Merging arrival flows without heading instructions

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Merging of arrival flows with open loop radar vectors

- Efficient and flexible

But…

- Highly demanding as it imposes rapid decisions for the controller and time-critical execution by the flight crew

Consequences

- Peaks of workload
- High frequency occupancy
- Lack of anticipation
- Difficulty to optimise vertical profiles and to contain the dispersion of trajectories
Merging of arrival flows with Precision Area Navigation

- Use of area navigation (RNAV, P-RNAV) to revisit the merging of arrival flows
- Definition of new route structures, e.g. “trombones”
- Merging achieved through route modification

But…
“... at high traffic loads, the controllers inevitably revert to radar vectoring in order to maximise capacity.”

EUROCONTROL TMA2010+ Business Case for an Arrival Manager with PRNAV in Terminal Airspace Operations (AMAN-P)

“The main disadvantage of RNAV procedures is that they reduce the flexibility that radar vectoring affords the controller and experience has shown that, without the help of a very advanced arrival manager, controllers tend to revert to radar vectoring during the peak periods”.

Examples

EDDF - 14/06/2007 (7:00-10:00)

EDDF - 14/06/2007 (17:00-20:00)

Source: stanlytrack.dfs.de/stanlytrack/stanlytrackEDDF.jnlp
Motivation

Key points
- Maintain flexibility to be able to expedite or delay aircraft
- Keep aircraft on Flight Management System trajectory
- Maximise runway throughput

When investigating airborne spacing (ASAS), a specific method and route structure was defined to expedite or delay aircraft in the terminal area

Can we now apply this method and the route structure without airborne spacing…?
- We created a merge point with legs at a constant distance for path shortening or stretching.

- Merging is achieved through “direct-to” instructions to the merge point.
A series of small-scale experiments to perform an initial assessment of feasibility, benefits and limits

Experimental conditions
- High traffic load (36 to 40 arrivals per hour with 20% heavy)
- Various wind conditions (no, moderate and strong)
- Various airspace configurations (two, three and four entry points)
- Various configurations of legs (same or opposite direction, parallel or non-parallel)
- Various geometries of legs (straight segments, segments approximating concentric arcs, with or without intermediate points)

Initial measurement of benefits with today’s method (open loop vectors) as baseline (2 x 3 runs)
Airspace (baseline)

Two frequencies: approach controller (APC) and final director (FIN)

- Holding SUDOK: FL100 / 140, 1 min / 220 kt
- Holding PONTY: FL080 / 140, 1 min / 220 kt
Airspace (point merge)

Two frequencies: approach controller (APC) and final director (FIN)

Holding SUDOK:
FL100 / 140
1 min / 220 kt

Holding PONTY:
FL080 / 140
1 min / 220 kt
Density of instructions

Baseline

Point merge
Geographical distribution of instructions

Final director

Baseline

Approach controller

Number of instructions

Distance to reference point (NM)
Number of instructions

Final director

Approach controller

Baseline Point merge Baseline Point merge

Level Direct Heading Speed

Number of instructions
Number of instructions per aircraft

- Number of instructions
- Heading
  - Direct
- Speed
- Level
- All

Baseline
- Point merge
Frequency occupancy

Final director
Approach controller

Baseline
Point merge
Spacing on final approach fix (NM)

Baseline

Point merge

Max
Max for 95%
Mean+STD
Mean
Mean-STD
Min for 95%
Min
Similar distance and time flown: 70 NM during 18 minutes on average
Descent profiles
Configurations tested (1/2)

- Straight sequencing legs
- Segmented sequencing legs
- 3 flows, with 2 sequencing legs of same direction
- Dissociated sequencing legs

- Merge point
- Common point
Configurations tested (2/2)
Summary

- Method found **comfortable, safe and accurate, even under high traffic load**, although less flexible than open loop vectors.
- Predictability and anticipation increased, workload and communications reduced.
- Open loop radar vectors no longer used and aircraft remained on lateral navigation mode.
- Final approach spacing as accurate as today.
- Descent profiles improved (potential for continuous descent from FL100).
- Flow of traffic more orderly with a contained and predefined dispersion of trajectories.
- All these elements should contribute to improve safety.
- No specific airborne functions or ground tools are required initially, except P-RNAV capabilities.
Conclusion

The “point merge” method

- Maintains flexibility to be able to expedite or delay aircraft
- Keeps aircraft on Flight Management System trajectory
- Maximises runway throughput
The “point merge” method is

- A transition towards extensive use of P-RNAV
- A sound foundation to support further developments such as continuous descent (CDA) and target time of arrival (4D)
- A step to the implementation of airborne spacing (ASAS)