SYSTEM ENGINEERING APPLIED TO THE AVIATION ECOSYSTEM

FLORIAN GUILLERMET

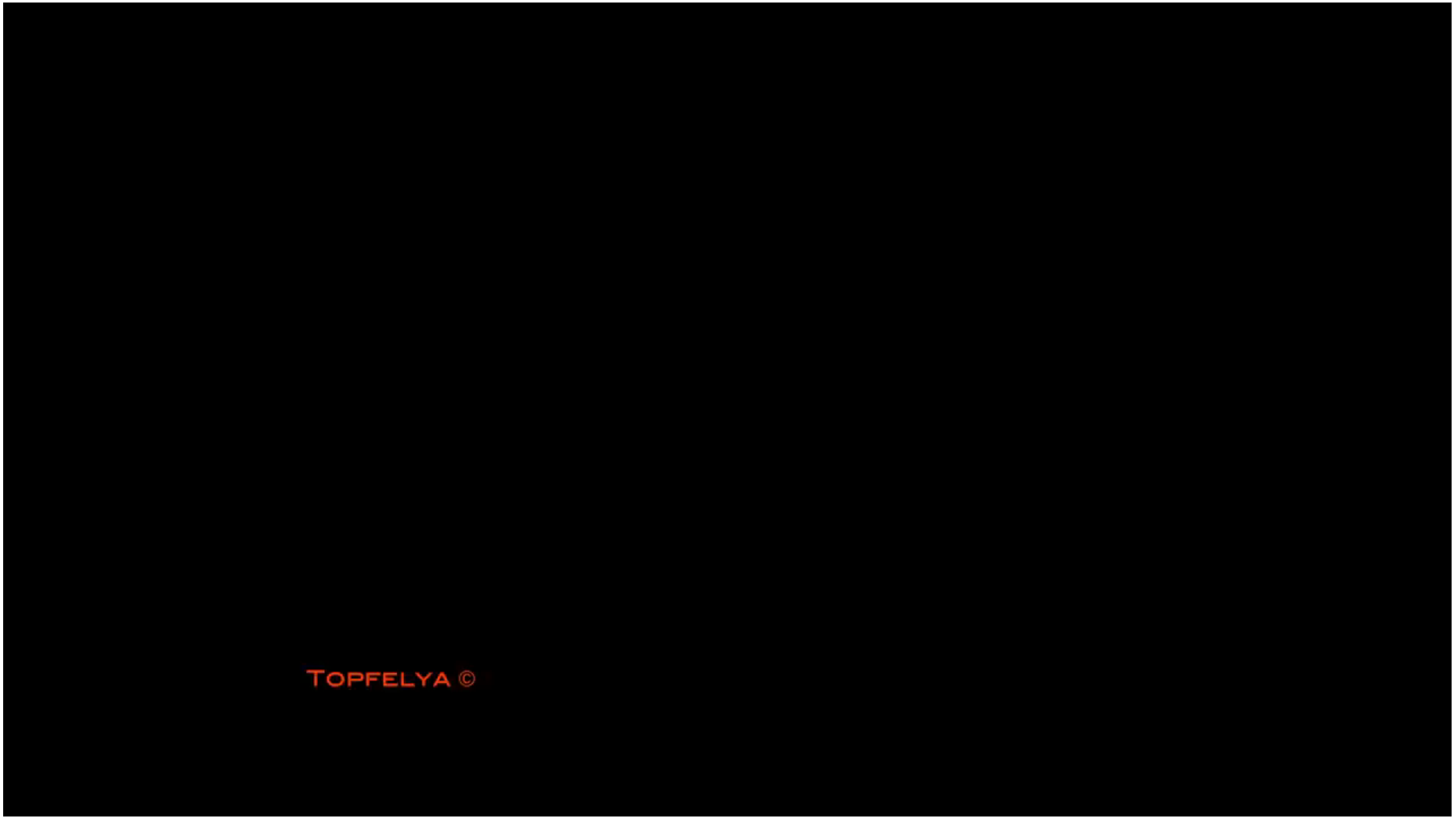
Executive Director SESAR Joint Undertaking

CSDM 2019

SESAR JOINT UNDERTAKING

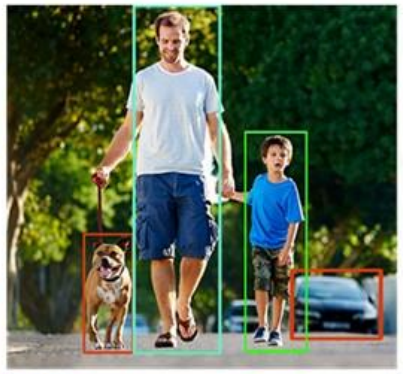
Founding Members

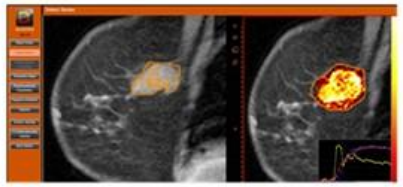
EUROPEAN UNION EUROCONTROL

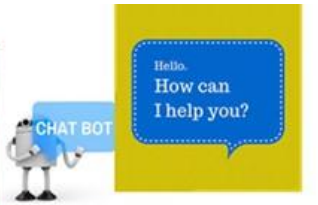

TOPFELYA ©

THE FUTURE OF AVIATION

The world around us is changing very fast





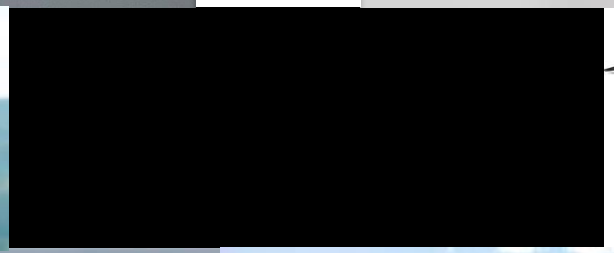


New vehicles

New players

UBER
UBER

easyJet
easyJet



intel

amazon
Prime Air
amazon
Prime Air

prototype
1

Global air mobility challenges and opportunities

Traffic growth

Technology disruption

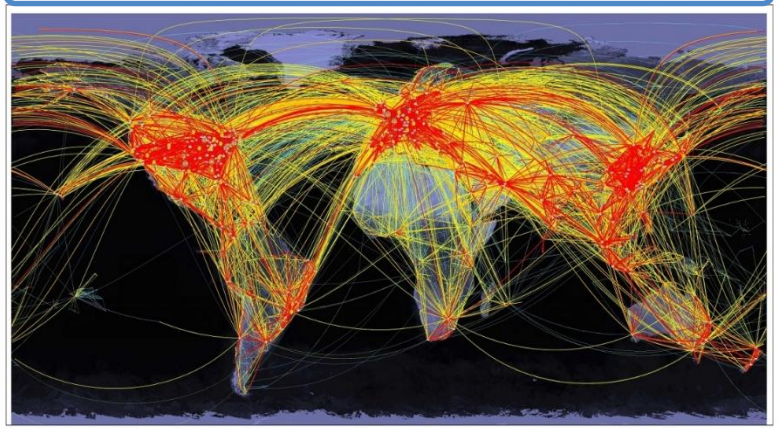
Customer expectations

Automation

Global competition

2010

2020



2030

2040

WHY WE NEED TO CHANGE?

The aviation value chain is transforming

- **High performing connected aircraft or air-vehicles**
  - ✓ Industry is continually developing and improving its products in response to competition
  - ✓ New entrants in a global market are driving innovation
  - ✓ Technology lifecycles are accelerating
- **Optimised airline operations & new air services**
  - ✓ Significant pressure is being placed on trajectory optimisation and reduction of environmental footprint
  - ✓ Future “airspace revenues” are increasingly generated from new services
  - ✓ New societal expectations
- **An ecosystem that will have to adapt**
  - ✓ Technology, regulation and policy are key drivers
  - ✓ Management of information is at the core of the system
  - ✓ Think “digital assets” vs. “physical ones”

In our skies…

What does this mean for Air Traffic Management?

Key drivers

Disruptive growth in traffic size

- **Tens of millions of digitally connected flights in the airspace in 2050**
  - **19 millions traditional (IFR) flights**
  - **85 million unmanned flights**

Automated systems

- **Highly automated vehicles**
  - **Singe pilot operations**
  - **Urban air mobility**
  - **Cargo drones**

Unprecedent level of hetero-geneity and complexity

- **Developments will lead to unprecedented level of heterogeneity and complexity**

Future ambition/vision

Unprecedented level of **heterogeneity** & **complexity** will require further…

Air & ground automation

Connectivity

…to ensure a **scalable**, **flexible**, **sustainable** **cost-efficient** and **resilient system with safety performance at or above current**

SO, WHAT DO WE DO?

