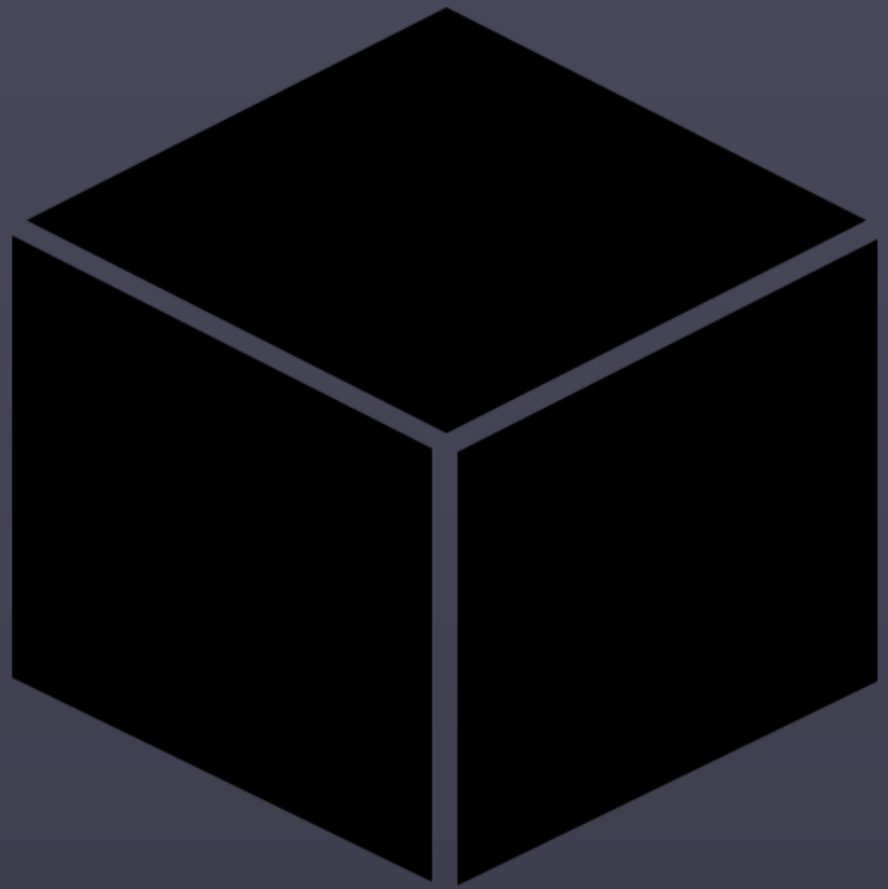
Designing a Modern Swift Network Stack

Philly CocoaHeads • January 10, 2019

Hello

My Client Story




Company API
Core Data
App
APIClient + MapModelManager
2000 lines each

Problems

- Cumbersome to Add and Refactor Code
- Lack of Documentation
- Lack of Unit Testing
- OAuth2 Token Renewal Bugs
- Lack of Respect for Current User State

Wishlist

- Break Problem into Smaller, Testable Parts
- Less Reliance on Global Data Management
- Different Environments (local, stage, production)
- Event Logging (For Debugging and Analytics)
- Bulletproof OAuth Token Renewal

Wishlist

- Simulate Network Responses to Demo App Scenarios
- Chain Dependent Network Requests
- Group Related Parallel Network Requests
- Cancel Network Requests
- System to Humanize All Possible Error Messages

Wishlist

- Draw Firm Lines for Breaking Down Responsibilities
- Utilize System Network Caching instead of Core Data
- Keep Logic and Resources as D.R.Y. as possible.
- Make Typical Use Cases as Simple as Possible.
- Deliver as a Sharable Framework

The Solution

Small, focused, single responsibility objects that work together.

Request / Response

Request

```
protocol RequestDescribing {
    var method: HTTPMethod { get }
    var path: String { get }
    var queryItems: [URLQueryItem]? { get }
    var headers: [String: String]? { get }
    var body: Data? { get }
    var responseType: ResponseDescribing.Type { get }
}
```

Places Request

```
struct FetchPlacesRequest: RequestDescribing {
    let method: HTTPMethod = .get
    let path = "/v2/places"
    let queryItems: [URLQueryItem]? = nil
    let headers: [String: String]? = nil
    let body: Data? = nil
    let responseType: ResponseDescribing.Type = FetchPlacesResponse.self
}
```

```swift
struct FetchClientSecretRequest: RequestDescribing {

    let method: HTTPMethod = .post
    let path = "/users/retrieve-client"
    let queryItems: [URLQueryItem]? = nil
    let headers: [String: String]? = RequestDefaults.JSONApplicationHeader
    var body: Data? {
        let values = [
        "email": email,
        "password": password],
        ]
        return try! JSONEncoder().encode(values)
    }
    let responseType: ResponseDescribing.Type = FetchClientSecretResponse.self

    let email: String
    let password: String
    init(email: String, password: String) {
        self.email = email
        self.password = password
    }
```

