FROM INNOVATION TO SOLUTION

SESAR: PERSPECTIVES ON AUTOMATION

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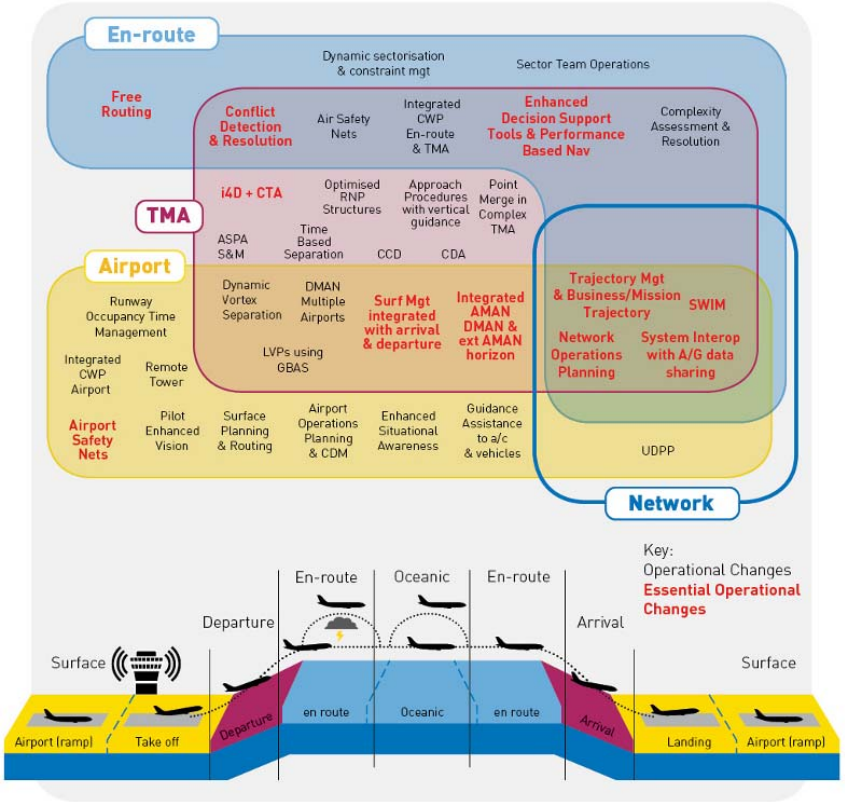
SESAR JOINT UNDERTAKING

founding members

EUROPEAN UNION EUROCONTROL

SESAR



The SESAR Programme

SESAR – Single European Sky Air Traffic Management Research – is the technology pillar of the Single European Sky (SES) Programme.

It pools together the knowledge and resources of the entire ATM community through a public-private partnership – the SESAR Joint Undertaking

FROM INNOVATION TO SOLUTION

Implementing the Single European Sky

5 pillars

Performance

Performance scheme

Performance Review Body

Functional Airspace Blocks

Network Manager

National Supervisory Authorities

Safety

EASA

Crisis coord. cell

Technology

SESAR

European ATM Master Plan

SESAR Joint Undertaking

Common projects

Airports

Airport observatory

Human factor

Specific sectoral dialogue Committee

Consultative expert group on social dimension of the SES

FROM INNOVATION TO SOLUTION

SESAR is Approaching the Deployment Phase

Definition phase

Create European ATM Master Plan

Development Phase

Develop new standards, operational procedures and technologies

Deployment Phase

Implement results of development to meet performance targets

2005-2008

2008.....

2015.....

06/2009
Launch

07/2009
400
contributors
20
projects

09/2009
Airlines
on board

03/2010
1,500
contributors
300
projects

06/2011
GA&R in the
ConOps
at a Glance

10/2012
Rotorcraft
Operators
(EHA)
full involvement

Today
3000+
contributors
35+
validation
exercises
17
SESAR Solutions

FROM INNOVATION TO SOLUTION

SESAR Projects

SWIM			4D		
2 Demo projects 1 ER project 1 PCP project	3 Solutions 2 ER projects 16 Demo projects	3 solutions 3 ER projects 2 PCP projects	2 solutions 9 ER projects 3 demo projects 2 PCP projects	1 solution 8 ER projects 3 Demos 2 PCP projects	1 solution 2 ER projects 1 PCP project

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HP SESAR VALIDATION LIFECYCLE

