Expert talk

The value of cloud at Rolls Royce

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Equipment Health Monitoring in Cloud

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Equipment Health Monitoring

several different equipment types

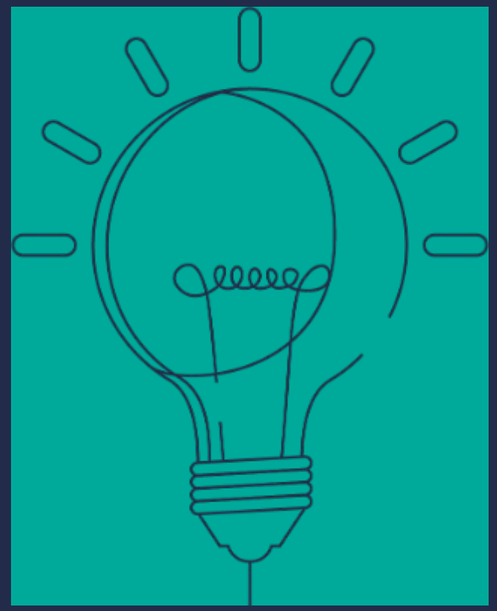
monitor millions miles flown every day

millions data parameters per day

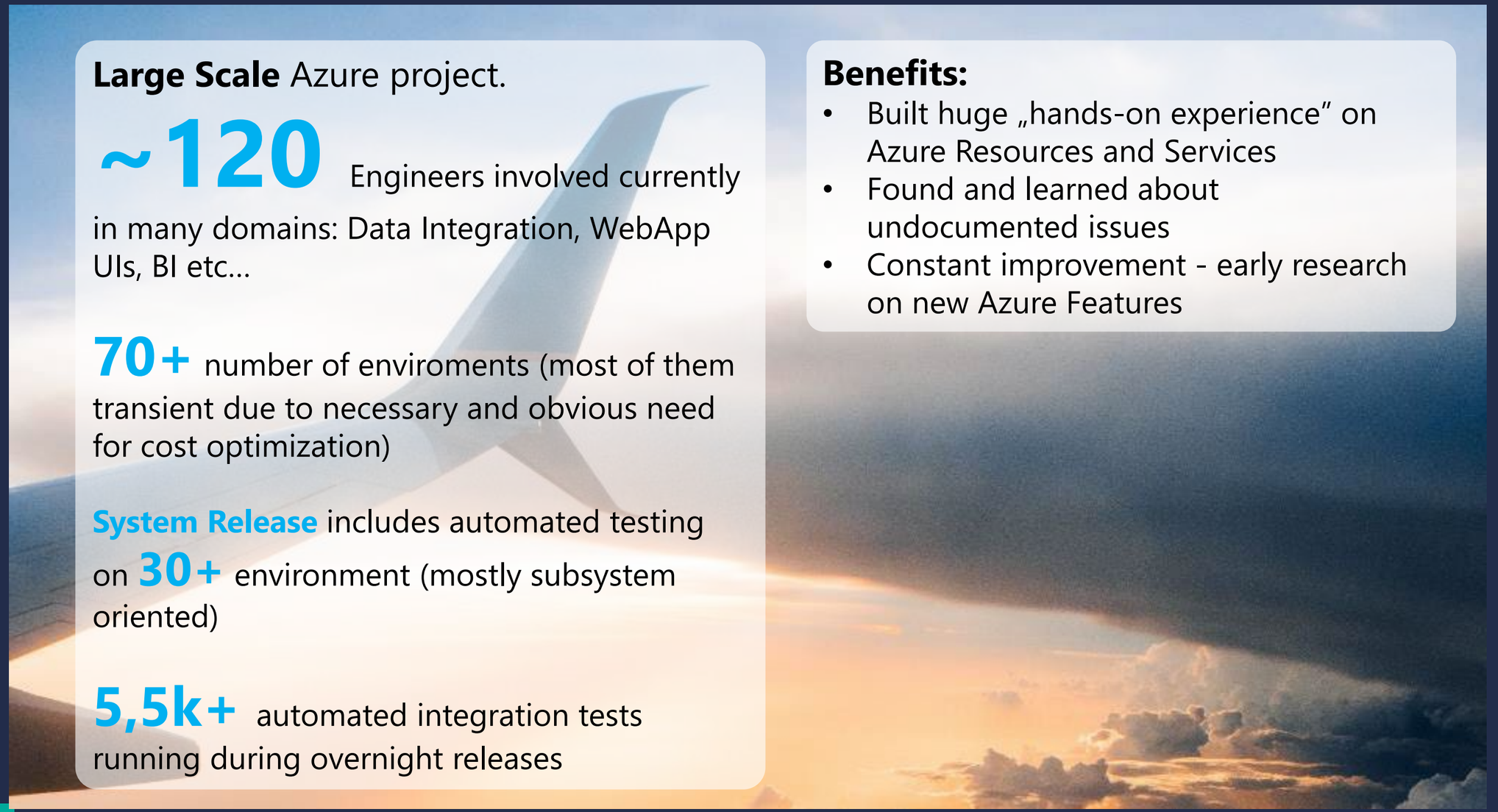
Thousands of users

Millions of savings

Hundreds of failure modes