Response

```
protocol ResponseDescribing {

    var httpURLResponse: HTTPURLResponse { get }

    init(data: Data?, httpURLResponse: HTTPURLResponse) throws
}
```

Places Response

```
struct FetchPlacesResponse: ResponseDescribing {

    let httpURLResponse: HTTPURLResponse
    let places: [Place]

    init(data: Data?, httpURLResponse: HTTPURLResponse) throws {
        // Error Handling Cut For Space

        let response = try JSONDecoder().decode(NetworkResponse.self, from: data)
        self.httpURLResponse = httpURLResponse
        self.places = response.data
    }
}

private struct NetworkResponse: Codable {
    let data: [Place]
}
```

Server Configuration & Server Connection

Server Configuration

```
protocol ServerConfiguration {
    var host: URL { get }
}

struct ProductionConfiguration: ServerConfiguration {
    let host = URL(string: "https://api.example.com")!
}

struct StagingConfiguration: ServerConfiguration {
    let host = URL(string: "https://staging-api.example.com")!
}
```

Server Connection

```
class ServerConnection {

    let serverConfiguration: ServerConfiguration

    init(configuration: ServerConfiguration) {
        self.serverConfiguration = configuration
    }

    func execute(_ request: RequestDescribing, completion: @escaping
((ResponseDescribing?, Error?) -> Void)) { ... }

}
```

```
// Inside of PlacesViewController

let request = FetchPlacesRequest()
serverConnection?.execute(request, completion: { (response, error) in

    if let error = error {
        // present alert
        return
    }

    guard let fetchPlacesResponse = response as? FetchPlacesResponse else {
        // present alert
        return
    }

    self.places = fetchPlacesResponse.places
    // refresh UI
})
```

What have we gained so far?

- Describe the API across many small files, instead of one large file.
- Can create 1:1 test files per API file.
- Dynamically configure our server connection per environment.
- Small amount of work to add API Key “request signing”.
- Small amount of work to add logging and analytics.

Responsibilities

- Requests
  - Defines the rules for each point of API engagement.
  - Can be initialized with attributes that influence a request.

Responsibilities

- Responses
  - Centralizes the decision making process on what a server response means.
  - Owns the deserialization process, turning server returned JSON blobs into a local, native object type.

Responsibilities

- ServerConnection
  - Processes requests at the request of the view controller.
  - Let’s the view controller work with local, native business objects (and errors) instead of having to process network JSON responses.

Error Message Provider

```
// Inside of PlacesViewController

let request = FetchPlacesRequest()
serverConnection?.execute(request, completion: { (response, error) in

    if let error = error {
        // present alert
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    }

    guard let fetchPlacesResponse = response as? FetchPlacesResponse else {
        // present alert
        return
    }

    self.places = fetchPlacesResponse.places
    // refresh UI
})
```

```
enum ServerConnectionError: Error {

    /// Typically refers to an internal error; XRequest expects, XResponse.
    case unexpectedResponse

    /// Holds server error messages intended for user presentation.
    case descriptiveServerError(String)

    /// Holds the HTTP Status Code. .descriptiveServerError is
preferred over .httpError when possible.
    case httpError(Int)
}
```

```swift
if let error = error {
    let alert = UIAlertController(title: "Could not load places.", error: error)
    self.present(alert, animated: true, completion: nil)
    return
}

extension UIAlertController {

    convenience init(title: String, error: Error) {
        self.init(title: title, message: nil, preferredStyle: .alert)
        self.message = ErrorMessageProvider.errorMessageFor(error)
        self.addAction(UIAlertAction(title: "OK", style: .default, handler: nil))
    }

}
```

```swift
public class ErrorMessageProvider {

    static func errorMessageFor(_ error: Error) -> String {
        if let serverConnectionError = error as? ServerConnectionError {
            return errorMessageForServerConnectionError(serverConnectionError)
        } else {
            return error.localizedDescription
        }
    }

    static func errorMessageForServerConnectionError(_ error: ServerConnectionError)
-> String {
        switch error {
        case .unexpectedResponse:
            return "Unexpected Response"
        case .descriptiveServerError(let message):
            return message
        case .httpError(let statusCode):
            return "HTTP Error \(statusCode)"
        }
    }
}
```

Authentication

What is OAuth 2?

