iPhone Application Programming
Lecture 09: Data Persistence

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RWTH Aachen University

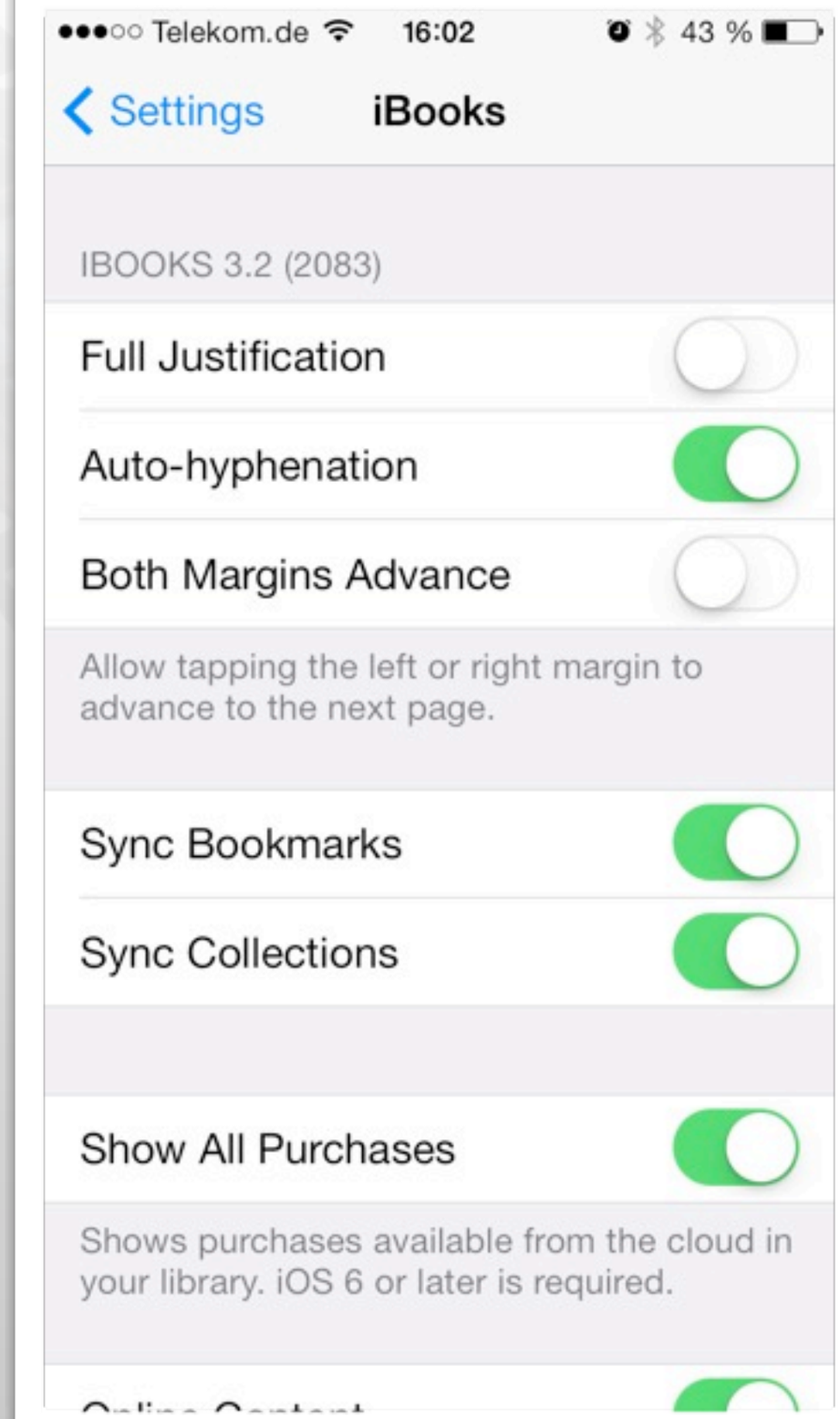
Winter Semester 2013/2014

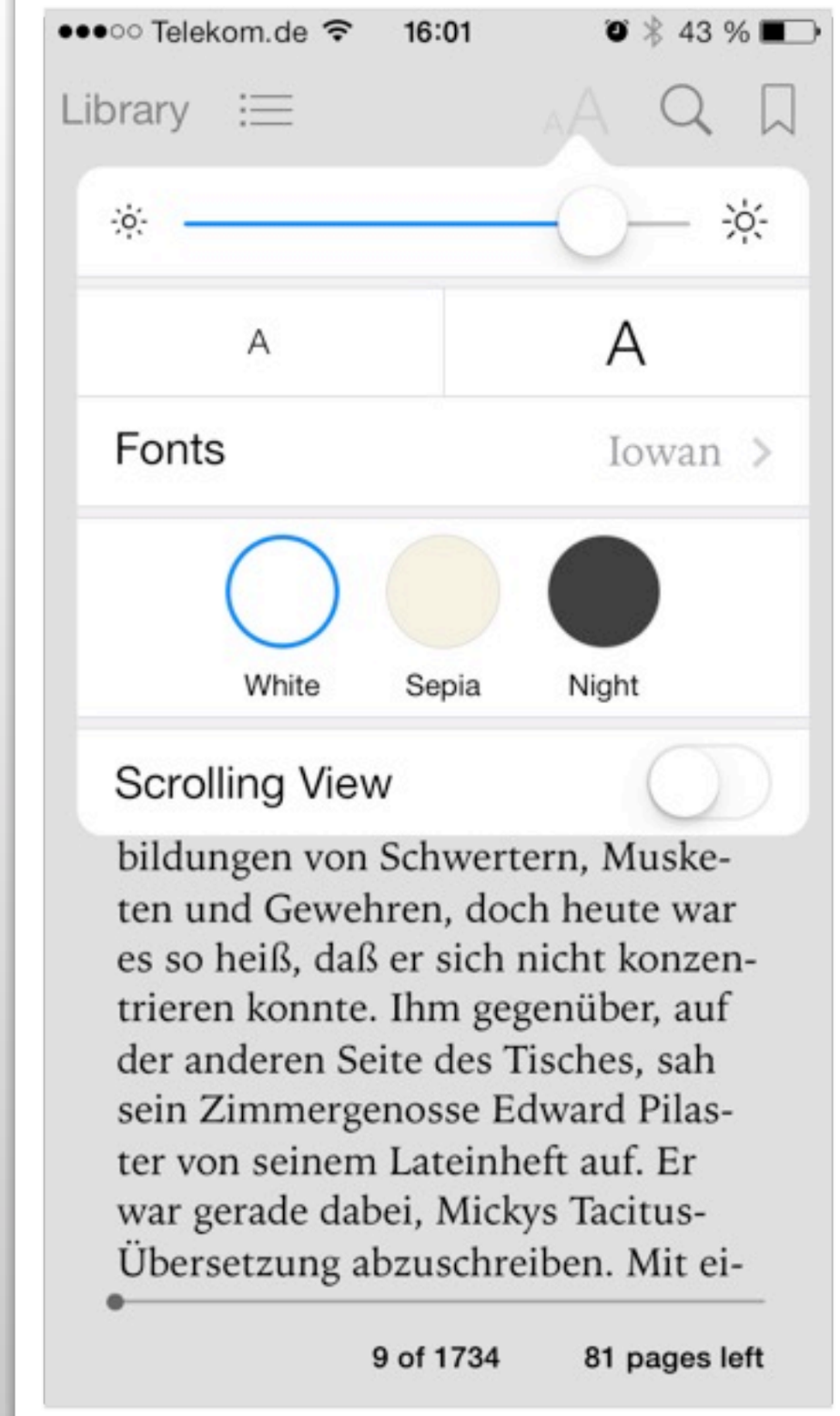
http://hci.rwth-aachen.de/iphone

RWTH AACHEN UNIVERSITY

What data do we have on devices?

How do we present data to the user?


Telekom.de 16:02 43 %
Settings
iBooks
IBOOKS 3.2 (2083)
Full Justification
Auto-hyphenation
Both Margins Advance
Allow tapping the left or right margin to advance to the next page.
Sync Bookmarks
Sync Collections
Show All Purchases
Shows purchases available from the cloud in your library. iOS 6 or later is required.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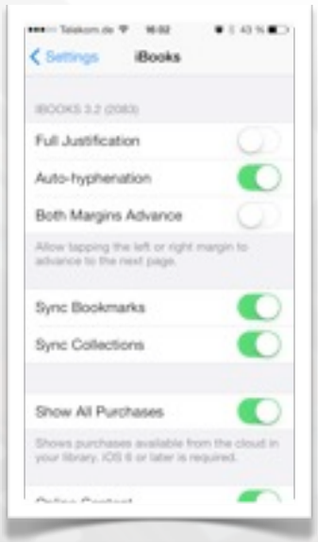
Scrolling View
bildungen von Schwertern, Musketen und Gewehren, doch heute war es so heiß, daß er sich nicht konzentrieren konnte. Ihm gegenüber, auf der anderen Seite des Tisches, sah sein Zimmergenosse Edward Pilaster von seinem Lateinheft auf. Er war gerade dabei, Mickys Tacitus-Übersetzung abzuschreiben. Mit ei-
9 of 1734
81 pages left