V1

- Operational and technical scope
- Potential performance benefits

V2

- Feasibility/acceptability
- Detailed task analysis, HMI
- Impact on teamwork , training needs
- Performance Measurement
- V2 Performance assessment

V3

- Pre-industrial development and integration
- HP case to support Business Case
- HP into Safety Case (HEA)

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The HP assessment process

STEP 1
- Define reference and solution scenarios for validation, as well as assumptions
- Identify related projects
- Review maturity

STEP 2
- Identify relevant HP arguments
- Identify and prioritize HP issues, impacts and benefits. Define HP validation objectives.
- Develop HP assessment plan

STEP 3
- Identification of normal and abnormal operating conditions
- Run validation activities
- Analyse results and improve the concept

STEP 4
- Manage HP recommendations and requirements
- Produce HP assessment report
- Is the concept ready for transition to the next V-phase?

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HP Arguments used in SESAR

Arg. 2	Technical systems support the human actors in performing their tasks.	In order for the technical systems to support the human in carrying out their tasks, the usability of the technical system must be assured. Usability is the extent to which a system allows people to achieve goals (tasks) in an effective, efficient and satisfactory way (HF Case v2.0).
Arg. 2.1	There is an appropriate allocation of tasks between the human and machine (i.e. level of automation).	Allocation of tasks between the human and machine relates to the level of automation introduced, i.e. the extent to which tasks are controlled/performed by the human operator or the machine.
Arg. 2.1.1	The task allocation between the human and the machine is consistent with automation principles.	The level of automation/distribution of tasks between the human and machine must be consistent with HF automation principles. Relevant HF automation principles are mentioned in the list of HP activities and required evidence.
Arg. 2.1.2	Changes to the task allocation between human and machine support human performance.	The proposed changes to task allocation must not negatively affect human performance and hence the ability of the human actor to achieve their tasks. The impact of the changes in the task on situational awareness, workload, human error/ performance must be considered.
Arg. 2.1.3	Transition from automatic to manual modes and vice versa, human-intended or failure induced, can be performed by the human actors in a timely, efficient and accurate manner. [not applicable in V1]	The change in mode of operations from automatic to manual and vice versa must be clear to the human actor (to ensure that mode errors are mitigated). Also, the actions required by the human actor in response to the mode change must be easy to perform.
Arg. 2.1.4	The level of workload (induced by the allocation of tasks between the human and the machine) is acceptable.	Subjective workload relates to an individual's perception of the effort expended to perform a task/set of tasks. Subjective workload is induced by cognitive and physical task demand

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SESAR HP assessment process in practice

Three examples of how human/automation interaction is assessed in SESAR:

