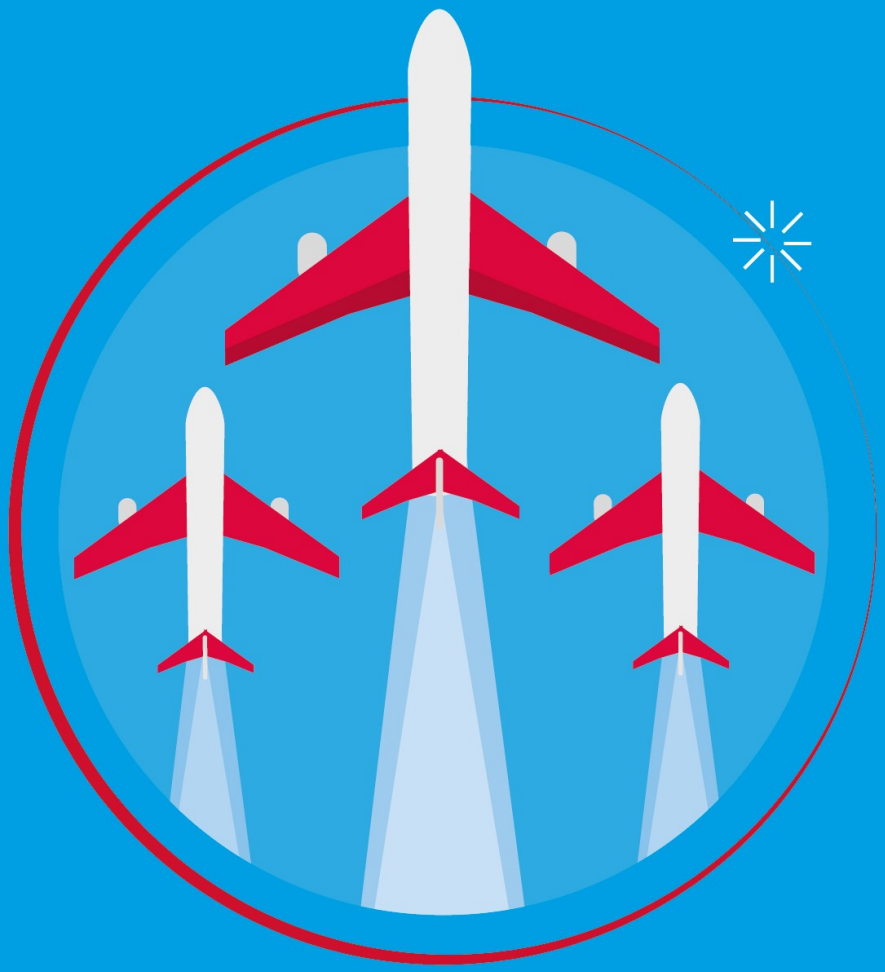
Python in the sky



Abstract

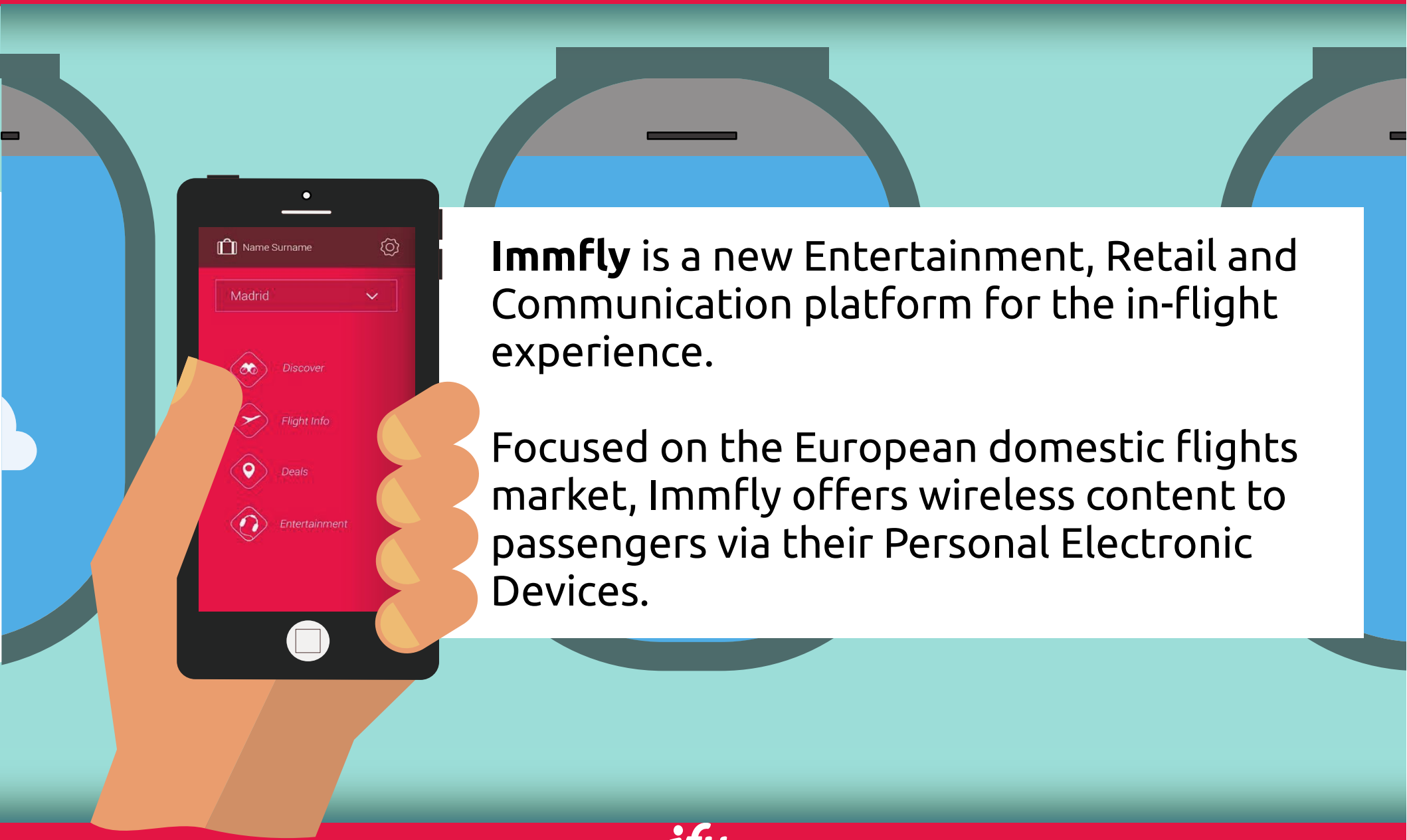
- “How we built a *W.I.F.E.** system using Python”
  - ***W**ireless **I**n-**F**light **E**ntertainment

- Main topics:
  - 1) Product requirements
  - 2) Architecture decisions
  - 3) Atypical challenges

Hi!

