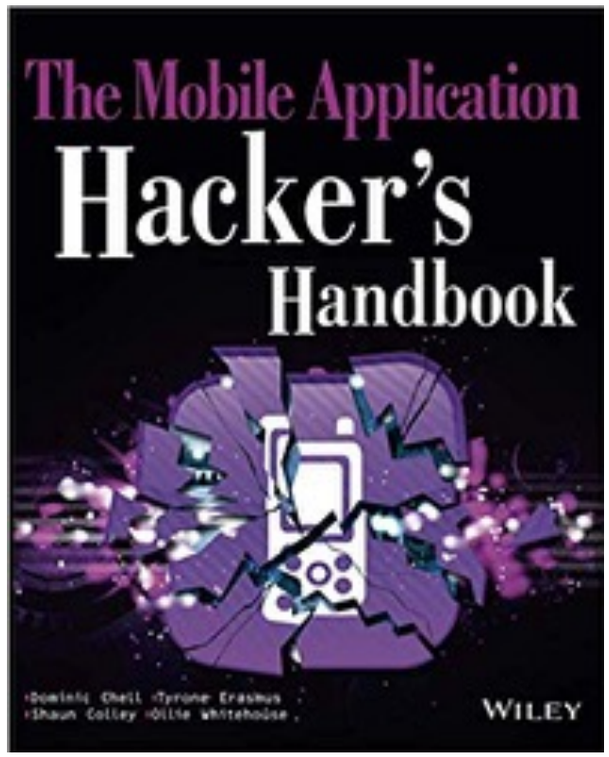
CNIT 128
Hacking Mobile Devices



3. Attacking iOS Apps
Part 2

Updated 5-12-2021

Topics: Part 1

- Introduction to Transport Security
- Identifying Insecure Storage
- Patching iOS Applications with Hopper

Topics: Part 2

- Attacking the iOS Runtime
- Understanding Interprocess Communication
- Attacking Using Injection

Attacking the iOS Runtime

The Runtime

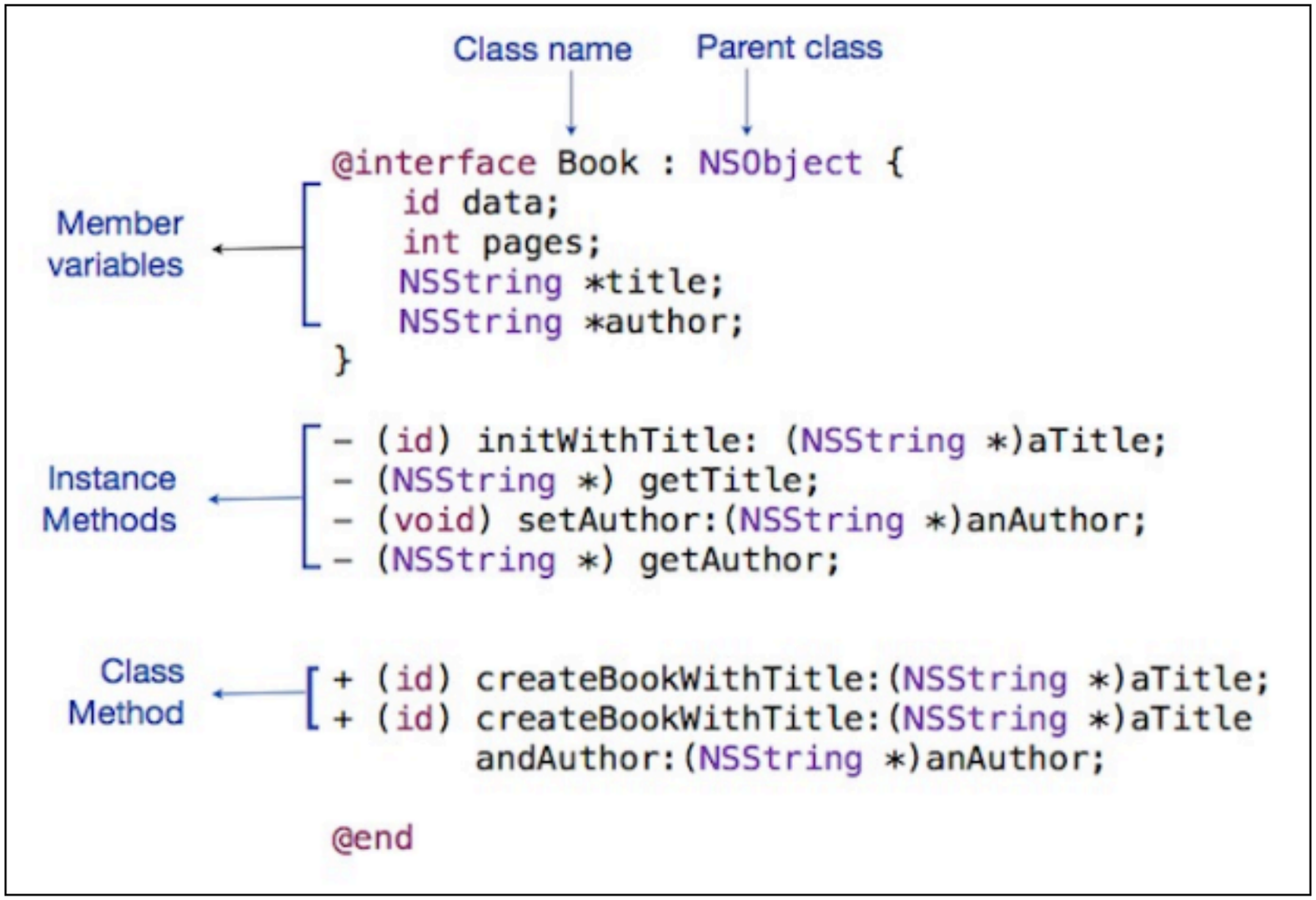
- Objective-C and Swift defer many decisions
  - From compile-and-link time
  - To runtime
- By using **reflection**
  - Apps modify their own behavior at runtime
  - Dynamically load new classes
  - Change method implementations