A public-private partnership

Created in 2007 as an EU Agency - EC 219/2007
R&D and demonstrators – 3.6 B€ - SESAR 1 & SESAR 2020
Implementation on-going since 2015 – 6 B€

3000 experts : engineers, researchers, operational staff

Blending academic research, industrial development and deployment

founding members

EUROPEAN UNION EUROCONTROL

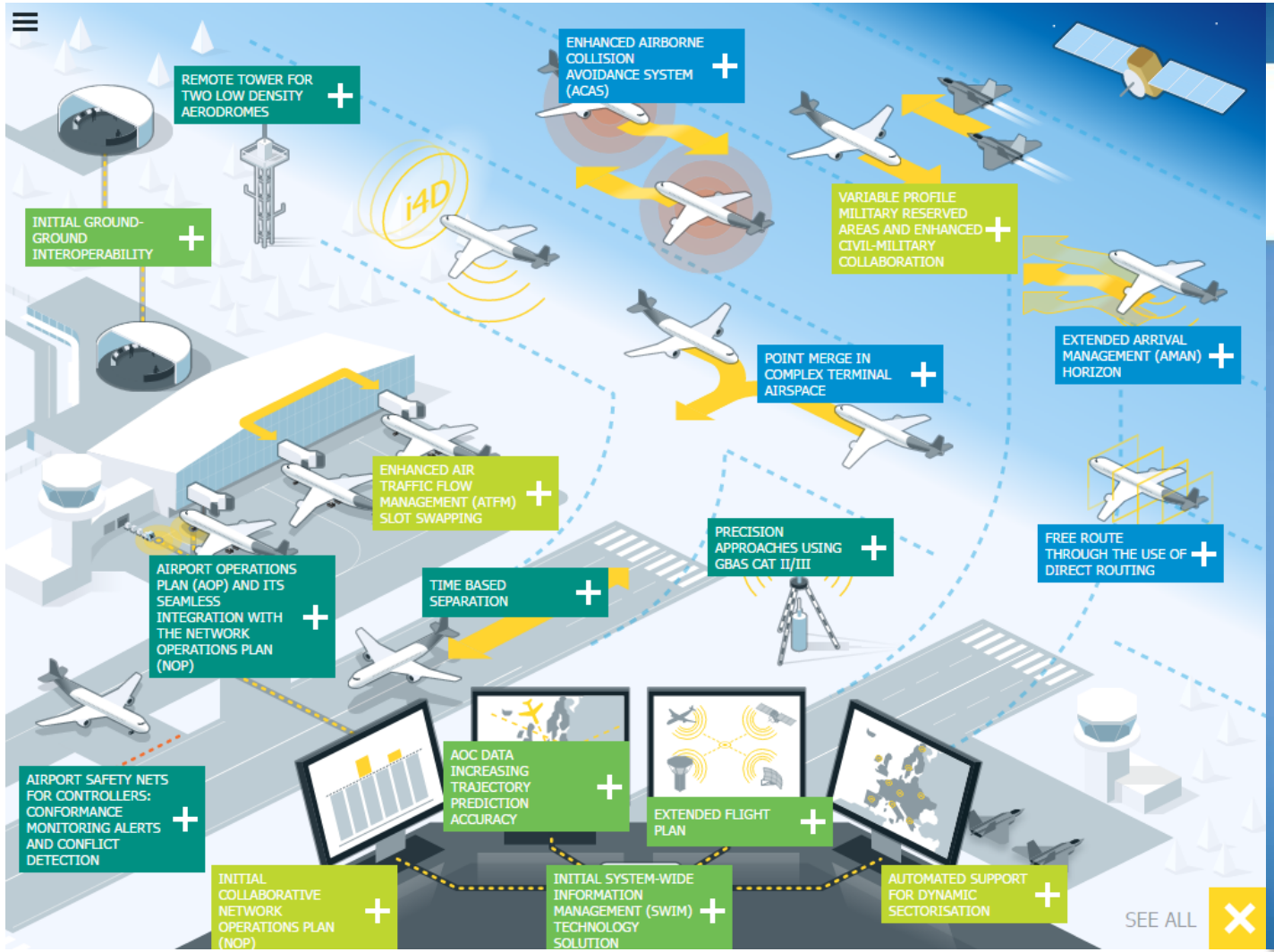
AIRBUS AT-One B4 CONSORTIUM COOPANS

DASSAULT AVIATION DFS Deutsche Flugsicherung dgac DSNA ENAIRE enav

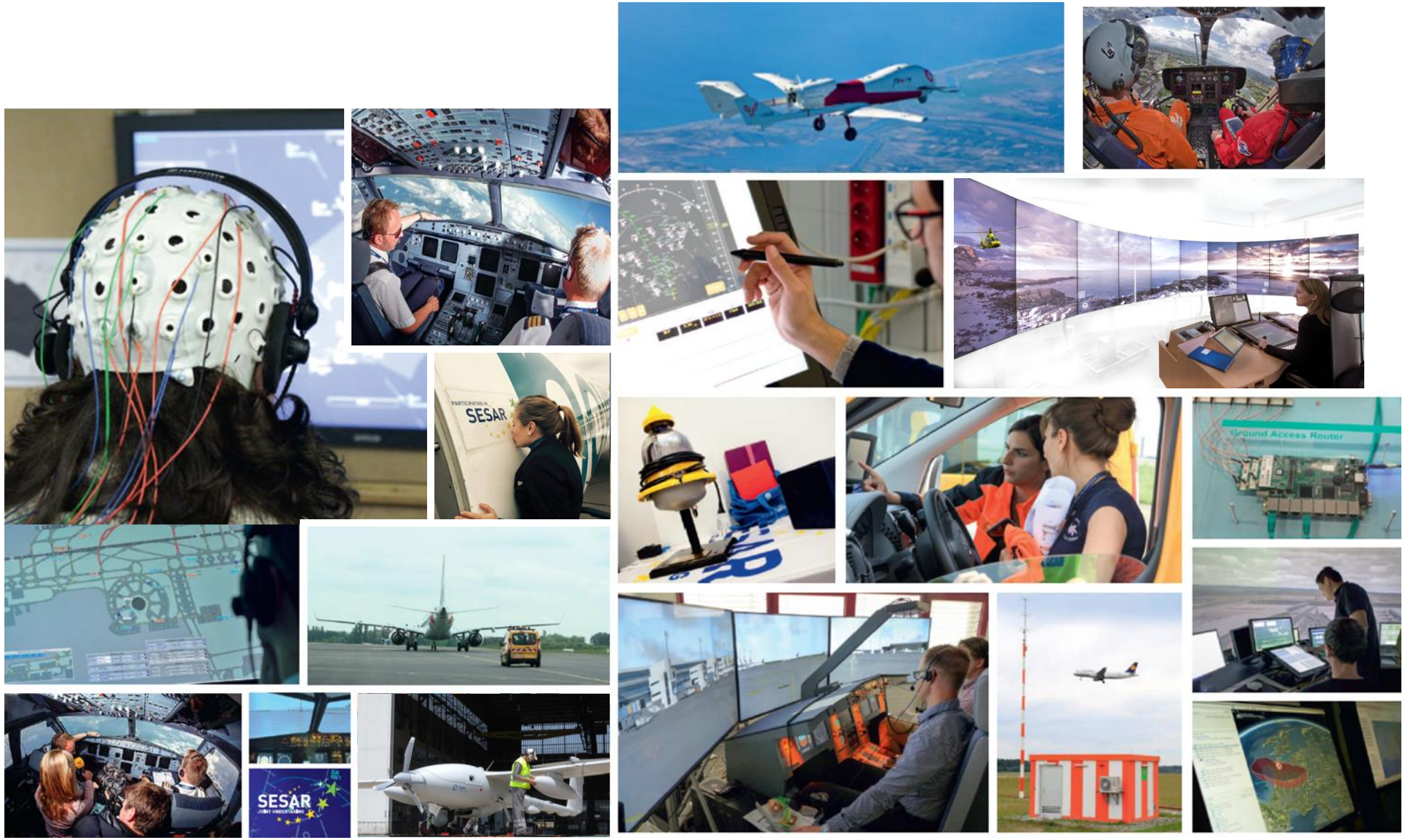
FREQUENTIS SESAR PARTNERS Honeywell indra LEONARDO NATMIG

NATS SEAC skyguide THALES

Managing all R&D efforts



Our activities

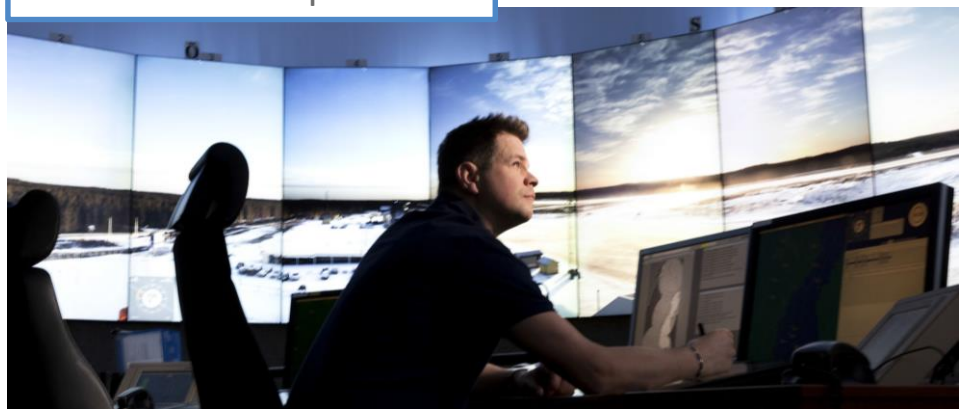


Virtualisation

BENEFITS

- Increased safety and resilience
- Increased cost efficiency through rationalisation and standardisation of systems and services
- Increased flexibility and demand balancing