Unique experience and technology excellence



Large Scale Azure project.

~120 Engineers involved currently in many domains: Data Integration, WebApp UIs, BI etc…

70+ number of enviroments (most of them transient due to necessary and obvious need for cost optimization)

System Release includes automated testing on **30+** environment (mostly subsystem oriented)

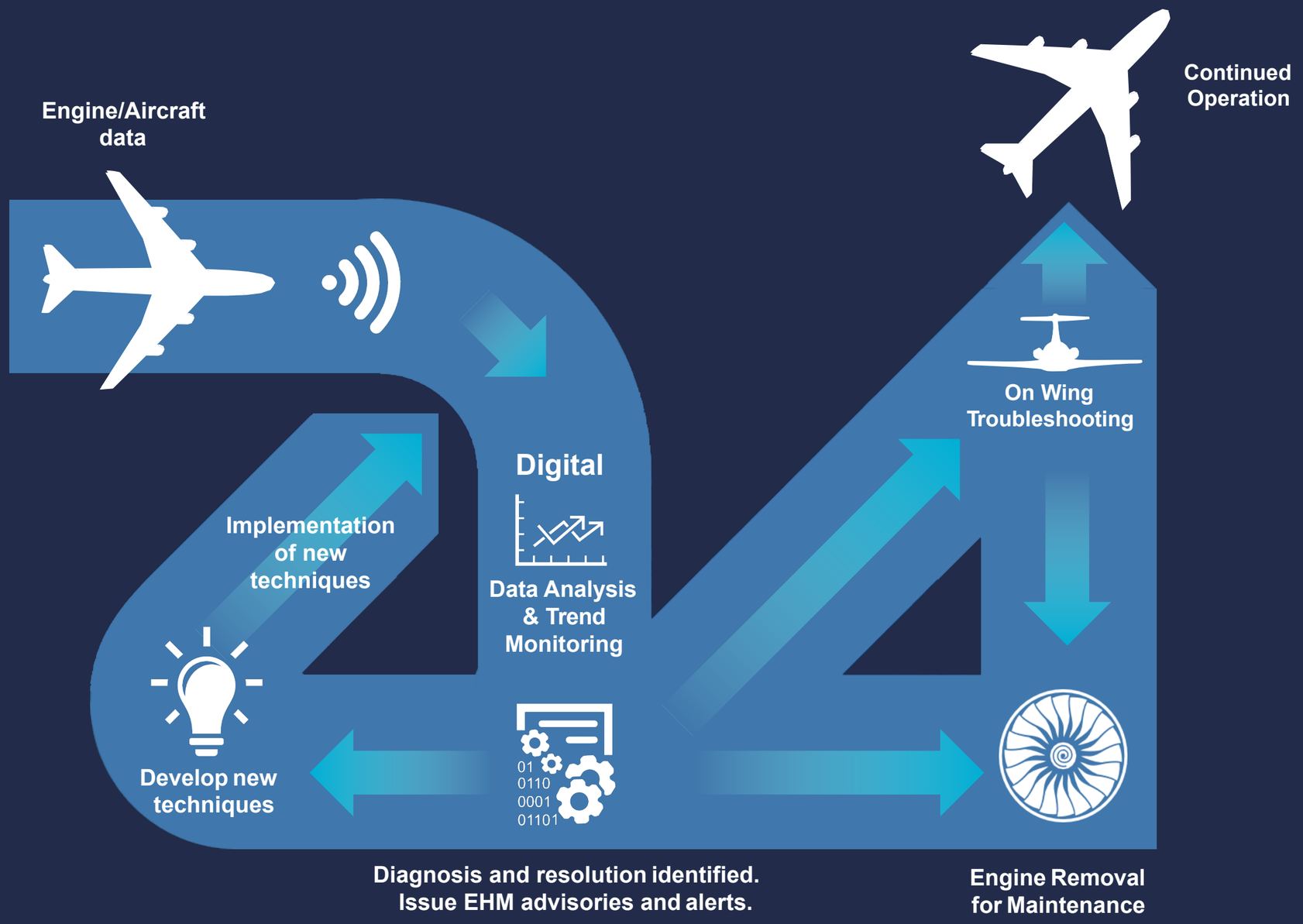
5,5k+ automated integration tests running during overnight releases

