This report describes a EUROCONTROL Airspace Model simulation study, using the top-down method, which was conducted on the airspace of Bulgaria, Romania and Turkey on behalf of the EATCHIP Development Directorate and with the full cooperation of the States concerned. The study assessed the impact of a solution to the Black Sea FIR boundary issue and the implementation of a future ATS route network on the airspace systems of Bulgaria, Romania and Turkey.
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ABBREVIATIONS AND ACRONYMS USED IN THE REPORT

<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/C</td>
<td>Aircraft</td>
</tr>
<tr>
<td>ARN</td>
<td>ATS (Air Traffic Services) Route Network</td>
</tr>
<tr>
<td>ARR(S)</td>
<td>Arrival(s)</td>
</tr>
<tr>
<td>ATS</td>
<td>Air Traffic Services</td>
</tr>
<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
</tr>
<tr>
<td>BUL</td>
<td>Bulgaria</td>
</tr>
<tr>
<td>CNF(S)</td>
<td>Conflict(s)</td>
</tr>
<tr>
<td>DCT</td>
<td>Direct</td>
</tr>
<tr>
<td>DEP(S)</td>
<td>Departure(s)</td>
</tr>
<tr>
<td>DIR</td>
<td>Direction</td>
</tr>
<tr>
<td>DOC</td>
<td>Document</td>
</tr>
<tr>
<td>EAM</td>
<td>EUROCONTROL Airspace Model</td>
</tr>
<tr>
<td>EATCHIP</td>
<td>European ATC Harmonisation and Integration Programme</td>
</tr>
<tr>
<td>ECAC</td>
<td>European Civil Aviation Conference</td>
</tr>
<tr>
<td>EEC</td>
<td>EUROCONTROL Experimental Centre</td>
</tr>
<tr>
<td>EUR-ANP</td>
<td>European Air Navigation Plan</td>
</tr>
<tr>
<td>FIR</td>
<td>Flight Information Region</td>
</tr>
<tr>
<td>FL</td>
<td>Flight Level</td>
</tr>
<tr>
<td>FLAS</td>
<td>Flight Level Allocation System</td>
</tr>
<tr>
<td>GAT</td>
<td>General Air Traffic (civil)</td>
</tr>
<tr>
<td>INTL</td>
<td>International</td>
</tr>
<tr>
<td>NM</td>
<td>Nautical mile(s)</td>
</tr>
<tr>
<td>OAT</td>
<td>Operational Air Traffic (military)</td>
</tr>
<tr>
<td>ORG</td>
<td>Organisation</td>
</tr>
<tr>
<td>ROM</td>
<td>Romania</td>
</tr>
<tr>
<td>R/T</td>
<td>Radiotelephony</td>
</tr>
<tr>
<td>TMA</td>
<td>Terminal Control Area</td>
</tr>
<tr>
<td>TUR</td>
<td>Turkey</td>
</tr>
<tr>
<td>UIR</td>
<td>Upper Flight Information Region</td>
</tr>
</tbody>
</table>
AIRSPACE MODEL SIMULATION
TOP-DOWN APPROACH TO ROUTE NETWORK
AND AIRSPACE DEVELOPMENT IN THE
AIRSPACE OF BULGARIA, ROMANIA & TURKEY

by

R. Dowdall

SUMMARY

As a result of the increase in traffic in the Bulgarian, Romanian and Turkish regions, complicated by the situation in former Yugoslavia, and of the possibility of a solution to the Black Sea (Simferopol) FIR boundary issue, it was decided by EATCHIP Development to conduct an Airspace Model top-down simulation of the area to assess the impact of a future route network on the existing airspace systems.

The top-down approach to airspace modelling examines the main flows of traffic (usually in vertical free-profile) and how they interact with each other in any given multinational airspace system. It is purely experimental: the development of an ideal airspace system not constrained by existing FIR/UIR boundaries or political elements.

The objective of the study was to assess an ATS route network (ARN) and supporting airspace sectorisation plan, regardless of current FIR boundary constraints, which:

- took full account of current and future civil and military airspace requirements;
- had the capacity to match forecast demand;
- was based on the agreed ARN route network plan and would be a building-block for its future development;
- offered full flexibility, in line with the concept of the flexible use of airspace;
- reduced, to the extent possible, the route length for air transport;
- met the full agreement of the civil and military representatives of Bulgaria, Romania and Turkey.

Two main organisations were simulated:

- a reference organisation simulating the route network existing on the 15th/16th of July 1994 (Friday/Saturday) and using the 24 hour actual traffic samples for each day;
- a future, ideal organisation not constrained by the Black Sea problem, which tested a route network based on Version 2 of the European Air Navigation Plan (EUR-ANP), as depicted in Map 2 (2 February 1995). Both traffic samples simulated for the reference organisation were amended accordingly. The samples were then further amended to take into account the recommended flows contained in annex 8/chart 8B of the EATCHIP report "Route Network Development and Associated Sectorisation Improvements in the ECAC Area" (EUROCONTROL Doc. 957005).

The airspace simulated was the TMA and en route sectors of the Bulgarian, Romanian and Turkish FIR/UIRs as well as that portion of the Simferopol FIR/UIR over the Black Sea affected by the route network changes. The present-day FIR/UIR boundaries were used in both organisations. The simulation of the reference organisation showed that:
Of the three States simulated, the results indicated Romania as having the greatest amount of potential spare capacity.

The areas giving the greatest problems were (see MAP3 in appendix A):

⇒ Bulgaria - MATEL to RIXEN and Bailovo (BLO) to Radovets (RAD);
⇒ Turkey - ADELI to RIXEN, BERGO to Biga (BIG), Afyon (KFK) to KUMRU and Goynuk (GOY) to PETAR.

Apart from the wider use of the Black Sea airspace and the harmonisation of flows to relieve the congestion over the Istanbul area, there was need to:

⇒ Dualise the U/G1 between Constanta (CND) and Istanbul.
⇒ Dualise the UA4 between BLO and Istanbul.
⇒ Use Chouchouligovo (CCO) for southbound and RODOP for northbound traffic and consider the introduction of a Flight Level Allocation System where these flows intersect the UA4.
⇒ Provide discrete inbound and outbound routeings for Burgas and Varna traffic via CND, and also for Izmir and Antalya traffic.

Because the future Black Sea sectorisation is still unknown, the present-day FIR/UIR boundaries were retained for the future organisation. The results of simulating the new flows and route network (including routes over the Black Sea) and retaining the present-day FIR/UIR boundaries showed that:

⇒ The redistribution of aircraft led to a 17% decrease in Bulgaria's traffic and a 10% decrease in Romania's, with the figures for Turkey remaining virtually unchanged.
⇒ The number of radar conflicts for the airspace as a whole was down by 40%, the biggest fall occurring in the number of opposite-direction conflicts, down 85%, due to the separation of climbing and descending opposite-direction flows.
⇒ Romania was the only country to experience an increase in total radar conflicts - up by 60%, but from a relatively small base. Bulgaria and Turkey experienced decreases of 70% and 45%, respectively.
⇒ Some problem areas still remained (see MAP6 in appendix A):
  ⇒ Bulgaria - BLO to RADS;
  ⇒ Romania - The Galati (GLT) area and the Arad (ARD) to DOMNA route south of CND;
  ⇒ Turkey - LTBAJ to RAD and ADORU to RDBAI;
  ⇒ Black Sea - DOMNA.

Simulating the present-day FIR/UIR boundaries had the effect of understating the number of aircraft that would have been controlled by Bulgaria and Romania under any new boundary arrangements. For Romania, any boundary change would mean the inclusion of DOMNA in its airspace and, therefore, the traffic through this point via KORAT or ANGOL. For Bulgaria, the boundary changes would mean the inclusion of either the bi-directional Baglum (BAG)-DOMNA route on its own, or the same route plus the busier unidirectional DOMNA to TALIK route.

In order to identify the influence of the new flows and route network in the context of any future boundary changes, further analysis was carried out which showed that:

⇒ The influence of the new route network and flows would be an overall reduction of 35% in the number of radar conflicts compared to the reference organisation.
⇒ The results for Turkey would remain the same as for the future organisation.
⇒ The inclusion of DOMNA in Romanian airspace and, therefore, the KORAT or ANGOL traffic would mean an average reduction in aircraft numbers of 6% compared to the reference organisation.
- Romania’s radar conflicts would almost double compared to the reference organisation (but from a relatively small base) due to the high number of crossing conflicts.

- For Bulgaria, including the bi-directional BAG-DOMNA route, on its own, would have little impact.

- The inclusion of the BAG-DOMNA route plus the busier DOMNA to TALIK route would lead to an average reduction in aircraft numbers of 5% compared to the reference organisation.

- Similar reductions in the number of radar conflicts found for Bulgaria in the future organisation with the present-day boundaries would also be found with the inclusion of the two routes.

Conclusions and Recommendations

This simulation provides an overview of the aircraft loadings and conflicts on the routes which are proposed in Version 2 of EUR-ANP. As such, they depict an ideal system which does not take into account the constraints currently imposed on planners as a result of the situation in former Yugoslavia and the political problem of the Black Sea FIR boundary delineation. Nevertheless, the results can be used to plan improvements to the route network in the area.

The results show that the new flows and route network provide a more efficient organisation of airspace in Bulgaria and Turkey, and should increase capacity. Romania will experience a moderate increase in workload with the inclusion of DOMNA in the airspace.

Considerable benefit was derived from simulating the separation of climbing and descending opposite-direction flows in Bulgaria and Turkey. To make this a reality and to permit a more flexible use of the airspace, closer cooperation between the civil and military authorities in both Bulgaria and Turkey will be required, as the results show that the civil/military interface is very clearly defined in both countries.

In reviewing the final results, the important views of the Turkish delegation were not available as the representatives were unable to attend the meeting. Although the beneficial results of the study are quite clear, the absence of the opinions of such a pivotal State is regrettable. Also, it would be desirable, though not necessary, to simulate the optimisation of the new route network in a further study. Should this be done, any significantly different views from Turkey or any other changes to the agreed network could also be included.