Settings
iBooks
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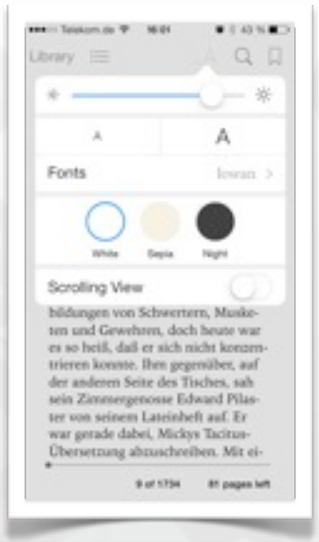
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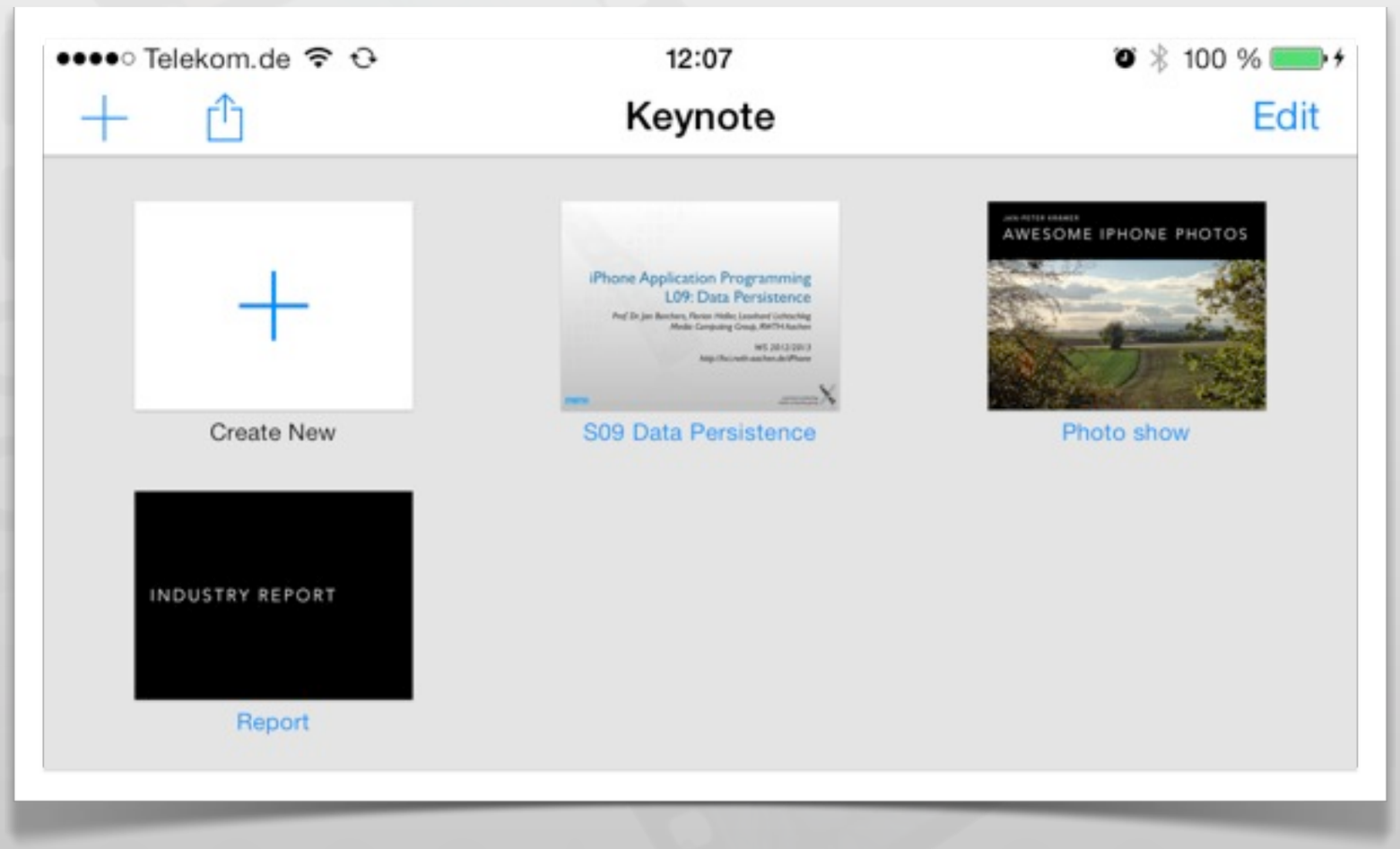
Scrolling View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12:07
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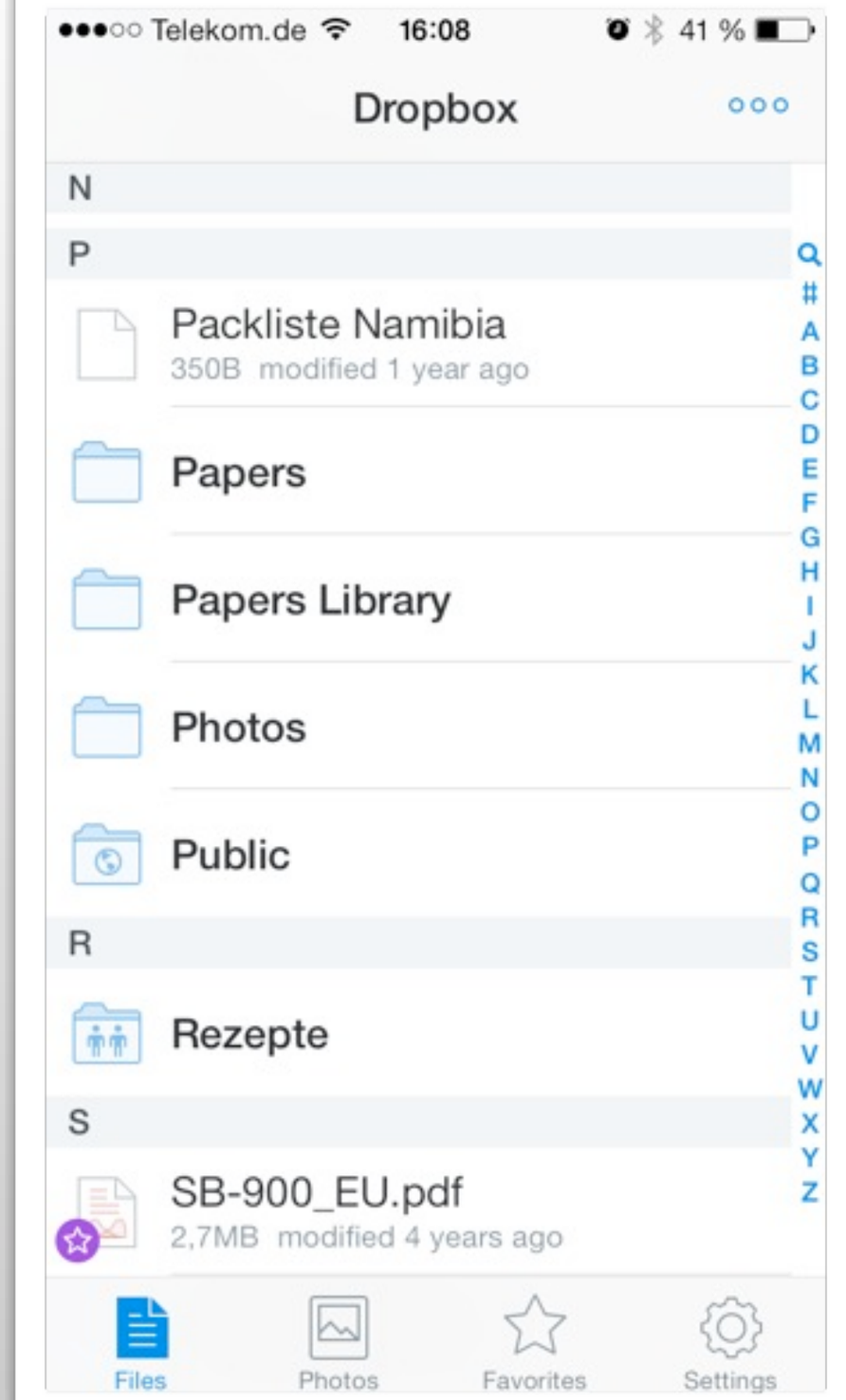
Keynote
Edit
Create New
iPhone Application Programming
L09: Data Persistence
S09 Data Persistence
AWESOME IPHONE PHOTOS
Photo show
INDUSTRY REPORT
Report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41 %
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Files
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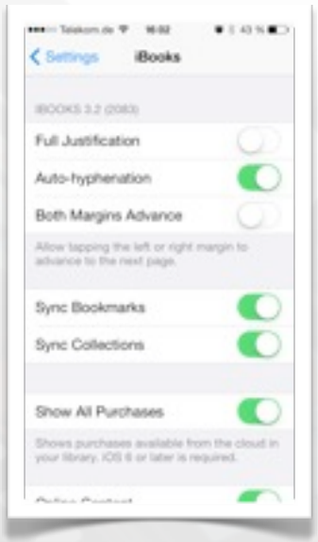
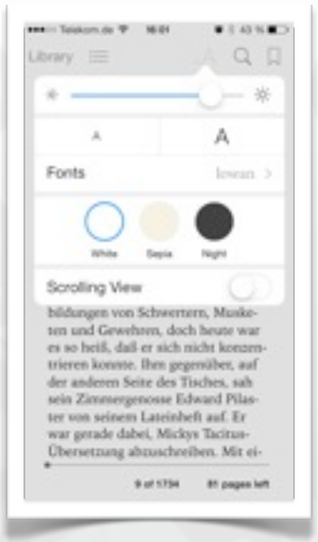
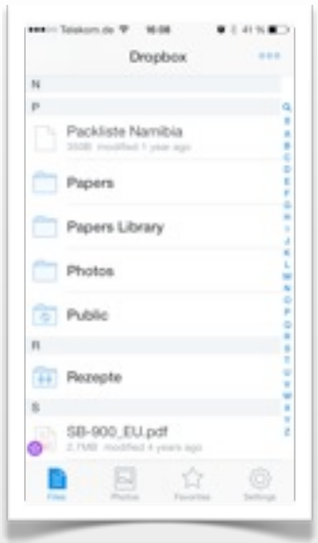
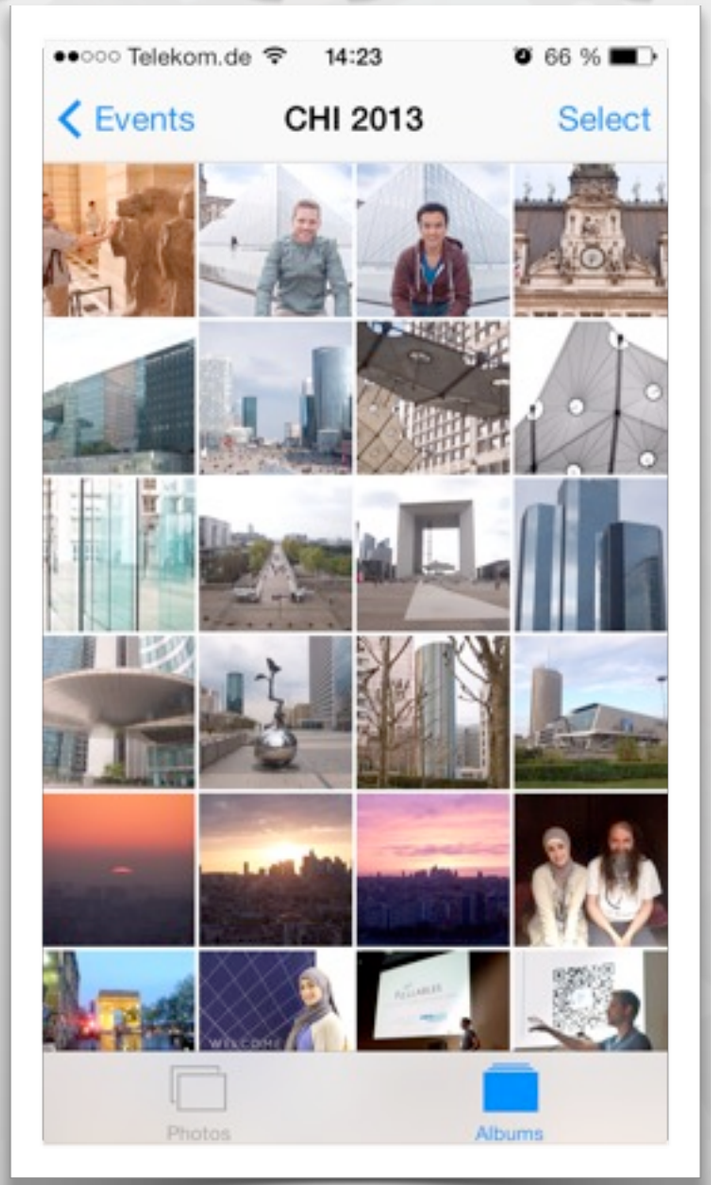
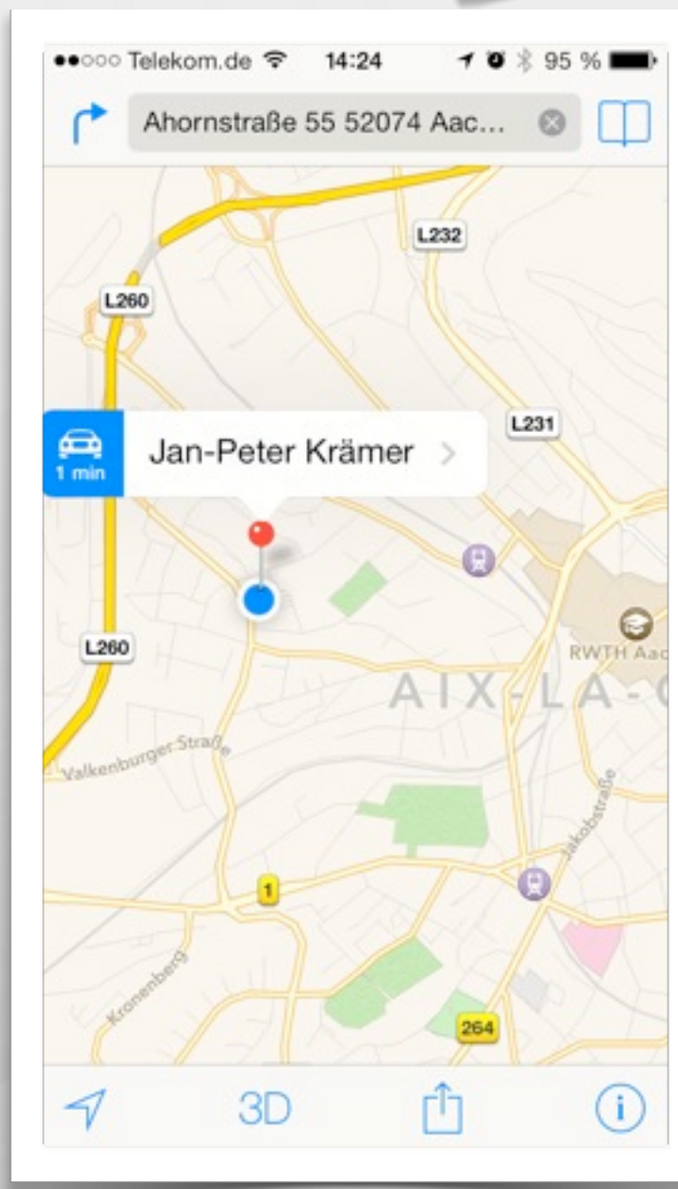
Settings



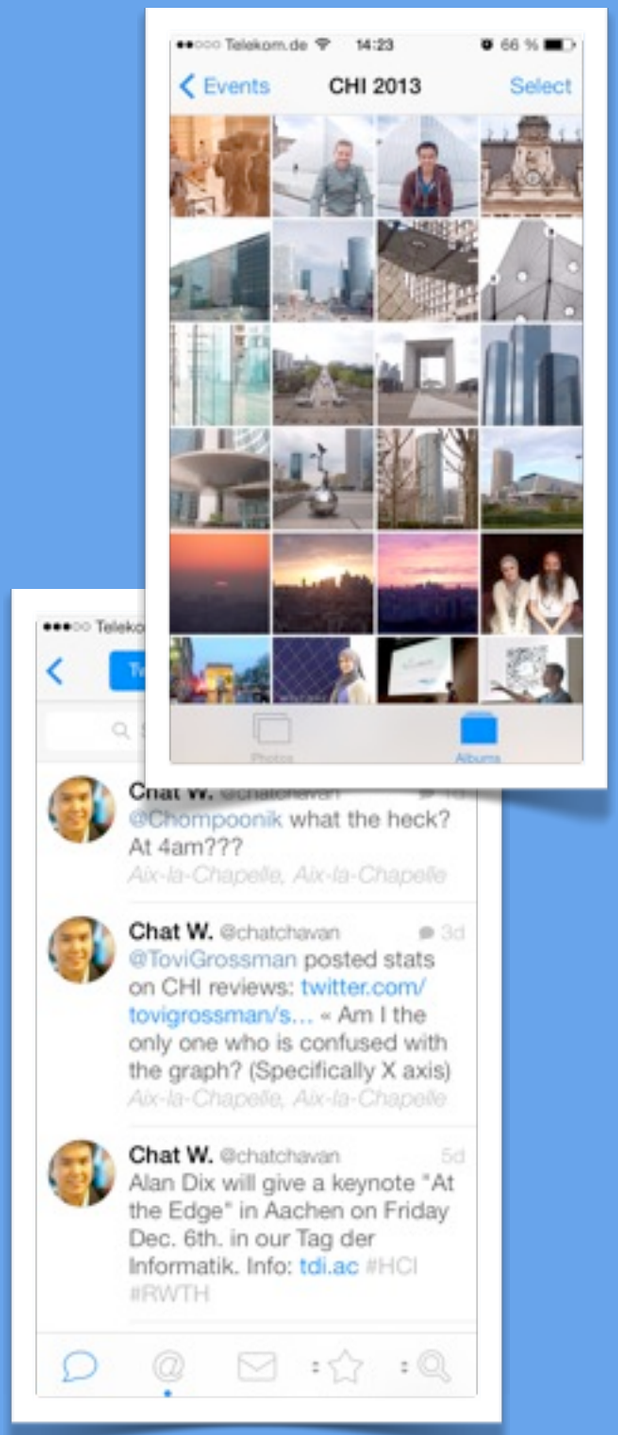




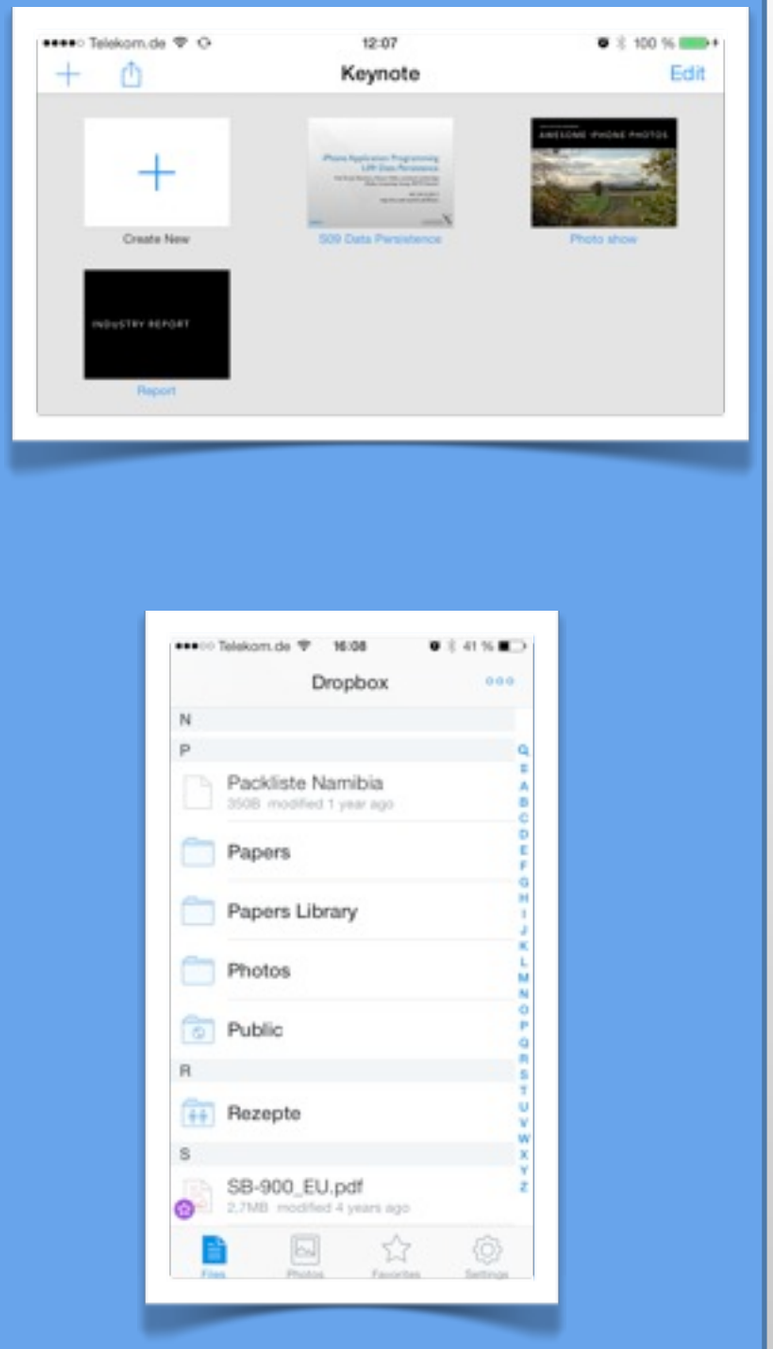




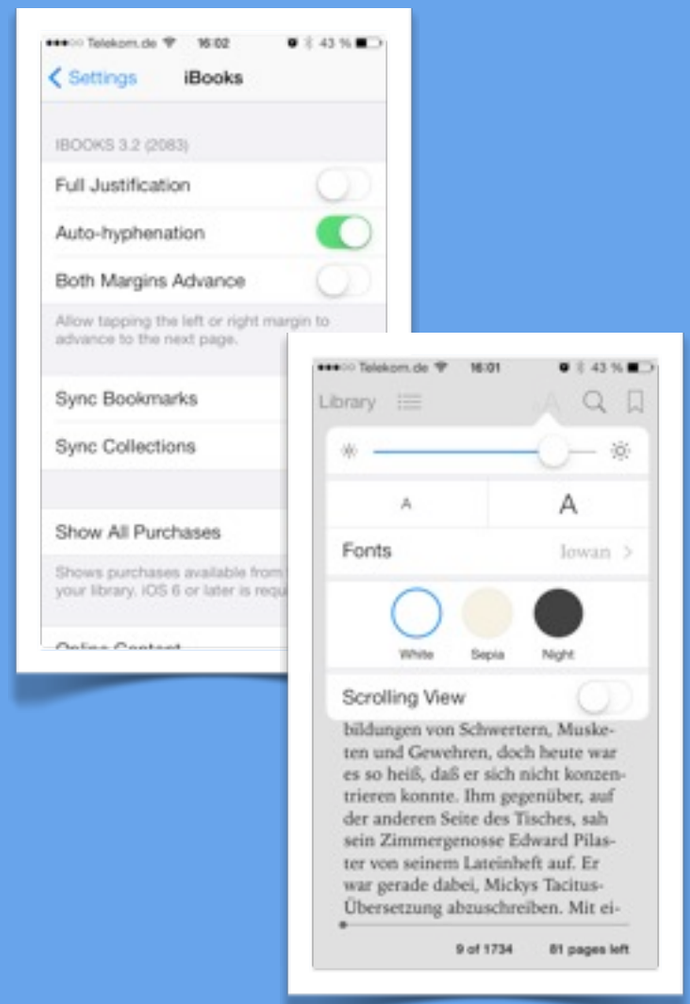
“Shoebox”



