

Writing a native Mac GUI application in Haskell

Nikolas Mayr <bobkonf@login.n-mayr.de>
BOBKonf2017

Agenda

- JSON Class Generator
- Joining the worlds
- Architecture
- In practice
- Retrospective

- Mac Application
- ~15.000 lines of Haskell
- ~ 3.000* lines of Objective-C



- Mac App Store
- Web 
- Sandboxed
- lifted.software

JSON Class Generator

Demo

SampleProject.apifile

Name	Type
Person	: Class
name	String
age	Int
gender	Gender
+ Property	
Gender	: Enum
female	
male	
+ Enum Value	

```
// This file was generated. It might get overwritten.  
// Try modifying the definition fed to the generator.  
  
#import <Foundation/Foundation.h>  
  
@class ApiError;  
  
// - - - Gender - - -  
  
typedef NS_ENUM(NSInteger, Gender) {  
    GenderFemale,  
    GenderMale  
};  
  
/// @brief apiError can be nil  
Gender GenderFromStringServer(NSString *str, ApiError *apiError);  
Gender GenderFromInteger(NSInteger i);  
NSString *NSStringFromGenderServer(Gender gender);  
NSString *NSStringFromGenderDisplay(Gender gender);  
  
// - - - Person - - -  
  
@interface Person : NSObject <NSCopying, NSSecureCoding>  
  
@property (nonatomic, copy) NSString *name;  
@property (nonatomic) NSInteger age;  
@property (nonatomic) Gender gender;  
  
+ Enum    + Class    ApiModel.h
```

Feedback Export Code

Recap

- Define Classes/Enums/Methods
- Export Objective-C code
- Use code to serialize/deserialize JSON
- Drop in (HTTP-)Client to connect to Service

How Did I Write It?

- Hardcoded types in Haskell source (2014)
- Command Line Tool (2015)
- Mac/Cocoa NSDocument based GUI App (2016)

```
1  data Type
2    = Int
3    | String
4    | Array Type
5    ...
6
7  apiService = ApiService
8    { apiFunctions = [ getOrder ]
9    , apiTypes = [ order ]
10   }
11
12 getOrder :: Function
13 getOrder = Function
14   { funcName = "get_order"
15   , funcConsts = consts GET "v1/order" RequiresAuthToken
16   , funcParams = [ "orderId" !! Int ]
17   , funcSuccess = ResultDirect "order" order
18   , funcFailure = resultError stdError
19   }
20
21 order :: Type
22 order = Class "Order" $
23   [ "id"           !! Int
24   , "products"    !! Array product
25   , "document"    !! document
26   , "attributes"  !! Array attribute
27   ]
```

Evolution

- Hardcoded types in HS source (2014)
- **Command Line Tool (2015)**
- Mac/Cocoa NSDocument based GUI App (2016)

```
> api --lang objc --def api.json --out ./src/api
```

```
1  {
2      "tag": "ApiDefinitionV0",
3      "contents": {
4          "apiDefinitionFunctions": [
5              {
6                  "name": "get_order",
7                  "consts": {
8                      "method": "GET",
9                      "path": "v1/order",
10                     "access": "RequiresAuthToken"
11                 },
12                 "params": {
13                     "orderId": "Int"
14                 },
15                 "success": {
16                     "order": "Order"
17                 },
18                 "failureUnwrap": {
19                     "ioErrorStr": {
20                         "subtype": "String",
21                         "type": "Optional"
22                     },
23                     "appError": {
24                         "subtype": "StdError",
25                         "type": "Optional"
26                     }
27                 }
28             },
29         ],
30         "apiDefinitionTypes": [
31             {
32                 "type": "Class",
33                 "name": "Order",
34                 "vars": {
35                     "id": "Int",
36                     "products": {
37                         "type": "Array",
38                         "subtype": "Product"
39                     },
40                     "document": "Document",
41                     "attributes": {
42                         "type": "Array",
43                         "subtype": "Attribute"
44                     }
45                 }
46             }
47         ]
48     }
49 }
```

Cutting Edge

- Hardcoded types in HS source (2014)
- Command Line Tool (2015)
- **Mac/Cocoa NSDocument based GUI App (2016)**

▼ Order	: Class	<input type="text"/> X
id	<input type="text"/> Int X	<input type="button"/>
products	<input type="text"/> [Product]	<input type="button"/>
document	<input type="text"/> Document	<input type="button"/>
attributes	<input type="text"/> [Attribute]	<input type="button"/>
+ Property		
▼ get_order	: Method	<input type="text"/> X
▼ Constants	: { String : String }	<input type="button"/>
method	GET	<input type="button"/>
path	v1/order	<input type="button"/>
access	RequiresAuthToken	<input type="button"/>
+ Constant		
▼ Parameters	: Property	<input type="button"/>
order_id	<input type="text"/> Int X	<input type="button"/>
+ Parameter		
▼ Success	: Property	<input type="button"/>
order	<input type="text"/> Order	<input type="button"/>
▼ Failure	: Property	<input type="button"/>
ioErrorStr	<input type="text"/> String? X	<input type="button"/>
appError	<input type="text"/> String? X	<input type="button"/>

Joining the Worlds

How to Build the UI

- Non-native UI
 - Web
 - Cross platform UI Libraries (GTK, QT)
- Native UI
 - Cocoa/ObjC UI + ObjC model -> call CLT
 - Cocoa/ObjC UI + HS model (together in one app)

Adding Some Glue

- Communicate to HS via FFI
 - c2hs
 - Bindings (HoC, ObjectiveHaskell)
 - language-c-inline
 - Others (Apache Thrift)
- Client-Server (no network)

How Do We Connect ObjC to a Server that Speaks JSON?

JSON Code Generator!



ObjC Generated



~3000 LoC



+ ~13000 LoC

~16000 LoC

How to Compile

- Compiled languages
- Xcode, not Terminal
- Build phases
 - HS to static library "-staticlib" => liba.a (ext. build tool)
 - Generate API from specification file
 - Compile ObjC (+Storyboards), copy assets/frameworks
 - Link with liba.a libiconv

Compile Attempts

hs-test1-simple-ffi	►	00-hsTest-buildTermi-mainHS-objectFiles-linkGHC	►
hs-test2-currency-converter	● ►	01-hsTest-buildTermi-mainHS-objectFiles-linkCLang	● ►
hs-test3-HSOBJC_Test	● ►	02-hsTest-buildTermi-mainHS-staticLib-linkGHC	►
hs-test4-nWaysToBuild	● ►	03-hsTest-buildTermi-mainHS-staticLib-linkCLang	►
hs-test5-pimpingJsonExport	● ►	04-hsTest-buildTermi-mainC-objectFiles-linkGHC	►
hs-test6-ffi-api	● ►	05-hsTest-buildTermi-mainC-objectFiles-linkCLang	►
hs-test7-ApiJs...CodeGenerator	● ►	06-hsTest-buildTermi-mainC-staticLib-linkGHC	►
hs-test8-language-c-inline	● ►	07-hsTest-buildTermi-mainC-staticLib-linkCLang	►
		08-hsTest-buildXCode-mainHS-objectFiles-linkGHC	● ►
		15-hsTest-buildXCode-mainC-staticLib-linkCLang	● ►

Application Launch

- Two runtimes to start
- Bound threads
- FFI
- -threaded

```
int main(int argc, char * argv[]) {  
    hs_init(&argc, &argv);  
    hs_mainCltOrGui();  
    hs_exit();  
    return 0;  
}
```

```
mainCltOrGui :: IO Int -- ExitCode  
mainCltOrGui = do  
    args <- getArgs  
    case args of  
        ("clt":as) -> mainClt as >> return 0  
        _                -> c_nsApplicationMain
```

```
int nsApplicationMain(void) {  
    return NSApplicationMain(0, NULL);  
}
```

