THE POTENTIAL OF LATERAL OFFSET FOR THE MULTI SECTOR PLANNER

Rüdiger Ehrmanntraut,
EUROCONTROL Experimental Centre (EEC), Brétigny sur Orge, France

Abstract

Lateral offset is a procedure in air traffic control that sets aircraft on a parallel track along the flight plan. Despite the fact that a high percentage of the flying aircraft fleet is equipped to fly the offset automatically, it is not used in operations. Therefore it would be useful to model the potential of lateral offset and to simulate it as a single manoeuvre to get a better understanding of its performance. This study uses a simulation model covering the densest parts of European en route airspace with traffic levels forecast up to the year 2025. Different parameters of the offset manoeuvre are evaluated like the moment of start of implementation, the offset angle, the offset distance, and the duration of the manoeuvre until its return to the initial flight plan. The main performance metric that is applied is the capability to resolve conflicts and conflict clusters. The discussion targets the use of lateral offset in the Multi Sector Planner concept.

I - Introduction

Lateral Offset (LO) is a procedure that sets aircraft on a parallel track along the flight plan [1]. The offset distance can be specified by the air traffic controller. Most aircraft of today’s flying fleet include a function in their onboard flight management system where the pilots can select the LO manoeuvre with the offset distance and the aircraft automatically implements the manoeuvre. This function is unused in today’s operations. However, air traffic controllers do set aircraft on offset using vectors to set the aircraft to the offset path and later vectors or direct routings to let them join back the flight plan. It should be noted that in many cases the aircraft should be set back on flight plan at centre handover to respect the letters of agreement between centres.

Recently research has started at MITRE CAASD. Herndon and DeArmon published two studies so far. The objective of their first study [2] was to investigate feasibility of LO and general acceptance of the LO procedure. Therefore field trials were conducted in Albuquerque and Houston Air Route Traffic Control Centers, USA. That allowed them to test LO for a single centre and also for two centres with the aircraft handed over during LO. In total 32 aircraft were set on LO and the result seems to be that controllers and pilots accept the procedure and their proposed phraseology. Their paper also gives a good introduction to the state of the art concerning LO, and the interested reader is directed to their document so that this study may add on without repeating.

The objective of their second study [3] is the evaluation and quantification of benefits. Flight trials in the Minneapolis ARTCC were conducted and 15 flights were recorded, but only some evaluated. The identified benefit is supposed to be the win when aircraft are enabled to overtake by LO. However, the small amount of test cases would not allow to state quantifiable benefits. The study reconfirms controller and pilot acceptance, and formulates the adopted phraseology.

II - Related Work

Even if not much research has been conducted so far on Lateral Offset, some other work can be related to the topic. In terms of navigation e.g. the Lateral Offset can be linked to closely spaced parallel...
routes and RNP\textsuperscript{2}, which are part of RNAV\textsuperscript{3} programmes. Basic RNAV e.g. allows spacing of 15 to 18 nautical miles between routes for aircraft capable of RNP5 \textsuperscript{4}. The routes can be spaced closer when RNP is improved, e.g. RNP4 could allow for 7 nautical miles spacing \textsuperscript{5}. Further improvements with RNP1 and RNP0.3 and more should allow for ever closer parallel routes where the major limiting factor is not the navigation performance of the aircraft, but rather the safety margins for the air traffic controllers.

Another link can be done to airspace design and the effort that is undertaken by the ICAO Separation and Airspace Safety Panel (SASP) to reduce horizontal separations to 5 and 3 nautical miles \textsuperscript{6}.

