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1999 ATFM SIMULATIONS

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Sponsor: Central Flow Management Unit	**Sponsor (Contract Authority) Name/Location:** Director CFMU rue de la Fusée 96 B -1130 BRUXELLES

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1999 ATFM SIMULATIONS

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Abstract:

This document describes the results of the ATFM (Air Traffic Flow Management) studies programme conducted by the Centre of Expertise Flight Data Research in 1999.

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EXECUTIVE SUMMARY

This document describes the results of the ATFM (Air Traffic Flow Management) studies conducted within the Centre of Expertise “Flight Data Research” (FDR) on behalf of the CFMU (Central Flow Management Unit) in 1999. The EEC Task number CFM-B-E1 was assigned to this project.
The work programme and the objectives of the different studies were defined by CFMU and EEC (Eurocontrol Experimental Centre) representatives and were approved by the directors of the CFMU and the EEC in a meeting held in Brétigny in December 1998.

The 1999 work programme consisted of the following studies

1 Operational studies

1.1 CEU Requests

1.1.1 Definition and validation of SRS simulation schemes (top priority for the preparation of summer 1999)

1.1.2 Evaluation of the increase in individual sector capacity necessary to handle an increase in traffic of 8% with decrease of total delay down to 1997 total ATFM delay (microscopic study)

1.1.3 Contingency plan evaluation (update of the departure rates)

1.2 FDO Requests

1.2.1 Validation of new major ENV data releases: ARNV3 phase 2

1.3 External Clients Requests

To Be Defined (Simulations for Langen transfer, Greece, Prague)

2 ATFM Operations

2.1 Study of CASA behaviour

2.1.1 Operational evaluation and studies to assist the ATFM working group

2.1.2 Evaluation of the variable Window Width and saving on smoothing delays

2.2 Pre-tactical operations

2.2.1 Pre-tactical using simulations, procedures and definition of the input Data

2.3 Airport Regulations

2.3.1 Co-ordination of departure ATFM slots with departure sequence: single runway operations

2.3.2 Airport Capacity Management

3 Conclusions

This note presents the results for the main ATFM studies conducted within the Flight Data Research Centre of Expertise . Nevertheless, others studies were conducted on behalf of the Central Flow Management Unit or external clients; the list of the different studies conducted is given below :

- Analyse of delays in 1999, evaluation of capacity
- Analyse of the load on sector GA from Brest UAC
- Canadian capacity shortfall impact on transatlantic flights
- Impact of Airport constraints on departure management
- Impact of global Traffic Volume on the Lower sectors of Zurich ACC
- Impact of LECB(Barcelona) regulations on LFMM (Marseilles)sectors
- Impact of shortfall of capacity for Greek aerodromes
- Impact on delays of the implementation of new equipment , 8__33
- Microscopic study delay vs capacity, evaluation of capacity
- New opening sectors scheme for Bordeaux ACC/UAC
- New regulation scheme on CTL/PON/PTV area
- New sectorisation for Barcelona and Marseilles in the framework of CHIEF
- re-orientation of traffic from a centre (Karlsruhe) to another one (Munchen)
- Shortfall of capacities linked to the implementation of ARNV3
- Shortfall of capacity on Traffic Volumes LSAZUA14, WSL and NSL – Zurich
- Simulation of exchange of messages when all flights are in RDY status, Studies to assist the ATFM Working Group
- Simulation of increase of capacity for sectors LFEE (Reims), LFEUE and LFEUR
- Simulation of re-routing for INS, KINES (Geneva sectors)
- Study of the exemption of arrivals/departures to/from LIMC from the Milano regulations
- Transfer of Frankfurt ACC to Langen
- translation of the R/T workload reduction in capacity increase for the Data Link 2000+
- Update of the departure rates Contingency plan evaluation
- Usability of the routes generated by CARAT Operational Evaluation of the Quality of CARAT Generated Routes

In 1999, 46 simulations were conducted in regard to the 7 simulations conducted in 1997 or the 17 simulations made in 1998; this was due to the availability of the tools, less failures of TACOT for example and the quality of technical and operational people.

1 INTRODUCTION

This document describes the results of the main ATFM (Air Traffic Flow Management) studies conducted within the Centre of Expertise Flight Data Research on behalf of the CFMU (Central Flow Management Unit) in 1999. The EEC Task number CFM-B-E1 was assigned to this project.
The work programme and the objectives of the different studies were defined by CFMU and EEC representatives and were approved by the directors of the CFMU and the EEC in a meeting held in Brétigny in December 1998.

2 TOOLS

The achievement of the study objectives were facilitated by the use of a range of ATFM Tools as TACOT (**T**ACT **A**utomated **Co**mmand **T**ool), AMOC (**A**tfm **Mo**deling **C**apability) , COSAAC (**Co**mmon **S**imulator to **A**ssess **A**tfm **C**oncepts) and CARAT(Computer Aided Route Allocation Tool).

2.1 TACOT (TACT Automated Command Tool)

The TACT Automated Command Tool is a simulation tool used for studies and simulations in support of CFMU Operations.
TACOT is based on existing tools currently in use within the TACT system.
TACOT sends automatically commands to the kernel of the CFMU TACT system; the input is a script containing service commands read, interpreted and propagated to TACT to create regulation, to cancel flights for example.
TACOT can run as a real part of TACT network, but it is used in ATFM simulations as a stand-alone process. Special services are provided so that TACOT can configure itself to a specific mode of execution.

In order to speed up the process, a time control gives to TACOT the capability to accelerate time, without affecting the integrity of the TACT system.
TACOT allows replaying special events, to create regulations and to analyse the results.

2.2 AMOC (ATFM Modelling Capability)

AMOC is the ATFM Modelling Capability, one of the EEC ATFM simulators.
It is composed of several modules :

- ATAC to generate 4D profiles (+ elementary sectors and times of entry) from the CFMU archives.
- FIPS to generate future traffic samples, using the STATFOR data and a parameterised programme for the hourly distribution.
- SELFLOW and FRED to select flights in specified traffic volumes.
- CASA to allocate slots to regulated flights.
- Several other functionalities such as “slot swapping”.

Several analysis programmes (in addition to the CFMU QC tools, fully integrated into AMOC) such as ISO (Index of Smoothing and Overload), Index of Equity, slot lists per regulation, per Airport, per AO…, to be able to compare different Slot Allocation Strategies.

An interface was made between AMOC and MECA (Economical Model) to make Cost Benefit Analysis of an ATFM simulation scheme (cost of capacity, made on CRCO basis, and cost of delay, using IATA figures and traffic distribution).

2.3 COSAAC (COmmon Simulator to Assess ATFM Concepts)

COSAAC is an ATFM simulation tool which can be used at pre-tactical phase.

COSAAC makes use of the following data input:

- ECAC maps: ACC sectors and beacons;
- CFMU archived data: flights and environment data;
- European ATC capacities;
- European ATC sectors configurations.

The current available functions are:

- Graphic display: flights lists, flow graph…
- Traffic demand/Capacity comparison for an entire ACC, hour per hour for a H24 period (superposition grids);
- Traffic flows creation and graphic display of them with possibility to apply parameters (increase, decrease) to those flows and creation by the system of new flights;
- Slot allocation module to manage aerodrome or ATC sectors constraints;
- Regulation impact display directly on superposition grids;
- Delays reports;
- Manual re-routing (waiting for CARAT results) of flights or flows;
- Re-routing impact display: on sector load, flights lists (before and after re-routing).

2.4 CARAT (Computer Aided Route Allocation Tool)

CARAT is a tool developed to validate, by iterative steps, an innovative system of flight plan re-routing, taking into account the operational constraints. These are defined by the necessity to pass by or to avoid ATC points or pieces of airspace, to respect the level restrictions and the time intervals accessibility of the route components (e.g. the CDR categories).

The first objective was to provide support to the CFMU route catalogue maintenance, with the further objective of playing the role of a dynamic and interactive resource to re-routing specific flights.

Another objective was to provide support to EEC activities involving massive re-routing, like contribution to SRS elaboration and validation (or CDR studies).

The method used for the system processing is based on an improvement of an algorithm mainly taking into account vertical profile and temporal restriction.

A significant effort of continuous adaptation to the numerous evolutions of CFMU environment databases has been sustained in the recent period.

For integration of SRS constraints, a protocol of exchange with an external, CFMU-provided, SRS checker has been defined and is being implemented, with the objective of delivering to CFMU an integrable system in summer 2000.