- I'm David Arcos
- Python/Django developer since 2008
- Co-organizer of **Python Barcelona**
- Lead engineer at **Immfly**

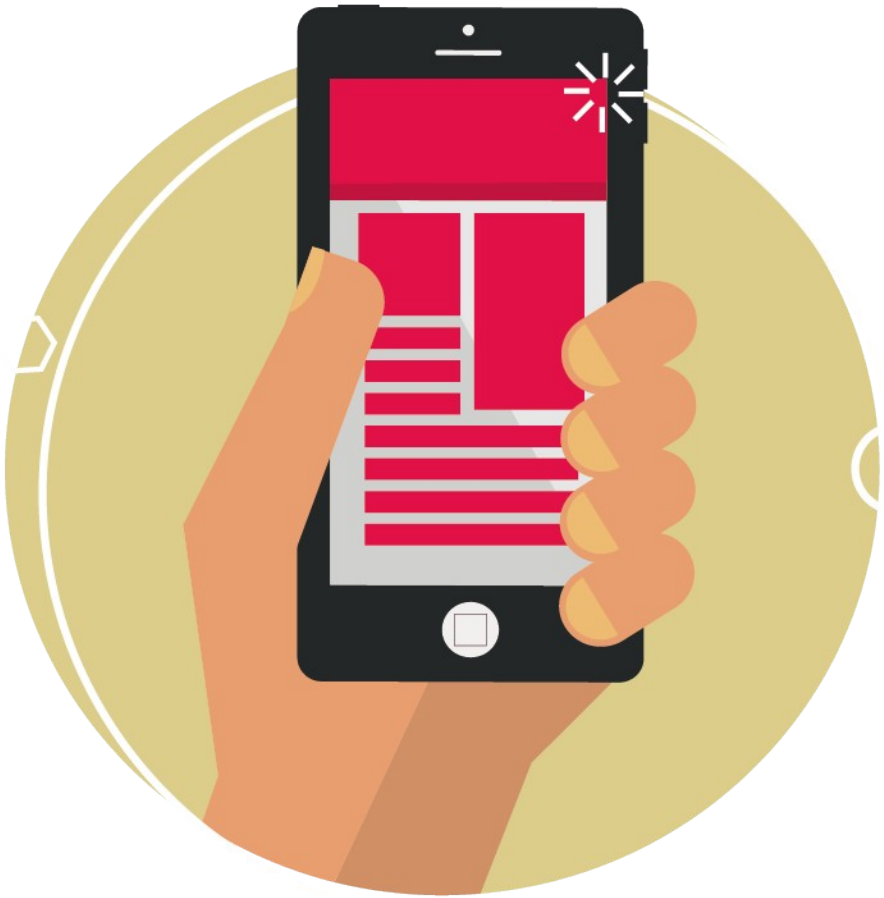
Immfly



Immfly is a new Entertainment, Retail and Communication platform for the in-flight experience.

Focused on the European domestic flights market, Immfly offers wireless content to passengers via their Personal Electronic Devices.

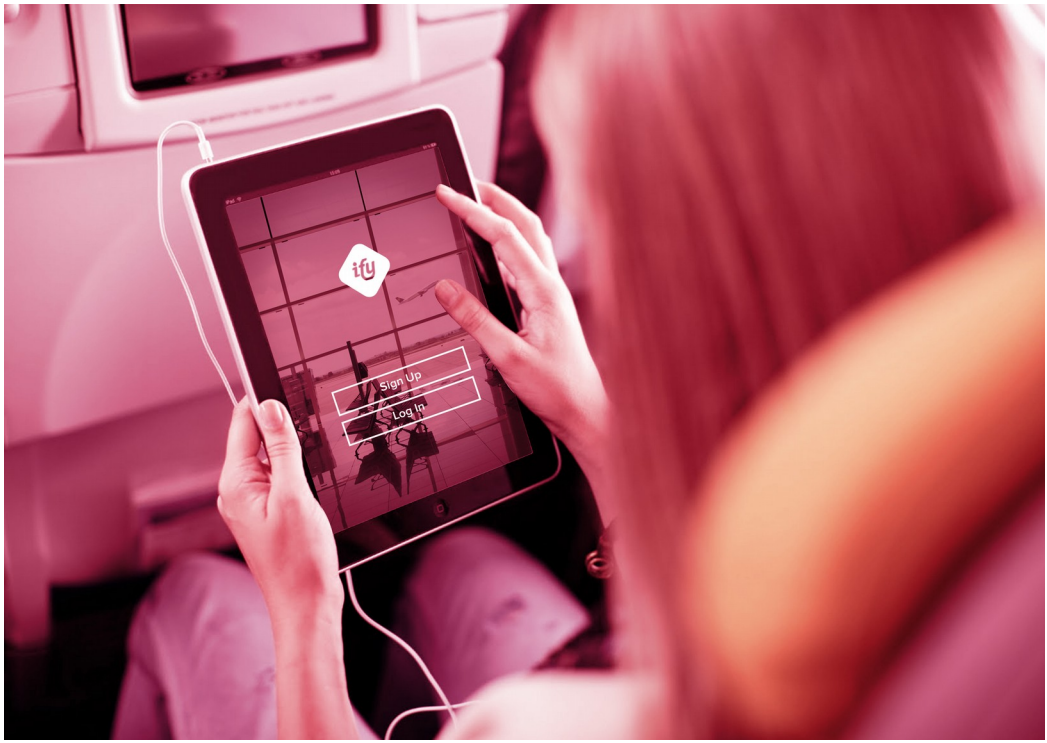
1) The product requirements



How does it work?

The passenger's device

(smartphone/tablet/laptop)



connects to the wifi

(no internet!)

