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3rd Tutorial Session Future ATM Programmes Europe

25/05/2020, Webex

Finke – Abdellaoui - Temme / DLR

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 875154

Content

- General ATM Development strategy
- Overview on ATM Research
- Life cycle – Research, Implementation, Operations
- Main ATM Research topics

5 min Break
at 10:00 CEST / 16:00 CST

GENERAL ATM DEVELOPMENT STRATEGY

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The European ATM Master Plan
Executive view

- Master Plan defines vision & objectives of the Single European Sky Air Traffic Management Research project
- Planning framework for ATM modernisation across Europe
- Innovations are key enabler and the core are Trajectory Based Operations (TBO)
- The solutions are
  - Digitalisation
  - Digital transformation of the underlying infrastructure
- Master Plan represents snapshot with yearly updates
- Target time period: 2040

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Main Aims of the ATM Master Plan

- ATM system, which is
  - resilient
  - fully scalable
- can handle growing air traffic of
  - manned
  - unmanned air vehicles
- in all classes of air spaces in a
  - safe
  - secure
  - sustainable manner
- with zero inefficiencies.

This shall be achieved through a combination of airspace design, new technologies, and a new level of collaboration and automation support.

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The Four Cornerstones of the ATM Master Plan

Optimized ATM network services

High-performing airport operations

Advanced air traffic services

Enabling aviation infrastructure

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The Four Phases of Implementation

a. Implementation of system and information management
   - Cross boarders and aircraft to address known critical network performance deficiencies

b. Launch first ATM data services
   - With cross-boarder free-route operations and
   - Initiate U-space services for drones

c. Defragmentation of European skies through
   - Dynamic airspace
   - Management routine drone operations

d. Digital European sky
   - As a full scalable system
   - With air-ground system integration
   - Data services

→ The boundaries between ATC and ATFM will blur.

ATC: Air Traffic Control
ATFM: Air Traffic Flow Management

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State of the Work – A SESAR Estimation

Goal: The Digital Sky in 2040

$^1/_3$ Of the SESAR solutions have been delivered

$^1/_3$ In development

$^1/_3$ To be undertaken in future research and development

Example: Level of automation

→ Necessary to meet this goal: Shortening the innovation cycle.

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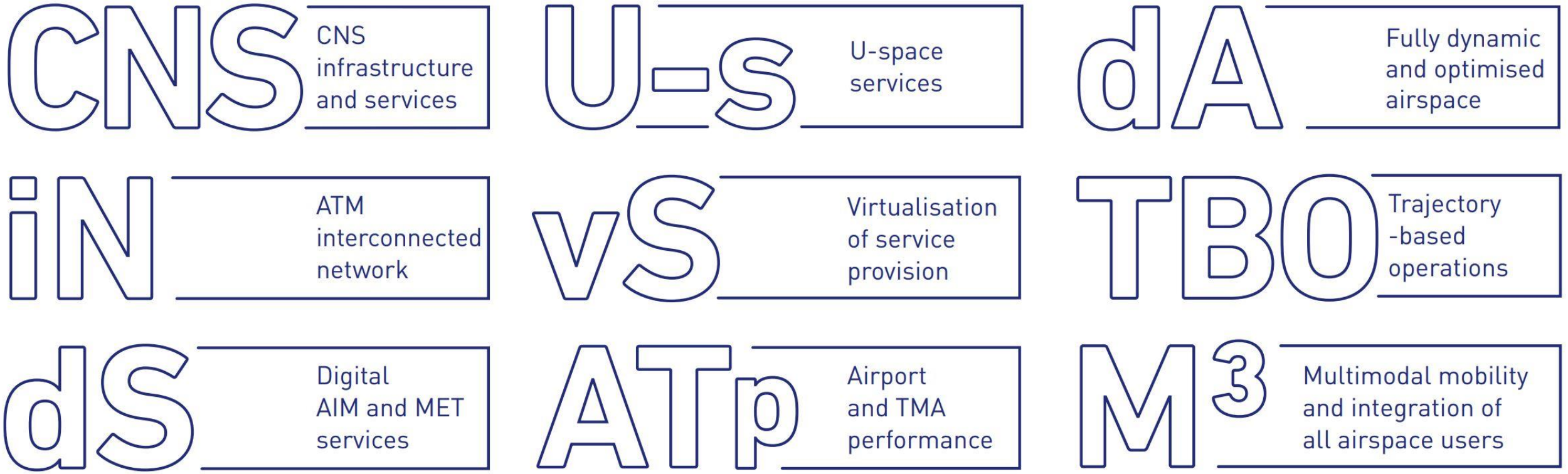
Essential Operational Changes (EOC)



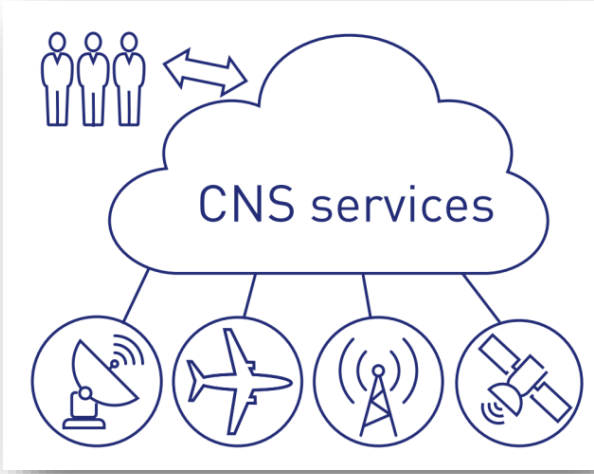
- Not independent of each other
- Precondition: Connected through high-bandwidth, low-latency network infrastructure

ATM: Air Traffic Management
AIM: Aeronautical Information Management
MET: Meteorology
TMA: Terminal Manoeuvring Area

Essential Operational Changes (EOC): CNS

CNS: CNS infrastructure and services

- Optimise infrastructure on ground and air
- Toward a service orientated architecture
- Separation of CNS service provider and ANSPs
- Transformation from voice to digital with broadband connectivity
- Based on CNS backbone comprising multilink Pan-European Network Service, GNSS and ADS-B



CNS: Communication, Navigation, Surveillance
ANSP: Air Navigation Service Provider
GNSS: Global Navigation Satellite System
ADS-B: Automatic Dependent Surveillance - Broadcast

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Essential Operational Changes (EOC): iN

iN: ATM interconnected network

- Many local and custom designed solutions with low performance
- For integration of ATFCM and ATC planning function
- Enable relevant stakeholders in collaborative decision making
- NOP with real-time visualisation of the evolving network environment
- Increase the available flexibility to airspace users for addressing unexpected business needs

ATFCM: Air Traffic Flow and Capacity Management
ATC: Air Traffic Control
NOP: Network Operations Plan

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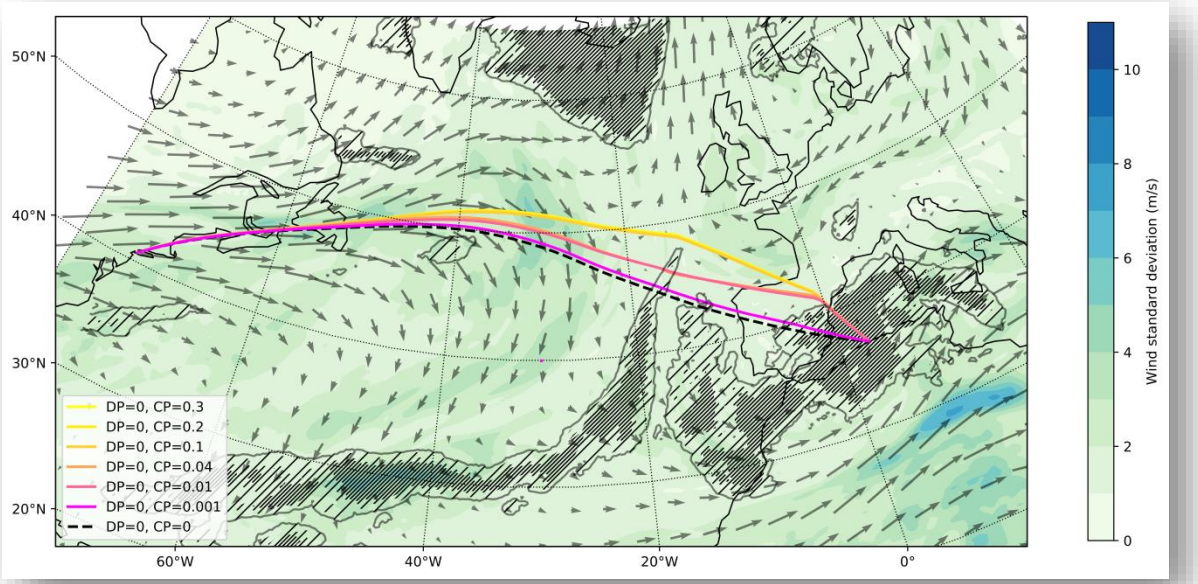
Essential Operational Changes (EOC):dS

dS: Digital AIM and MET services

- Providing static and dynamic aeronautical and meteorological information in digital form
- For human operators and ATM systems
- Processed for individual requests, specific geographic areas, or functional features
- Data acquisition on ground and on-board



Manual Arnedo 2018

AIM: Aeronautical Information Management
MET: Meteorology

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Essential Operational Changes (EOC): U-s

U-s: U-space services

- Airspace for UAS operations
- Framework for drone traffic management system
- Defines new airspace types
- Designed for high drone traffic volumes
- Scalable by design for high level of autonomy and connectivity
- Supports safe, efficient and secure access to airspace and digital system
- Existing ground infrastructure does not meet requirements and needs safe, secure, clear, and effective interfaces

EUROCONTROL U-space Blueprint 2019

UAS: Unmanned Aircraft System

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Essential Operational Changes (EOC): vS

vS: Virtualisation of service provision

- Today, ANS bases on local implementations
- Separating positions of systems and point of use lead to virtual-centres
- More interoperability between functional systems
- Applied for airport, TMA and extended TMA and en-route

DLR 2018

- Using standardised operating methods, procedures, technical equipment, and services throughout Europe
- First applications are remote tower operations (RTO) and remote tower centre (RTC)

ANS: Air Navigation Service

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Essential Operational Changes (EOC): ATp

ATp: Airport and TMA performance

- Airport operations and airspace user operations are significant contributor to network-wide delays
- Bad weather conditions are a capacity factor
- Many airports work to a large extend at capacity limit and are vulnerable to disturbances
- Airports and TMAs are critical factors for whole network
- Actions to raise airport capacity are traffic sequencing, reduced separation, and a more predictable runway occupancy time
- Enhanced taxi management and navigation in low-visibility conditions

Sydney Airport 2019

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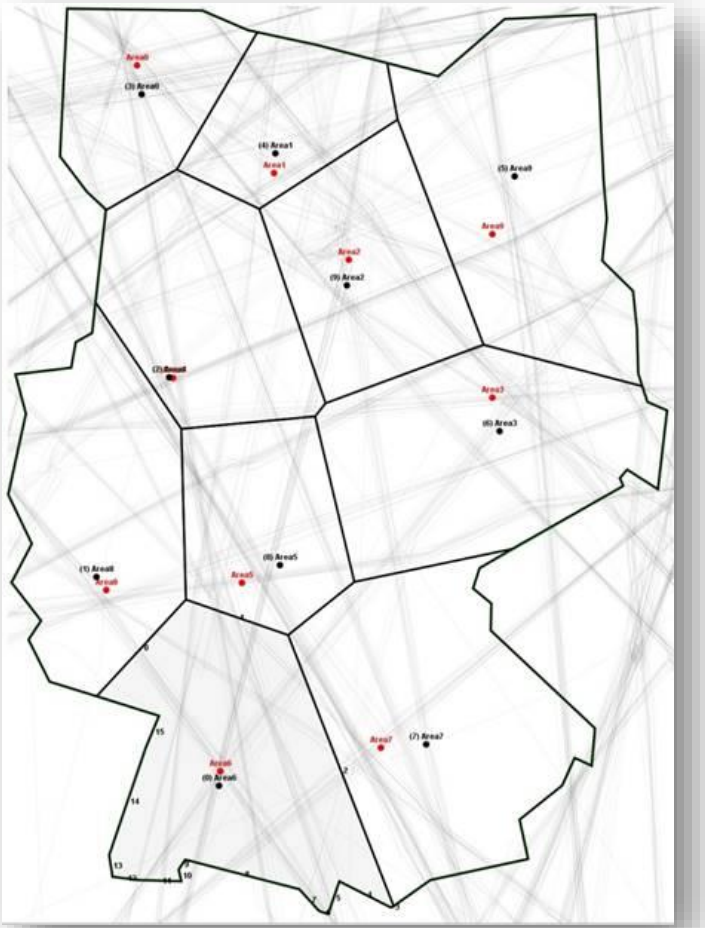
Essential Operational Changes (EOC): dA

dA: Fully dynamic and optimised airspace

- Airspace is partitioned into sectors, organised and managed on state level by national ANSPs
- Enhancing free-route airspace (FRA) processes and system support
- Dynamic airspace will be network-centric optimised for the full trajectories of flights and major flows
- Supports vertical and horizontal interconnectivity
- Covers large-scale cross-border free-route airspace
- Supported by automated tools
- Works on local, subregional and regional level