Featured Video: OAuth 2.0 Access Tokens Explained

OAuth 2.0

OAuth 2.0 is the industry-standard protocol for authorization. OAuth 2.0 supersedes the work done on the original OAuth protocol created in 2006. OAuth 2.0 focuses on client developer simplicity while providing specific authorization flows for web applications, desktop applications, mobile phones, and living room devices. This specification and its extensions are being developed within the IETF OAuth Working Group.

Questions, suggestions and protocol changes should be discussed on the mailing list.

OAuth 2.0 Core

- OAuth 2.0 Framework - RFC 6749
- OAuth 2.0 Grant Types
  - Authorization Code
  - Implicit
  - Password
  - Client Credentials
  - Device Code
  - Refresh Token
- OAuth 2.0 Bearer Tokens - RFC 6750
- Threat Model and Security Considerations - RFC 6819
- OAuth 2.0 Security Best Current Practice

Mobile and Other Devices

- Native Apps - Recommendations for using OAuth 2.0 with native apps
- PKCE - Proof Key for Code Exchange, better security for native apps
- Browser-Based Apps - Recommendations for using OAuth 2.0 with browser-based apps (e.g. an SPA)
- OAuth 2.0 Device Flow

Token and Token Management

- OAuth 2.0 Token Introspection - RFC 7662, to determine the active state and meta-information of a token
- OAuth 2.0 Token Revocation - RFC 7009, to signal that a previously obtained token is no longer needed

https://oauth.net/2/

OAuth 2.0 is the modern standard for securing access to APIs.

Read on for a complete guide to building your own authorization server.