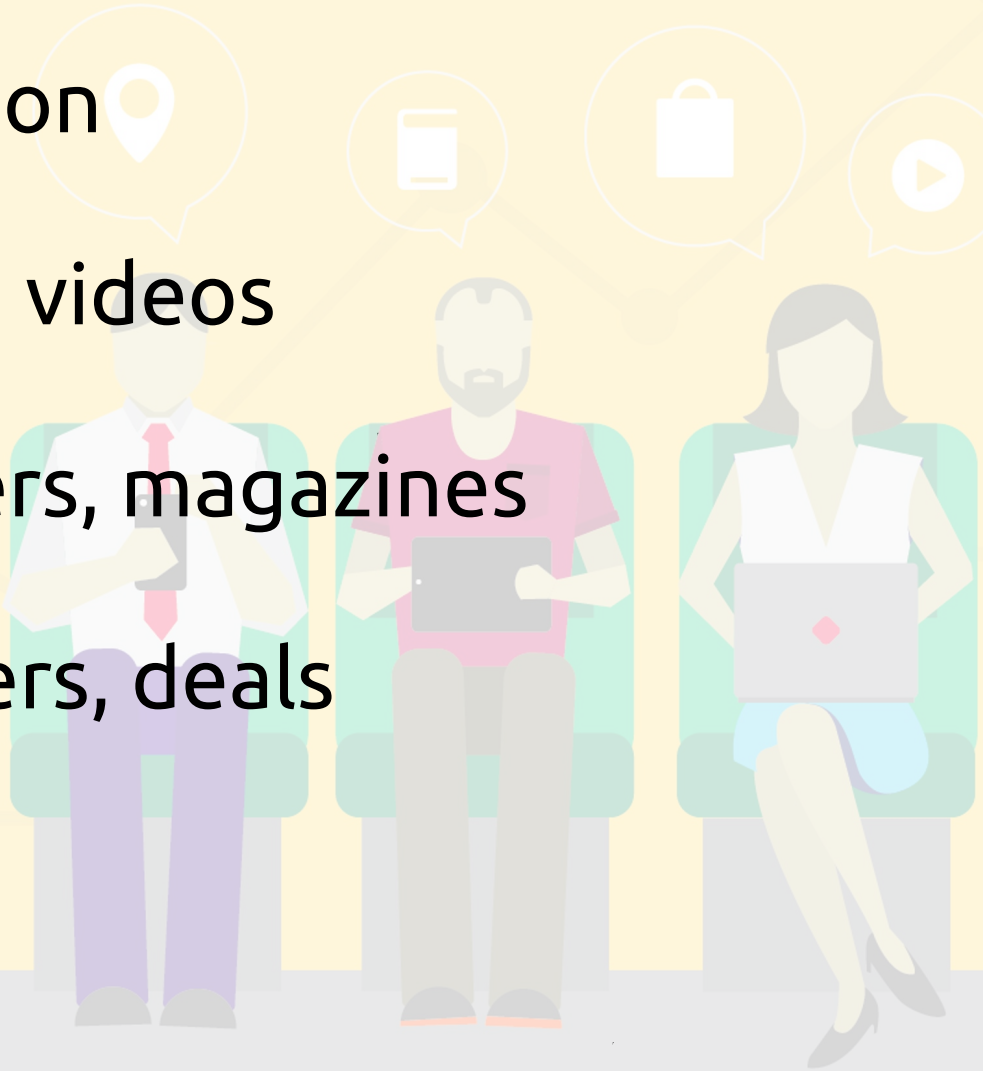
and opens the app

(web/android/ios)

What kind of services?

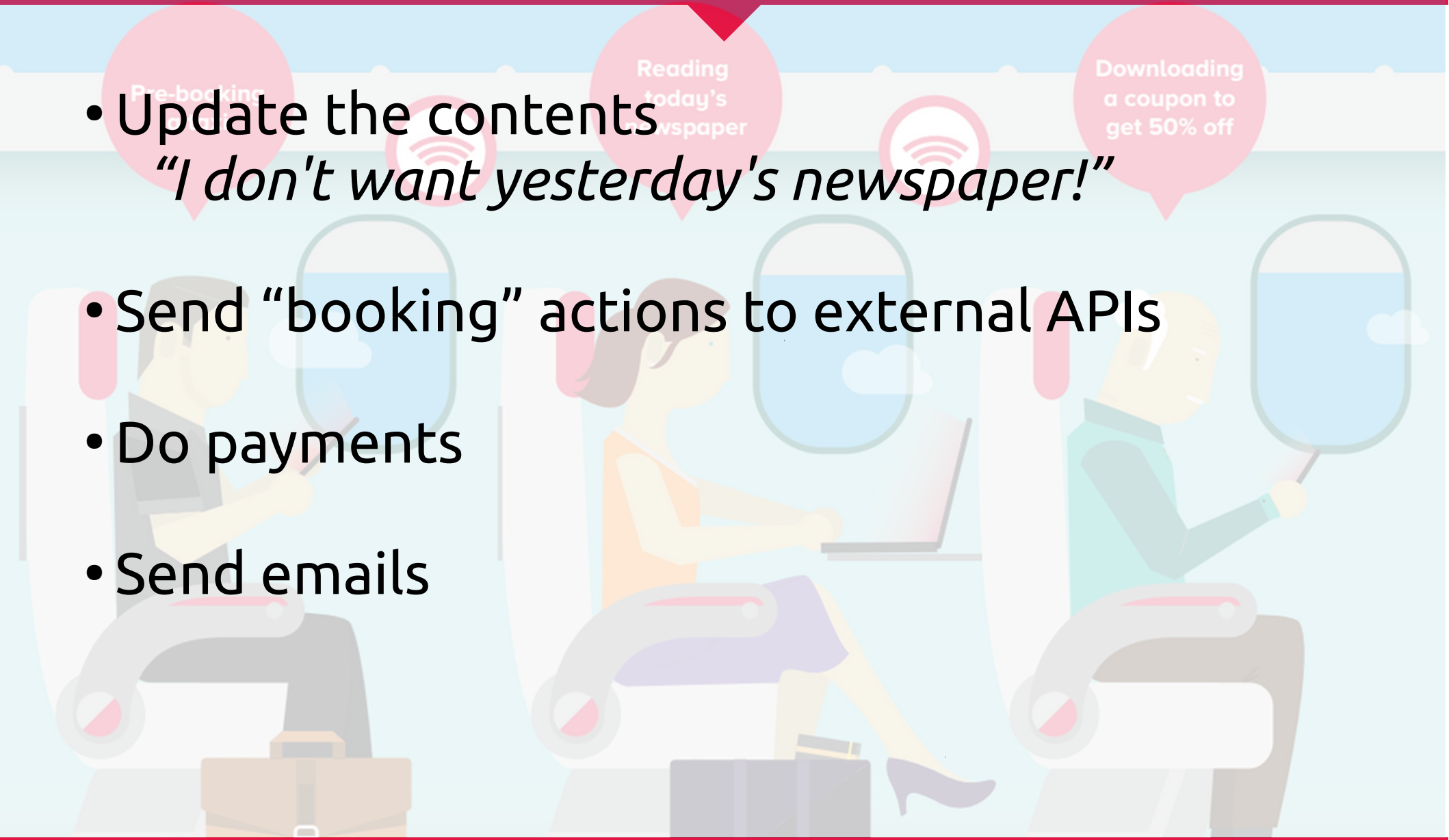
What kind of services?

- Flight information
- View TV Shows, videos
- Read newspapers, magazines
- Get guides, offers, deals
- Etc...