3 OPERATIONAL STUDIES : CEU REQUESTS

3.1 ARNV3.2 Implementation (March 1999)

3.1.1 Study Objective

The objective of the simulation was to evaluate, in term of delays, the impact of the implementation of a new route network and the capacity shortfall requested by several countries during this period.

3.1.2 ARN V3 First Day

3.1.2.1 Reference Day

The simulation was done with the data of February 27, 1998, using the TACOT simulator

3.1.2.1.1 Rates decreased by 50%

For the reference day, only French, Swiss regulations plus EGLL arrivals were implemented.

The first conclusion was that all traffic could not fly through the Geneva airspace if rates were decreased by 50%. Even with regulations running until midnight , significant bunching on LSAGSUP,KIN and INN were found.

3.1.2.1.2 Rates decreased by 30 %

The same simulation has been done, with TACOT, with a decrease of 30% in LSAG.

3.1.3 ARN V3 Continuation

The simulation was made with the data of March 13, 1998, with TACOT.
For the reference day, only French, Swiss regulations with some UK and German regulations.

LSAG : -20%
LSAZ : -30%
LFMM : -15%
LFEE : East -20%
North-West -15%
On simulation scheme 1, UNXN and ESE were collapsed.
On simulation scheme 2, the 4 sectors were split.
LFFF : -15%
LFBB : -20%

The situation in terms of regulations depended on the number of opened sectors and then checked on pre-tactical (J-2).

3.1.4 ARN V3 Continuation-Final

The simulation was made, with TACOT, using the data of March 27, 1998
For the reference day, all major regulations were implemented.

For simulation scheme 1 :

LSAG : -10%
LSAZ : -20%
LFMM : -15%
LFEE : East -20%
North-West -15%
On simulation scheme 1 ,UNXN and ESE were collapsed.
On simulation scheme 2 , the 4 sectors are split.
LFFF : Nil
LFBB : -10%

For simulation scheme 2 :

LFEE : -10%

3.1.5 Conclusion

The objective of this set of simulations was to evaluate, in term of delays, the impact of the capacity shortfall requested by several countries during this period.
According to the date of the implementation of the new route network and the late request of several countries for a capacity shortfall ,the study was conducted rapidly, the results were sent to the CFMU and were useful to prepare the AIM and to inform the ACCs.

3.2 INS (April 1999)

3.2.1 Study Objective

The Standard Route Scheme (SRS) is a strategically planned routing system designed to make the most effective use of ATC capacity. They enables ATC to maximise capacity by defining routings that provide an organised system of major traffic flows through congested areas and reduce the crossing of major flows at critical points.
According to the definition of SRS and to the Work Programme defined between the CFMU and the EEC, the CEU asked the Centre of Expertise Flight Data Research to define operational simulation schemes and to find available routings to avoid INS sector in the Geneva airspace.

3.2.2 Study Method

The study approach consisted in re-routing some flows in order to decrease the number of flights entering INS sector and then reducing delays but taking into account the load of other Sectors around the Geneva airspace.

Data of Friday 19/03/1999 was used for this study and were used in TACOT.
These data were extracted from ARC data of the CFMU
For the purpose of regulations, several traffic volumes were used.
A traffic volume is a set of flights crossing an airspace (Sector or point), coming from an area and going to an other area.

The description of the traffic volumes is given below:

Traffic Volume name	Traffic Volume description	Reg. name
EDMMSR1	**Munchen Sector SR1**	**EDMS1**
EDUUFFM	**Karlsruhe Sector FFM**	**EDUFF**
EDUUTGO	**Karlsruhe Sector TGO**	**EDUTG**
EDUUWUR4	**Karlsruhe Sector WUR**	**EDUWU**
LFMLELS1	**Marseille Sector LELS**	**LELS**
LSAGINS	**Geneva Lower South**	**LSINS**
LSAZUA14	**Zurich UAC (TRA/ZUE)**	**TRAZU**
LFEXH	**Reims Sector XH**	**XH**

After several queries made with CARAT, 3 different simulation schemes were defined and led to re-routed flows.

The following airports were involved in the re-routing

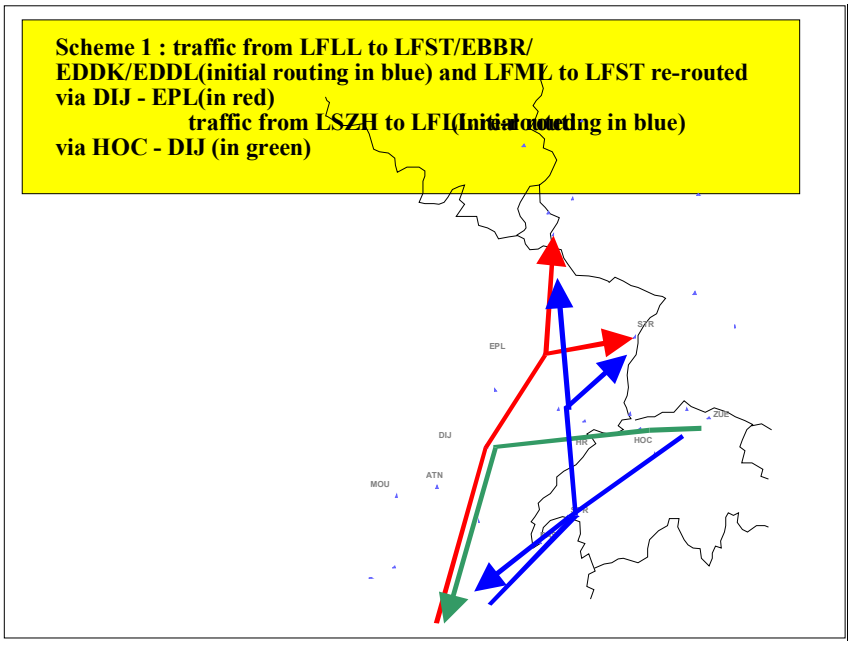
Airport	
EBBR	Brussels-National
EDDK	Kholn
EDDL	Dusseldorf
EHAM	Amsterdam-Schiphol
ELLX	Luxembourg
LFLL	Lyon-Satolas
LFML	Marseille-Provence
LFST	Strasbourg-Entzheim
LIMC	Milano-Malpensa
LIME	Bergamo-Orio Al Serio
LIMJ	Genova-Sestri
LIRF	Roma-Fiumicino
LSZH	Zurich

3.2.3 Simulation schemes

3.2.3.1 Simulation scheme 1 (sc1):

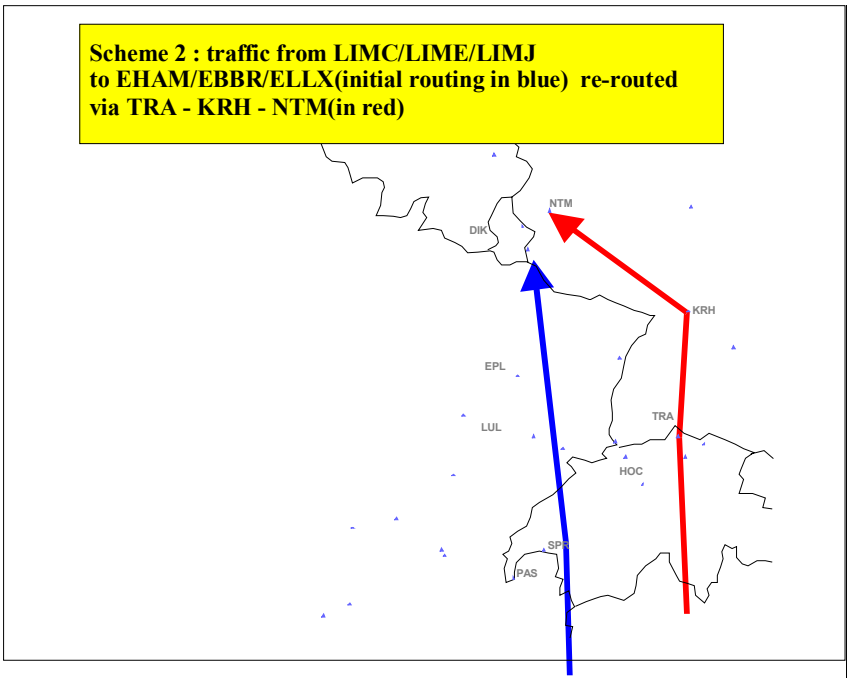
- LFLL to LFST/EBBR/EDDK/EDDL Re-routed via DIJ/EPL
- LFML to LFST Re-routed via DIJ/EPL
- LSZH to LFLL re-routed via HOC-DIJ FL 200