The simulation was carried out using a base 1994 traffic sample. During the course of the study, traffic in the area has increased. Should the Black Sea boundary issue remain unresolved while the traffic continues to increase there will be a high loading on the Istanbul to JULIA/KEREK/KARIL routes. The solution to this problem will require the retention of the ARGES to Oradea (ORA)/KEREK route as an important offload for the parallel KOMAN-JULIA route.

Finally, the study concludes that Version 2 of the EUR-ANP will provide an overall better balanced distribution of traffic and workload. It will reduce the loadings in the bottleneck areas and, therefore, should increase overall capacity. However, the full benefits of Version 2 are dependent upon the implementation of the new routes over the Black Sea, so the consequential increases in capacity can only be realised when these routes have been implemented. A resolution of the Black Sea FIR boundary issue is, therefore, an urgent necessity.
FOREWORD

In May 1994 the initial meeting for the study took place in Brussels at which the objective of the Bulgaria, Romania and Turkey top-down simulation was defined. The study was given the EEC task number AF52.

A number of subsequent meetings were held during the execution of the simulation between representatives of the three States involved and the EUROCONTROL study team. The purpose of these meetings was to outline the simulation methodology, define the organisations and traffic samples to be simulated, verify the input data, and review the interim results.

The final presentation of results took place in Romania in June 1995 and an intermediate report was issued the following month.

This report analyses the results of the study and is organised into the following chapters:

**Chapter 1**  Objective and description of the study plus the input data used.

**Chapter 2**  Analysis of the results for the reference organisation.

**Chapter 3**  Analysis of the results for the addition of the military samples to the reference organisation.

**Chapter 4**  Analysis of the results for the new flows and route network simulated.

**Chapter 5**  Summary and conclusions.

**Acknowledgements**

The EUROCONTROL study team would like to thank the ATC administrations of Bulgaria, Romania and Turkey for the assistance given during the execution of this study. Thanks must also go to all the working group members from the three States for the excellent facilities provided at each meeting.
1 INTRODUCTION

1.1 The Top-Down Approach to Airspace Modelling

The top-down approach to airspace modelling examines the main flows of traffic (usually in vertical free-profile) and how they interact with each other in any given multinational airspace system. It is purely experimental: the development of an ideal airspace system not constrained by existing FIR/UIR boundaries or political elements.

By analysing the results of such a simulation in terms of aircraft flows and the radar conflicts produced when these flows interact, the airspace under study can be significantly "deconflicted". Methods to achieve this include: alternative routeings leading to reductions in route lengths; dualisation of certain airways; level restrictions; and level-capping of city-pair flows.

Consideration must be given to the wider picture beyond the simulated area by ensuring the harmonisation of proposed route networks for the particular airspace with other network plans such as the ATS Route Network (ARN). Other factors considered are future traffic demand of both en route and arrival/departure traffic at major and secondary airports and, in order to be realistic, military airspace requirements.

1.2 Objective of the Study

The objective of this study of Bulgarian, Romanian and Turkish airspace was to assess an ATS route network and supporting airspace sectorisation plan, regardless of current FIR boundary constraints, which:

- took full account of current and future civil and military airspace requirements;
- had the capacity to match forecast demand;
- was based on the agreed ARN route network plan and would be a building-block for its future development;
- offered full flexibility, in line with the concept of the flexible use of airspace;
- reduced, to the extent possible, the route length for air transport;
- met the full agreement of the civil and military representatives of Bulgaria, Romania and Turkey.

1.3 General Description of the Study

The airspace simulated was the TMA and en route sectors of the Bulgarian, Romanian and Turkish FIR/UIRs as well as that portion of the Simferopol FIR/UIR over the Black Sea affected by the route network changes.

Simulated Organisations

Two main organisations were simulated:

- a reference organisation simulating the route network existing on the 15th/16th of July 1994 (Friday/Saturday) and using the 24 hour actual traffic samples for each day;
- a future, ideal organisation (called "revised scenario") not constrained by the Black Sea problem, which tested a route network based on Version 2 of the European Air Navigation Plan (EUR-ANP), as depicted in Map 2 (2 February 1995). Both traffic samples simulated for the reference organisation were amended accordingly. The samples were then further amended to take into account the recommended flows contained in annex B/chart 8B of the EATCHIP report "Route Network Development and Associated Sectorisation Improvements in the ECAC Area" (EUROCONTROL Doc. 957005).
A third organisation simulated the GAT samples used for the reference organisation with representative military samples from each country added.

In each organisation, all arrivals were simulated down to their respective TMA exit points (approximately FL100) and all departures were treated from the runway upwards to ensure correct profiles on entering en route airspace.

Separation Standards

In practice, separation standards varying from 3nm to 15 minutes are used in different parts of the simulated airspace. As the application of these different standards (eight altogether) would have required major software modifications to the Airspace Model and may have led to possible difficulties in meeting the simulation schedule, it was decided to apply a combination of the normal internal en route radar separation used by each of the three countries and the radar or procedural separation required at each of the FIR/UIR entry/exit points.

Table 1 summarises the separation standards simulated.

<table>
<thead>
<tr>
<th>FIR/UIR</th>
<th>Internal Separation</th>
<th>External FIR/UIR Separation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bulgaria</strong> (LBSR/LBWR)</td>
<td>15nm</td>
<td>Romania/Turkey: 20nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Belgrade (LYBA): 30nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simferopol (UKFF): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Athens (LGGG): 10 minutes</td>
</tr>
<tr>
<td><strong>Romania</strong> (LRBB)</td>
<td>20nm</td>
<td>Bulgaria: 20nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Budapest (LHCC): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Belgrade (LYBA): 30nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lvov (UKLL): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kishinev (LUKK): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Odessa (UKOD): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simferopol (UKFF): &quot;</td>
</tr>
<tr>
<td><strong>Turkey</strong>   (LTAA/LTBB)</td>
<td>20nm</td>
<td>Bulgaria: 20nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Athens (LGGG): 10 minutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nicosia (LCCC): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Damascus (OSTT): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simferopol (UKFF): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rostov (URRV): &quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teheran (OIIX): 15 minutes</td>
</tr>
<tr>
<td><strong>Black Sea</strong> (Revised Scenario)</td>
<td>20nm</td>
<td>Bulgaria/Romania/Turkey: 20nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simferopol (UKFF): 30nm</td>
</tr>
</tbody>
</table>

Table 1

It was accepted that the internal separation used would produce more conflicts in the TMA areas than would, in reality, occur. However, the main analysis of the results excluded from the calculations all conflicts occurring below FL165 as not being relevant to the main objectives of the study.

Sectors

The ideal method of conducting a top-down simulation is to treat the complete simulated airspace as one sector. The benefit is that a true number of radar conflicts are detected. With multiple sectors, the conflicts occurring close to sector/centre boundaries, either vertically or horizontally, are recorded in both sectors/centres concerned. In the context of a detailed study of controller workload, this situation is realistic as such radar conflicts are usually subject to radar handovers and are, therefore, an integral part of each sector/centre’s workload.

A top-down approach, however, does not require this level of detail which, in fact, only makes the analysis of the results more difficult. That said, where a difference exists in internal radar separation standards then sectorisation is unavoidable. This was the case with this simulation (see table 1, above) but the sectorisation was kept to a minimum by making each country’s airspace one complete sector and ignoring any internal sectorisation.
Each of the three sectors (four in the revised scenario organisation) was simulated from FL45 to unlimited. The analysis of the results excluded the duplicate radar conflicts recorded at the FIR/UIR boundary points.

1.4 Traffic Samples Tested and Aircraft Performance Data

The specifications of the study required the detailed simulation of two busy 24 hour samples taken from each country’s GAT traffic records for 1994. The dates agreed between all parties were the 15th/16th July 1994 (Friday and Saturday). A representative OAT sample for each country was also supplied.

GAT Traffic Sample

Eight GAT samples were received:

<table>
<thead>
<tr>
<th>Day</th>
<th>Ankara</th>
<th>Istanbul</th>
<th>Bulgaria</th>
<th>Romania</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friday</td>
<td>665 flights</td>
<td>1107 flights</td>
<td>1127 flights</td>
<td>905 flights</td>
<td>3804 flights</td>
</tr>
<tr>
<td>Saturday</td>
<td>681 flights</td>
<td>925 flights</td>
<td>1249 flights</td>
<td>1018 flights</td>
<td>3873 flights</td>
</tr>
</tbody>
</table>

Resulting in 1702 simulated aircraft.

The reduction of 55% from total flights to simulated aircraft on both days is due to the numbers of flights common to two or more of the original samples.

A more detailed analysis of the simulation samples can be found in the next chapter dealing with the reference organisation, starting on page 5.

OAT Traffic Samples

Three OAT samples were received containing military flights affecting civil airspace:

<table>
<thead>
<tr>
<th>Country</th>
<th>Aircraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>124</td>
</tr>
<tr>
<td>Romania</td>
<td>336</td>
</tr>
<tr>
<td>Turkey</td>
<td>103</td>
</tr>
<tr>
<td>Total</td>
<td>563</td>
</tr>
</tbody>
</table>

This sample was added to both Friday and Saturday samples to assess the impact of these flights on the existing civil route network.

Aircraft Performance Data

The airspace model recognises more than 200 different aircraft types. These types have been grouped into 60 categories of aircraft performance. Detailed data on the cruising/climb/descent speeds and the rates of climb/descent is available for each category of aircraft. The model can also distinguish between long, medium and short range flights.

The data has been derived from studies of aircraft performance, previous simulations, airline operating practices and particular characteristics observed by operational controllers in various simulated areas. The aircraft performance data is used to construct the requested and actual profile of each aircraft within the simulated airspace.
1.5 Simulation Work Index

A normal airspace model simulation provides a detailed workload analysis by identifying and recording all ATC tasks necessary to process each flight through the airspace system under study. These ATC tasks are grouped under five broad categories: flight data management; coordination; conflict search; routine R/T; and radar.