Understanding Objective-C and Swift

- Object-oriented languages
- **Objects** encapsulate data in the form of **classes**
- **Classes** contain
  - Instance variables
  - Methods
  - Properties

Interface File

- Defines a class structure
  - Image from https://blog.teamtreehouse.com/an-introduction-to-objective-c



Methods

- **Instance methods** can only be invoked
  - After creating an **instance** of the **class**
- **Class methods** can be invoked
  - Without actually creating an **instance** of the **class**

Swift Class

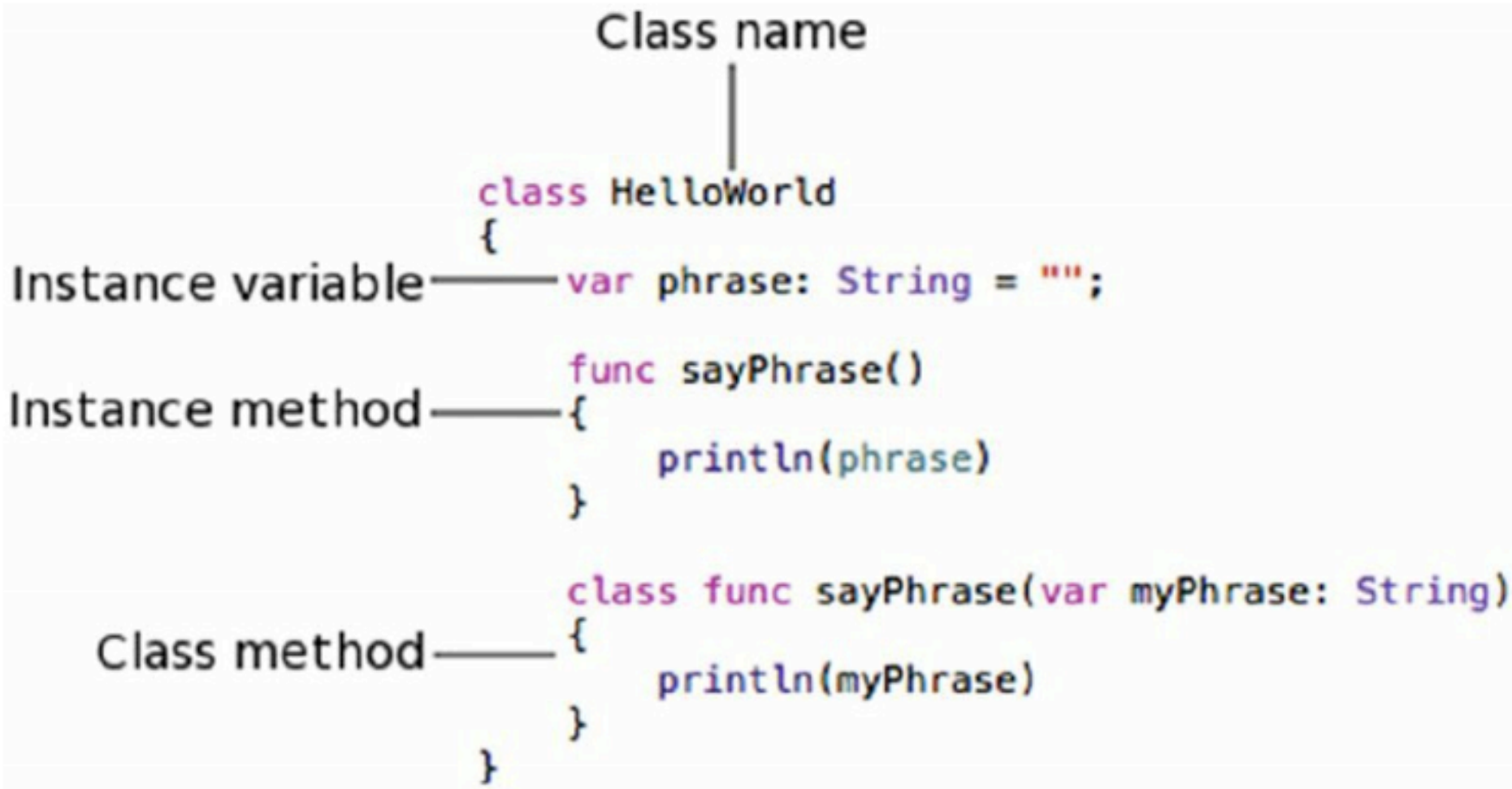


Figure 3.18 A breakdown of Swift class

Instrumenting the iOS Runtime

- Tracing, debugging, or otherwise profiling the execution of an app at runtime
- Examples:
  - Bypassing jailbreak detection
  - Stealing encryption keys
  - Force-loading view controllers
  - Attacking local authentication
  - Pivoting to internal networks
  - Demonstrating the risks of malware
  - Inspecting a custom encryption protocol

Instrumenting Objective-C

- Objective-C is by far easiest to instrument
- To invoke a function
  - Pass it a message
  - Through the runtime's **objc_msgSend()** function
- To instrument it, simulate calls to **objc_msgSend()**

Method Swizzling

- Replace the implementation of a method at runtime
- A **class** maintains a **dispatch table**
  - With a map of **selectors** to **implementations**
  - **Selector**: name of **method**
  - **Implementation**: pointer to function
- Replacing pointers achieves swizzling

Instrumenting Swift

- Swift uses direct function calls and vtable lookups
- Requires more effort to instrument

Cydia Substrate

- Runtime manipulation framework
- Created by saurik
- Can instrument apps on iOS
- Inherent in most jailbreaks
- Pre-installed with Cydia

Tweaks

- Also called **substrate extensions**
- Developed using the Cydia Substrate C API
- Compiled as dynamic libraries
- Placed in **/Library/MobileSubstrate/DynamicLibraries**
- Loaded into an app by **MobileLoader**

Filters

- Prevent your extension being loaded into every new process
- **Filters** are plist files
- In binary plist, XML, or JSON format
- Name is same as your tweak, with **.plist** file extension

```
-rw--r-xr-- x 1 root   staff 1485584 Oct 24 16:12 mdsectweak.dylib*

-rw-r—r— 1 root   staff     304 Oct 24 16:12 mdsectweak.plist
```