Benefits:

- Built huge „hands-on experience" on Azure Resources and Services
- Found and learned about undocumented issues
- Constant improvement - early research on new Azure Features

HOW IT WORKS?

IOT for Jet Engine Manufacturer



Flexible DATA platform - wide business use

Operations

- Optimized Maintenance
- Manufacture planning
- Stock Planning

Value Added Services/Upsell

New services based on data

Research and development

- Experimental work based on historical data
- Digital twin models - Simulations of efficiency assuming equipment changes

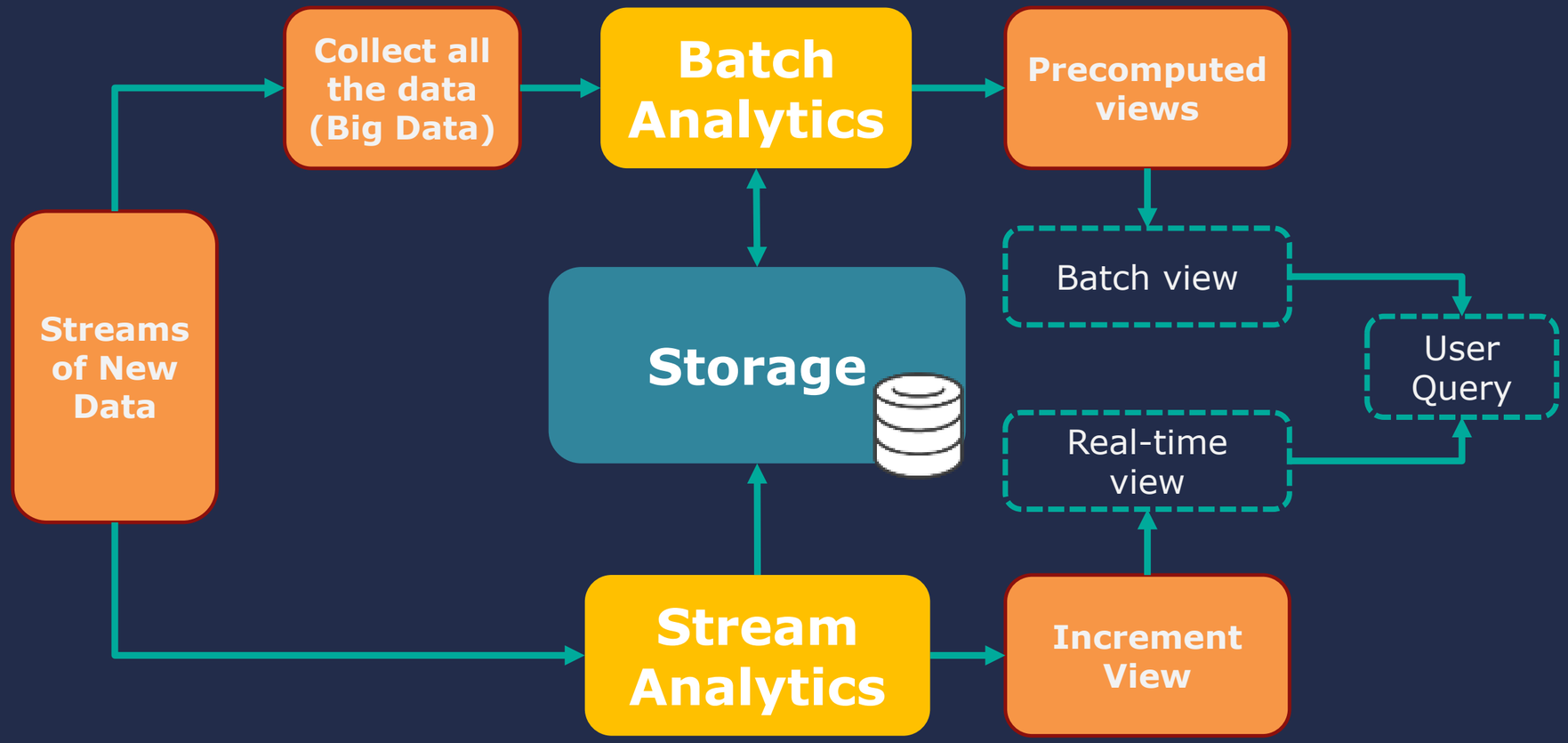
PLATFORM and TECHNOLOGY

LAMBDA ARCHITECTURE

BIG DATA ARCHITECTURE

FOR

NEAR-REALTIME SYSTEMS

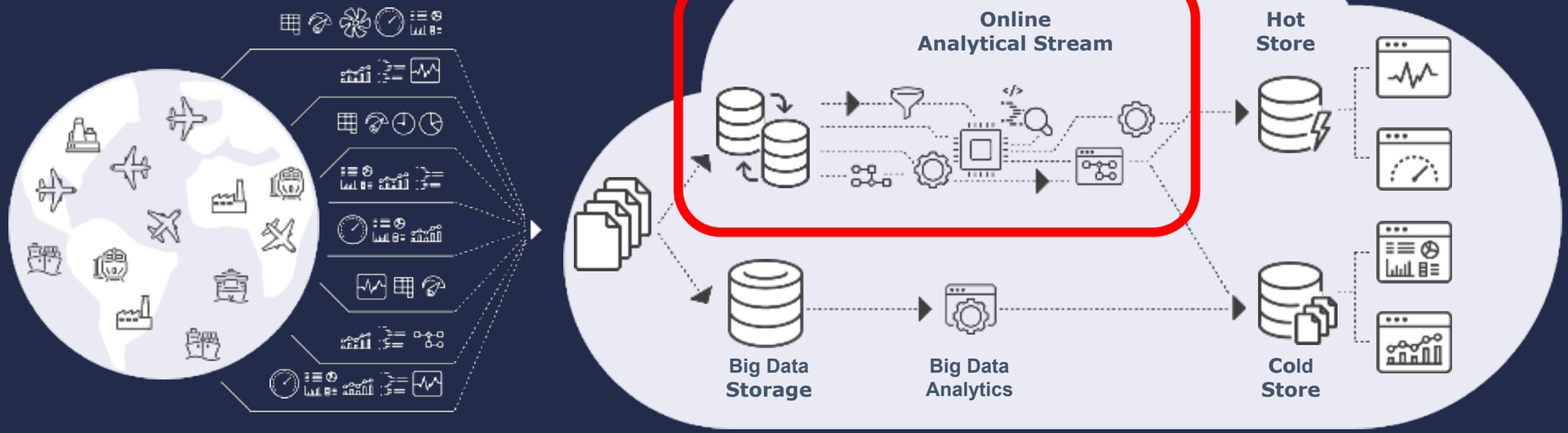


Equimpment Health Monitoring

Large scale project - built-in PaaS model (on Azure cloud).