-25 flights concerned



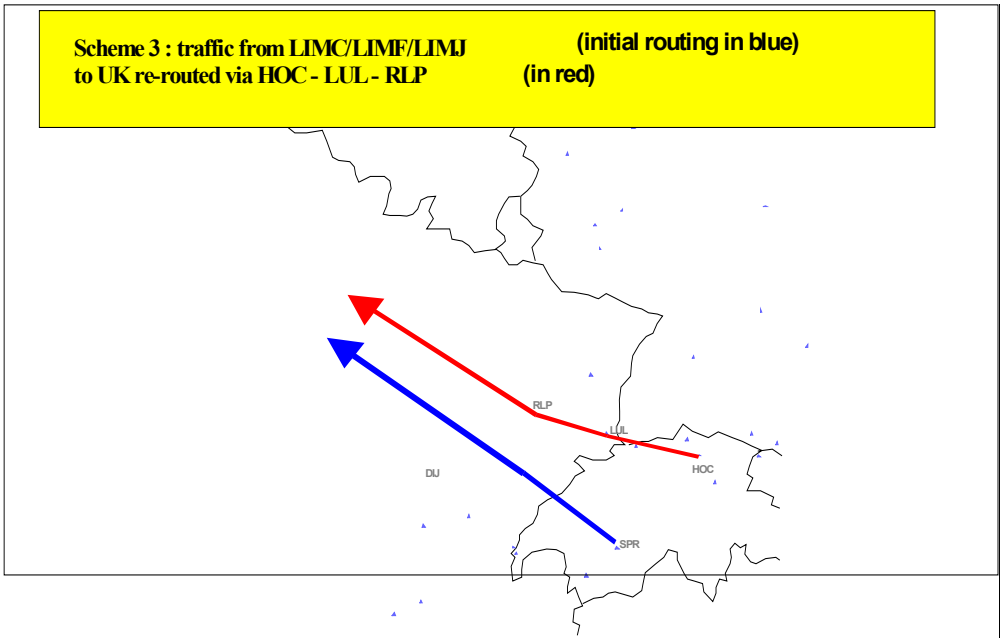
3.2.3.2 Simulation scheme 2 (sc2):

LIMC/LIME/LIMF to EHAM/EBBR/ELLX Re-routed via TRA-KRH/NTM
-19 flights concerned



3.2.3.3 Simulation scheme 3 (sc3):

LIMC/LIMF/LIMJ to UK Re-routed via HOC-LUL-RLP
-21 flights concerned



3.2.4 Results :

Delays for main regulations with the total for all of the day

REGUL_NAME	REF DELAY	SC1 DELAY	SC2 DELAY	SC3 DELAY	SC1+2 DELAY	SC2+3 DELAY	SC1+3 DELAY	SC1+2+3 DELAY
EDMS119	1290	1290	1290	1290	1290	1446	1290	1446
EDUFF19	845	845	845	845	845	845	845	845
EDUFF19M	2099	2099	2099	2099	2099	1967	2099	1967
EDUTG19	468	482	468	468	477	479	468	479
EDUWU19	293	293	293	293	293	208	293	208
LELS19A	657	659	657	657	659	657	659	659
LSESLA	393	393	393	393	393	455	393	455
LSESLM	544	544	544	544	544	552	544	552
LSINS	6664	3796	3577	5335	2489	3669	3786	2460
LSWSL	733	787	821	743	787	701	791	920
TRAZU19M	1183	1277	1331	1277	1331	1309	1277	1309
UPTT19	1141	1333	1141	1141	1333	1125	1333	1317
XH19M	146	144	85	146	94	94	146	85
TOTAL	**44835**	**42206**	**41782**	**43455**	**40900**	**41756**	**42190**	**41001**

It can be seen that on this table that the combination of simulation schemes 1 and 2 gave a significant decrease of delay regarding the reference simulation scheme. Nevertheless, all simulation schemes, combined or not led to a decrease in the total amount of delays.

Regarding LSAGINS, all simulation schemes tested showed an improvement of the present situation; the best simulation schemes were the combination of simulation schemes 1 and 2 or combination of simulation schemes 1, 2 and 3.

Regarding the other traffic volumes concerned, the simulation schemes tested did not lead to a significant change.

3.2.5 Conclusions

The study objective consisted in re-routing some flows in order to decrease the number of flights entering INS sector and then reducing delays but taking into account the load of others Sectors around the Geneva airspace.

Several simulation schemes were tested for this simulation, combination of several simulation schemes led to a significant decrease in delays.

3.3 KINES (May 1999)

3.3.1 Study objective

According to the definition of SRS and to the Work Programme defined between the CFMU and the EEC, the CEU asked the Centre of Expertise Flight Data Research to define operational simulation schemes and to find available routings to avoid KINES sector in the Geneva airspace

3.3.2 Study Method

The flows of traffic into the specified sector were analysed to find possible re-routings.
The simulation schemes were validated by simulations to estimate the costs/benefits (additional mileage, delays…).

3.3.3 Study approach and simulation schemes

The study approach consisted in re-routing some flows in order to decrease the number of flights entering the KINES sector and then reducing delays but taking into account the load of others Sectors around Geneva airspace.

Data of Friday 04/02/1999 was used for this study with TACOT.
These data were extracted from ARC data of the CFMU.
For the purpose of regulations, several traffic volumes were used.
A traffic volume is a set of flights crossing an airspace (Sector or point), coming from an area and going to an other area.

The description of the traffic volumes is given below:

Traffic Volume name	Traffic Volume description
LSAGKIN	Geneva Sector KINES
LSAGSUP	Over-flights Geneva above FL265
LSAGINN	Geneva Lower North
LSAGINS	Geneva Lower South
LSAZUA14	Zurich UAC : TRA/ZUE
LFMUA	Marseille UAC Sector UA combined A1+A2
LFMUW	Marseille UAC Sector UW combined W1+W2
LFMW1	Marseille UAC Sector W1
LFMW2	Marseille UAC Sector W2
LFMUT	Marseille UAC Sector UT combined T1+T2
LFMT2	Marseille UAC Sector T2
LFMUK	Marseille UAC Sector UK combined K1+K2
LFMUB	Marseille UAC Sector UB combined B1+B2
LFMB1	Marseille UAC Sector B1
LSAGB4	Geneva SUP + KIN above FL265
LSAGSU2	Geneva INS + KIN below FL 265

In order to get a traffic sample as close as possible to a summer one, some flights were added.

- From UK to Italy (LIR and LIC) and LMML
- From LEPA to Germany and vice-versa

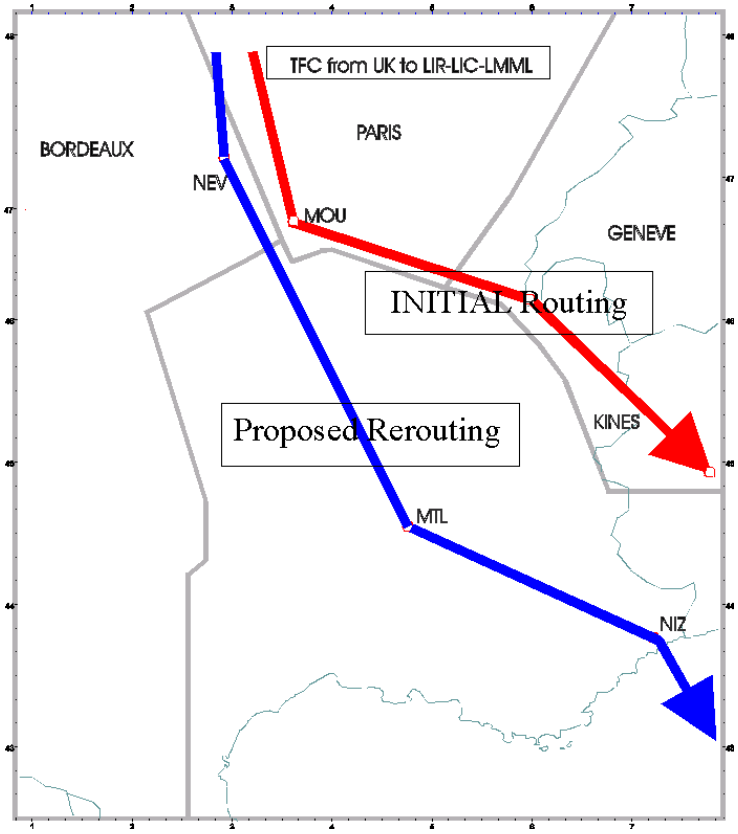
About 72 flights were added in the Kines sector (112 in LSAGSUP).