This level of detail, however, is not required in a top-down simulation. Instead, a work index is calculated in order to:

- allow the results to be put into a readily understood context;
- provide a basis for comparing the reference organisation with the revised scenario organisation;
- identify implied spare capacity.

Note: It is important to understand that the work index is merely a simple indicator of the potential work involved in processing the simulated aircraft through the airspace system. It is not a measure of the real workload that would be required in controlling the aircraft through a multi-sector environment nor can it be used to calculate capacity with any of the recognised methods in use today.

Calculation of the Work Index

The work index is based on the major elements of two of the ATC task categories:

- **Routine R/T:** This part of the index takes into account the routine R/T work involved in the first call from an aircraft and the transfer of the aircraft to the next frequency.
- **Radar:**
  - **Radar interventions** require the tactical alteration of an aircraft’s heading, level or speed in order to ensure minimum radar separation between aircraft at all times;
  - **Radar supervisions** involve the close monitoring of potential conflict situations between aircraft without the necessity of tactical interventions.

The model identifies nine types of radar conflicts in evaluating interventions and supervisions:

- **Type 1** Same track, same level, both aircraft in cruise;
- **Type 2** Same track, one in cruise, one in climb or descent;
- **Type 3** Same track, both in climb or descent;
- **Type 4** Crossing tracks, same level, both aircraft in cruise;
- **Type 5** Crossing tracks, one in cruise, one in climb or descent;
- **Type 6** Crossing tracks, both in climb or descent;
- **Type 7** Opposite tracks, same level, both aircraft in cruise;
- **Type 8** Opposite tracks, one in cruise, one in climb or descent;
- **Type 9** Opposite tracks, both in climb or descent.

Over a range of simulations performed by the Airspace Model, there is an approximate task execution time ratio of 1:1:3 between first + last call to an aircraft, a radar supervision and a radar intervention. On this basis one point is allocated per aircraft worked, one point per radar supervision recorded and three points per radar intervention recorded.
2 REFERENCE ORGANISATION

This organisation tested the existing airspace structure using two 24 hour traffic samples for the 15th/16th July 1994 (Friday and Saturday). The purpose of the reference organisation was:

- to determine the main flows of traffic and how they interact;
- to highlight areas of difficulty;
- to identify any implied spare capacity in the region simulated;
- to provide a basis for comparison with the revised scenario organisation.

MAP 1 of appendix A shows the route network tested.

2.1 Analysis of the Traffic Samples

Category and Distribution of Traffic

The Friday sample contained 1702 aircraft and Saturday's 1724 aircraft. Fig 1 shows the four flight categories - domestic, international arrivals, international departures and transit - making up each country's total number of flights (shown in blue) for the two days. The percentage of transit flights is shown in red in the appropriate part of each bar. No military flights were included in this organisation.

The first point to note is the difference in the composition of traffic between Bulgaria and Romania on the one hand, and Turkey on the other. Only 25% of Turkey's traffic was transiting, whereas more than 80% of the traffic for the other two countries was overflying. In the case of Bulgaria 60% of its transit flights were to/from Turkish airports and for Romania the figure was 45%.

On the Friday, Turkey had 32% more flights than Romania and 24% more on the Saturday. In all three countries, domestic flights were reduced on the Saturday as compared to the Friday.
Flight Level Usage

**Fig 2** shows the distribution of cruising flight levels over the two days. As usual, FL330 was the clear favourite, with FL370, FL350 and FL310 not too far behind, particularly on the Friday.

**Analysis of Cruising Flight Levels Used**

*Reference Organisation - Friday / Saturday*

![Flight Level Usage Chart](image)

Concerning the subject of free routeing in the future, the percentage of the traffic at FL370 and above was 20% on both days and at FL350 and above 35%, again on both days.

**Aircraft Types**

**Fig 3** shows the ten most frequently occurring aircraft types for each day. In the traffic samples received, very few of the B737s were categorised as to low-performance series 200 or high-performance 300/400/500. In order to reflect the reality of greater numbers of high-performance aircraft in use today, three out of every four B737-200s (perhaps conservative) appearing in the samples were recategorised as B737-300/400/500s. These high-performance aircraft appear in **fig 3** as "B73S".

**Most Frequently Occurring Aircraft Types**

*Reference Organisation - Friday / Saturday*

![Aircraft Types Chart](image)
Evolution of the Traffic during the Day

Fig 4 gives a picture, hour by hour, of the number of aircraft in the system, i.e. in the airspace taken as one complete unit, during the Friday.

The average count per hourly period was approximately the same for the two days, 143 and 148. The block in red on the chart indicates the counts of aircraft 20% or more above the hourly average. As can be seen from the aircraft figures on the bottom, these periods were well defined - 1100h to 1700h. On the Saturday these periods were from 1000h to 1700h.

Fig 5 demonstrates the evolution of the traffic in each country’s airspace during the same hourly periods for the Saturday. Aircraft counts 20% or more above each country’s individual average are shown in red.

Evolution of Aircraft per Country during the Day
The Saturday chart is marked by a consistent flow of traffic up to 1000h followed by a quick surge to a higher, steady flow until 1700h and then a fast return to the previous level of consistent traffic until the end of the simulation period. The busy periods were 1000h to 1700h for Romania, 1000h to 1600h for Bulgaria and 1100h to 1600h for Turkey.

On Friday, there was a gradual build-up to the peak periods (0900h to 1600h Romania, 1100h to 1600h Bulgaria, 1100h to 1700h Turkey) then a gradual tapering off before a small surge at the end of the day.

For Romania and Bulgaria the average aircraft per hour was 10% higher on Saturday, but for Turkey the average was similar for both days. Turkey's average was 30% higher than the other two countries.

**Significant Flows of Traffic**

MAP 2 in appendix A shows all routes that had a significant flow of traffic (typically 24 aircraft or more) during one or both days. The green routes indicate south- or eastbound flows and the blue north- or westbound. The thickness of each route segment is determined by the number of aircraft, as shown in the map legend. Each segment has a box attached indicating the number of aircraft - the upper figure for Friday and the lower for Saturday. Also included are the numbers of aircraft through each of the "internal" boundary points with blue and green indicating the direction of that flow and upper and lower figures indicating Friday and Saturday.

**Note:** As the map does not show all routes simulated, some inconsistencies will be found in the aircraft numbers before and after certain joining, leaving or boundary points. In the case of SOMOV, for example, a small northbound flow for both days (16 and 9) is indicated, but neither was of sufficient size to be shown as a significant flow.

The more important route segments (92+ aircraft per 24 hours) are summarised in tables 2a and 2b (next page) and isolated in MAP 2A in appendix A.

<table>
<thead>
<tr>
<th>Direction of Flow</th>
<th>Route Segment</th>
<th>Significant Traffic (in order of volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South &amp; East</td>
<td>BATOG-SOMOV-RAD</td>
<td>Germany - UK - France/Switzerland - Austria</td>
</tr>
<tr>
<td></td>
<td>KAL-RAD</td>
<td>Germany - France/Switzerland - UK - Amsterdam</td>
</tr>
<tr>
<td></td>
<td>RAD-EKI</td>
<td>Germany - France/Switzerland - UK</td>
</tr>
<tr>
<td></td>
<td>TIKRU-CND</td>
<td>Germany - Scandinavia</td>
</tr>
<tr>
<td></td>
<td>CND-DINRO-RIXEN</td>
<td>Germany - Scandinavia - Former Soviet Union</td>
</tr>
<tr>
<td></td>
<td>BKZ-YAA</td>
<td>Istanbul - Germany</td>
</tr>
<tr>
<td></td>
<td>YAA-KARGI-KFK</td>
<td>Istanbul - Germany - UK - Scandinavia</td>
</tr>
<tr>
<td></td>
<td>GOY-PETAR (BAG)</td>
<td>Germany - Istanbul - UK - France/Switzerland</td>
</tr>
<tr>
<td>North &amp; West</td>
<td>IMR-BIG</td>
<td>Izmir - Dalaman</td>
</tr>
<tr>
<td></td>
<td>VESAR-MUT-KFK</td>
<td>Middle East - Far East</td>
</tr>
<tr>
<td></td>
<td>KFK-KARGI-YAA</td>
<td>Middle East - Antalya - Far East</td>
</tr>
<tr>
<td></td>
<td>YAA-BKZ-RIXEN</td>
<td>Middle East - Antalya</td>
</tr>
</tbody>
</table>

Table 2a
Chapter 2 - Reference Organisation

Table 2b

The most significant volume of international traffic (25%) was to or from Turkish airports. Next came to/from Germany 17%, the Middle East 7%, Bulgaria 6% then France/Switzerland, Greece and the UK each with 5%.

2.2 Interaction of the Flows

Initially, all radar conflicts were analysed, in TMAs and above. However, as the study was only examining the higher en route flows and because the use of en route sector separation in the TMAs resulted in a higher number of conflicts than would occur in reality, only the results for FL165 and above will be dealt with.

Fig 6 gives the results for the radar conflicts at FL165 and above, subdivided into same direction, crossing and opposite direction conflicts.