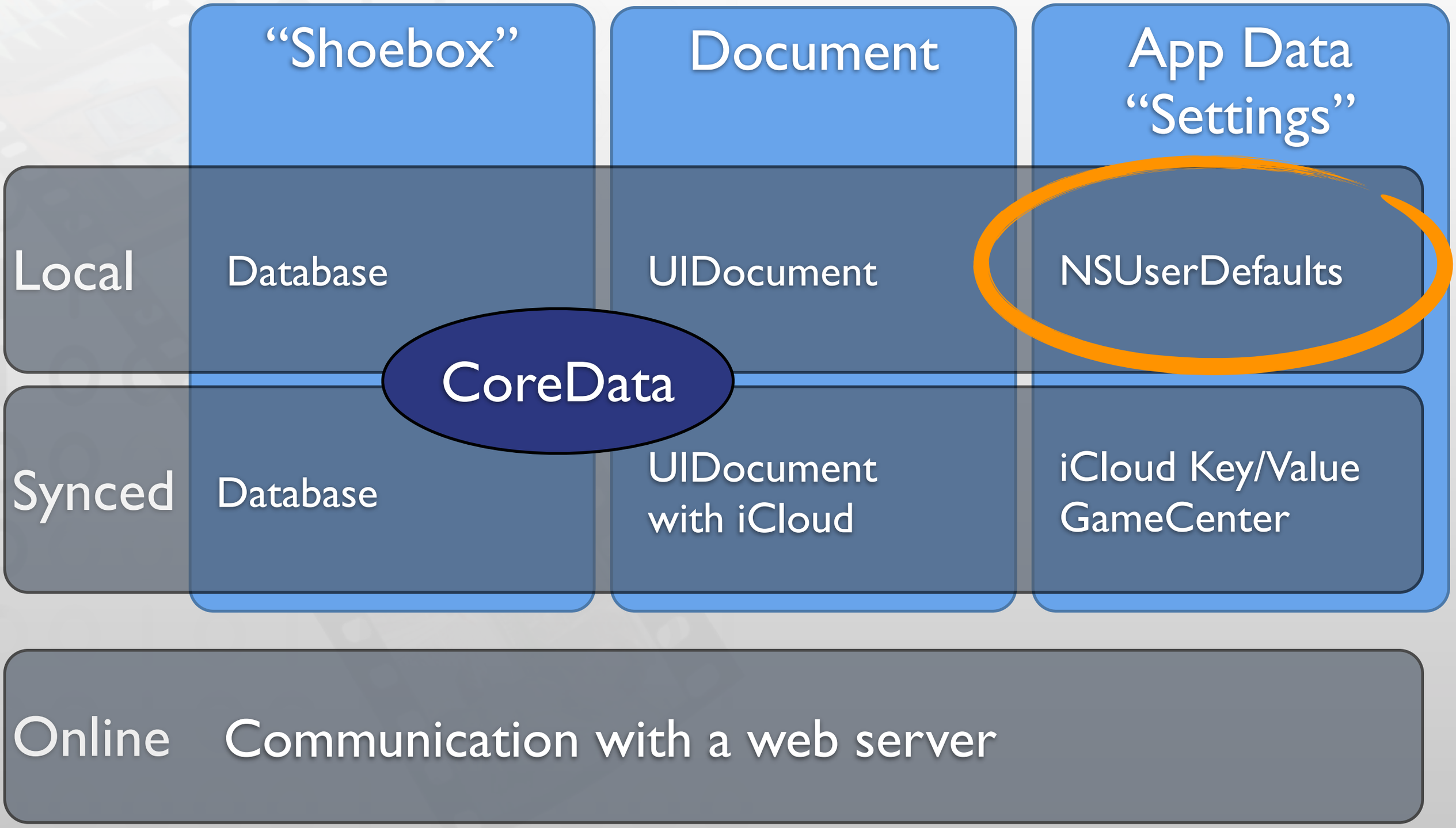
“Documents”



“Settings”



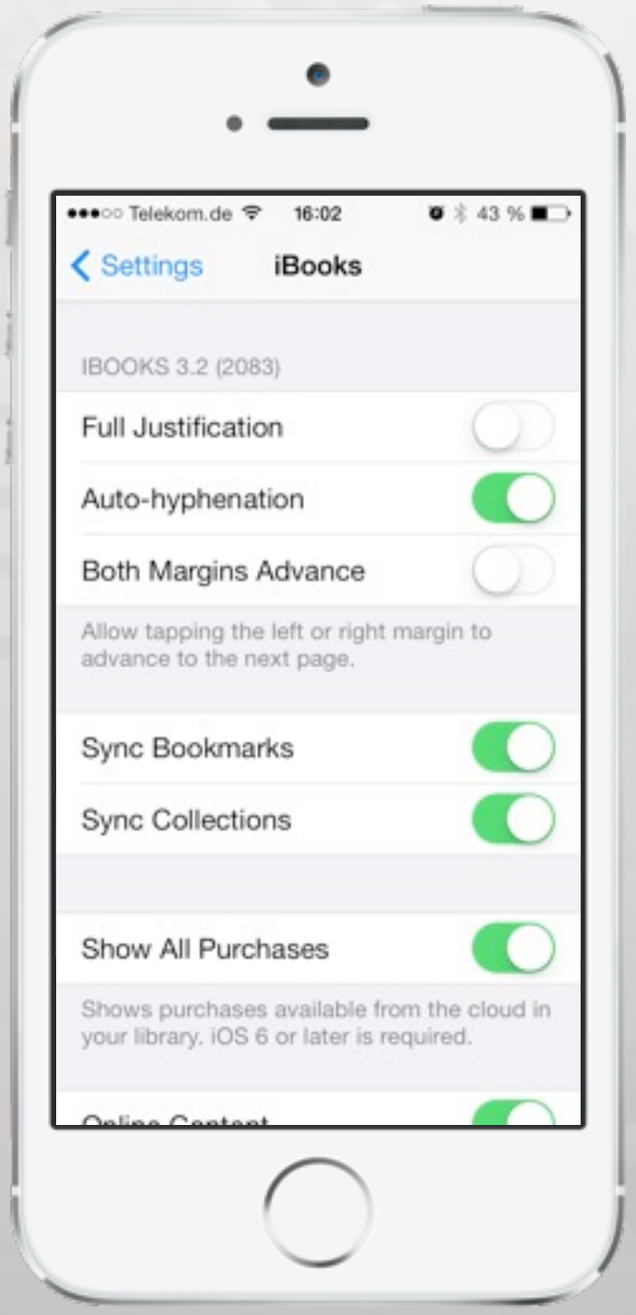
Data Handling Overview



Preferences and Settings

- NSUserDefaults
  - Singleton
  - Key/value pairs
  - Provides standard values (factory defaults)
- Settings Bundle
  - Describes preferences managed in settings
  - Same keys as in NSUserDefaults

Preferences and Settings



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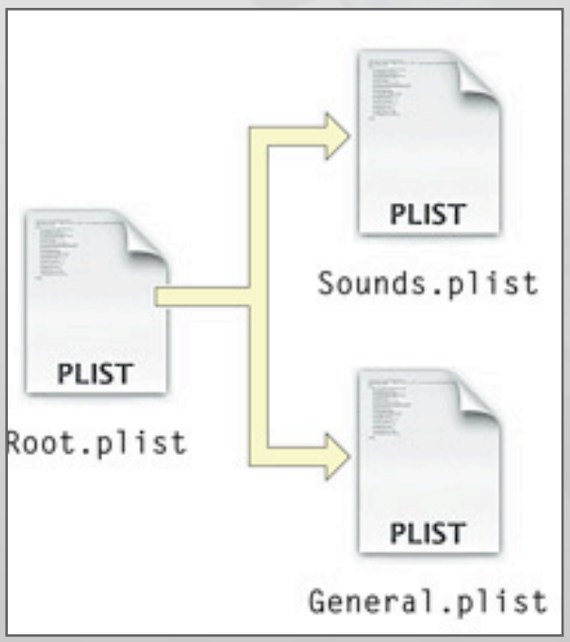
Preferences and Settings



NSUserDefaults

Application

Demo

Data Handling Overview

	"Shoebox"	Document	App Data "Settings"
Local	Database	UIDocument	NSUserDefaults
Synced	Database	UIDocument with iCloud	iCloud Key/Value GameCenter

Online Communication with a web server

Where to put files?

```
- (NSURL *) localDocumentsDirectoryURL
{
  static NSURL *localDocumentsDirectoryURL = nil;
  if (localDocumentsDirectoryURL == nil)
  {
    // use system function
    NSString *documentsDirectoryPath =
          [NSSearchPathForDirectoriesInDomains(NSDocumentDirectory,
                                NSUserDomainMask,
                                YES) objectAtIndex:0];

    localDocumentsDirectoryURL
                  = [NSURL fileURLWithPath:documentsDirectoryPath];
  }

  return localDocumentsDirectoryURL;
}
```

UIDocument

- High level API for file access
- Always represents a user document
- Can handle file packages
- Autosaving
- Undo
- Handles remote changes from iCloud
- UIManagedDocument for CoreData

Creating a new document

```
// creating a new document
self.document = [[UIDocument alloc] initWithFileURL:fileURL];
// document created in memory
[self.document saveToURL:self.document.fileURL
         forSaveOperation:UIDocumentSaveForCreating
        completionHandler:^(BOOL success)
  {
    // file created on disk
    if (success)
        [self displayFileContents];
  }];
```

```
// UIDocument
- (id) initWithFileURL:(NSURL *)url {
    self = [super initWithFileURL:url];
    if (self)
       self.textcontents = @"Hello world!";
    return self;
}
```

Saving a UIDocument

- gets saved when file is closed *or*
- autosaved when changes are pending
  - NSUndoManager
  - or call updateChangeCount:

```
// Return NSData representation for saving
- (id) contentsForType:(NSString *)typeName
                 error:(NSError **)outError
{
  NSData *data = [self.contents dataUsingEncoding:
                                NSUTF8StringEncoding];
  return data;
}
```

Data Handling Overview

	"Shoebox"	Document	App Data "Settings"
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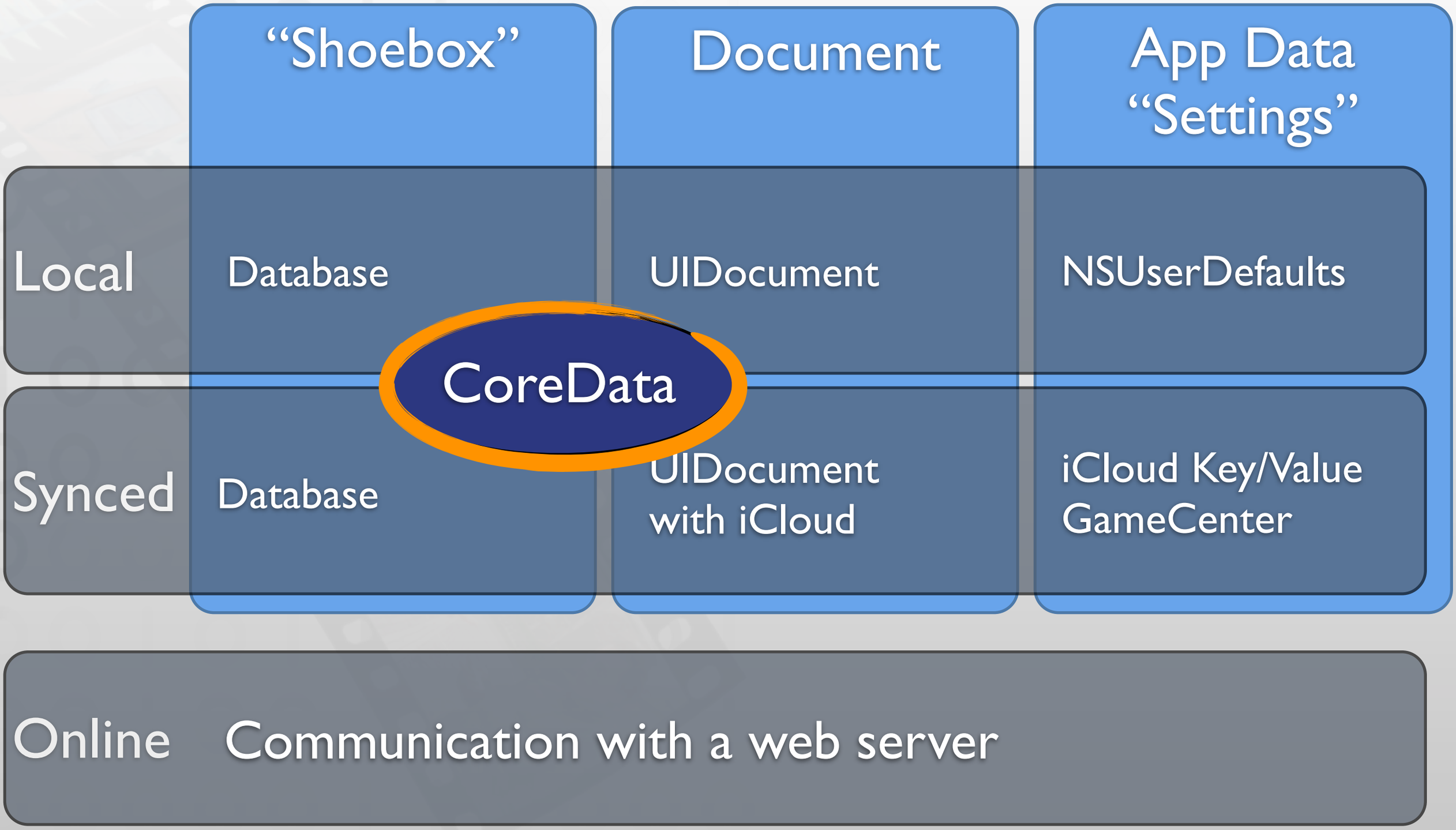
Online Communication with a web server