3.3.4 Simulation schemes

3.3.4.1 Simulation scheme 1 (sc1):

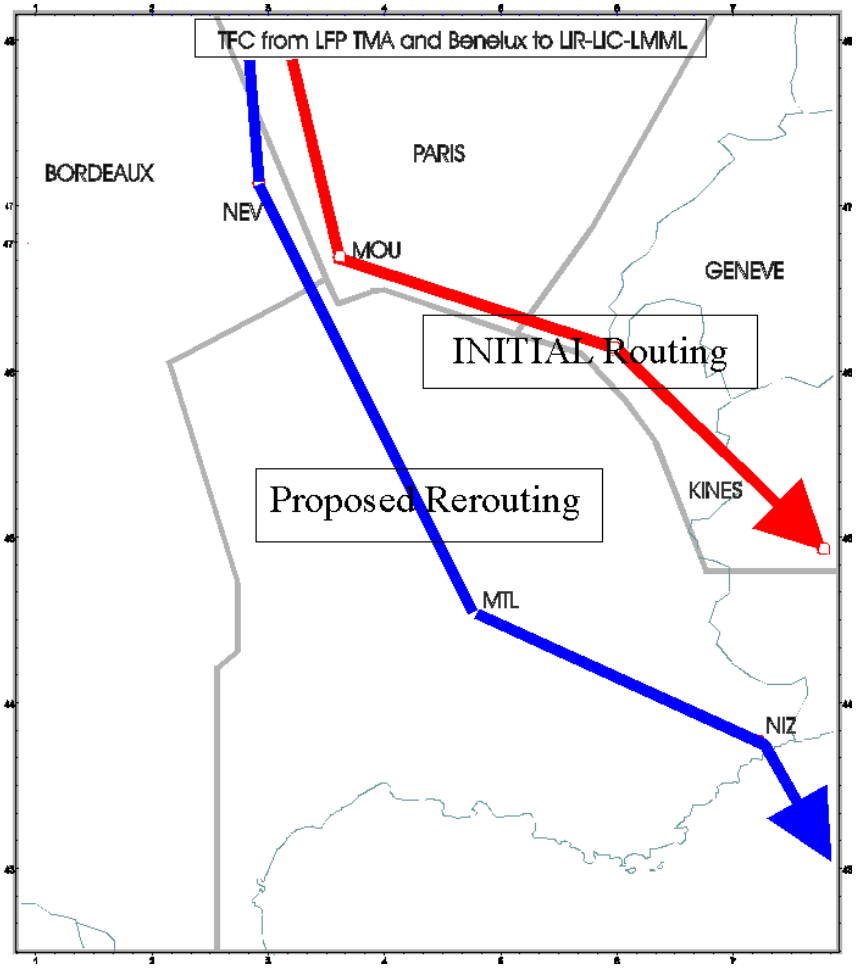
Traffic from UK to LIR, LIC and LMML were re-routed via NEV-BTA or NEV-ALG

-53 flights concerned



3.3.4.2 Simulation scheme 2 (sc2):

Traffic from Paris TMA and Benelux to LIR, LIC and LMML were re-routed via NEV-BTA or NEV-ALG
-39 flights concerned



3.3.5 Results : Delays for main regulations

REGUL NAME	ref	sc1	sc2
	DELAY	DELAY	DELAY
EDUFF02	413	413	432
EDUTG02	132	132	132
EE02GF1	310	310	246
LFMT202	436	397	261
LFMTW02	84	143	84
LFMW202	*1511*	*2965*	*3614*
LIMESL02	1477	1479	1340
LIMWSL02	37	47	57
LIPSLS02	643	566	670
LIRFA02A	418	491	214
LS02A	939	939	826
LSAGB4	1652	0	0
LSAGSUP	2707	2774	3110
LSINN	351	384	314
LSINS	9007	9343	9445
LSKIN	*14238*	*2722*	*4795*
LSSU2	216	76	76
MF102	651	985	838
MST02M	2025	1642	1591
TRAZUE	3756	3666	3516
UH02M	447	399	501
UHXH02A	615	740	559
W1	942	1069	1095
TOTAL	*62197*	*50667*	*52440*

3.3.6 Conclusions and Recommendations

As a conclusion, the results have to be taken very carefully, regarding the Balkans crisis in 1999 .

It can be said that simulated re-routings via LFMM ACC to avoid the Kines Sectors in LSAG are acceptable only if LFMM ACC is able to split the following Sectors:

- W, T and B Sectors all day (from 06h00 to 20h00)
- K sector in the morning (from 06h00 to 13h00)

For this study, the impact on LIRR ACC Sectors was not checked.

3.4 Marseille/Barcelona (August 1999)

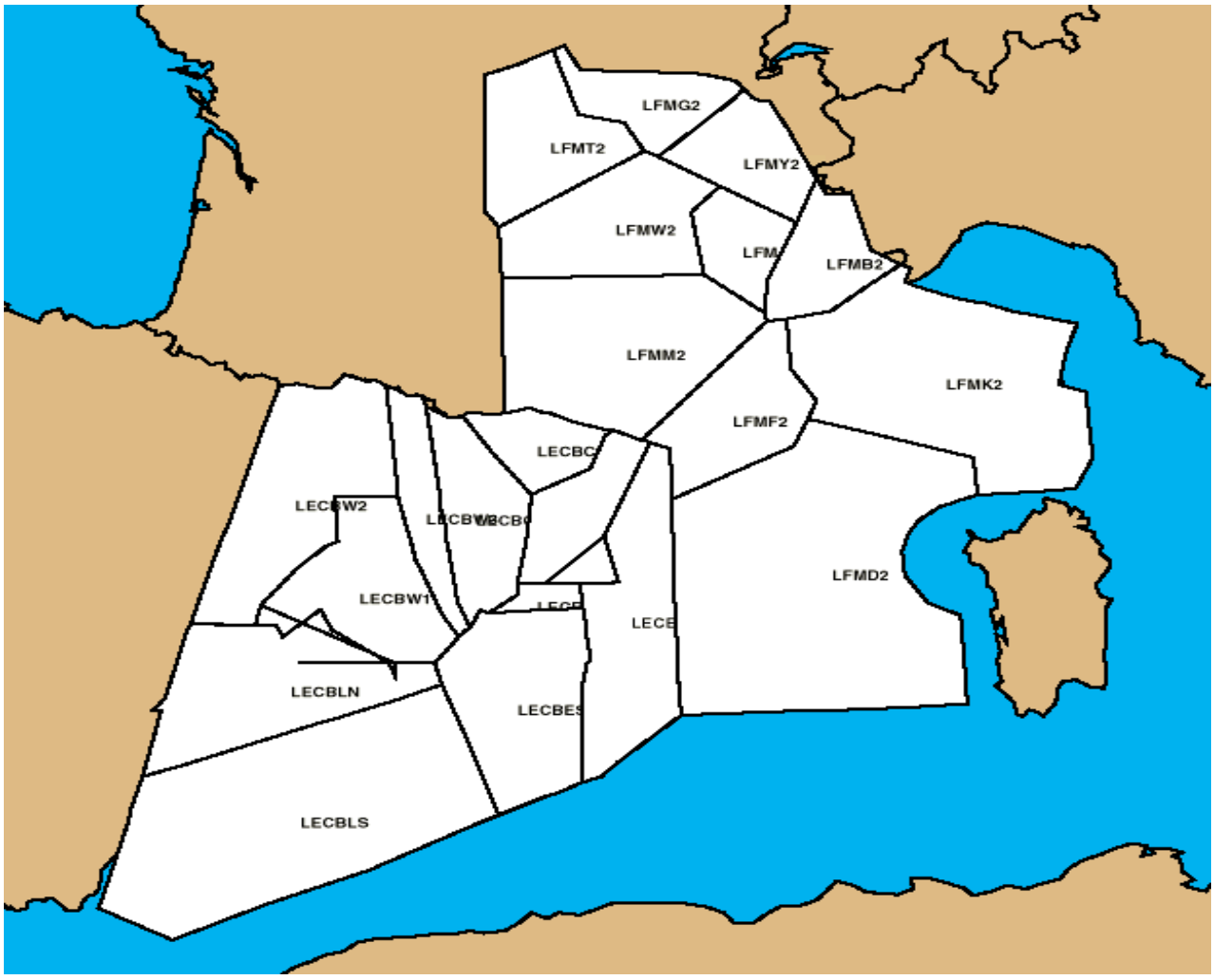
3.4.1 Study Objectives

In congested areas, regulations are in force to protect this airspace, but it was interesting to analyse, in a very crowed area, the impact of regulations from an airspace to an other one.