Architecture

ApiDocument : NSDocument

```

NS_ASSUME_NONNULL_BEGIN

@class Document;
@class Product;
@class Document;
@class Attribute;

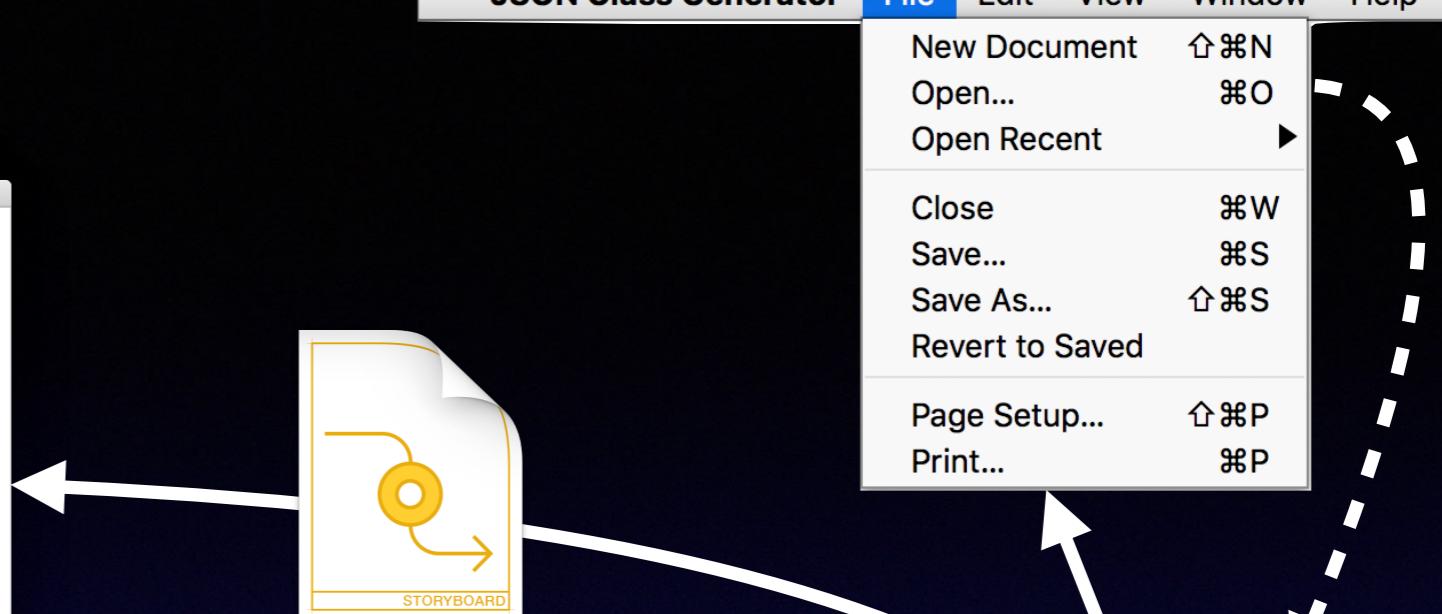
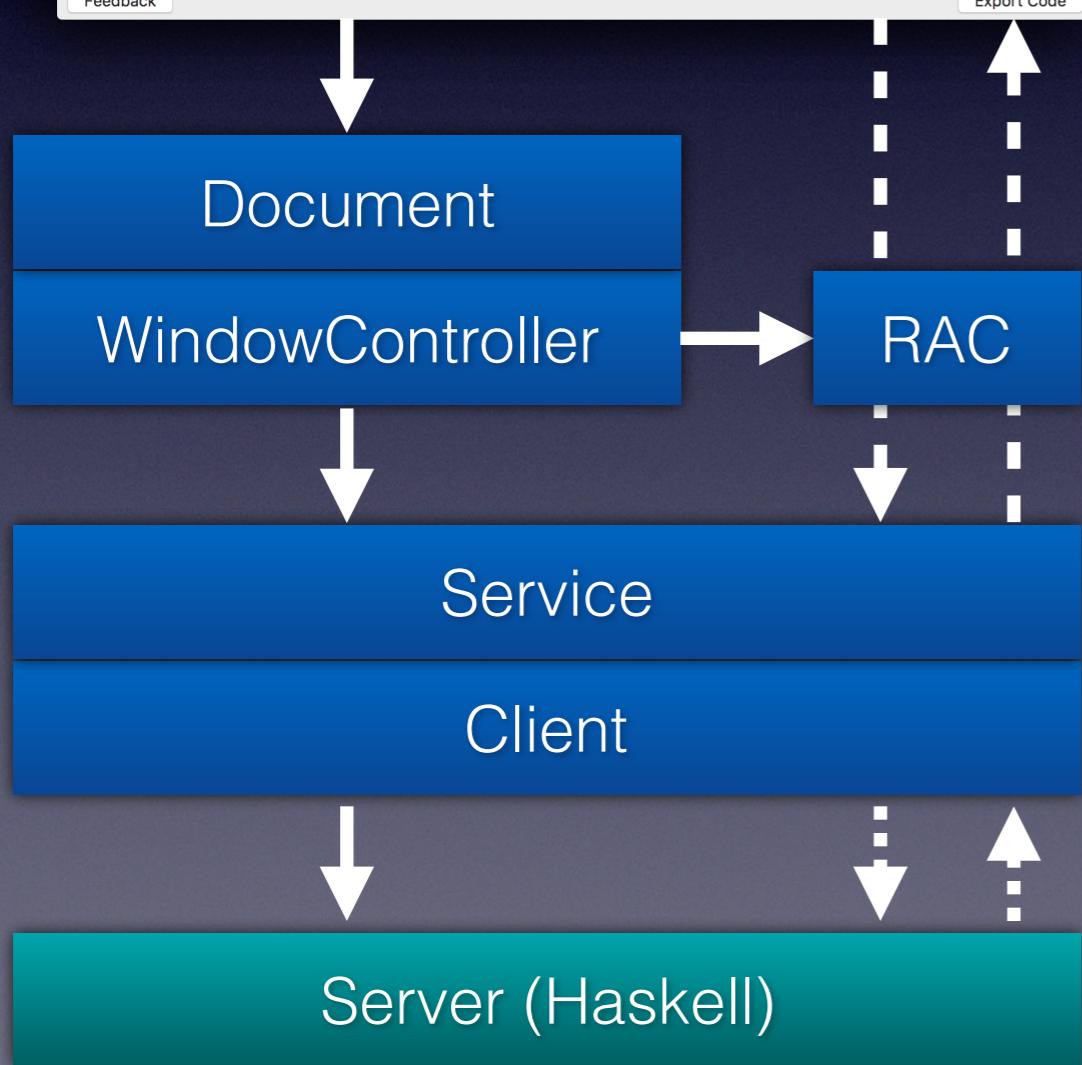
@interface Order : NSObject <NSCopying, NSSecureCoding>

@property (nonatomic) NSInteger id;
/// @brief [Product]
@property (nonatomic, copy) NSArray *products;
/// @brief Document
@property (nonatomic) Document *document;
/// @brief [Attribute]
@property (nonatomic, copy) NSArray *attributes;

#pragma mark direct initialization

-(instancetype)init;
/// @brief products :: [Product]; attributes :: [Attribute]
-(instancetype)initWithId:(NSInteger)id_products:(NSArray *)products
document:(Document *)document attributes:(NSArray *)attributes
NS_DESIGNATED_INITIALIZER;