III - Simulation Model

Lateral Offset Resolution Model

For the simulations in this study, a model for lateral offset has been developed in the RAMS\textsuperscript{4} Plus simulator \textsuperscript{7} and resulted in its version 5.24. It simulates an operational procedure to offset with a controller specified turn angle/heading:

$$\begin{align*}
\text{AT (time)} & \text{ TURN RIGHT/LEFT (heading or number of degrees)} \\
\text{OFFSET (distance)} & \text{ REJOIN ROUTE ABEAM (location)}
\end{align*}$$

That corresponds to the following parameters:

1. The start time of the manoeuvre is a parameter that is set for the entire simulation setup. The resolution algorithm can either start its search at the position of detection of the conflict, or at the conflict start position. In the first case it will iterate in steps forwards from the detection towards the conflict, in the latter case backwards from the conflict start towards the detection point. The size of the steps can be configured. Let $\Delta T_{\rightarrow}$ and $\Delta T_{\leftarrow}$ be the resolution time window in forward or backward direction, $\partial T$ the iteration time steps in that solution window, the forward iteration start at conflict detection time $t_{CD}$ and the backward iteration start at conflict start time $t_{CS}$, as depicted in Figure 1.

![Figure 1: LO time parameters](image)

2. The offset angle $\alpha$ in degrees, $0 < \alpha \leq 45^\circ$, is set for the entire simulation setup. The resolution algorithm starts with a mean value and iterates in increasing steps until a minimal and maximal value. The mean, variation and step size ($\bar{\alpha}, \Delta \alpha, \alpha_\infty$) values can be configured.

3. The LO distance $d_{L\parallel}$ in nautical miles is a parameter that is set for the entire simulation setup. The resolution algorithm starts with a minimal value and iterates to a maximum value using steps. The minimum,

---

\textsuperscript{2} RNP – Required Navigation Performance  
\textsuperscript{3} RNAV - Area Navigation  
\textsuperscript{4} RAMS – Reorganised ATC Mathematical Simulator, www.ramsplus.com
maximum and step size values can be configured \(d_{\text{II-\text{min}}}, d_{\text{II-\text{max}}}, d_{\text{II-\Delta}}\).

4. The location of rejoin is set in the rule base. It can be set to rejoin at the end of the route, at sector exit, centre exit, or at top of descent \((Y_{\text{EoS}}, Y_{\text{EoC}}, Y_{\text{EoR}}, Y_{\text{TOD}})\). \(Y_{\text{TOD}}\) should be interpreted as "stay on LO until as late as possible".

If left and right offset directions are not programmed in the rule base, then the default algorithm behaves as follows:

\[
\text{FOR EACH } Y_{\text{EoS}}, Y_{\text{EoC}}, Y_{\text{EoR}}, Y_{\text{TOD}} \text{ (rule-base driven)}
\]

\[
\text{FOR flight1 AND flight2 (rule-base driven)}
\]

\[
\text{FOR } \Delta T_{\rightarrow}, \text{ OR } \Delta T_{\leftarrow}
\]

\[
\text{FOR EACH } d_{\text{II}}
\]

\[
\text{FOR EACH } \mu
\]

\[
\text{FOR EACH } \alpha
\]

\[
\text{TRY new trajectory}
\]

**Figure 2: LO parameters**

Figure 2 illustrates a conflict between two aircraft in a sector, where the adjacent sector is in the same centre. Then the four rejoin locations are 1. \(Y_{\text{EoS}}\), 2. \(Y_{\text{EoC}}\), 3. \(Y_{\text{EoR}}\), and 4. \(Y_{\text{TOD}}\).

**Figure 3: Simulator example trajectory**

Figure 3 depicts an example trajectory with its offset from one of the simulations. Further modifications of the RAMS simulator allow for different workload values for the controllers for the different rejoin locations in order to model eventual conflict co-ordinations or infringement of letters of agreement. However, workload evaluations have not been part of this study. Furthermore, the return angle \(\beta\) has not been modeled and the same parameter as the offset angle is used \((\beta = \alpha)\), whereas in reality the return would be arbitrary applying a resume-own-navigation or direct-to manoeuvre. This is proposed here as an enhancement to the specifications from Herndon [2].