Heavy regulations to protect Barcelona ACC create delays and push back a lot of traffic to the beginning of evening when the number of opened Sectors in Marseille ACC decrease.
The study must show the real impact of LECB regulations on LFMM ones.

3.4.2 Study Method

Data of Saturday 10 of July 1999 with ENV 192 were used and input in AMOC.
These data were extracted from ARC data of the CFMU.



For the purpose of regulations, several traffic volumes were used.
A traffic volume is a set of flights crossing an airspace (Sector or point), coming from an area and going to an other area.

The description of the traffic volumes is given in the table below.

Traffic Volume Name	Traffic Volume description
LFMAB	Marseille ACC/UAC collapsed Sectors A1+A2+B1+B2
LFBUX2	Bordeaux UAC Sector X2
LFBUCR2	Bordeaux UAC Sectors C2+R2
EDUUSLN3	Karlsruhe UAC Sector Global SLN
EGTTLMW	London ACC/UAC Sector Middle West
EGT4LUE	London UAC Sector Upper East
EGTTLUW	London UAC Sector Upper West
LFMK1	Marseille ACC/UAC Sector K1
LFMK2	Marseille ACC/UAC Sector K2
LFMKD	Marseille ACC/UAC collapsed Sectors K1+K2+d1+d2
LFMKK	Marseille ACC/UAC collapsed Sectors K1+K2
LEBLARR	Destination Barcelona airport
LECMBLV	Madrid ACC/UAC Sector BLV
LECB_E	Barcelona ACC/UAC collapsed Sectors CEN+ECO+MED
LECBCEN1	Barcelona ACC/UAC Sector CEN
LECBW13	Departure from Barcelona airport to VLC excluded
LECBECO3	Barcelona ACC/UAC Sector ECO
LECBEM3	Barcelona ACC/UAC Sector ECO/MED excluding departure from LEPA via ISTER
LECBLEV4	Barcelona ACC/UAC Sector LEV
LECBWA	Departure from Barcelona airport to VLC excluded
LFMNARR1	LFMN/LFMD arrivals
LFMYY	Marseille ACC/UAC collapsed Sectors Y1+Y2
LSAGINS1	Geneva ACC Lower South
LSAGKIN	Geneva ACC/UAC Sector KINES
LFMMF	Marseille ACC/UAC collapsed Sectors M1+M2+F1+F2
LFMMF1	Marseille ACC/UAC sector F1
LFMMF2	Marseille ACC/UAC Sector F2
LFMMFDK	Marseille ACC/UAC collapsed Sectors F1+F2+D1+D2+K1+K2
LFMT2	Marseille ACC/UAC Sector T2
LFMTGWY	Marseille ACC/UAC collapsed Sectors T1/2+G1/2+W1/2+Y1/2
LSAZUA14	Zurich ACC/UAC via TRA/ZUE
LFMWT1A	Marseille ACC/UAC Collapsed Sectors T1+W1
LFMWT2A	Marseille ACC/UAC Collapsed Sectors T2+W2

3.4.3 Definition of simulation schemes

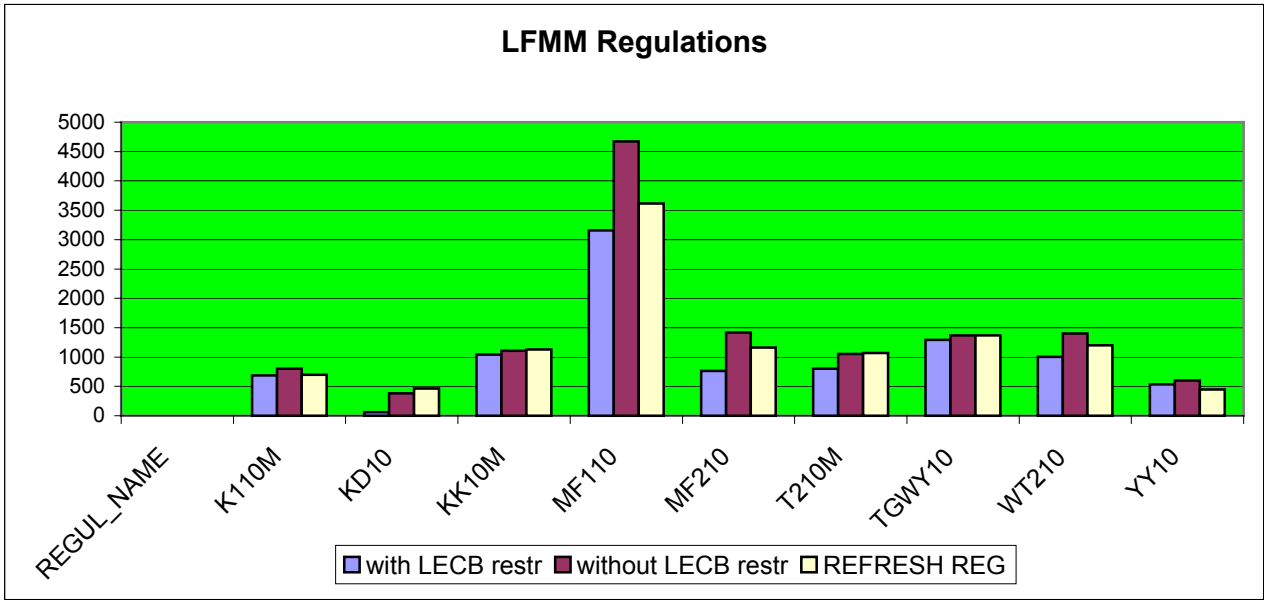
First simulation was run with all regulations in force that day and ends approximately when regulations were cancelled in tactical.
In the second simulation, all LECB regulations were cancelled.
In the third one LFMM regulation periods were adjusted to have only regulations when they were really necessary.

3.4.4 Results

The table below shows regulations with heavy delays and big variations regarding different simulation schemes.

The total is for all regulations of the day.

REGUL_NAME	TFV	PERIOD	with LECB restriction DELAY	without LECB restriction DELAY	CHG of PERIOD	REFRESH REG DELAY
AB10	LFMAB	1920-2100	59	27		38
BUX210	LFBUX2	0800-2000	5053	2786		3026
CR210M	LFBUCR2	1000-2000	2604	180		288
EDUSL10	EDUUSLN3	1500-1800	1067	2256		2376
EGLMW10	EGTTLMW	1240-1600	1044	2061		2122
EGLUE10	EGT4LUE	0920-1630	1850	3326		3299
EGLUW10	EGTTLUW	0500-2100	4582	5744		6144
K110M	LFMK1	0720-1930	685	803	0720-1730	698
K210M	LFMK2	0720-1000	4	59	CNL	
KD10	LFMKD	1915-2230	62	381		464
KK10M	LFMKK	0500-0725	1039	1109		1130
LEBLA10	LEBLARR	1230-1500	199	251		300
LEBLV10	LECMBLV	1600-2120	2084	2187		1596
LECBE10	LECB_E	0400-0530	512			
LECEN10	LECBCEN1	0600-1800	18055			
LECEN10X	LECBCEN1	1800-2100	11			
LEE1310	LECBW13	1530-2130	2384			
LEECO10	LECBECO3	1030-2100	13620			
LEECX10	LECBEM3	0500-1000	6153			
LEECX10M	LECBEM3	1030-1700	12152			
LELEV10	LECBLEV4	1430-2100	776			
LEW10	LECBWA	1900-2300	1610			
LEW10M	LECBWA	1730-1230	10221			
LFMNA10	LFMNARR1	0600-1600	937	1367		1309
LFMYY10	LFMYY	0430-0900	21	35		36
LSINS10M	LSAGINS1	0800-1730	6738	8081		8365
LSKIN10	LSAGKIN	0600-1815	2400	3564		3684
MF10N	LFMMF	2100-2230	0	0	CNL	
MF110	LFMMF1	1115-2100	3158	4671	1115-1730	3613
MF210	LFMMF2	1800-2100	765	1419		1160
MFDK10	LFMMFDK	2220-2330	0	0	CNL	
T210M	LFMT2	0900-1800	800	1052	0900-1500	1071
TGWY10	LFMTGWY	0300-0500	1294	1368		1368
TRAZUE10	LSAZUA14	0500-2020	10874	15624		15094
WT110	LFMWT1A	0430-0800	260	323	CNL	
WT210	LFMWT2A	0430-0930	1003	1401	0630-0930	1197
YY10	LFMYY	1600-2000	534	600	1600-1800	445
TOTAL			**243775**	**196831**		**196904**



3.4.5 Conclusions

Heavy regulations to protect Barcelona ACC produced delays and forced a lot of traffic at the beginning of evening when the number of opened Sectors in Marseille ACC decrease.
The study had to show the real impact of LECB regulations on LFMM ones

With the cancellation of LECB regulations, the LFMM ones became the most penalising.