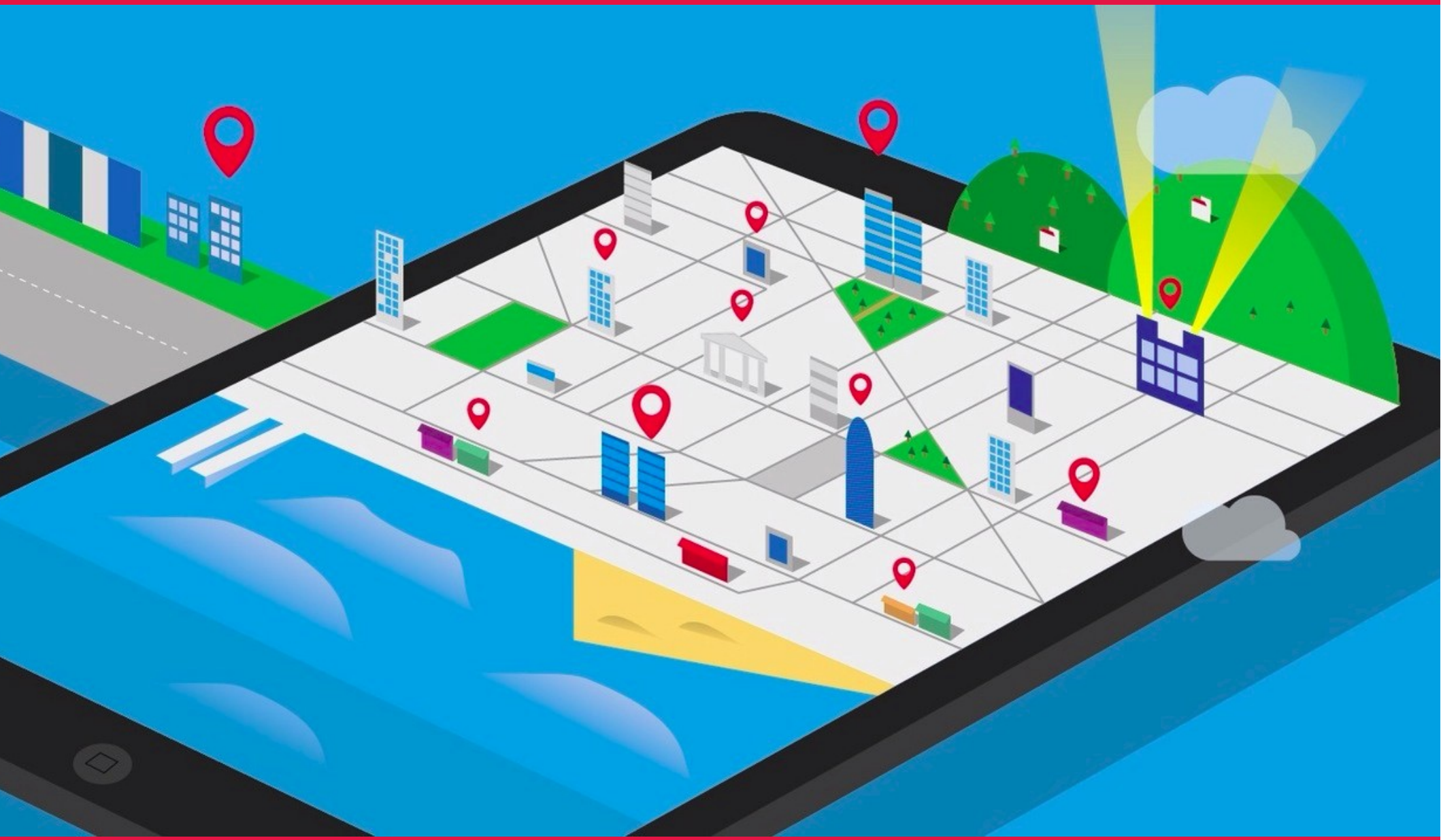
But it's off-line

We need eventual connectivity



- Update the contents
  “I don't want yesterday's newspaper!”
- Send “booking” actions to external APIs
- Do payments
- Send emails

Ground mode



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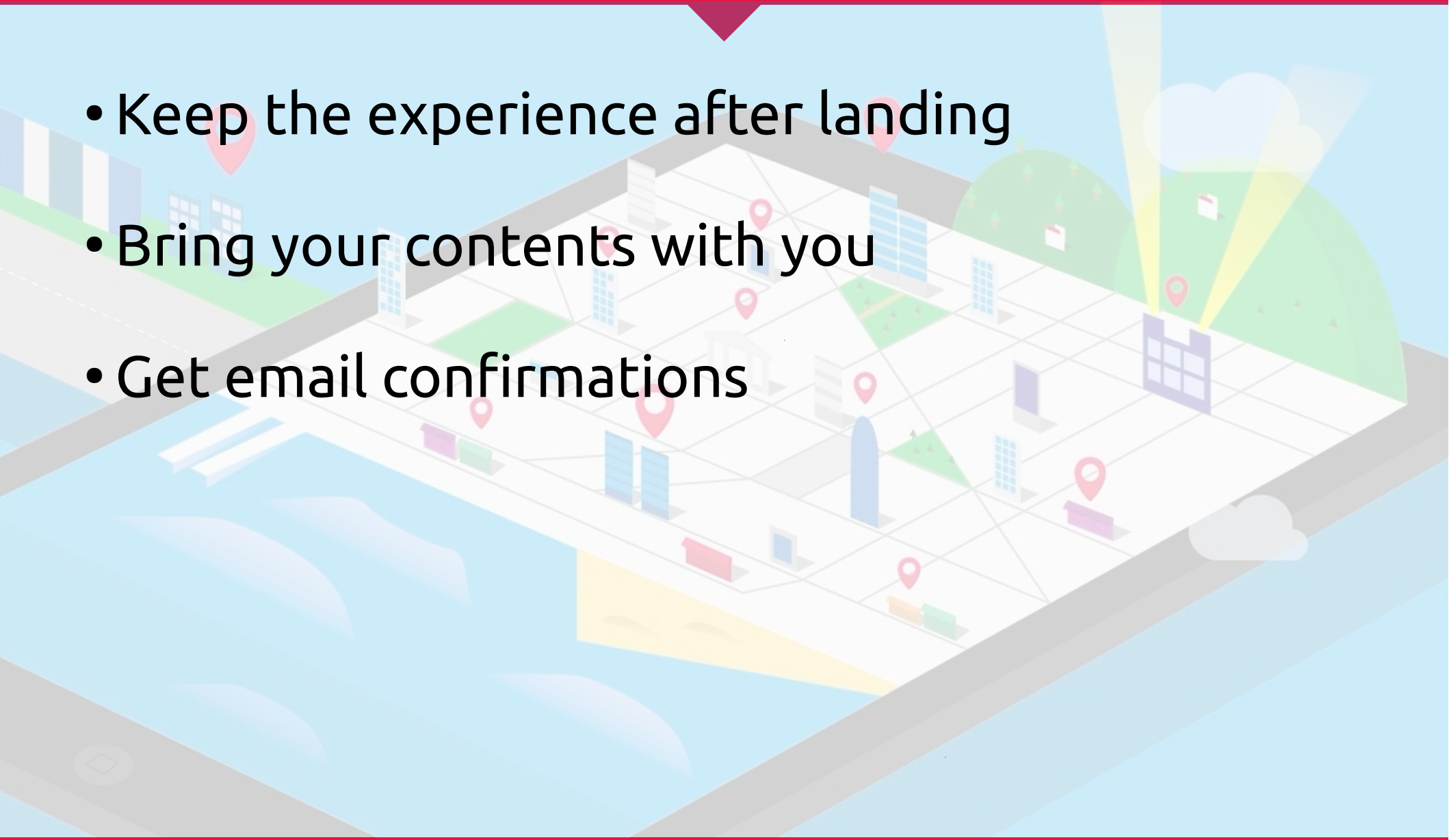
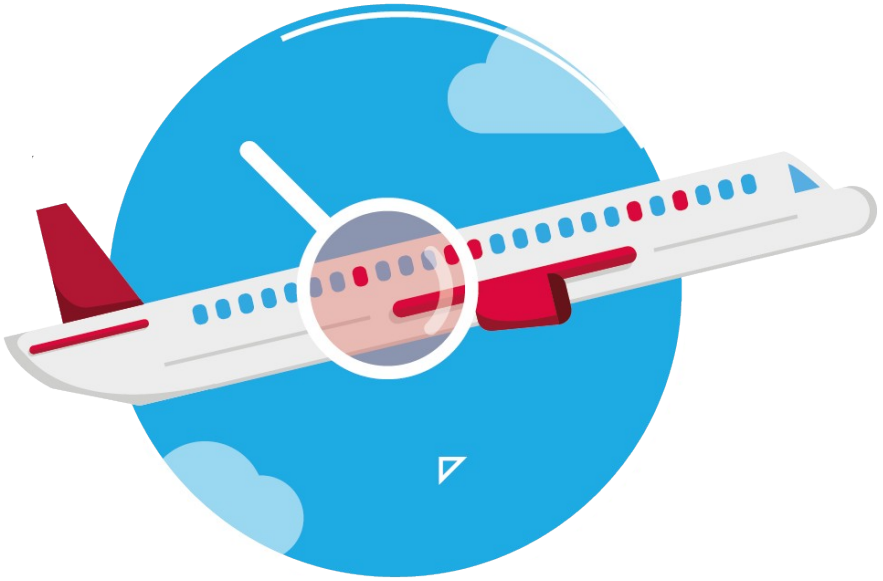