A. Temme & I. Gerdes 2017

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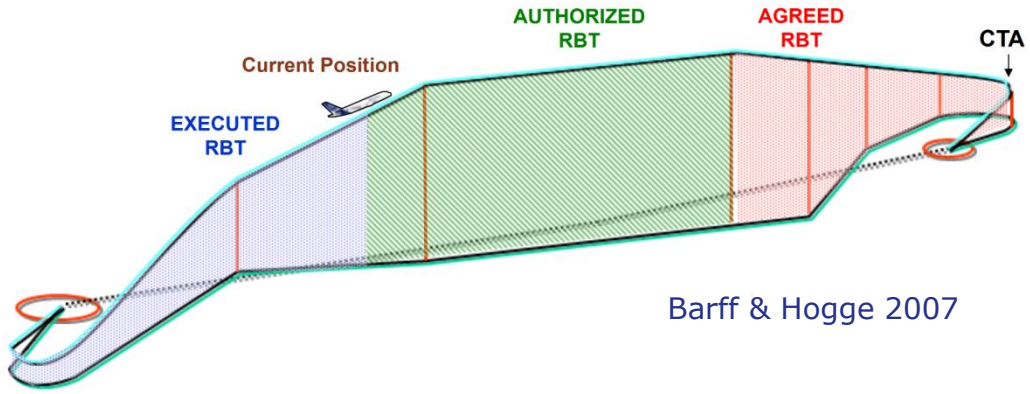
Essential Operational Changes (EOC): TBO

TBO: Trajectory-based operations

- TBO is the overarching SESAR concept
- Controllers, pilots, military, and advanced systems need all the same trajectory information



Barff & Hogge 2007

- Trajectories are used to detect, analyse, and resolve potential conflicts and to monitor agreed optimised trajectories
- TBO will be deployed through extended flight plan (eFPL) and updated through ATC during flight

ATC: Air Traffic Control
CTA: Calculated Time of Arrival
RBT: Reference Business Trajectory

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Essential Operational Changes (EOC): M^3

M^3: Multimodal mobility and integration of all airspace users

- Mobility as a service connecting numerous modes of transport for people and goods in a seamless door-to-door service
- Over the next years, the diversity of aircraft will rise continuously
- For a trip, modes of transport as car, train, airplane, helicopter, and drones will be combined seamlessly
- Integration of RPAS, rotorcraft, business, and general aviation through IFR procedures using performance-based CNS infrastructure is priority

RPAS: Remotely Piloted Aircraft Systems
IFR: Instrument Flight Rules

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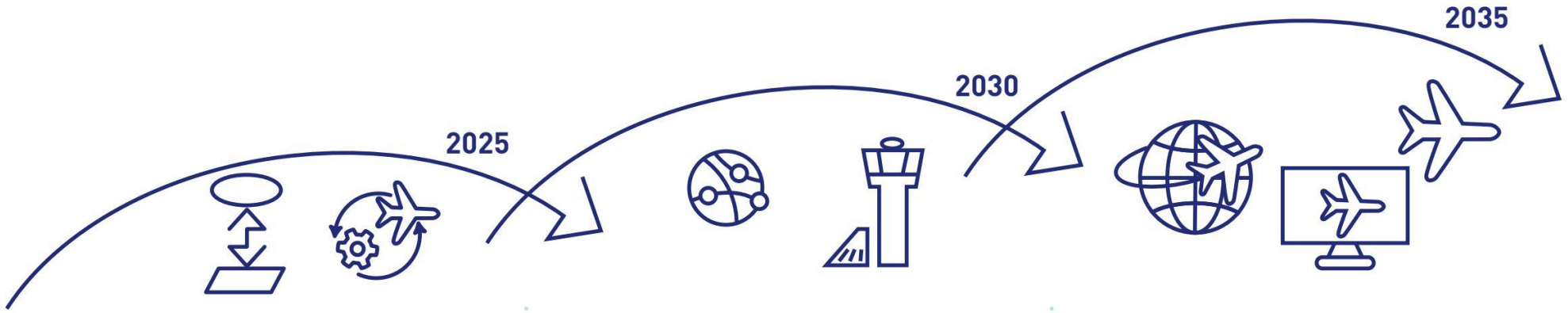
Airspace Architecture Study Transition Strategy



- 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 **high levels of automation** supported by SESAR Solutions
- **Capacity-on-demand** arrangements implemented accross 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

ADSP: Automatic Dependent Surveillance Panel
ECAC: European Civil Aviation Conference

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OVERVIEW ON ATM RESEARCH

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Overview on ATM Research – Research Programmes

Internal Research Activities

- Project is done just by one research organization, e.g. DLR and its Institutes
- Financed by the public
- Internal processes and conditions are to be considered
- Decided by internal management

Activities funded by Research Programmes

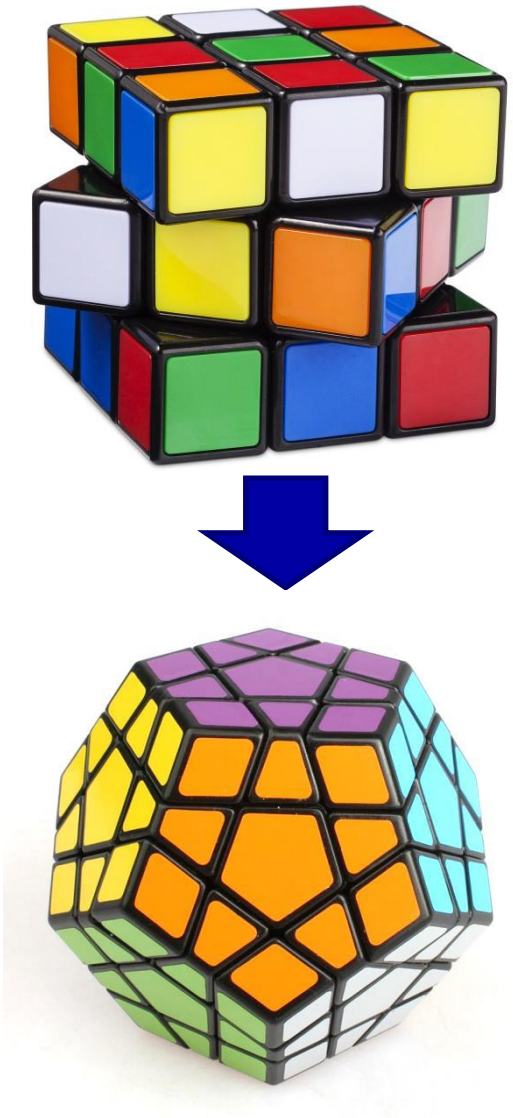
- Project is usually done by a consortium of different partners
- National Research Programmes (e.g. LuFo, Take-Off)
- European Research Programmes (e.g. SESAR)
- Call / Application

Activities funded directly by clients

- Project is done on direct order from a public authority, industry, companies etc.
- Conditions are negotiated individually
- Tender & Offer

Overview on ATM Research – History of SESAR (1)

- Single European Sky Initiative (SES) was founded in 2000
- Goals:
  - Restructure national airspaces and according to main traffic flows
  - Standardize air traffic services and airspace structure throughout Europe
  - Modernize ATM infrastructure to provide capacity needed for future air traffic demand
- SESAR (=Single European Sky ATM Research) is the technological pilar of the Single European Sky Initiative (SES), founded in 2004 by European Union & Eurocontrol



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Sources:
https://www.sesarju.eu/discover-sesar/history
www.atmmasterplan.eu

SESAR
JOINT UNDERTAKING

Overview on ATM Research – History of SESAR (2)

- Role of SESAR is to define, develop and deploy what is needed to increase ATM performance and build Europe's future air transport system

- SESAR Joint Undertaking has been established in 2007 as a public-private partnership and coordinates and concentrates all ATM relevant research and innovation efforts in the EU

- Goal of SESAR: defining, developing and delivering new or improved technologies and procedures (SESAR Solutions), based on the notion of TBO

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Sources:
https://www.sesarju.eu/discover-sesar/history
www.atmmasterplan.eu

Overview on ATM Research – History of SESAR (3)

- Definition phase (2004–2008)
  - ATM master plan for the development and deployment of the next generation of ATM systems

- Development phase: SESAR 1 (2008–2016) and SESAR 2020 (2016-2024):
  - Develop new generation of technological systems and components

- Deployment phase (2014–2040)
  - Implementation of the new air traffic management infrastructure

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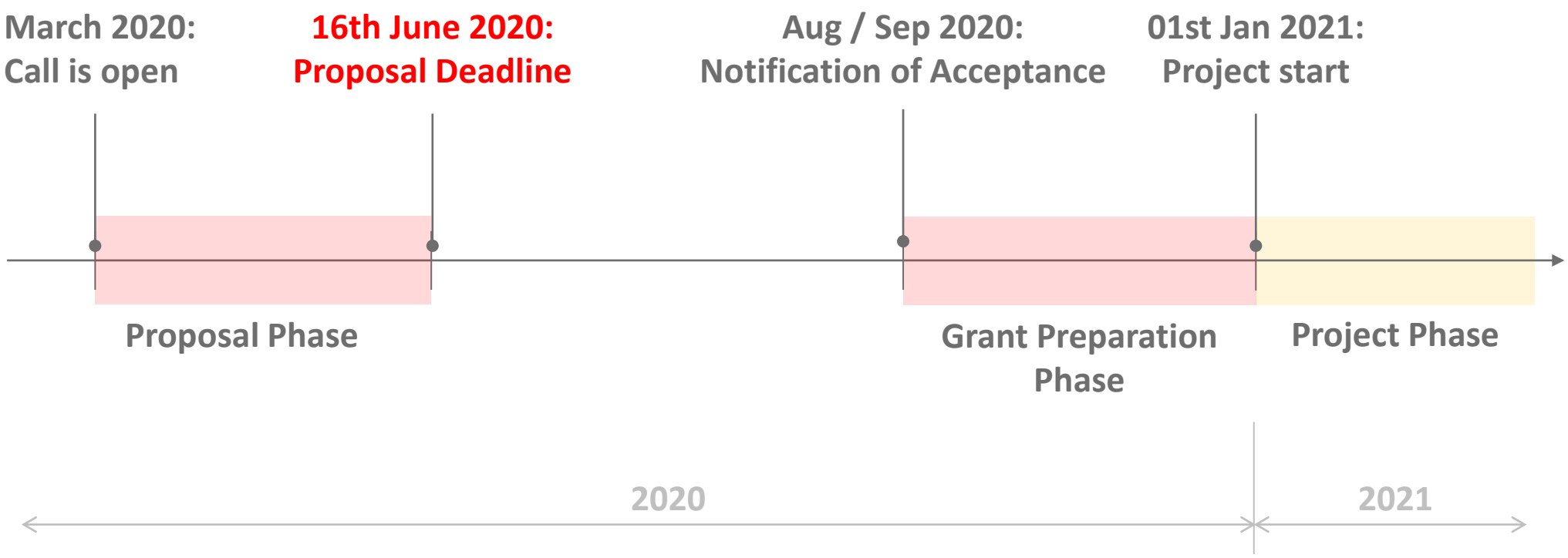
Overview on ATM Research – SESAR Members