- Remote Tower
- Time Based Separation (TBS)
- i4D operations

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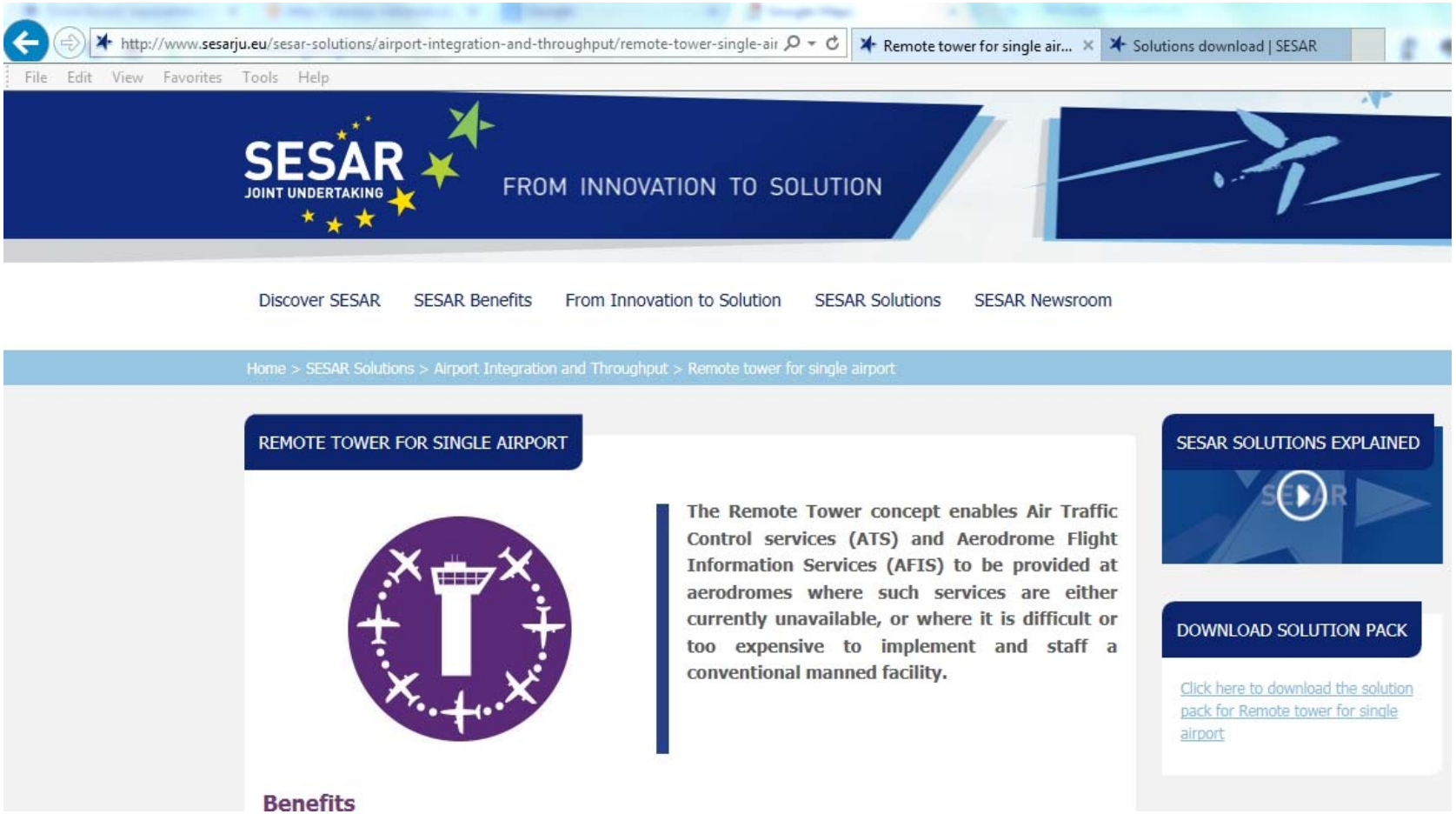
SESAR SOLUTION: Remote Tower for Single Airport



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What is a “Remote Tower”?

- Aim of Remote Tower Research in SESAR:
  - Development and assessment of an operational concept that enables the cost effective provision of Air Traffic Services (ATS) at one or more airports from a control facility that is not located in the local ATS Tower.
- Validation Targets:
  - It is feasible to provide ATS from a remote facility;
  - Human Performance is not negatively impacted and is at least as good as with current operations (from a local Tower). Any instances of Human Performance degradation are either mitigated or acceptably offset by improvements in other areas;
  - Safety levels are maintained; and
  - The airspace and runway capacity for the target candidate environments is not negatively impacted by the Remote Provision of ATS under normal conditions, and may be positively impacted.

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Remote Tower Classification

- Remote Tower ATC services (single tower)
- Remote TWR Airport Flight Information Services
- Contingency Tower services
- Remote Tower ATC services (multiple tower)