- Keep the experience after landing
- Bring your contents with you
- Get email confirmations

2) The Architecture

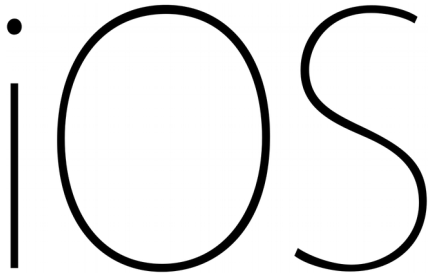
- In the airplane:
  - Frontend & Backend
  - System services
  - Hardware
- In the datacenter:
  - The "Hangar"
  - Ingests



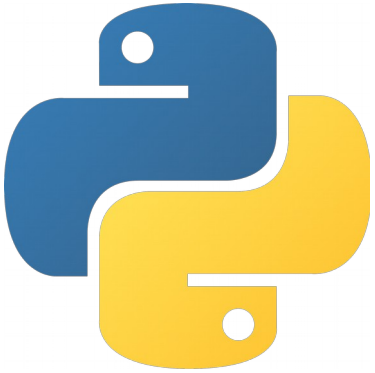
Frontend apps

- Web app:

- Native apps:



Backend API



- *"A widely used general-purpose, high-level programming language"*
- *"The web framework for perfectionists with deadlines"*
- *"A powerful and flexible toolkit that makes it easy to build Web APIs"*

HTTP server

- Web Server
- Static contents

- WSGI Server

- Monitor and control:
  - API
  - daemons
  - celery

Databases

- SQL data
  - Django ORM
  - Critical transactions
- NoSQL data
  - Cache, sessions
  - Metrics, expirations

Network

SSH

- Through VPN
- Hidden port
- PK Auth

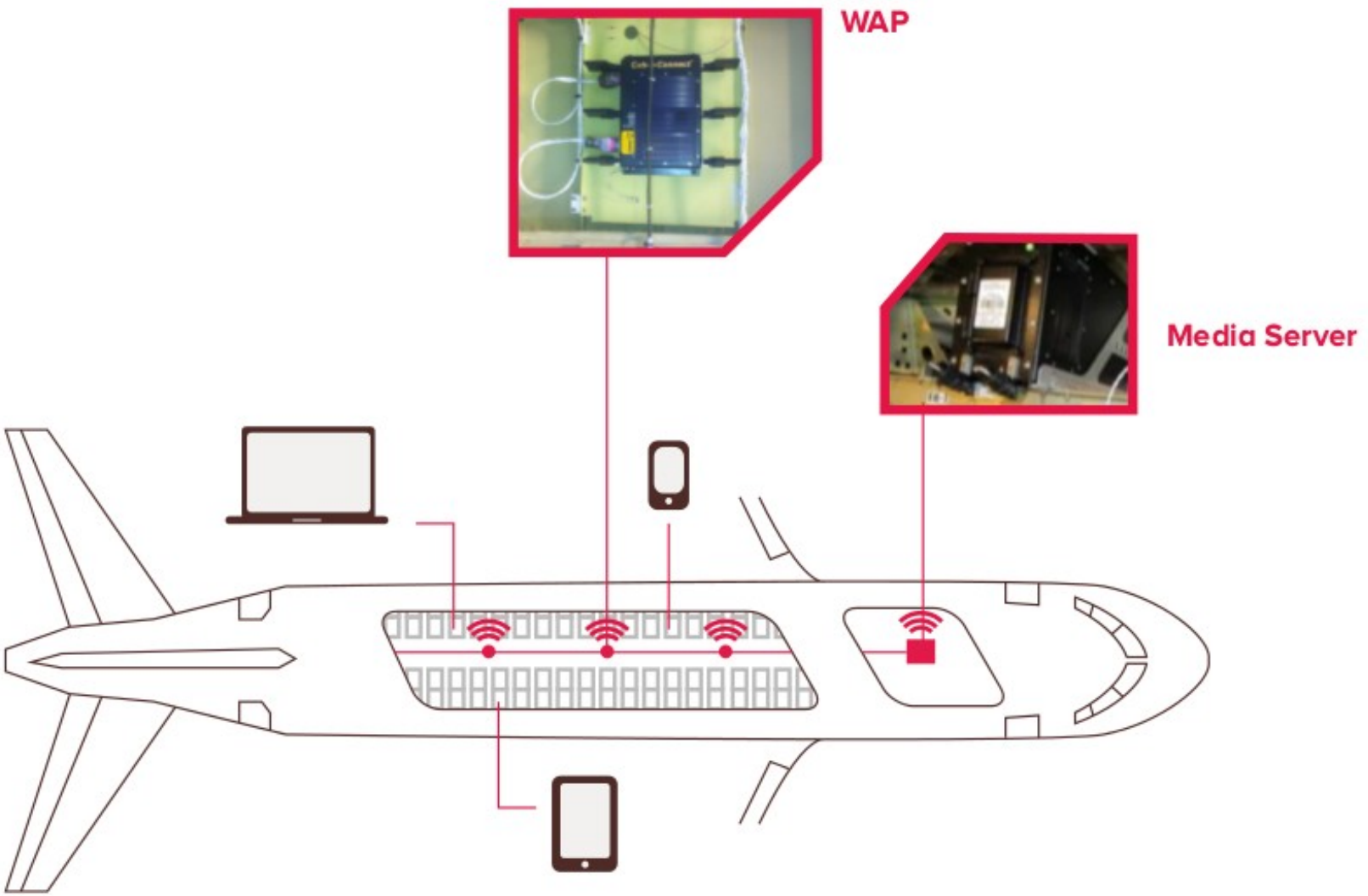
Ansible

- Deployment
- Config Management
- Pull mode

Fabric

- Initializing
- Other tasks

Hardware



Wireless Access Points

- 3 WAPs per plane
- Provide the WiFi
  - Intranet
- Isolated users

Aircraft Server

- Embedded computer:
  - Hardened, certified, military-grade
- Internal 3G data card
  - used when grounded
- Avionics bus
  - read-only!