SQLite

Data Handling Overview

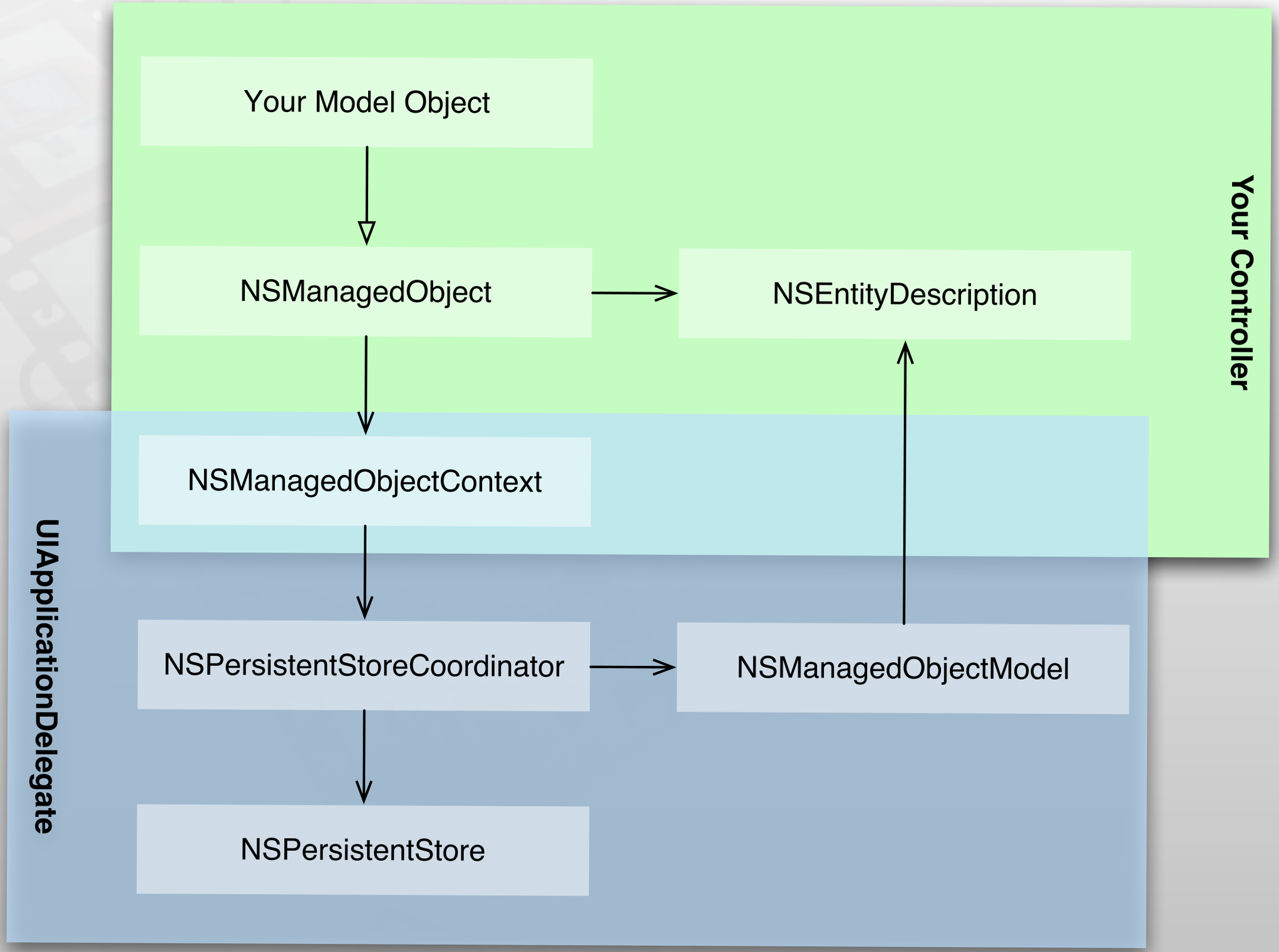


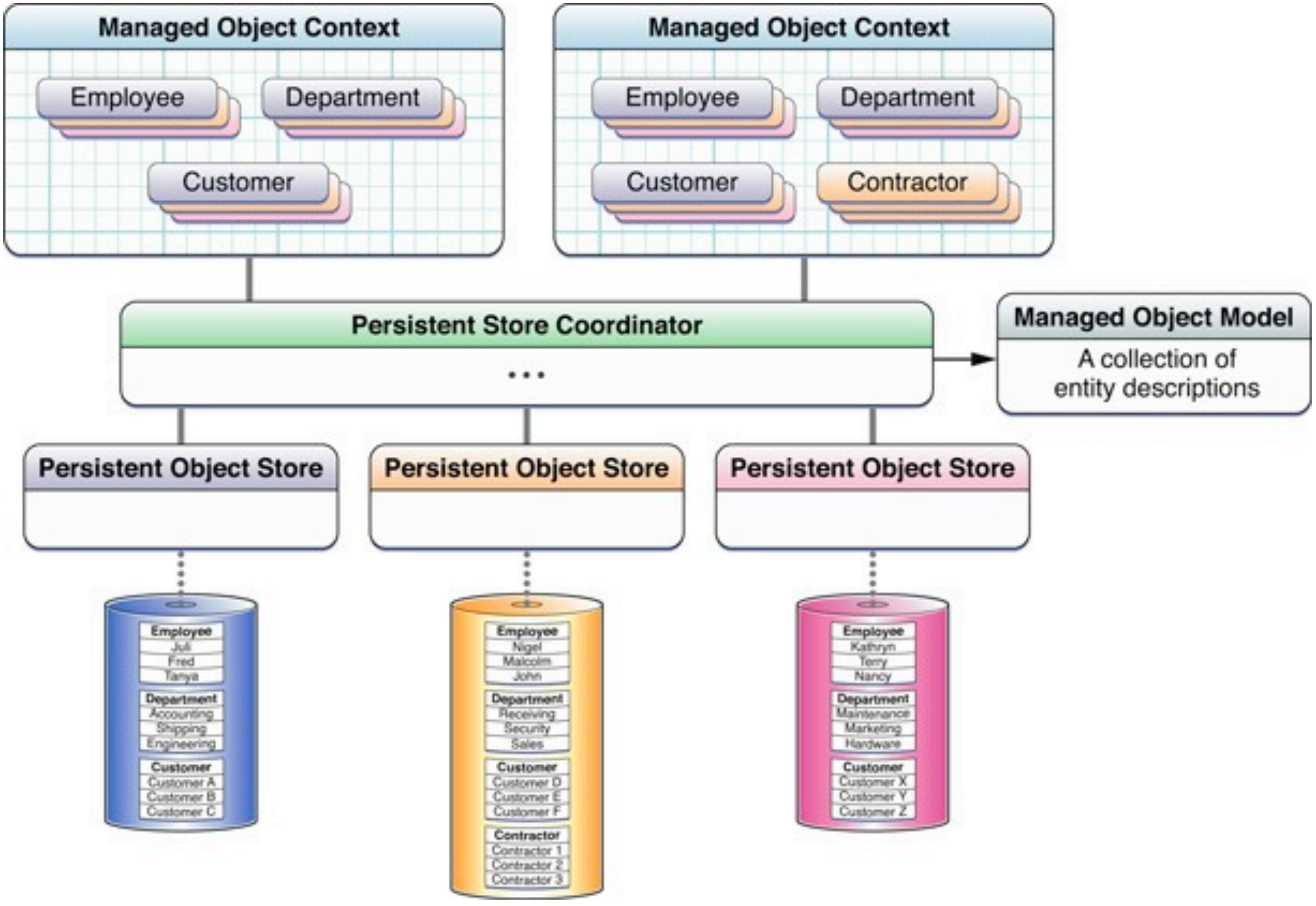
Core Data

Core Data

- High level relational data storage
- Automatic persistence
- High performance access
- Get undo/redo for free
- Available data stores
  - Memory
  - Binary file
  - SQLite

Core Data Stack




Managed Object Context
Employee
Department
Customer
Managed Object Context
Employee
Department
Customer
Contractor
Persistent Store Coordinator
...
Managed Object Model
A collection of entity descriptions
Persistent Object Store
Persistent Object Store
Persistent Object Store
Employee
Juli
Fred
Tanya
Department
Accounting
Shipping
Engineering
Customer
Customer A
Customer B
Customer C
Employee
Nigel
Malcolm
John
Department
Receiving
Security
Sales
Customer
Customer D
Customer E
Customer F
Contractor
Contractor 1
Contractor 2
Contractor 3
Employee
Kathryn
Terry
Nancy
Department
Maintenance
Marketing
Hardware
Customer
Customer X
Customer Y
Customer Z

Recipes.xcdatamodel

Recipes.xcdatamodel ▸ Recipe

Entity	Abs	Class
Image	☐	NSManage
Ingredient	☐	Ingredient
Recipe	☐	Recipe
RecipeType	☐	NSManage

Property	Kind	Type or
image	Relationship	Image
ingredients	Relationship	Ingredient
instructions	Attribute	String
name	Attribute	String
overview	Attribute	String
prepTime	Attribute	String
thumbnailImage	Attribute	Transformable
type	Relationship	RecipeType

Relationship

Name: image

☑ Optional ☐ Transient

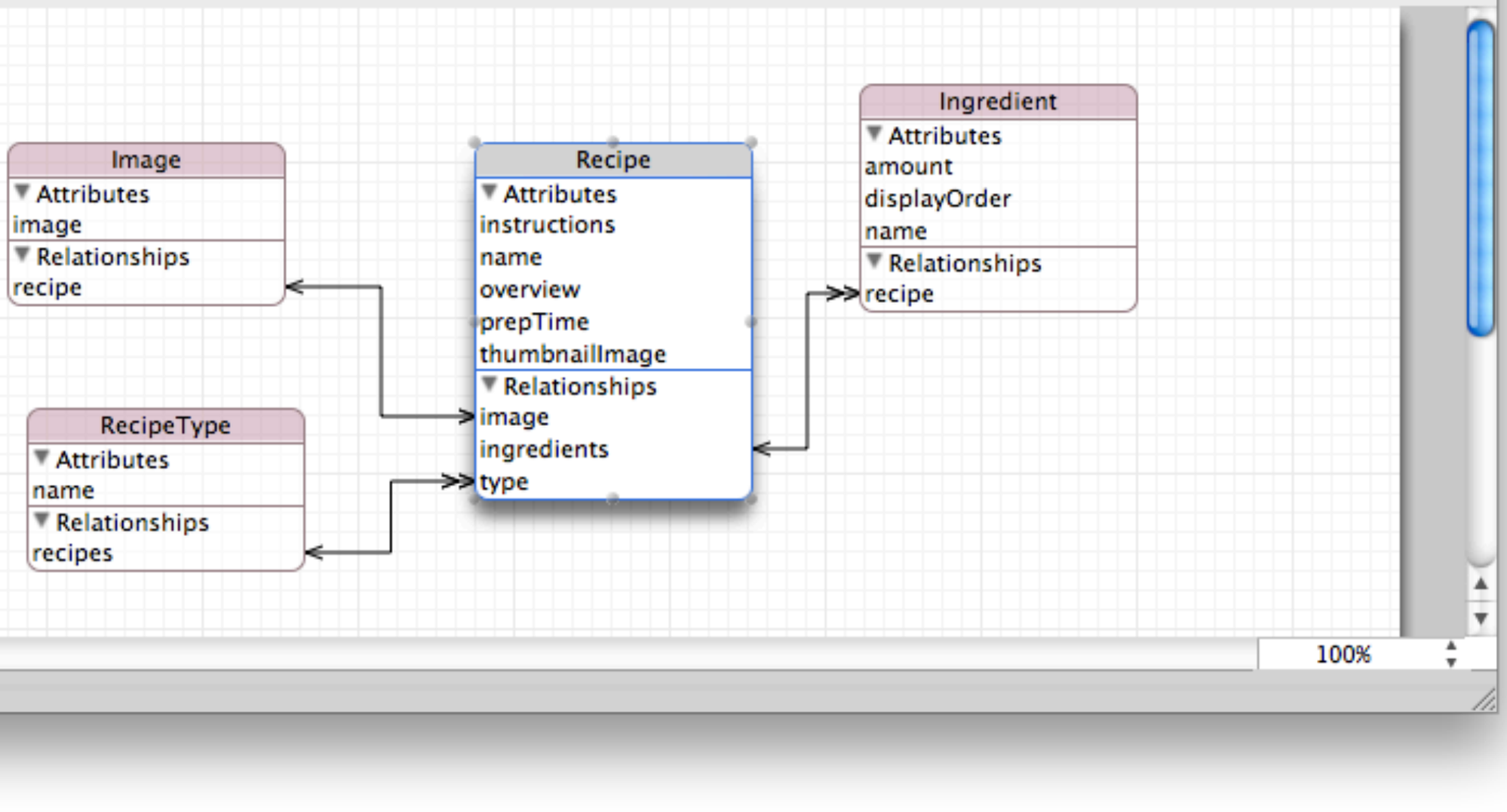
Destination: Image

Inverse: recipe

☐ To-Many Relationship

Min Count: 1 Max Count: 1

Delete Rule: Cascade



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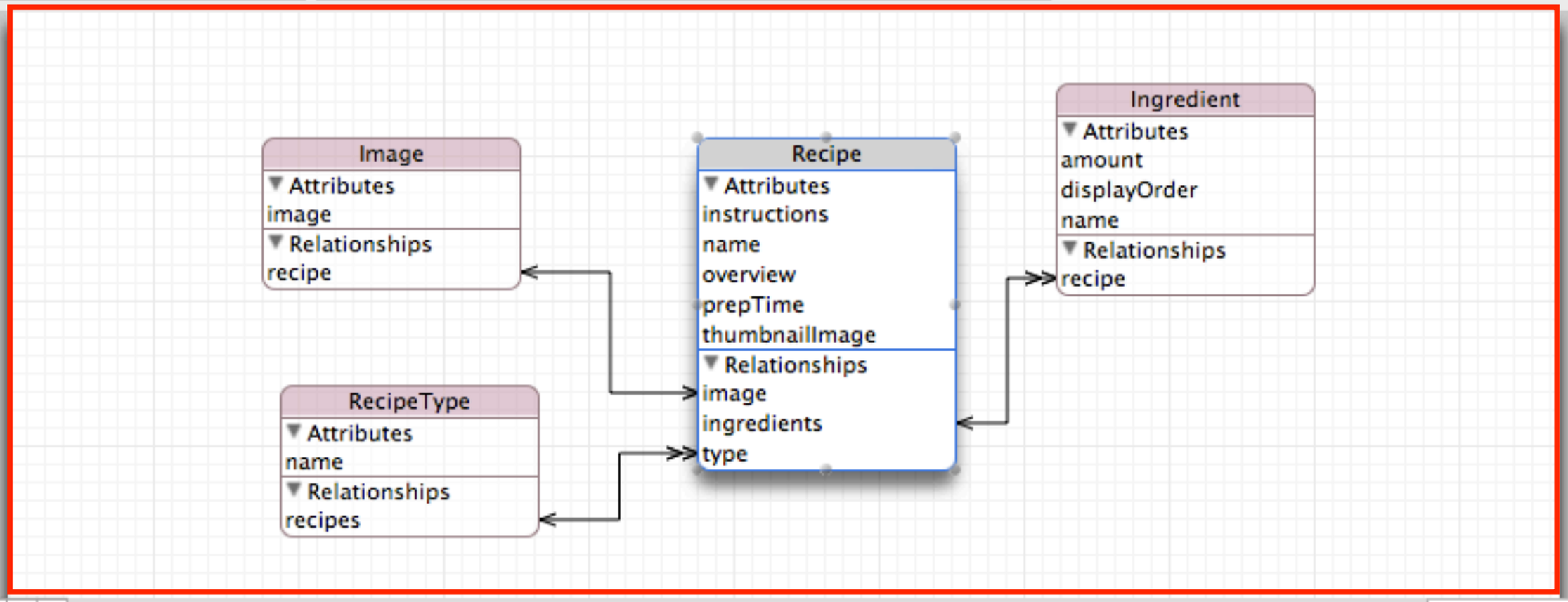

100%

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name	Attribute	String
overview	Attribute	String
prepTime	Attribute	String
thumbnailImage	Attribute	Transformable
type	Relationship	RecipeType

Relationship

Name: image

☑ Optional ☐ Transient

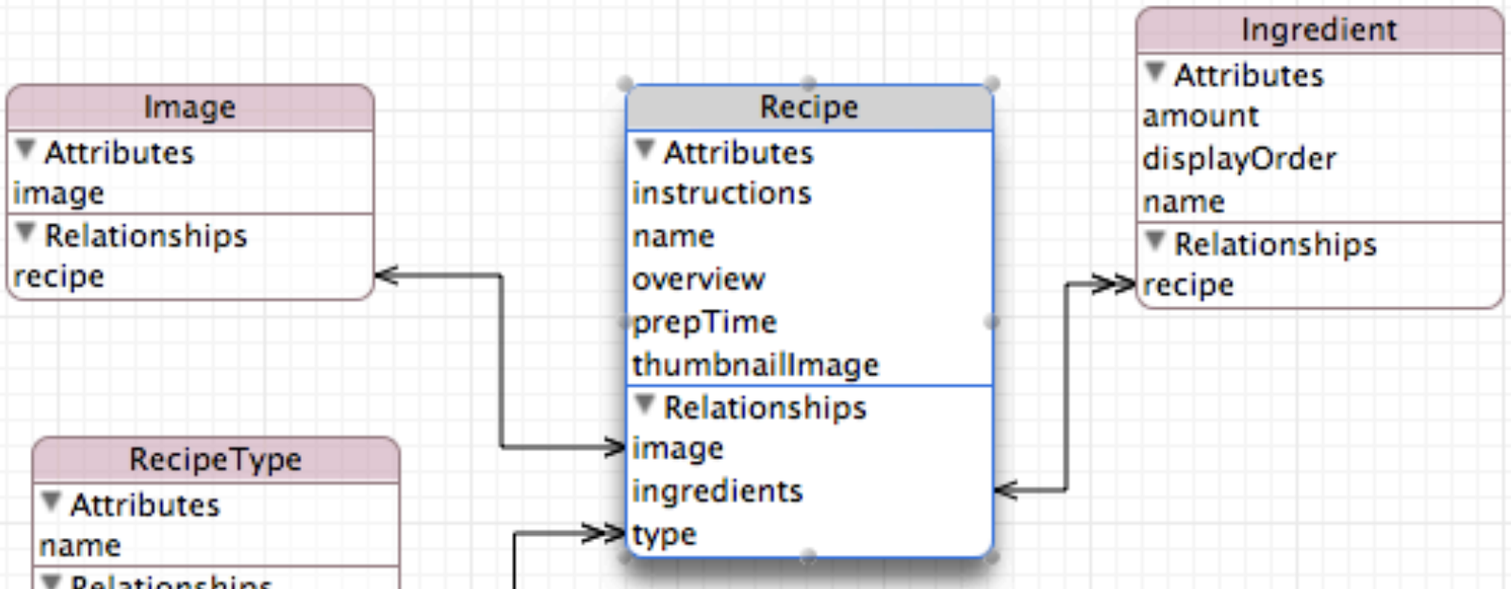
Destination: Image

Inverse: recipe

☐ To-Many Relationship

Min Count: 1 Max Count: 1

Delete Rule: Cascade



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Recipes.xcdatamodel

Recipes.xcdatamodel ▸ Recipe

Entity	Abs	Class
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instructions	Attribute	String
name	Attribute	String
overview	Attribute	String
prepTime	Attribute	String
thumbnailImage	Attribute	Transformable
type	Relationship	RecipeType