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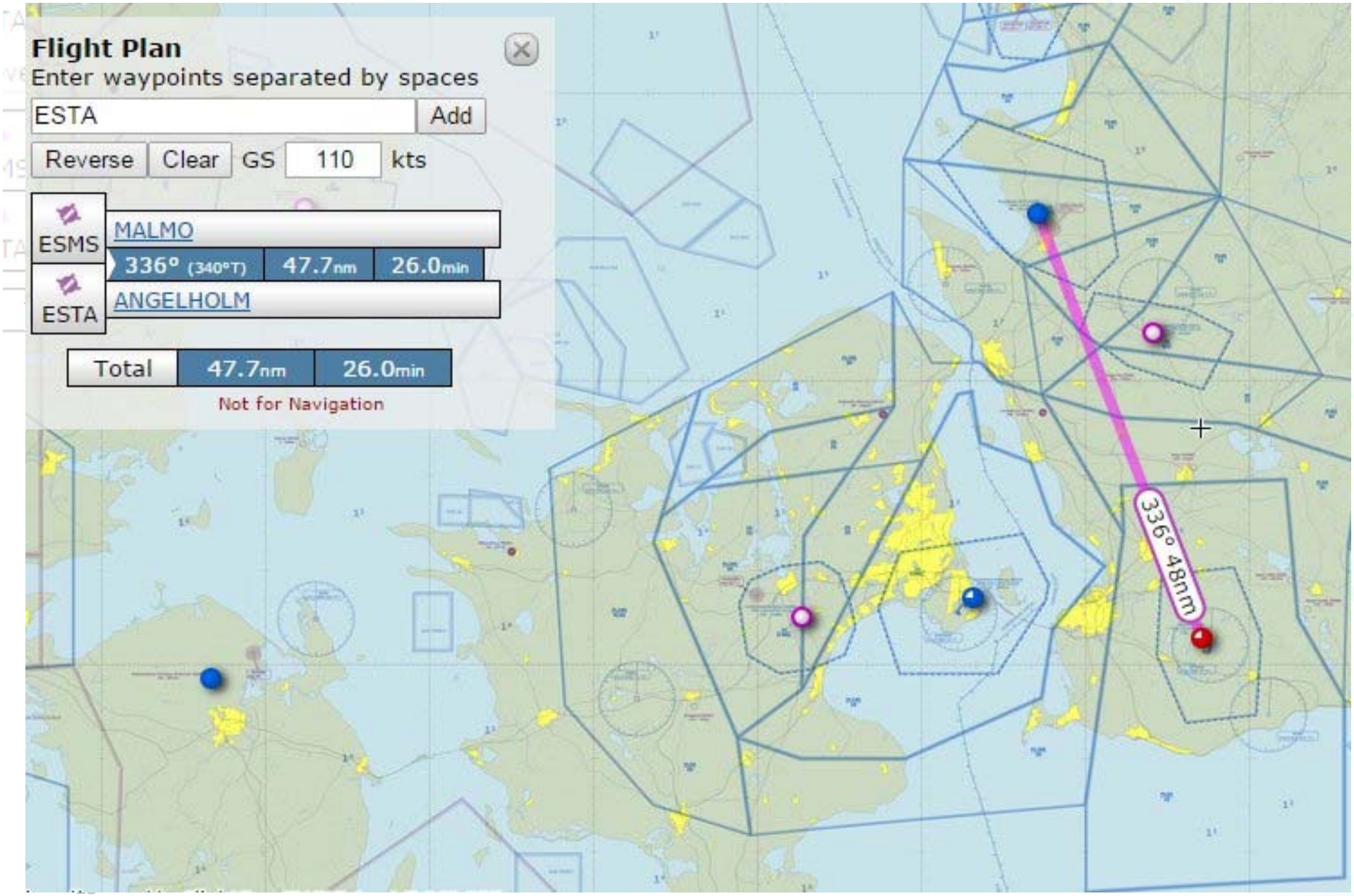
HP Arguments for Single Airport Remote Tower (1/2)



HP Arguments for Single Airport Remote Tower (2/2)

Effect on team structures and communication

Need for maintenance technicians for new equipment, allocation of certain tasks (e.g. METOBS) to airport staff rather than ATCOS, phraseology, impact on perception of ATC authority, relationship and communication between RT and airport

HP-related transition factors

State tower is RT on first contact, need for ATCOs to remain tower controllers (rather than radar/simulator controllers), need to maintain ATCOS knowledge of the local environment /aerodrome as if they worked there, how professionally stimulating new setting is, staffing levels

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RT Single Airport Standardization

- EUROCAE WG-100 kicked-off summer 2014
- MASPS related to visual presentation are expected to be published summer 2016:
  - Resolution
  - Glare
  - Latency
  - Blur effect
  - Etc.