mdsectweak.plist

Filters by bundle identifier

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
        <key>Filter</key>
        <dict>
                <key>Bundles</key>
                <array>
                        <string>com.mdsec.lab1-1a</string>
                </array>
        </dict>
</dict>
</plist>
```

Tweak Development Environments

- iOSOpenDev
  - Limited to OS X
- **Theos**
  - Works on iOS, OS X, and Linux
  - Recommended
- Captain Hook
  - Dated, limited to OS X

Key Functions

- MSHookFunction
- MSFindSymbol
- MSGetImageByName
- MSHookMessageEx

Key Functions

- MSHookFunction
  - Hooks native C or C++ code functions
    - Uses a trampoline to divert the execution flow to a replacement function
- MSFindSymbol
  - Finds symbols by name
  - Not possible with stripped apps

Key Functions

- MSGetImageByName
  - Loads a dynamic library
    - If it's not already loaded
- MSHookMessageEx
  - Implements method swizzling for functions that inherit from **NSObject**

Example

```
1:  #include <substrate.h>
2:  #include <sys/stat.h>
3:
4:  static int (*oldStat)(const char *path, struct stat *buf);
5:
6:  int newStat(const char *path, struct stat *buf)
7:  {
8:      NSLog(@"Stat hooked - checking for bash");
9:      if (strcmp(path, "/bin/bash") == 0)
10:         return ENOENT;
11:
12:     return oldStat(path, buf);
13: }
14:
15: MSInitialize {
16:     MSHookFunction(stat, newStat, &oldStat);
17: }
```

- Line 4: **oldStat** points to original **stat()** function, which shows a file's status
- Lines 6-13: Replacement stat
  - If path argument is **/bin/bash**, print an error message

Example