Avionics data bus

We have access to this data, in real-time:

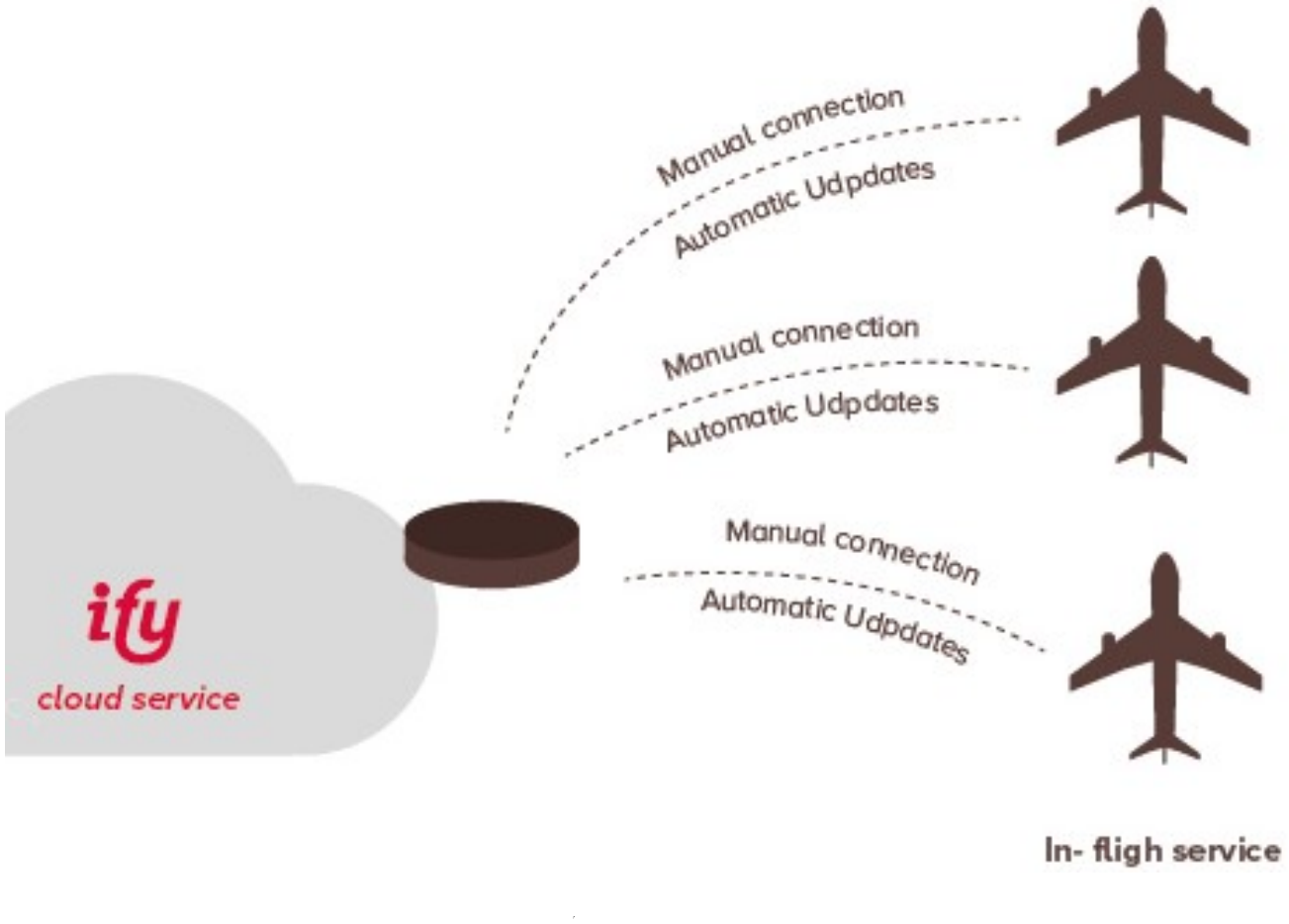
- `altitude`
- `flight_id`
- `ground_speed`
- `heading`
- `latitude`
- `longitude`
- `mach_speed`
- `outside_temperature`
- `pitch`
- `roll`
- `wind_speed`
- `yaw`

Discrete-time signals

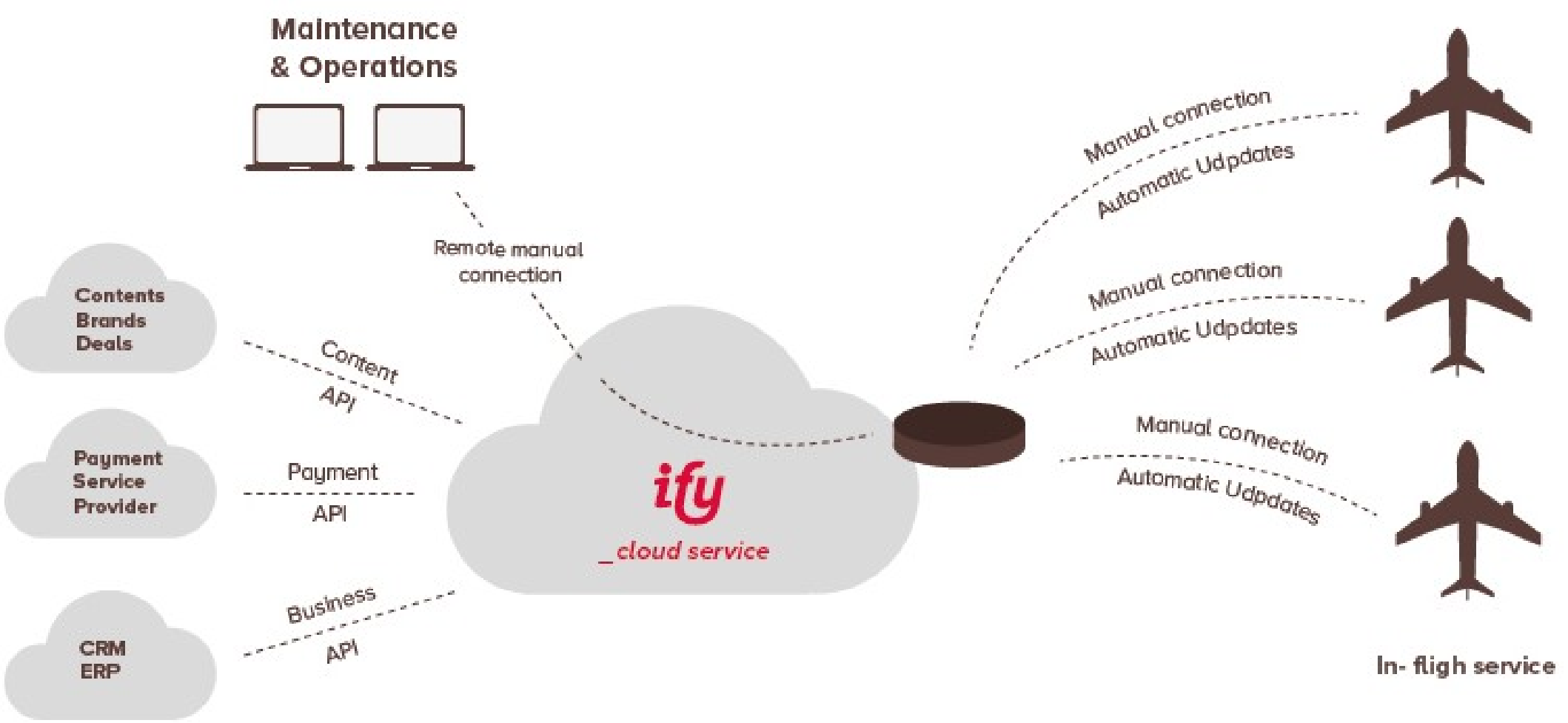
- DCFAILSIG
- ACFAILSIG
- OVERTEMPSIG
- GSM_POWER_STATUS
- ENB2SIG
- ENB1SIG
- ENB0SIG
- GSMSIG_STATUS
- CPLD_REV0
- CPLD_REV1
- SYSENSIG
- ENB3SIG
- ENB4SIG
- ENB5SIG
- ALERT
- CONFIGSIG0
- CONFIGSIG1
- CONFIGSIG2
- INTTEST_OUT
- INTTEST_IN
- ISO_OUT0
- ISO_OUT1
- ISO_OUT2
- ISO_OUT3
- GPIO_DCFAILSIG
- GPIO_ACFAILSIG
- GPIO_OVERTEMPSIG
- GPIO_SYSENSIG

