



ERASMUS



ERASMUS *Operational Concept*

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Plan

- Operational Content
- Modus Operandi
 - 4D Business Trajectory
 - Aircraft and Pilot
 - Controller Working Position and Controller

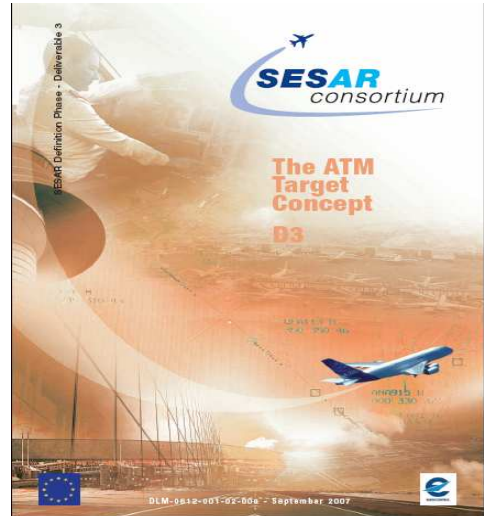
ERASMUS Scope

4D Trajectory Management

Airport

TMA

En-route



Density mngt

Strategic de-conflicting mngt

Separation mngt

Improving strategic de-conflicting to Increase the sector productivity

Improving strategic de-conflicting

Aiming at in-flight adjustment of the 4D Business Trajectory to reduce:

- The number of conflicts, i.e. to generate conflict free segment feasible on short route segment (15 min)

Improving separation management to increase sector capacity:

Conflict-free segment increase

- Reduce the need for tactical interventions

High-precision 4D Business Trajectory

- Guarantee of information to increase the decision aids performance



To address these issues, ERASMUS will investigate a new separation mode :
TC-SA (Trajectory Control by minor Speed Adjustment)

An Innovative Solution : TC-SA

Trajectory Control by minor Speed Adjustment (TC-SA)

In order to generate *conflict-free segment* (15 min) ERASMUS proposed real-time 4D Business Trajectory adjustment based on minor speed adjustment

- [-5%, +2%] minor speed change of each conflictive a/c would increase their separation distance at the crossing point by 7 Nm
- Air/Ground closed-loop trajectory control
 - Pilots are informed. Agreement by the pilot
 - Controllers are not informed : Autonomous computer actions from the controller point of view.
Subliminal : Not perceived by controllers (There is a fuzziness of the vision of the controller depending of airspeed, wind, climbing & descending rate, mental extrapolation of 3D position) : Transforming the fuzziness into a welcome opportunity to not disturb their cognitive activity
- **Key Enabler : high-precision 4D Trajectory Prediction**