**IV - Simulation Setup**

All simulations in this study use lateral offset as the sole conflict resolution, no other resolution manoeuvres like vertical offset, speed, horizontal vectors or directs are considered. The objective is to evaluate the potential of lateral offset only and in isolation so that it can be compared to the other manoeuvres and with a special focus on the use for a long term strategic planning like for a multi sector planner.

The controller model imitates the behaviour of an executive Planning Controller (PC) and a traditional Tactical Controller (TC). In contrary to reality, however, the PC in the model does issue clearances and is therefore called an executive PC. The main difference between PC and TC is the look-ahead time when conflicts are detected, which was set to \(T_{\text{look-ahead}}(\text{PC}) = 15\) min, and \(T_{\text{look-ahead}}(\text{TC}) = 0\) min. i.e. the planner detects conflicts 15 minutes before the aircraft enters the sector, and the radar controller exactly at sector entry.

The simulated airspace is the same as the ones used for the speed resolution [8][9] studies and is not explained here. The only difference is the use of lateral offset instead of speed.

For the purposes of this study, most of the parameters that are evaluated are global to the simulation and use very restricted rule base programming. The rule system was minimised to only one step without taking care of the conflict geometry and classification, and without intelligent conflict co-ordination i.e. the choice of the aircraft which has to move. The simple logic only
selects one rejoin rule, i.e. rejoin on TOD, sector exit, or centre exit. The rejoin at the end of route was also applied; however, the function almost works similar to the TOD due to the fact that the simulation setup does not have a correct model of routes as would be expected equivalent to real flight plans.

In addition a combination of rejoin rules has been found to perform best by various incremental simulations.

V - Simulation Results

The high number of parameters that are to be evaluated leads to an explosion of combinations. The main scenario that was used simulates one day for approximately year 2010 traffic entering the three measured centres Karlsruhe, Maastricht and Reims, with more than 10,000 flights. One run takes about 1.5 days on a 2GHz Pentium, which reduces the number of possibly feasible simulations. Therefore an exhaustive treatment of all combinations of parameters is practically unfeasible. Instead some scenarios analyse the sensitivity to change of parameters.

Rejoin Rules

The first set of simulations evaluates the performance of the four rejoin rules and a combination that was found to be optimal. In this setup the offset angle was set to 30 degrees and the offset distance to start at 5NM and iterate in steps of 2NM until a maximal offset distance of 15NM. In addition the resolution search started at the detection of the conflict, which was set to 15 minutes before sector entry. The traffic sample for the year 2010 corresponds to 200% related to a 1997 baseline, which was already used in previous studies [8][10].

\[
\begin{align*}
\text{d}_{\text{min}} &= 5 \text{NM}, \\
\text{d}_{\text{max}} &= 15 \text{NM}, \\
\text{d}_{\text{a}} &= 2 \text{NM}, \\
\alpha &= 30^\circ, \\
\Delta \alpha &= 5^\circ, \\
\alpha_{\infty} &= 15^\circ, \\
T_{\text{CD}} &\geq 15 \text{ min}, \\
\Delta T_{\infty} &\leq 30 \text{ min}, \\
\partial T &= 300 \text{ sec}
\end{align*}
\]

Figure 4 shows the number of conflicts (mauve column, left scale), the resolution rates $\rho$ (green triangles, right scale), the absolute number of unresolved conflicts (blue column, left scale), and the number of unresolved conflicts related to the number of flights (yellow rectangles, right scale). The variations that can be observed are very small and all scenarios perform well. The combination of the different rejoin rules performs best with 75% resolution rates and 11% of unresolved conflicts per flight.