```



ApiDocument : NSDocument

```

// This file was generated. It might get overwritten.
// Try modifying the definition fed to the generator.

#import <Foundation/Foundation.h>
@class ApiError;

NS_ASSUME_NONNULL_BEGIN

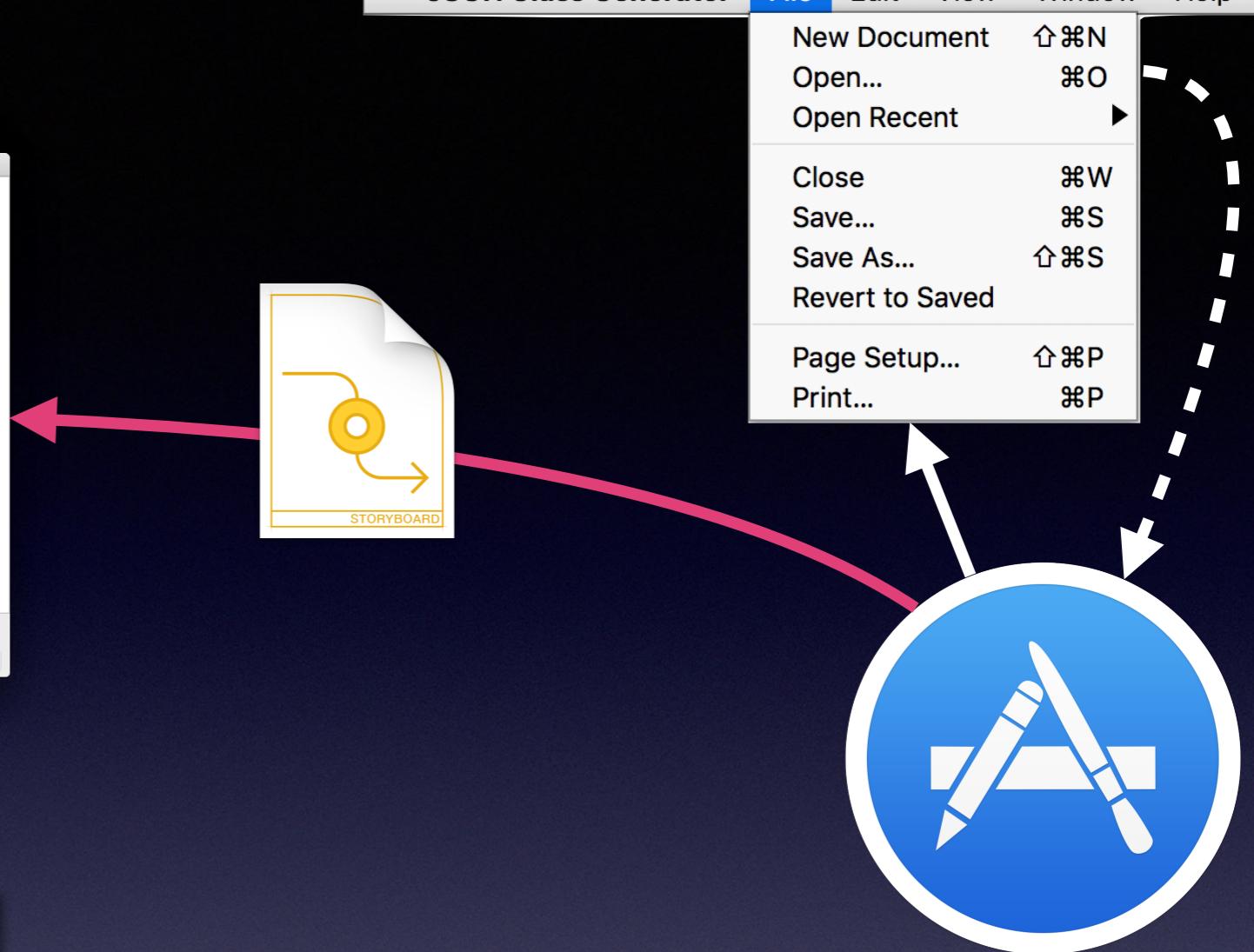
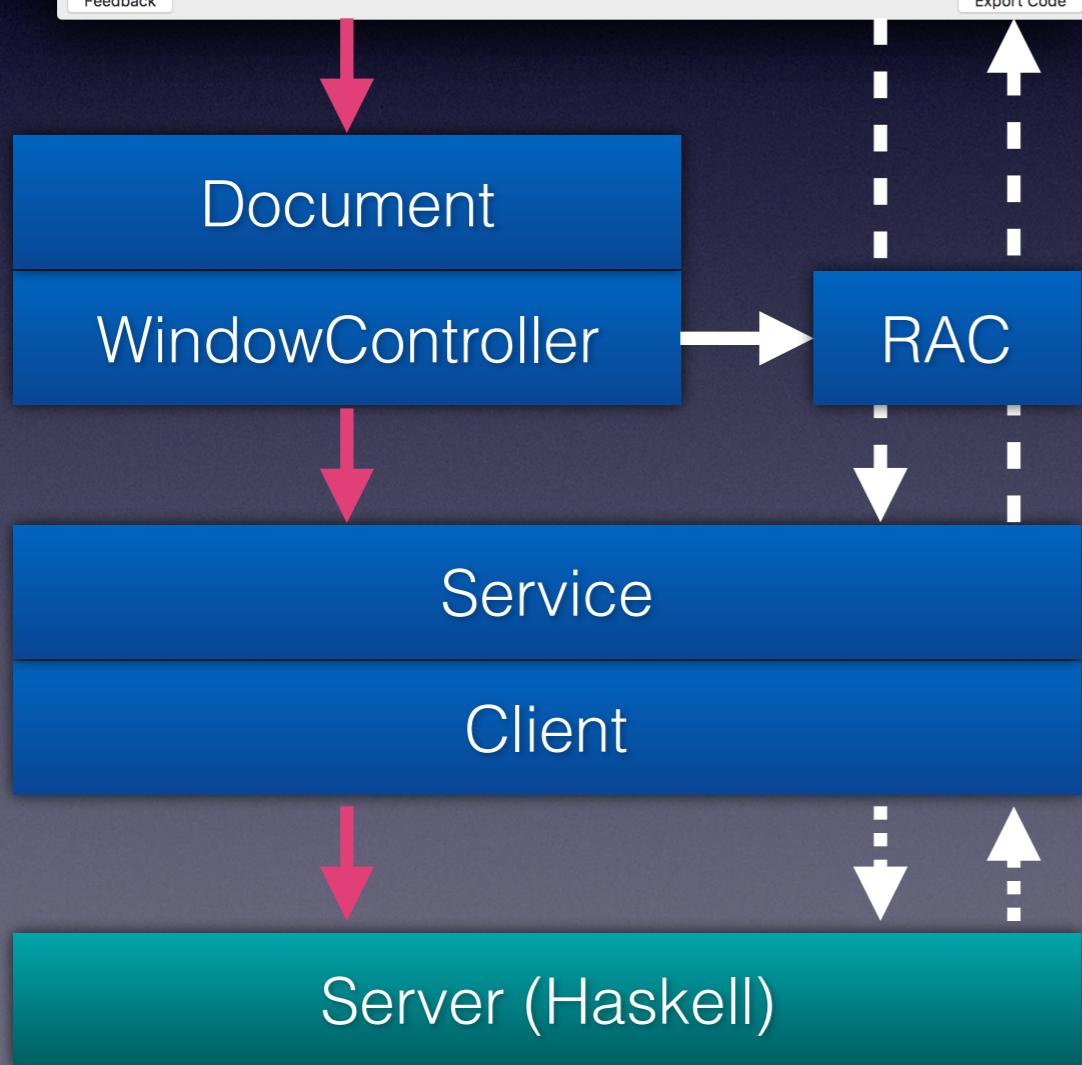
@interface Order : NSObject <NSCopying, NSSecureCoding>

@property (nonatomic) NSInteger id_;
/// @brief [Product]
@property (nonatomic, copy) NSArray *products;
@property (nonatomic) Document *document;