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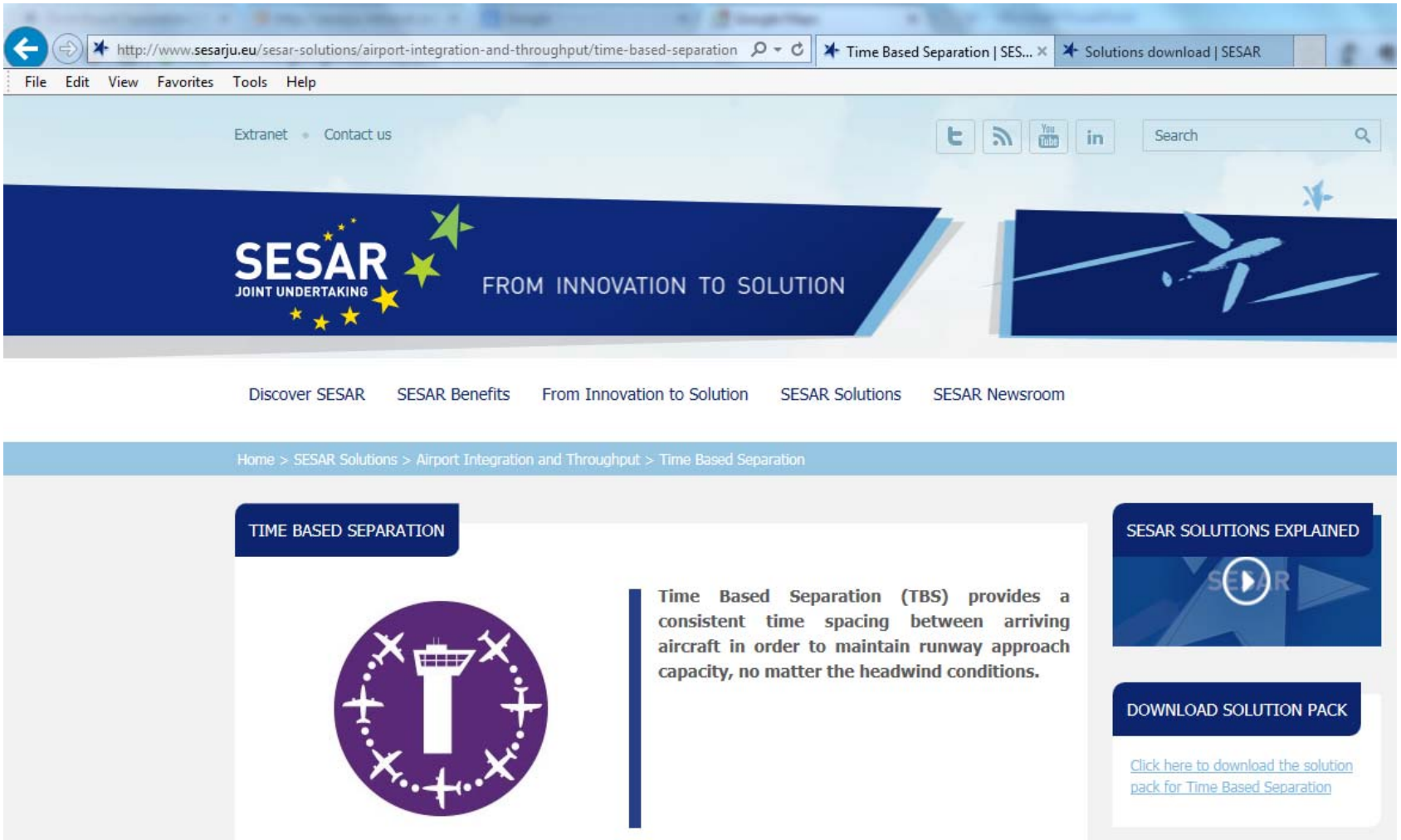
SESAR Solution: Time Based Separation



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Time-Based Separation (TBS)

Aircraft land against the wind

Wind dissipates wake vortex faster

Ground speed (GS) = TAS – Headwind

Higher headwind (HW) = Lower GS

2.5NM wake vortex separation LM-LM	=	60 seconds 150 KT no HW (GS = 150 KT)	=	70 seconds 150 KT and 20 KT HW (GS = 130 KT)

With HW, less wake vortex danger, but we separate more!