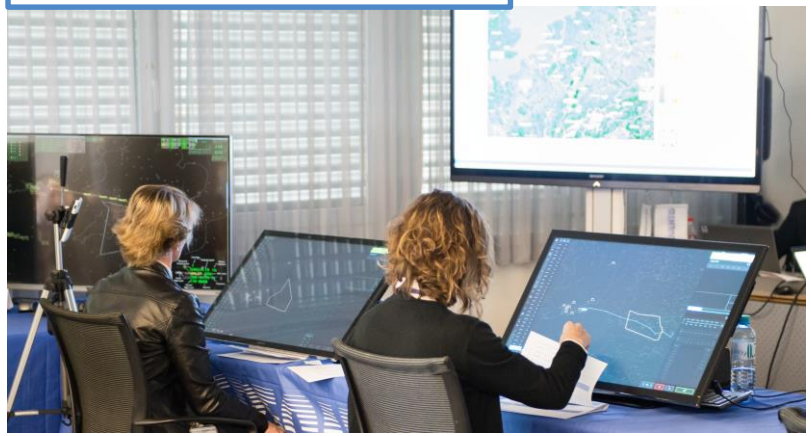
Remote tower operations



CHALLENGES

- Regulatory framework supporting cross boarder service provision
- Staff training

Virtual center's operations



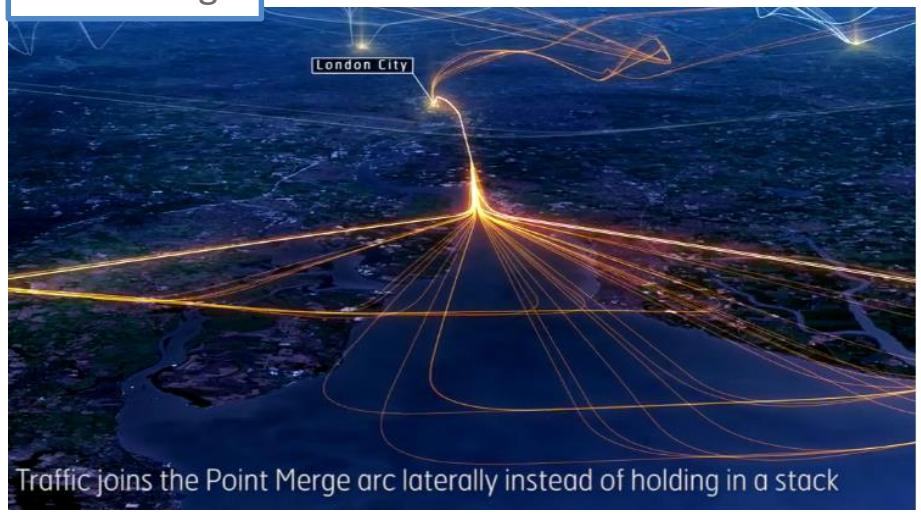
Augmented and synthetic vision

Automation support

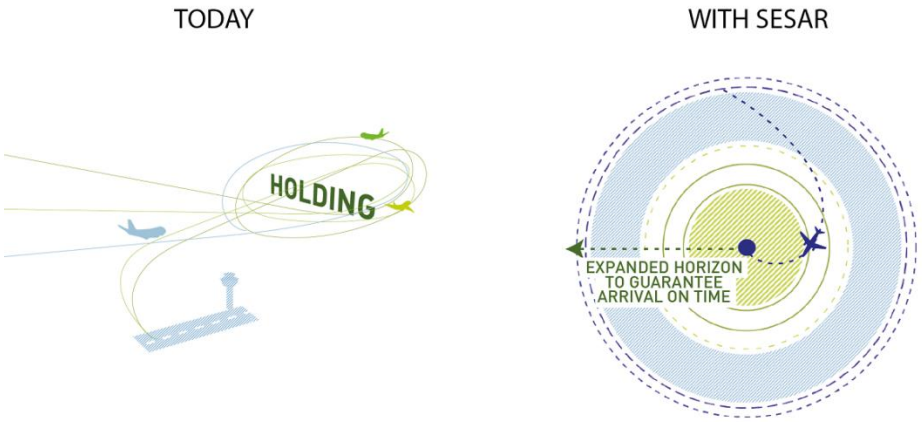
BENEFITS
- Improved safety and quality of service
- Improved operational efficiency by reducing holding times as well as fuel burn and emissions
- Scalability

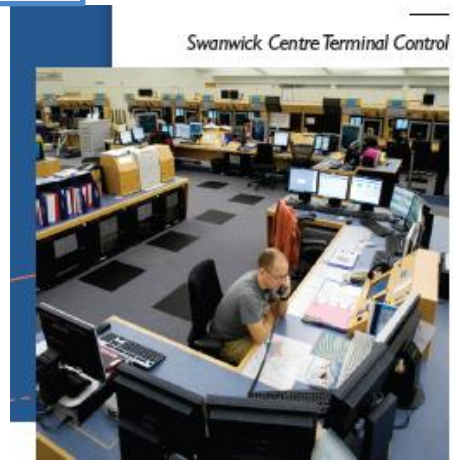
CHALLENGES
- Human factor: balancing automation and human role
- Certification of systems

Point Merge



Extended AMAN

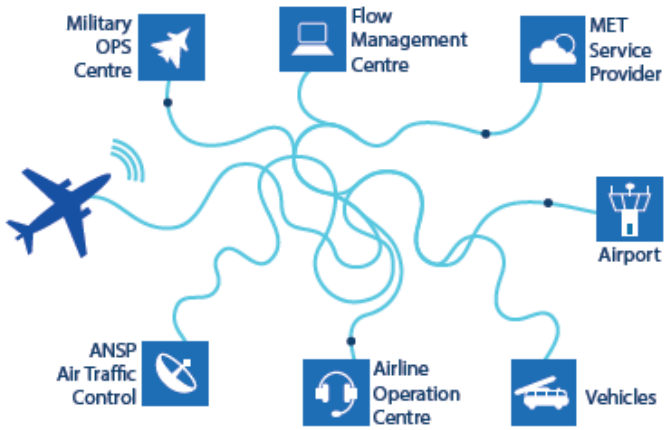



Swanwick Centre Terminal Control

Reims UAC / ControlWorkPosition with the XMAN tool developed by Thales

System Wide Information Management

TODAY



- Specific systems and networks
- Point to point communication
- Physical infrastructure
- Low connectivity
- Poor Automation

=

Low exposure
Limited impact

SECURABLE BY DESIGN

TOMORROW

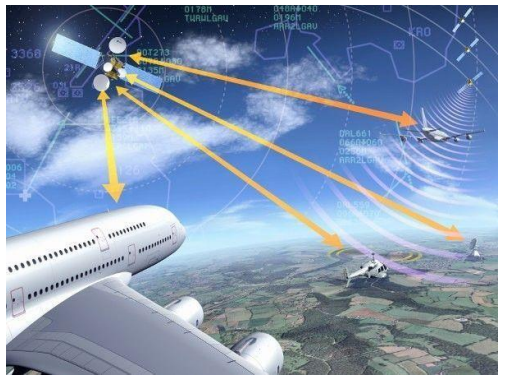
- Multi-stakeholder system of systems
- Public networks
- Increased use of COTS and standard protocols
- Virtual infrastructure
- High connectivity
- Increased Automation

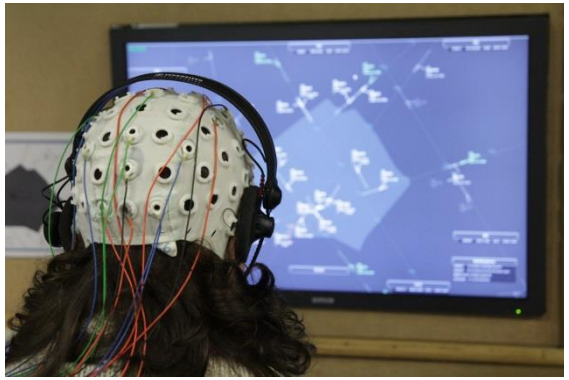
=

High exposure
High impact

Flight- and flow-centric operations

- Flight- and flow-centric operations with Initial 4D trajectories
- Performance Based Navigation (PBN)
- Air/ground Data Communication





Airliner World
THE GLOBAL AIRLINE SCENE

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FREE App

Home › News › SESAR conducts world first 4D flight trial

SESAR conducts world first 4D flight trial

Published: February 13th, 2012

Easyjet Starts Flights Downlinking Projected Profile Data to Maastricht

By Woodrow Bellamy III | July 26, 2019

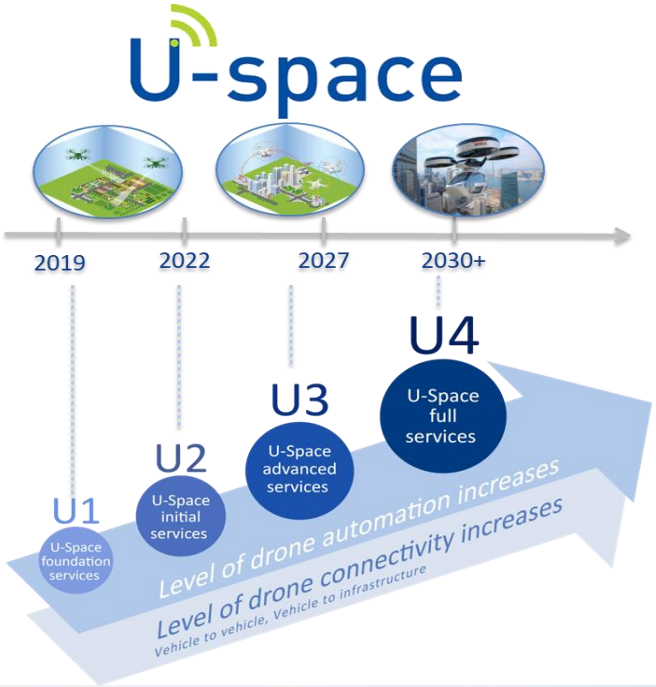
Send Feedback | @WBellamyIIIAC

Our solutions

63 SESAR Solutions delivered, more candidate solutions in the pipeline

39 already **under deployment** across Europe
Disseminated through innovative **EU aviation standards**

Angelholm airport controlled from Malmö (100 km away)



WHAT COULD POSSIBLY GO WRONG?