/// @brief [Attribute]
@property (nonatomic, copy) NSArray *attributes;

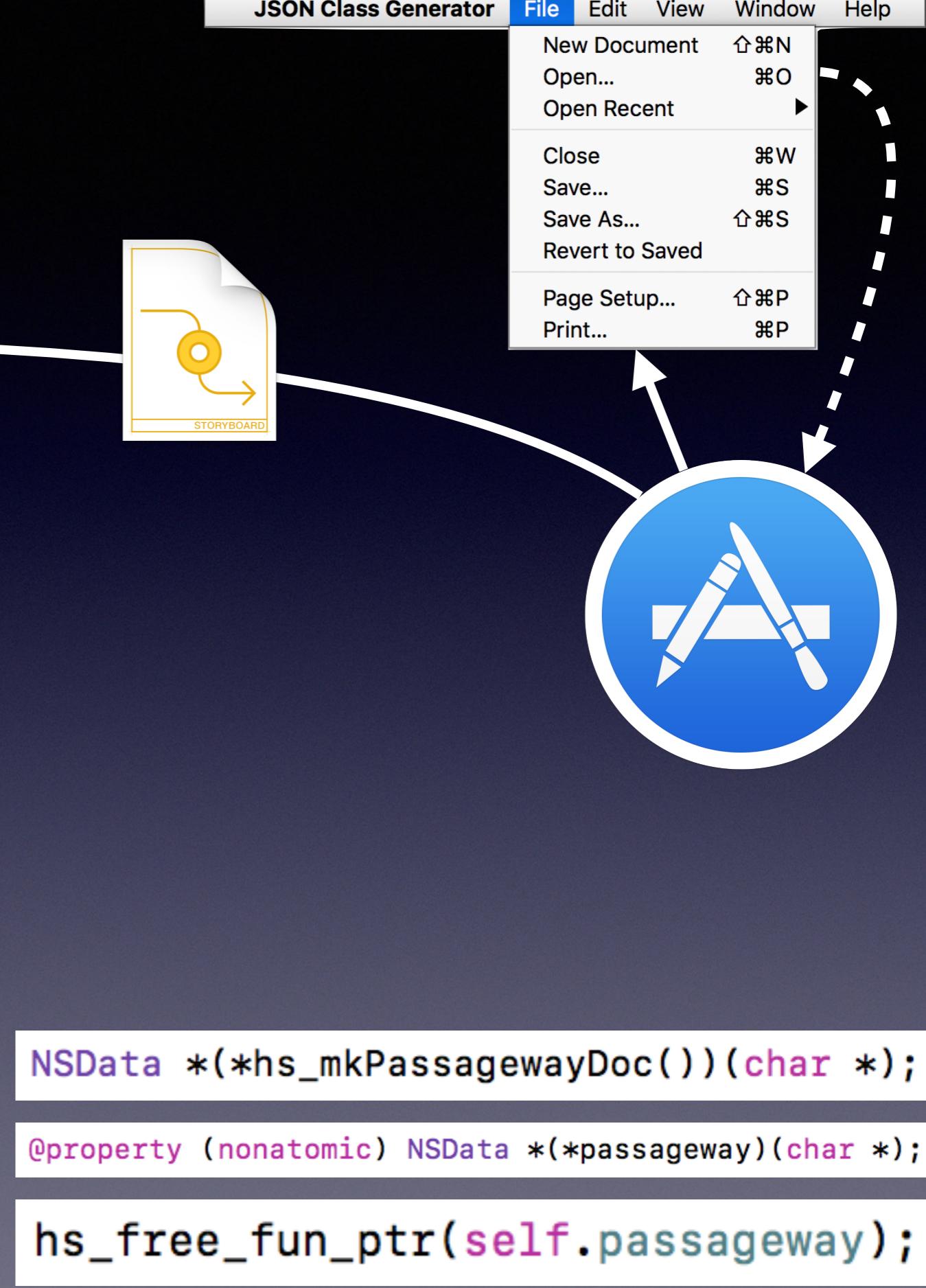
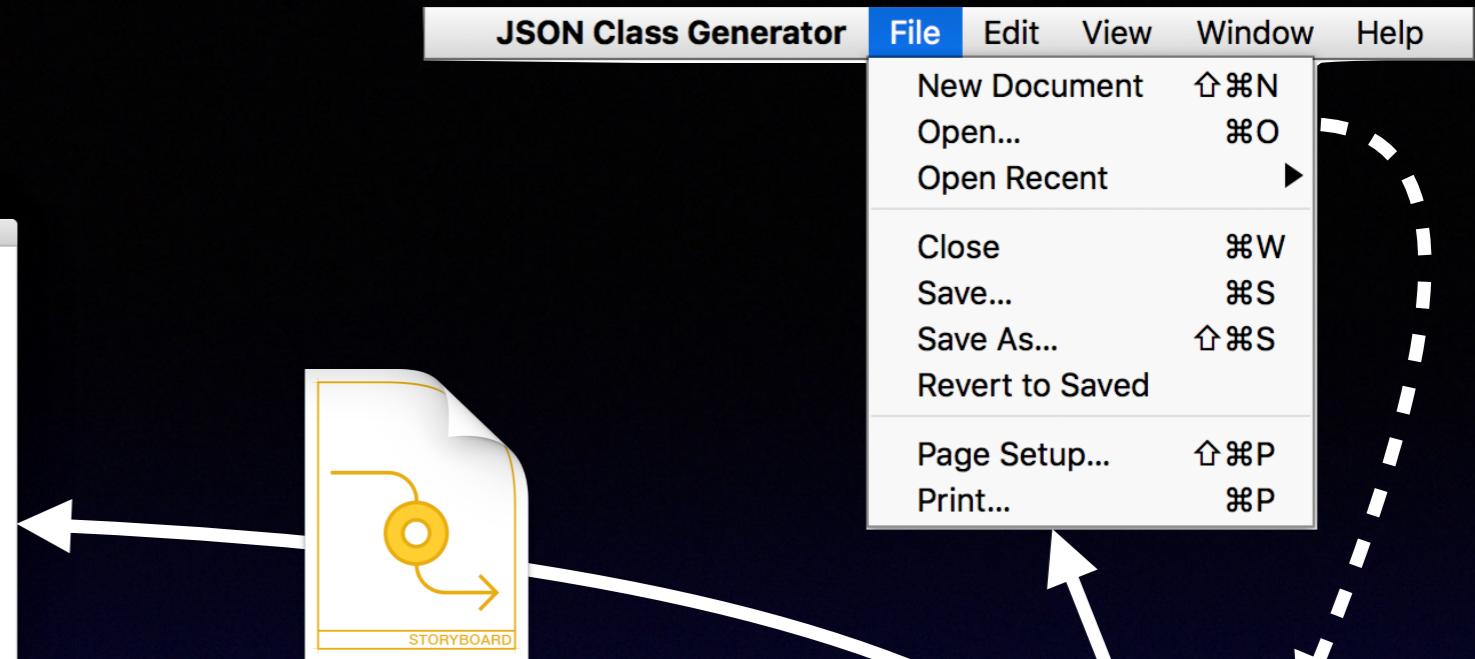
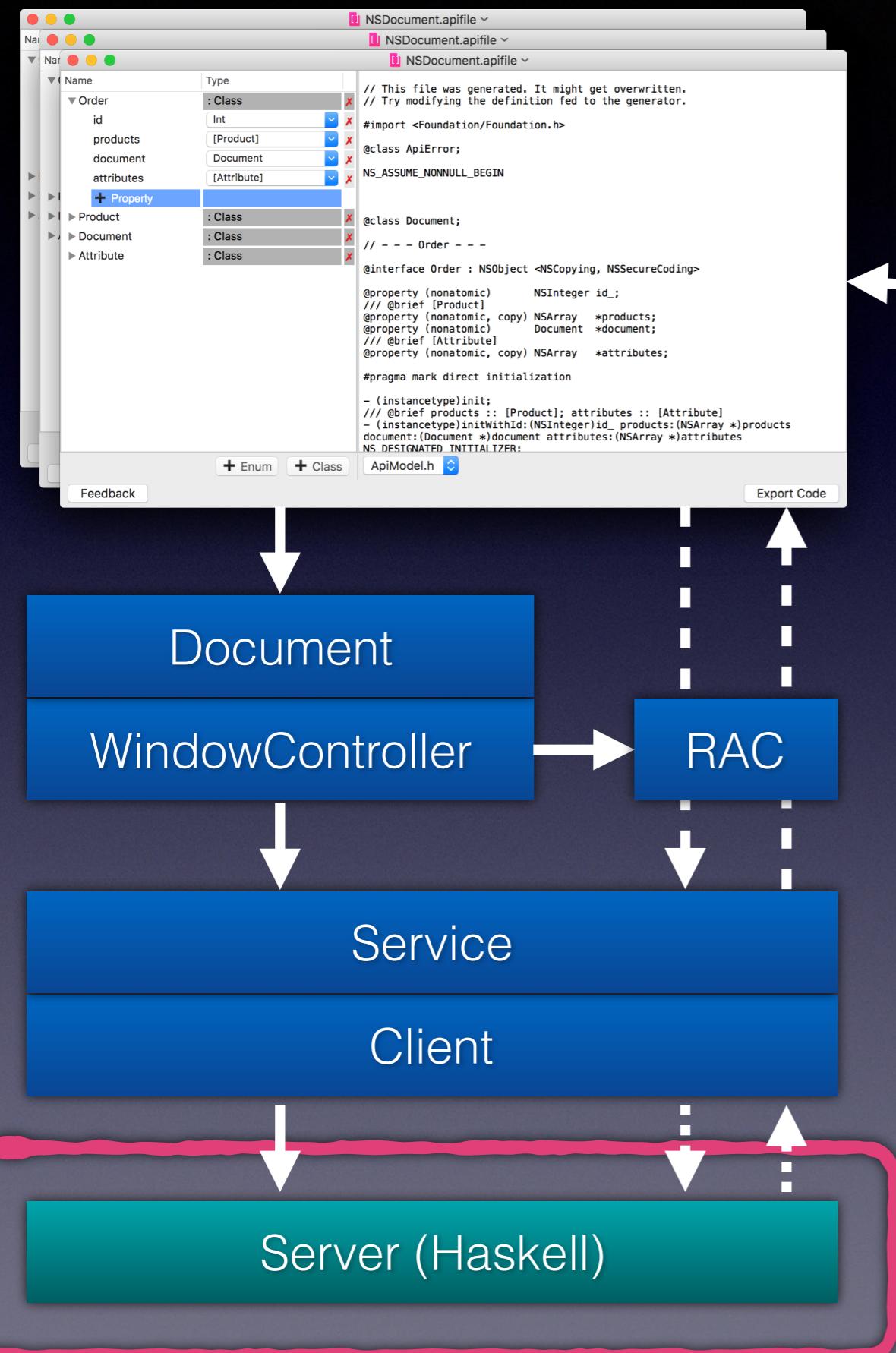
#pragma mark direct initialization

-(instancetype)init;
/// @brief products :: [Product]; attributes :: [Attribute]
-(instancetype)initWithId:(NSInteger)id_products:(NSArray *)products
document:(Document *)document attributes:(NSArray *)attributes
NS_DESIGNATED_INITIALIZER;