---

<table>
<thead>
<tr>
<th>Direction of Flow</th>
<th>Route Segment</th>
<th>Significant Traffic (in order of volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Origin</td>
</tr>
<tr>
<td>North &amp; West (cont.)</td>
<td>RIXEN-MATEL</td>
<td>Turkey - Middle East - Far East</td>
</tr>
<tr>
<td></td>
<td>MATEL-KOMAN-DVA</td>
<td>Turkey - Middle East - Far East - Bulgaria</td>
</tr>
<tr>
<td></td>
<td>DVA-ARPUX-JULIA</td>
<td>Turkey - Middle East - Far East - Bulgaria - Greece</td>
</tr>
<tr>
<td></td>
<td>RAD-BLO</td>
<td>Turkey - Middle East - Far East</td>
</tr>
<tr>
<td></td>
<td>BLO-KAL</td>
<td>Turkey - Middle East</td>
</tr>
<tr>
<td></td>
<td>BLO-OSTOV-BARIM</td>
<td>Greece - Turkey</td>
</tr>
<tr>
<td></td>
<td>BARIM-DVA</td>
<td>Greece</td>
</tr>
</tbody>
</table>

---

Fig 6 gives the results for the radar conflicts at FL165 and above, subdivided into same direction, crossing and opposite direction conflicts.
The clear difference between the number of conflicts for Romania and the numbers for Bulgaria and Turkey is quite evident from the chart. While the smaller number of aircraft was a factor, the difference was due primarily to the system of unidirectional airways in Romania coupled with a higher incidence of traffic in cruise. Of the total number of conflicts for each day Turkey had 50%, Bulgaria 40% and Romania 10% on the Friday and, on the Saturday, Turkey had 43%, Bulgaria 43% and Romania 14%.

There was a high number of opposite direction conflicts recorded for both Bulgaria and Turkey. In the case of Bulgaria, more than 50% of these conflicts concerned Istanbul arrivals or departures in evolution between RIXEN and MATEL. In the case of Turkey, 25% of the opposite direction conflicts also concerned Istanbul arrivals and departures between RIXEN and ADELI. Both results suggest the need to dualise the G1 airway between Constanta and Istanbul.

MAP 3, appendix A, shows the main conflict areas and tables 3a and 3b summarise these areas.

<table>
<thead>
<tr>
<th>ROMANIA</th>
<th>Conflicts Fri Sat</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PELES</td>
<td>18 12</td>
<td>All were CROSSING conflicts between the BATOG-TGJ and the NARKA-LOMOS flows.</td>
</tr>
<tr>
<td>2 DVA</td>
<td>13 16</td>
<td>Mostly CROSSING conflicts involving the KOMAN-JULIA flow against the OSTOV-KEREK/KARIL flows.</td>
</tr>
<tr>
<td>3 CND - DINRO</td>
<td>4 16</td>
<td>Only 20% of the traffic here was landing Burgas or Varna but most conflicts involved one of these items (50% on Friday, 75% on Saturday) descending to FL290/270 by DINRO.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BULGARIA</th>
<th>Conflicts Fri Sat</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 DINRO - MATEL</td>
<td>13 10</td>
<td>No particular pattern noticeable. 60% of conflicts for both days were OPPOSITE-DIRECTION. On the Friday, 60% of conflicts involved a Burgas or Varna arrival.</td>
</tr>
<tr>
<td>5 MATEL</td>
<td>32 22</td>
<td>There were 433 aircraft over MATEL on the Friday, 479 on the Saturday. Same direction conflicts were the most common, almost all concerning northbound aircraft in climb after RIXEN.</td>
</tr>
<tr>
<td>6 MATEL - RIXEN</td>
<td>93 91</td>
<td>The area with the highest number of conflicts on either day. 70% were OPPOSITE-DIRECTION. Fri: 73 conflicts (82%) involved an Istanbul arrival or departure. Sat: 80 conflicts (88%) involved an Istanbul arrival or departure.</td>
</tr>
<tr>
<td>7 RIXEN</td>
<td>25 29</td>
<td>The heaviest loaded point in terms of traffic - 470 aircraft (Fri), 493 aircraft (Sat). Mixture of conflicts, the most common being SAME-DIRECTION.</td>
</tr>
<tr>
<td>8 BLO - CCO</td>
<td>15 16</td>
<td>Mostly OPPOSITE-DIRECTION conflicts involving LGxx arrivals and departures.</td>
</tr>
<tr>
<td>9 BLO</td>
<td>26 38</td>
<td>One of the busiest points in terms of aircraft numbers - 407 aircraft (Fri), 494 aircraft (Sat). Fri: 25 CROSSING conflicts - 20 involved an LGxx (7 deps/13 arrs). Sat: 33 CROSSING conflicts - 32 involved an LGxx (25 deps/7 arrs).</td>
</tr>
<tr>
<td>10 BLO - RAD</td>
<td>15 34</td>
<td>50% SAME-DIRECTION, 50% OPPOSITE-DIRECTION conflicts. Most conflicts occurred near to RAD due to level adjustments being made.</td>
</tr>
<tr>
<td>11 RAD</td>
<td>34 33</td>
<td>RAD was another heavily loaded point - 363 aircraft (Fri), 448 aircraft (Sat). Mixture of conflicts with the majority being CROSSING.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TURKEY</th>
<th>Conflicts Fri Sat</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 RAD - EKI</td>
<td>15 28</td>
<td>Fri: mostly SAME-DIRECTION conflicts, all involving an Istanbul arrival. Sat: 60% OPPOSITE-DIRECTION conflicts, all involving an Istanbul arrival versus one of the increased Izmir/Dalaman departures.</td>
</tr>
<tr>
<td>13 BIG - BERGO</td>
<td>30 27</td>
<td>All conflicts involved an Izmir arrival or departure. 19 conflicts on each day (63% and 70%) were OPPOSITE-DIRECTION.</td>
</tr>
</tbody>
</table>

Table 3a
2.3 Work Index

Over a range of simulations performed by the Airspace Model, there is an approximate task execution time ratio of 1:1:3 between first + last call to an aircraft, a radar supervision and a radar intervention. On this basis one point was allocated per aircraft worked, one point per radar supervision recorded and three points per radar intervention recorded. Fig 7 shows the work index and number of aircraft for each country on both days.

Romania's index was 55% of Turkey's on the Friday and 60% of Turkey's on the Saturday. If looked at in terms of points per aircraft, the results are the same on both days for each country: 1.2 work index points per aircraft for Romania, 1.5 for Bulgaria and 1.6 for Turkey.
2.4 Summary of Results for the Reference Organisation

- There was a roughly equal mix of transit, international arrival and international departure traffic in Turkey. For both Bulgaria and Romania a high level of transit traffic was recorded (>80%), a large proportion of which was landing or departing Turkey.

- The most significant volumes of traffic were those serving Turkish and German airports with 25% and 17% of the samples, respectively.

- Of the three States simulated, the results indicated Romania as having the greatest amount of potential spare capacity.

- The areas giving the greatest problems were:
  - Bulgaria - MATEL to RIXEN and BLO to RAD;
  - Turkey - ADELI to RIXEN, BERGO to Big, KFK to Kumru and GOY to PETAR.

- Apart from the wider use of the Black Sea airspace and the harmonisation of flows to relieve the congestion in the Istanbul area, the results showed the need to:
  - Dualise the U/G1 between Constanta and Istanbul.
  - Dualise the UA4 between BLO and Istanbul.
  - Use CCO for southbound and RODOP for northbound traffic and consider the introduction of a Flight Level Allocation System where these flows intersect the UA4.
  - Provide discrete inbound and outbound routeings for Burgas and Varna traffic via CND, and also for Izmir and Antalya traffic.
3 MILITARY SAMPLES ORGANISATION

Three OAT samples were received containing military flights affecting civil airspace:

- Bulgaria 124 aircraft
- Romania 336 aircraft
- Turkey 103 aircraft
- Total 563 aircraft

Initially, this OAT sample was added to the Friday GAT sample to quickly assess the impact of these flights. The results showed an overall increase of 10% in the number of radar conflicts, i.e. between military and civil aircraft - conflicts between military aircraft were ignored. This was less than anticipated as the weekend route structure in the GAT samples ignored the military areas normally active during the week, so the OAT sample could have been expected to show a greater impact. The original intention was to change the GAT samples to reflect the midweek routes and to add the OAT samples but, as this would yield an even smaller increase in conflicts, it was decided by the working group to apply the OAT sample to the GAT samples as they stood, and to highlight the major differences.

The results were similar for both days. Fig 8 shows the results for Saturday where the greatest impact was found. The percentage increases in conflicts from the reference organisation are shown in red.

Overall, there was an 11% increase in the total conflicts at FL165+ on the Friday and 14% on Saturday. The results for the Friday were: Romania +73%, Bulgaria virtually unchanged and Turkey +5%. Romania had the largest OAT sample and most of the increased conflicts occurred there. Four main areas were affected:

- CND-TND-GALIT;
- TGJ-RASVA-OSTOV-LOPRA;
- SA-FAGET;
- CLJ-TGM.

The results for Turkey and Bulgaria indicate that the civil/military interface in both countries is very clearly defined. They also suggest, together with the results for the reference organisation, that a more flexible use of the airspace could be made with increased cooperation between the civil and military authorities in each country. The results for Romania, on the other hand, indicate a more flexible approach between the authorities but one that requires more tactical coordination between the controllers concerned.
4 REVISED SCENARIO ORGANISATION

This organisation tested a route network based on Version 2 of the EUR-ANP as depicted in Map 2 (2 February 1995) and applied the recommended flows contained in annex 8/chart 8B of the EATCHIP report “Route Network Development and Associated Sectorisation Improvements in the ECAC Area”.

All aircraft were simulated in free vertical profile which necessitated the removal of level restrictions such as Istanbul departures to RIXEN climbing to FL240 until after RIXEN. No military flights were simulated.

MAP 4, appendix A, shows the route network simulated. The routes shown in pink are the new routes tested. Table 4 summarises the main changes.