INDEPENDENT
Belgian airspace closed: Air traffic control failure grounds all flights causing 'chaos' at Brussels airport
Windows 3.1 Is Still Alive, And It Just Killed a French Airport
PC
The Telegraph
Lufthansa plane nearly collides with drone near Warsaw
BBC NEWS
FT FINANCIAL TIMES
Airport disruption: Flights recover after Nats system failure
REUTERS
$2 billion air traffic control system failed by running out of computer memory

AVIATION

Europe travelers can expect flight delays again this summer

Half a million people saw delayed or cancelled flights to and from France

Gatwick Airport: Drones ground flights

20 December 2018 Share

Gatwick drone shutdown

Air Traffic Control Delays Continue Upward Creep in Europe

by Cathy Buyck - March 18, 2019, 12:19 PM

The recent stark warning from Eurocontrol director general Eamonn Brennan that the continent's air traffic system is close to "hitting a wall" appeared validated by data for February—typically a quiet time of year—

Air traffic management delays growing disproportionately vs traffic

AIRLINES FOR EUROPE

Source: Eurocontrol, Performance Review Unit

Extinction Rebellion protester climbs on plane at London City Airport

Another arrested protester who refused to get off a plane told passengers he was "extremely sorry for the inconvenience".

Les Echos

À la une | Idées | Économie | Politique | Monde | Tech-Médias | Entreprises | Bourse | Finance - Marchés | Régions | Patrimoine

FOCUS

Climat : les compagnies aériennes rattrapées par les taxes

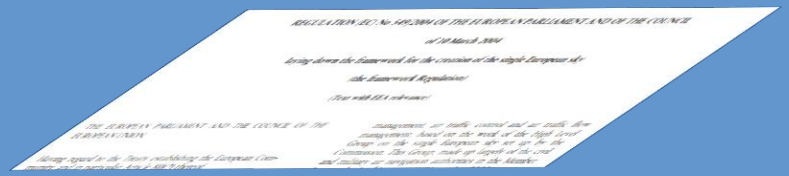
L'Assemblée nationale a voté jeudi l'éco-contribution sur les billets d'avion, qui s'ajoute à taxe de solidarité existante. Et le ministre de l'économie Bruno Le Maire se dit favorable à la création d'une nouvelle taxe, européenne cette fois, sur le kérosène.

SO, HOW DO WE MAKE IT HAPPEN?

SYSTEM ENGINEERING APPLIED TO THE EUROPEAN AIRSPACE ARCHITECTURE

Reconnecting the various dimensions of the ecosystem

Regulatory



Air navigation services

OPERATIONAL FRAMEWORK DIMENSIONS

*Services are **enabled by airspace and technology** and **dependent on the infrastructure & data services** and corresponding **preliminary regulatory analysis***

Airspace

Operations & Technology

Infrastructure & data services

FUNCTIONAL AND TECHNICAL DIMENSIONS

***Stronger coupling** between airspace, operations and technical evolution and **measurement of the impact** through simulations factoring in known deployments and roadmaps from the Master Plan*

The current architecture is the result of national historical evolution

Current architecture

OPERATIONAL VISION

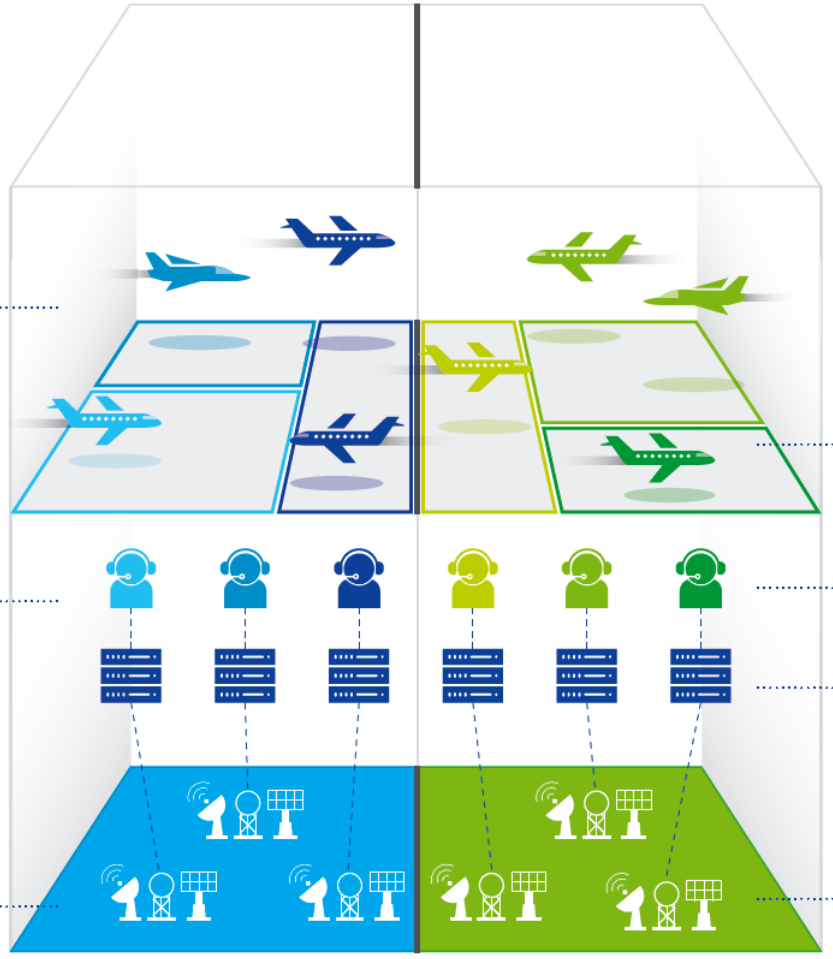
FUNCTINAL VISION

TECHNICAL VISION

Airspace layer

Air traffic service layer
with vertical integration of applications and information (weather, surveillance...)

Physical layer
(sensors, infrastructure...)



