Performance Improvements in TMA and En-Route

Eric Hoffman
Head of Advanced Traffic Services, EUROCONTROL
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Improved Parallel Operations
Motivations & Principles

- Reinforce safety at/around intercept
- Increase the arrival capacity to cope with higher peaks
- Reduce environmental impact, improve fuel efficiency
- Ensure adherence to PBN procedure even during traffic peaks

*PBN routes with embedded path stretching/shortening (TMA Capacity)*

*Connecting to*...

*PBN transitions to final (safety, environment, fuel efficiency)*

IAF1  IAF2  IAF3  IAF4
Tracks: Baseline (peak)

- Trajectory dispersion & low altitudes
Tracks: Future (peak)

- Iterative series of ground RTS (50+ runs), pilot workshops
- Full adherence to PBN procedure, remain on lateral navigation
- Trajectory containment & higher profiles/altitudes
Safety benefits: sensitivity analysis

• Mathematical modelling (presented at ATM seminar 2019)
• Monte Carlo approach with millions of runs to capture rare events
• Confirmed potential for significant safety benefits: risk of loss of separation down 20% (peak) and 8% (off-peak) compared to vectoring
• High sensitivity to design/geometry of final part

![Graph showing runway spacing and improvement in PBN vs. vectoring](image_url)
Study outcome

- **Operability**: feasible and usable in a typical dense and complex environment

- **Systematisation**: limited radar vectoring and systematic use of direct-to instructions

  leading to:

- **Safety**: effective segregation of arrival flows with regular traffic patterns

- **Environment**: slightly higher vertical profiles and limited dispersion at low altitude
TMA Performance Metrics
Arrival operations: new method to assess potential for short term improvements

• Objectives
  • Characterise arrival operations, focus on the terminal area
  • Identify best practices and possible inefficiencies
  • Assess the potential for short term improvements

• New method
  • Reference trajectories relying on best practices of each airport
  • New metrics at different time horizons informing on the dynamic of the operations

• Perspectives
  • Trajectory deviation (longitudinal, lateral, vertical)
  • Metering and sequencing (sequence pressure and spacing deviation)
  • Separation (proximity and dynamicity)
Example: vertical efficiency in descent

- Assessment of vertical efficiency in descent using best profiles of each airport (flow, runway, ..) as reference

- Case study: top 4, 50NM around airport, 6 months from 2018, +200k flights

- Next: identify causes of deviations and possible ways to reinforce adherence to best profiles

- Profiles generally **2300ft below** best profiles (median vertical deviation)

- Some profiles **4300ft below** best profiles for a same additional time (95th percentile)

- Differences among airports (low dispersion for EGLL below FL70, high for EHAM)
Leveraging Datalink in EnRoute
ATS Unit – SESAR studies

- Researching Trajectory Management using Datalink: triggered by some specific outcomes
  - EU mandates on datalink: significant increase of connections
  - Significant validation gaps on the usage of CPDLC

- Key concept
  - Provide planning information well in advance to the aircraft (flying in other upstream sector/centre), with clearance to execute

  - By anticipating changes, the new procedures will allow to move from tactical to planning horizon:
    - Act earlier – more efficient approach with a better adherence between air / ground predictions
    - Increased predictability - more certainty in flight deck situational awareness
      - changes in 2D route remaining in a close loop situation via CPDLC instructions
      - more useful trajectory data from the aircraft
  - Shared & synchronised air / ground views
    - Detect & correct discrepancies

- Is not a today datalink evaluation
  - Not a re-run or re-assessment of CPDLC Benefits / Use Case . . .
  - Not a replacement of a voice based procedure with a CPDLC one
Route modification
In ‘today’s world’...
Route modification – solution
Concept but using today’s CPDLC datalink . . . . . .

Performance Improvements in TMA and En-Route
“Route modification … ”
Concept but using today’s CPDLC datalink

Intention is to give the aircraft trajectory change in advance, and by CPDLC, in order to:
• Enables aircrew to plan – effectively and in good time - their onward profile
  • Using FMS to build an accurate trajectory and execute it
  • Fly their ‘expected profile’

• Enables route messages (beyond DCT) to be delivered / suitably assessed by aircrew
  • Possibility to read/re-read

Benefits:
• Getting the ‘right’ information only in advance (STAR, RWY): increased predictability and certainty
• Supports pilots better arrange their flights - with potential fuel/time savings and environmental efficiencies
“When ready, descend . . . .”
In ‘today’s world’ . . .

Current Operating Method

- Limited use
- Normally given by voice (EXE only)
- Normally given not far from anticipated TOD, but TOD is not known
- Normally without reliance on system support conflict detection, limited check
“When ready, descend . . . .”
Concept validation

Give the aircraft descent clearance well in advance, and by CPDLC, in order to:

**Potentially Benefit Airspace User**

- Enables aircrew to plan – effectively and in good time - their descent profile
  - Using FMS to built trajectory per C.I. (with constraint information, if necessary)
  
- Enables aircrew to effectively plan/execute their descent briefing, related cockpit ops
  - As per their company / cockpit SOPs
  - Fly their ‘expected profile’ from ToD (at least to the exit of that ATC sector/unit)

- This type of concept could also be an enabler for other concepts, such as CDO
- Ability to descend without the need for the R / T to be unoccupied at the appropriate time
Early conflict resolution: typical (current) scenario

Situation
Conflict detected in sector between two inbounds.

Action
Planner asks previous sector to put one of the aircraft on a heading to solve conflict.

Issues
1. The actual separation achieved is dependent on when the manoeuvre is effected;
2. The actual path of the aircraft is subject to wind drift (if the wind changes) whilst on an assigned heading;
3. A further instruction is needed for the aircraft to resume its planned route;
4. Until this second instruction is given, the further route is unknown to the aircrew and the downstream controllers.
Early conflict resolution: Conflict Resolution Using Closed Clearance

**Action**
Planner asks previous sector to clear the aircraft to point “DEF” via point “ABC” via

**Impacts**
1. The separation achieved is much less dependent on when the manoeuvre is effected;
3. As the clearance constitutes a “closed loop”, no further clearance is required;
4. Both the aircrew and downstream sectors are aware of the complete route.

**Benefits**
- Reduced controller workload
- Increased ATC Capacity
- Fewer delays
Questions ?