```



ApiDocument : NSDocument



Client-Server (HS)

- Stores model (synchronized access)
- Serves JSON API
- No HTTP needed (server hardwired)
- Blocking calls
- No latency
- One instance per Document

Haskell Server

```
processAction :: Action -> App -> (App, Value)
processAction action_ = case action_ of

    ActionProcessContinuationIdStrButton buttonId ->
        continueWithContMStrBut (Just buttonId)
    ActionProcessContinuationIdStrTextField textFieldId txt ->
        continueWithContMStrTxt (Just textFieldId) txt

    ActionHistoryCanUndo -> -- Bool
        readHistoryOfModel historyCanUndo
    ActionHistoryUndoMenuItemTitle -> -- String
        readHistoryOfModel $ maybe "Undo" ("Undo: "++) . historyUndoName

    ActionExport ->
        readModel modelGetApiGenerated

    ActionModiClassCreate -> -- return TypeDefinitionId
        runStateDefinition (addClass "") $ show action_
```

Model

- Undo Manager
- Outline View
- Encoding Callbacks
- Continuation Passing Style
- Performance (outline view, json serialization)

ApiDocument : NSDocument

```

NS_ASSUME_NONNULL_BEGIN

@class Document;
@class Product;
@class Document;
@class Attribute;

@interface Order : NSObject <NSCopying, NSSecureCoding>

@property (nonatomic) NSInteger id;
/// @brief [Product]
@property (nonatomic, copy) NSArray *products;
/// @brief Document
@property (nonatomic, copy) Document *document;
/// @brief [Attribute]
@property (nonatomic, copy) NSArray *attributes;

#pragma mark direct initialization

- (instancetype)init;
/// @brief products :: [Product]; attributes :: [Attribute]
- (instancetype)initWithId:(NSInteger)id_products:(NSArray *)products
document:(Document *)document attributes:(NSArray *)attributes
NS_DESIGNATED_INITIALIZER;

```

Feedback **Export Code**

Document

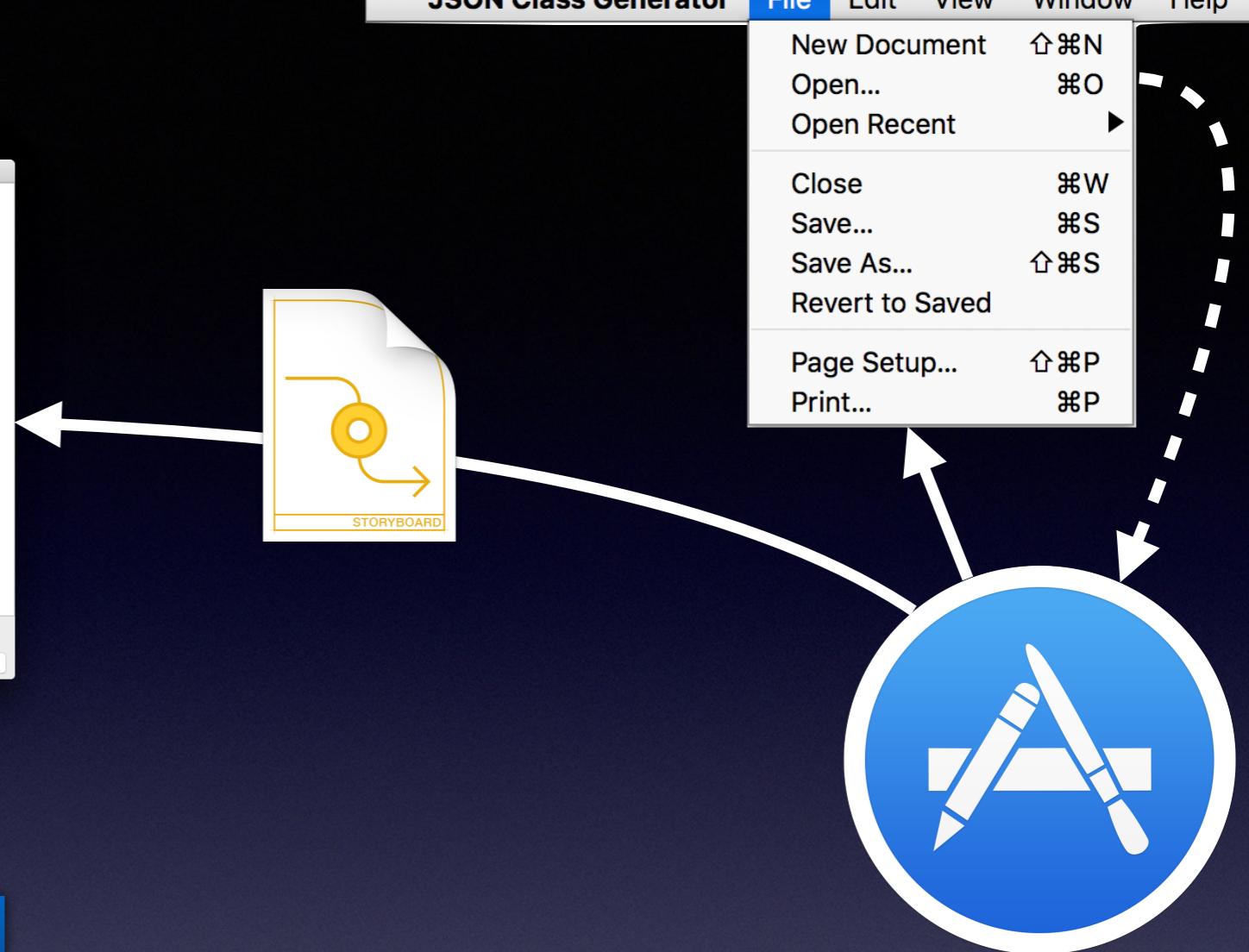
WindowController

RAC

Service

Client

Server (Haskell)



(ObjC) Client-Server

- Powers service
- Serializes requests (Object -> JSONValue -> char *)
- Memory management
- Deserializes responses (NSData * -> JSONValue -> Object)
- Logs errors and exceptions
- Updates ModelRevisionCounter

(ObjC) Client-Server

- Powers service
- Serializes requests (Object -> JSONValue -> char *)
- Memory management
- Deserializes responses (NSData * -> JSONValue -> Object)
- Logs errors and exceptions
- Updates ModelRevisionCounter

Memory Management

- ObjC ARC
- HS GC
- Avoidance
- Request: FFI bracket
- Response: NSData allocation, ARC
- Problem: wasting memory (make model strict)

Exception Handling

- Error reporting
- What happens if ObjC crashes?
- What happens if HS crashes?
- Problem: Lost exceptions

ApiDocument : NSDocument

```

NS_ASSUME_NONNULL_BEGIN

@class Document;

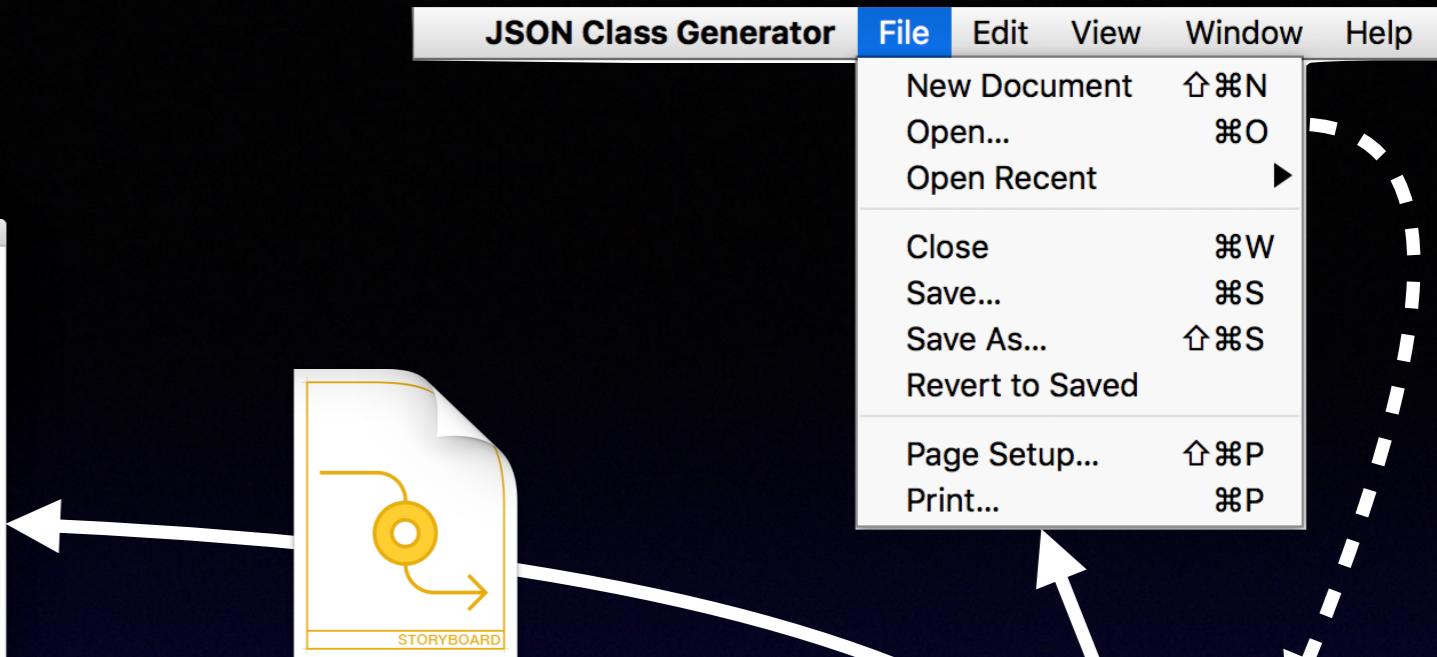
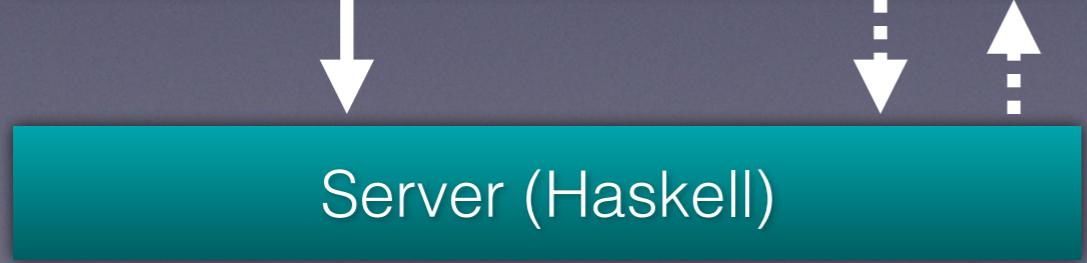
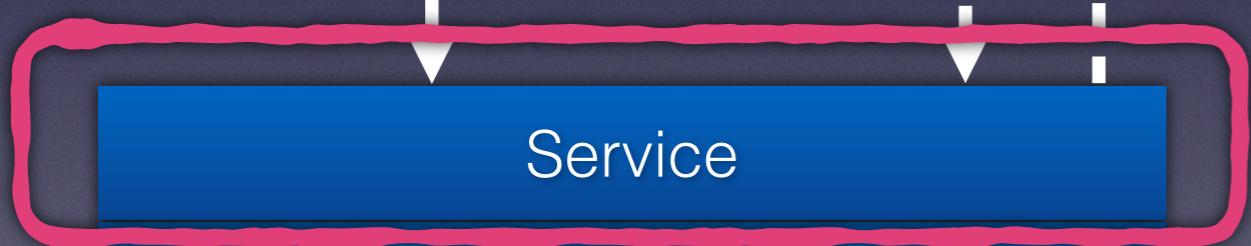
@interface Order : NSObject <NSCopying, NSSecureCoding>

@property (nonatomic) NSInteger id;
@property (nonatomic, copy) NSArray *products;
@property (nonatomic, copy) Document *document;
@property (nonatomic, copy) NSArray *attributes;

#pragma mark direct initialization

-(instancetype)init;
/// @brief products :: [Product]; attributes :: [Attribute]
-(instancetype)initWithId:(NSInteger)id_products:(NSArray *)products
document:(Document *)document attributes:(NSArray *)attributes
NS_DESIGNATED_INITIALIZER;