Learn about OAuth 2.0 | Solve it with Okta

Table of Contents

Search for a Topic

https://www.oauth.com/

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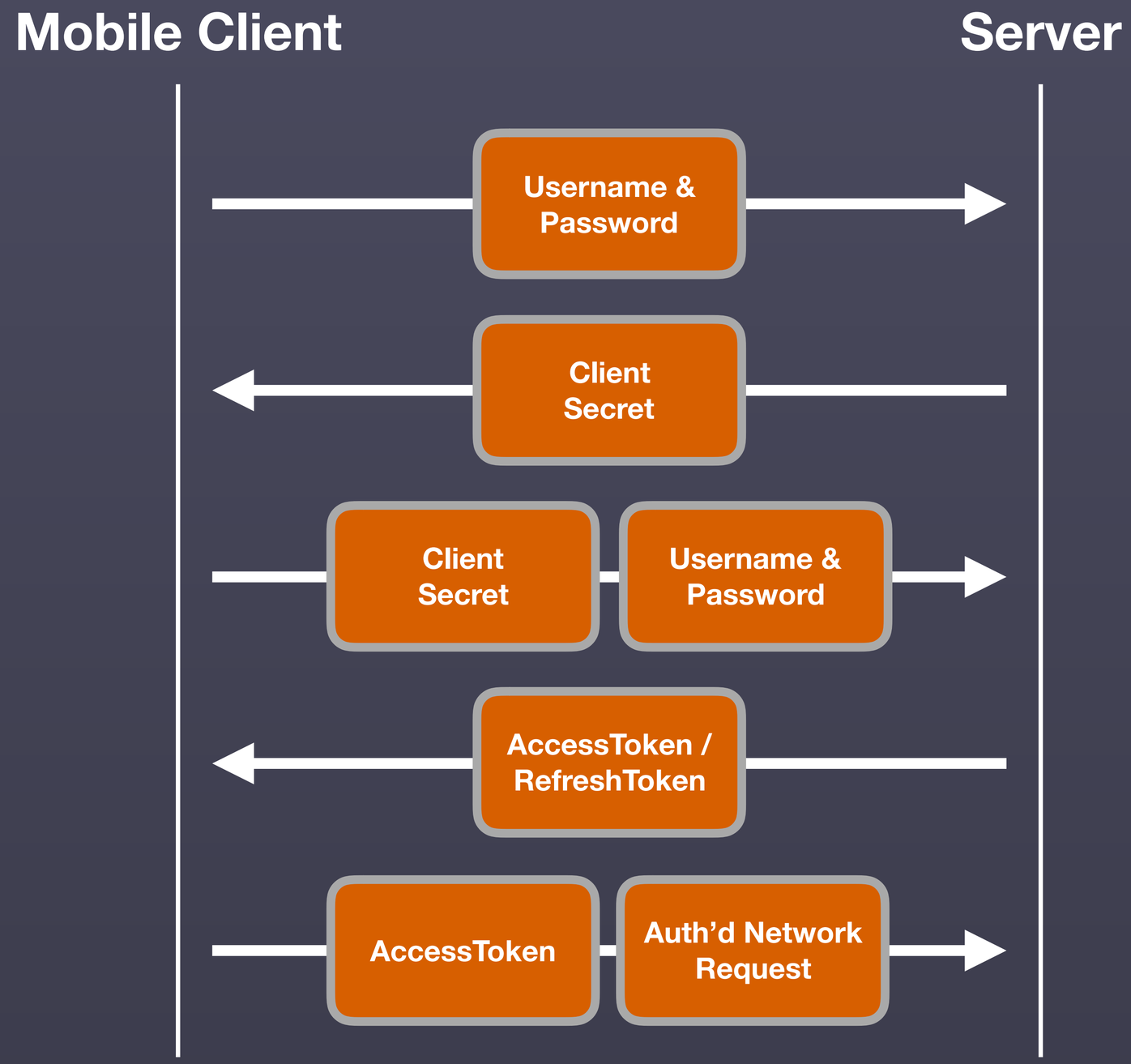
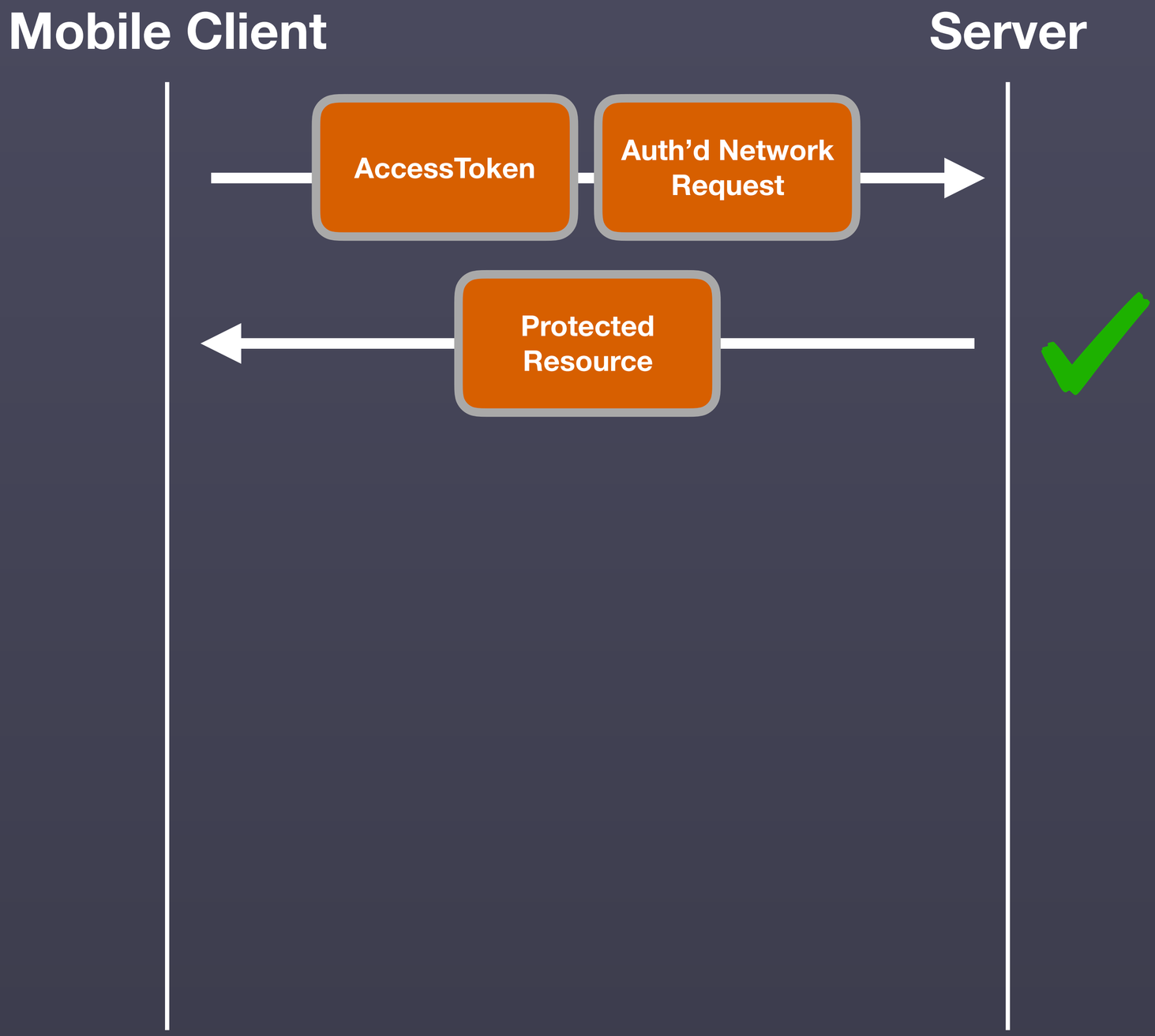
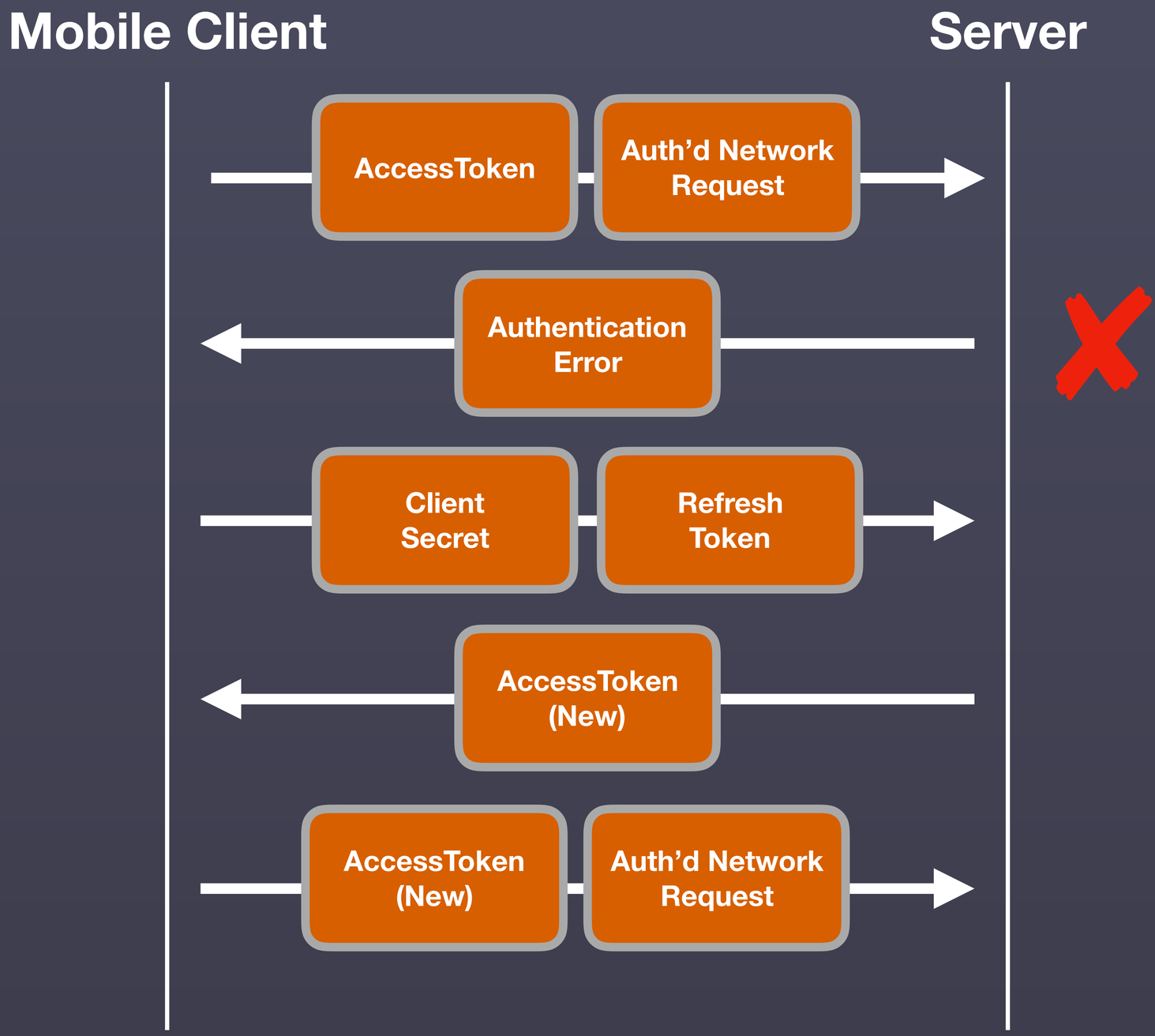