Key Enabler : high-precision 4D Trajectory Prediction

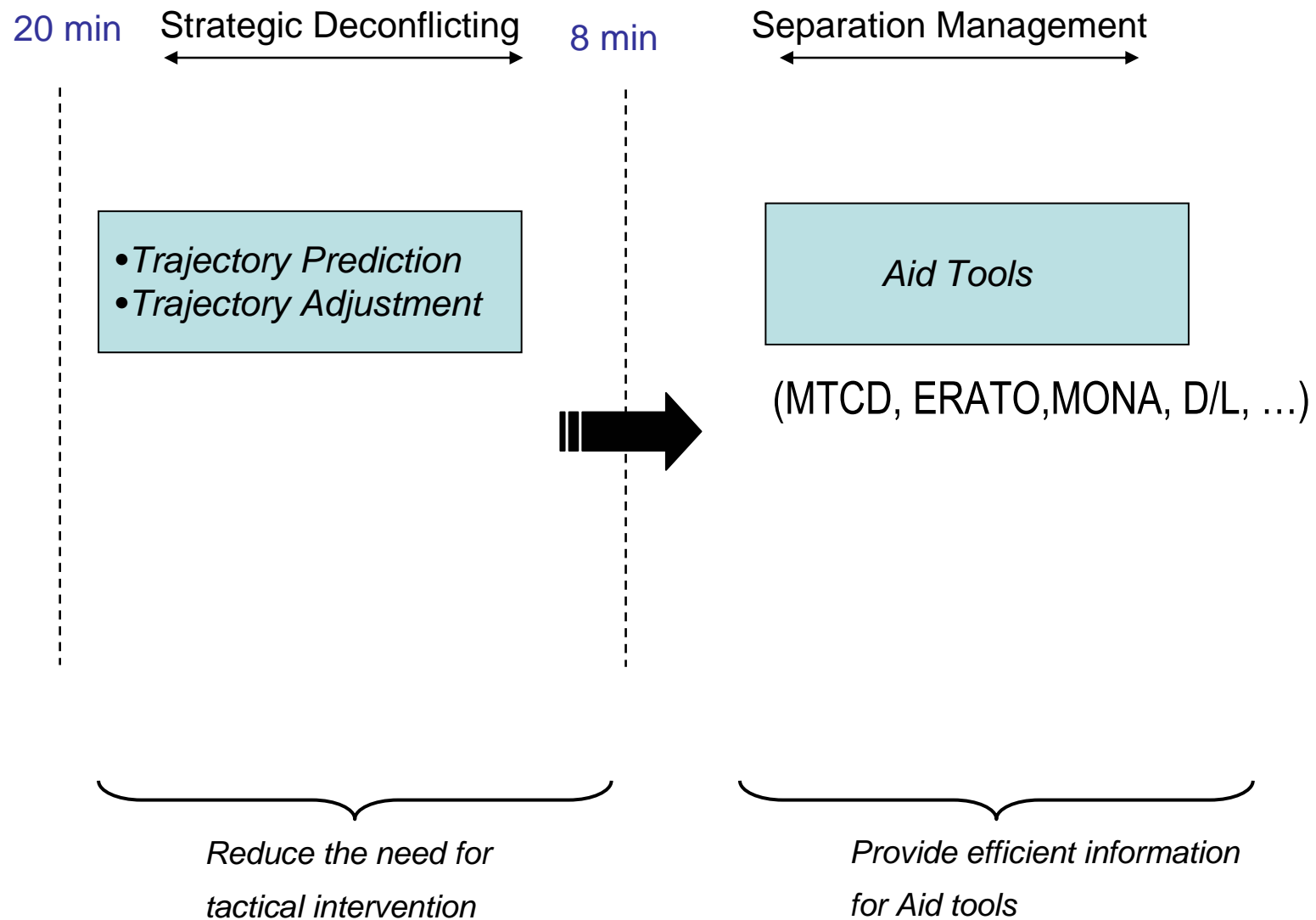
Improved Performance of Controller aid tools

A progressive improvement in the accuracy of trajectory prediction through reduced uncertainty will lead to improved performance of controller support tools