```



Service

```
// Export

- (id<...>)actionViewModelCodeOfFileForFileName:(NSString *)fileName
                                         success:(void(^)(NSString *content))success

- (id<...>)actionExportSuccess:(void(^)(ApiGenerated *apiGenerated))success

// Outline

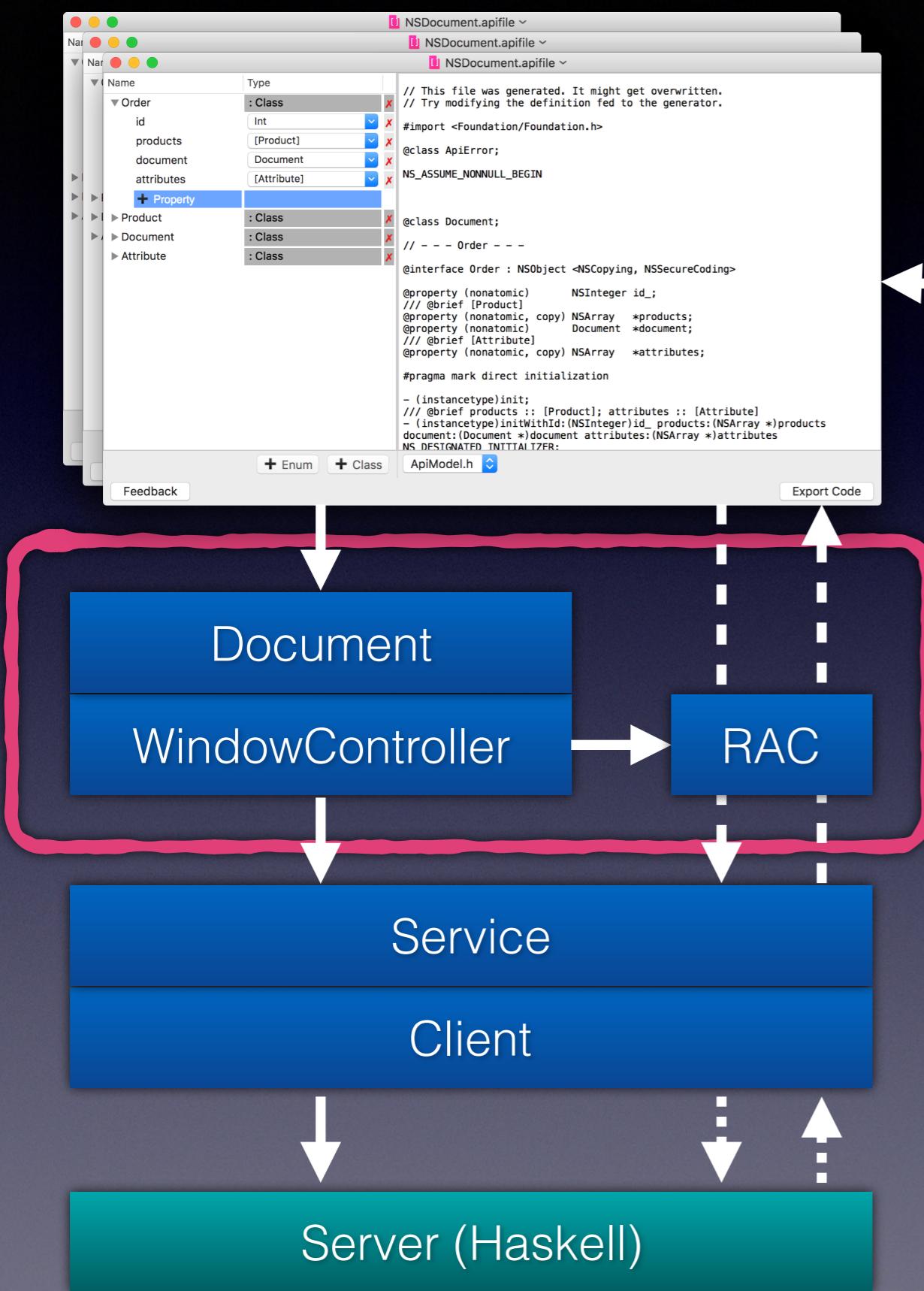
- (id<...>)actionModelOutlineGetSuccess:(void(^)(Outline *outline))success

- (id<...>)actionModelOutlineDiffGetFromRevision:(NSInteger)fromRevision
                                         toRevision:(NSInteger)toRevision
                                         success:(void(^)(OutlineDiff *outlineDiff))success

- (id<...>)actionProcessContinuationIdStrButtonForActButtonId:(NSString *)actButtonId
                                         success:(void(^)(id value))success

- (id<...>)actionProcessContinuationIdStrTextFieldForActTextFieldId:(NSString *)actTextFieldId
                                         actText:(NSString *)actText
                                         success:(void(^)(id value))success
```

ApiDocument : NSDocument



NSDocument RAC Write

```
self.btnPath.rac_command = [[RACCommand alloc]
initWithSignalBlock:^RACSignal *(id input) {
    [self chooseFileWithRecommendedPath:nil];
    return [RACSignal empty];
}];

self.btnAddClass.rac_command = [[RACCommand alloc]
initWithSignalBlock:^RACSignal *(id input) {
    [self.service actionModiClassCreateSuccess:^(NSInteger elemId) {}];
    return [RACSignal empty];
}];
```

NSDocument RAC Read

```
[self.modelCurrentChangedSignal subscribeNext:^(id _) {
    [self.service actionConfigurationGetPathSuccess:^(NSString *text) {
        self.btnPath.title = text;
        self.btnPath.hidden = !text.length;
    }];
}];

RACSignal *uiChanged = [self.modelCurrentChangedSignal map: ...
RACSignal *generatedCodeCacheSignal =
    [[[uiChanged merge:uiCalculated] scanWithStart:@[] reduce: ...
[[generatedCodeCacheSignal deliverOnMainThread]
    subscribeNext:^(NSArray<HashAndResult *> *hashAndResults) {
        HashAndResult *hashAndResult = hashAndResults.firstObject;

        if (hashAndResult.hasResult) {
            [self.progressIndicator stopAnimation:nil];
        } else {
            [self.progressIndicator startAnimation:nil];
        }
    }];
}];
```