Mobile Client
Server
Username & Password
Client Secret
Client Secret
Username & Password
AccessToken / RefreshToken
AccessToken
Auth’d Network Request


Mobile Client
Server
AccessToken
Auth'd Network Request
Protected Resource


Mobile Client
Server
AccessToken
Auth'd Network Request
Authentication Error
Client Secret
Refresh Token
AccessToken (New)
AccessToken (New)
Auth'd Network Request

Session

Session

```
class Session {
    let clientSecret: ClientSecret
    let accessToken: AccessToken

    init(clientSecret: ClientSecret, accessToken: AccessToken) {
        self.clientSecret = clientSecret
        self.accessToken = accessToken
    }
}
```

Session

```
struct ClientSecret: Equatable {
    let id: String
    let secret: String
}

struct AccessToken: Codable {
    let value: String
    let type: String
    let expiresAt: Date
    let refreshToken: String
}
```

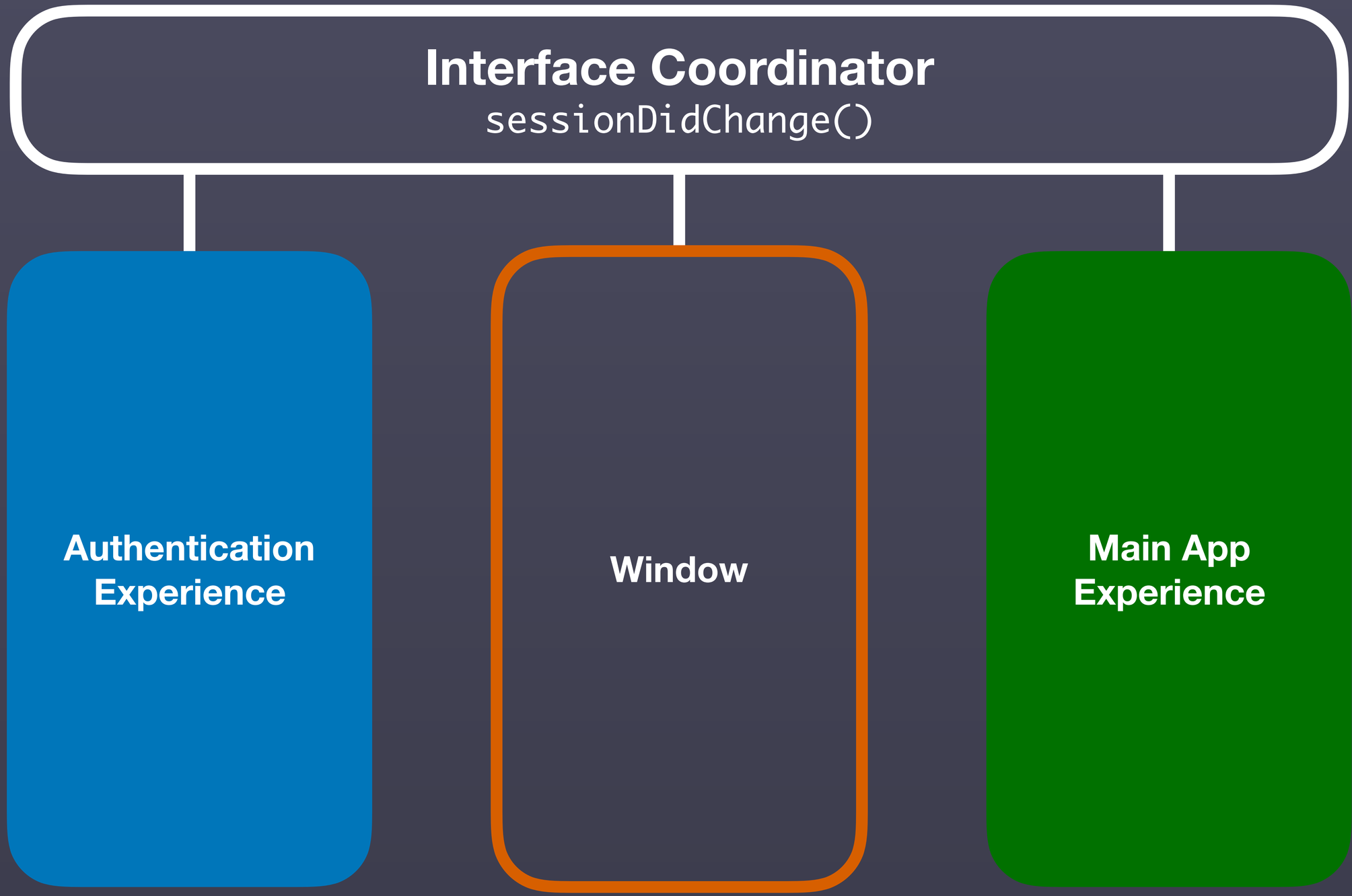
ServerConnection

```
class ServerConnection {

    private (set) var session: Session? {
        didSet { postSessionDidChangeNotification() }
    }

    func logIn(session: Session) throws

    func logOut() throws

}
```