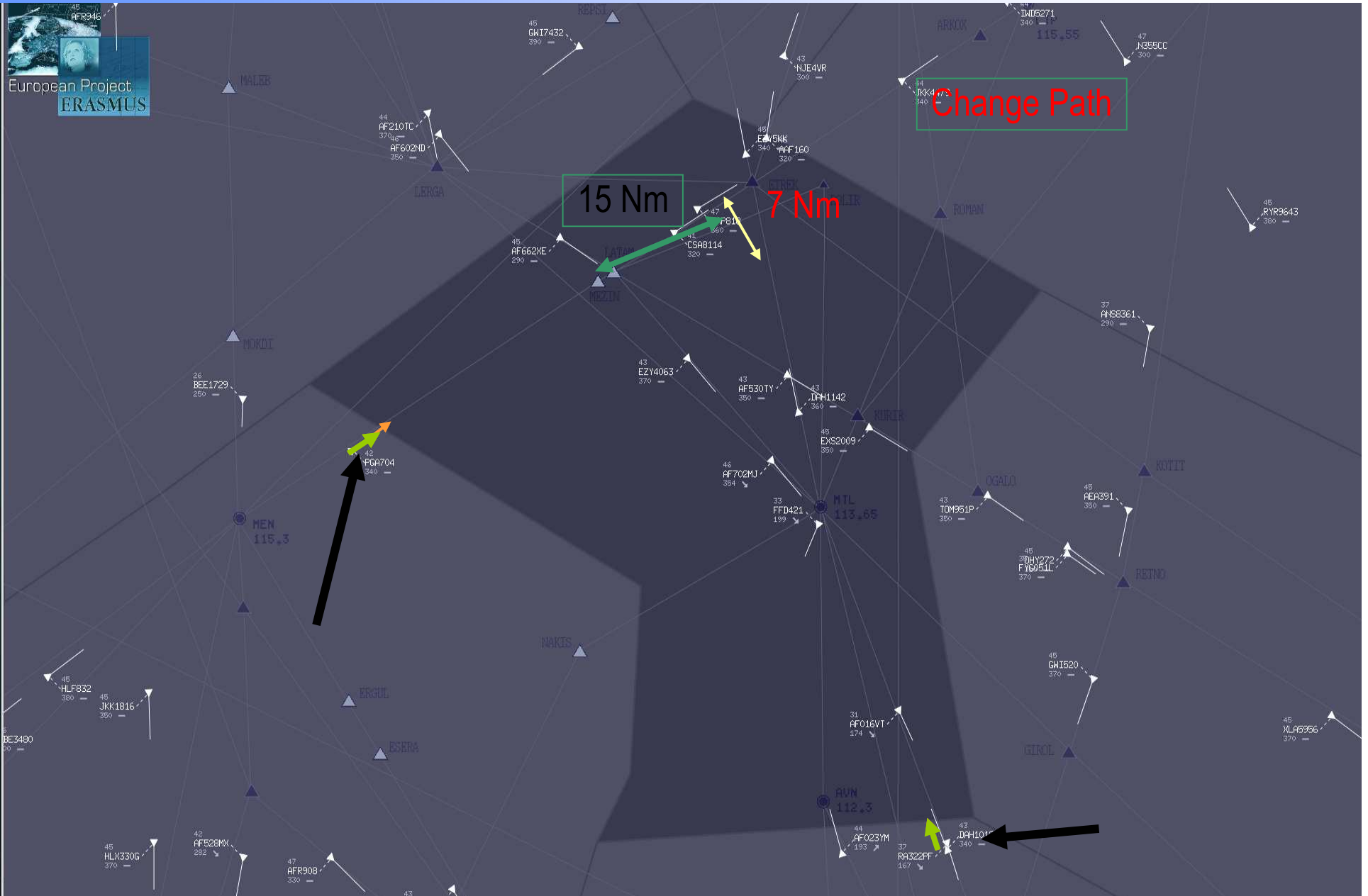
- Guaranteed conflict proposed to the controllers' aid tools
 - Controller focus on real conflict and not on perceived/subjective conflicts
 - To save controller mental resource and to manage more aircrafts



Strategic de-conflicting fundation

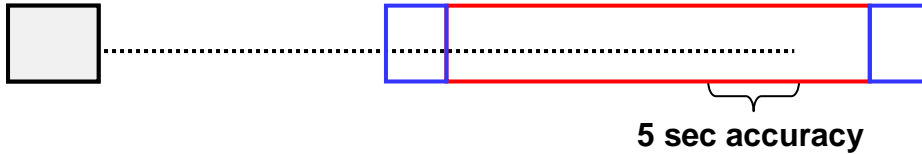


Conflict-free segment without ERASMUS



Strategic de-conflicting process

Future 4D position in 15 min ?