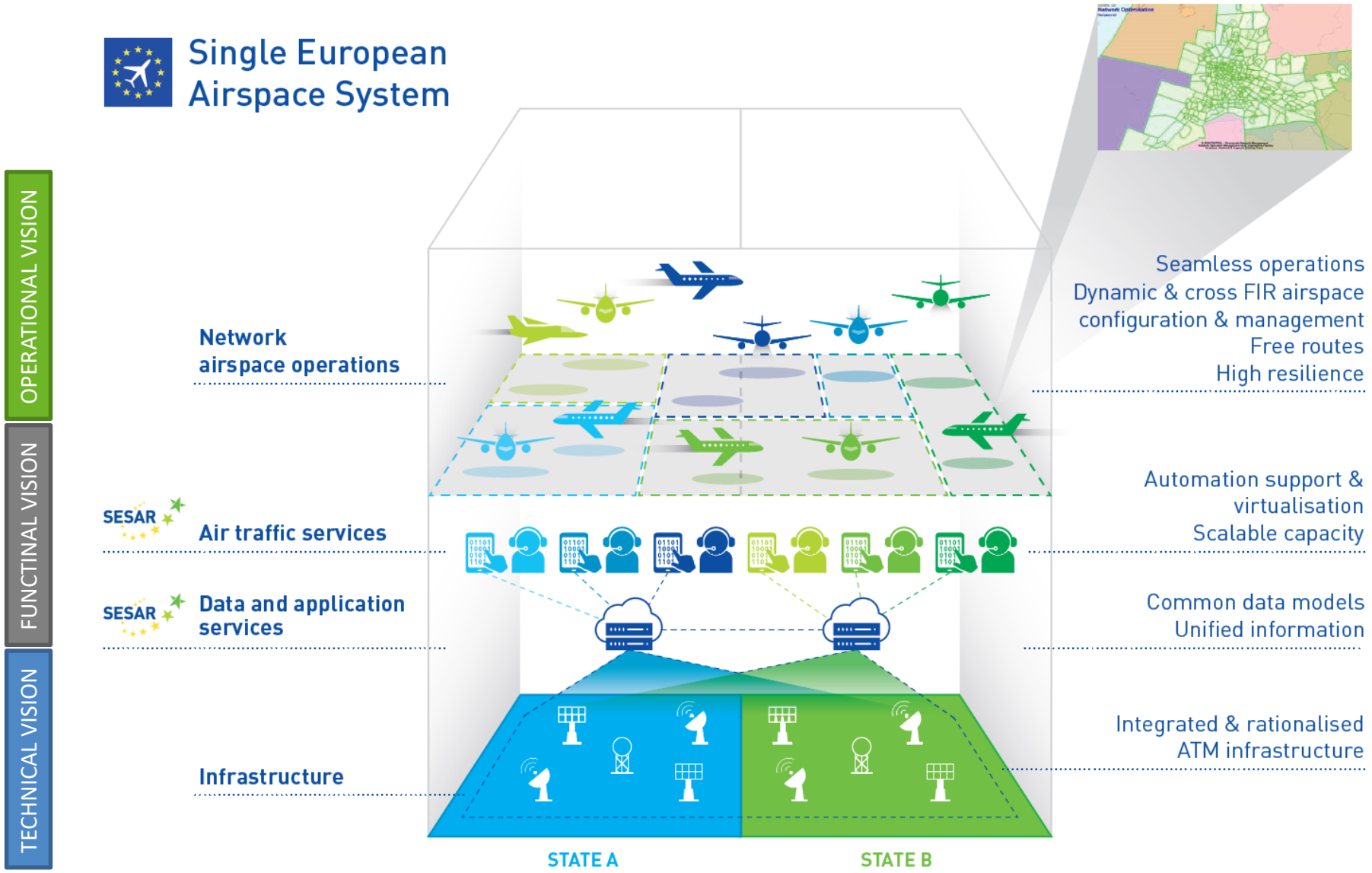
Limited capacity
Poor scalability
Fixed routes
Fixed national airspace structures