Figure 5 quantifies the resolution rates depending on the conflict encounter angle $\theta, 0^\circ \leq \theta \leq 180^\circ$ and the aircraft attitudes $\vartheta$ for the combination of rejoin rules, $\rho(\theta, \vartheta)$. It shows that in general LO has most difficulties to resolve conflicts where both aircraft are climbing, and resolves best where both aircraft are in descent, or one aircraft in
cruise and the other in descent. Dependency on the encounter angle is high for climb-climb and descent-descent encounters, the first having relatively high resolution rates for very small or very high $\theta$, and the latter having absolute high resolution rates wide anlges. It should be noted that the simulated traffic scenario generates a high rate of cruise-type conflicts in comparison to the pan-European study [11], with 33% of cruise-cruise conflicts (Figure 6) – compared to 18% for the pan-European traffic. This might be due to the higher flight level cut, this study measuring en-route air traffic control centres above flight level 245 compared to flight level 180 for the referenced study.

Offset Angles

The setup for the rejoin rules used a range of offset angles $\alpha$. Figure 7 shows the distribution of resolutions when the offset angles iterated +/- 15° starting from 30° ($\alpha = 30^\circ$, $\Delta \alpha = 5^\circ$, $\alpha_{\infty} = 15^\circ$).

The offset angle influences the performance of LO manoeuvres to resolve conflicts. This is due to two reasons:

1. Small LO angles need longer implementation times $t_{LO-implementation}$. The smaller the LO angle, the longer the time until the aircraft reaches the offset track, the longer $t_{LO-implementation}$. The time difference between the conflict detection $t_{CD}$ and conflict start $t_{CS}$ times must be bigger than the implementation time. The horizontal approximation by simple geometry is:

$$t_{CD} - t_{CS} \geq t_{LO-implementation} \geq \frac{60 \cdot d_{\parallel}}{\bar{v} \cdot \tan \alpha}$$

where $\bar{v}$ is the average speed in knots of the aircraft. If $d_{\parallel} = 5 \text{NM}$, $\bar{v} = 430 \text{knots}$ and $\alpha = 10^\circ$, then the value $t_{LO-implementation} \geq 3.9 \text{min}$.

2. Small LO angles require more airspace $A$, with the probability that this airspace is used by other environmental aircraft that may hinder the resolution process. The horizontal approximation by simple geometry is:

$$A = \frac{d_{\parallel}^2}{\tan \alpha}, \quad A_1 = \frac{\tan \alpha_1}{\tan \alpha_2}$$

E.g. 15 degrees occupy almost 4 times the airspace of 45 degrees LO angles.

Figure 6: Conflict types in three measured centres Karlsruhe, Maastricht and Reims.

Figure 7: Distribution of resolutions over LO angles.

Figure 8: Resolution rates over LO angles.

---

5 And other assumptions about usable airspace areas.
Figure 8 shows the results from simulations with offset angles set to a single value without iterations around it. The scenarios run 10 to 45 degree offset angles in steps of 5 degrees
\[ \alpha = \{10, 15, 20, 25, 30, 35, 40, 45\}^\circ, \Delta \alpha = 0^\circ, \]
\[ \alpha_{co} = 0^\circ. \]
The return angles are the same, \( \beta = \alpha \). An empirical optimum concerning conflict resolutions can be observed at \( \alpha = 35^\circ \). The decreasing resolution rates for \( \alpha = 40^\circ \) and \( \alpha = 45^\circ \) can only be explained with the aircraft performance model that would reject the computation of zig-zagging trajectories.

**Limited Offset Distances**

It would be of interest to limit the offset distances to discrete values to emulate closely spaced parallel routes. Three simulations have been set up using offset distances with multiples of 7NM, where the resolutions could find one, two or three parallel tracks on each side, depending on the scenario. The offset angle was set to 35 degrees, the rejoin rules were the combination which performed best, and the planning controller implemented the offset manoeuvres starting at conflict detection with the look-ahead of 14 minutes and made every 200 seconds a new iteration.

\[ \frac{1000}{\text{Unresolved/Flights \%}} \]
\[ \frac{10}{\text{Resolutions \%}} \]
\[ \frac{1}{\text{Unresolved}} \]

**Figure 9: Offset to distinct parallel tracks.**

Figure 9 depicts the result of the three simulations and for comparison the scenario that allowed for more parallel tracks between 5 and 15 nautical miles. It can be seen that still very high resolution rates are achieved, but lower than the comparison scenario. There is no difference between two or three parallel tracks with 71% resolution rates and 13% unresolved conflicts per flight. One parallel track performs less well, with 65% resolution rates and 16% unresolved conflicts per flight.