Relationship

Name: image

☑ Optional ☐ Transient

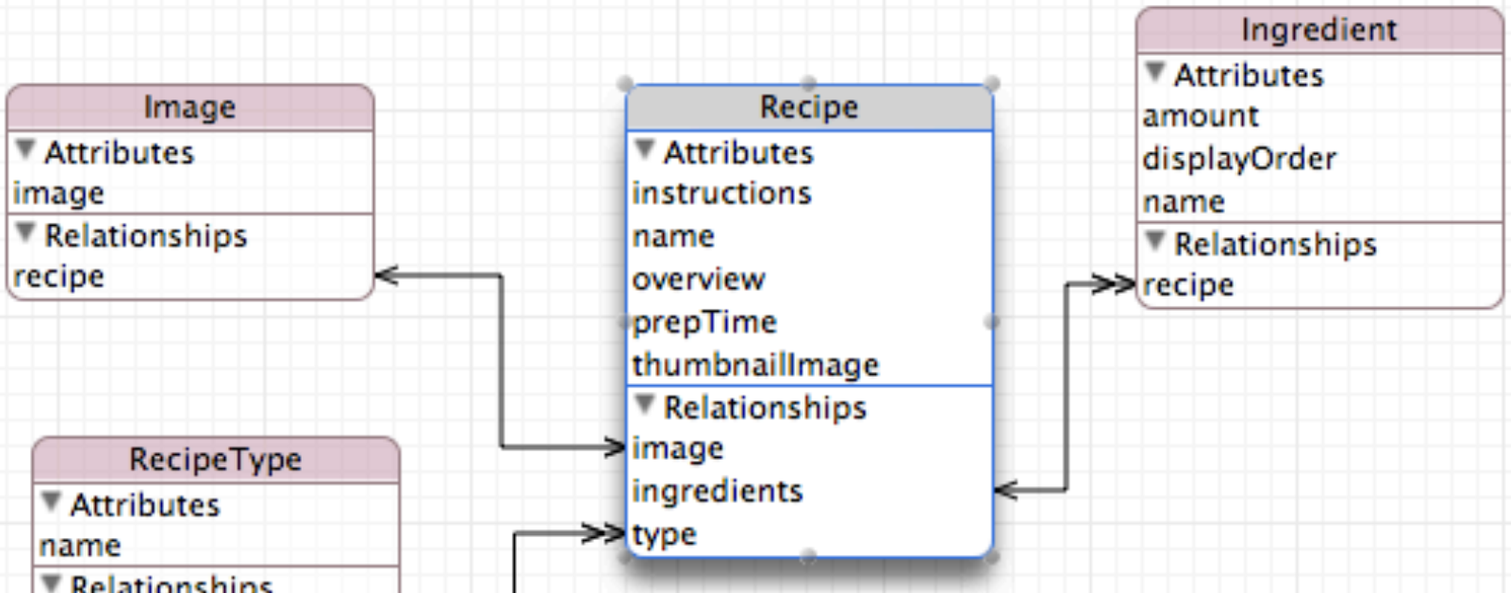
Destination: Image

Inverse: recipe

☐ To-Many Relationship

Min Count: 1 Max Count: 1

Delete Rule: Cascade



100%

Recipes.xcdatamodel

Recipes.xcdatamodel ▸ Recipe

Entity	Abs	Class
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Ingredient	☐	Ingredient
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name	Attribute	String
overview	Attribute	String
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type	Relationship	RecipeType

Relationship

Name: image

☑ Optional ☐ Transient

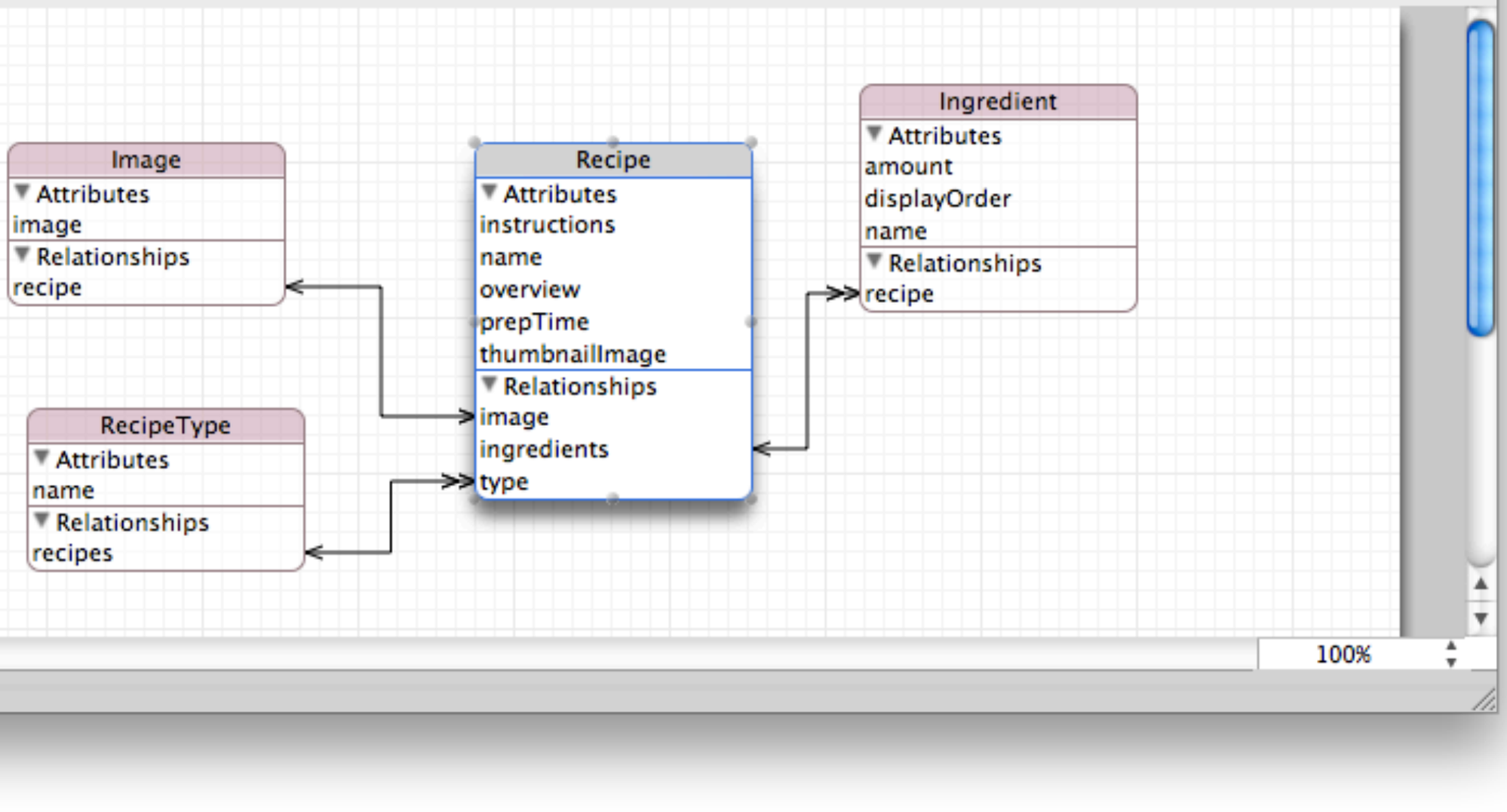
Destination: Image

Inverse: recipe

☐ To-Many Relationship

Min Count: 1 Max Count: 1

Delete Rule: Cascade



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Custom Model Class

```
   // Recipe.h
@interface Recipe : NSManagedObject {}
@property(retain) NSString *title;

// Recipe.m
#import "Recipe.h"

@implementation Recipe
@dynamic title;
@end
```

Creating / Deleting Managed

- Create (Insert)
  - NSManagedObjectContext
  - Entity name

```
[NSEntityDescription insertNewObjectForEntityForName:
  [entity name] inManagedObjectContext:context]
```

- Delete
  - NSManagedObjectContext
  - NSManagedObject

```
[context deleteObject:managedObject];
```

- Save context to make change persistent

Retrieving Managed Objects

- NSFetchRequest
  - Entity: NSEntityDescription
  - Sorting criteria: NSSortDescriptors
  - Search criteria: NSPredicate
- NSFetchedResultsController
  - Tailored to provide data for UITableViews
  - Requires: NSFetchRequest, NSManagedObjectContext
  - Change tracking via delegate

Fetch Data

```
//Set up the fetch request
NSFetchRequest *request = [[NSFetchRequest fetchRequestWithEntityName:@"Recipe"];

//Configure the fetch request
NSSortDescriptor *sortDescriptor = [NSSortDescriptor
                                    sortDescriptorWithKey:@"creationDate" ascending:NO];
[request setSortDescriptors: @[ sortDescriptor ]];

// Execute the request
NSError *error = nil;
NSArray *fetchResults;
fetchResults = [managedObjectContext executeFetchRequest:request error:&error];
if (error) {
  // Handle the error.
}
```

Undo Manager

```
   // attach undo manager
undoManager = [[NSUndoManager alloc] init];
[self.managedObjectContext setUndoManager:undoManager];

//perform undo
[self.managedObjectContext undo];
```

Demo

Performance

- Use batch fetches
- Just fetch needed values
- Use predicates to filter results
- Use SQLite for calculations
- Use SQL Debugging

```
[request setPropertiesToFetch:@[ @"name" ]];
[request setPropertiesToGroupBy:@[ @"major" ]];
```

Performance

- Use batch fetches
- Just fetch needed values
- Use predicates to filter results
- Use SQLite for calculations
- Use SQL Debugging

```
request.predicate = [NSPredicate predicateWithFormat:
                        @"age > %@ AND name == %i", name, age];
```

Numeric comparison is cheap

Text comparison is expensive

Performance

- Use batch fetches
- Just fetch needed values
- Use predicates to filter results
- Use SQLite for calculations
- Use SQL Debugging

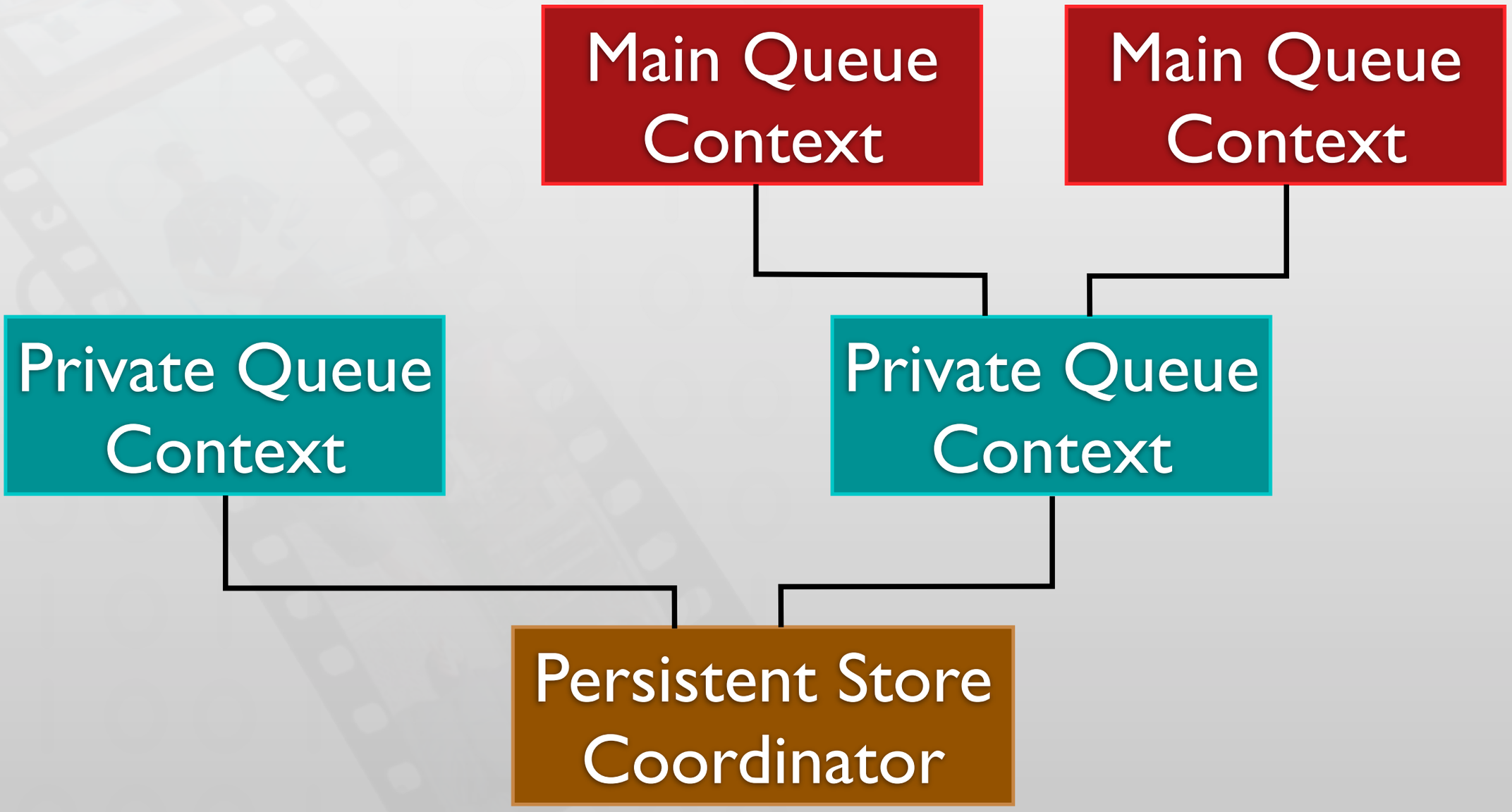
```
NSExpressionDescription *ed =
[[NSExpressionDescription alloc]
init];

ed.name = @"minimum";
ed.expression = [NSExpression
expressionForFunction:@"min:"
arguments:@[ [NSExpression
expressionForKeyPath:@"grade"] ]];

[request
setPropertiesToFetch:@[ ed ]];
```