20b
data points
a day

180
signatures monitored per engine



Agile
response to fleet demands

Differential data streams from multiple sources

Data acquisition

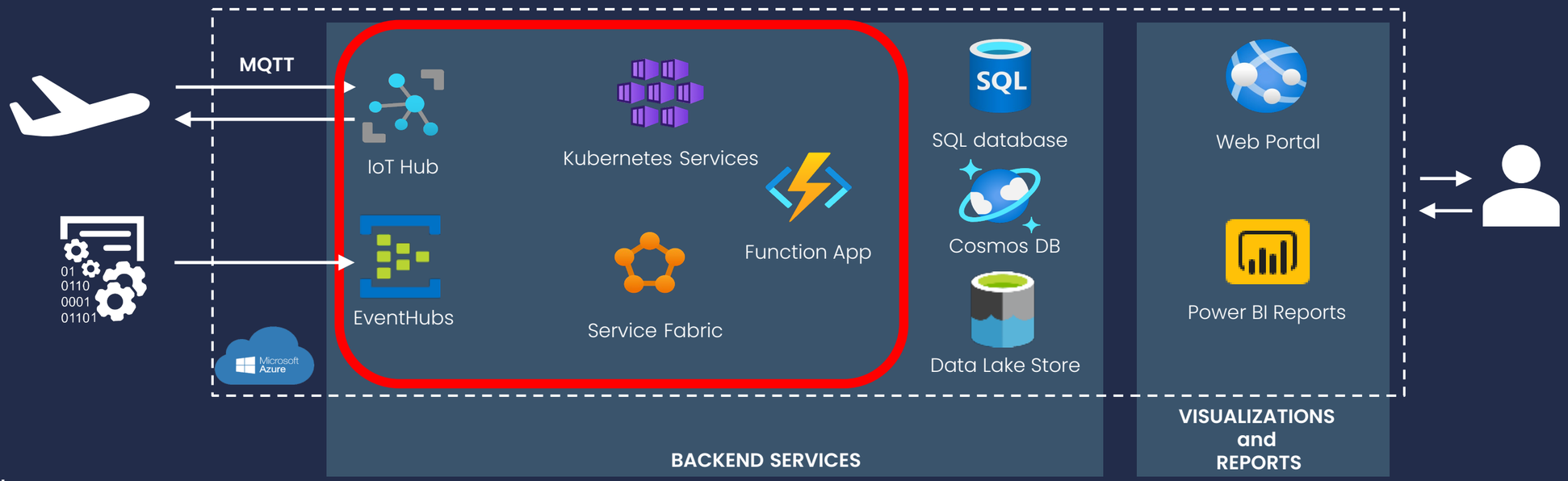
Data processing

Business Services & Reporting

AZURE IOT HUB AND STREAMING

WE ARE EXPERTS IN IOT AND STREAMING SOLUTIONS

Inetum Poland has successfully run bi-directional communication with IoT devices mounted within the plane to exchange telemetry data, settings and multiple engine parameters. Communication is run with IoT Hub resources and uses secured MQTT protocol.



IOT processes

- Device Provisioning
- 1-way communication (Air-to-ground)
- 2-way communication

Streaming processes (examples)

- Flight high-frequency data
- Flight live tracking
- Weather data

Engine Health Management

Large scale project - built-in PaaS model (on Azure cloud).

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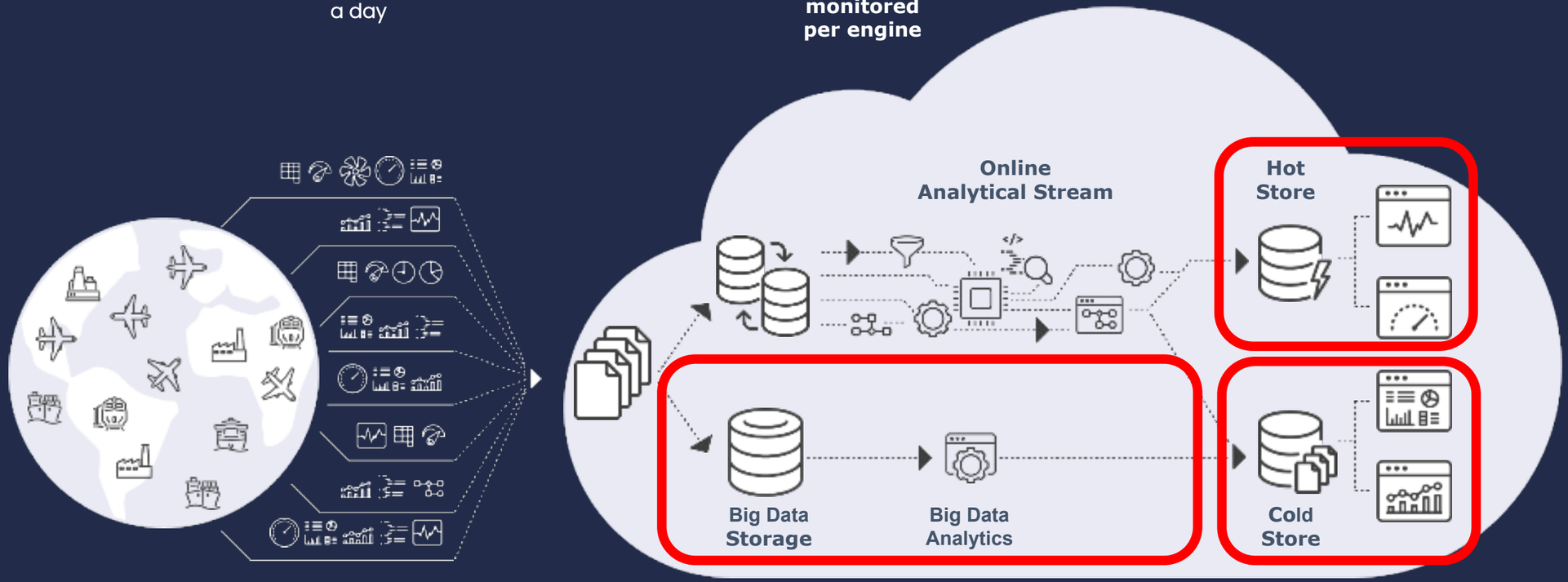