It should be highlighted that the resolution algorithm has no memory whether aircraft have already been put on offset or not, and will always try the left side first. Therefore it happens that the aircraft distribution over the multiple parallel tracks is slightly on the left side, and that more than the one, two or three parallel tracks are used, but only for a small number of aircraft.

**Figure 10: Aircraft distribution log(N) over parallel resolutions and number of deviations per aircraft.**

Figure 10 indicates how many resolved aircraft have been put on which parallel track (negative = left side) for the scenario that uses only one parallel track for resolutions. 83% of resolved aircraft are deviated by one track of 7NM, 8% by 14NM and less than 1% by 21NM left and right side confounded, and 8% back to the flight plan. A normal distribution seems to apply here. Furthermore, 24% of all aircraft suffer only one, 5% two, 1% three and much less than 1% four deviations.

That means that airspace is dramatically under-utilised in the parallel tracks, given that the percentage of conflicts per flight is the same on each parallel track, and the central track absorbs 75% of the traffic. From this it

\[ \frac{10000}{\text{Unresolved/Flights \%}} \]
\[ \frac{1000}{\text{Resolutions \%}} \]
\[ \frac{100}{\text{Unresolved}} \]

\[ \begin{aligned}
\text{0 deviation} & \quad \text{1 deviation} \\
\text{2 deviations} & \quad \text{3 deviations} \\
\text{4 deviations} & \quad \text{5 deviations}
\end{aligned} \]

\[ \begin{aligned}
\text{Conflicts} & \quad \text{Unresolved} \\
\text{4 Resolutions \%} & \quad \text{Unresolved/Flights \%}
\end{aligned} \]
can be assumed that a more intelligent distribution of the LO to the left and the right would further improve the performance of this manoeuvre.

Figure 11: LO resolutions normalised with baseline per encounter attitudes, $\|P(\vartheta)\|$.

Figure 11 normalises the resolution rates of the three scenarios with distinct LO with the scenario with the 2NM steps, $\|P\| = \frac{P_n}{P_{\text{baseline}}}$.

One parallel track performs worse than the baseline, two and three parallel tracks perform better in the cruise-cruise category.

**High Trajectory Uncertainties**

All the previous simulations have set a relatively small uncertainty of predicted trajectories, which is emulated with an increased separation buffer using an ellipse of 2 x 7NM long and 2 x 5NM short sides, i.e. minimal separation of $D_{\min,\text{lead}} = D_{\min,\text{trail}} = 7\,\text{NM}$, $D_{\min,\text{lat}} = 5\,\text{NM}$.

This compensates for along track uncertainty only. The ellipse is now further stretched for 2 x 10NM, 2 x 20NM and 2 x 30NM long sides. With the same rationale as already applied in the previous study [10], this corresponds roughly to 0.7%, 1%, 2% and 3% of uncertainty per 10 minutes; or 4.2%, 6%, 12% and 18% per hour. [Recent unpublished studies on trajectory prediction seem to converge towards a value of 1.25% per 10 minutes for existing algorithms of trajectory prediction in the en-route environment in Europe.]

Figure 12: Resolution rate for PC and TC for predicted trajectory uncertainties per hour.

Figure 12 shows the resolution rates depending on the controller and the uncertainty. The PC has in all cases higher resolution rates than the TC, due to the longer implementation window caused by the different look-ahead horizons, as explained above. The LO resolution rates drop with increasing uncertainties, as can be expected. It is noticeable that the resolution rates are high even with unrealistically extreme uncertainty values. The radar controller is less sensitive in proportion to the increase of uncertainty, but has lower resolution rates in absolute values than the planner, due to the reduced resolution spaces by the shorter look-ahead time.