<table>
<thead>
<tr>
<th>Direction</th>
<th>Route Segment</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>South &amp; East</td>
<td>ARD-DOMNA-TALIK-TBN-ERZ-BONAM</td>
<td>Unidirectional until TALIK and again from ERZ to BONAM. Ankara arrivals route TALIK-ASTAL.</td>
</tr>
<tr>
<td></td>
<td>ERZ-VAN-BNMXX(-TBZ)</td>
<td>Tested as a tactical contingency route in the event of difficulty in achieving 15 minutes separation at BONAM.</td>
</tr>
<tr>
<td></td>
<td>TGI-IST-YAA-MUT TGI-IST-YAA-KFK</td>
<td>Requires BULEN (ROM/BUL) to be moved to the west.</td>
</tr>
<tr>
<td></td>
<td>BLO-ADORU-EKI BLO-ADORU-DENIZ-LTBA BLO-ADORU-BANDO-KFK BLO-ADORU-BANDO-MUT</td>
<td>ADORU is the intersection between BLO-YAA and RAD-EKI. BLO to ADORU is very close to Greek northern boundary. Via EKI for Izmir/Dalaman/Antalya arrivals only.</td>
</tr>
<tr>
<td></td>
<td>CND-LBWN/LBBG dct.</td>
<td>For Burgas/Varna arrivals via CND. Tested to reduce the load between CND and MATEL.</td>
</tr>
<tr>
<td></td>
<td>CND-IST-CRD CND-IST-YAA-KFK CND-IST-YAA-MUT</td>
<td>Dualised U/G1. Via CRD for Antalya and Dalaman arrivals only. YAA-MUT dualised with MUT-BKZ.</td>
</tr>
<tr>
<td></td>
<td>CND-DOMNA-TALIK-TBN-ERZ CND-DOMNA-BAG-MUT</td>
<td>DOMNA-BAG bi-directional. Ankara arrivals route TALIK-ASTAL.</td>
</tr>
<tr>
<td></td>
<td>PELES-CCO</td>
<td>Requires LOMOS (ROM/BUL) to be moved to the west. Flight Level Allocation System applied to all Greek arrivals - level FL290/270 on crossing UA4.</td>
</tr>
</tbody>
</table>

Table 4

Using this route structure, the new recommended flows were applied. In applying these flows, North Germany was considered to be the Berlin FIR/UIR and all airports north of Düsseldorf, North UK was considered to be all airports from Newcastle northwards, and Iran, UAE and Oman were included with the Far East traffic.
These flows are summarised in tables 5a (below) and 5b (next page). In keeping with the colour scheme used in chart 8b of the EATCHIP report mentioned above, the blue arrow indicates a south- or eastbound flow and the red a north- or westbound flow.

**Note:** DF = Frankfurt, DK = Köln, DL = Düsseldorf, DM = Munich, DN = Nürnberg, DS = Stuttgart.

<table>
<thead>
<tr>
<th>FLOW</th>
<th>ROUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany (S) UK (S) France Luxembourg Switzerland Belgium</td>
<td>BATOG BATOG-BULEN BATOG-DOMNA-TALIK-ASTAL BATOG-DOMNA-TALIK-BONAM BATOG-LOMOS-CCO</td>
</tr>
<tr>
<td>➔ Romania</td>
<td>➔ Burgas/Varna</td>
</tr>
<tr>
<td>➔ Sofia</td>
<td>➔ Istanbul</td>
</tr>
<tr>
<td>➔ Greece/Egypt</td>
<td>➔ NARLA-LOMOS-CCO</td>
</tr>
<tr>
<td>Germany (N)</td>
<td>➔ Burgas/Varna</td>
</tr>
<tr>
<td>➔ Romania</td>
<td>➔ Greece</td>
</tr>
<tr>
<td>➔ Istanbul</td>
<td>➔ Ankara</td>
</tr>
<tr>
<td>➔ TALIK-ASTAL-SALGO-BKZ</td>
<td>➔ TALIK-ASTAL</td>
</tr>
<tr>
<td>➔ CATAL/SORET</td>
<td>➔ ANGOL/BIKAR/CAST/SORET-CND</td>
</tr>
<tr>
<td>➔ Former Soviet Union</td>
<td>➔ Istanbul</td>
</tr>
<tr>
<td>➔ BUKOV</td>
<td>➔ BUKOV/TIKRU-CND</td>
</tr>
<tr>
<td>➔ Romania</td>
<td>➔ Burgas/Varna</td>
</tr>
<tr>
<td>➔ Istanbul</td>
<td>➔ Ankara</td>
</tr>
<tr>
<td>➔ Austria</td>
<td>➔ BATOG</td>
</tr>
<tr>
<td>➔ Roman</td>
<td>➔ Istanbul</td>
</tr>
<tr>
<td>➔ Ankara</td>
<td>➔ Middle East</td>
</tr>
<tr>
<td>➔ Amsterdam</td>
<td>➔ TIKRU-CND-DOMNA-TALIK-ASTAL</td>
</tr>
<tr>
<td>➔ Istanbul</td>
<td>➔ Izmir</td>
</tr>
<tr>
<td>➔ TIKRU-CND-DOMNA-TALIK-ASTAL</td>
<td>➔ TIKRU-CND-DOMNA-TALIK-BAG-MUT-VESAR</td>
</tr>
<tr>
<td>➔ KAL-ADORU-DENIZ</td>
<td>➔ KAL-ADORU-EBKI-BERGO</td>
</tr>
</tbody>
</table>

**Table 5a**
### Table 5b

<table>
<thead>
<tr>
<th>FLOW</th>
<th>ROUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Iran, UAE, Oman, Far East</strong></td>
<td><strong>Turkey</strong>&lt;br&gt;<strong>Germany (N)</strong>&lt;br&gt;<strong>UK (S), Germany (S), France/Switzerland, Amsterdam, Austria</strong></td>
</tr>
<tr>
<td><strong>Greece</strong></td>
<td><strong>Germany (DM/DS, DN/DS), France/Switzerland</strong>&lt;br&gt;<strong>Germany (DK/DL), UK (all), Austria, Amsterdam</strong>&lt;br&gt;<strong>Germany (N), Scandinavia</strong></td>
</tr>
<tr>
<td><strong>Middle East</strong></td>
<td><strong>Turkey</strong>&lt;br&gt;<strong>UK (S), France/Switzerland, Germany (S)</strong>&lt;br&gt;<strong>Amsterdam, Austria, Hungary</strong></td>
</tr>
<tr>
<td><strong>Cyprus/Israel</strong></td>
<td><strong>Turkey</strong>&lt;br&gt;<strong>Germany (N)</strong>&lt;br&gt;<strong>Denmark, Norway, Sweden</strong>&lt;br&gt;<strong>Finland</strong>&lt;br&gt;<strong>Former Soviet Union</strong>&lt;br&gt;<strong>UK (S), France/Switzerland</strong>&lt;br&gt;<strong>UK (N), Austria, Hungary</strong></td>
</tr>
<tr>
<td><strong>Istanbul</strong></td>
<td><strong>Iran, UAE, Far East</strong>&lt;br&gt;<strong>Middle East/Cyprus</strong>&lt;br&gt;<strong>Israel/Egypt</strong>&lt;br&gt;<strong>Germany (S), UK (S), France/Switzerland</strong>&lt;br&gt;<strong>Former Soviet Union</strong>&lt;br&gt;<strong>Germany (N)</strong>&lt;br&gt;<strong>Austria/Amsberg/Hungary</strong></td>
</tr>
<tr>
<td><strong>Dalaman, Izmir</strong></td>
<td><strong>Germany (S), UK (S), France/Switzerland</strong>&lt;br&gt;<strong>UK (N), Austria, Amsterdam</strong>&lt;br&gt;<strong>Germany (N), Scandinavia</strong></td>
</tr>
<tr>
<td><strong>Antalya</strong></td>
<td><strong>Germany (S), France/Switzerland</strong>&lt;br&gt;<strong>Germany (N), Scandinavia</strong>&lt;br&gt;<strong>Amsterdam, Austria</strong>&lt;br&gt;<strong>Former Soviet Union</strong></td>
</tr>
<tr>
<td><strong>Ankara</strong></td>
<td><strong>Germany (S), France/Switzerland</strong>&lt;br&gt;<strong>Germany (N)</strong>&lt;br&gt;<strong>Amsterdam, Austria</strong></td>
</tr>
<tr>
<td><strong>Burgas, Varna</strong></td>
<td><strong>Former Soviet Union</strong>&lt;br&gt;<strong>Germany (N), Scandinavia</strong>&lt;br&gt;<strong>Germany (DF/DK/DL), UK (S)</strong>&lt;br&gt;<strong>Germany (DM/DS, DN/DS), France/Switzerland</strong></td>
</tr>
<tr>
<td><strong>Sofia</strong></td>
<td><strong>Former Soviet Union</strong>&lt;br&gt;<strong>Greece, Egypt, Italy, Spain</strong>&lt;br&gt;<strong>Germany (S), France/Switzerland, UK</strong>&lt;br&gt;<strong>Germany (N), Hungary, Austria</strong></td>
</tr>
<tr>
<td><strong>Bucharest</strong></td>
<td><strong>Cyprus/Israel</strong>&lt;br&gt;<strong>Iran, UAE, Far East</strong>&lt;br&gt;<strong>Middle East</strong>&lt;br&gt;<strong>Former Soviet Union</strong>&lt;br&gt;<strong>Austria, Germany (DF), UK (S), Amsterdam, Hungary, Belgium</strong>&lt;br&gt;<strong>France/Switzerland, Germany (DM), Italy, Spain</strong></td>
</tr>
</tbody>
</table>

In applying flows to a traffic sample there is always a risk of applying them too rigidly leading to a significant flow being lost from a particular country. There was a certain element of that here and the Romanian delegation expressed its reservations about one specific flow - south UK to Turkish airports. In the reference organisation most of this traffic routed via BATOG but was simulated here via KAL.
4.1 Sectorisation

Because the future Black Sea sectorisation is still unknown, it was decided to simulate the FIR/UIR boundaries as they are today (1995) and to add a fourth sector ("Blacksea") for the revised scenario. The effect of this, however, was to understate the real number of aircraft that would have been controlled by Bulgaria and Romania under any new boundary arrangements.

For Romania, any boundary change would mean the inclusion of DOMNA in its airspace and, therefore, the traffic through this point via KORAT or ANGOL. For Bulgaria, the boundary changes would mean the inclusion of either the bi-directional BAG-DOMNA route on its own, or the same route plus the busier unidirectional DOMNA to TALIK route.

The results are based on the 1995 boundaries. However, it was possible to calculate the influence of the new flows and network in the context of possible changes, and this is commented on where appropriate.