The Hangar

- Hosted in the Internet
- Central point
- Orchestrates the operations
- Update contents, databases, code...



Hangar Operations



Resource ingest

- Thousands of resources, from ~20 providers
  - Per language
  - Per country
  - Per category: Videos, Readings, Deals...

- Some external APIs are questionable:
  - Missing SSL, Documentation...
  - Manually updates to an ftp...
  - Data in excel files...

Ingesting videos

- Ingest from SFTP / AWS S3
- Send to AWS ElasticTranscoder
  - Convert to HLS (HTTP Live Streaming)

- Sync chunk by chunk

Ingesting readings

- Ingest from SFTP / AWS S3

- Celery task:
  - Reduce size (image resolution)
  - Generate thumbnails

Ground mode

- Similar to the *"Aircraft"* mode

- Minor differences:
  - No Videos (we don't have the permissions)
  - More focus on destination offers
  - Online functionality (like *"forgot my password"*)

- Made to scale

3) Atypical challenges

- Specific perks of working with aircrafts
- Dealing with airplanes has extra challenges
- Problems we weren't expecting beforehand
- Also, *“mistakes where made”*

Regulations & Certifications

End of 2013, EASA allowed use of PEDs

EASA Safety Information Bulletin

SIB No.: **2013-21**
Issued: **09 December 2013**

Subject: **Use of Portable Electronic Devices during Commercial Air Transport Aircraft Operation**

Certificate everything!

- Had to certificate every step
  - The hardware was already certified
  - The WAPs were already certified
  - Lots of wireless tests
- Even the smallest screw has to be certified!
- Took us 6-9 months!

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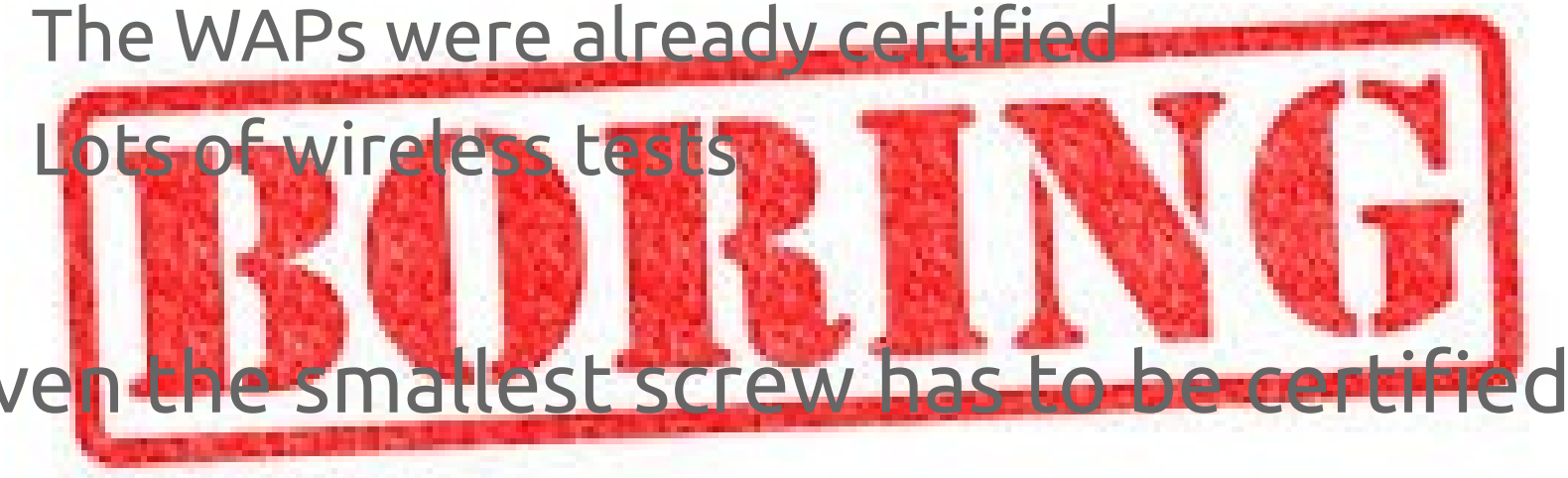


- Took us 6-9 months!

Intermittent connectivity

- We get 30~90m of connectivity per day
  - **10-15** minutes after each flight
- Sometimes, **roaming** applies
  - Limited synchro
- Improve the deployment tools
- Optimize the performance

Hard shutdown

- Electrical power is suddenly removed, and our airplane server is turned off
- Happens often:
  - When changing power from engine to external, after landing
  - If there is a storm, or just if the pilot wishes
- We could only mitigate...

Mistake: trusted the hardware

- File system corruption
  - The HDD write buffer is sometimes lost
  - Corrupted files
  - ***fsck*** at start
  - ***sync*** after each deploy
  - Added several consistency checks (for contents)

- Internal clock corruption
  - Logs showed wrong times
  - Added NTP checks (requires connectivity)

The CAP Theorem

"It's impossible for a distributed system to simultaneously provide all three:"