```
1:  #include <substrate.h>
2:  #include <sys/stat.h>
3:
4:  static int (*oldStat)(const char *path, struct stat *buf);
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6:  int newStat(const char *path, struct stat *buf)
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8:      NSLog(@"Stat hooked - checking for bash");
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11:
12:     return oldStat(path, buf);
13: }
14:
15: MSInitialize {
16:     MSHookFunction(stat, newStat, &oldStat);
17: }
```

- Line 15: **MSInitialize** loads its contents first when the app loads
- Line 16: **MSHookFunction** has three arguments
  - Symbol to replace, new function, old function

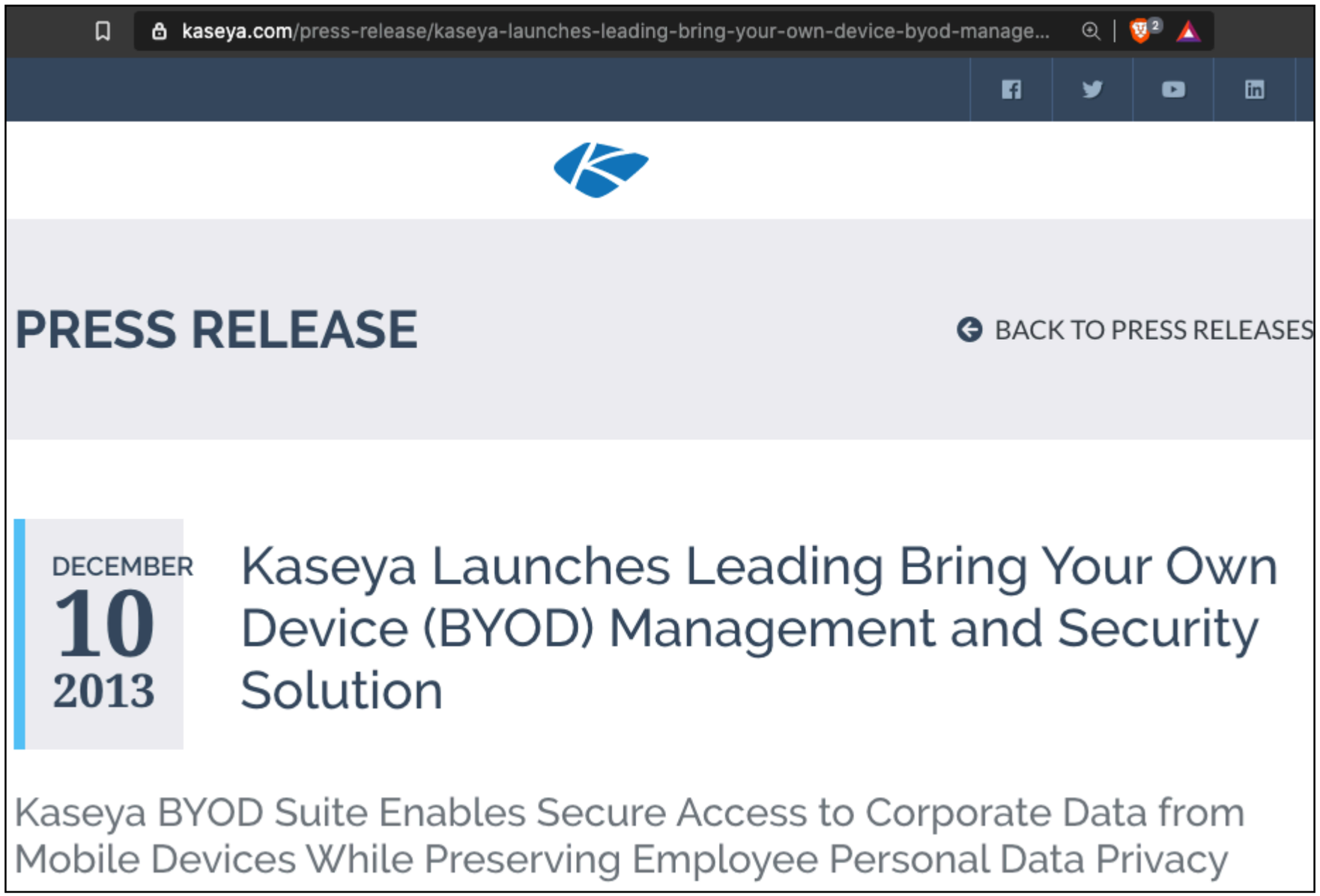
Cycript

- A runtime instrumentation tool for iOS apps
  - Blends JavaScript and Objective-C
  - Can access and manipulate objects in a running app
- Able to
  - Brute-force local authentication
  - Steal encryption keys from populated objects
  - Force loading of view containers

Pivoting to Internal Networks

- **BYOD** (Bring Your Own Device)
- **MDM** (Mobile Device Management)
  - Apps that let you connect to company resources from a phone
  - If vulnerable, allow an attacker into the internal network

Kaseya BYOD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PRESS RELEASE
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Kaseya Launches Leading Bring Your Own Device (BYOD) Management and Security Solution
Kaseya BYOD Suite Enables Secure Access to Corporate Data from Mobile Devices While Preserving Employee Personal Data Privacy

Attacking Kaseya BYOD

- Kaseya gateway provides service to internal resources
  - Can be accessed by **Kaseya Secure Browser**
  - With no further authentication
- Compromise of mobile device exposes internal resources

Instrumentation with Frida

- Frida is a standalone instrumentation framework
  - Does not use Substrate
- No modification to the device required
  - Other than running the **frida-server** binary
- Controlled by a client over USB or the network

Dynamic Linker

- In Linux, the **LD_PRELOAD** environment variable
  - Dynamically loads a library into a process
- In Mac OS or iOS, use **DLYD_INSERT_LIBRARIES**

