ROWAN WILLSON

EFB'S

(OzRunways)
TOPICS

- Programming errors & disasters (including EFB)
- iOS languages & toolchain
- OzRunways Practices
  - Development
  - DevOps
  - Distribution
  - Security
- CASR Part 175
- Interaction of EFB with Avionics
OzRunways EFB + RWY GO
Let's start with regulations...
CAR 233 (1) (h) -- All pilots

(1) The pilot in command must not commence a flight until they ensure:

... (h) The aeronautical data and aeronautical information ... is carried in the aircraft and is *readily accessible* to the flight crew"
CASA

- The Acts Interpretations Act 1901

+ Electronic Transactions Act 1999

= Allows the use of digital media to display documentation as required by the Civil Aviation Act.
EFB REGULATIONS

CASA

- CAO 82.0 Appendix 9 -- Use of EFB under a company AOC
  - Defines functionality levels & classes (copies FAA AC 120-76D)
  - Software Application Validation (performance, W&B etc)
  - Permitted EFB in ops manual
  - EFB Administrator
  - Training
  - Backup device (or paper)
  - Hardware Integrity
  - Data integrity
  - Flight Crew Procedures
  - Maintenance Control

- CAAP 233-1(1)
  - Human readable guide plus best practice recommendations
INTERNATIONAL

- FAA AC 120-76D
- Transport Canada: AC No. 700-020
  - Annex F checklist is useful (user interface)
- EASA AMC 20-25
A person commits an offence if
(a) the person conducts a data service activity, and
(b) the person does not hold a certificate under regulation 175.295 ...

Data Service Activity:

- Publishing Aeronautical Data
- Publishing Aeronautical Information
- Publishing an Aeronautical Chart
- Supplying Aeronautical data in a database for use in navigation equipment or systems.
CASR PART 175

- Civil legislation
  - Part 175.B - AIS Providers (Airservices Australia)
  - Part 175.C - Data Service Providers (OzRunways, Jeppesen...)
- CASA approved Ops manual
- Annual CASA audits on data procedures & activities
- Internal Safety Systems & Audits
- Timeliness & accuracy of data delivered to users
- Archives, backups, recovery plans, etc.
CASR 175.C - WHAT IT IS DESIGNED TO ACHIEVE:

- **Timely, Accurate & Complete** data delivery

- Mostly concerns the *company*
- Automated Systems (read: scripts)
- Integrity: Data is not altered from source data whilst in storage, transit or formatted.
- RTCA DO-200B "Standards for processing aeronautical data"
- Good data citizen: notifying originators of errors

- **It is not:**
  - Software certification like DO-178
**EFB REGULATIONS**

**OPS MANUAL, DATA SCRIPTS**

---

**11.1 Data Service Provider**

OzRunways provides 24-hour 7 days a week re-publishing of AIP data as a Data Service Provider (all IAP components, i.e. AIP & NOTAM) to its paid subscribers for all Australian FIR airspace contained in DAM and all ERSA airfields in accordance with the following table (Figure 3).