Delays even for night regulations were most important.

- With LECB restrictions LECB delays = 65 494 minutes
  LFMM delays = 9 684 minutes
- Without LECB restrictions LFMM delays = 13 248 minutes
- After modification or cancellation of LFMM regulations
  LFMM delays = 112 20 minutes

3.5 Zurich regulations (November 1999)

3.5.1 General purpose of the study.

Regulations for lower sectors in Zurich ACC (LSAZ AC) used traffic volumes which exclude some flows (i.e. domestic flights or flights of city pairs LSGG-LSZH).

So a certain number of flights were not regulated and there was no equity in term of delays between all flights entering the Zurich lower airspace.

3.5.2 Study Objectives

The objective of this study was to measure the benefit of the use of global traffic volumes in terms of load and delays.

3.5.3 Selected Study Approach

5 simulations were run with TACOT and compared with the reference which was the result of regulations in force during the day of reference.

3.5.4 Data Requirements and simulation schemes

Data of Friday 3rd of September 1999 has been used . This day was a very busy one with a demand of 27871 flights and 241 regulations.

3 new traffic volumes were created to implement new regulations

-LSAZESL instead of LSAZESL2
-LSAZWSL instead of LSAZWSL3
-LSAZNSL instead of LSAZNSL1

Using global traffic volumes it can be noted that, for the full day

- 63 flights are excluded in ESL sector
-114 flights are excluded in NSL sector
-171 flights are excluded in WSL sector

5 runs were made with global traffic volumes, with different periods, rates and/or window width.

3.5.5 Results

All results are on the tables below

- In run 1 : global traffic volumes were used, changing rates and adjusting periods regarding the demand, and with a window width of 10 minutes.
  The simulation gave a decrease of delays in ESL and NSL but an increase in WSL
- In run 2 : periods of regulations were the same as in the reference and rates as in run1 - the simulation gave less delays in ESL, approximately the same delays as in NSL and an increase of delays in WSL during the morning period.
- In run 3 : with the same periods of regulations as in the reference rates were increased for NSL and WSL, the window width was still at 10 minutes and the simulation gave less delays in ESL and NSL and the same delays as in the reference in WSL.

- In run 4 :with the same periods and rates as in run3 but the window width was set at 4 minutes the situation was better for NSL but worst for WSL (morning period) and no real change for ESL.
- In run 5 :rates were increased for NSL and WSL regulations and the simulation gave lower delays in NSL and globally equals in the others Loads.

On the reference ,the maximum number of flights in 1 hour is :

-for ESL =46

-for NSL =44

-for WSL =47

In all runs theses numbers were exceeded

-for ESL =45

-for NSL =41

-for WSL =45

3.5.6 Conclusions

It can be said that, using global traffic volumes for implementation of regulations in lower sectors of Zurich ACC, does not create overloads and gives less delays with a better equity between all flights.
The run 5 would be the best solution to be checked in real time ,giving less average delays as well as less maximum delays with acceptable loads for the 3 sectors.

4 Operational studies : External requests

4.1 Dualization of UR11 (February 1999)

Objective of the simulation The objective of the simulation was to evaluate the impact of rerouting flow from a centre to an other one

4.1.1 Simulation schemes

The simulations were run on 09, 11 and 25 September 1998 using the TACOT simulator. All flight plans and change messages have been loaded in order to get as close as the actual demand. The actual regulation plan has been loaded as well. Here are the regulations definitions of Rhein and Munchen ACCs :

09 September 1998

REGUL_NAME	TFV	PERIOD	RATE
EDMCS3*	EDMMCS3	1200-1330	62
EDMSR1*	EDMMSR1	0900-1200	40
EDMS1A09	EDMMSR1B	1500-1630	18
EDUER09M	EDUUER2	0900-1100	34
EDUER09A	EDUUER2	1220-1900	34
EDUFF09	EDUUFFM	0500-1400	62
EDUFF09L	EDUUFFM	1440-1700	62
EDUFF09A	EDUUFFM5	1400-2000	56
EDUTG09M	EDUUTGO	0945-1145	54
EDUTG09	EDUUTGO	1730-1930	54
EDUWU09	EDUUWUR4	1330-1900	58

11 September 1998

REGUL_NAME	TFV	PERIOD	RATE
EDMCS3*	EDMMCS3	0930-1430	62
EDMMSR1*	EDMMSR1	0830-1500	40
EDMN211	EDMMNR2	1640-1900	42
EDMSR211	EDMMSR2	0900-1200	46
EDMSR311	EDMMSR3	1020-1200	39
EDMUR211	EDMMUR2Z	0900-1200	46
EDUER11	EDUUER2	0600-1200	34
EDUER11A	EDUUER2	1250-2100	34
EDUFF11	EDUUFFM	0500-1300	62
EDUFF11A	EDUUFFM	1800-1930	62
EDUNT11A	EDUUNTM3	1730-2000	42
EDUTG11	EDUUTGO	1300-1600	54

25 September 1998

REGUL_NAME	TFV	PERIOD	RATE
EDMMCS3M*	EDMMCS3	0800-1500	62
EDMMSR1*	EDMMSR1	1000-1700	40
EDUER25M	EDUUER2	0530-2000	34
EDUFF25A	EDUUFFM	1500-2000	62
EDUTG25	EDUUTGO	1300-1930	54
EDUWU25	EDUUWUR4	0800-2000	58

(* means that this regulation has been implemented for simulation purposes).

EDMMCN5 with a 70 capacity didn't need any restriction.

The new SRS for summer 99 was simulated :

As 980925 was a Friday, traffic planned via SPI-UG1/UR10 FFM UB1/UL603 VIW has been re-routed via SPI-UL607-ALGOI-UL74-VIW and traffic planned via TRA-KRH-FFM-WRB has been re-routed via TRA UG5/UG52 TGO UG5/UN851 FUL UB230 WRB.

Methodology

For each day, three simulation schemes were run

- Simulation scheme **All flights via UR11**.
- Simulation scheme **Actual traffic**.
- Simulation scheme **All flights via UN871**.

4.1.2 Results

		Wednesday 09 September			Friday 11 September			Friday 25 September		
Number of flights via UR11 in actual traffic		18			22			41		
Number of flights via UN871 in actual traffic		12			11			15		
Scenari		All flights via UR11	Actual traffic	All flights via UN871	All flights via UR11	Actual traffic	All flights via UN871	All flights via UR11	Actual traffic	All flights via UN871
Regulations delays (in minutes)	**EDUER**	1589	1369	1180	1024	873	756	2555	2073	1967
	EDUFF	5949	6076	5974	1736	1702	1718	851	958	789
	EDUTG	2303	2070	2182	579	758	225	1972	1864	1165
	EDUWU	1269	1293	907	-	-	-	2765	2304	1903
	EDMMSR1	516	641	641	1054	1726	1661	1318	1073	1592
	EDMMCS3	768	847	890	3574	3880	4878	5763	7824	9990
Total CFMU delay with EDMMCS3 regulation		54338	54400	53570	54193	54978	55224	117888	119023	119877
Total CFMU delay without EDMMCS3 regulation		53570	53553	52680	50619	51098	50346	112125	111199	109887

4.1.3 Conclusion

When EDMMCS3 regulation was not implemented (this means that sectors are split), the re-routing via UN871 always ends up with a total delay decrease due to the implementation of Rhein regulations.
When EDMMCS3 regulation was implemented (sectors were collapsed), the re-routing via UN871 seemed to end up with a total delay increase but depending on Rhein and Munich ACCs situation

4.2 Greece aerodromes (March 1999)

4.2.1 Objective of the study

The goal was to measure the impact of regulations only applied on Greek airports on ATC sectors loads.

4.2.2 Reference day

The reference day was the 11/9/1998 and the simulations were run with TACOT

It was not possible to compare with real traffic of this day because some regulations were missing in the archives.

For the reference simulation, total delay is 63907 minutes.
The total delay for Greek regulations is 20924 minutes.
On the OVERLOAD table are shown Traffic Volumes with overloaded hours.