4.2 Distribution of Traffic

The evolution of the traffic during each day was similar to that in the reference organisation. Fig 9 shows the comparison between the number of aircraft controlled by each country in the revised scenario and in the reference organisation for both days. The figures in red indicate the percentage change.

The reductions in aircraft numbers occurred in Bulgaria and Romania only. In the context of the FIR/UIR boundaries remaining as they are, i.e. as simulated, these reductions were due entirely to the application of the new flows and route network. This led to a better distribution of traffic between the two States and also to the transfer of aircraft previously controlled to the Blacksea sector. However, as mentioned above, the percentage reductions are overstated if looked at in terms of any future boundary changes.

In the case of Romania, aircraft numbers would be higher with the inclusion of the KORAT/ANGOL traffic via DOMNA. Further analysis showed that, with this traffic included, the influence of the new flows and route network would be a percentage reduction in aircraft numbers of 3% on Friday and 9% on Saturday.

As far as Bulgaria is concerned, the inclusion of the bi-directional BAG to DOMNA route would have had little impact on the results but the inclusion of the last named route plus the busier DOMNA to
TALIK route would mean that the influence of the new flows and route network would be a percentage reduction in traffic of 4% on Friday and 6% on Saturday.

**Significant Flows of Traffic**

MAP 5, appendix A, shows all routes that had 24 aircraft or more during one or both days as well as the numbers of aircraft for most of the new routes simulated.

The more important route segments (94+ aircraft per 24 hours) are listed in **table 6** and shown in MAP 5A.

<table>
<thead>
<tr>
<th>Direction</th>
<th>Route Segment</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>South &amp; East</td>
<td>BATOG-DOMNA-TALIK</td>
<td>New route taking all Ankara, Middle East and Iran/UAE/Oman/Far East traffic entering at BATOG.</td>
</tr>
<tr>
<td></td>
<td>TALIK-ASTAL</td>
<td>All Ankara inbounds ex DOMNA route via TALIK to avoid a military area north-west of Ankara.</td>
</tr>
<tr>
<td></td>
<td>TIKRU-CND-IST</td>
<td>New route accommodating mostly Istanbul/Antalya/Dalaman arrivals from northern Europe and the former Soviet Union.</td>
</tr>
<tr>
<td></td>
<td>ADORU-RDBAI</td>
<td>Mostly Istanbul arrivals.</td>
</tr>
<tr>
<td></td>
<td>VAN-BONAM</td>
<td>Traffic via BAG and via TALIK meet at VAN for BONAM.</td>
</tr>
<tr>
<td>North &amp; West</td>
<td>DASIS-ERZ</td>
<td>Increased traffic from Iran/UAE/Oman/Far East to central and northern Europe crossing the Black Sea and avoiding the Istanbul area.</td>
</tr>
<tr>
<td></td>
<td>BUK-BKZ</td>
<td>Mostly Ankara departures for Istanbul and central Europe via KAL.</td>
</tr>
<tr>
<td></td>
<td>LTBAJ-RAD-BLO-KAL</td>
<td>Half of the traffic is departing Istanbul and joining Izmir/Dalaman traffic mostly to KAL.</td>
</tr>
<tr>
<td></td>
<td>IMR-ADOI</td>
<td>Izmir/Dalaman traffic northbound including Istanbul arrivals.</td>
</tr>
<tr>
<td></td>
<td>BGDOJ-BGWNJ</td>
<td>Numbers increased to over 100 on the Friday by 13 Ankara departures via SALGO to GLT unable to take advantage of the direct routeing BAG-GLT due to the military area north-west of Ankara.</td>
</tr>
<tr>
<td></td>
<td>RODOP-OSTV1-DVA</td>
<td>Northbound traffic was previously spread between RODOP and CCO. Traffic from RAD joins at OSTV1</td>
</tr>
<tr>
<td></td>
<td>DVA-JULIA (BKS)</td>
<td>Traffic from KOMAN, RODOP and Bucharest join at DVA.</td>
</tr>
<tr>
<td></td>
<td>GLT-JULIA (BKS)</td>
<td>New route with traffic for central Europe from the Black Sea.</td>
</tr>
</tbody>
</table>

**Table 6**

4.3 Interaction of the Flows

Figs 10a and 10b (next page) give a comparison between the reference organisation and the revised scenario for the radar conflicts at FL165+ and above, one chart for each day.

The total number of radar conflicts FL165+ was down by 40% on both days. The largest fall was in the number of opposite direction conflicts: down by 85% on both days. Same direction conflicts fell by a third, again on both days. However, it was not all good news; the total number of crossing conflicts rose by 35% on the Friday and 50% on the Saturday. This increase occurred in Romania and Turkey only, as Bulgaria had less crossing conflicts than in the reference organisation.

Bulgaria’s total radar conflicts fell by 70%. Opposite direction conflicts were almost eliminated due to the dualisation of the U/G1 and UA4 and the organisation of north/south flows at RODOP/CCO. Crossing conflicts were down by 60% due to the Flight Level Allocation System simulated for aircraft to/from Greece crossing the UA4 in the BLO area (FL280/260 northbound and FL290/270 southbound).
Turkey's total conflicts fell by 45%. This was due to reductions of 25% in same direction and 80% in opposite direction conflicts with the separation of opposite climbing/descending flows such as the Istanbul, Antalya, Izmir and Dalaman traffic. Crossing conflicts increased, however, by 25% on the Friday and 50% on the Saturday, but no definite reason could be found for this. Two possible explanations are: firstly, the increase in the number of intersecting routes as a result of the new route network and, secondly, a number of same direction conflicts becoming crossing conflicts with the separation of the flows. Optimisation of the route network would help here. As a percentage of the total number of conflicts for Turkey, crossing conflicts amounted to 30% on Friday and 40% on Saturday.

Romania's total conflicts increased by 60%. Crossing conflicts became the major problem, representing 75% of each day's total. On the Friday these conflicts more than doubled in the revised scenario and on the Saturday more than trebled, putting Saturday's total radar conflicts for Romania almost on a par with Turkey. They occurred in two main areas: the GLT area and the route segment ARD to DOMNA, in the area between CND and DINRO. In both cases, it was simply a matter of two major same-direction flows crossing each other.
MAP 6, appendix A, shows the main conflict areas and table 7 summarises these areas.

<table>
<thead>
<tr>
<th>ROMANIA</th>
<th>Conflicts Fri</th>
<th>Conflicts Sat</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ARD - DOMNA</td>
<td>25</td>
<td>37</td>
<td>Mostly CROSSING conflicts. 75% of them concerned traffic on the ARD-DOMNA route versus traffic on the CND-IST route. 20% involved LBBG/LBWN arrivals or departures.</td>
</tr>
<tr>
<td>2 GLT</td>
<td>16</td>
<td>19</td>
<td>Mostly all CROSSING conflicts. Two major westbound flows intersect: TALIK-GLT-JULIA (BKS) and CND-GLT-KARIL. Some conflicts also involved traffic to/from SORET.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BULGARIA</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3 BLO - RADS</td>
<td>7</td>
<td>20</td>
<td>Almost all the conflicts were supervisions due to level adjustments being made before the boundary with Turkey, i.e. with aircraft not having the required 20nm separation at RADS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TURKEY</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4 LTBAJ - RAD</td>
<td>22</td>
<td>17</td>
<td>Practically all conflicts concerned Istanbul departures in climb to their respective cruising levels. Some of these (10%) were CROSSING conflicts with Izmir arrivals from RIXNW or RADE having changed level with the change of direction at these two points.</td>
</tr>
<tr>
<td>5 RAD</td>
<td>15</td>
<td>16</td>
<td>80% of the conflicts here were due to Izmir/Dalaman departures joining or crossing the main flow.</td>
</tr>
<tr>
<td>6 ADORU - RDBAI</td>
<td>22</td>
<td>10</td>
<td>All conflicts along this segment were due to Istanbul arrivals descending and in conflict with lower transit aircraft or with each other.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BLACKSEA</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7 DOMNA</td>
<td>15</td>
<td>9</td>
<td>Mostly CROSSING conflicts between traffic to TALIK and traffic from KORAT.</td>
</tr>
</tbody>
</table>

Table 7

In the context of the revised FIR/UIR boundaries, the influence of the new route network and flows would mean a reduction of 35% in the total number of radar conflicts. Similar reductions to those found when simulating the present-day boundaries in the revised scenario would also be found for both Bulgaria and Turkey. However, in the case of Romania, which would include DOMNA and its conflicts in the airspace, the total number of radar conflicts would almost double compared to the reference organisation. Again, the main problem with Romania would be the high number of crossing conflicts.

Other Results

It was decided not to simulate a Flight Level Allocation System in the DVA/PELES area for aircraft via NARKA or KARIL to/from Greek airports as the distance from Athens is approximately 450nm and any such FLAS would be punitive. In the end, the crossing conflicts were slightly reduced for both areas in the revised scenario, even after combining the conflicts for the two points, each, where the NARKA or KARIL flows intersect the now-split ARD or JULIA (BKS) flows, respectively: DVA area from 13 (Fri) and 16 (Sat) in the reference organisation to a combined 11 (Fri) and 14 (Sat) in the revised scenario; PELES area from 18 and 12 in the reference to 13 and 12 in the revised.

Because of the increased traffic routeing through BONAM (Turkey to Iran) and the need to establish 15 minutes separation between aircraft at the same level, a tactical contingency route was simulated from VAN direct to TBZ for use in cases where the 15 minutes could not be established, due to the “bunching” of aircraft, with the only option being to reclear the aircraft at an inefficient level such as FL270. On both days there were six occasions, representing 6% of the daily traffic, when this tactical route had to be resorted to.
4.4 Work Index

Figs 11a and 11b, one chart for each day, compare the work index figures for the reference organisation with those calculated for the revised scenario. The number of aircraft is also included.