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Big Data and Data-based Services

Big Data platform

Do it right!

Must be: Big but open platform, ready for various use

- Use **Data Lakes** for structured and non-structured data
- **Lakehouse** over Monolith Warehouse
- Use **Data Catalogs** to organize/understand data
- Isolate workspaces per Business Service projects
- Ready-to-use sandbox/framework for quick onboarding of Research projects - ready for innovations (AL/ML)

Reporting platforms

- Internal-use reports
- Customer-oriented reports

Services & Portals

- Value-Added Customer-Facing Service Portals
- Internal Service Portals
- Live Equipment Monitoring
- Real-time dashboards ?

Ad-hoc reporting

- Research reports

Data Mesh approach

Microservices as Foundation

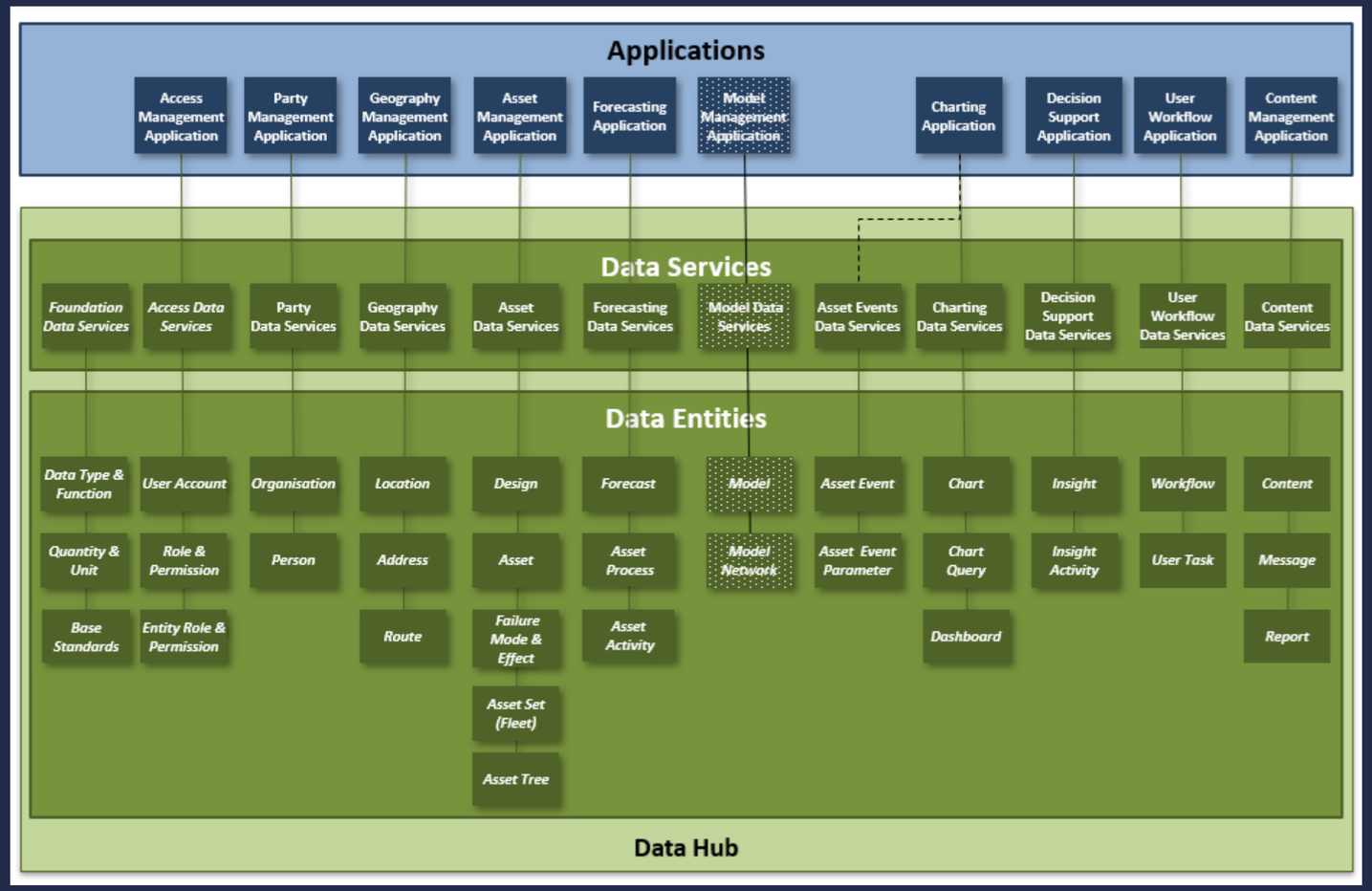
Data Hub to define the proper context of Big Data