**Conflict Resolution Times**

The resolution algorithm searched for solutions within a time window and a search direction, $\Delta T_\rightarrow$ and $\Delta T_\leftarrow$. The search boundaries fixed the size of $\Delta T$ and the step size $\partial T$ the granularity of the search. Figure 13 shows results of some simulations where only the radar controller resolved; the window size varies $\Delta T = (1\,\text{min},5\,\text{min},14\,\text{min})$ and both directions are applied with small steps of $\partial T = 30\,\text{sec}$ for the small windows. A correlation seems to exist between these parameters. The backward search has lower resolution rates, but is hardly sensitive to the window size, whereas the forward search has higher resolution rates but is very sensitive to small windows. It is difficult to explain this effect, and might be due to a bug.
VI - Found Issues

It is very important to improve the syntax of the clearance for the case where one aircraft is issued more than one LO clearance. E.G. the scenario using $d_{\text{off}} = n \cdot 7 \text{NM}$ issued more than one clearance to 7% of flights. If the aircraft is already flying in offset and another offset is issued, then it is unclear whether it is relative to the current trajectory or to its initial flight plan. E.g. if aircraft flies 7NM offset to the left, and the ATCO wants to add 5NM offset to the left, should the new clearance offset to 12-left or 5-left nautical miles? After discussion in the EEC we suggest to use the absolute offset distance all the times.

The syntax of the clearance proposed by Herndon et al. also allows for confusion of the offset direction $\mu = \text{(left, right)}$. The clearance used in this work is simpler and does not bear this risk.

If LO is used very often, then the offset direction $\mu$ should be optimised for the flights so that the cost of the manoeuvre is minimised. A simple model could e.g. compute the direction of a sector or centre exit point, or the arrival airport, and put the aircraft in that direction.

VII - Discussion

In the Multi Sector Planner (MSP) concept as formulated by Ehrmanntraut [12] there are a number of actions that the MSP conducts as a function of traffic and sector complexity, and depending on complexity prediction.
It measures the standard deviation of aircraft headings and distances relative to the bearing of their current route leg; or relative to the average bearing of a sequence and its main axis. The operational rationale is that aircraft flying close to their initial flight plan are recognised to be in order, whereas others would be exceptions and herewith create work. The cognitive assumption is that aircraft flying parallel to their flight plan are easily recognised as such by ATCOs.

LO has very high degree-of-order because the time that headings differ from the routes is short. The later the rejoin rule is activated, the longer the aircraft flies parallel. It is assumed that handing over aircraft that are kept in LO does not add workload. Therefore aircraft in LO should be kept on LO until the latest moment.

**Flow Safety Maximisation**

The objective is to organise the configuration of aircraft that are members of the same sequence in order to maximise the time-to-chaos $T_{chaos}$. $T_{chaos}$ is a system parameter that indicates when the system would generate conflicts or collisions in the case that no clearances are issued, e.g. at a total communication failure. Therefore sequence members are put on lateral and vertical offset to increase leading distances. Figure 14 illustrates two sequences that comply with the criteria defined in [12]. Sequence $S_A$ circularly offsets aircraft for safety only.

**Dynamic 3D Routes**

MSP as defined in [12] uses dynamic 3D routes for a segregation of traffic for centre flow optimisation. LO can be considered as a virtual parallel route, especially when using a limited number of discrete LO distances. The capabilities of LO to resolve en-route and low encounter angle conflicts give a first indication of the performance of dynamic 3D routes.

**Lateral Offset or Speed**

The previous studies [9][10] have investigated the potential and other performance parameters of speed control. The second study already contained comparison of speed control to other manoeuvres. For the comparison with LO, some new scenarios are run with similar parameters. Of special interest for the MSP are the comparison of resolution rates and the sensitivity to uncertainty.