Performance

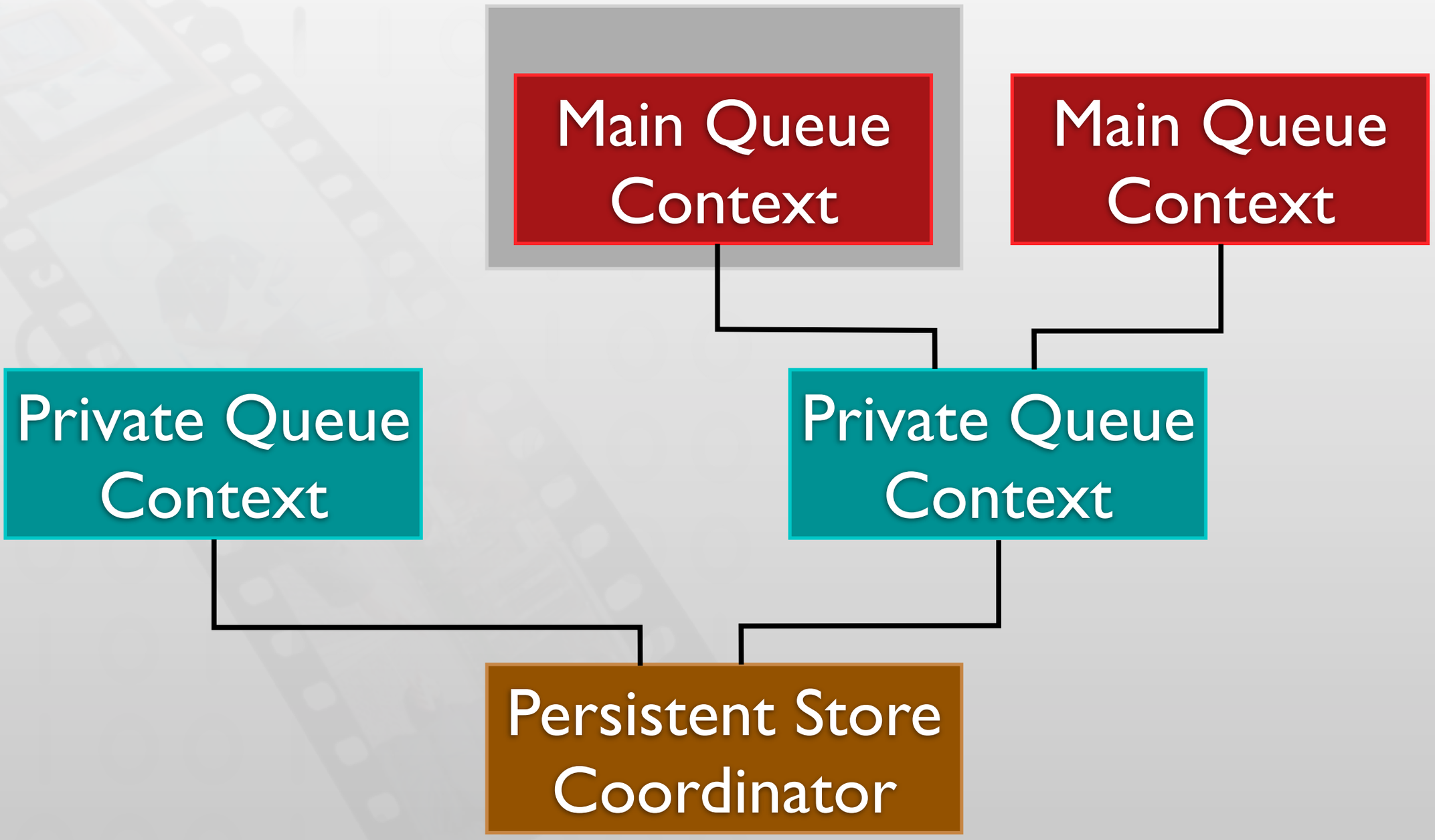
- Use batch fetches
- Just fetch needed values
- Use predicates to filter results
- Use SQLite for calculations
- Use SQL Debugging

```
-com.apple.CoreData.SQLDebug 1
```

Concurrency



Concurrency



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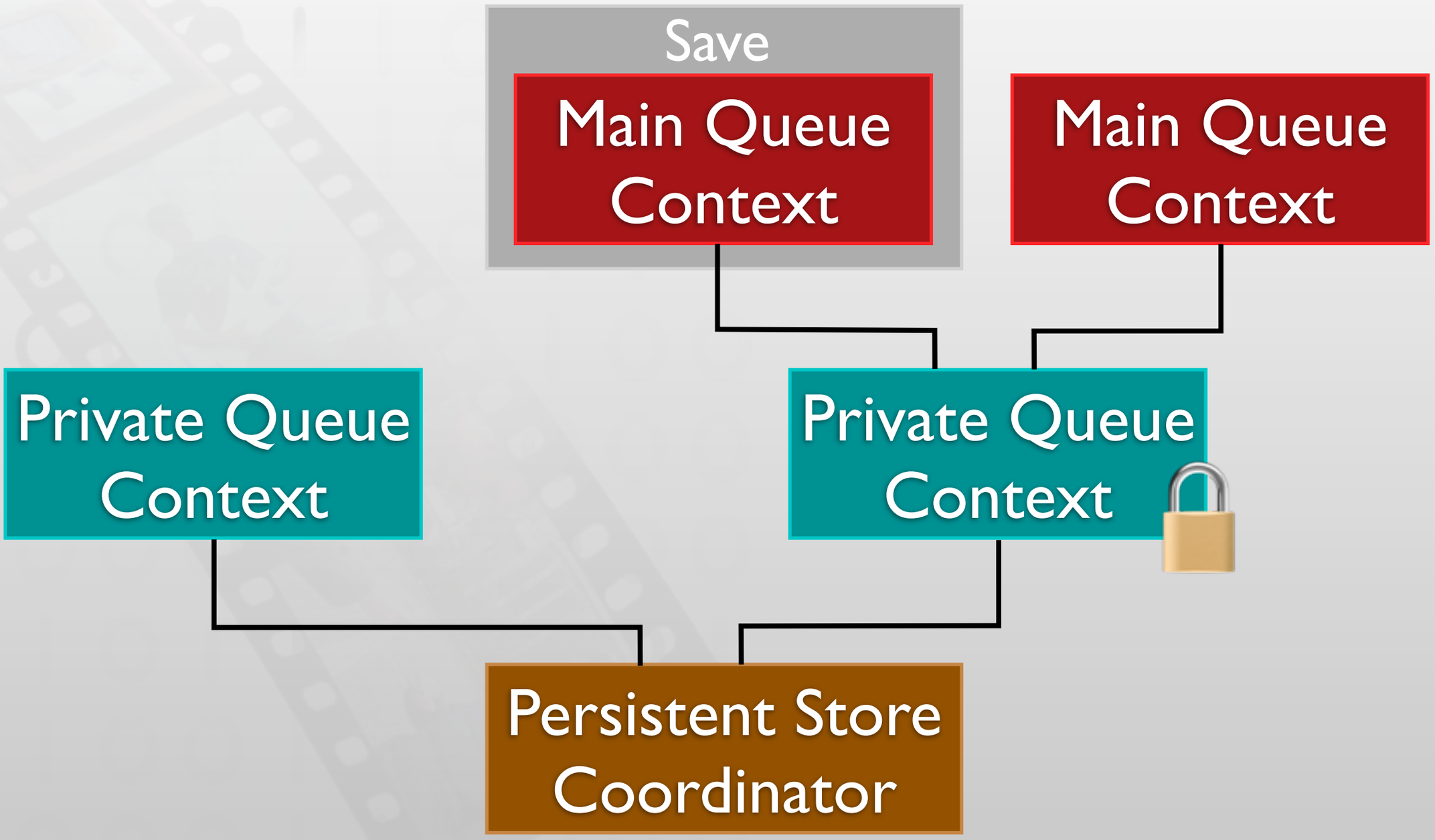
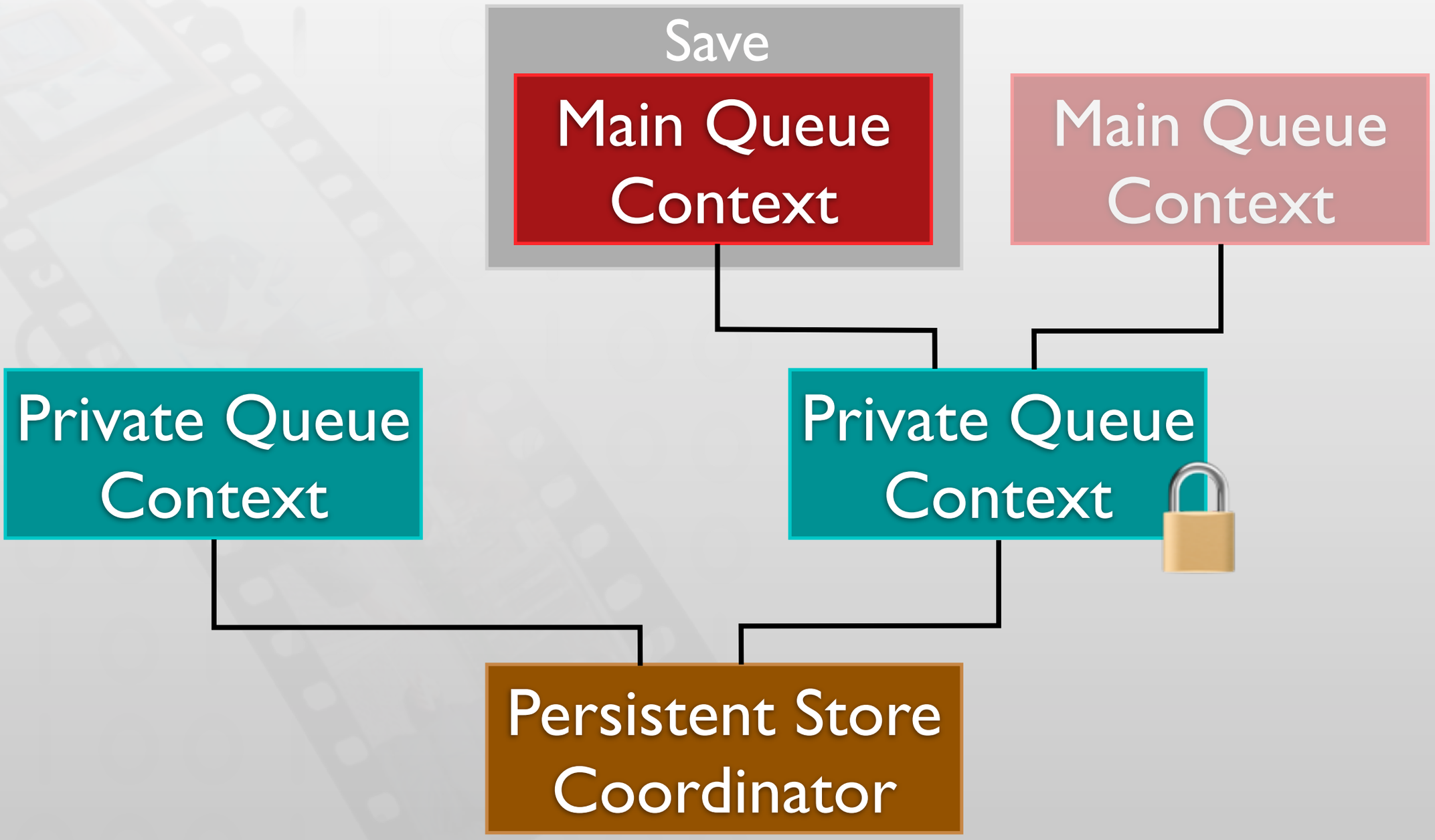
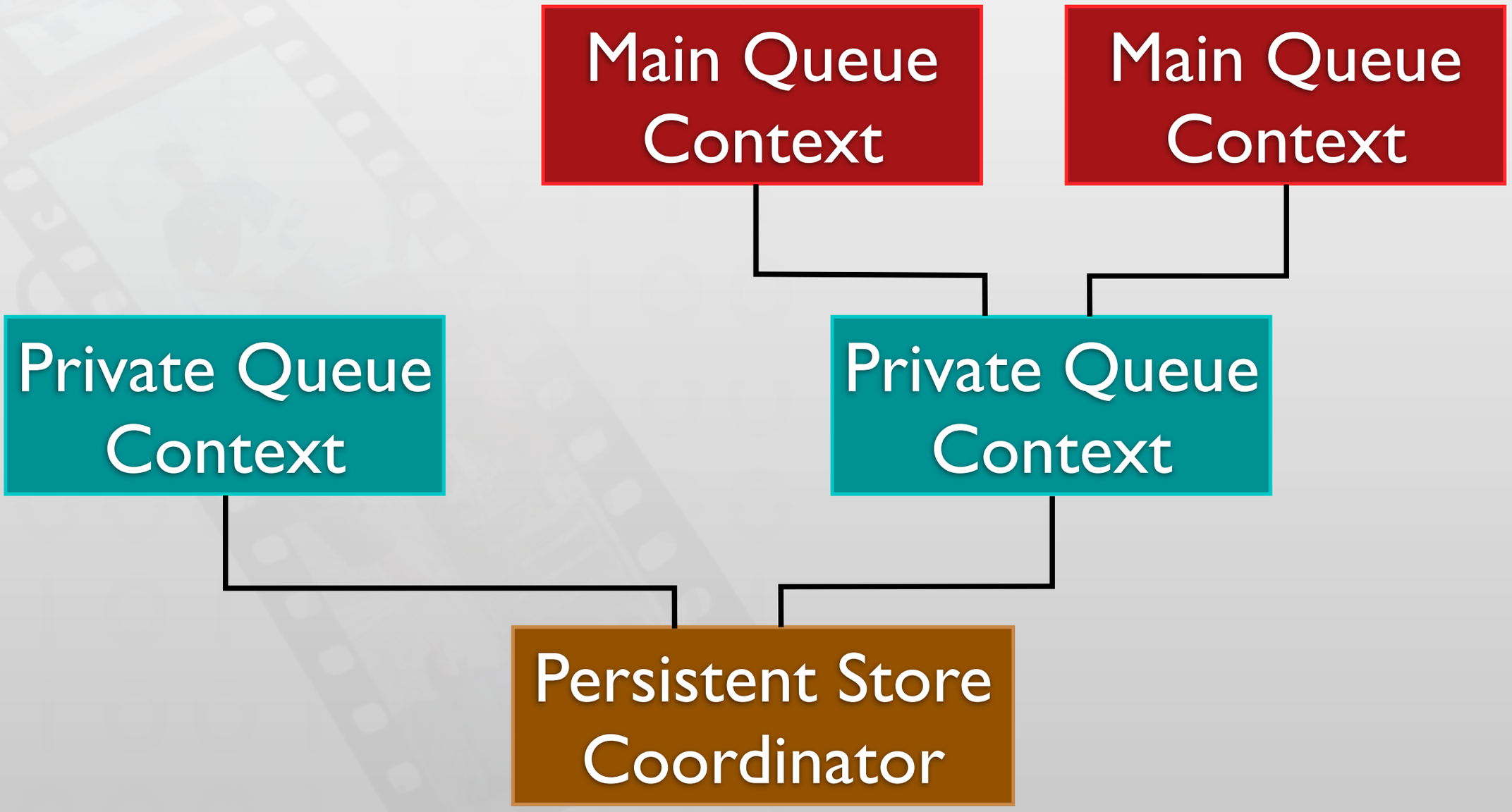


