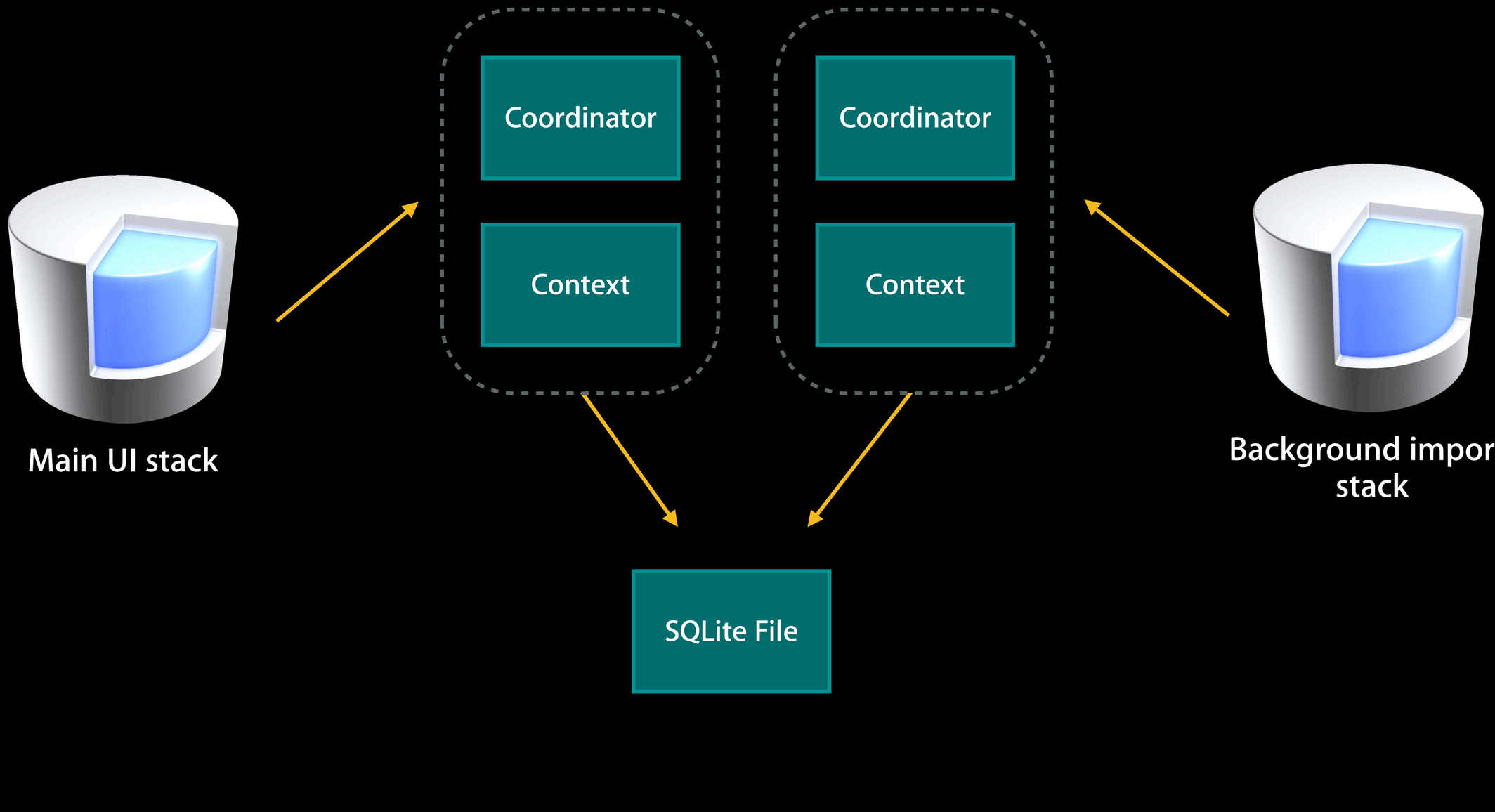
SQLite File

Background import stack

Leveraging WAL Concurrency



Leveraging WAL Concurrency



Using Multiple NSPersistentStoreCoordinators

- Cannot pass objects between NSPersistentStoreCoordinators
  - Including objectIDs
  - Use -URIRepresentation instead
- Excellent for background updates
  - Importing data
  - Batch changes
- Allows UI to perform reads without blocking
  - Especially useful for responsiveness on launch

Sharp Edges with WAL

- Not recommended for files you moved around
- Not recommended for read only files
- Not recommended as document format without a package wrapper
- First introduced in 10.7

Setting Old Behavior

- WAL default for applications rebuilt for iOS 7 and 10.9
- Classic behavior is “pragma journal_mode=DELETE”
- Set in options dictionary to -addPersistentStoreWithType:

Setting Old Behavior

- WAL default for applications rebuilt for iOS 7 and 10.9
- Classic behavior is “pragma journal_mode=DELETE”
- Set in options dictionary to -addPersistentStoreWithType:

```
NSDictionary* storeOptions = @{ NSSQLitePragmaOptions : @{ @”journal_mode” :
@”DELETE” } };
```

General SQLite Caveats

- Never use file system routines directly on open db files
  - Bypassing SQLite APIs is hazardous
- Network file systems
  - No cache coherency between machines
- Avoid changing pragma synchronous behavior
  - Apple customizes its behavior

Other Enhancements

- Improvements with lock contention
- Power management changes
  - Integration with I/O throttling
- Guarded file descriptors

More Information

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Cocoa Feedback
cocoa-feedback@apple.com

Core Data Documentation
Programming Guides, Examples, Tutorials
http://developer.apple.com/

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

Related Sessions

Core Data Performance Optimization and Debugging	Nob Hill Wednesday 2:00PM
Hidden Gems in Cocoa and Cocoa Touch	Nob Hill Friday 10:15AM

Labs

Core Data Lab	Services Lab B Wednesday 3:15PM
iCloud Lab	Tools Lab C Thursday 9:00AM
Core Data Lab	Frameworks Lab A Thursday 2:00PM
Core Data Lab	Services Lab A Friday 9:00AM

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