![Figure 15: Comparison Speed – Lateral Offset](image)

Figure 15 indicates the comparison for the 200% and 300% traffic increase on the baseline of 1997, which is approximately presenting traffic of the year 2010 and 2025. The comparison should be regarded as an indication, because the scenarios for speed and LO are based on different assumptions, which are possibly not balanced. E.g. speed scenarios allow for speed increase and reduction of +/- 15% and LO scenarios for offset distances of 5-15NM in steps of 2NM. Other parameters were identical. This limitation in mind, it can be seen that they produce equivalent results. The best metric is the percentage of unresolved conflicts per flights, where both resolutions perform equally well. Speed resolutions lead to higher numbers of conflicts for the same scenario, which means that they produce more work than LO. Therefore the cautious statement could be made in favour of LO.
The MSP requires long look-ahead time; therefore the sensitivity of speed control regarding uncertainty is tested. Figure 16 shows results for 4%, 12% and 18% of uncertainty per hour for the 2010 traffic sample. It can be seen that speed control has even beneficial behaviour for 12% uncertainty per hour, but drops in performance for 18% uncertainty, where LO is still very stable, because the treatment of uncertainty seems to decrease the total number of conflicts and the percentage of unresolved conflicts per flight remains very low. With the above mentioned precautions it can be stated that both resolutions are performing well, with a clear advantage of LO.

VIII - Conclusions

The LO resolution rate in one of the densest areas in core Europe with traffic forecast for the years 2010 and 2025 seems to be high with P \approx 75% and P \approx 65% respectively. The optimum offset LO angle seems to be \alpha = 35^\circ.

LO is best suited for conflict resolutions of cruising en-route traffic. LO operates well even with reduced numbers of available parallel tracks. LO has high capability to resolve conflicts under high uncertainties. There are open issues:

- The syntax must be improved to avoid possible misunderstanding concerning the offset distance and the offset direction.

- The syntax could include the return angle.

- The offset direction should be locally optimised to set the flights into the direction of their destination.

LO has a very high potential to support Multi Sector Planning, because of its ability to resolve conflicts and conflict clusters, its usability for safety functions, and its ability to reduce complexity. The good performance of discrete LO distances is an encouraging indicator for the Multi Sector Planner dynamic 3D routes concept.

LO and speed control perform both very well. LO performs better than speed control if uncertainties are considered for Multi Sector Planning.

The fundamental research of the different parameters of LO indicates very high potential of this procedure. It should be emphasized that the implementation of LO would be relatively inexpensive, given that most of the aircraft are already equipped with this functions, and that it would only require the introduction of the new operational procedure. Then further investigations concerning other performance parameters like delay, fuel burn, workload and implementation cost would be needed. At this stage it can be summarized that LO has very high potential.

The Author

Rüdiger Ehrmanntraut is a scientist at the EUROCONTROL Experimental Centre in the research area Innovation (EEC-INO). Since 2003 he has been working on a thesis investigating the automation of air traffic management. He has been co-ordinator of the TALIS consortium, an EC project that finished in spring 2004. From 1999 until 2003 he has been CNS Business Area Manager. From 1996 until 1999 he has conducted several projects on air-ground integration. Before joining EUROCONTROL in 1996 he worked as a software engineer for an industrial company. He holds a diploma of telecommunications engineer from RWTH Aachen, Germany in 1991.
Acknowledgements

Special thanks to Kenny Martin from ISA Software for the cooperative refinement of the specifications of Lateral Offset and implementing the necessary change requests in the RAMS simulator.

Thanks to M. Brochard and R. Dowdall for discussion, support and review.

References


www.eurocontrol.int/eec/publications.html


[12] Ehrmanntraut, R., 2005, Multi Sector Planner Detailed Concept for Medium-Term Traffic Organisation, draft, EEC Note to be released