High-precision
Trajectory Prediction

CTA/CTD
Minor s
Longitu

Constraints can be lifted
Atco
Pilot

the RBT Tolerance

Ground Processing to determine
Conflict-free segment for the next 15 min



Inside the shape of the
controller perception



Modus Operandi Impacts

- Business Trajectory Management
- Aircraft & Pilot
- Controller Working Position & Controller

Business Trajectory Management Impact

- Strategic de-conflicting generate minor trajectory modification (± 1 minute) that should impact the RBT tolerance window ($> \pm 2$ minutes ?)
- Real-time Business Trajectory adjustment policy, processing and performance shall be transparent to Users
- Equiped aircrafts eligible for trajectory adjustment shall have clear identified benefits

Aircraft & Pilot Modus Operandi Impact



Aircraft & Pilot Modus Operandi Impact



FMS will receive CTO/CTA constraint

Pilot can accept or reject

Pilot Role and responsibility are unchanged !

CROSS [position] at [time]
CROSS [position] at or before [time]
CROSS [position] at or after [time]

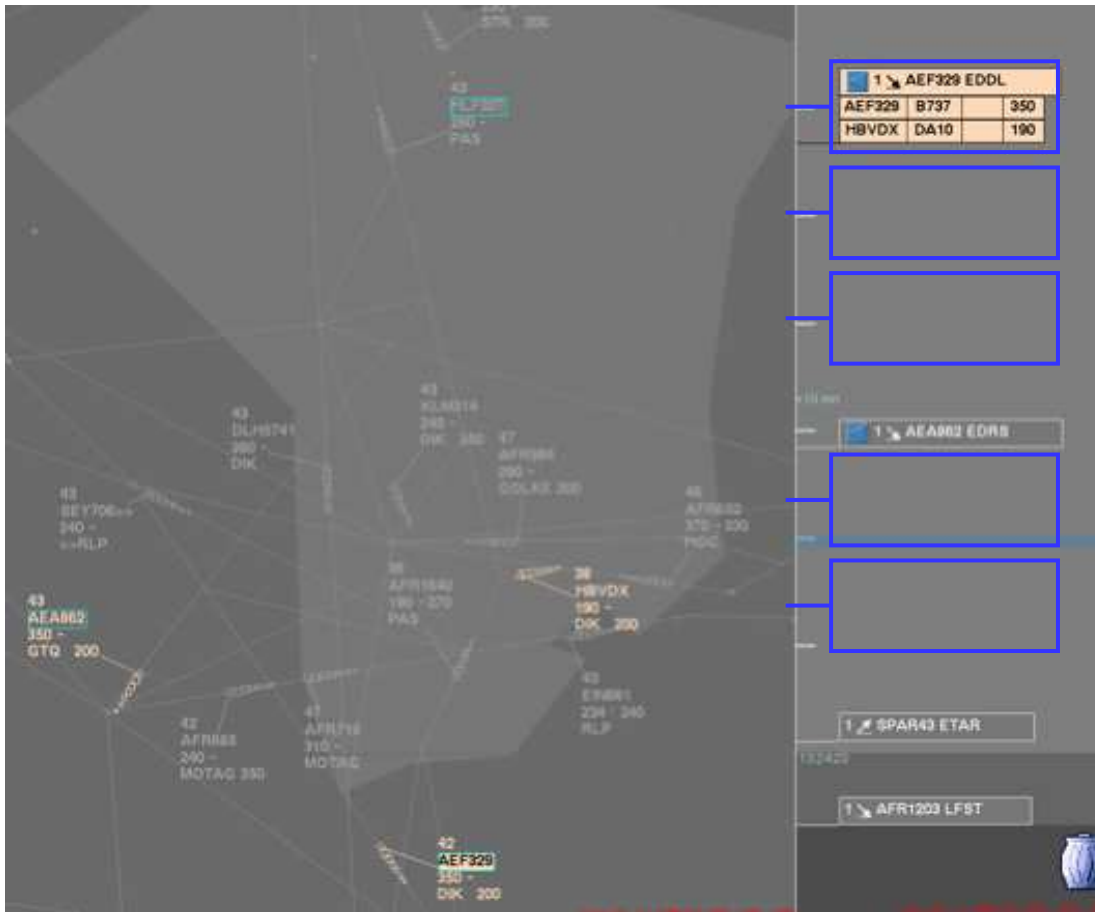
⇒ *Accepted*

⇒ *Rejected*

CWP & Controller Modus Operandi Impact



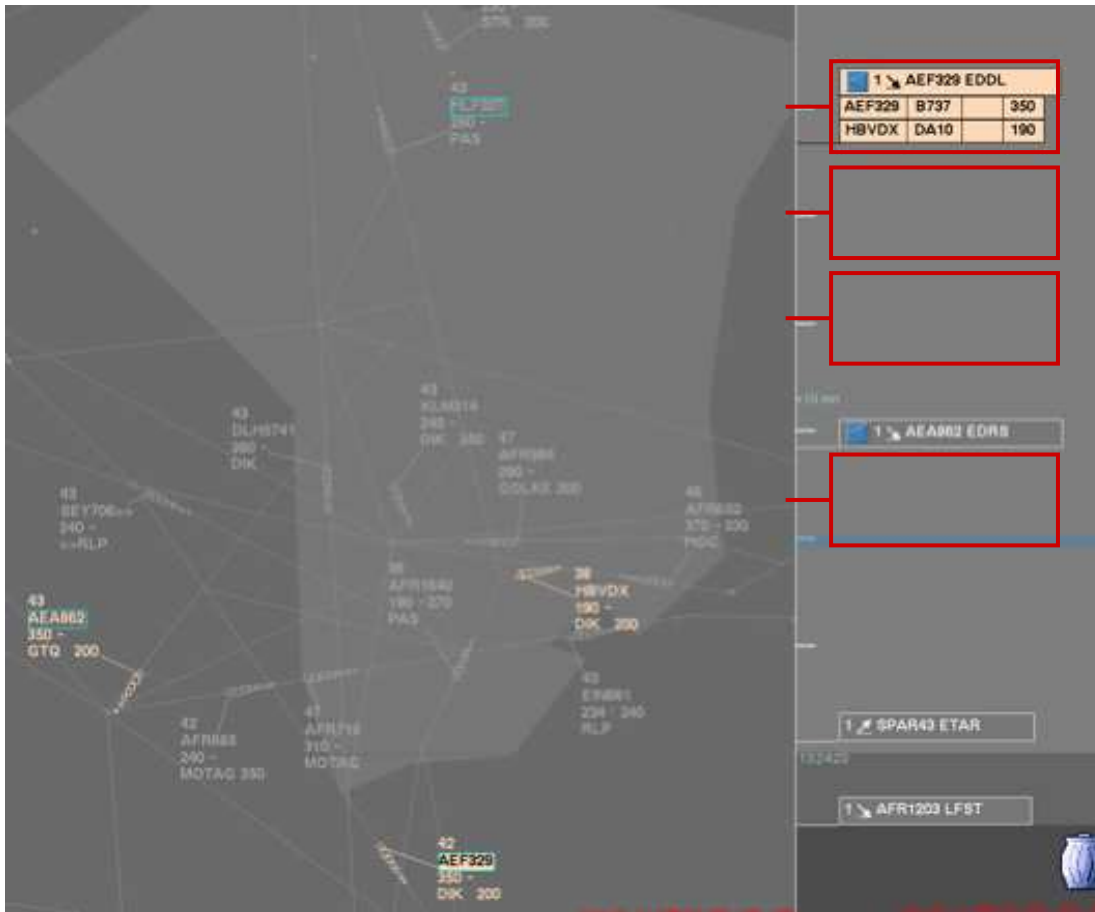
CWP & Controller Modus Operandi Impact (baseline)



MTCD with low-precision trajectory prediction

- . « Unconfident » Conflicts detected
- . Remaining additional conflicts perceived by the controller