<table>
<thead>
<tr>
<th>IAP Component</th>
<th>End User Format (File Type)</th>
<th>Format (From AA)</th>
<th>App</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIP Book</td>
<td>eDocument (pdf)</td>
<td>pdf</td>
<td>OzRunways, RWW</td>
</tr>
<tr>
<td>En Route Supplement Australia (ERSA)</td>
<td>eDocument (pdf)</td>
<td>pdf</td>
<td>OzRunways, RWW, RWY, RWW Check</td>
</tr>
<tr>
<td>Departure and Approach Procedures (East)</td>
<td>eDocument (jpg)</td>
<td>pdf</td>
<td>OzRunways, RWW</td>
</tr>
<tr>
<td>Departure and Approach Procedures (West)</td>
<td>eDocument (jpg)</td>
<td>pdf</td>
<td>OzRunways, RWW</td>
</tr>
<tr>
<td>AIP Supplement</td>
<td>eDocument (pdf)</td>
<td>pdf</td>
<td>OzRunways, RWW, RWY, RWW Check</td>
</tr>
<tr>
<td>NOTAM</td>
<td>On demand eText (Parsed. IOn)</td>
<td>On demand - SOAP</td>
<td>OzRunways, RWW, RWY, NAIS, RWY Go, RWW Check</td>
</tr>
<tr>
<td>Aeronautical Information Guide (AIC)</td>
<td>eDocument (pdf)</td>
<td>pdf</td>
<td>OzRunways, RWW</td>
</tr>
<tr>
<td>Terminal Area Chart (TAC)</td>
<td>eChart (Tokyo Cabinet, jpg, png, webp)</td>
<td>Geoiff</td>
<td>OzRunways, RWW</td>
</tr>
<tr>
<td>En Route Chart (High and Low; ERC-H &amp; ERC-L)</td>
<td>eChart (Tokyo Cabinet, jpg, png, webp)</td>
<td>Geoiff</td>
<td>OzRunways, RWW</td>
</tr>
<tr>
<td>Planning Chart Australia (PCA)</td>
<td>eChart (Tokyo Cabinet, jpg, png, webp)</td>
<td>Geoiff</td>
<td>OzRunways, RWW</td>
</tr>
<tr>
<td>Visual Navigation Chart (VNC)</td>
<td>eChart (Tokyo Cabinet, jpg, png, webp)</td>
<td>Geoiff</td>
<td>OzRunways, RWW, RWY Check, Dynon</td>
</tr>
<tr>
<td>Visual Terminal Chart (VTC)</td>
<td>eChart (Tokyo Cabinet, jpg, png, webp)</td>
<td>Geoiff</td>
<td>OzRunways, RWW, RWY Check, Dynon</td>
</tr>
<tr>
<td>Designated Airspace Handbook (DAH)</td>
<td>Overlays, searchable database (SQLITE).</td>
<td></td>
<td>OzRunways, RWW, RWY Check</td>
</tr>
</tbody>
</table>

**Figure 3. OzRunways IAP data structure**

---

```tcl
proc raf_documents {} {
    log notice "RAAF Documents"
    global datadir
    global file_id
    global raf_codes
    set version [dict get $v cycle]
    set ups {}
    set dest $datadir/RAAF/renamed

    set i 0
    foreach line [split [filereadtext $datadir/RAAF/documents] \\
                 \n] {
        if {([string index $line 0] eq "#") continue
        incr i
        set line [split [string trim $line] "," ]
        lassign $line pfx title
        dict set documents [string tolower $pfx] title $title
        dict set documents [string tolower $pfx] seq $i
    }
    set maxdate [clock format [dict get $v date] -gmt 1 -format "%Y%m%d"]

    file mkdir $dest
    set files [glob [lsort -decreasing [file join $datadir/RAAF/29*/.pdf]]]
    foreach file $files {
        # Only interested in files for which there is an ICAO code
        set fn [file tail $file]
        set issue [index [split $file "/"] end-1]
        if {($issue > $maxdate)} {
            #todo do continue when we have all files...
            #continue
        }
        set name [index [split [file rootname $fn] "_" ] 0]
        # Now name contains just the name SOMETHWN part from
        # YYYYY/MM/DD/SOMETHWN_1May14.pdf
        if {([dict exists $documents [string tolower $name]])} {
            #log debug "Skip $fn - Name not in map"
            # Not a file we're interested in.
            continue
        }
        if {([dict exists $ups [string tolower $name]])} {
            continue
        }
    }
```
SAFETY CONSIDERATIONS:

- Airservices incorrectly (silently) amending approach plates,
- http Cache-Control headers & silent proxies
- CDN ttl and invalidating content
- CDN acl (public)
- http Content-Encoding header and gzip on CDN's
WEATHER / NOTAMS
Human Factors: User Interface (UI)