Sources:
https://www.sesarju.eu/discover-sesar/history

Overview on ATM Research – Organization of SESAR projects (1) – Overall Process



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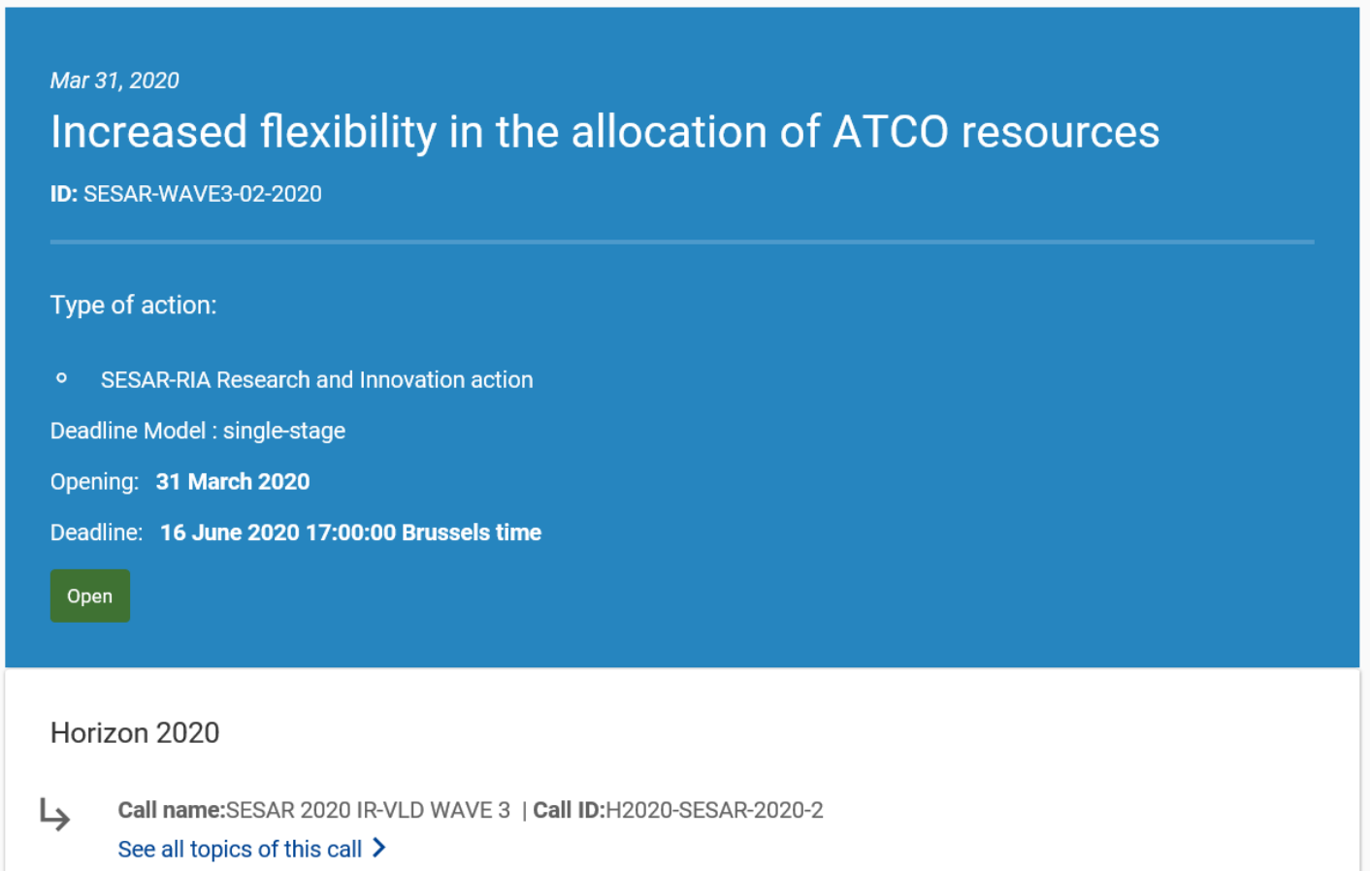
Overview on ATM Research – Organization of SESAR projects (2)

Call:

- Topics that can be addressed
- Expected TRL / Maturity
- Funding constraints
- Eligible countries
- Proposal template
- Deadlines
- Guidance
- …



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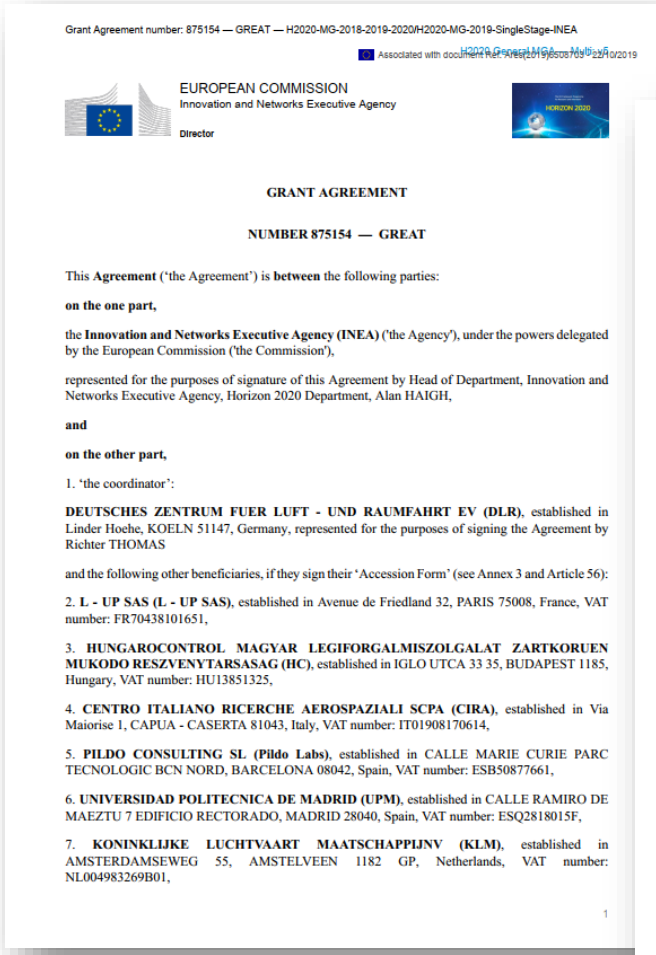
Overview on ATM Research – Organization of SESAR projects (3)

Grant Agreement:

= agreement between EU (as „client“) and all participating partners of the consortium (as „contractor“)



Grant Agreement number: 875154 — GREAT — H2020-MG-2018-2019-2020/H2020-MG-2019-SingleStage-INEA

Associated with document Ref. Ares(2019)6508779 - 22/10/2019

EUROPEAN COMMISSION
Innovation and Networks Executive Agency

Director

GRANT AGREEMENT

NUMBER 875154 — GREAT

This **Agreement** ('the Agreement') is **between** the following parties:

on the one part,

the **Innovation and Networks Executive Agency (INEA)** ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

represented for the purposes of signature of this Agreement by Head of Department, Innovation and Networks Executive Agency, Horizon 2020 Department, Alan HAIGH,

and

on the other part,

1. 'the coordinator':

DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV (DLR), established in Linder Hoehe, KOELN 51147, Germany, represented for the purposes of signing the Agreement by Richter THOMAS

and the following other beneficiaries, if they sign their 'Accession Form' (see Annex 3 and Article 56):

2. **L - UP SAS (L - UP SAS)**, established in Avenue de Friedland 32, PARIS 75008, France, VAT number: FR70438101651,

3. **HUNGAROCONTROL MAGYAR LEGIFORGALMISZOLGALAT ZARTKORUEN MUKODO RESZVENYTARSASAG (HC)**, established in IGLO UTCA 33 35, BUDAPEST 1185, Hungary, VAT number: HU13851325,

4. **CENTRO ITALIANO RICERCHE AEROSPAZIALI SCPA (CIRA)**, established in Via Maiorise 1, CAPUA - CASERTA 81043, Italy, VAT number: IT01908170614,

5. **PILDO CONSULTING SL (Pildo Labs)**, established in CALLE MARIE CURIE PARC TECNOLOGIC BCN NORD, BARCELONA 08042, Spain, VAT number: ESB50877661,

6. **UNIVERSIDAD POLITECNICA DE MADRID (UPM)**, established in CALLE RAMIRO DE MAEZTU 7 EDIFICIO RECTORADO, MADRID 28040, Spain, VAT number: ESQ2818015F,

7. **KONINKLIJKE LUCHTVAART MAATSCHAPPIJNV (KLM)**, established in AMSTERDAMSEWEG 55, AMSTELVEEN 1182 GP, Netherlands, VAT number: NL004983269B01,

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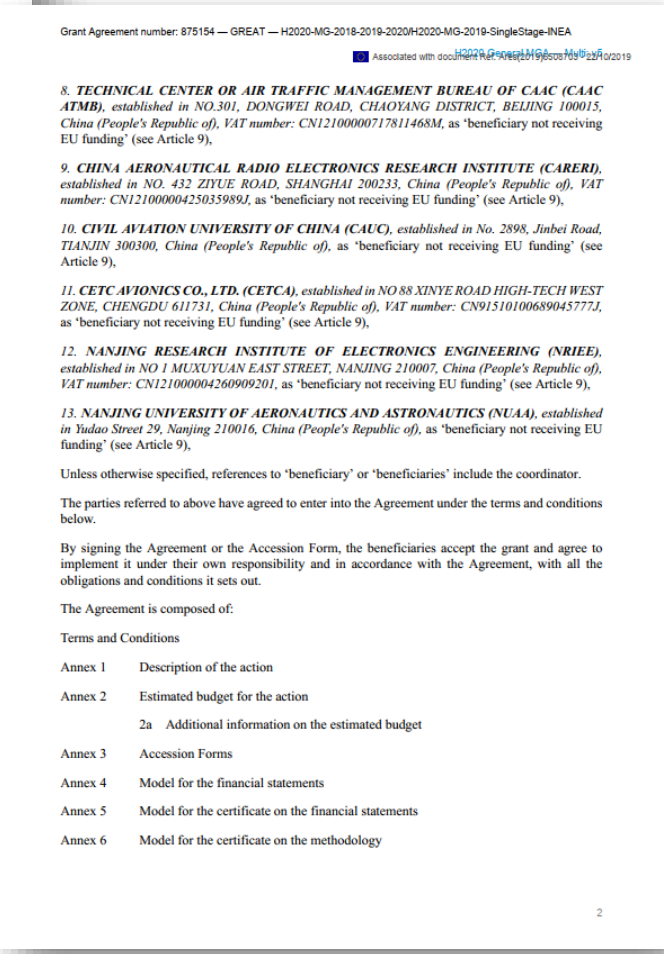

Grant Agreement number: 875154 — GREAT — H2020-MG-2018-2019-2020/H2020-MG-2019-SingleStage-INEA

Associated with document Ref. Ares(2019)6508779 - 22/10/2019

*8. **TECHNICAL CENTER OR AIR TRAFFIC MANAGEMENT BUREAU OF CAAC (CAAC ATMB)**, established in NO.301, DONGWEI ROAD, CHAOYANG DISTRICT, BEIJING 100015, China (People's Republic of), VAT number: CN12100000717811468M,* as 'beneficiary not receiving EU funding' (see Article 9),

*9. **CHINA AERONAUTICAL RADIO ELECTRONICS RESEARCH INSTITUTE (CARERI)**, established in NO. 432 ZIYUE ROAD, SHANGHAI 200233, China (People's Republic of), VAT number: CN12100000425035989J,* as 'beneficiary not receiving EU funding' (see Article 9),

*10. **CIVIL AVIATION UNIVERSITY OF CHINA (CAUC)**, established in No. 2898, Jinbei Road, TIANJIN 300300, China (People's Republic of),* as 'beneficiary not receiving EU funding' (see Article 9),

*11. **CETC AVIONICS CO., LTD. (CETCA)**, established in NO 88 XINYE ROAD HIGH-TECH WEST ZONE, CHENGDU 611731, China (People's Republic of), VAT number: CN91510100689045777J,* as 'beneficiary not receiving EU funding' (see Article 9),

*12. **NANJING RESEARCH INSTITUTE OF ELECTRONICS ENGINEERING (NRIEE)**, established in NO 1 MUXUYUAN EAST STREET, NANJING 210007, China (People's Republic of), VAT number: CN12100000426090920I,* as 'beneficiary not receiving EU funding' (see Article 9),

*13. **NANJING UNIVERSITY OF AERONAUTICS AND ASTRONAUTICS (NUAA)**, established in Yudao Street 29, Nanjing 210016, China (People's Republic of),* as 'beneficiary not receiving EU funding' (see Article 9),

Unless otherwise specified, references to 'beneficiary' or 'beneficiaries' include the coordinator.

The parties referred to above have agreed to enter into the Agreement under the terms and conditions below.

By signing the Agreement or the Accession Form, the beneficiaries accept the grant and agree to implement it under their own responsibility and in accordance with the Agreement, with all the obligations and conditions it sets out.

The Agreement is composed of:

Terms and Conditions

Annex 1	Description of the action
Annex 2	Estimated budget for the action
	2a Additional information on the estimated budget
Annex 3	Accession Forms
Annex 4	Model for the financial statements
Annex 5	Model for the certificate on the financial statements
Annex 6	Model for the certificate on the methodology

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Overview on ATM Research – Guidelines and Standards for Research

SESAR Project Handbook:

https://ec.europa.eu/research/participants/data/ref/h2020/other/guides_for_applicants/jtis/h2020-guide-project-handbook-sesar-ju_en.pdf

Ethics:

https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/ethics_en.htm

European Charter for Researchers:

https://euraxess.ec.europa.eu/sites/default/files/am509774cee_en_e4.pdf

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LIFE CYCLE – RESEARCH, IMPLEMENTATION, OPERATIONS

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Life Cycle - From vision to reality

Sources:
https://www.sesarju.eu/sites/default/files/documents/SESAR%20Innovation%20Pipeline.pdf

EXPLORATORY RESEARCH

Explores new concepts beyond those identified in the European ATM Master Plan or emerging technologies and methods. The knowledge acquired can be transferred into the SESAR industrial and demonstration activities.