1- REF = overloads with all regulations of the reference day.
(details of Greek reg. on REGULATIONS table)
2- WITHOUT REG = overloads without any regulation.
3- WITH A/D REG ONLY = overloads with regulations for Greek airports as defined on REGULATIONS table.
4- CAPA = capacities for each airports or ATC sectors.

First conclusion:

Only regulations for traffic from/to LGAT and from/to LGIR are needed.
If those regulations are implemented an increase of capacity is needed on:

-D3 ≈15 to 25% (25% for a short period)
-D4 ≈10%
-D6 ≈25 to 30% (max for a short period)
-D8 ≈10%

D6 and D8 can be collapsed not before 21h00 UTC.

The total delay for LGAT has decreased but the rate 32/60 since 16h00 instead of 16h45 as in the reference day was applied.

The same simulation has been made with Friday 25 of September 1998 as reference day.

The same conclusion can be made as for the first simulation.

Except for D3 and D4 where a severe overload appears :
-between 11h00 and 12h00 for D4
-between 08h00 and 09h00 for D3

Same evening problem for D68

But the main problem is the increase of delays for LGAT Global Regulation

4.3 Milan TMA (June 1999)

4.3.1 Study Objectives

Flights, according to their nature or geographical location, can be exempted from the requirement to obtain a slot for a reference location within the ATFM area. These flights are taken into account in the allocation of slots but are not delayed.

Heavy regulations to Milano ACC make delays for traffic departing, arriving or overflying TMA. The objective of this study was to analyse the impact on delays of the exemptions from the Milano regulations for flights departing from LIMC or arriving to LIMC.

4.3.2 Study approach

Data of Saturday 2nd of April 1999.
These data came from ARC data of the CFMU and were used in TACOT.
For the purpose of regulations, several traffic volumes were used.
A traffic volume is a set of flights crossing an airspace (Sector or point), coming from an area and going to an other area.

The description of the traffic volumes is given in the table below.

Traffic Volume Name	Traffic Volume description
LIMMENL4	**Milano Sector ENL below FL275**
LIMMESL1	**Milano Sector ESL below FL275**
LIMMUWH	**Milano Sector UWH above FL275**
LIMMWSL2	**Milano Sector WSL below FL275**

The following airports were involved in the simulation

Airport	
LIMC	Milano-Malpensa
LIML	Milano-Linate
LIME	Bergamo-Orio Al Serio
LIRA	Roma-Ciampino
LIRF	Roma-Fiumicino
LIRE	Practica Di Mare
LIRP	Pisa
LIRQ	Firenze
LSZA	Lugano
LSZH	Zurich

First simulation was run with all flights submitted to the different regulations.

On a second run, Flights departing from LIMC or going to LIMC were exempted from the Milano regulations.

The results are given in the next paragraph.

4.3.3 Results

4.3.3.1 Results on delays

Here are the delays (in minutes) for the reference situation and after the exemption:

Regulation name	Reference DELAY	After exemption DELAY	Difference	%
LIMENL02	**4 276**	**4 093**	**- 183**	**- 4**
LIMESL02	**1 666**	**2 005**	**+ 339**	**+ 20**
LIMESL2X	**4 003**	**3 717**	**- 286**	**- 7**
LIMUWH02	**2 968**	**2 967**	**- 1**	**0**
LIMWSL02	**351**	**335**	**- 16**	**- 5**
Total	**13 264**	**13 117**	**-147**	**- 1**

The table above shows a slight decrease of the total delays of 1%. Nevertheless, exempted flights had no delay in the regulation, but some other flights were moved later in the slot list, and their delay increased.

Here are the delays (in minutes) of the flights departing or arriving at:

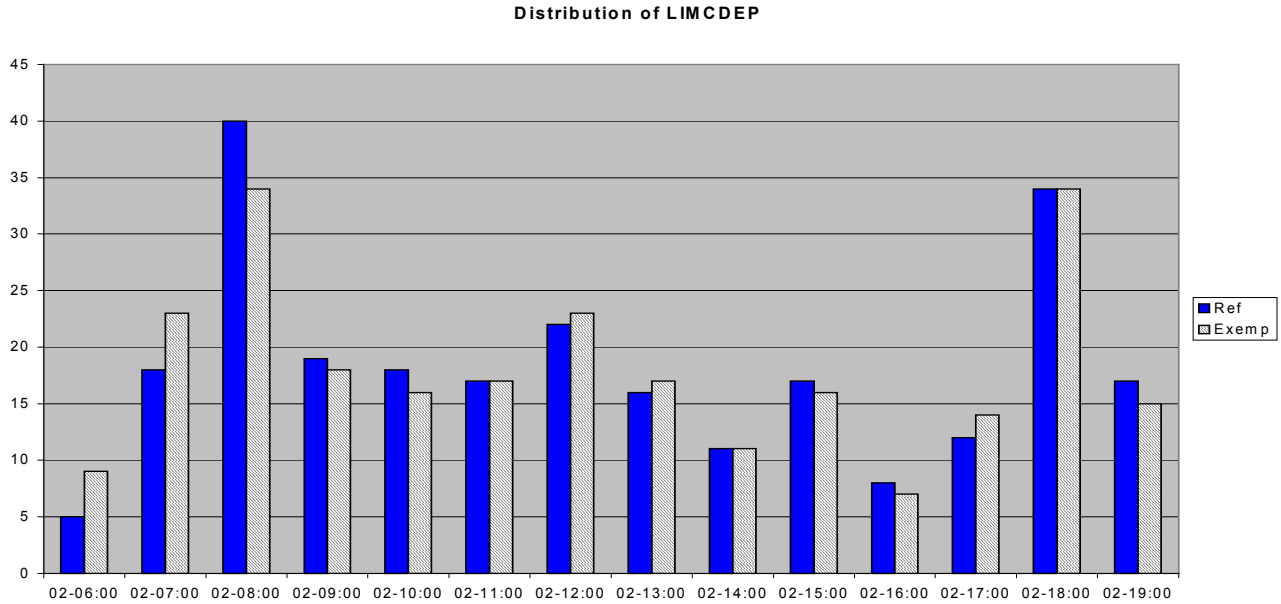
Airport	Reference	After exemption	Difference	%
LIMC	12 393	8 734	-3659	- 30
LIML	4 490	4 930	+440	+ 10
LIME	2 187	2 374	+187	+ 9
LIRA	813	851	+38	+ 5
LIRF	13 449	13 098	-351	- 3
LIRE	142	165	+23	+ 16
LIRP	1 036	905	-131	- 13
LIRQ	2 131	19 53	-128	- 8
LSZA	636	671	+35	+ 6
LSZH	7 388	7 544	+156	+ 2
Total	**44 665**	**39 272**	**-3390**	**- 12**

With the exemptions, the total delay decreased by 12 %; it can be noted that there was a significant decrease of the delays for LIMC (-30%).

4.3.3.2 Results on the load of the different Sectors

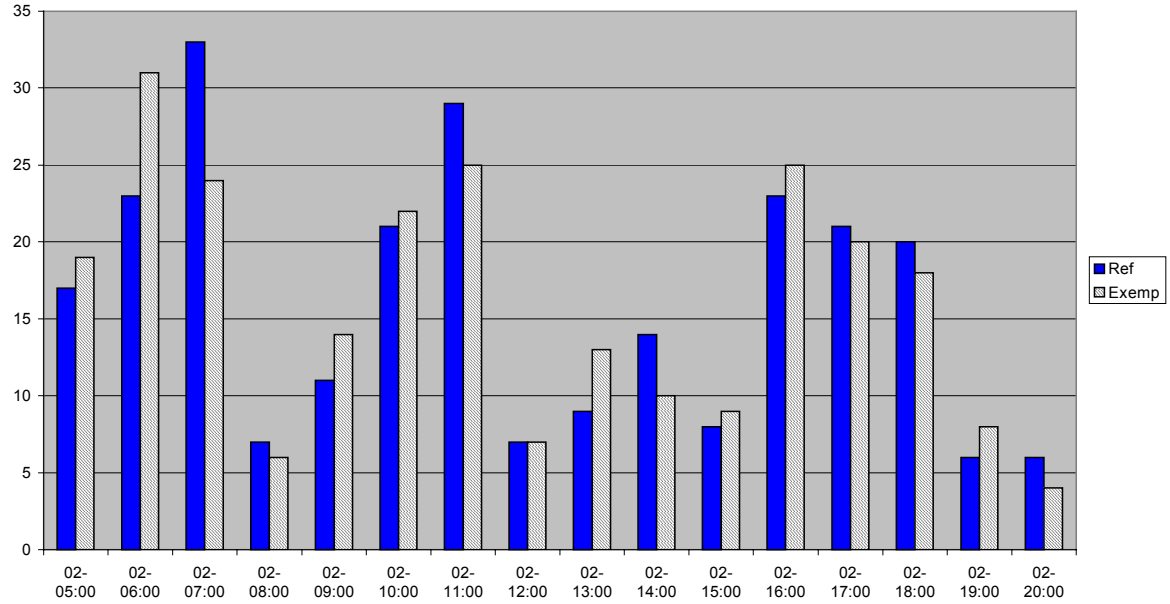
Definition of the load : number of aircraft per hour entering a sector.
By analysing the figures, it can be noted that aircraft were moved earlier or later due to the exemption.
For instance, for LIMCDEP, five aircraft were moved earlier : from 08:00/10:00 to 06:00/07:00.

