Towards Systematic Air Traffic Management in a Regular Lattice

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Outline

- SuperHighway project
- Regular lattice basic design
- Lattice operation
- Initial simulation results
- Vertical movements
- Sectorisation
- Simulation results
- Conclusion
Super Highway Project

European Commission 6\textsuperscript{th} Framework Program

Started April 2006, Duration 2 years

Assessment of two scenarios
Questions ...

Where should the Super Highways be?
How many will there be?
Where will they be in relation to one another?
How will they cross? How will they connect?
What will be the place of Super Highways in a Single European Sky?
What principles would allow systematic airspace design?
Enablers

Technical – **area navigation**

The existing route network has grown over time based on navigation from beacon to beacon.

Area navigation allows aircraft to navigate along arbitrary routes, and opens the door to clean-sheet redesign of the route network.

Political – **Single European Sky**
Starting point – safety – crossing conflicts

July 1st, 2002

European Organisation for the Safety of Air Navigation
Layers of parallel tracks could eliminate crossing conflicts between cruising aircraft.

4 layers, 4 pairs (8) of allowed directions of flight.
Navigating with fixed directions

Right turn + climb 1000 ft

Left turn + descent 1000 ft
Idea 2:

Regular lattice

Airspace structure and operation same throughout region
Horizontal inefficiency 1.02
Horizontal inefficiency 1.06
Define a volume of interest – similar to core area
~ 500 nm x 500 nm, beginning at FL300

Subset SESAR 2005 traffic (entering the volume of interest)

Aircraft have nominal mass

Vary routing and cruise level allocation scheme within volume of interest

Measure number of conflicts and total fuel consumption
Conflicts

No crossing conflicts between cruising aircraft

Lattice 70 nm, 5% increase in total number of conflicts

55% same direction, climbing/descending through level
Suggests need to separate climbing/cruising/descending

Need to perform flow management (ground holding) for lattice rather than use departure times for current routes and sectors
Joining the lattice - vertical movements

Max. vertical movement

- Joining the Lattice: 1000-4000 feet
- Move. between layers: 4000 feet

Aircraft performance assumptions:
- speed ~8 nm/min.
- climb/descent 1000 feet/min.
Vertical movements on diagonal tracks

~50 nm

Green and brown tracks

Alternative climb and descent

70 nm
Vertical movements on horizontal/vertical tracks

Red and blue tracks
Stepped climb and descent
Vertical movements in the lattice
Sectorisation of the lattice

A first level
Sectorisation of the lattice

A second level
Fast-time simulation

Define a volume of interest – similar to core area
~ 500 nm x 500 nm, beginning at FL300

Subset SESAR 2005 and 2020 traffic (entering the volume of interest)

Aircraft have nominal mass

Vary Lattice spacing within volume of interest

Measure number of conflicts and fuel consumption (in volume of interest)
No crossing conflicts between cruising aircraft
26% reduction of conflicts estimated with separated climbing/descending lanes
Linear dependency between SESAR 2005 and 2020 traffic
Lattice 70nm $\Rightarrow$ space for vertical movements and reserved areas
Extra fuel consumed in area of interest compared to a direct routes baseline.
Potential advantages

- Regular structure allows replication of airspace design solutions throughout a region
- Common operating procedures throughout a region
- Elimination of crossing conflicts between cruising aircraft.
- Two easily identifiable populations – “stable” (low monitoring), “transition” (higher monitoring)
- Multiple routes facilitate traffic distribution and rerouting around reserved areas
- Easy to extends the lattice area if required
- Towards “Single European Sky”
Further investigation

- Improve model of aircraft mass
- Investigate use of joining/leaving lanes to separate climbing/descending/cruising aircraft
- Apply suitable flow management algorithm
- Operational feasibility
- Rerouting around reserved areas
- Workload and capacity
Comments / questions / suggestions?