What are some consequences?
AIR INTER FLIGHT 148

- A320
- VSI (-33)
- FPA (-3.3)
- Sharing same display
- Mode confusion → Everybody dies
EMIRATES YMML (2009)

- Emirates A340-541
- Actual 362 tonnes
- Entered 262 tonnes into EFB
- $V_1$ 30kts low
MORE DATA ENTRY ACCIDENTS / INCIDENTS

- DC8 1991: Could not rotate → Abort → Tore off 4 engines. FENG TOW 242,000 vs 342,000 lbs
- A330 2002: Tailstrike due $V_1$ 126kts (actual 156 kts)
- B747 2003: Tailstrike (ZFW vs TOW in calculations)
- B747 2003: 20kt V speed (ZFW vs TOW again - 100,000 kg)
- B747 2003: Tailstrike lbs vs kg, 120,000kg diff.
RECOMMENDATIONS

- Responsiveness (0.1 feels instant reaction, 1.0 flow of thought, 10 attention)
  - Consumer Hardware, therefore
  - Operator also responsible to regularly upgrade hardware

- Readability (text size, contrast ratio, tap target sizes)

- Colours: Warning & Caution

- User interface consistent & Intuitive
  -- *Can it be used with zero training?*

- Data Entry:
  - Does not accept incorrect data (range, type)

- Operator Workload
  - Number of taps to reach desired information
EXAMPLE: RWY GO

- Label placement
- Windsock placement
- Letter Styling (contrast)
UI DESIGN - WHAT IS THE BEST WAY TO REPRESENT DATA

DESIGN ITERATIONS
UI DESIGN - ITERATIONS

DECIDING WHAT DATA NEEDS TO STAND OUT
(FINAL CHOICE)
What kinds of tools are available for iOS developers?
LANGUAGES: SWIFT, OBJECTIVE-C

- Swift statically typed (at compile time)

```swift
let number = 86
let letter: Character = number // Cannot convert value of type 'Int' to specified type 'Character'
```

- Thread safety (libdispatch)

```swift
// Background thread
let result = expensiveTask()

DispatchQueue.main.async {
// Main thread
    updateUI(with: result)
}
```

- Runtime crash vs undefined behaviour

```swift
var number: UInt8 = 255
number += 1 // error: Execution was interrupted, reason: EXC_BAD_INSTRUCTION
```
SOME HELPERS

- Asserts (DEBUG builds)

```swift
var ZFW = calculateZFW(withPOB: 8)
assert(ZFW > 32000, "Error: Small ZFW")  // error: Execution was interrupted
```

- Extensive Compiler Warnings

```swift
let list : [String]? = ["a","b"]

for object in list as! [String] {
    // more
}
```

⚠️ Forced cast from '[String]?' to '[String]' only unwraps optionals; did you mean to use '!'?

⚠️ Immutable value 'object' was never used; consider replacing with '_' or removing it

Replace 'object' with '_'

Fix
- (void)viewDidLoad {
    [super viewDidLoad];

    int x;
    x = 0; /* Value stored to 'x' is never read */
    char *text = malloc(4); /* Unused variable 'text' */
}

Potential leak of memory pointed to by 'text'
RUNTIME CHECKING

- Advanced testing of potential issues
PROFILING

- Performance, network, energy, disk ...
/* Radials every 30° on magnetic ... */

```objective-c
for (int i=0; i<360; i+=30) {
    const double angle = i - bullseyeMagDec;
    const CLLocationCoordinate2D outerCoord = [self pointFrom:bullseye.coordinate
        withDistance:500.0 angle:angle];
    const CGPoint outerPoint = [self coordToScreen:outerCoord];
    CGContextMoveToPoint(context, bullseyePoint.x, bullseyePoint.y);
    CGContextAddLineToPoint(context, outerPoint.x, outerPoint.y);
}

/* Draw the arcs outwards... */

for (int j=1; j<=10; j++) {
    const CLLocationCoordinate2D coord1 = [self pointFrom:bullseye.coordinate
        withDistance:j*50 angle:angle];
    const CLLocationCoordinate2D coord4 = [self pointFrom:bullseye.coordinate
        withDistance:j*50 angle:angle+30];
    const CLLocationCoordinate2D coordMiddle = [self
        pointFrom:bullseye.coordinate withDistance:j*50 angle:angle+15];
    // half way
    const CGPoint p1 = [self coordToScreen:coord1];
    const CGPoint p4 = [self coordToScreen:coord4];
    const CGPoint pMiddle = [self coordToScreen:coordMiddle];
    const CGFloat cp1x = 2*pMiddle.x - 0.5*p1.x - 0.5*p4.x;
```