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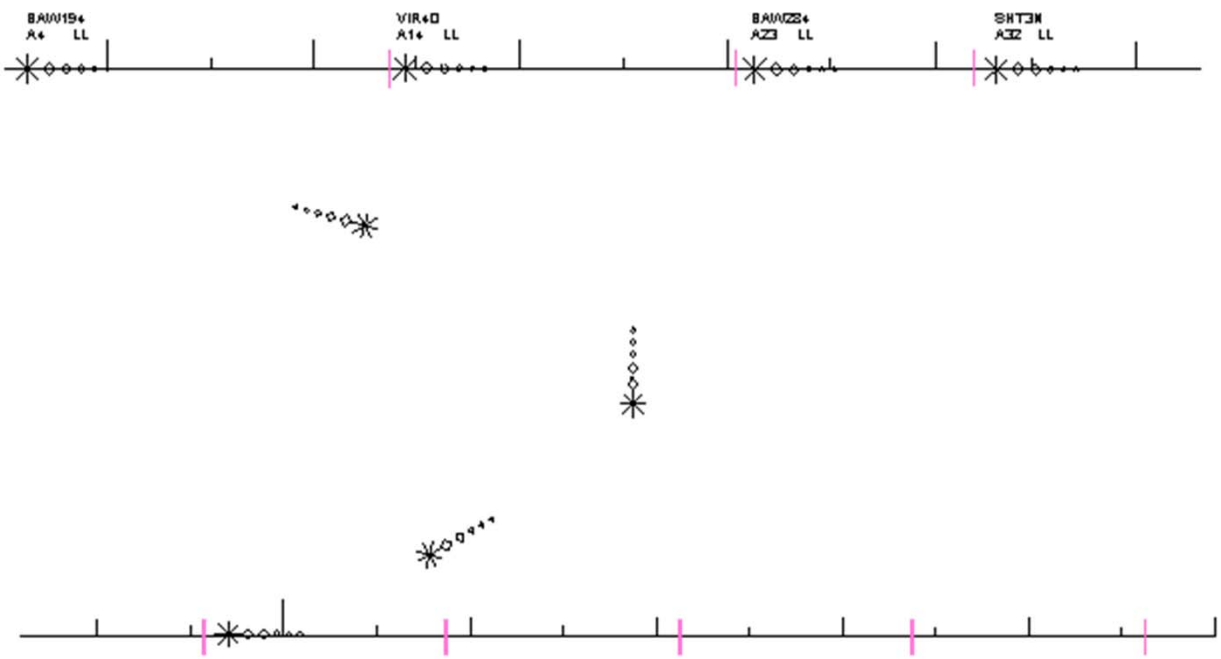
TBS: Controller Support Tools

Extended Runway Centre-Line Distance Markings

Separation Indicators to Support Turn Decisions on to Final Approach

Requires updated AMAN sequence



Additional applications: Support for implementation of variable separation targets for additional purposes (06.08.04 AMAN/DMAN integration)

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HP Arguments for TBS (1/2)

Role of the human is consistent with human capabilities/limitations

Need for pilots to be briefed on TBS, TWR/APP role allocation (in particular supervisory roles), reversion to Distance Based Separation (DBS) if situation becomes abnormal, need for ATCOs to increase speed monitoring,

Technical systems support to human actors

HMI to clearly differentiate between TBS and DBS (avoid mode error), need to look at TCAS/TBS interaction, time when TBS indicator should be removed (extend from threshold to touchdown?), SA and workload levels are maintained, separation for wake-pairs is more accurate, how clutter on screen may be reduced (selectively eliminate mile marker?), adequate level of trust, possibility to incorporate compression factor into future evolutions of the TBS tool.

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HP Arguments for TBS (2/2)

Effect on team structures and communication

RT usage remains the same, phraseology needs to be adapted to support TBS

HP-related transition factors

Need for ATCOS to maintain DBS skills, training needs, transition: first implement DBS with indicators and then gradually reduce distance between indicators to TBS minima