ApiDocument : NSDocument

```

NS_ASSUME_NONNULL_BEGIN

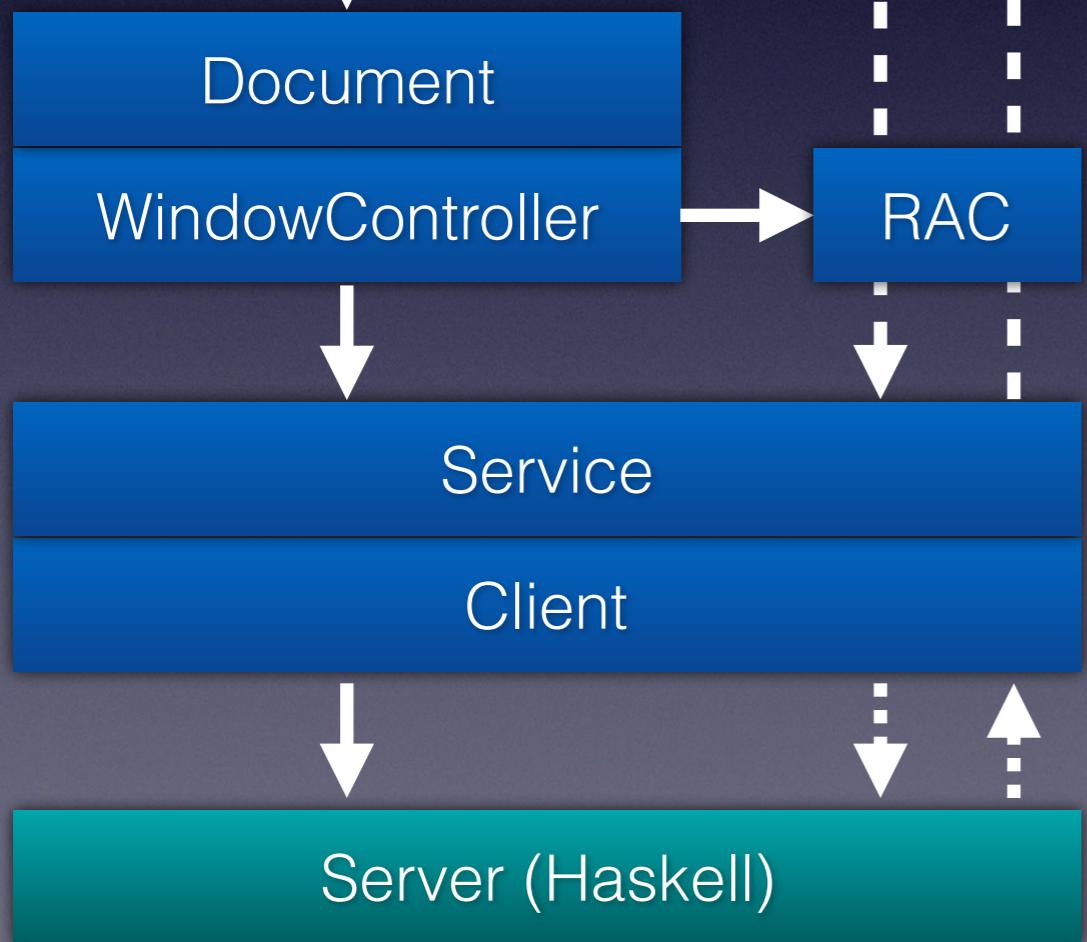
@class ApiError;

@interface Order : NSObject <NSCopying, NSSecureCoding>

@property (nonatomic) NSInteger id;
@property (nonatomic, copy) NSArray *products;
@property (nonatomic, copy) Document *document;
@property (nonatomic, copy) NSArray *attributes;

@end

NS_ASSUME_NONNULL_END
  
```



User Interface

The screenshot shows the Xcode interface with the following details:

- Project Navigator:** Shows the project structure for "HSMac".
- Outline View:** Displays the XIB file structure for "ApiWindowController.xib".
- Preview View:** Shows a window with a split view containing two table view cells.
- Code Editor:** Displays the "ApiWindowController.m" implementation file.
- Assistant Editor:** Shows the "JSON Class Generator (Direct)" output.

```
// ApiWindowController.m
// HSMac
//
// Created by Nikolas Mayr on 15.09.15.
// Copyright (c) 2015 Lifted Software. All rights reserved.

#import "ApiWindowController.h"
#import "Api.h"
#import "ReactiveCocoa.h"
#import "ApiLogger.h"
#import "ApiDocument.h"
#import "HsInterfaceClient.h"
#import "ApiOutlineViewController.h"
#import "ViewExtensions.h"
#import "FoundationCategories.h"
#import "DevMateProxy.h"
#import "MBProgressHUD.h"
#import "ViewExtensions.h"
#import "ApiAppRater.h"

NS_ASSUME_NONNULL_BEGIN

@interface ApiWindowController : NSWindowDelegate
@property (nonatomic) ApiService *service;
@property (nonatomic) RACSignal *modelCurrentChangedSignal;
@property (nonatomic) ApiOutlineViewController *outlineViewController;
@property (nonatomic) DevMateProxy *devMateProxy;
@property (nonatomic) ApiAppRater *appRater;
//@property (nonatomic) ApiSurveyCollector *surveyCollector;
@property (nonatomic, weak) IBOutlet NSOutlineView *outlineView;
@property (nonatomic, weak) IBOutlet NSTextField *lblDefinitionInfo;
@property (nonatomic) IBOutlet NSTextView *lblSourceOut; // NSTextView
@property (nonatomic, weak) IBOutlet NSPopUpButton *popFileChooser;
@property (nonatomic, weak) IBOutlet NSProgressIndicator *progressIndicator;
@property (nonatomic, weak) IBOutlet NSButton *btnAddClass;
@property (nonatomic, weak) IBOutlet NSButton *btnAddEnum;
@property (nonatomic, weak) IBOutlet NSButton *btnExport;
@property (nonatomic, weak) IBOutlet NSButton *btnPath;
@property (nonatomic, weak) IBOutlet NSFeedback *feedback;
@property (nonatomic) Constraints
@end

@implementation ApiWindowController
- (instancetype)initWithService:( ApiService *)service {
    NSAssert(service != nil, @"must provide a service");
}
```