Limited automation

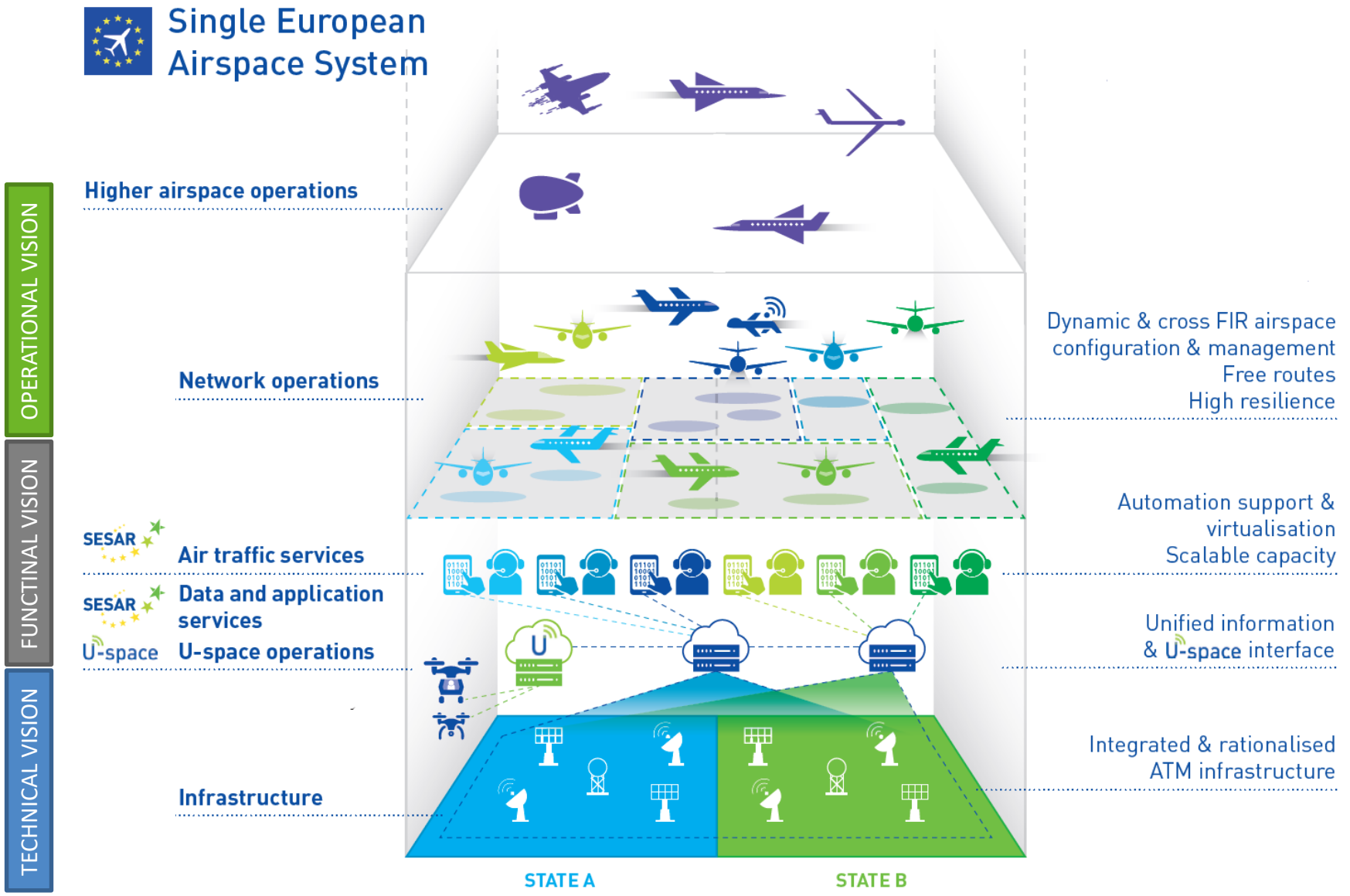
Low level of information sharing

Fragmented ATM infrastructure

The new proposed architecture : a Single European Airspace System

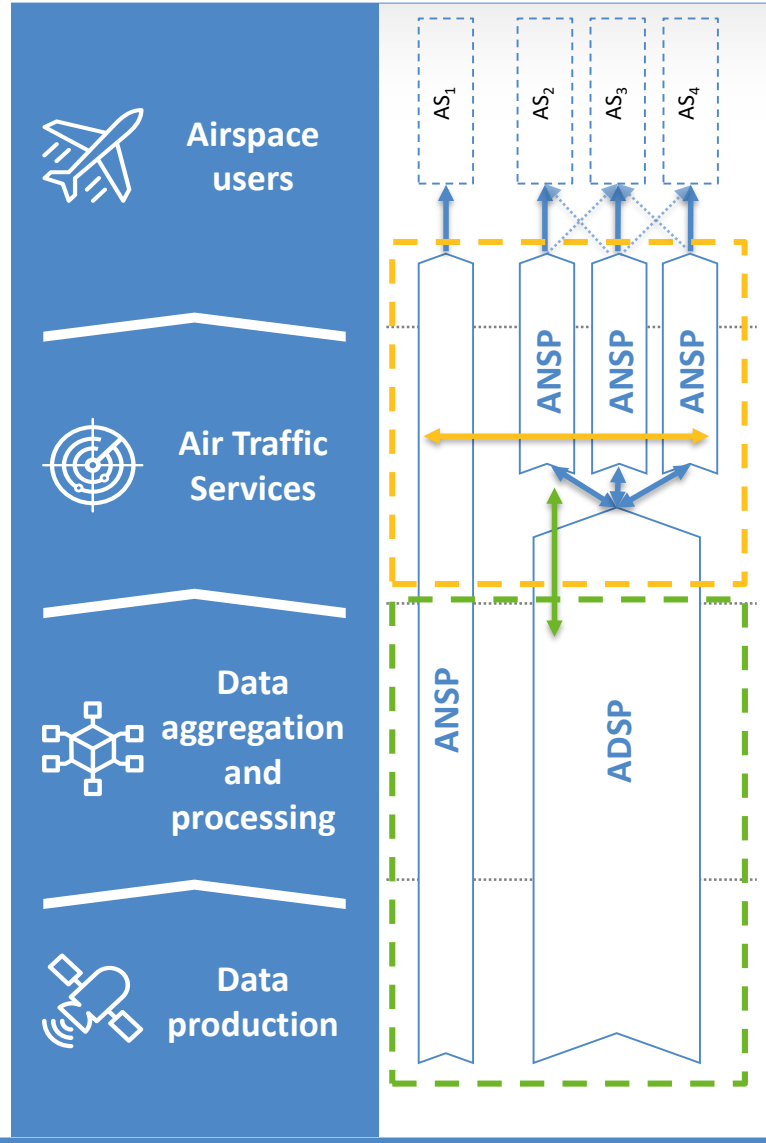


Single European Airspace System: a future proof architecture



THE BUSINESS VIEW

There are conditions to increase the chances of success



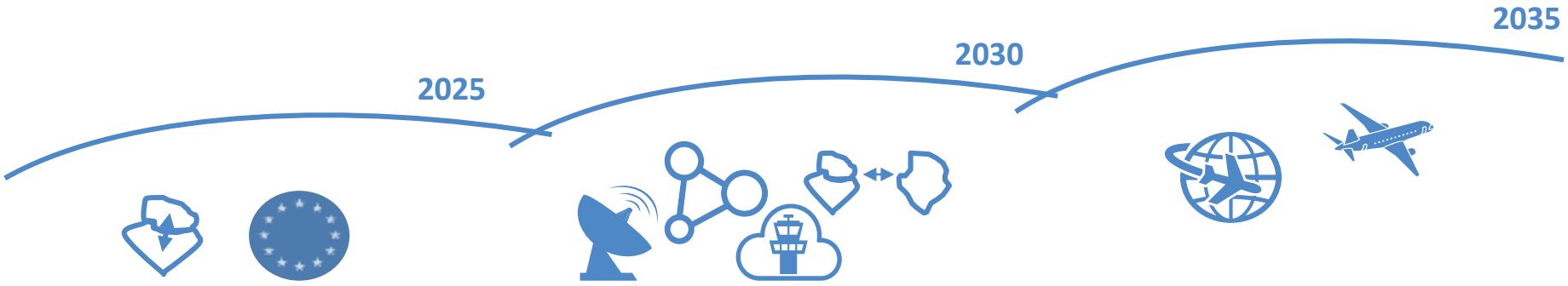
CAPACITY-ON-DEMAND: Increase the resilience of the ATM system through horizontal collaboration between ANSPs

ATM DATA SERVICE PROVIDER – ADSP: Promote a new Air traffic Data Service Provider model jointly servicing multiple ANSPs

REWARD EARLY MOVERS: Reward actors that are the first to implement recommended improvements or that shift towards innovative delivery models

THE TRANSITION VIEW

A possible way forward with progressive transition every 5 years

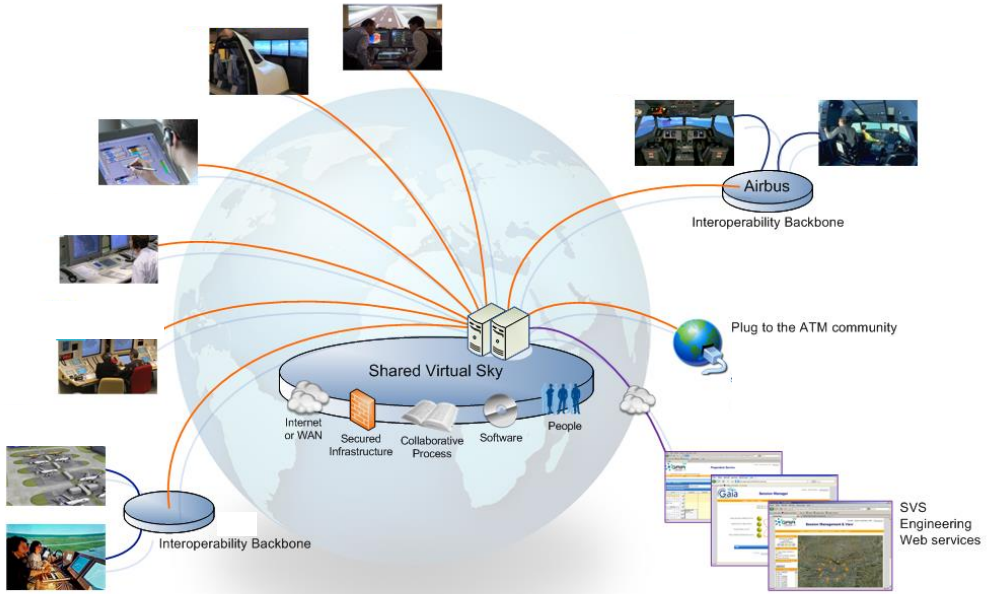


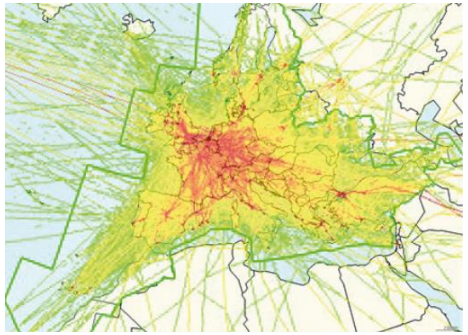
- ECAC-wide implementation of **cross-border Free Route, air-ground** and **ground-ground** connectivity
- Launch **airspace re-configuration** supported by **operational excellence** Programme
- Set up an **enabling framework** for **ADSP**, **capacity-on-demand** service and **rewards for early movers**, first ADSP is certified

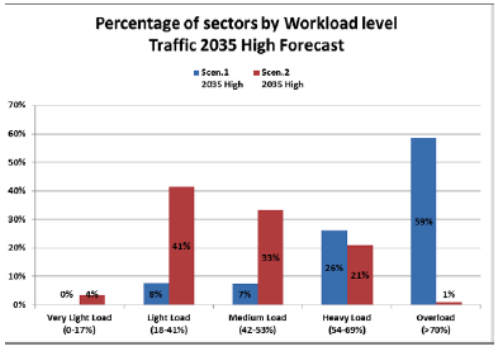
- Implement **virtual centres** and **dynamic airspace configuration** at large scale
- Gradual transition towards **higher levels of automation** supported by SESAR Solutions
- **Capacity-on-demand** arrangements implemented across Europe
- **New ATM Data service provision model** is implemented across Europe

- Transformation to **flight/flow centric operations**
- **Trajectory-based operations**
- **Service-oriented** air traffic management

Modelisation to assess performance and system behavior is key







Without further measures the situation will continue to deteriorate

8.5

Minutes average en-route delay per flight vs 0.9 minutes in 2017

45

Congested Air Control Centres

15x

Number of en-route delay minutes vs 2017

THE PERFORMANCE VIEW
Impact assessment

Do nothing scenario

8.5

MINUTES AVERAGE EN-ROUTE DELAY PER FLIGHT vs 0.9 minutes in 2017

Full implementation of the transition strategy

0.5

MINUTES AVERAGE EN-ROUTE DELAY PER FLIGHT

Environment

Between 77 and 143 kg of fuel saved per flight

BACK TO THE REGULATORY & POLICY LAYER
The study recommendations

1

Launch **airspace re-configuration** and **operational excellence** programmes to achieve quick wins

