

Trajectory Based Operations (TBO) The principles

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What is TBO?

BEFORE TBO

- In-flight changes were only **between flight crew and ATC via voice**
- Only **the portion of the trajectory visible to ATC (immediately ahead)** can be effectively revised
- The ground has **no visibility of the FMS trajectory**
- Clearances are delivered via voice -> **only simple clearances are possible**

→ **Fragmentation of the trajectory**

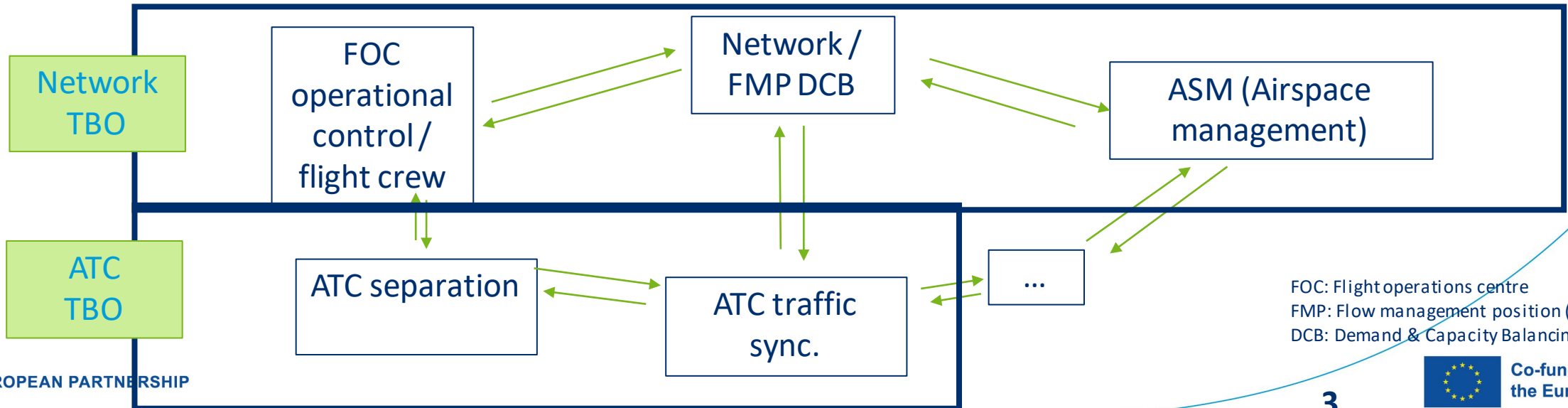
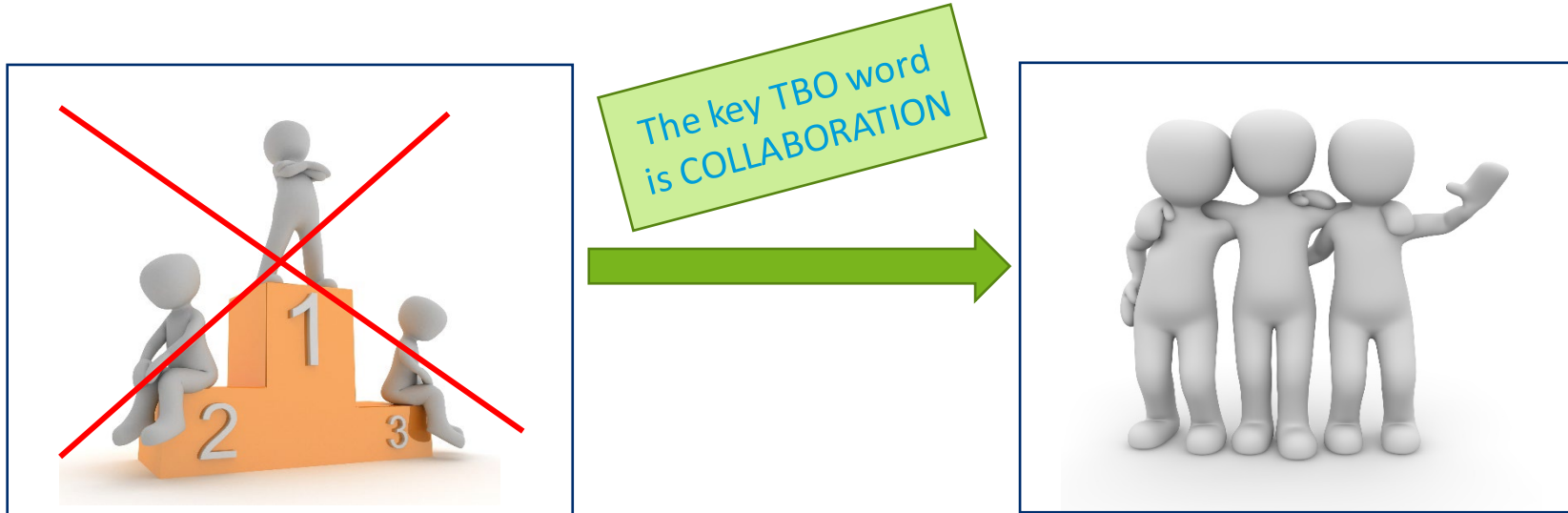


WITH TBO

- The trajectory in the flight plan can be **revised at any time** during the flight
- Strategic changes (longer look ahead time) are coordinated **between NM and FOC, ATC is not involved**
- Tactical changes (separation management, traffic synchronisation) are still possible and managed by ATC
- **Clearances** for all trajectory revisions (tactical or strategic) are delivered via **CPDLC** and correct implementation is **checked with EPP**

→ **A/G are always synchronised**

Network TBO & ATC TBO



What TBO is NOT...