Concurrency



Concurrency



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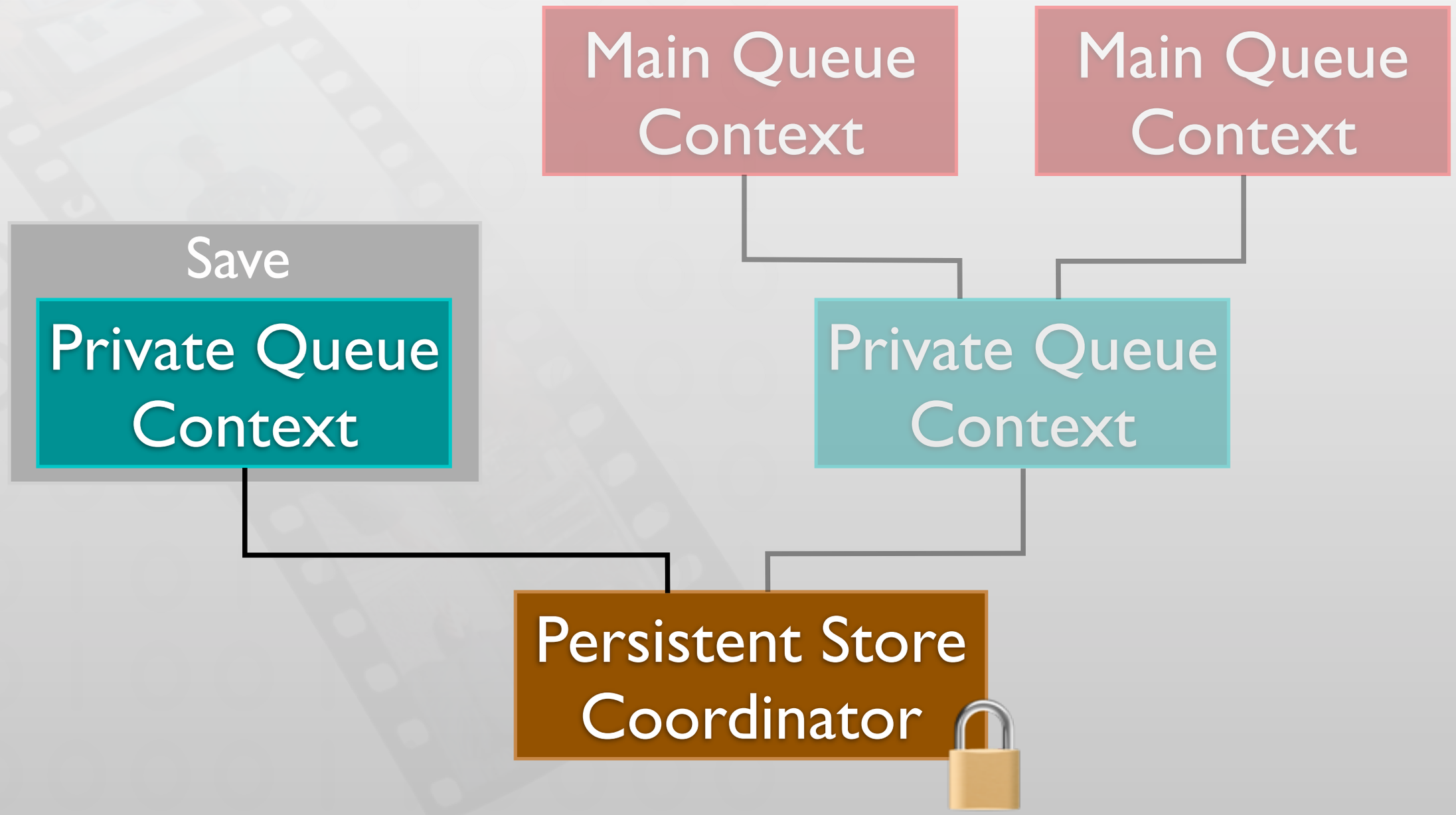

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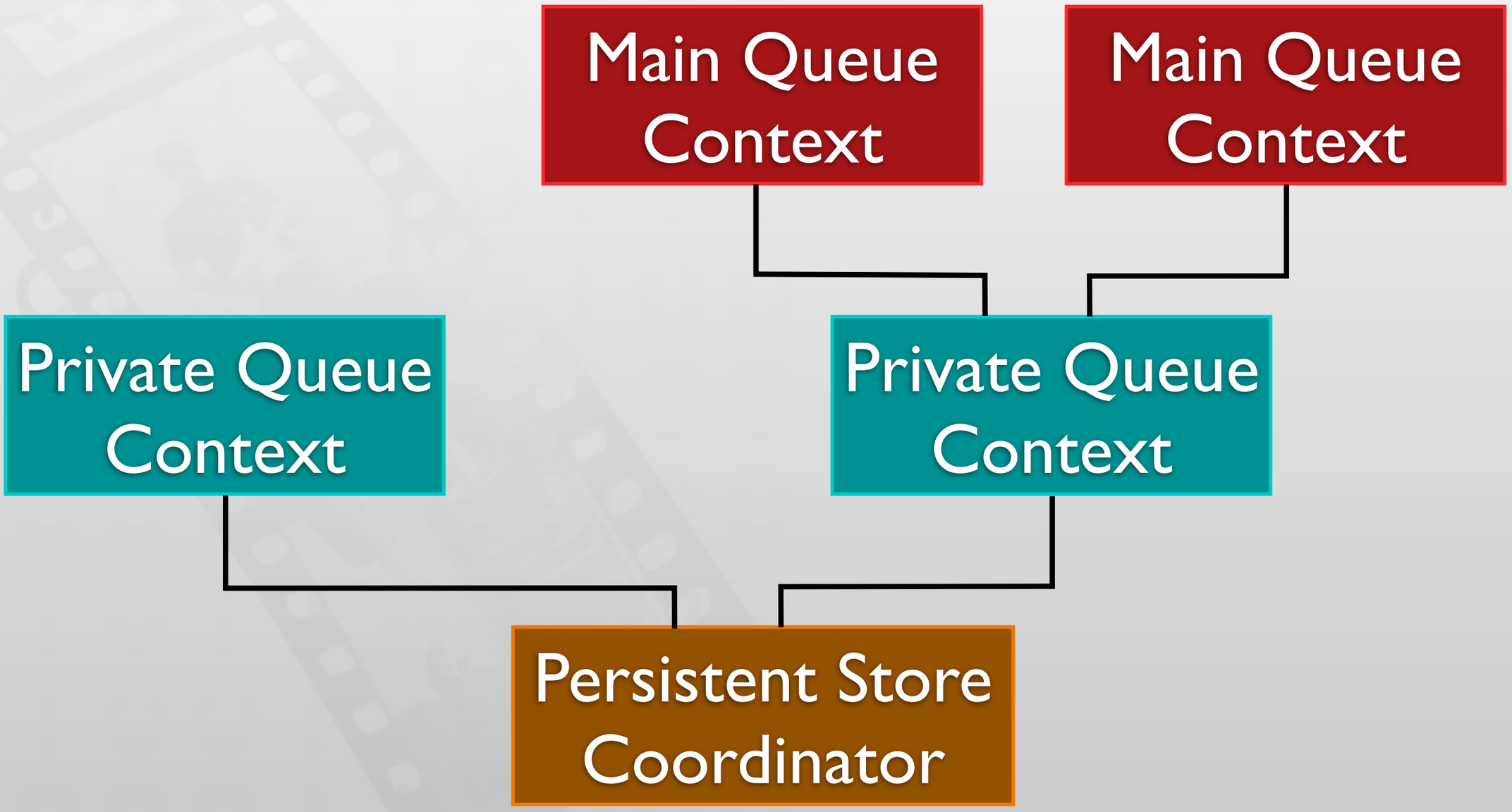
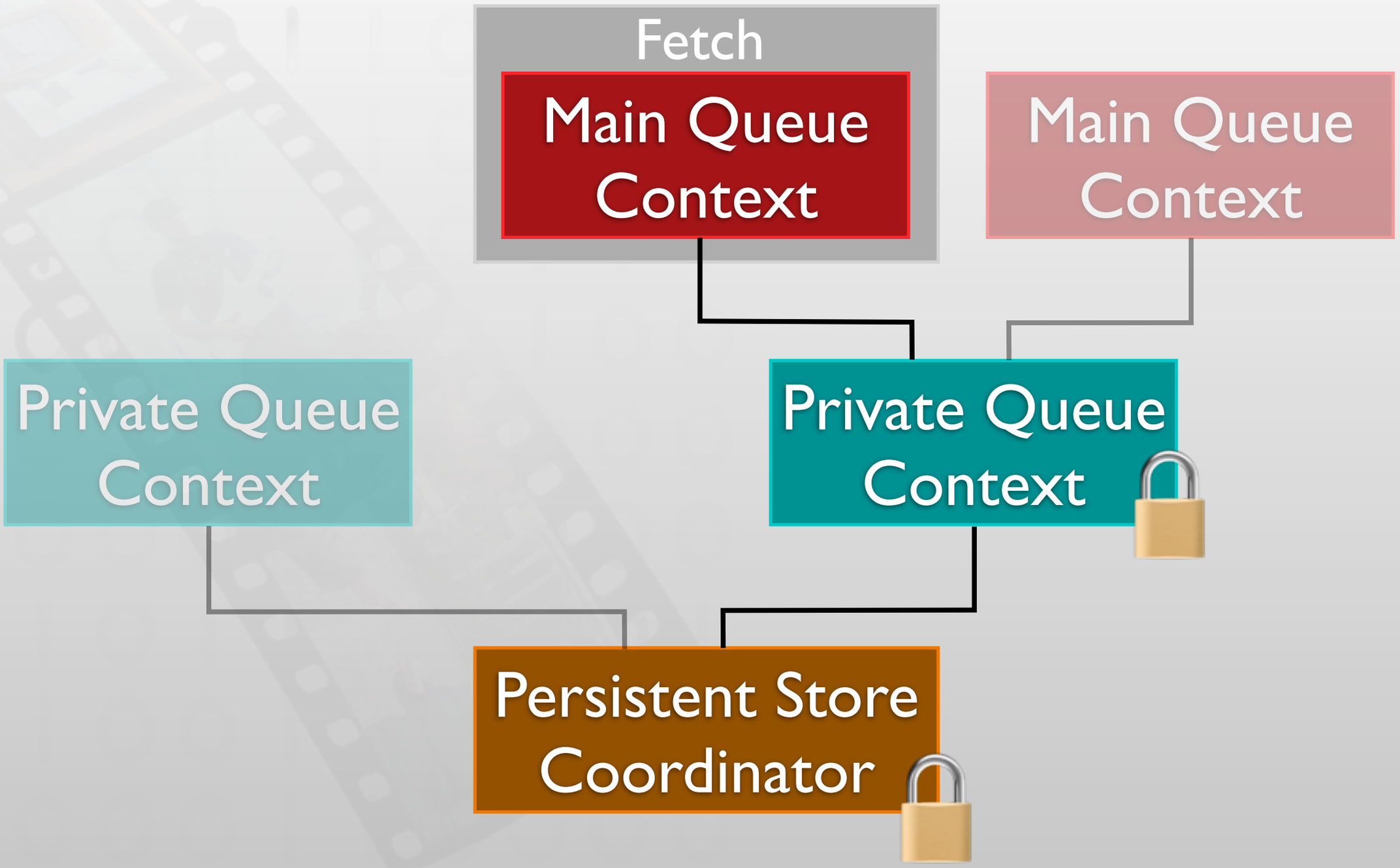


Concurrency



Data Handling Overview

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Local	Database	UIDocument	NSUserDefaults
Synced	Database	UIDocument with iCloud	iCloud Key/Value GameCenter

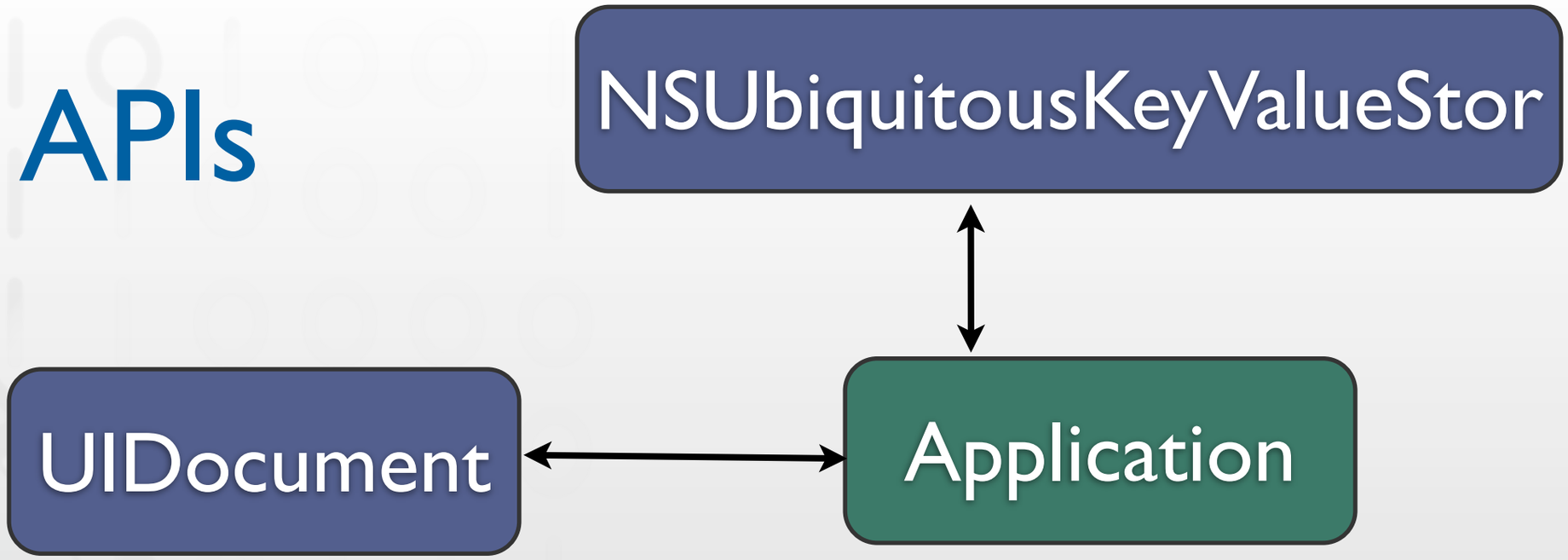
Online Communication with a web server

iCloud

iCloud Basics

- Changes on one device are automatically pushed to other devices
- User can pick up any device and will always have access to her data
- Sync is per app and per user
- Free subscription is 5GB shared among all apps

iCloud APIs



- Settings: use NSUbiquitousKeyValueStore (similarly to NSUserDefaults)
  - 1MB limitation
  - Syncs within minutes
  - Last value always wins
- Documents: UIDocument on a URL in a special folder
  - No limit
  - Syncs within seconds
  - Can merge conflicting files

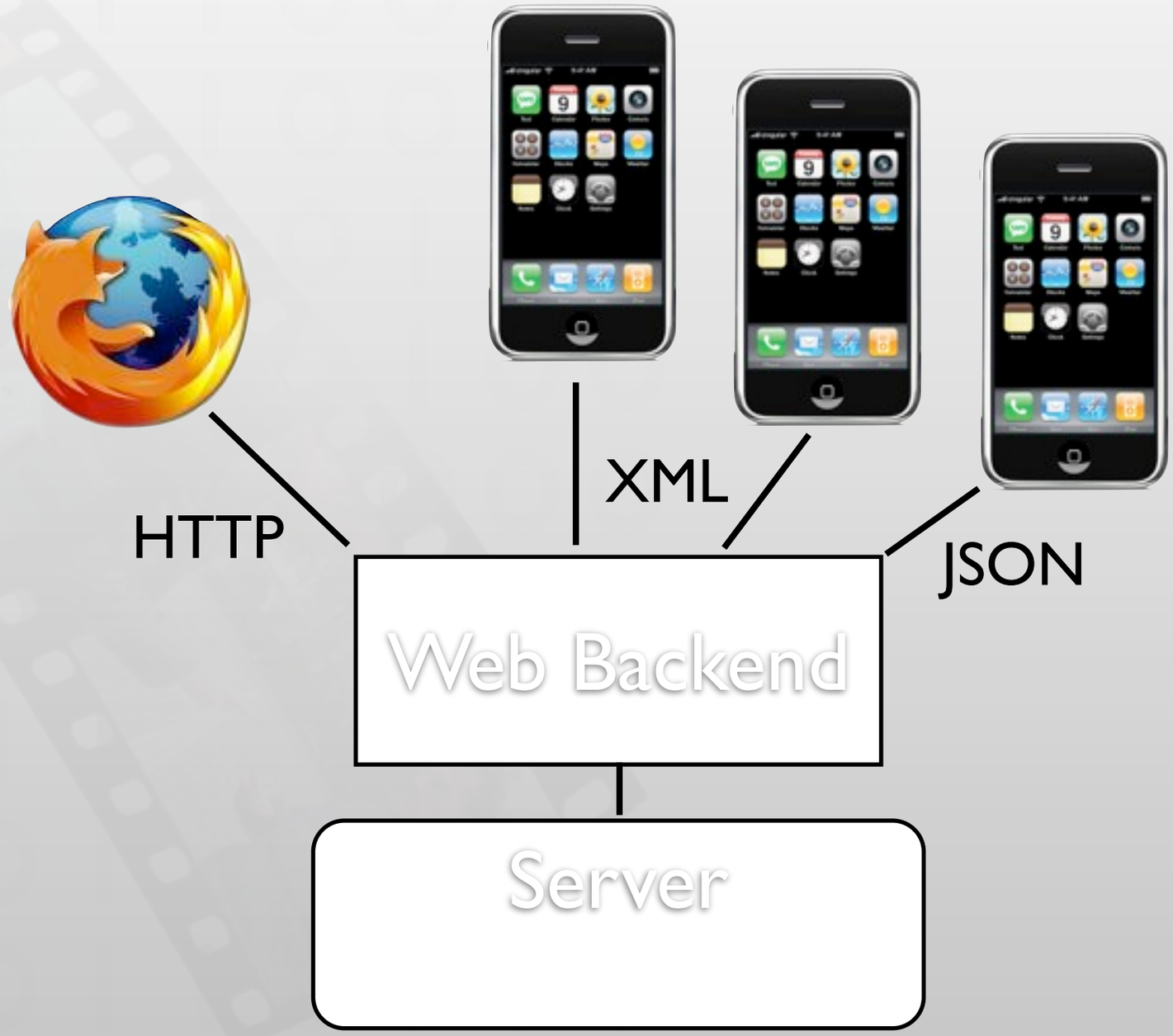
Data Handling Overview

	"Shoebox"	Document	App Data "Settings"
Local	Database	UIDocument	NSUserDefaults
Synced	Database	UIDocument with iCloud	iCloud Key/Value GameCenter