(lldb) po outerPoint
(x = 1400.4738224431057, y = -5640.3876374220126)

(lldb)
# iOS Tools

## Unit Tests

```swift
import XCTest
@testable import OnRumpys

class SmartBriefTests: XCTestCase {

    override func setUp() {
        // Put setup code here. This method is called before the invocation of each test method in the class.
    }

    func testWithDateFormatter() {
        let dateFormat = DateFormatter()
        dateFormat.dateFormat = "yyyy-MM-dd HH:mm:ss Z"
        let date = Date(timeIntervalSince1970: 0)
        let formattedDate = dateFormat.string(from: date)
        // Do something with the formatted date
    }

    override func tearDown() {
        // Put teardown code here. This method is called after the invocation of each test method in the class.
    }

    func nodeTextGetDateFromNode(node: Node, dateFormat: String) -> String {
        // Implement logic to get date from node
        return node.text
    }
}
```

## Code Coverage

<table>
<thead>
<tr>
<th>Name</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SampleCalc.app</td>
<td></td>
</tr>
<tr>
<td>m main.m</td>
<td></td>
</tr>
<tr>
<td>CalcViewController.m</td>
<td></td>
</tr>
<tr>
<td>M -[CalcViewController init]</td>
<td></td>
</tr>
<tr>
<td>M -[CalcViewController...</td>
<td></td>
</tr>
<tr>
<td>Calculator.m</td>
<td></td>
</tr>
<tr>
<td>M -[Calculator init]</td>
<td></td>
</tr>
<tr>
<td>M -[Calculator displayValue]</td>
<td></td>
</tr>
<tr>
<td>M -[Calculator input:]</td>
<td></td>
</tr>
<tr>
<td>CalcAppDelegate.m</td>
<td></td>
</tr>
<tr>
<td>M -[CalcAppDelegate init]</td>
<td></td>
</tr>
</tbody>
</table>

## Testing

### Parallel UI tests
A look into OzRunways Ops...
OzRUNWAYS PRACTICES

BUG / ISSUE TRACKING

Gitlab (migrated from Atlassian JIRA 12 months ago)
USE OF GIT

- Branches & Tags
- Production: Triggers App Store CI build
- Preview: Triggers TestFlight (beta tester) CI build
CONTINUOUS INTEGRATION (CI)

▸ Automate everything!

Rebase HEAD → Triggers CI → Full release build → Distribution

OzRunways iOS

Status | Pipeline | Commit | Stages | Time
--- | --- | --- | --- | ---
Passed | #60629909 by | master → 96b1abb2 | ✔️ | 00:12:56
Passed | #60628509 by | master → aa31b7a0 | ✔️ | 00:11:17
Passed | #60623239 by | production → ca674d4a | ✔️ | 00:37:58
Canceled | #60623205 by | master → ca674d4a | ❌ | 00:02:44
OzRUNWAYS PRACTICES

MONITORING

grafana.ozrunways.com

- Disk space usage rate
- Certificate Expiry
- CPU / Network
- Number of NOTAM’s, age of data etc.
OzRUNWAYS PRACTICES

ALERTING

- Slack Channel alerts #devops-alerts

---

[Image of Slack alert: dev_ops_alerts APP 9:16 AM]