INDUSTRIAL RESEARCH & VALIDATION

Assesses and validates technical and operational concepts in simulated and real operational environments according to a set of key performance areas. This process transforms concepts into SESAR Solutions.

VERY LARGE SCALE DEMONSTRATIONS

Tests SESAR Solutions on a much larger scale and in real operations to prove their applicability and encourage the early take-up of solutions.

Sources:
SESAR JU, European ATM Master Plan
Digitalising Europe's Aviation Infrastructure - Executive view

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Life Cycle - From vision to reality

Ideas

Definition

EUROCONTROL

2005 - 2008
CONOPS
Roadmap

Development & validation

SESAR JOINT UNDERTAKING

2008-2024
SESAR1 (2008-2016)
SESAR 2020 (up to 2024)

Deployment

SESAR DEPLOYMENT MANAGER

2015-2040
voluntary or **mandated**
local or **coordinated**
through Pilot Common Project

Operations

Progressive but overlapping phases to shorten the innovation life cycle from 30 years to approximately 15-20 years

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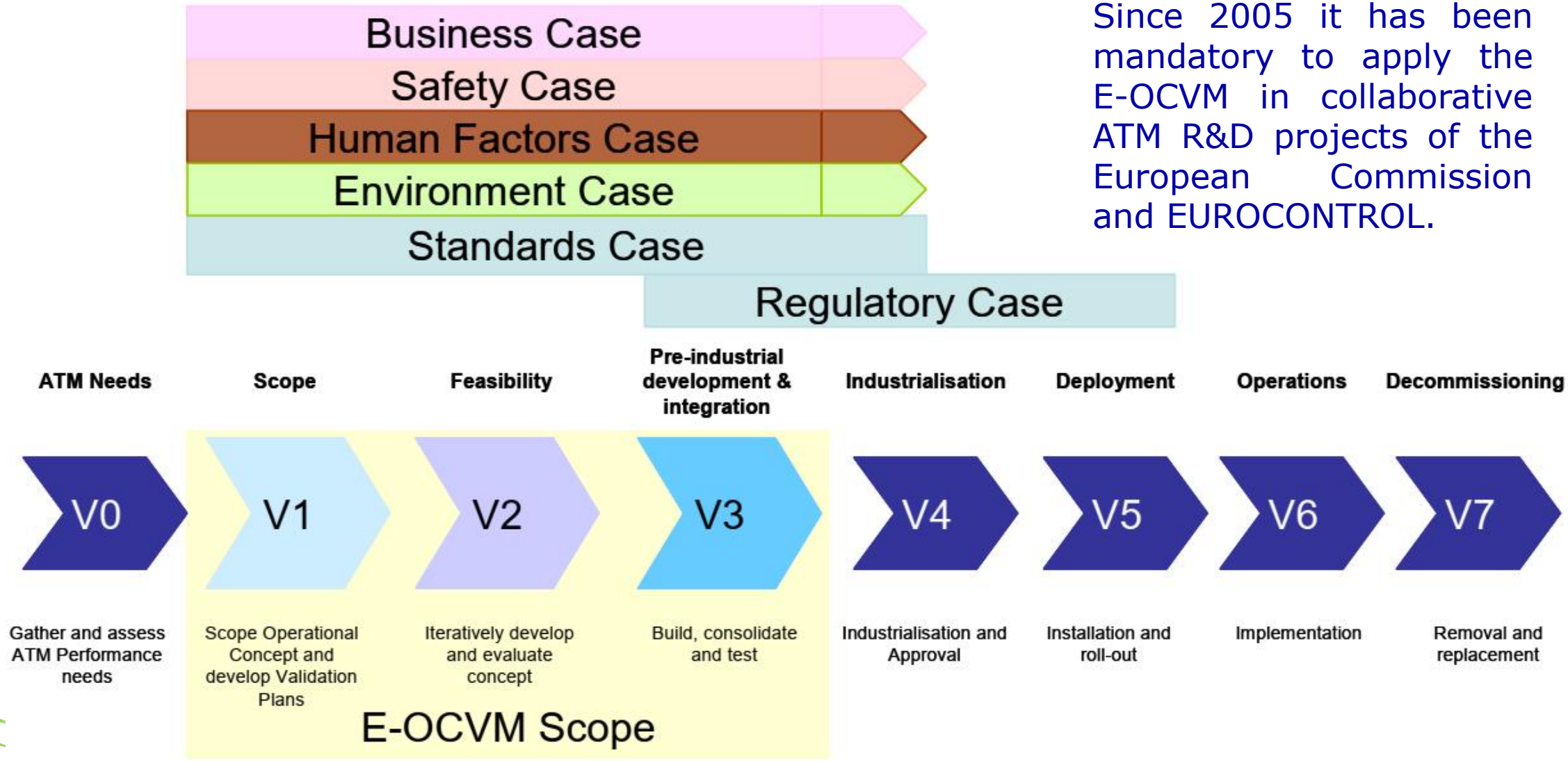
Development & Validation – E-OCVM



Since 2005 it has been mandatory to apply the E-OCVM in collaborative ATM R&D projects of the European Commission and EUROCONTROL.

Sources:
https://www.eurocontrol.int/publication/european-operational-concept-validation-methodology-eocvm

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Development & Validation – SESAR Maturity Criteria

- **SESAR ATM Solutions**

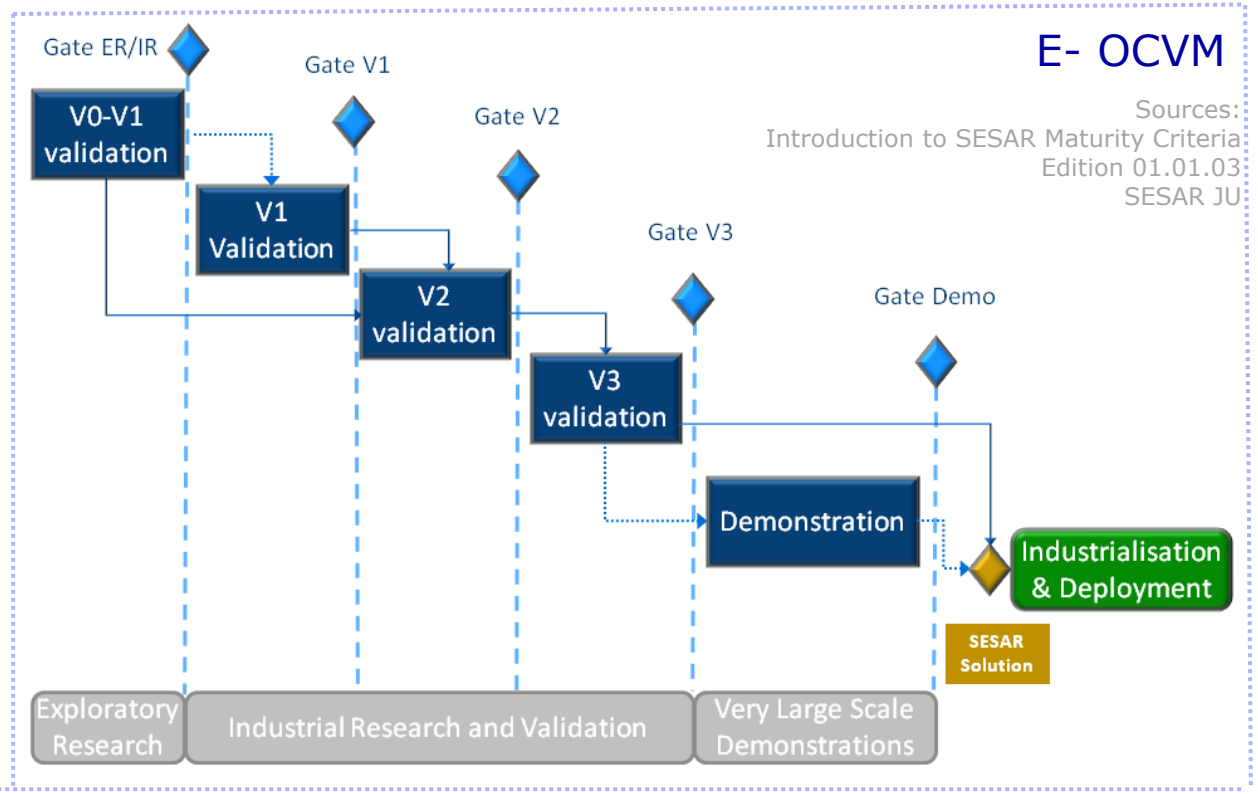
  E-OCVM Levels V1, V2 and V3

- **Topics under the scope of exploratory research projects**

  Initial maturity levels e.g. TRL1 / TRL2

- **SESAR Technological Solutions**

  Technology Readiness Levels TRL2, TRL4 and TRL6 + TRL7 related criteria for the scope under the responsibility of the Very Large Demonstrations (VLDs)



Technology Readiness Levels

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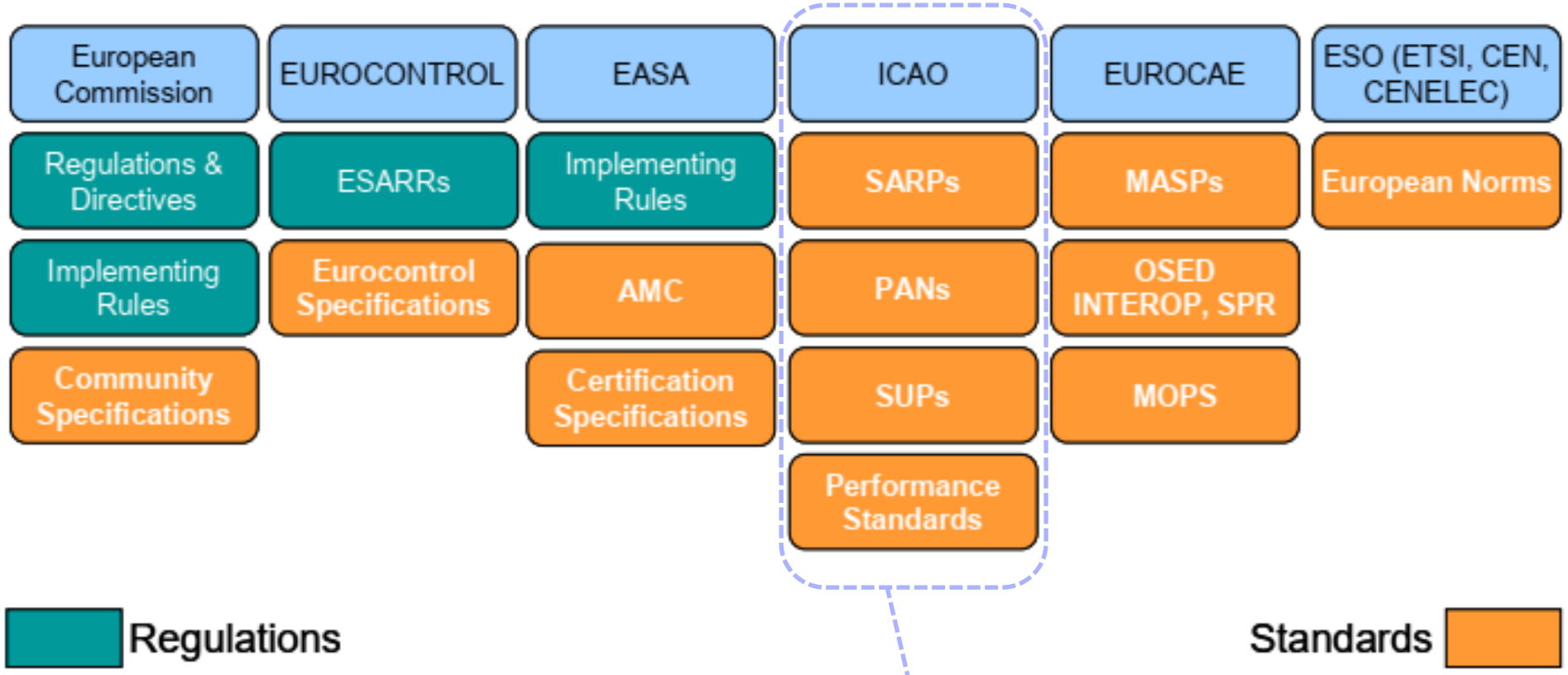
Standards and Regulation in SESAR

Types of regulatory and standardisation material they produce

Organizations involved in European ATM standardisation and regulation



Global alignment & Commitment to global interoperability and harmonisation

ESARR: Eurocontrol Safety Regulatory Requirement
EASA: European Aviation Safety Agency
AMC: Acceptable Means of Compliance
EUROCAE: European Organisation for Civil Aviation Equipment
MASPS: Minimum Aviation System Performance Specifications
MOPS: Minimum Operational Performance Specifications
INTEROP: interoperability requirements
SPR: Safety and Performance requirements
OSED : Operational Services and Environment Description

Sources:
https://www.eurocontrol.int/publication/european-operational-concept-validation-methodology-eocvm

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Life Cycle – Standards and Regulation Cases

- Standards are the principal enablers of **interoperability**, specifying how systems should be implemented to ensure that they work together.
- Interoperability is essential in a system-of-systems such as is implemented in a complex ATM operational concept.
- Regulations provide a legal **obligation** to implement particular standards, assuring that all appropriate systems meet the interoperability requirement.
- The EASCG is a **joint coordination and advisory group** established to coordinate the ATM-related standardisation activities, essentially stemming from the European ATM Master Plan, in support of Single European Sky implementation.