The biggest change occurred with Bulgaria which, over the two days, showed a reduction of 35% in the index and a 20% decrease in traffic. Turkey's index fell by 20% with aircraft levels remaining the same and Romania showed a slight increase on the Friday and a slight decrease on the Saturday for an average 10% fall in traffic. Also, there was an improved balance in the work index between the three States (the standard deviation [dispersion about the mean value] fell by 33% on the Friday and 50% on the Saturday). Romania and Bulgaria returned almost identical indices between them.

In terms of work index points per aircraft, Romania was up from 1.2 points to 1.3 in the revised scenario, Bulgaria down from 1.5 to 1.2 and Turkey also down from 1.6 to 1.3.
In the context of the revised boundaries, the inclusion of DOMNA in Romanian airspace would have led to increases in the work index of 13% on the Friday and 4% on the Saturday as compared to the reference organisation. Similarly, including the BAG-DOMNA and DOMNA-TALIK routes in Bulgarian airspace would have led to a smaller, but still significant, reduction of 25% in Bulgaria’s work index from that recorded in the reference organisation.

4.5 Summary of Results for the Revised Scenario

Present-Day Black Sea FIR/UIR Boundaries

- Simulating the new flows and route network led to a 17% decrease in Bulgaria's traffic and a 10% decrease in Romania's, with the figures for Turkey remaining virtually unchanged.

- The total number of radar conflicts (including the Blacksea sector) was down by 40%, the biggest fall occurring in the number of opposite direction conflicts, down 85%, due to the separation of climbing and descending opposite direction flows.

- Romania was the only country to experience an increase in total radar conflicts - up by 60%. Bulgaria and Turkey experienced decreases of 70% and 45%, respectively.

- The work index for Bulgaria fell by 35%, for Turkey by 20% and was almost unchanged for Romania.

- Some problem areas still remained:
  ⇒ Bulgaria - BLO to RADS;
  ⇒ Romania - GLT and ARD to DOMNA;
  ⇒ Turkey - LTBAJ to RAD and ADORU to RDBAI;
  ⇒ Blacksea - DOMNA.

Influence of the New Flows and Route Network with Possible FIR/UIR Boundary Changes

- The results for Turkey would remain the same as for the revised organisation.

- The influence of the new route network and flows would be an overall reduction of 35% in the number of radar conflicts compared to the reference organisation.

- The inclusion of DOMNA in Romanian airspace and, therefore, the KORAT or ANGOL traffic would mean a percentage reduction in aircraft numbers of 3% on Friday and 9% on Saturday.

- Romania’s radar conflicts would almost double compared to the reference organisation due to the high number of crossing conflicts.

- The work index for Romania would increase by 13% on the Friday and 4% on the Saturday as compared to the reference organisation.

- For Bulgaria, including the bi-directional BAG-DOMNA route, on its own, would have little impact.

- The inclusion of the BAG-DOMNA route plus the busier DOMNA to TALIK route would lead to a percentage reduction in aircraft numbers of 4% on Friday and 6% on Saturday from the reference organisation.

- Similar reductions in the number of radar conflicts found for Bulgaria in the revised scenario with the present-day boundaries would also be found with the inclusion of the two routes.

- There would be a reduction of 25% in Bulgaria’s work index from that recorded in the reference organisation.
5 SUMMARY OF RESULTS AND CONCLUSIONS

5.1 Reference Organisation

- There was a roughly equal mix of transit, international arrival and international departure traffic in Turkey. For both Bulgaria and Romania a high level of transit traffic was recorded (>80%), a large proportion of which was landing or departing Turkey.

- The most significant volumes of traffic were those serving Turkish and German airports with 25% and 17% of the samples, respectively.

- Of the three States simulated, the results indicated Romania as having the greatest amount of potential spare capacity.

- The areas giving the greatest problems were:
  ⇒ Bulgaria - MATEL to RIXEN and BLO to RAD;
  ⇒ Turkey - ADELI to RIXEN, BERGO to BIG, KFK to KUMRU and GOY to PETAR.

- Apart from the wider use of the Black Sea airspace and the harmonisation of flows to relieve the congestion over the Istanbul area, the results showed the need to:
  ⇒ Dualise the U/G1 between Constanta and Istanbul.
  ⇒ Dualise the UA4 between BLO and Istanbul.
  ⇒ Use CCO for southbound and RODOP for northbound traffic and consider the introduction of a Flight Level Allocation System where these flows intersect the UA4.
  ⇒ Provide discrete inbound and outbound routeings for Burgas and Varna traffic via CND, and also for Izmir and Antalya traffic.

5.2 Reference Organisation with the Military Samples Added

- Practically all of the radar conflicts between civil and military aircraft occurred in Romania, indicating a flexible approach between the civil and military authorities there but one that requires more tactical coordination between the controllers concerned.

- The results for Turkey and Bulgaria suggest that the civil/military interface in both countries is very clearly defined. They also suggest, together with the results for the reference organisation, that a more flexible use of the airspace could be made with increased cooperation between the civil and military authorities in each country.

5.3 Revised Scenario


- Simulating the new flows and route network led to a 17% decrease in Bulgaria’s traffic and a 10% decrease in Romania’s, with the figures for Turkey remaining virtually unchanged.

- The total number of radar conflicts (including the Blacksea sector) was down by 40%, the biggest fall occurring in the number of opposite direction conflicts, down 85%, due to the separation of climbing and descending opposite direction flows.

- Romania was the only country to experience an increase in total radar conflicts - up by 60%. Bulgaria and Turkey experienced decreases of 70% and 45%, respectively.

- The work index for Bulgaria fell by 35%, for Turkey by 20% and was almost unchanged for Romania.
Some problem areas still remained:

- Bulgaria - BLO to RADS;
- Romania - GLT and ARD to DOMNA;
- Turkey - LTBAJ to RAD and ADORU to RDBAI;
- Blacksea - DOMNA.

Influence of the New Flows and Route Network with Possible FIR/UIR Boundary Changes

- The results for Turkey would remain the same as for the revised organisation.
- The influence of the new route network and flows would be an overall reduction of 35% in the number of radar conflicts compared to the reference organisation.
- The inclusion of DOMNA in Romanian airspace and, therefore, the KORAT or ANGOL traffic would mean a percentage reduction in aircraft numbers of 3% on Friday and 9% on Saturday.
- Romania’s radar conflicts would almost double compared to the reference organisation due to the high number of crossing conflicts.
- The work index for Romania would increase by 13% on the Friday and 4% on the Saturday as compared to the reference organisation.
- For Bulgaria, including the bi-directional BAG-DOMNA route, on its own, would have little impact.
- The inclusion of the BAG-DOMNA route plus the busier DOMNA to TALIK route would lead to a percentage reduction in aircraft numbers of 4% on Friday and 6% on Saturday from the reference organisation.
- Similar reductions in the number of radar conflicts found for Bulgaria in the revised scenario with the present-day (1995) boundaries would also be found with the inclusion of the two routes.
- There would be a reduction of 25% in Bulgaria’s work index from that recorded in the reference organisation.

5.4 Conclusions and Recommendations

This simulation provides an overview of the aircraft loadings and conflicts on the routes which are proposed in Version 2 of EUR-ANP. As such, they depict an ideal system which does not take into account the constraints currently imposed on planners as a result of the situation in former Yugoslavia and the political problem of the Black Sea FIR boundary delineation. Nevertheless, the results can be used to plan improvements to the route network in the area.

The results show that the new flows and route network provide a more efficient organisation of airspace in Bulgaria and Turkey, and should increase capacity. Romania will experience a moderate increase in workload with the inclusion of DOMNA in the airspace.

Considerable benefit was derived from simulating the separation of climbing and descending opposite-direction flows in Bulgaria and Turkey. To make this a reality and to permit a more flexible use of the airspace, closer cooperation between the civil and military authorities in both Bulgaria and Turkey will be required, as the results show that the civil/military interface is very clearly defined in both countries.

In reviewing the final results, the important views of the Turkish delegation were not available as the representatives were unable to attend the meeting. Although the beneficial results of the study are quite clear, the absence of the opinions of such a pivotal State is regrettable. Also, it would be desirable, though not necessary, to simulate the optimisation of the new route network in a further study. Should this be done, any significantly different views from Turkey or any other changes to the agreed network could also be included.
The simulation was carried out using a base 1994 traffic sample. During the course of the study, traffic in the area has increased. Should the Black Sea boundary issue remain unresolved while the traffic continues to increase there will be a high loading on the Istanbul to JULIA (BKS), KEREK and KARIL routes. The solution to this problem will require the retention of the ARGES to ORA (KEREK) route as an important offload for the parallel KOMAN-BKS route.

Finally, the study concludes that Version 2 of the EUR-ANP will provide an overall better balanced distribution of traffic and workload. It will reduce the loadings in the bottleneck areas and, therefore, should increase overall capacity. However, the full benefits of Version 2 are dependent upon the implementation of the new routes over the Black Sea, so the consequential increases in capacity can only be realised when these routes have been implemented. A resolution of the Black Sea FIR boundary issue is, therefore, an urgent necessity.
VERSION FRANCAISE DU SOMMAIRE ET DES CONCLUSIONS

SIMULATION PAR MODELE ESPACE ETUDE TOP-DOWN
DU RESEAU DES ROUTES ET DU DEVELOPPEMENT
DES ESPACES AERIENS DE LA BULGARIE, LA ROUMANIE ET LA TURQUIE

de

R. Dowdall

SOMMAIRE

En raison de l’accroissement du trafic en Bulgarie, en Roumanie et en Turquie, accentué par la situation en ex Yougoslavie, et par l’éventualité d’une solution pour les limites de la FIR de la Mer Noire (Simferopol), il a été décidé par le développement EATCHIP, de réaliser une simulation Modèle Espace de ces régions afin d’évaluer l’impact d’un futur réseau de routes sur l’espace aérien déjà existant.