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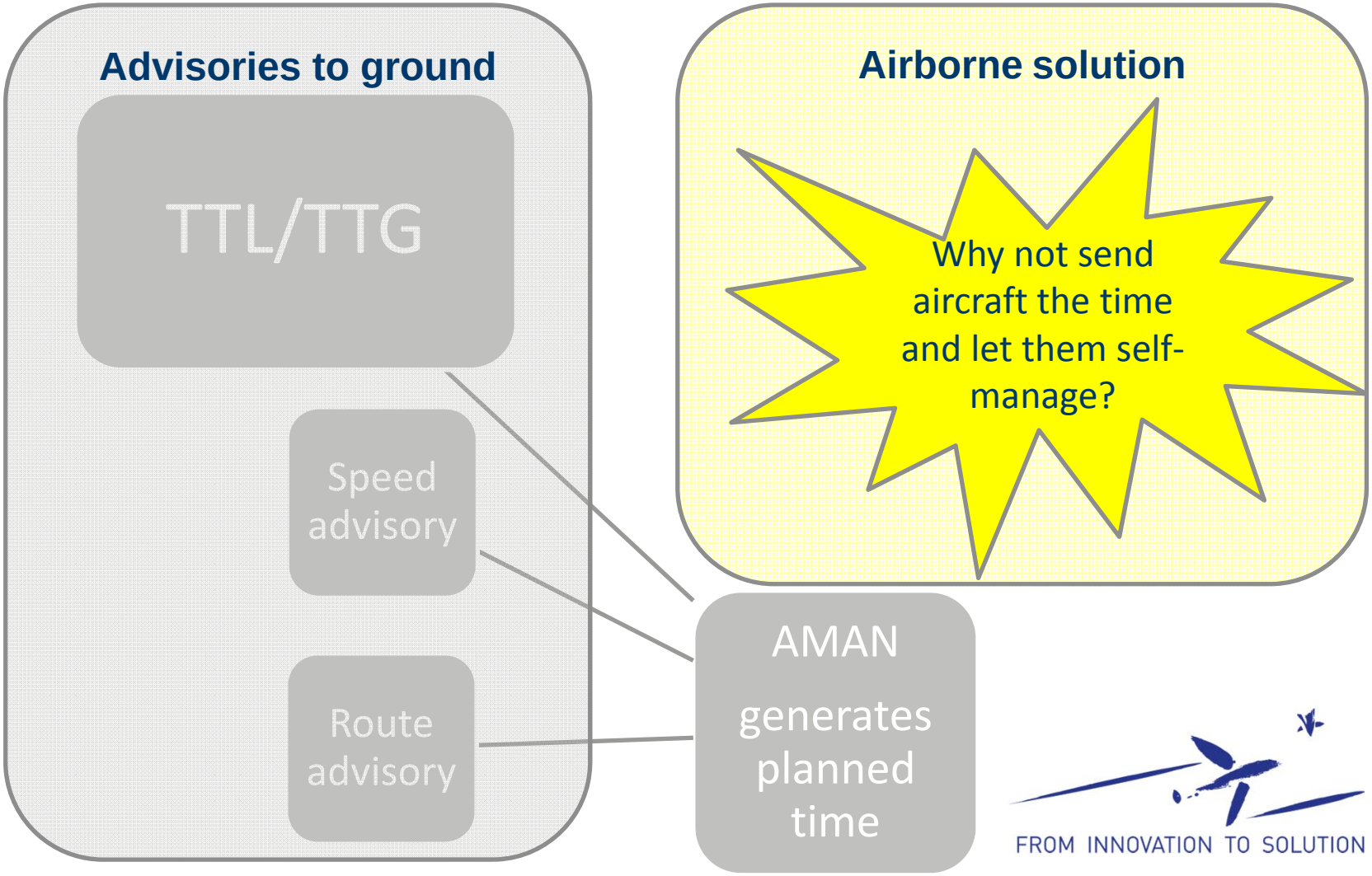
i4D and Controlled Time of Arrival (CTA)



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i4D + CTA (Simple Scenario)

14:30

ADS-C
Estimate +
RTA min/max

CPDLC
CTA constraint

I estimate the metering point at 15:04, but I could adjust my flight to be there between 15:00 and 15:06

Reach CTA fix at 15:06

ATCO

Desirable equipage:
- RTA (+-10 sec 95% confidence)
- ADS-C
- CPDLC

15:06

METERING POINT

LOCATED 30 NM BEFORE RWY THRESHOLD

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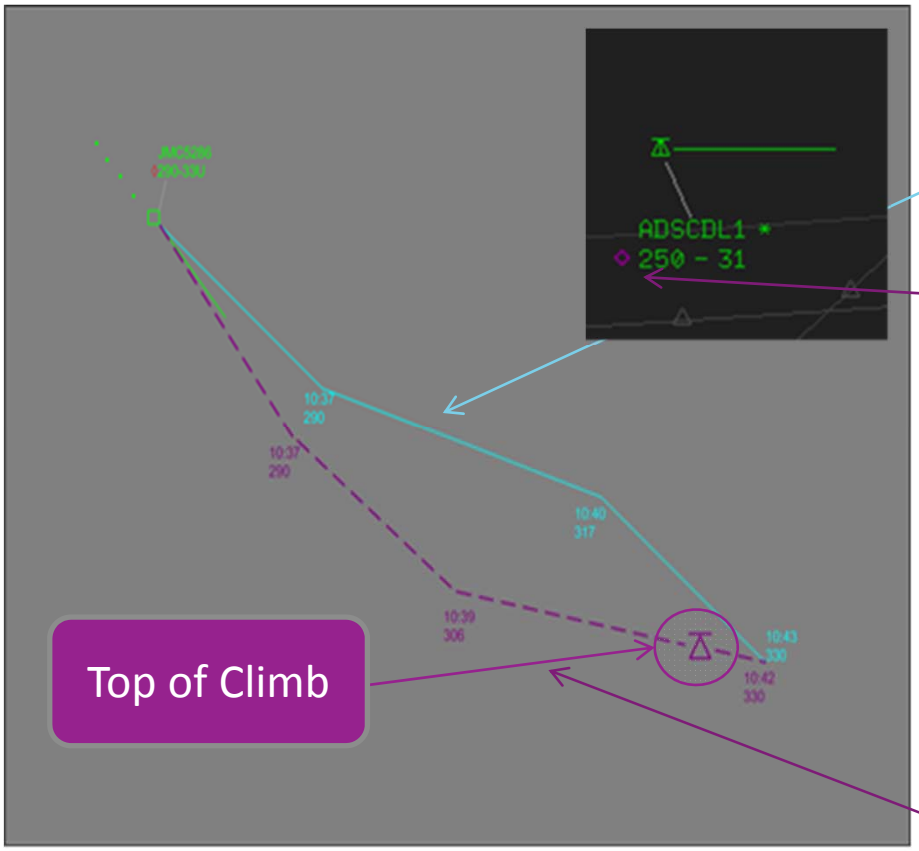
i4D: Operational Use of EPP