European Commission

ETSI World Class Standards

EUROCAE

EASA European Aviation Safety Agency

EUROCONTROL

SESAR JOINT UNDERTAKING

CEN CENELEC

European ATM Standards Coordination Group

EASCG

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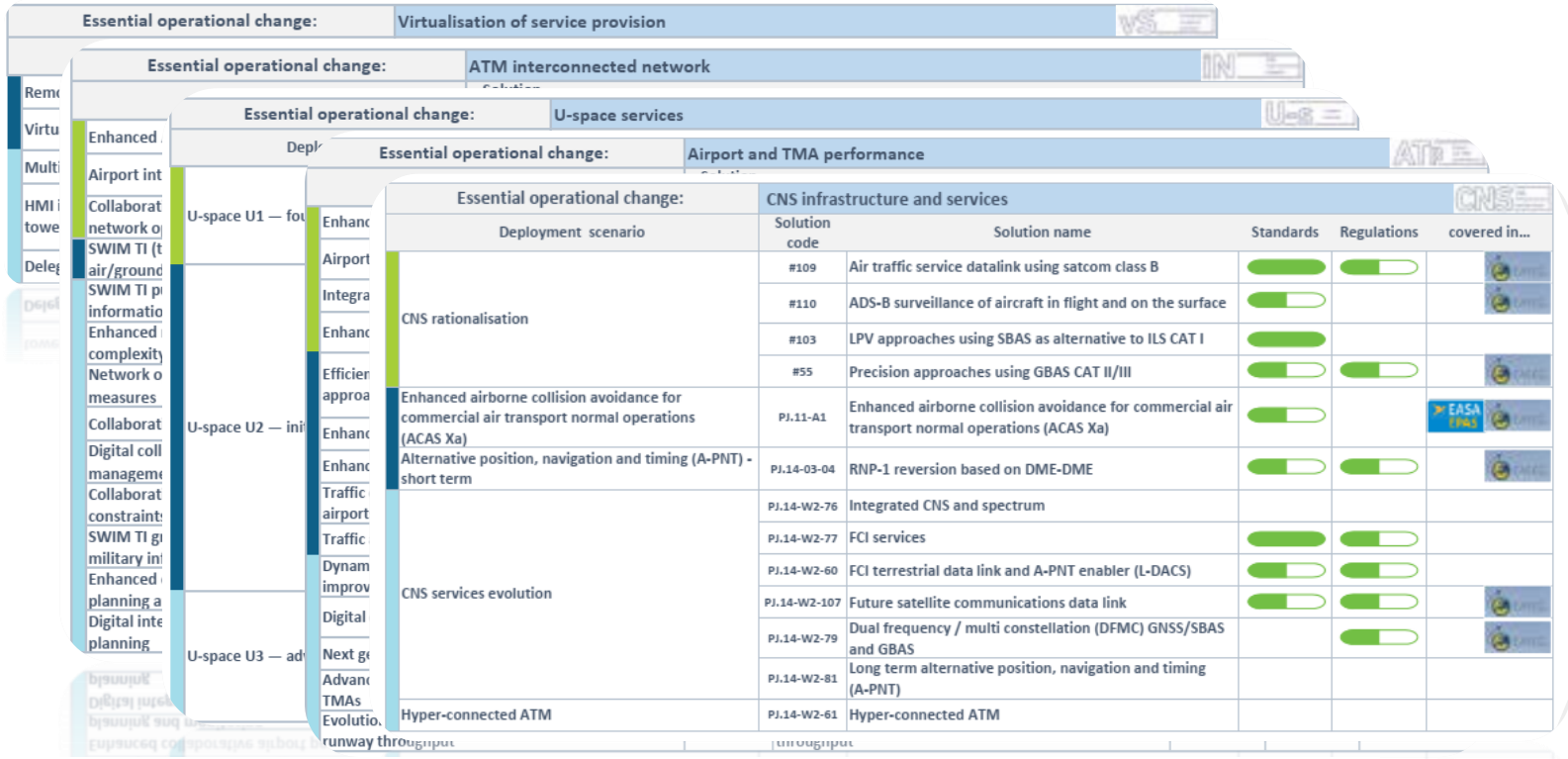
Bridge the gap between R&D and standards & regulation

SESAR Standardisation and Regulatory roadmaps

- Appropriate regulations, technical specifications and means of compliance supported by standards are necessary to deploy the SESAR EOCs required to build the future European ATM system.

- Roadmaps are provided **at early stage** to identify the required standardization and regulatory activities to implement the operational and technological improvements validated in SESAR.



Essential operational change: Virtualisation of service provision

Essential operational change: ATM interconnected network

Essential operational change: U-space services

Essential operational change: Airport and TMA performance

Essential operational change: CNS infrastructure and services

Deployment scenario	Solution code	Solution name	Standards	Regulations	covered in...
CNS rationalisation	#109	Air traffic service datalink using satcom class B			
	#110	ADS-B surveillance of aircraft in flight and on the surface			
	#103	LPV approaches using SBAS as alternative to ILS CAT I			
	#55	Precision approaches using GBAS CAT II/III			
Enhanced airborne collision avoidance for commercial air transport normal operations (ACAS Xa)	PJ.11-A1	Enhanced airborne collision avoidance for commercial air transport normal operations (ACAS Xa)			EASA EPAS
Alternative position, navigation and timing (A-PNT) - short term	PJ.14-03-04	RNP-1 reversion based on DME-DME			
CNS services evolution	PJ.14-W2-76	Integrated CNS and spectrum			
	PJ.14-W2-77	FCI services			
	PJ.14-W2-60	FCI terrestrial data link and A-PNT enabler (L-DACS)			
	PJ.14-W2-107	Future satellite communications data link			
	PJ.14-W2-79	Dual frequency / multi constellation (DFMC) GNSS/SBAS and GBAS			
	PJ.14-W2-81	Long term alternative position, navigation and timing (A-PNT)			
Hyper-connected ATM	PJ.14-W2-61	Hyper-connected ATM			

No additional needs identified in R&D

Standardisation need identified in R&D

Standardisation/Regulatory work planned or ongoing

<blank> Analysis in R&D pending

EASA EPAS covered in EPAS

covered in EASCG Rolling Development Plan

covered in EUSCG Rolling Development Plan

EPAS : European Plan for Aviation Safety
EUSCG - The European UAS Standards Coordination Group

Sources:
EUROCONTROL (2020). European ATM Master Plan: Digitalising Europe's Aviation Infrastructure - Executive view
MG-07-18-084-EN-N
SESAR JU

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Life Cycle – Standardization activities

- Close involvement of
- European Aviation Safety Agency (EASA)
- European Organisation for Civil Aviation Equipment (EUROCAE)

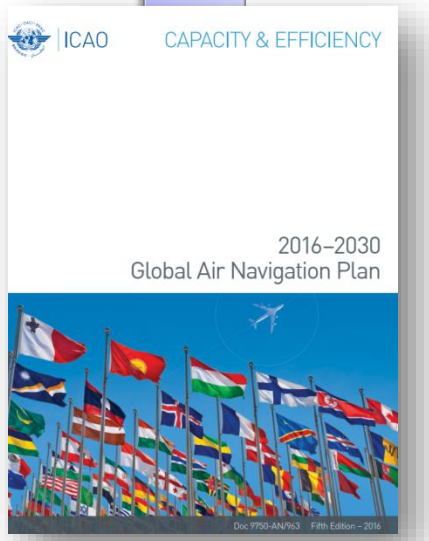
- SESAR has continuously and actively contributed to the development of the **ICAO GANP** and the aviation system block upgrades (**ASBUs**).

- To ensure alignment and the required links to the Master Plan, the SJU has, together with the **EC, EASA and Eurocontrol**, actively supported the **ICAO** Secretariat through organised working groups

- Cooperative arrangements have been established with the **United States** and **several other states and regions of the world** at the level of agreeing common views regarding GANP-related developments and their implementation

- **New standards for safety and security**: The increase in the number of connected devices and common standards will result in increase in vulnerabilities and a higher possibility of cyberattacks

align well in vision, performance ambitions, structure and technical content



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Transfer technology from SESAR to full implementation

The Pilot Common Project
(6 ATM functionalities)
2014 -2024

- **AF1 – Extended AMAN and Performance Based Navigation in the High Density TMAs**
- **AF2 – Airport Integration and Throughput**
- **AF3 – Flexible Airspace Management and Free Route**
- **AF4 – Network Collaborative Management**
- **AF5 – Initial System Wide Information Management**
- **AF6 – Initial Trajectory Information Sharing**

Regulation 716/2014 - Establishment of the Pilot Common Project Supporting the implementation of the European ATM Master Plan

Identify & make mandatory the deployment of ATM functionalities that:

- Contribute to achieving the ATM Master plan **essential operational changes**
- Are **mature** enough for implementation
- Require a **synchronised** deployment

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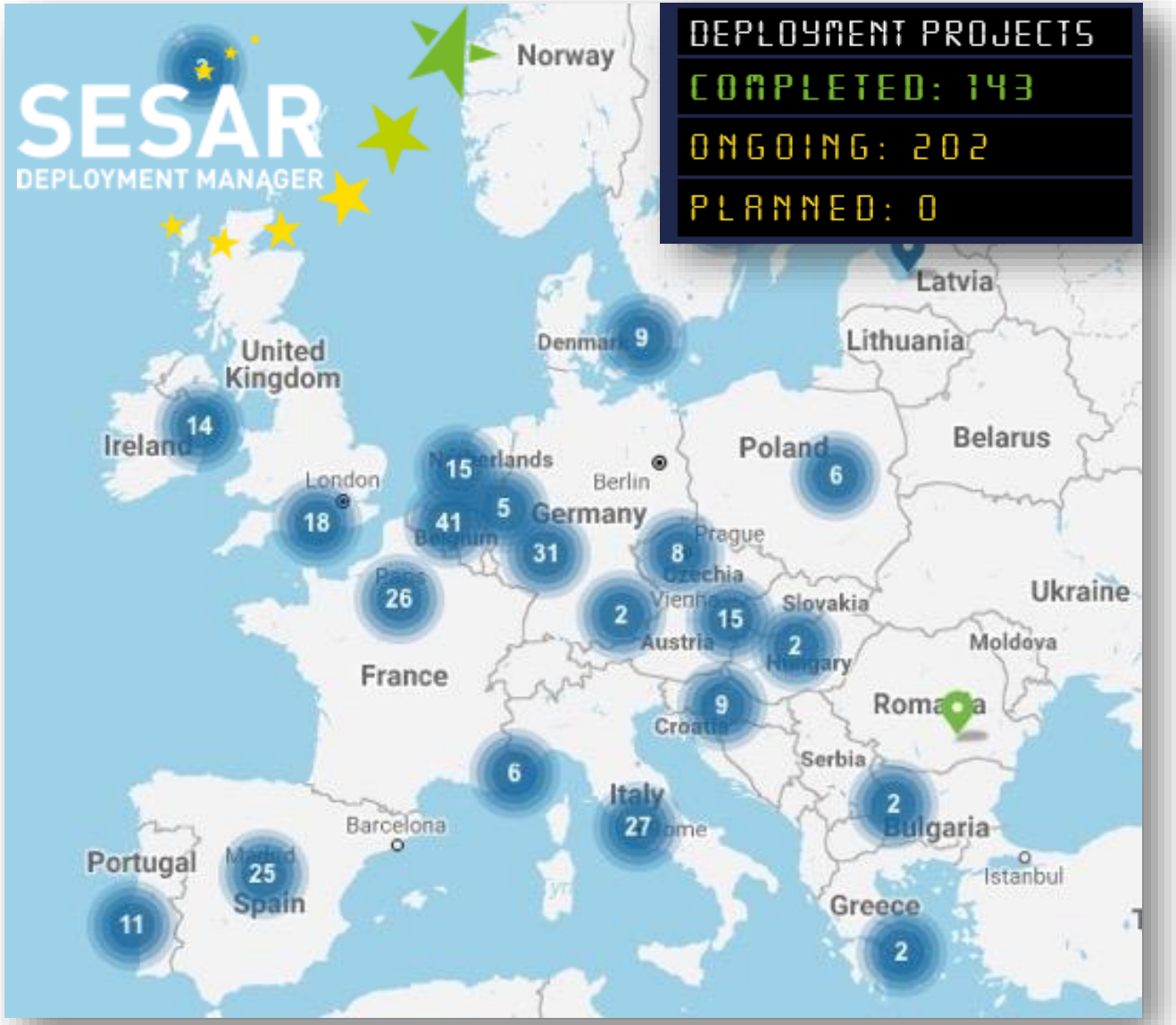
Transfer technology from SESAR to full implementation

The Pilot Common Project - Roadmaps

AF1 → Jan.1, 2024
AF2 → Jan.1, 2021
AF3 → Jan.1, 2022
AF4 → Jan.1, 2022
AF5 → Jan.1, 2025
AF6 → Jan.1, 2025

The EC has instructed the SESAR JU to propose content for inclusion in a second **Common Project (CP2)**, from among the 60 plus solutions it has delivered to date.