Microservice architecture

Used to define the common domain of data processing

- Assets
- Locations
- Organizations
- User Workflows (Service workflows)
- … others

Distributed object model. Individual development and release cadence.



Microservice Platform

CAN WE REPEAT THIS PATH???

ROADMAP FOR DATA PROCESSING EXCELLENCE

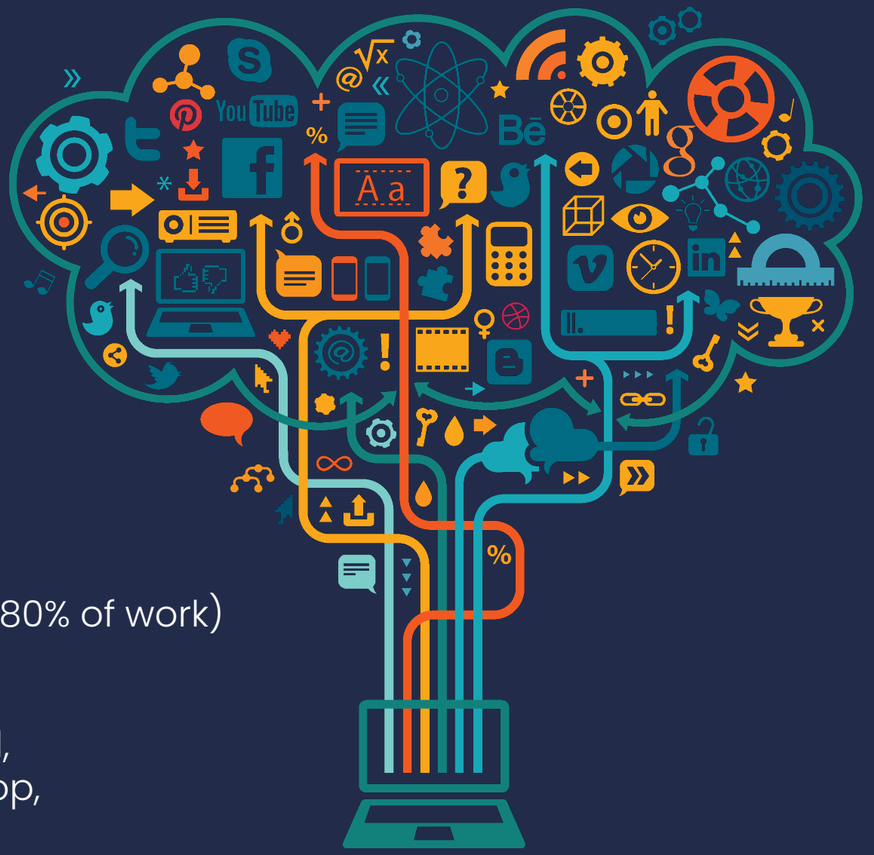
See potential of YOUR data...