ApiDocument : NSDocument

```

NS_ASSUME_NONNULL_BEGIN

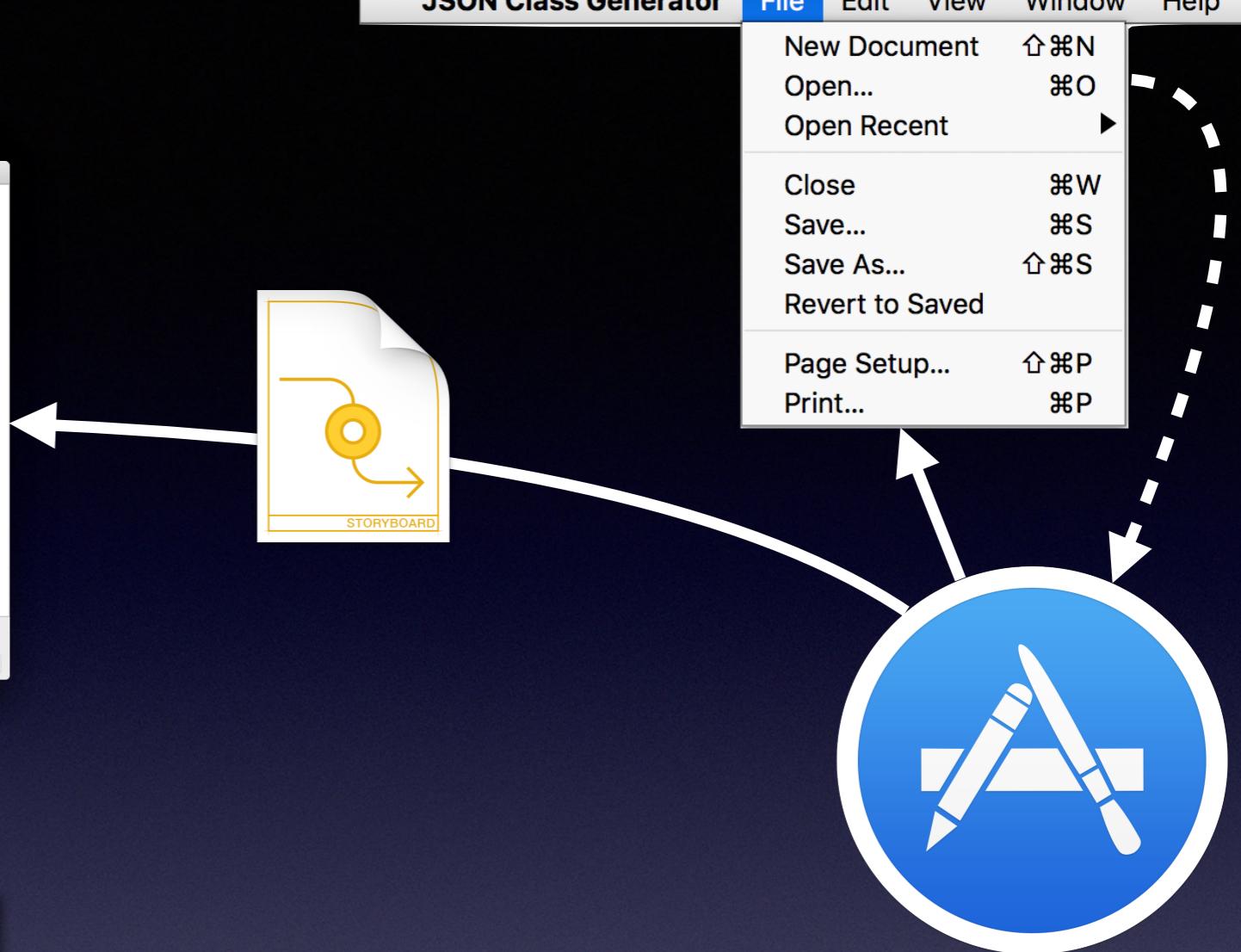
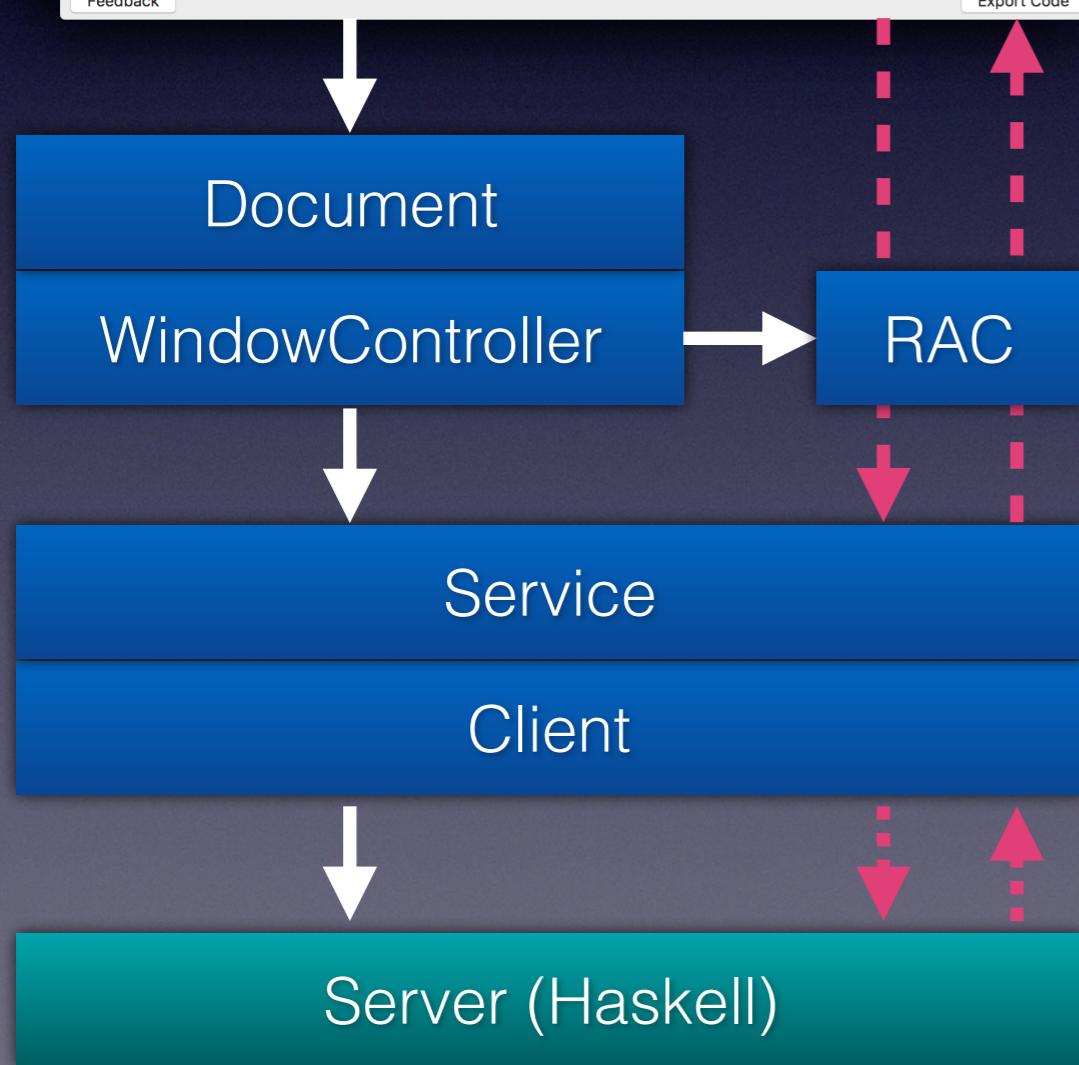
@class Document;
@interface Order : NSObject <NSCopying, NSSecureCoding>

@property (nonatomic) NSInteger id;
@property (nonatomic, copy) NSArray *products;
@property (nonatomic, copy) Document *document;
@property (nonatomic, copy) NSArray *attributes;

#pragma mark direct initialization

- (instancetype)init;
/// @brief products :: [Product]; attributes :: [Attribute]
- (instancetype)initWithId:(NSInteger)id_products:(NSArray *)products
document:(Document *)document attributes:(NSArray *)attributes
NS_DESIGNATED_INITIALIZER;

```



Unidirectional Data Flow

In Practice

Development Tools

- Xcode, -debugger, for ObjC
- Haskell for Mac (Haskell.app IDE) for HS
- Sublime: for shell scripts (Haskell Shelly)
- Instruments
- ThreadsScope (performance), RTS opts MEM

Debugging

JSON Class Generator (Di...)

- CPU
- Memory
- Energy Impact
- Disk Zero KB/s
- Network Zero KB/s

Thread 1 Queue: co...hread (serial)

- 0 -[NSData(CString) hsmac_wi...
- 1 -[HsInterfaceClient sendReq...
- 2 -[ApiService actionModiClas...
- 3 -[ApiWindowController add...
- 4 _36-[ApiWindowController...
- 5 -[RACCommand execute:]
- 6 -[NSControl(RACCommands...
- 7 _os_activity_initiate
- 8 -[NSApplication sendAction:...
- 9 -[NSControl sendAction:to:]
- 10 _26-[NSCell _sendActionF...
- 11 _os_activity_initiate
- 12 -[NSCell _sendActionFrom:]
- 13 _os_activity_initiate
- 14 -[NSCell trackMouse:inRec...
- 15 -[NSButtonCell trackMouse...
- 16 -[NSControl mouseDown:]
- 17 -[NSWindow _handleMouse...
- 18 -[NSWindow _reallySendEv...
- 19 -[NSWindow sendEvent:]
- 20 -[NSApplication sendEvent:]

```

66 @end
67
68 @implementation NSData (CString)
69
70 - (id _Nullable)hsmac_withCString:
71     NSUInteger len = self.length;
72     char *bytes = malloc((len+1)*s
73     if (!bytes) {
74         logMsg(@"no bytes malloc-e
75             return nil;
76     }
77     [self getBytes:bytes length:len
78     bytes[len] = '\0';
79     id result = fun(bytes);
80     free(bytes);
81     return result;
82 }
83
84 @end
85
86 void logErr(const char *str) {
87     NSLog(@"%@",str);
88 }
89
90 @interface HsInterfaceClient ()
91 @property (nonatomic, readwrite) N
92 @property (nonatomic, readwrite) N
93 @end

```

(lldb)

JSON Class Gene...

- CPU 0%
- Memory 9,7 MB
- Energy Impact Low
- Disk 432 KB/s
- Network Zero KB/s

Thread 1 Queue:... (serial)

- 0 dataFromString
- 1 c3uHf_info
- 2 ImageLoaderMachO...
- 3 ckyE_info
- Thread 2
- Thread 3 Queue:... (serial)
- Thread 4
- Thread 5
- Thread 6
- Thread 7
- Thread 8
- Thread 9
- Thread 10
- Thread 12 Queue:... (current)

```

42 }
43 #ifdef DEBUG_NSDATA
44     static dispatch_once_t onceToken;
45     dispatch_once(&onceToken, ^{
46         datas = [NSMutableArray array];
47     });
48 #endif
49 NSData *data = [[NSData alloc] initW
50 if (!data) {
51     logMsg(@"no NSData created");
52     data = [NSData data];
53     return data;
54 }
55 #ifdef DEBUG_NSDATA
56     [datas addObject:[NSString stringWithFormat:@"Data %d"], data];
57 #endif
58     return data;
59 }
60
61 @interface NSData (CString)
62
63 /// @brief temporarily allocates c string
64 - (id _Nullable)hsmac_withCString:(id _N
65
66 @end
67
68 @implementation NSData (CString)
69
70 - (id _Nullable)hsmac_withCString:(id _N

```

(lldb)

ObjC

HS

Testing

- Unit tests for ObjC and HS
- UI tests
- **Server interface tests**

Retrospective

Challenges

- Getting started
 - Building, Setup, Architecture
- Debugging
- Persistence. All problems solvable.

Reflecting

- Haskell Language
- Two Languages in one app
 - Domain specific
 - Cross platform
- Swift
- Cross platform UI Libraries

Where to get started

- Tim Scheffler's blog ([1](#)) ([2](#)) ([3](#))
- FFI section of HS2010 report
- Dropbox CppCon2014 Cross Platform ([1](#)) ([2](#))
- Libs: language-c-inline ([talk](#)) ([github](#)) ([hackage](#))
- Haskell for Mac IDE

Questions?

Thank You!

Feel free to contact me.

Nikolas Mayr <bobkonf@login.n-mayr.de>