Sources:
https://www.sesardeploymentmanager.eu/

SESAR deployment- delivers benefits

150 projects out of 345 are in operation bringing benefits to passenger (representing 24% of the investment)

	On passengers time we save:		On the environment we save:		
In 2020	1.5m minutes	75m euro	25k tons of fuel	79k tons of CO_2	19m euro
By 2030	20m minutes	1bn euro	357k tons of fuel	1.1m tons of CO_2	250m euro

Cumulated minutes saving of first 150* completed projects

169,000 flight's average time

Cumulated CO_2 savings of first 150* completed projects

2,300,000 trees

Cumulated Fuel equivalent savings of first 150* completed projects

57,000 flight's average fuel consumption

*150 projects completed by June 2020

DLS equipped flights in Europe:

40% 2018

68% Jan 2020

ADS-B Implementation Status in Europe:

EU27+4 registered fleet, Version Number 2 (ED-102A/ DO260B)

24% Aug 2018

63% Dec 2019

72%

of the Pilot Common Project (PCP) deployment completed or in progress

Sources:
https://www.sesardeploymentmanager.eu/publications/folders-and-brochures/

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Life Cycle - Remote Towers

2002-2004 V0

INVENTION

Idea of "Virtual Tower" created by DLR

2005-2015 V1-V2-V3

PROTOTYPING, PATENT & VALIDATIONS

- ViTo 2002-2004
- RApTOr 2005-2008
- RAiCe 2008-2012

2014-2016 V4

INDUSTRIALISATION

2014 - Technology transfer to Frequentis

2014

2016 - 2018 V5

DEPLOYMENT

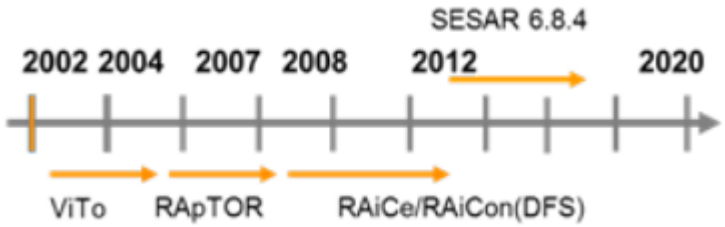
Frequentis & Rheinmetall Defence Electronics supplied DFS Remote tower solution

2018 - NOW V6

OPERATIONS

2018 : remote operations at Saarbrücken from Leipzig centre

17 YEARS



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Life Cycle - Remote Towers

2008 -2016

SESAR 1

- **(#71)** ATC and AFIS service in a single low-density aerodrome from a remote CWP
- **(#12)** Single remote tower operations for medium traffic volumes
- **(#52)** Remote tower for two low-density aerodromes
- **(#13)** Remotely-provided air traffic services for contingency situations at aerodromes (project 6.8.4)

✔ These solutions are available for industrialization/ deployment

2016 - 2019 www.remote-tower.eu/

SESAR 2020

Project PJ.05 - Remote Tower for Multiple Airports

The Hungarian validation:

- **3 Hungarian airports**: Budapest Airport, Pápa Military Airbase, and Debrecen Airport
- **DLR**: Responsible for project coordination within SESAR
- **HungaroControl**: Experienced ANSP
- **Frequentis**: Technology partner

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SESAR - Remote Towers

Remote towers is one of the success stories in SESAR!

HungaroControl ABOUT US SOLUTIONS CORPORATE RESPONSIBILITY CAREER CONTACT US BLOG

Main page > Press Room > News > Successful SESAR PJ05 multi-remote passive shadow validation and open day at HungaroControl

Successful SESAR PJ05 multi-remote passive shadow validation and open day at HungaroControl

April 2019, Budapest – Air Traffic Management (ATM) experts from aroun
headquarters in Budapest to experience a passive shadow validation for m
collaboration with Frequentis. Participants got to see first-hand the passiv
in real time.

LFV ABOUT US SERVICES GLOBAL NEWS PRESS CONTACT SV

Start / News / News 2015

Sweden first in the world with remotely operated air traffic management

As of today, the air traffic service at Örnsköldsvik Airport is operated using Remote Tower Service (RTS). Throughout the day, the first planes controlled from the LFV Remote Tower Centre in Sundsvall have been taking off and landing at Örnsköldsvik Airport.

Investor relations | Press Room | Where we are | English | Search

indra Transport Air Traffic Defence and Security Minsait Talent About Indra

Indra successfully validates with Avinor multiple remote tower operations to boost airport capacity worldwide

News
Indra in the media
Events
Multimedia content
Press contact

14 May 2019 Spain

- The validation was run as a real-time simulation for three Norwegian aerodromes, using a single touchscreen with Indra's InNOVA tower solution as the industrial platform
- With this validation, part of the SESAR Joint Undertaking, Indra positions itself in the forefront of remote tower development, working with Avinor on the largest remote tower program in the world

Indra has successfully validated multiple remote tower operations with Norwegian air navigation service provider (ANSP) Avinor, showing the possibility to manage multiple airports from one single integrated screen. The validation was part of the PJ05 SESAR Remote Tower project.

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MAIN ATM RESEARCH TOPICS

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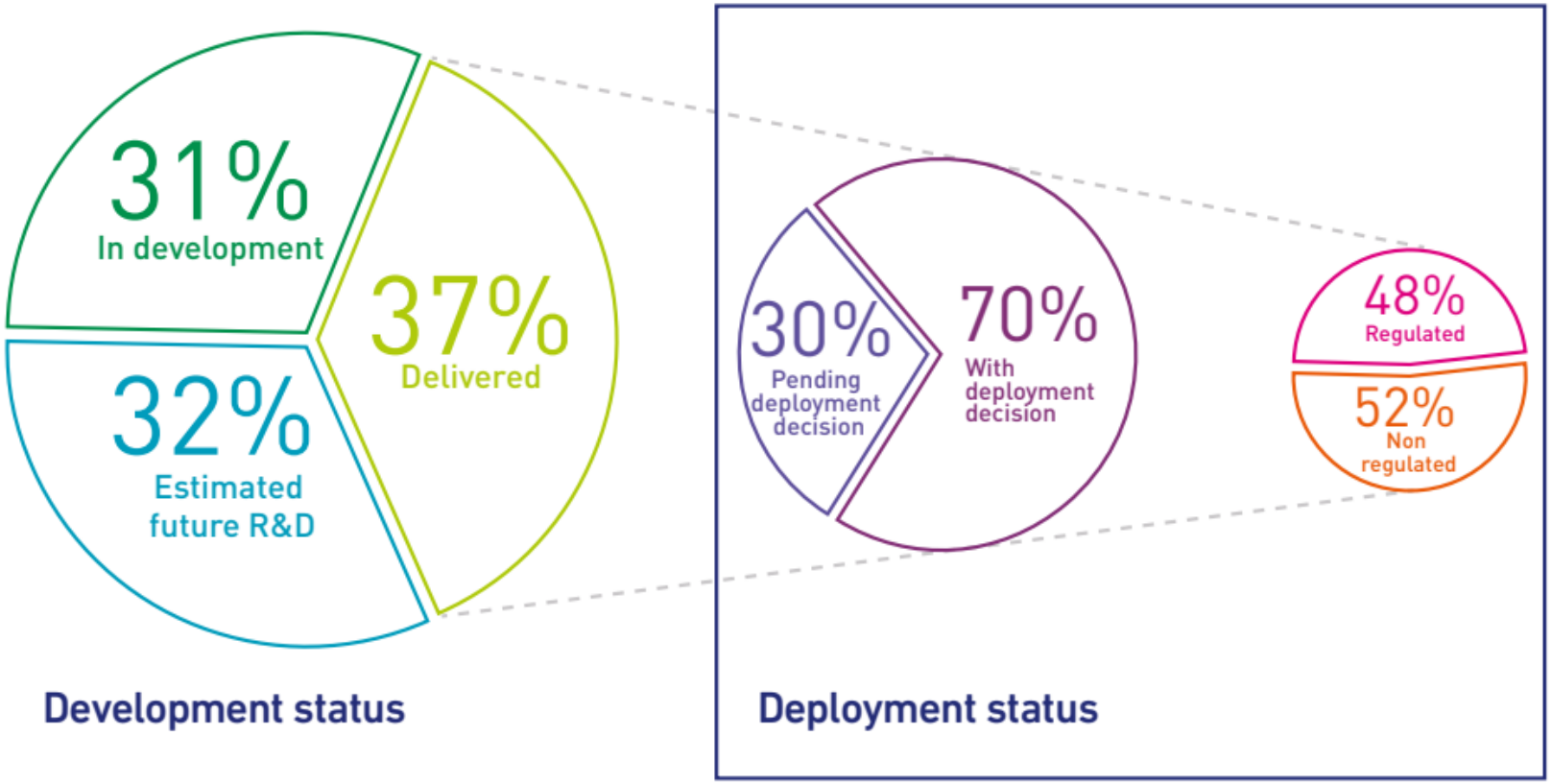
Main ATM Research Topics – SESAR Solutions

SESAR Solution: Programme output of R&I activities which relates to either an operational or a technological improvement which have been designed, developed and validated in response to performance needs identified in the European ATM Plan.



- Status of SESAR solutions
  - **65 delivered Solutions**
  - **80 candidate solutions** in the pipeline
  - **40+ already under deployment** across Europe

SESAR Solutions – Key Performance Areas

Improved predictability: measured by the variability in the duration of the flight;

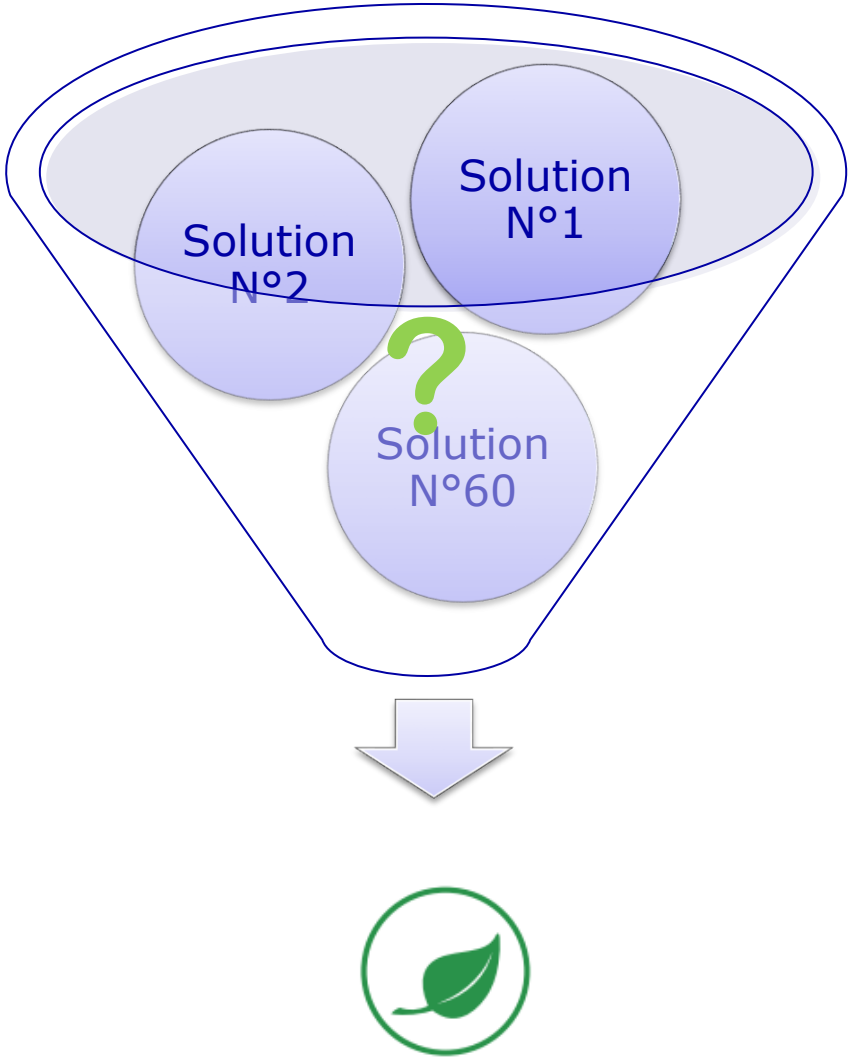
Reduced costs: refers to the costs associated with air navigation service provision;

Increased airport capacity: refers to runway throughput at 'best-in-class' airports which already operate close to their capacity limit;

Increased en-route airspace capacity: refers to en-route airspace, which is close to saturation

Increased TMA airspace capacity: refers to airspace in the surrounding area of one or more airports (terminal manoeuvring area)

Reduced fuel consumption and emissions: refers to the average reduction in fuel consumption per flight in Europe (at the level of European Civil Aviation Conference).