- **C**onsistency

  All nodes see the same data at the same time

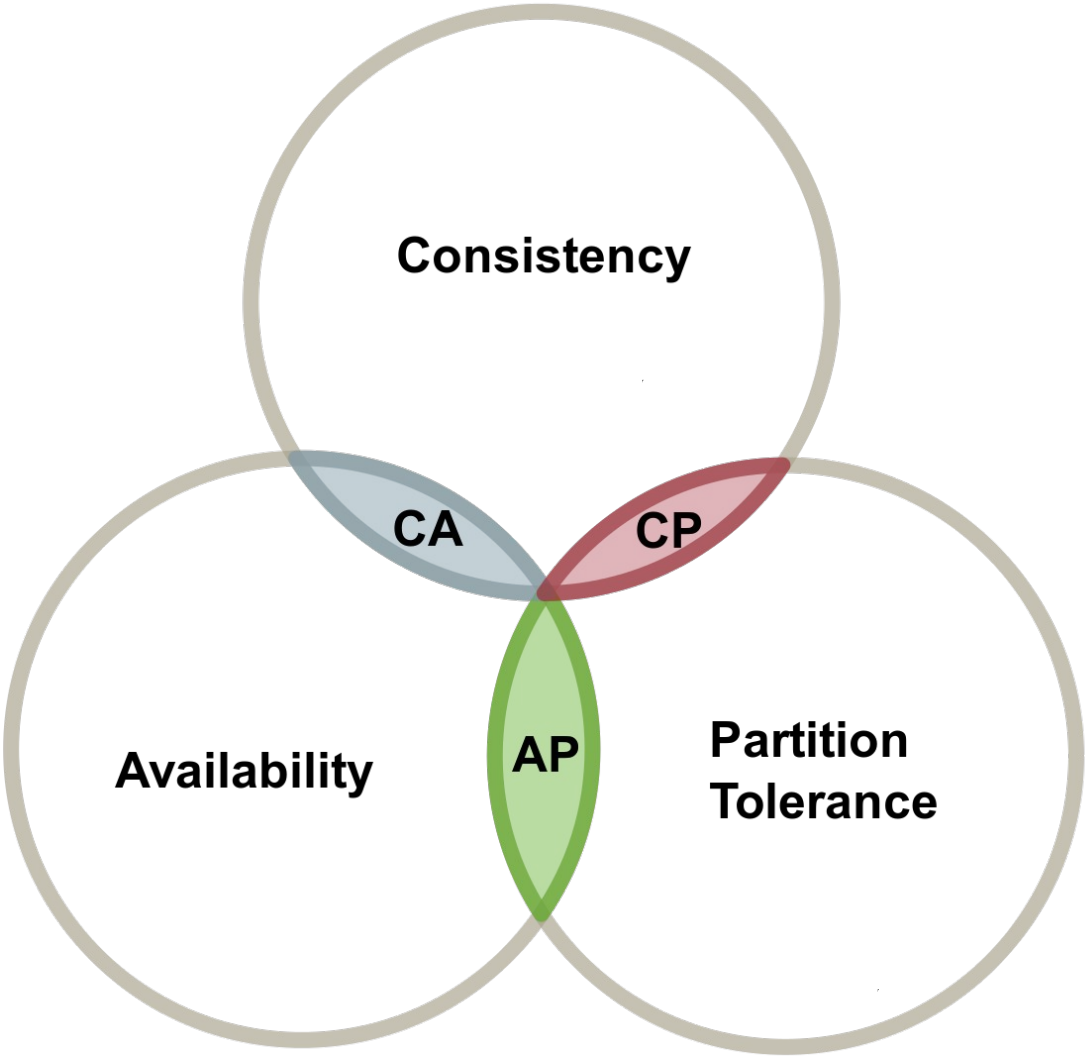
- **A**vailability

  Guarantee that every request receives a response

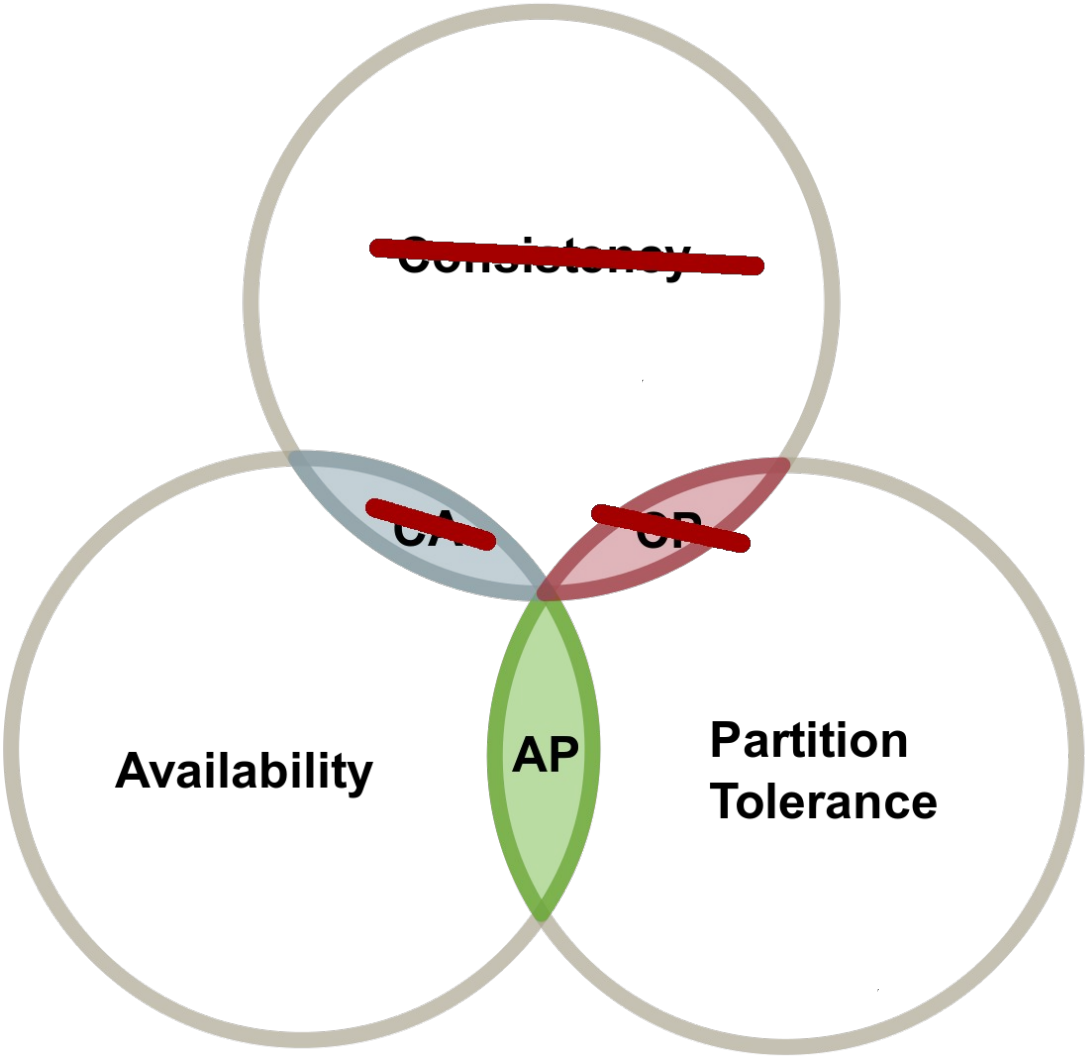
- **P**artition tolerance

  Continue to operate despite network partitioning

Big mistake: try to beat the CAP



Settled for “Eventual Consistency”



Recap

- Complex project with lots of features
  - Kept a modular design
- Could implement everything
  - helped by existing Python libraries
- Learned a lot from unexpected challenges

Conclusions

- Python made it possible!
- Very versatile, covers all our use cases
- *“We stand on the shoulders of giants”*
- Developed in a short time

Thanks for attending!

- Get the slides at http://slideshare.net/DZPM

- **We're hiring! http://immfly.com/jobs**

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Questions?