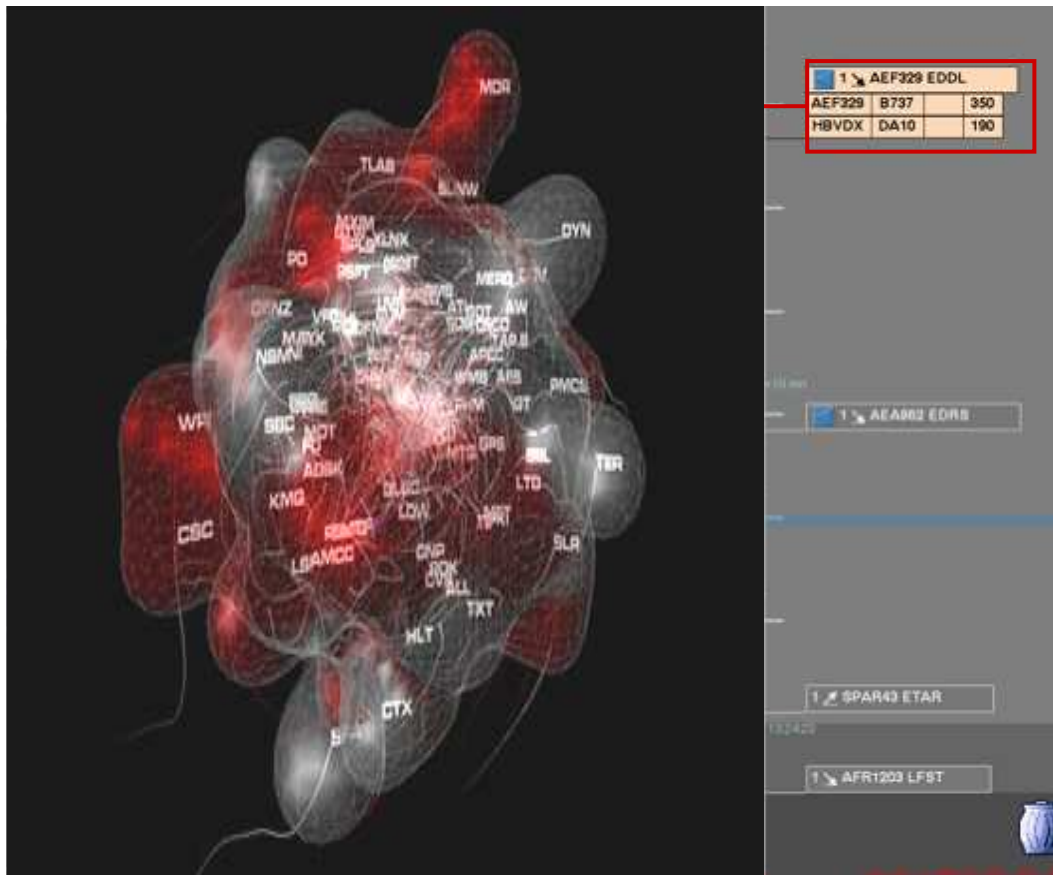
CWP & Controller Modus Operandi Impact (2020)



MTCD with high-precision trajectory prediction

- « **Guaranteed** » Conflicts detected
- **Controller focus on real conflicts and not on perceived conflicts**
- **It will save mental resources**
- **But Transfer of responsibility/Liability issue**

CWP & Controller Modus Operandi Impact (2020)



More aircraft (i.e. 30 aircraft)

➤ *New Controller role*

⇒ *'Separator'*

⇒ *RBT monitoring*

➤ *Automation failure strategy*

Impacts Synthesis

What is the consequence of a more automated system

System Design

- Precise and share 4D trajectory information
- Information concerning the aircraft separation distance guaranteed
- Certified system

System Management

- Increasing predictability
- Increasing performance

Pilot

- Minor impact for the pilot

Controller

- Big impact on controller role and responsibility
 - Responsibility transfer and liability issue
- Preserve the controller cognitive activity
 - Trajectory adjustment by minor speed adjustment will allow the autonomous system not interfering/disturbing the mental activity
 - Full mental picture will be supported by aid tools