Sources:
SESAR JU, SESAR SOLUTIONS CATALOGUE 2019
Third edition

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EOC TBO – Related SESAR Solutions

Extended projected profile (EPP) availability on ground	#115
ATC planned trajectory performance improvement	PJ.18-06a
Tactical and NM trajectory performance improvement	PJ.18-06b
Enhanced short-term conflict alert (STCA) for terminal manoeuvring areas (TMAs)	#60
Enhanced STCA with down-linked parameters	#69
eFPL supporting SBT transition to RBT	PJ.18-02c
Improved ground trajectory predictions enabling future automation tools	PJ.10-02a
Trajectory based operations (TBO)	PJ.18-02a
Airspace Users (AU) processes for trajectory definition	PJ.07-01
Dynamic E-TMA for advanced continuous climb and descent operation	PJ.01-03b
Controlled time of arrival (CTA) in medium density / medium complexity environment	#06
MTCD and conformance monitoring tool	#27
ACAS ground monitoring and presentation system	#100
Extended hybrid surveillance	#101
Enhanced airborne collision avoidance system (ACAS)	#105
Airborne spacing flight deck interval management	PJ.01-05
Trajectory prediction service	PJ.15-08
Enhanced short-term conflict alert (STCA) and non transgression zone (NTZ) ground based safety nets making use of DAPs information	PJ.11-G1

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EOC TBO – Deployment status

The timescales for the deployment
The timescales for the delivery of benefits

Deployment Scenario	Timeline	Solution	Solution V3 Gate
1. In deployment phase: Key SESAR Solution			
Enhanced safety nets	2019 – 2028	#60	-
		#69	-
2. In development phase: Key Solutions Approaching Maturity			
eFPL supporting SBT transition to RBT	2021 – 2029	PJ.18-02c	-
3. In development phase: Key R&D Activities			
Enhanced integration of AU trajectory definition and network management processes	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	PJ.07-01	-
		PJ.07-W2-38	31-12-2022
Improved ground trajectory predictions enabling future automation tools		PJ.10-02a1	10-12-2019
		PJ.10-02a2	-
		PJ.10-02b	-
		PJ.18-W2-53	31-12-2022
Improved vertical profiles through enhanced vertical clearances		PJ.18-W2-56	-
RBT revision supported by datalink and increased automation	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	PJ.18-02a	-
		PJ.18-W2-57	31-12-2022
4. Additional SESAR Solutions in deployment			
ACAS ground monitoring and presentation system	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	#58	-
		#100	-
Controlled time of arrival (CTA) in medium density / medium complexity environment	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	#06	-
Enhanced Airborne Collision Avoidance System (ACAS)	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	#105	-
Extended hybrid surveillance	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	#101	-
MTCD and conformance monitoring tool	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	#27	-
5. Additional R&D Activities in development			
Airborne spacing flight deck interval management	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	PJ.01-05	-
Enhanced short-term conflict alert (STCA) and non transgression zone (NTZ) ground based safety nets making use of DAPs information	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	PJ.11-G1	-
Trajectory prediction service	Not Available - To be defined when Solution reaches MP Category 2. In development phase: Key Solutions Approaching Maturity	PJ.15-08	-
		PJ.18-W2-88	-

The deployment is planned only for Solutions that are sufficiently mature

Sources: https://www.atmmasterplan.eu/

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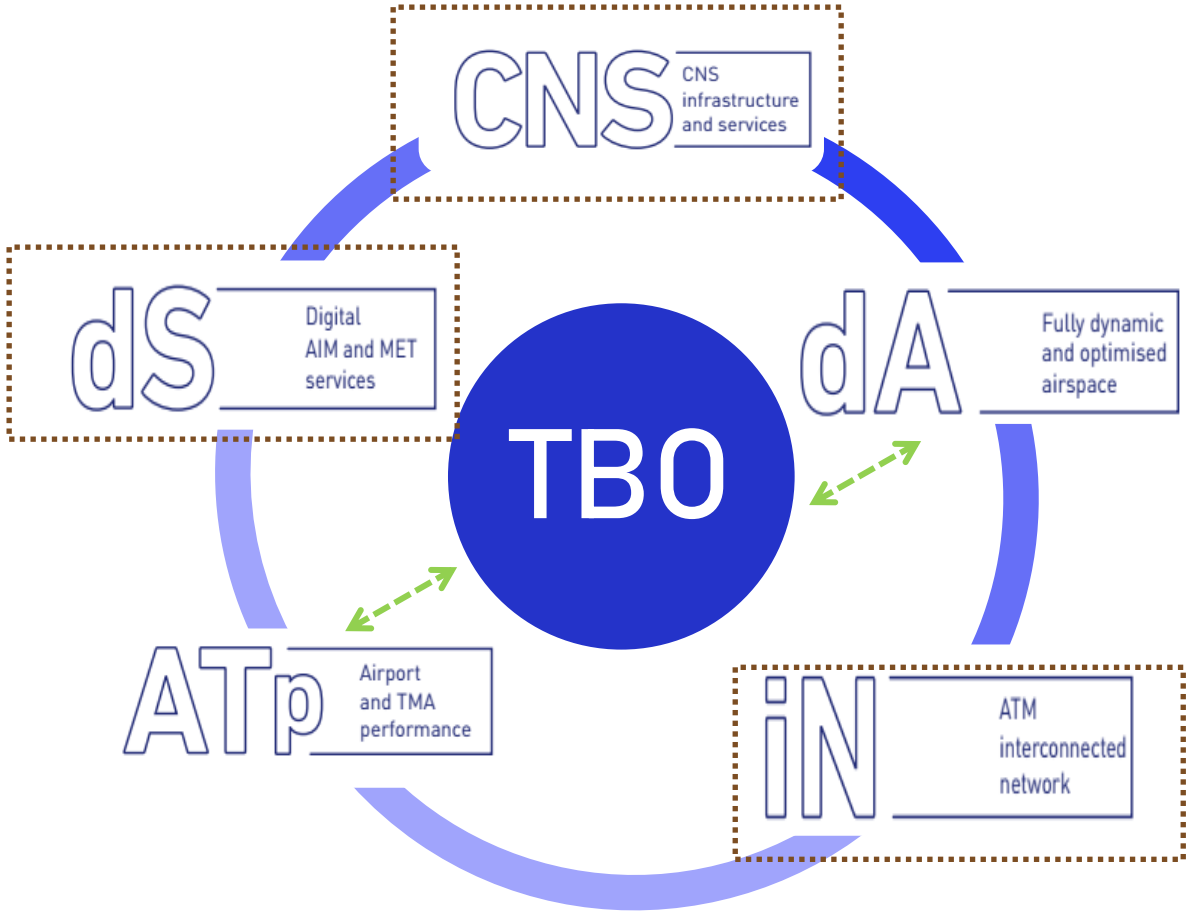
Main ATM Research Topics - related to TBO & Environment

- i4D - initial Trajectory Information sharing (AF6.1) – EOC TBO
- Continoues descent operations (CDO) using point merge (#11) – EOC ATp
- Pre-departure sequencing supported by route planning (#53) – EOC ATp
- User-Preferred Routing (#65)– EOC dA



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i4D - Initial trajectory information sharing (AF6.1)

Initial Trajectory Information Sharing (i4D) consists of the improved use of target times and trajectory information, including where available the use of on-board 4D trajectory data by the ground ATC system and Network Manager Systems, implying fewer tactical interventions and improved de-confliction situation.

Target times and 4D trajectory data shall be used to enhance ATM system performance.

Trajectory information and target times shall be enhanced by the use of air-ground trajectory exchange.

Implementation Steps

SESAR 1

- **Extended projected profile (EPP) availability on the ground** (#115)

SESAR 2020

- ***ATC planned trajectory performance improvement*** *(#PJ.18-06a)*
- ***Tactical and NM trajectory performance improvement*** *(#PJ.18-06b)*

PCP **AF6.1 — Initial trajectory information sharing (i4D)**

Fundamental Concept

Linked KPA

Overall progress and goals achieved

- initial four-dimensional flight in February 2012 demonstrated **the feasibility**
- A second trial in March 2014 to test the air-ground data exchange (flying from Toulouse to Copenhagen and then Stockholm) demonstrated **the maturity and the robustness** of the concept
- EPP is being deployed in a synchronised way across **22 ATC centres and 18 TMA and airports** across Europe