Online — Communication with a web server

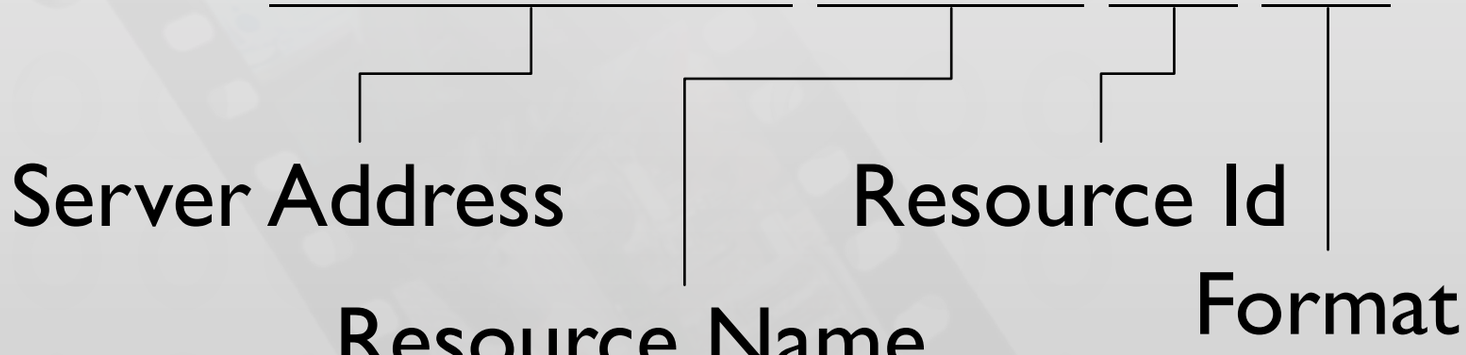
Remote (Web) Objects

Remote (Web) Objects



Representational State Transfer (REST)

- Resource manipulation via HTTP operations
- URL describes resource
  - http://my.server.com/person/127.xml



- Data encoded in XML or JSON
- GET, PUT, POST, DELETE operations are used to manipulate resources

iPhone HTTP Requests

```
// create request
NSURL *url = [NSURL URLWithString:@"http://server/people.xml"];
request = [[NSMutableURLRequest alloc] initWithURL:url];

// set the HTTP operation
[request setHTTPMethod:@"POST"];

// set the post data
NSData *postData = [@"id=1&person[name]=Paul"
                     dataUsingEncoding:NSUTF8StringEncoding];
[request setHTTPBody:postData];

// fire the request
connection = [NSURLConnection connectionWithRequest:request
                                           delegate:self];
[connection start];
```

Remote (Web) Objects

Server

Web Backend

NSURLConnection

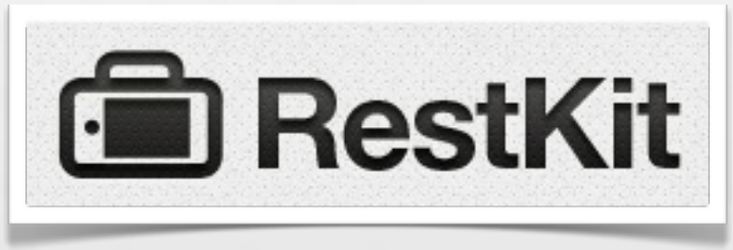
NSData

NSXMLParser

NSJSONSerialization

Basic Data

RestKit Basics



- RestKit knows RESTful Webservices
- Can interact with CoreData
- Key paradigm: Mapping response from the web to Objective-C objects

RestKit Structure

Entity/Object Mapping

Request Descriptor

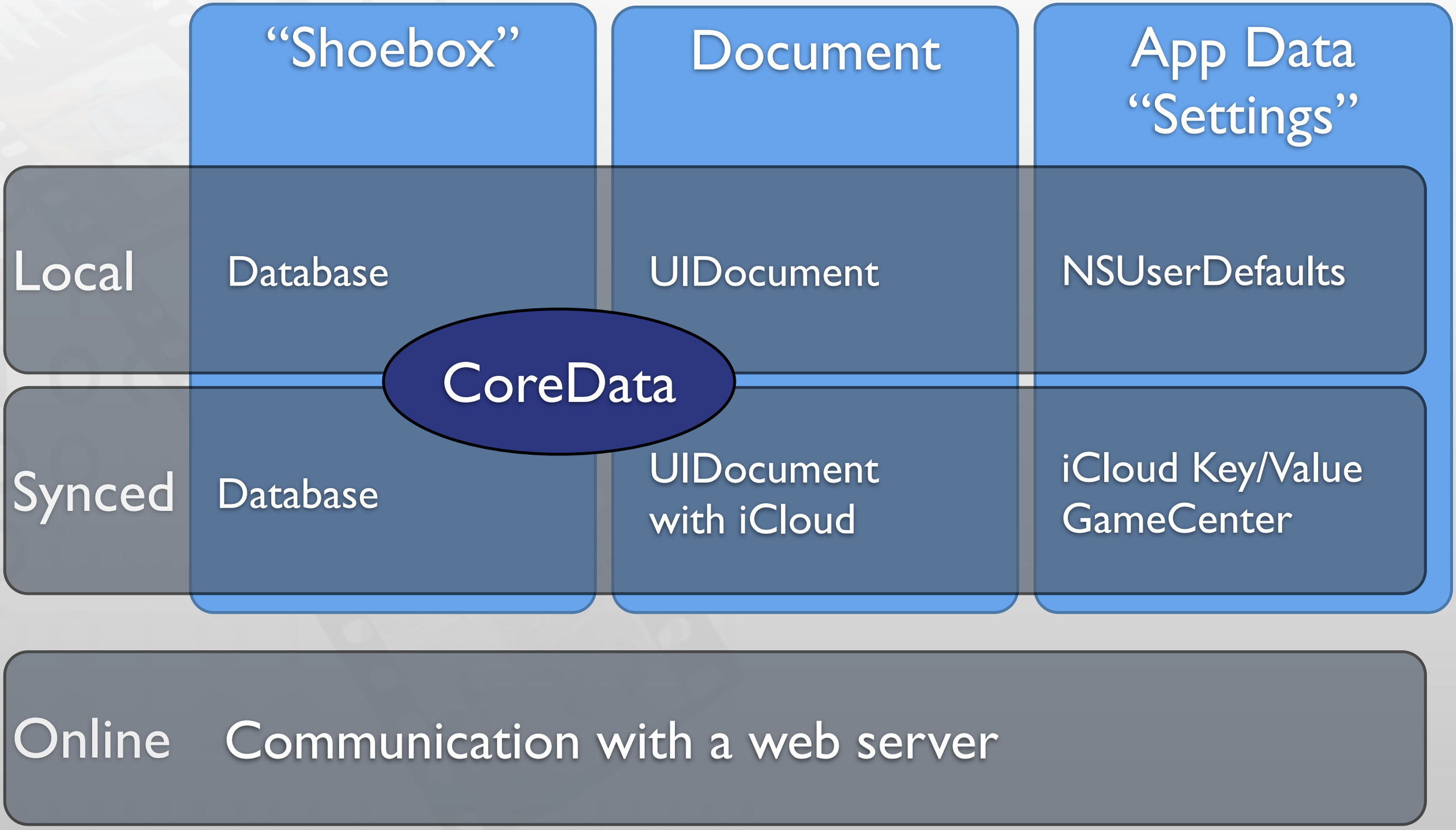
Response

Object Manager

Managed Object Store

Demo

Data Handling Overview



More Information

- SQLite Online Documentation
- Apple Guides
  - Archives and Serialization Programming Guide
  - Core Data Programming Guide
  - Document-Based Application Programming Guide
  - URL Loading System Programming Guide
- restkit.org
- github.com/lichtschlag/iCloudPlayground
- github.com/lichtschlag/Chronos

Epilogue: Sharing data locally

- How to get data from app to app?
- “Open with...” ?

- UIDocumentInteractionController
  - Apps publish what files they can open
  - Sender app pushes document, user selects target app
  - Data is copied between app sandboxes
  - No way to track files

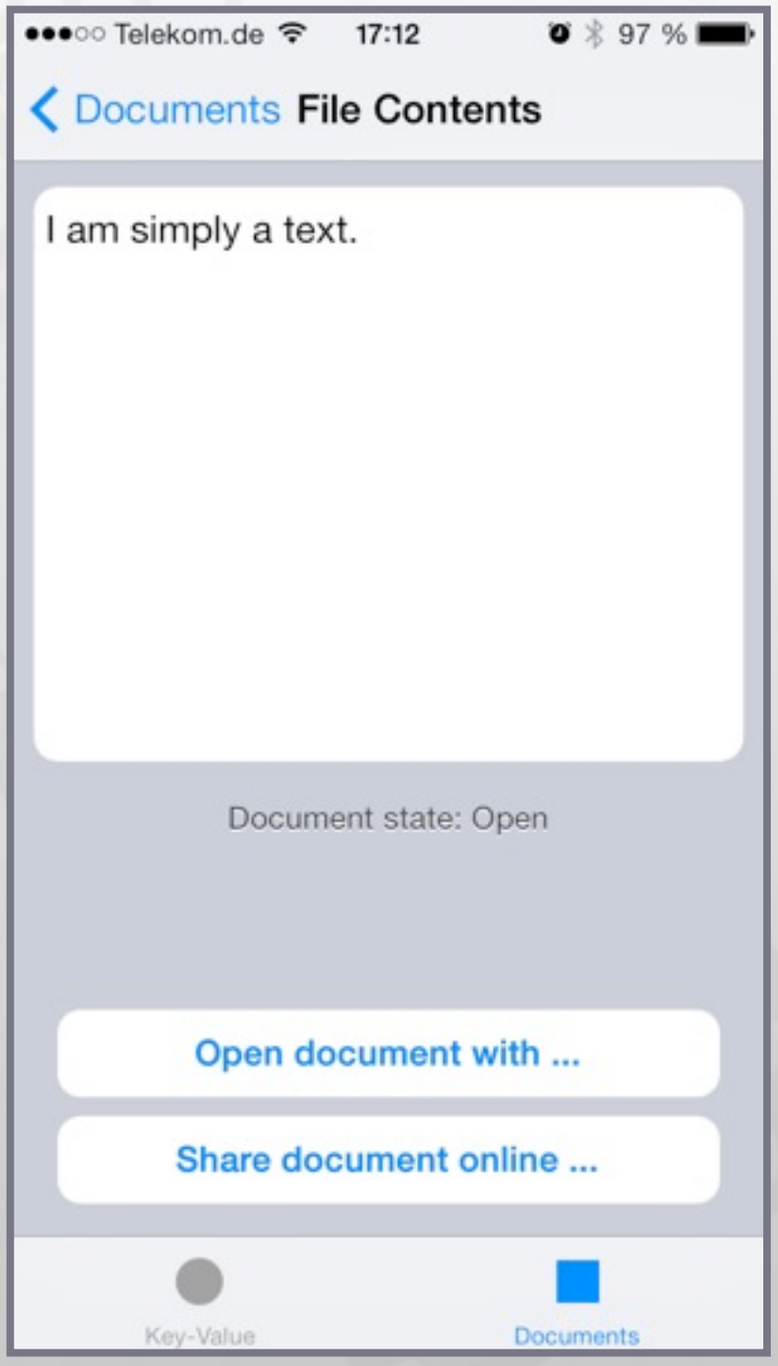
UIDocumentInteractionController

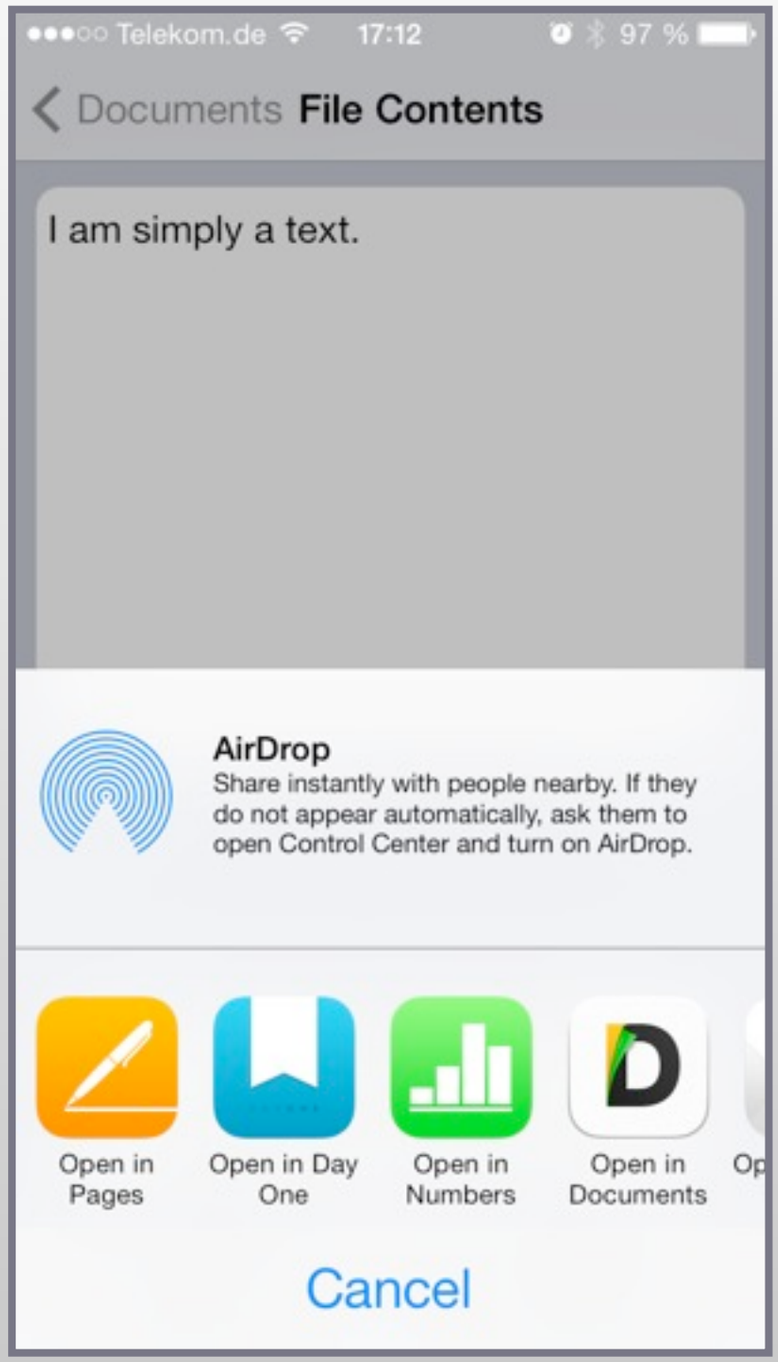
```
- (IBAction) openExternally:(id)sender
{
    // save first
    [self.document saveToURL:self.document.fileURL
           forSaveOperation:UIDocumentSaveForOverwriting
           completionHandler:^(BOOL success)
     {
         // bring up dialog from doc interaction controller
         self.docController = [UIDocumentInteractionController
                               interactionControllerWithURL:self.document.fileURL];

         BOOL didOpen = [docController presentOpenInMenuFromRect:CGRectZero
                                                          inView:self.openButton
                                                        animated:YES];

         if (!didOpen)
         {
             [[[UIAlertView alloc] initWithTitle:@"Cannot open file in other apps"
                                         message:@"Unfortunately, there is no app installed
                                                  that can handle this kind of file."
                                        delegate:nil
                               cancelButtonTitle:@"Ok"
                               otherButtonTitles:nil] show];
         }
     }];
}
```

UIDocumentController in Action





Check the iCloudPlayground demo code for more info