The “Intervention by exception” misunderstanding:

- TBO is NOT a 4D contract between ANSP and AU
Note that concept for use of multiple time constraints along the route was removed from ATM MP
- Flights DO NOT need to adhere to this contract by going from time constraint to time constraint every few miles
- ATC intervention WILL NOT BE the exception

In fact, TBO will not eliminate the need for routine ATC intervention.

- Separation provision/conflict management
- Traffic synchronisation

SESAR ATC TBO R&D aim is NOT to eliminate/reduce the need for ATC intervention, but to **INCREASE THE EFFICIENCY OF ATC** thanks to ↑ automation support

Why not?

- **To ensure separation and traffic sync. without ATC, large separation buffers would need to be added → huge reduction of capacity**
- Time constraints/time adherence has limitations:
If used for separation ↑↑ fuel burn/CO2 emissions
It can support traffic sync., but needs to be complemented by other sequencing techniques

Take off time uncertainty +/- XX (assuming perfect adherence to the second after take-off)	YY margin to be added	New minima (5NM + 2*YY) (assuming 420-480KT)
[-5 min, + 10 min] current off-block tolerance for regulated flights in Europe	105- 120 NM	215 – 245 NM
+/- 30 seconds	7-8 NM	19 - 21 NM
+/- 10 seconds	2.3 – 2.7 NM ≈ 3 NM	11NM

Illustration of separation buffers required to avoid the need for in-flight separation provision

What comes next: TBO R&D in SESAR

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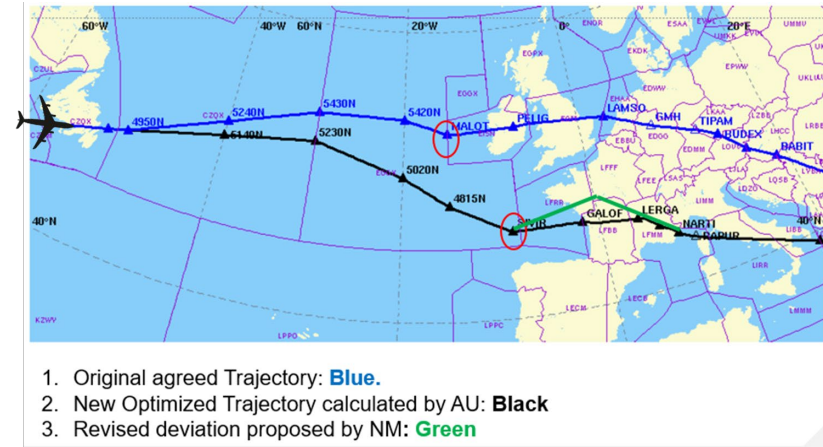
Builds on new flight plan format (eFPL) and processes (FF-ICE)

Extension to allow AU the **revision of the flight plan during the execution** of the flight (currently only ATC can initiate the revision)

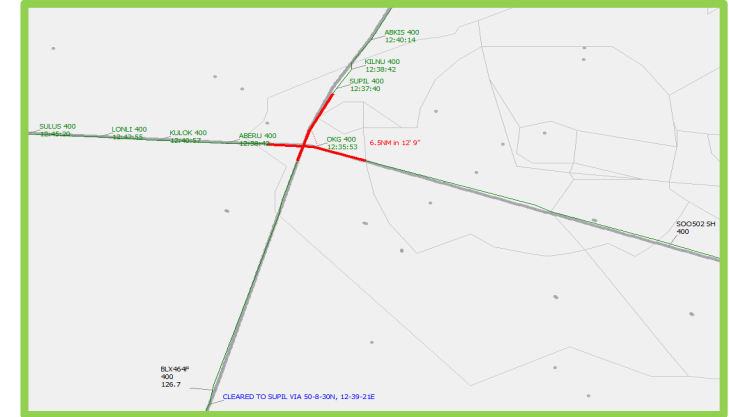
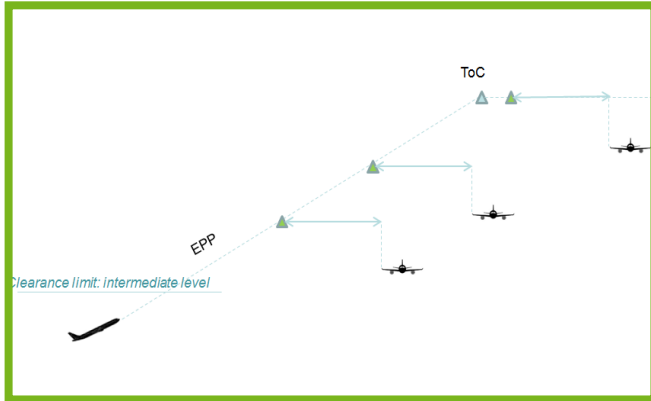
Collaborative decision making -> flight optimisation

Information sharing across the network

Increased network predictability -> better use of ATC capacity



R&D ATC TBO: advanced ATS B2 A/G sync



Enhanced vertical clearances

- EPP provides ground with desired vertical profile
- Ground uses this intelligence to compose vertical clearance avoiding intermediate level-offs
- ATN B2 clearance via CPDLC to be auto-loaded to the FMS
- Expected to **dramatically improve efficiency of vertical profiles**

EPP



Integration with CPDLC & loaded onto FMS

NEW



Uplink 2D trajectory revision

- Substitutes vector + resume own navigation
- Message composed by the ground system
- New 2D route loaded to the FMS

Thank you