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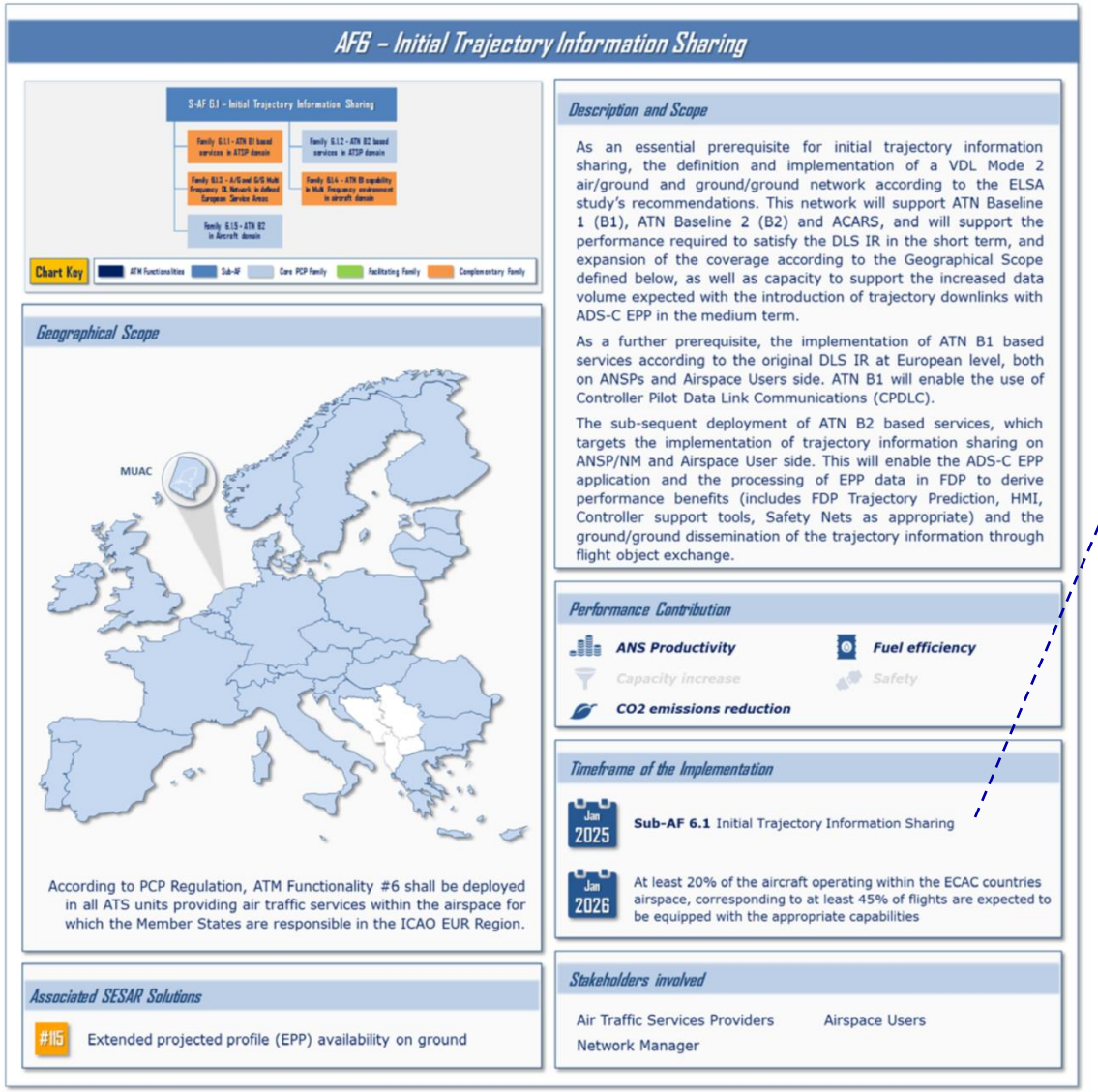
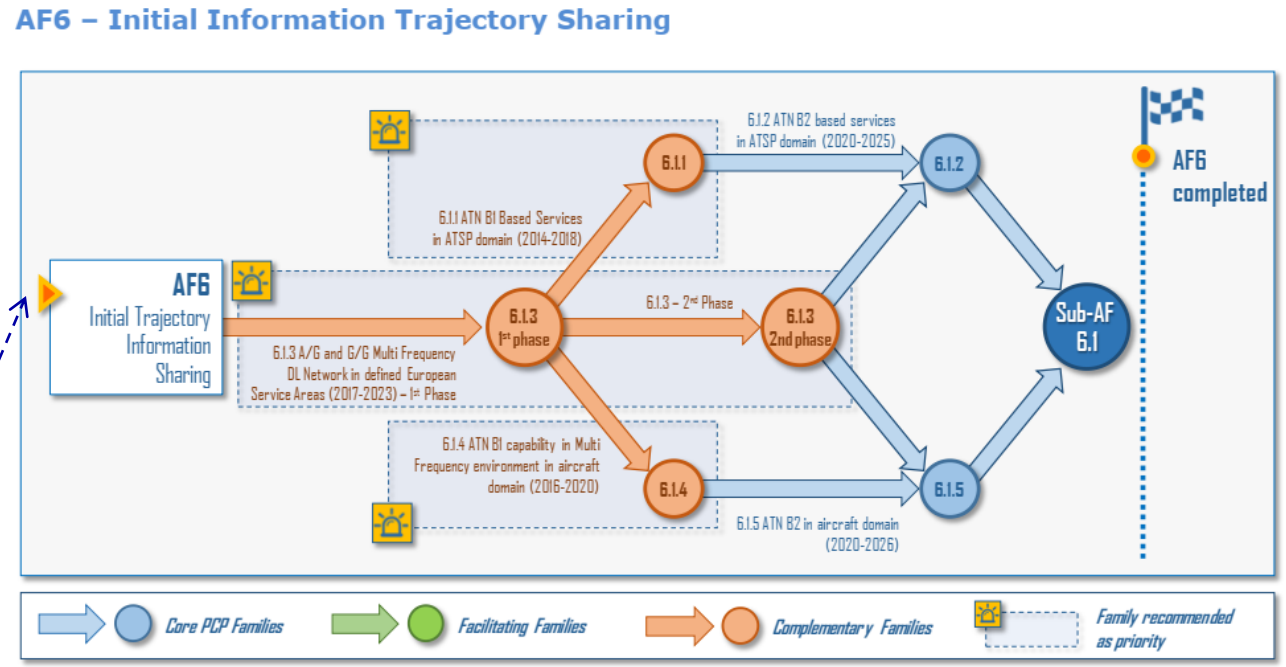
i4D - Initial trajectory information sharing (AF6.1)



Sources:
DEPLOYMENT PROGRAMME 2018
Delivrable D1.1 MOVE/E3/SUB/2016-402/SI2.745134
SESAR Deployment Manager



Sources:
Guidance Material for SESAR Deployment Programme Implementation Planning View 2017
SESAR Deployment Manager

Implementation Roadmap

PCP

Related Projects/ main Players

indra
THALES
EUROCONTROL
AIRBUS
Honeywell
noracon

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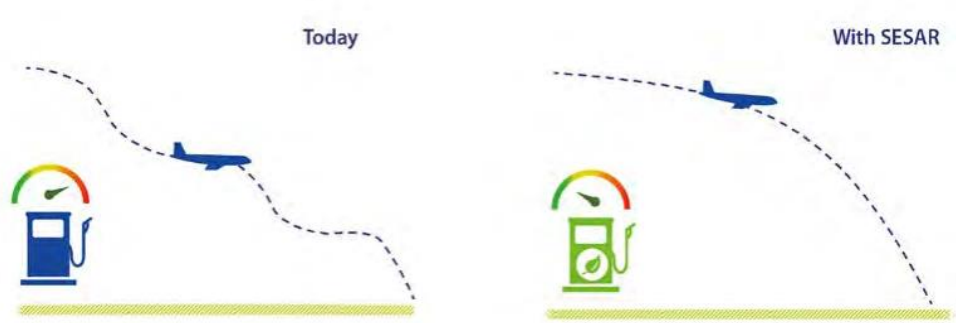
Continuous Descent Operations using point merge (#11)



Aircraft engines have become quieter but an aircraft's flight path can also help reduce noise levels by following a smooth descent down to the runway threshold rather than a conventional stepped approach. By combining it with point merge techniques, CDO can be applied to **high-density traffic** environments at **a lower altitude** and in a **small and very constrained airspace.**

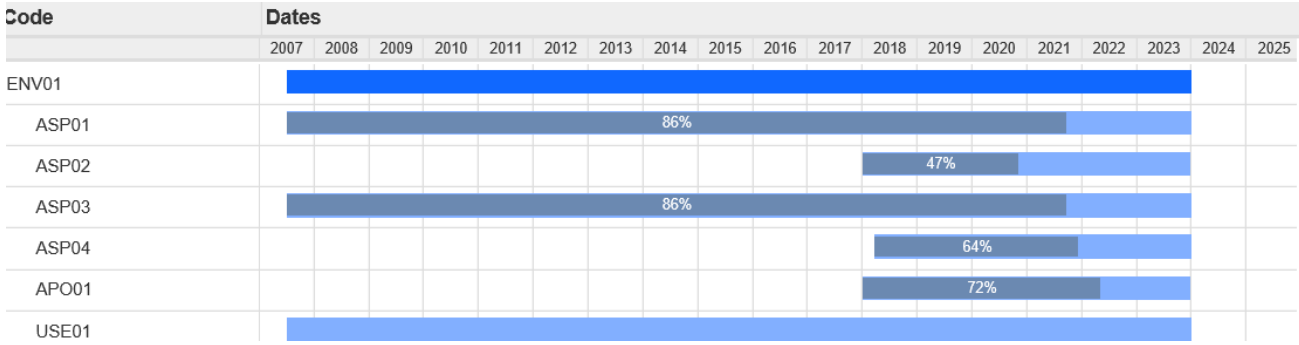
Fundamental Concept

Linked KPA

Stakeholder Lines of Action (SLoAs)

SloA ref.	Title	From	By
ENV01-ASP01	Implement rules and procedures for the application of CDO techniques	01/07/2007	31/12/2023
ENV01-ASP02	Design and implement CDO procedures enabled by PBN	01/01/2018	31/12/2023
ENV01-ASP03	Train controllers in the application of CDO techniques whenever practicable	01/07/2007	31/12/2023
ENV01-ASP04	Monitor and measure the execution of CDO	23/03/2018	31/12/2023
ENV01-APO01	Monitor and measure the execution of CDO	01/01/2018	31/12/2023
ENV01-USE01	Include CDO techniques in the aircrew training manual and support its implementation wherever possible	01/07/2007	31/12/2023

Implementation Steps



Sources: https://www.atmmasterplan.eu/

Overall progress and goals achieved

- ✔ Implemented in Austria, Germany, France, Hungary and Ireland and planned in Italy, Lithuania, Latvia and Portugal.

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CDO - References

EUROCONTROL - CCO, CDO harmonised definitions, metrics and parameters
https://www.youtube.com/watch?v=mUkMPb5eVJI

EUROCONTROL - EUROCONTROL CDO/CCO Supporting Material
https://www.eurocontrol.int/concept/continuous-climb-and-descent-operations

EUROCONTROL - European Joint Industry CDA Action Plan
https://www.eurocontrol.int/publication/european-joint-industry-cda-action-plan

ICAO - Doc 4444 - Air Traffic Management - Edition 15 / 11/2010
https://store.icao.int/

ICAO - Doc 9426 - Air Traffic Services Planning Manual - Edition 1 / 12/1992
http://www.icao.int/publications/Pages/catalogue.aspx

ICAO - Doc 9613 - Performance-based Navigation (PBN) Manual - Edition 4 / 03/2013
http://store1.icao.int/

ICAO - Doc 9931 - Continuous Descent Operations (CDO) Manual - Edition 1 / 12/2010
https://store.icao.int/

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Pre-departure sequencing supported by route planning (#53)

The routing and planning function of the **A-SMGCS** calculates accurate **taxi times** depending on the airport environment (e.g. runway configuration) and traffic on the airport surface. These taxi times are used by the **DMAN** instead of static taxi-time tables. The DMAN uses the same rules for calculating TTOT and TSAT as in the current operating method

Fundamental Concept

Linked KPA

Implementation Steps

SESAR 1
- Solution #53

SESAR 2020
- Sub-AF 2.1

Timeframe of the Implementation

Jan 2021
- **Sub-AF 2.1** Departure Management Synchronized with Pre-departure sequencing
- **Sub-AF 2.2** Departure Management integrating Surface Management constraints
- **Sub-AF 2.5** Airport Safety Nets

Jan 2024
- **Sub-AF 2.3** Time-Based Separation for Final Approach
- **Sub-AF 2.4** Automated Assistance to Controller for Surface Movement Planning and Routing

Sources:
SESAR DM, DEPLOYMENT PROGRAMME 2018
Delivrable D1.1 MOVE/E3/SUB/2016-402/SI2.745134

Overall progress and goals achieved

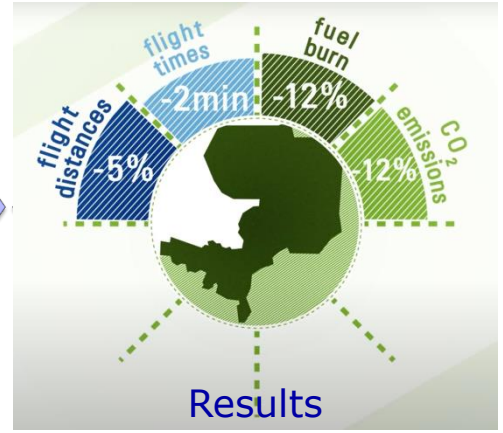
This solution is available for industrialisation

PCP

UPR - User-Preferred Routing (#65)

This enables the operator's flight planning system to calculate the most efficient route taking into consideration wind speed and direction, turbulence, temperature, aircraft type and performance.

Real-time simulations were carried out at the MUAC for testing a new set of DCTs and concerned H24/7 operations



Sources:
https://www.sesarju.eu/sesar-solutions/user-preferred-routing

Timeframe of Implementation:
Sub-AF 3.2 – Free Route : 2022

Fundamental Concept

Implementation Steps

Linked KPA

Overall progress and goals achieved

- The Maastricht Upper Area Control centre now offers more than 250 user-preferred routes
- This solution is available for industrialisation

PCP

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On the horizon …

MASTERING METEOROLOGICAL UNCERTAINTY IN AVIATION

Meteorological uncertainty management for trajectory-based operations – TBO-Met

TBO-Met project focused on three research topics:

- Trajectory planning
- Storm avoidance
- and sector demand analysis, considering meteorological forecast uncertainties

More information: https://tbomet-h2020.com

Sources:
SESAR JU, SESAR SOLUTIONS CATALOGUE 2019
Third edition

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On the horizon …

TRAJECTORY PREDICTION – LETTING THE MACHINE DO THE MATH

Data driven aircraft trajectory prediction research - DART

DART explored the potential of **machine learning methods** using **historical data** to increase the predictability for individual trajectories, and **multi-agent collaborative reinforcement learning methods** to resolve demand-capacity balancing (DCB) problems, supporting the incorporation of stakeholders' **preferences** into the planning process.

More information: http://dart-research.eu

Sources:
SESAR JU, SESAR SOLUTIONS CATALOGUE 2019
Third edition

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This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 875154 GreAT.

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