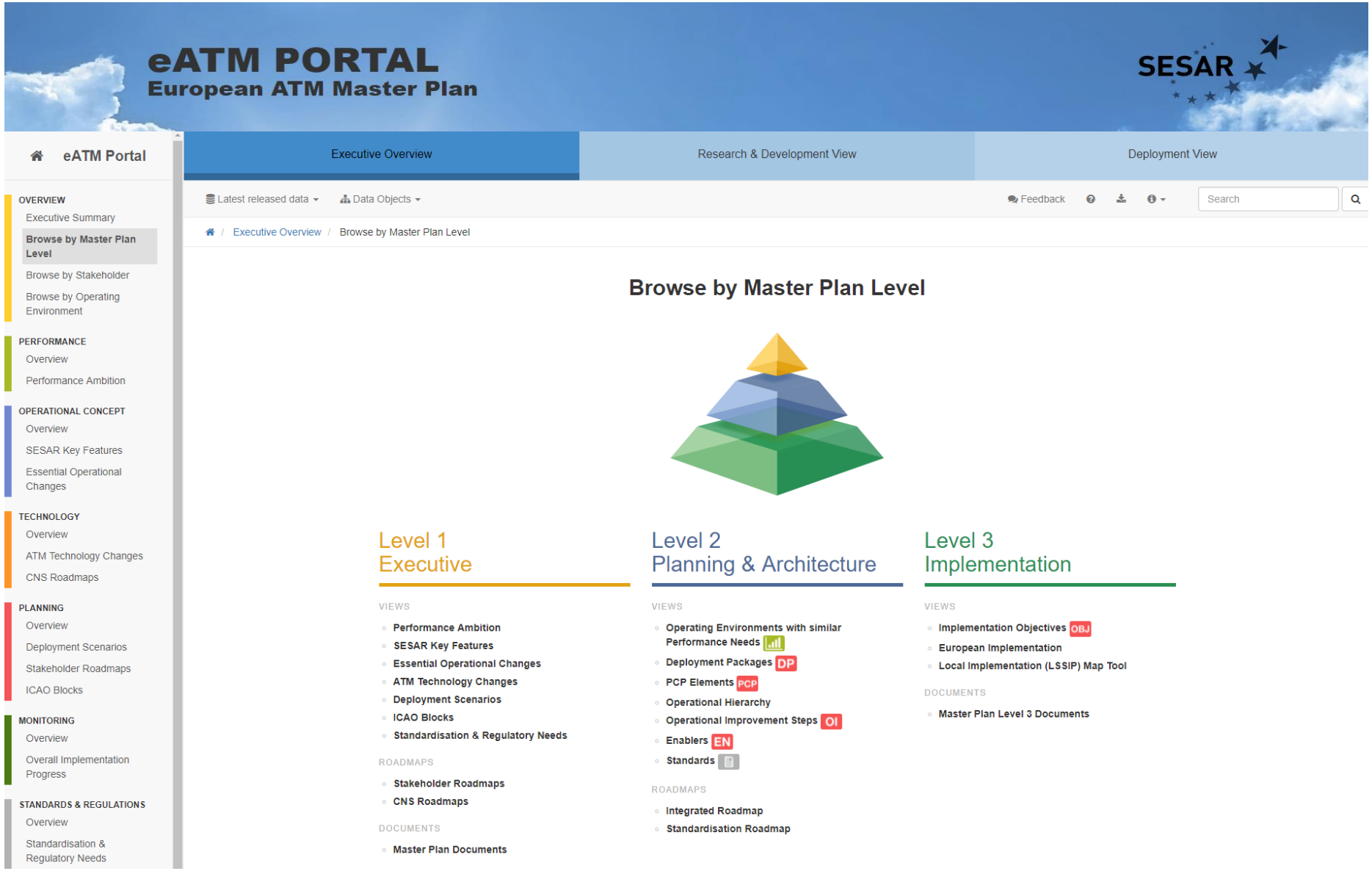
2

Realise **virtual de-fragmentation of European skies**

3

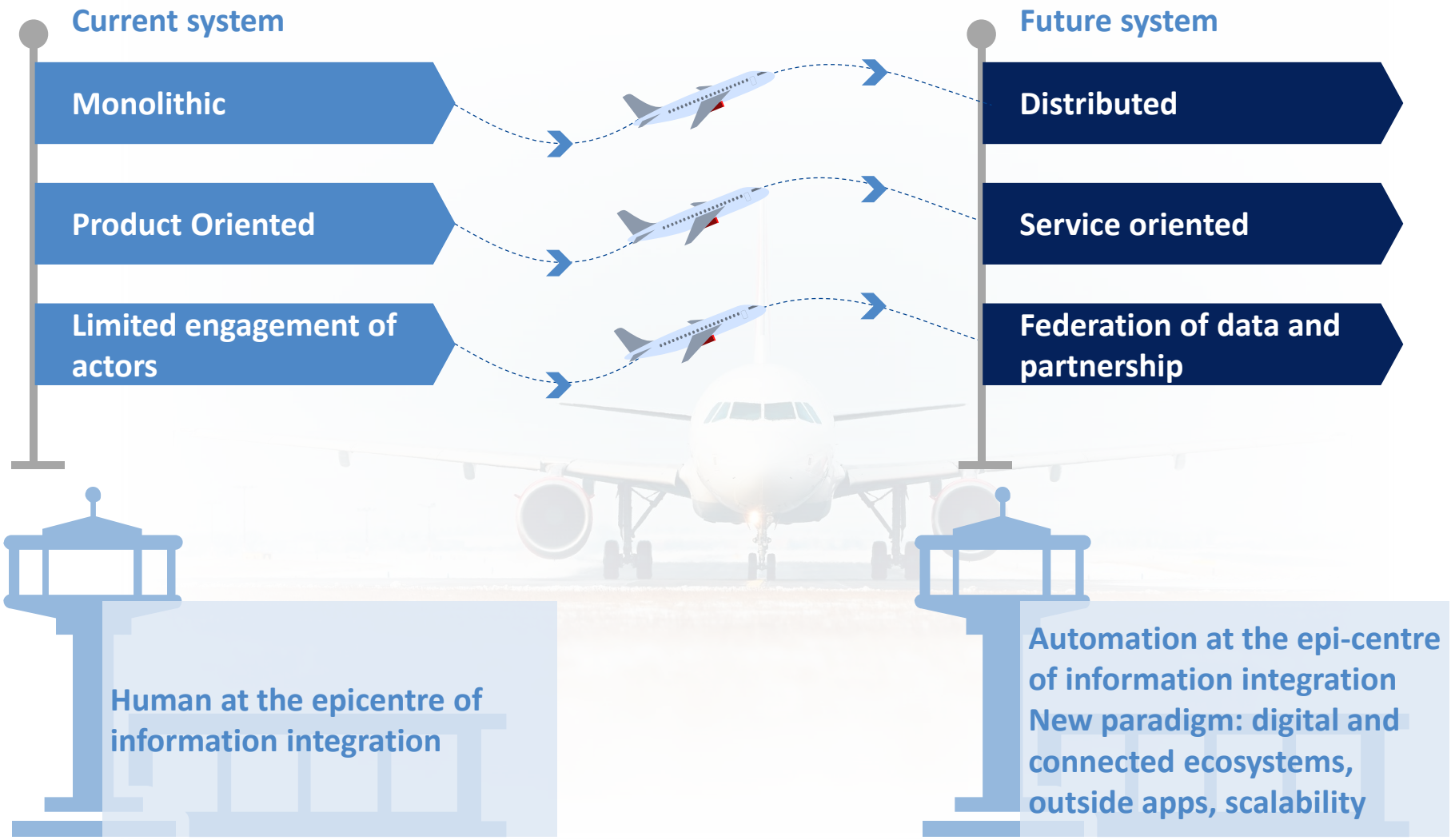
Evolve SES framework to **rewards early movers**