Source: 04.03 D64 draft (MUAC RTS)

Ground Trajectory Prediction (TP)

Route discrepancy indicator (2D)

EPP downlink (FMS trajectory)

- Estimates according to FMS horizontal speed schedule
- Altitudes / flight levels according to FMS vertical speed schedule

Lateral discrepancy to be resolved by ATCO:

- Uplink (CPDLC) ground route (only dct possible in VP-463, more to come…) or more likely…
- Update ground trajectory to match EPP

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HP Arguments for i4D + CTA (in progress) 1/2

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HP Arguments for i4D + CTA (in progress) 2/2

Effect on team structures and communication

RT vs. CPDLC usage, air crew task allocation for new tasks (between PF and PNF), ATCO task allocation (planning controller/executive controller),

HP-related transition factors

Training needs, mixed equipage

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i4D + CTA HP LOG (in progress)

	A	B	C	D	E	F	G	H	I	J
11	Arg. 1.2.5: Operating methods can be followed in an accurate, efficient and timely manner.	Not satisfied			Open	Air/Ground				Evaluate adequacy of recovery procedure in case of CPDLC failure while ADS-C remains operational.
12	Arg. 3.3.3: Changes in communication means & modalities are identified and acceptable.	Not satisfied		I4D operations require a lot of Controllers-Pilots communications - for RTA and route negociation). The use of DataLink as communication mode would contribute to maintain workload at an acceptable level and to ensure a good level of communications reliability, making i4D operations acceptable.	Open	Airborne	High		Safety	Assess the impact of the CPDLC communication mode (including load function) on communication workload
13	Arg. 3.3.3: Changes in communication means & modalities are identified and acceptable.	Not satisfied		The use of ADS-C as means of synchronisation of air and ground trajectory predictions would contribute to reduce the number of radio communications and therefore to maintain workload at an acceptable level.	Open	Airborne	High		Safety	Assess the impact of route synchronisation via ADS-C on workload.
14 15	Arg. 3.3.3: Changes in communication means & modalities are identified and acceptable.	Not satisfied	16	Voice is the primary communication medium between pilots and ATCOs, and CPDLC is used for non time critical communications and 4D negotiation. The conditions of voice reversion could be difficult to understand (after RTA refusals, or RTA missed). The crew and ATCO may use inappropriate communication means: - if they use CPDLC instead of voice, thus the information may arrive too late and/or the workload may increase - on the contrary, if they use voice instead of CPDLC, it may block the frequency and affect more critical voice exchanges.	Open	Air/Ground	Low			Evaluate adequacy of the procedure relative to the reversion to voice during i4D operations

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Human Error Analysis in SESAR

- Errors are classified according to error type:
  - Detection error
  - Interpretation error
  - Planning error
  - Execution error
- HEA is performed <u>qualitatively</u>
- Use of quantitative error analysis has been discussed, but not adopted
- NexGen uses qualitative error analysis, but probability of error is used in some cases

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Conclusions

- A good HP assessment process is needed to prevent that tools are deployed and end up not being used
- There is a need to balance the need for strategic control (where automated tools thrive) with the need to retain flexibility in the system (to account for uncertainty)
- Transition factors are key to ensure success

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Thanks for your attention

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