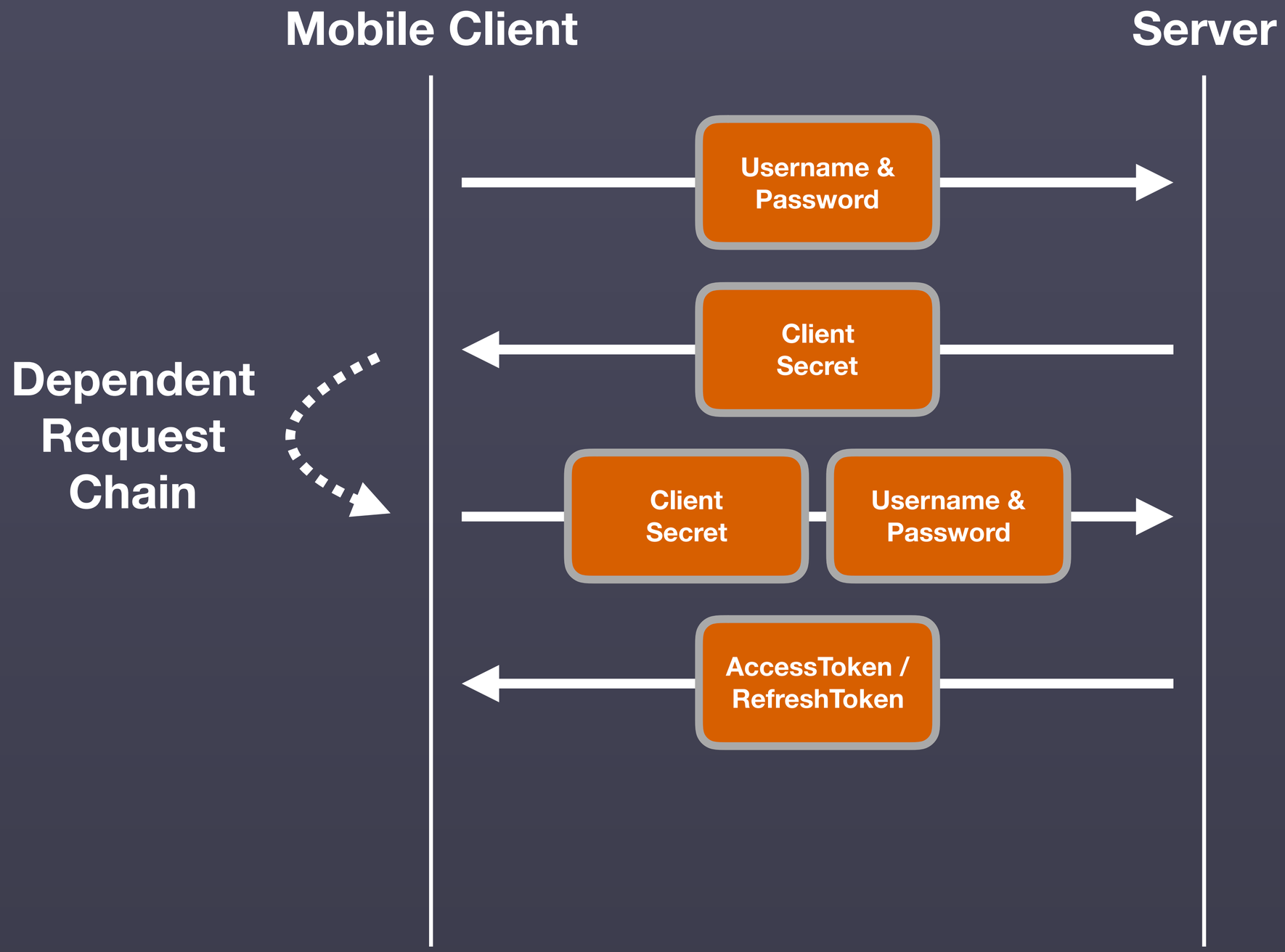
RequestDescribing

```
protocol RequestDescribing {

    var authenticationRequirement: AuthenticationRequirement { get }

    // previously described
}

enum AuthenticationRequirement {
    case none
    case accessToken
}
```

Interface Coordinator


Interface Coordinator
sessionDidChange()
Authentication Experience
Window
Main App Experience

Making a New Session


Mobile Client
Server
Dependent Request Chain
Username & Password
Client Secret
Client Secret
Username & Password
AccessToken / RefreshToken

```
// Inside of PlacesViewController

let request = FetchPlacesRequest()
serverConnection?.execute(request, completion: { (response, error) in

    if let error = error {
        // present alert
        return
    }

    guard let fetchPlacesResponse = response as? FetchPlacesResponse else {
        // present alert
        return
    }

    self.places = fetchPlacesResponse.places
    // refresh UI
})
```