Linking technology, operations, services and… regulation



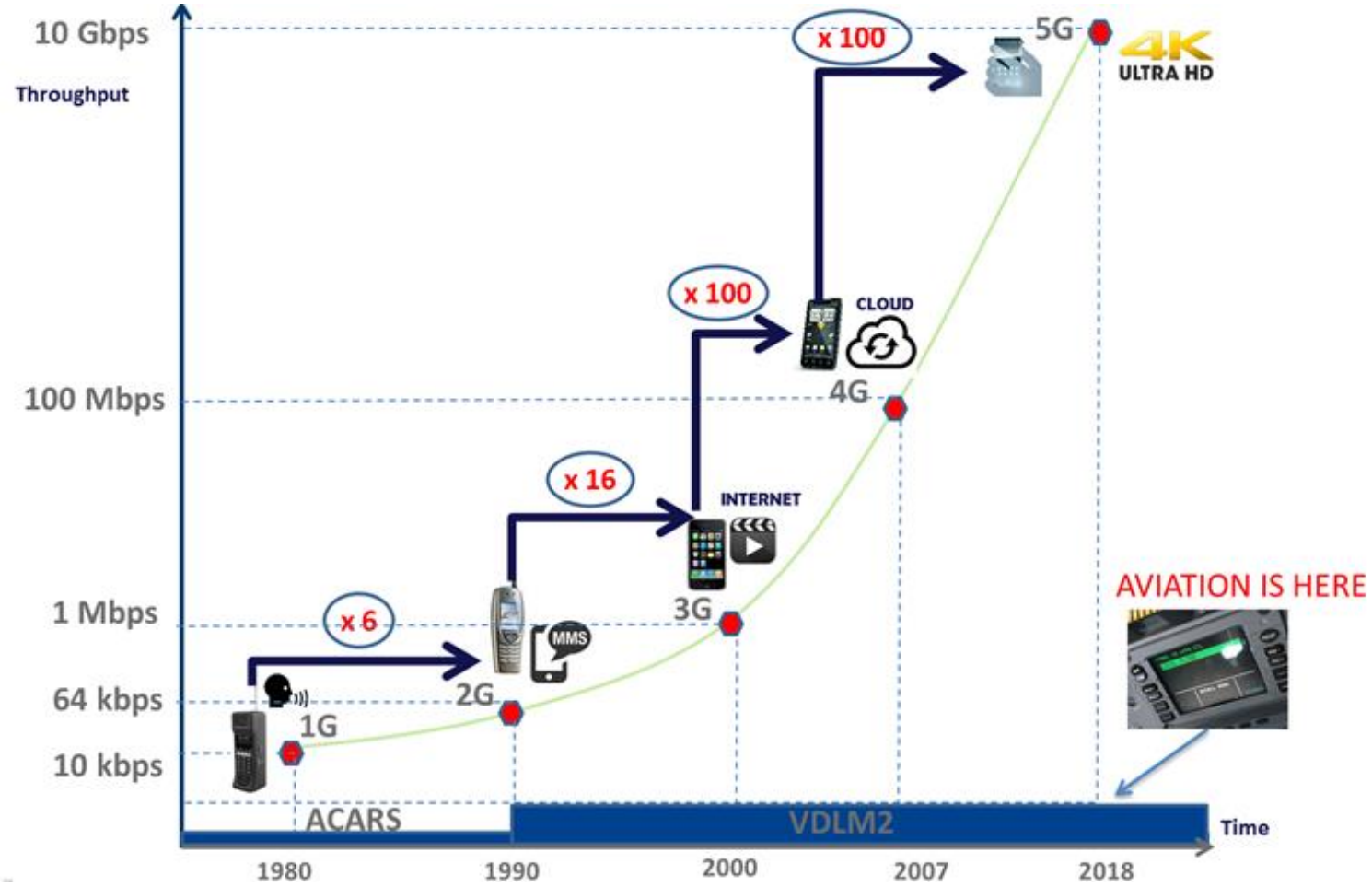
SOME LESSONS LEARNT

Architect role is essential and strongly coupled with business models evolution

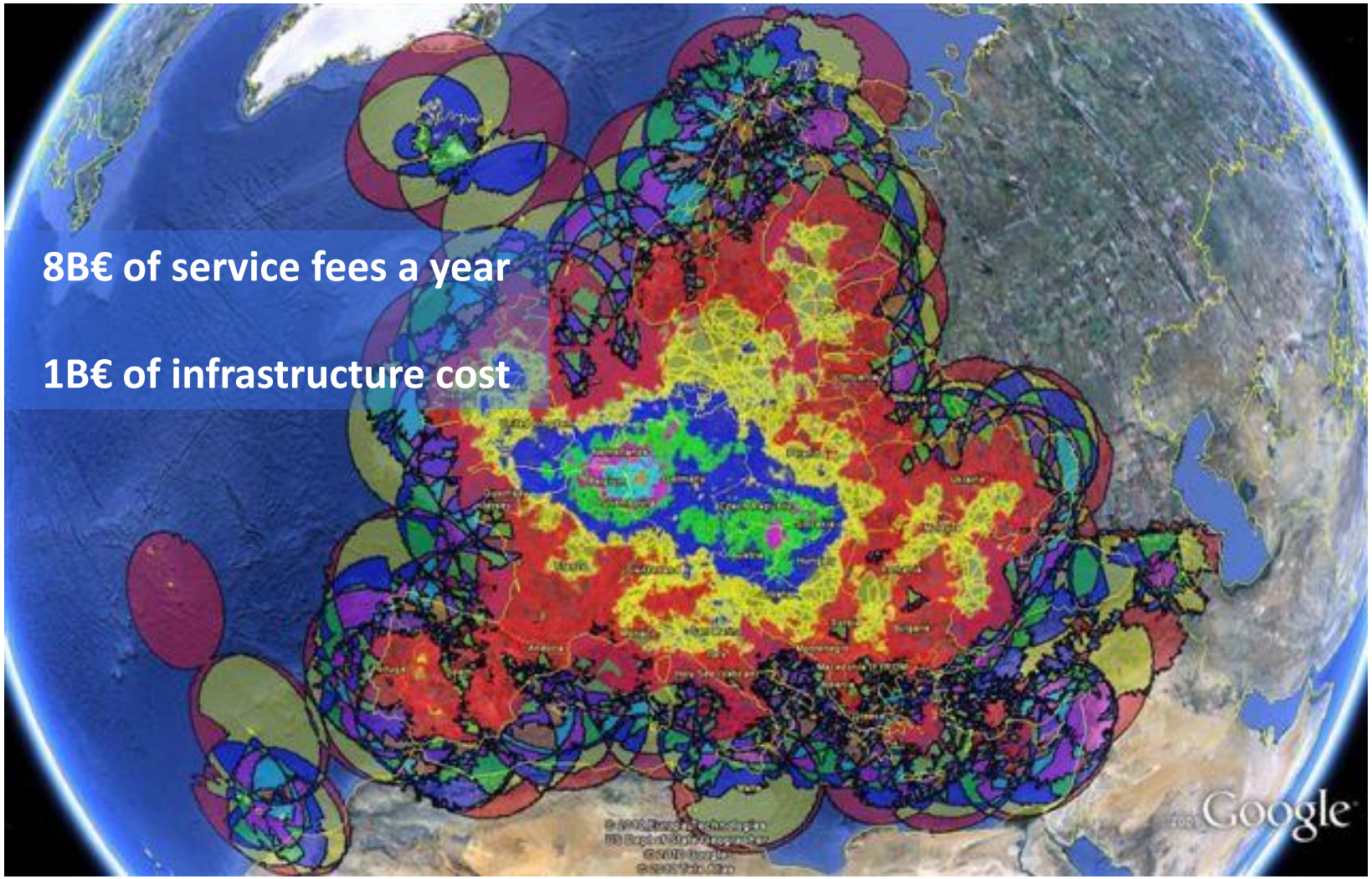


SOURCE: SESAR Digitalisation Vision (2018)

Investing in the right technology…
the « not-invented here » syndrome



Investing in the right way…

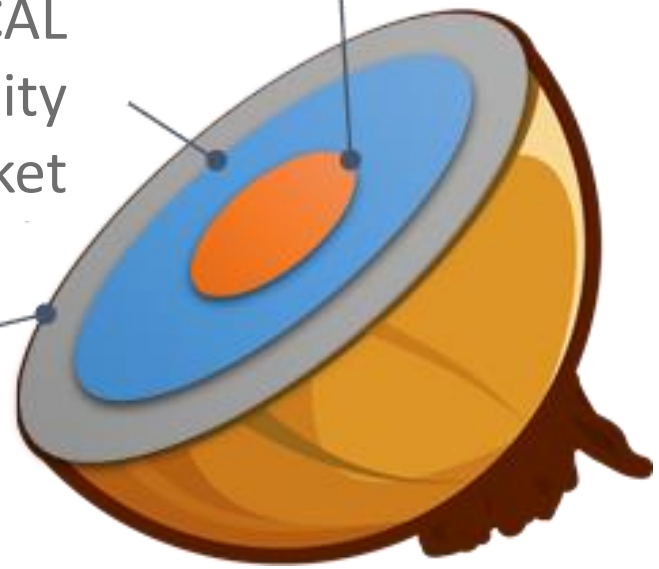


What about safety? The Onion theory…

SAFETY CRITICAL

BUSINESS CRITICAL
+agility
+time to market

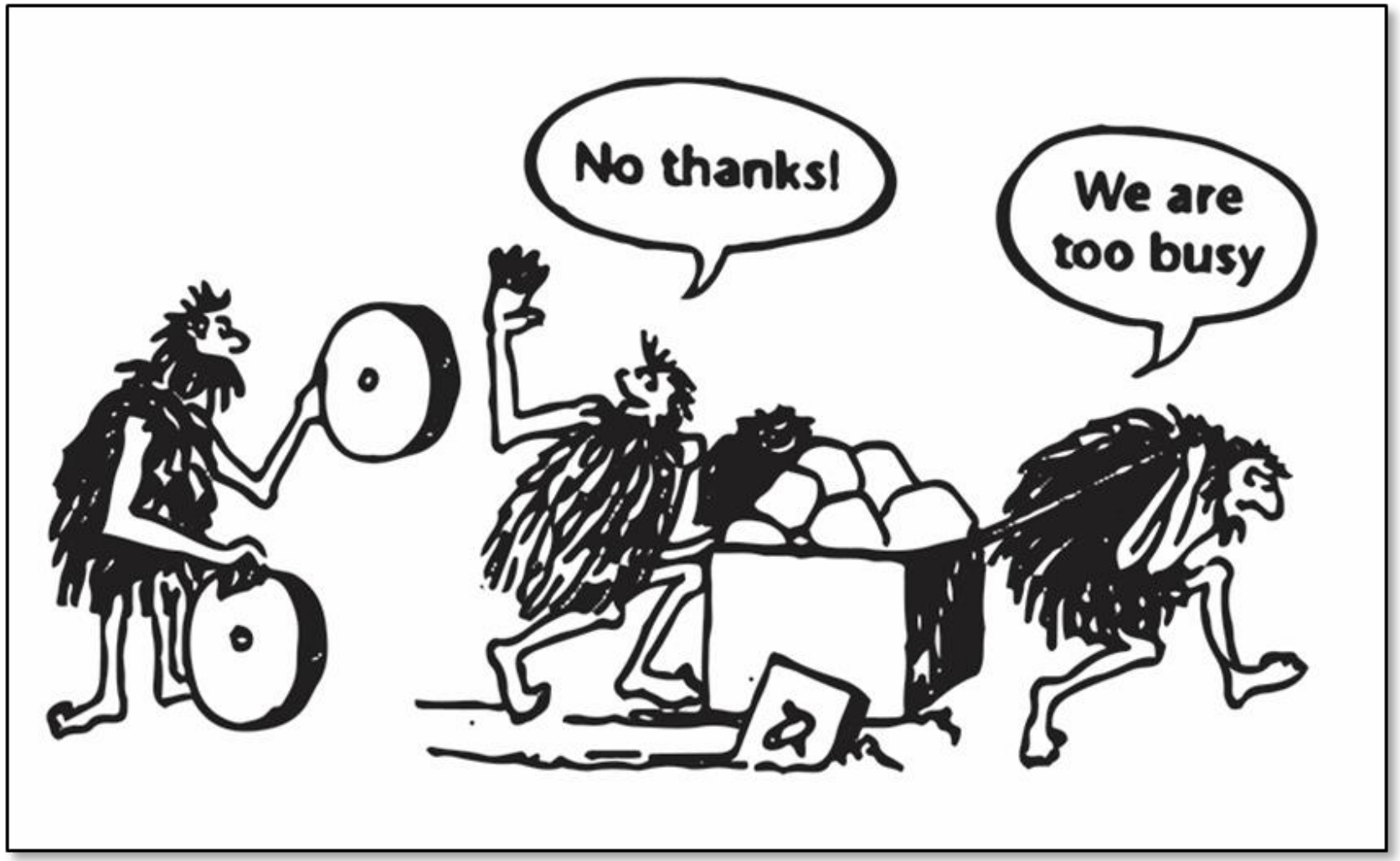
NON CRITICAL



Technology value has expiry date…

“Technology is like a fish. The longer it stays on the shelf, the less desirable it becomes”

Thank you! Merci!



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