L’approche top-down de la modélisation d’un espace consiste à examiner les principaux flux de trafic (généralement libre-profil vertical) et la façon dont ils se mélangent au sein de n’importe quel espace aérien multinational. L’idée purement expérimentale est de développer un système idéal d’espace aérien qui ne subisse aucune contrainte quelle qu’elle soit, ni en raison des limites existantes de la FIR/UIR, ni de facteurs politiques.

Le but de cette étude était d’évaluer un réseau de routes ATS (ARN) en respectant la sectorisation aérienne, mais sans tenir compte des actuelles contraintes de limites de la FIR. Ce réseau devait :

- Tenir pleinement compte des demandes, en termes d’espace aérien, du trafic civil et militaire, qu’il soit actuel ou futur.
- Avoir la capacité de gérer les demandes futures du trafic.
- Être fondé sur le réseau de routes ATS (ARN) approuvé, et être une des composantes de son futur développement.
- Offrir une flexibilité totale, en accord avec le concept d’utilisation flexible de l’espace aérien.
- Réduire dans la mesure du possible, la longueur des routes pour les compagnies.
- Recevoir l’entière approbation des représentants civils et militaires.

Deux organisations principales ont été simulées :

- Une organisation dite de référence simulant le réseau des routes en vigueur au 15/16 juillet 1994 (vendredi/samedi), utilisant un échantillon de trafic de 24 heures pour chaque jour.


L’espace aérien simulé était la TMA et les secteurs en route des FIR/UIR de la Bulgarie, de la Roumanie et de la Turquie, ainsi que la partie de la FIR/UIR de Simferopol sur la Mer Noire qui était affecté par les changements de routes. Les limites 1995 de la FIR/UIR ont été utilisées pour ces deux organisations.
La simulation de l’organisation de référence a montré que :

- Parmi les trois États simulés, les résultats indiquent que c’est la Roumanie qui a le plus important potentiel de capacité.

- Les zones présentant les problèmes les plus importants sont (voir Carte 3 en annexe A) :
  - Bulgarie : MATEL à RIXEN et de Bailovo (BLO) à Radovets (RAD);
  - Turquie : ADELI à RIXEN, BERGO à Biga (BIG), Afyòn (KFK) à KUMRU et de Goynuk (GOY) à PETAR.

- Mis à part la plus large utilisation de l’espace aérien au-dessus de la Mer Noire et l’harmonisation des flux en vue de soulager l’encombrement de la région d’Istanbul, il était nécessaire de :
  - Dédouble l’U/G1 entre Constanta (CND) et Istanbul.
  - Dédouble l’UA4 entre BLO et Istanbul.
  - Utiliser Chouchouligovo (CCO) pour le trafic vers le sud et RODOP pour le trafic vers le nord et étudier l’introduction d’un système d’allocation de niveaux de vols (FLAS) à l’intersection de ces vols avec l’UA4.
  - Donner des routes séparées pour les vols en provenance et à destination de Burgas et Varna via CND, ainsi que pour ceux d’Izmir et d’Antalya.

Puisque la future sectorisation de la Mer Noire est toujours inconnue, ce sont les limites de 1995 des FIR/UIR qui ont été choisies pour la future organisation. Les résultats des nouveaux flux et du nouveau réseau de routes simulés (incluant les routes au-dessus de la Mer Noire) utilisant les limites 1995 de la FIR/UIR, ont montré que :

- La redistribution des avions a résulté en une baisse de trafic de 17% pour la Bulgarie et une baisse de 10% pour la Roumanie, alors que les chiffres demeuraient inchangés pour la Turquie.

- Le nombre de conflits radar pour l’espace tout entier a baissé de 40%, la plus forte baisse concernant le nombre de conflits de direction opposée, qui a baissé de 85%, grâce à la séparation des flux de direction opposée, en montée et en descente.

- La Roumanie a été le seul pays qui ait connu une augmentation du nombre total de conflits radar - jusqu’à 60%, mais sur une base très faible. La Bulgarie et la Turquie ont connu respectivement une baisse de 70% et de 45%.

- Quelques problèmes demeurent pour certaines régions (voir Carte 6 en annexe A) :
  - Bulgarie : de BLO à RADS;
  - Roumanie : la région de Galati (GLT) et la route de Arad (ARD) à DOMNA, au sud de CND.
  - Turquie : de LTBAJ à RAD et de ADORU à RDBAI;
  - Mer Noire : DOMNA.

Simuler les limites 1995 de la FIR/UIR a entraîné une sous estimation du nombre d’avions qui devraient être contrôlés par la Bulgarie et la Roumanie dans le cadre de nouvelles frontières. Pour la Roumanie, n’importe quel changement de limite impliquerait d’inclure DOMNA dans son espace et en conséquence d’intégrer également le trafic qui passe par ce point via KORAT ou ANGOL. Pour la Bulgarie, les changements de limites impliquerait d’inclure soit la route bi-directionnelle Baglum (BAG)-DOMNA seulement, ou bien cette même route plus la route uni-directionnelle DOMNA à TALIK, plus chargée.

Afin de déterminer l’influence de ces nouveaux flux et réseau de routes dans le cadre d’éventuels futurs changements de limites, de plus amples études ont été menées et démontrent que :

- L’influence de ces nouvelles routes et nouveaux flux permettrait de réduire de 35% le nombre de conflits radar par rapport à l’organisation de référence.
• Les résultats pour la Turquie resteraient les mêmes que dans l’organisation future.

• L’intégration de DOMNA dans l’espace aérien roumain, ce qui entraînerait l’inclusion du trafic survolant KORAT ou ANGOL, générerait une réduction moyenne de 6% du nombre d’avions par rapport à l’organisation de référence.

• Les conflits radar de la Roumanie doubleraient presque par rapport à l’organisation de référence (mais sur une base relativement faible) en raison du nombre élevé de conflits de croisement.

• Pour la Bulgarie, l’intégration de la route bi-directionnelle BAG-DOMNA seulement n’aurait que peu d’impact.

• L’intégration de la route BAG-DOMNA plus celle, plus chargée, de DOMNA à TALIK entraînerait une réduction moyenne de 5% du nombre d’avions, par rapport à l’organisation de référence.

• Des réductions similaires dans le nombre de conflits radar se produiraient pour la Bulgarie dans le cadre de la future organisation simulée avec les limites 1995, ainsi que dans le cas de l’intégration des deux routes.
CONCLUSIONS ET RECOMMANDATIONS

Cette simulation offre une vue d'ensemble de la charge de trafic et des conflits sur les routes proposées dans la version 2 de EUR-ANP. En tant que tel, c’est un système idéal qui ne tient pas compte des contraintes actuelles imposées aux planificateurs par la situation dans l’ex Yougoslavie, ni des problèmes politiques du tracé des limites de la FIR de la Mer Noire. Les résultats peuvent néanmoins être pris en compte pour l’amélioration du réseau de routes dans cette région.

Les résultats montrent que les nouveaux flux et les nouvelles routes engendreraient une organisation plus efficace de l’espace aérien en Bulgarie et en Turquie, et permettraient d’accroître la capacité. La Roumanie connaîtrait une augmentation modérée de la charge de travail avec l’intégration de DOMNA dans son espace aérien.

La simulation de flux séparés pour les descentes et les montées de direction opposée en Bulgarie et en Turquie a monté des avantages considérables. Pour faire de ceci une réalité et permettre une plus grande flexibilité de l’utilisation de l’espace, une coopération plus étroite entre les autorités civiles et militaires tant en Bulgarie qu’en Turquie serait nécessaire, les résultats montrant que l’interface civile/militaire est clairement définie dans ces deux pays.

Lors de la présentation finale des résultats, le point de vue de la délégation turque n’a pu être exposé, ses représentants n’ayant pu participer à la réunion. Bien que les avantages révélés par cette étude ne fassent aucun doute, l’absence d’un tel état pivot ne peut être que regrettable. Il serait donc souhaitable, bien que non indispensable, de simuler l’optimisation du nouveau réseau de routes dans le cadre d’une prochaine étude. Dans le cas où elle serait réalisée, tout différent point de vue significatif émis par la Turquie, ou toute autre modification du réseau approuvé pourrait être prise en compte.

La simulation a été menée sur la base d’un échantillon de trafic de 1994. Pendant son déroulement, le trafic de cette région a augmenté. Si le problème des limites du secteur de la Mer Noire demeure irrésolu, alors que le trafic continue d’augmenter, une forte charge se produira sur les routes d’Istanbul à JULIA/KEREK/KARIL. Résoudre ce problème passera par le maintien de la route de ARGES à Oradea (ORA)/KEREK comme une route de soulagement pour la route parallèle KOMAN-JULIA.

Enfin, l’étude conclut que la Version 2 de EUR-ANP produirait une distribution d’ensemble plus équilibrée du trafic et de la charge de travail. Les goulots d’étranglement seraient réduits et la capacité totale devrait être augmentée. Cependant les avantages de la Version 2 dépendent de la mise en place de nouvelles routes sur la Mer Noire, alors l’augmentation de capacité qui en découle ne pourrait se produire qu’une fois ces routes mises en place. La résolution de la position des limites de la FIR de la Mer Noire est une urgente nécessité.
APPENDIX A

MAP 1 - Simulation Route Map Reference Organisation

MAP 2 - Significant Flows Reference Organisation

MAP 2A - Major Flows Reference Organisation

MAP 3 - Major Conflict Areas FL165+ Reference Organisation

MAP 4 - Simulation Route Map Revised Scenario

MAP 5 - Significant Flows Revised Scenario

MAP 5A - Major Flows Revised Scenario

MAP 6 - Major Conflict Areas FL165+ Revised Scenario
BULGARIA/ROMANIA/TURKEY
TOP-DOWN - AF52

MAP 3
MAJOR CONFLICT AREAS FL165+
REFERENCE ORGANISATION

KEY
- Southbound
- Northbound
- Fri Sat
- Line Thickness:
  - Up to 50 aircraft
  - 51 to 100 aircraft
  - 101 to 150 aircraft
  - 151 to 200 aircraft
  - 201 to 250 aircraft
  - 251 to 300 aircraft