```
launchctl setenv DYLD_INSERT_LIBRARIES "/usr/lib/isjailbroken.dylib"
```

Understanding Interprocess Communication

Sandbox

- iOS apps run in an isolated sandbox
- Interprocess communication is prohibited
- Exceptions
  - Pasteboard
  - Registered protocol handlers
  - Application extensions

Attacking Protocol Handlers

- To open the App Store app, use
  - **itms-apps:**//itunes.apple.com/app/id<num>
- You can define a custom URL scheme in your app's **Info.plist** file, such as
  - myvoip://dialer/?call=123

Automatic Loading

- In an iframe on a web page
  - <iframe src="myvoip://dialer/?call=0044906123123 "></iframe>
- This happened with Skype

Application Extensions

- Some are pre-defined by Apple
  - **Today** -- extend the Today view of the notification center
  - **Share** -- to share content with other apps
  - **Custom Keyboard**

Application Extensions

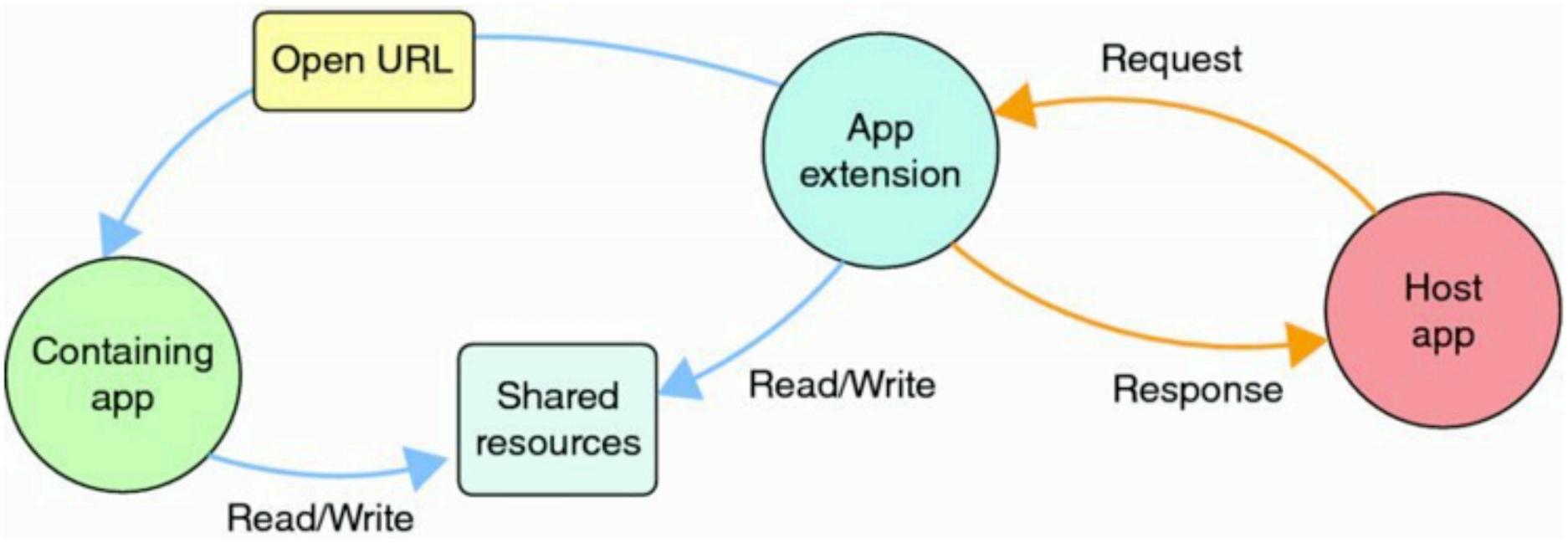

Figure 3.24 An app extension can indirectly communicate and share resources with the containing app.

1Password

- Uses an extension so other apps can query credentials, such as Twitterific
- A malicious app could request credentials for any domain

Attacking Using Injection

iOS Entry Points

- Input enters through:
  - Web applications
  - URL schemes
  - File types
  - AirDrop
  - iBeacons
  - Bluetooth
  - Wi-Fi
  - Pasteboards
  - Application extensions

Injecting into UIWebViews

- UIWebView renders web content from
  - HTML
  - PDF
  - RTF
  - Office documents
  - iWork documents
- Built on WebKit, like Safari and MobileSafari

UIWebViews

- Supports JavaScript
  - Cannot be disabled
- XSS attacks are possible
  - Can steal content, such as the Address Book

Skype XSS

- Skype iOS app allowed script injection into a user's full name
- Could access the local file system
- And upload the address book

Injecting into Client-Side Data Stores

- SQLite databases
  - Vulnerable to SQL injection
- Exposes data, but not usually command injection

Injecting into XML

- "Billion Laughs" DoS attack
  - Multiple nested XML entities
    - Expanding them uses excessive resources
- If parsing of external entities is allowed
  - Could be used to attack web apps on the local network

Injection into File-Handling Routines

- Less common, but some apps have this injection vulnerability
- User controls a filename
- Directory traversal attacks
- Example:
  - Joe can upload a profile pic to **Documents/joe/joepic.png**
  - Joe can change the filename to
    - **../jane/janepic.png** to read or write to another user's folder


Kahoot!