Most of the companies and authorities are currently already able to

do the first two steps

ARTIFICIAL INTELLIGENCE ONBOARDING

Artificial Intelligence is not tomorrow – it's today....



AI Integration (Standard Path)

Using ready to use models for most common scenarios....
There are already plenty of models available:
Pre-trained models for Computer Vision, Speech recognition
Hosted in a cloud for easy integration

Machine Learning (Unique Value path)

Using best of your Data to build and train models for solving unique problems.

Requires careful Data Analysis.... Cleansing.... Augmentation.... (it's usually up to 80% of work)

This is Research Type Project:

- the outcomes depend on data quality and sometimes cannot be promised,
- models can be improved/refactored in endless „constant improvement" loop,

Good news is.... In case of Custom Models even non-perfect accuracy can give impressive benefits

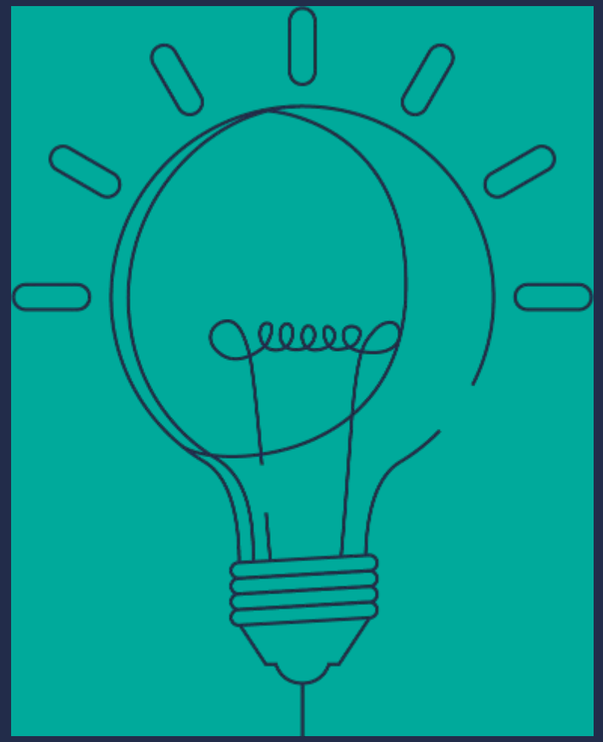
LESSONS LEARNED

Think about **scalability**

- **Estimate you current and expected(!) workloads**.
- **Be prepared for data stream growth.** When your on-premise resouces are about to be finished, think of extending your capabilities by using cloud resources in mode pay-as-you-use (hybrid systems).
- **When you scale grows to overwheloming size think about moving fully to the cloud** (to PaaS services) – to reduce maintenance costs.

Be prepared for **Data Variability**

- Design **extensible components of Data Ingestion**.
- Design **Common Rules for your Data Storages** (formats, encodings, conventions etc.)



Do it **iteratively**

- Do high-level general design but **start with something small.** Adjust your plans and extend your system in iterations.

Think about **extensibility and maintainability**

- **Use technologies allowing easy portability – open source tools, containerization etc...**
- Modular design (microservices) – for easy extensions and upgrades of small parts of the big system.
- Create susbystem tests and deployments system to reduce a cost.

Avoid **Big-Data pitfalls**

- **Ingest the data you have clear purpose for** – Focus first on bussines benefits
- Select proper data processing (do you really need real-time data streams)
- **Do not limit to just your data** (buy/exchange the data you need)
- **Avoid analysis on small samples** (collect big sets before rich Analytics)
- **Consider legal requirements**

SUMMARY OF BENEFITS

- IOT and Big Data allows to optimize cost related to product maintenance (in this case ~200M €+/year)
- IOT and Big Data approach enables switching to **Product-as-Service model** and revenue sharing
- Data (especially IOT stream) is “new gold” and foundation for AI-based (intelligent) equipment. Start data gathering right now.
- How?..... start “small”, but think “big”