[Image of Grafana: Chart directory cache age]


---
OzRUNWAYS PRACTICES

RELEASE CYCLES

▸ Major v8.x.x  (not Semantic Versioning... more marketing)

▸ Minor v8.2.x

▸ Patch  v8.2.3

iOS Release v7 series summary

Release v %7.3.4

- #202 (closed) - Fix Settings > Logs freezing UI  Bug
- #203 (closed) - Fix airplane icon showing light aircraft  Bug
- #204 (closed) - Fix radar time showing +600 on iOS9 devices  Bug
- #205 (closed) and #209 (closed) - Stealth Mode  Feature  Not for Public Notes
- #207 (closed) - Fix "Share my callsign" setting  Bug  Not for Public Notes
- #208 (closed) - Fix clipping of DAPS own-ship icon  Bug
- Some GDL90 improvements (52512f16)
- Fix blurry airplane icon on first install (ab96bb2b, ec9e40d0)  Bug
OzRUNWAYS PRACTICES

ANALYTICS

OzRunways iOS
com.ozrunways.ozrunways

3.5k -1.1%
Daily Active Users

46
Daily New Users

Set your KPI
Track key metrics for your app’s performance.

99.6% -0.1%
Crash-Free Users for All Builds

93.7%
Adoption of 7.3.4 (7697)

Build | Adoption | Stability
--- | --- | ---
7.3.4 (7697) | 83.7% | 99.8%

Stability by Crashlytics
Latest Release
## OzRUNWAYS PRACTICES

### CRASH LOGS (Firebase)

**Latest Session (2 days ago)**

<table>
<thead>
<tr>
<th>File Path</th>
<th>Method</th>
<th>Function</th>
<th>Severity</th>
<th>Source</th>
<th>Line</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fatal Exception: NSInvalidArgumentException</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>0</strong></td>
<td>CoreFoundation</td>
<td>__exceptionPreprocess</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Foundation</td>
<td>[NSString stringByAppendingString:]</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>OzRunways</td>
<td>MapScreenShareButtonTVC.m</td>
<td>line 470</td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[MapScreenShareButtonTVC showShare]</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>OzRunways</td>
<td>MapScreenShareButtonTVC.m</td>
<td>line 249</td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[MapScreenShareButtonTVC tableView:didSelectRowAtIndexPath:]</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>UIKitCore</td>
<td>UITableView _selectRowAtIndexPath:animated:scrollPosition:notifyDelegate:]</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>16</strong></td>
<td>UIKitCore</td>
<td>UIApplicationMain</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>17</strong></td>
<td>OzRunways</td>
<td>main.m</td>
<td>line 16</td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td>main</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td><strong>18</strong></td>
<td>libdyld.dylib</td>
<td>start</td>
<td></td>
<td></td>
<td></td>
<td><img src="" alt="Image" /></td>
</tr>
</tbody>
</table>
ARCHITECTURE - NETWORK & SYSTEMS (Some of our infrastructure)

- HTTP/2 (soon TLS 1.3)
- Multipath TCP
- Explicit Congestion Notification (ECN)
- IPv4 + IPv6
- DNS (latency) based routing
- Ubuntu 18.04 LTS
ANSIBLE PLAYBOOKS - FAST & STANDARDISED DEPLOYMENTS

---
# Common stuff to install on all our servers
- name: Install common utilities
  apt: name="{{packages}}" cache_valid_time=3600
  vars:
    packages:
    - zip
    - brotli
    - unattended-upgrades
    - update-notifier-common # required for Unattended-Upgrade rebooting

- name: Configure automatic updates
  copy:
    src=src/periodic dest=/etc/apt/apt.conf.d/10periodic