Request / Response

Job / JobResult

```
let job = LogInJob(email: email, password: password)

serverConnection?.run(job, completion: { (jobResult, error) in

    if let error = error {
       return // Error Handling Cut For Space
    }

    guard let logInJobResult = jobResult as? LogInJobResult else {
        return // Error Handling Cut For Space
    }

    guard let session = logInJobResult.session else {
        return // Error Handling Cut For Space

    }

    // ServerConnection.login(session: session)
})
```

How do we implement?

```
run(_ job: Job)
```

NSOperation / NSOperationQueue

AsyncOperation

```
class AsyncOperation: Operation {

    // https://gist.github.com/parrots/f1a6ca9c9924905fd1bd12cfb640337a

}
```

NetworkRequestOperation

```
class NetworkRequestOperation: AsyncOperation {

    var request: RequestDescribing
    var result: Result<ResponseDescribing>?
    var accessToken: AccessToken?

    init(request: RequestDescribing) {
        self.request = request
    }
}

enum Result<T> {
    case success(T)
    case failure(Error)
}
```

Job Protocols

```
protocol Job {
    var resultType: JobResult.Type { get }
    var rootOperation: AsyncOperation { get }
}

protocol JobResult {
    init(operation: Operation) throws
}
```

LogInJob

```
struct LogInJob: Job {

    let email: String
    let password: String
    var resultType: JobResult.Type = LogInJobResult.self
    var rootOperation: AsyncOperation

    init(email: String, password: String) {
        self.email = email
        self.password = password
        self.rootOperation = LogInJobOperation(email: email, password:
password)
    }
}
```

LogInJob

```
class LogInJobOperation: AsyncOperation {

    let email: String
    let password: String

    var result: Result<Session>?

    init(email: String, password: String) {
        // Skipped for space
    }

    override func main() {
        // First does an inline NetworkRequestOperation for ClientSecret
        // Then Build an inline NetworkRequestOperation for AccessToken
        // Then packages Result, marks us as .finished
     }
}
```

LogInJob

```
struct LogInJobResult: JobResult {

    let session: Session?

    init(operation: Operation) throws {

        // Cast operation as LogInJobOperation
        // Pull the result out of LogInJobOperation

        switch result {
        case .failure(let error):
            throw error
        case .success(let session):
            self.session = session
        }
    }

}
```

```
let job = LogInJob(email: email, password: password)

serverConnection?.run(job, completion: { (jobResult, error) in

    if let error = error {
       return // Error Handling Cut For Space
    }

    guard let logInJobResult = jobResult as? LogInJobResult else {
        return // Error Handling Cut For Space
    }

    guard let session = logInJobResult.session else {
        return // Error Handling Cut For Space

    }

    // ServerConnection.login(session: session)
})
```

Job / JobResult

- -

NetworkRequestOperation / AsyncOperation (Subclasses)

- -

Request / Response

What have we gained?

- Can perform chained requests to generate OAuth tokens.
- ServerConnection now owns the Session.
- Interface Coordinator now owns ServerConnection.
  - Also, listens for Session changes to manage UI.
- ViewControllers still have simple work abstraction but they can now run lots of network requests to be fulfilled.
- ServerConnection can now mark Authenticated Requests.

Odds and Ends

SeverConnecton.run()

```
func run(
    _ job: Job,
    completion: @escaping JobCompletion,
    completionDispatchQueue: DispatchQueue = DispatchQueue.main)
-> JobToken



func cancel(_ requestToken: JobToken)
```

More Odds and Ends

- **OAuth Token Renewal, part of `run(_ job: Job)`**
- **Persisting Log In**
  - **Storing Session in Keychain between app execution**
- **Network Caching**
  - **Increase disk cache sizes**
  - **Honor ETag and cache headers, instead of using Core Data**
- **Integration Testing with Custom URLRequest Protocols**

Regrets

- Lots of files for a single API endpoint:
  - Request, Response, Job, JobResult, JobOperation, Custom AsyncOperation Subclass (complicated needs).
  - Can be lessened through Swagger code generation.
- Might be able to add-to NetworkRequestOperation to handle collections of Requests.

Take Aways

- Separate Design and Code Time.
- Draw and Sketch Out Systems Before Attempting To Code.
- Build Small, Focused, Single-Responsibility Objects.
- Make It Work, Make It Pretty, Make It Testable, Make It Documented.
- Iterate And Refactor Aggressively.
- Break Big Problems into Small Solutions Over Time.

Recommended

- Atlas, an unified approach to mobile development cycle: networking layer
  - https://medium.com/iquii/a5ccb064181a
- John Sundell: The Lost Art of System Design
  - https://www.youtube.com/watch?v=ujOc3a7Hav0

Thanks

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