- name: Enable Unattended-Upgrade to reboot system
  lineinfile:
    dest: /etc/apt/apt.conf.d/51unattended-upgrades-user
    regexp: "\s{{item.regexp}}\s"
    line: "{{item.line}}"
    create: yes
  with_items:
    - regexp: Unattended-Upgrade::Automatic-Reboot false
      line: Unattended-Upgrade::Automatic-Reboot "true"
    - regexp: Unattended-Upgrade::Automatic-Reboot-Time "18:00"
      line: Unattended-Upgrade::Automatic-Reboot-Time "18:00"

- name: sshd config
  lineinfile:
    dest=/etc/ssh/sshd_config
    regexp="\s{{item.regexp}}\s"
    line="{{item.line}}"
    validate="sshd -f %s -T"
  with_items:
    - regexp: "^PasswordAuthentication no"
      line: PasswordAuthentication no
    - regexp: "^PermitRootLogin"
      line: PermitRootLogin no
    notify: restart ssh

PLAY [tcmapservers] ******************************************************
TASK [Gathering Facts] ******************************************************
ok: [tcmapau3.rwy.io]

TASK [ubuntu-common : Install common utilities] ******************************************************
ok: [tcmapau3.rwy.io]

TASK [ubuntu-common : Configure automatic updates] ******************************************************
ok: [tcmapau3.rwy.io]

TASK [ubuntu-common : Enable Unattended-Upgrade to reboot system] ******************************************************
ok: [tcmapau3.rwy.io] => (item={"regex": "Unattended-Upgrade::Automatic-Reboot\s\s", "line": "Unattended-Upgrade::Automatic-Reboot \s= "true";"})
ok: [tcmapau3.rwy.io] => (item={"regex": "Unattended-Upgrade::Automatic-Reboot-Time\s\s", "line": "Unattended-Upgrade::Automatic-Reboot-Time \s= "18:00";"})

TASK [ubuntu-common : sshd config] ******************************************************
ok: [tcmapau3.rwy.io] => (item="^PasswordAuthentication\s\s", "line": ^PasswordAuthentication no")
ok: [tcmapau3.rwy.io] => (item="^PermitRootLogin\s\s", "line": ^PermitRootLogin no")

TASK [UnderGreen.prometheus-exporters-common : install needed packages] ******************************************************
ok: [tcmapau3.rwy.io] => (item=curl)
ok: [tcmapau3.rwy.io] => (item=tar)
ok: [tcmapau3.rwy.io] => (item=bzip2)

TASK [UnderGreen.prometheus-exporters-common : create prometheus system group] ******************************************************
SOME SECURITY BEST PRACTICES

- SSH public Key authentication
  - Disable password SSH access
  - Disable root login

- Firewall all servers

- 2FA

- TLS v1.2 (https) on all servers ([letsencrypt.org](https://letsencrypt.org)), HSTS

- Deployment Keys as environment variables (not in repo)

- Encrypted laptops

- [bitwarden.ozrunways.com](https://bitwarden.ozrunways.com) (password vault)

- No Microsoft Windows computers!
INTEGRATION WITH AIRCRAFT AVIONICS

- Dynon Skyview series
  - WiFi Access Point
  - Google Protobuf spec
  - TCP
  - Over writes active plan

- Avidyne IFD540 series
  - WiFi Access Point
  - Provided C++ interface
  - 50ms polling
  - UDP
  - Send plans into Stored Routes
  - ARINC 424, 702A
INTEGRATION WITH AIRCRAFT AVIONICS

▸ ADS-B Receivers
  - WiFi / Bluetooth
  - GDL90
  - GPS

▸ OzRunways > Jeppesen
  - ARINC 633
  - iOS URL schemas
A LITTLE ABOUT iOS LOCATION SERVICES

- Assisted GPS (USA)
  - Downloads Almanac over internet with ionospheric model

- GLONASS (Russia)

- GALILEO (Europe)

- QZSS (Japanese)

- L5 Dual-Freq coming soon (Broadcom released 2018)

- RAIM + FDE

- Geoid corrections for .altitude

- Apps Request location to desired accuracy
  - Receive 1Hz Locations (abstracted source)
CONTACT

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