LIMCDEP			
Time	reference	exempt	Capacity
02-00:00	0	0	29
02-01:00	0	0	29
02-02:00	0	0	29
02-03:00	0	0	29
02-04:00	0	0	29
02-05:00	5	5	29
02-06:00	5	9	29
02-07:00	18	23	29
02-08:00	40	34	29
02-09:00	19	18	29
02-10:00	18	16	29
02-11:00	17	17	29
02-12:00	22	23	29
02-13:00	16	17	29
02-14:00	11	11	29
02-15:00	17	16	29
02-16:00	8	7	29
02-17:00	12	14	29
02-18:00	34	34	29
02-19:00	17	15	29
02-20:00	8	8	29
02-21:00	3	3	29
02-22:00	1	1	29
02-23:00	0	0	29
Total	271	271	



LIMCARR1			
Time	reference	exempt	Capacity
02-00:00	0	0	29
02-01:00	2	2	29
02-02:00	0	0	29
02-03:00	0	0	29
02-04:00	2	2	29
02-05:00	17	19	29
02-06:00	23	31	29
02-07:00	33	24	29
02-08:00	7	6	29
02-09:00	11	14	29
02-10:00	21	22	29
02-11:00	29	25	29
02-12:00	7	7	29
02-13:00	9	13	29
02-14:00	14	10	29
02-15:00	8	9	29
02-16:00	23	25	29
02-17:00	21	20	29
02-18:00	20	18	29
02-19:00	6	8	29
02-20:00	6	4	29
02-21:00	1	1	29
02-22:00	0	0	29
02-23:00	1	1	29
Total	261	261	

Distribution of LIMCARR



LIMMENL4			
Time	reference	exempt	Capacity
02-00:00	1	1	27
02-01:00	2	2	27
02-02:00	6	6	27
02-03:00	2	2	27
02-04:00	2	2	27
02-05:00	24	24	28
02-06:00	28	29	28
02-07:00	28	29	28
02-08:00	28	28	28
02-09:00	28	29	30
02-10:00	29	25	30
02-11:00	32	32	27
02-12:00	19	20	27
02-13:00	20	21	27
02-14:00	21	20	27
02-15:00	27	27	27
02-16:00	30	31	27
02-17:00	23	23	27
02-18:00	32	31	27
02-19:00	25	25	27
02-20:00	13	13	27
02-21:00	7	7	27
02-22:00	2	2	27
02-23:00	1	1	27
Total	430	430	

LIMMESL1			
Time	reference	exempt	Capacity
02-00:00	2	2	29
02-01:00	0	0	29
02-02:00	1	1	29
02-03:00	3	3	29
02-04:00	4	4	29
02-05:00	27	28	29
02-06:00	28	28	29
02-07:00	28	29	29
02-08:00	28	27	29
02-09:00	27	28	29
02-10:00	24	24	29
02-11:00	26	24	29
02-12:00	28	26	29
02-13:00	29	32	29
02-14:00	27	29	29
02-15:00	29	30	29
02-16:00	29	30	29
02-17:00	29	25	29
02-18:00	29	30	29
02-19:00	29	28	29
02-20:00	20	19	29
02-21:00	9	9	29
02-22:00	3	3	29
02-23:00	0	0	29
Total	459	459	

LIMMWSL2			
Time	**reference**	**exempt**	**Capacity**
02-00:00	**2**	**2**	**31**
02-01:00	**3**	**3**	**31**
02-02:00	**3**	**3**	**31**
02-03:00	**1**	**1**	**31**
02-04:00	**5**	**5**	**31**
02-05:00	**22**	**22**	**31**
02-06:00	**31**	**29**	**31**
02-07:00	**14**	**15**	**31**
02-08:00	**29**	**29**	**31**
02-09:00	**35**	**36**	**31**
02-10:00	**36**	**36**	**31**
02-11:00	**25**	**25**	**31**
02-12:00	**29**	**26**	**31**
02-13:00	**29**	**32**	**31**
02-14:00	**27**	**27**	**31**
02-15:00	**29**	**31**	**31**
02-16:00	**25**	**23**	**31**
02-17:00	**20**	**20**	**31**
02-18:00	**26**	**27**	**31**
02-19:00	**23**	**21**	**31**
02-20:00	**16**	**17**	**31**
02-21:00	**5**	**5**	**31**
02-22:00	**4**	**4**	**31**
02-23:00	**1**	**1**	**31**
Total	**440**	**440**	

4.3.4 Conclusions

This study had to analyse the impact on delays of the exemptions from the Milano regulations for flights departing from LIMC or arriving to LIMC.
The study showed that the exempted flights got no delay in the regulation, but some other flights were moved later in the slot list, and their delay increased, so delay had not significant change in Milano regulations.

4.4 Implementation of 8.33 kHz Channel Spacing (September 1999)

4.4.1 Objectives

The main objective of 8.33 study was to measure the potential delay increase due to the implementation plan of the 8.33 kHz Channel Spacing equipment over seven countries :

- France,
- Netherlands,
- Belgium,
- Luxembourg,
- Switzerland,
- Austria,
- Germany.

This study had an other significant aspects
The change of flight levels for traffic not equipped ; Only 8.33 kHz equipped aircraft were allowed to enter the airspace for which the carriage and operation of 8.33 kHz channel spacing capable radio equipment was declared mandatory., so flights not equipped with 8.33 instrumentation had to fly below flight level 245 over the 8.33 zone.

4.4.2 Study Approach

The measure of the delay and the load into specific sectors: A reference simulation was completed with the TACOT tool to know the load and delay before the flight level change.

All the results were produced according to this reference.

To measure the load, all the modified flight plans were injected in the tool.

To measure the delay change, a new regulation plan according to the load, to the true regulation scheme, and to the opening scheme of the day, was implemented.

4.4.3 Data and Tools

For the purpose of the study, the following data were used to simulate the reference days in ATFM studies:

- Flight plan,
- Regulations data,
- Environment data (points, airports, sector definitions).

These data were used with three tools:

- TACOT for ATFM results as close as possible as operational TACT system,
- AMOC for rapid simulations,
- COSAAC for pre-tactical study.
- Change the flight level for the point over the 8.33 zone,
- Write the correct flight plans for any simulation tool.

The results are shown for Switzerland on table below.

Center	Sector	Level	Airspace	Delay Ref Before Level change	Delay after level change
LSAG	LOWER NORTH	265-	INF+SUP	19	132
LSAG	LOWER SOUTH	265-	INF+SUP	285	618
LSAG	LOWER SOUTH	265-	INF+SUP	142	940
LSAG	KINES	185+	INF+SUP	2322	1206
LSAZ	LSAZ UAC (TRA/ZUE)	245+	SUP	3701	1118
LSAZ	EAST LOW SECTOR	245-	INF	1343	2706
LSAZ	NORTH LOW SECTOR	245-	INF	2410	9630
LSAZ	NORTH LOW SECTOR	245-	INF	910	725
LSAZ	WEST LOW SECTOR	245-	INF	6100	11819
ALL Swiss				**17232**	**28894**

Center	Sector	Level	Airspace	Load Before level change (nb of traffic)	Load After level change (nb of traffic)
LSAG	LOWER NORTH	265-	INF+SUP	24	23
LSAG	LOWER SOUTH	265-	INF+SUP	77	85
LSAG	LOWER SOUTH	265-	INF+SUP	72	82
LSAG	KINES	185+	INF+SUP	380	375
LSAZ	LSAZ UAC (TRA/ZUE)	245+	SUP	845	736
LSAZ	EAST LOW SECTOR	245-	INF	214	226
LSAZ	NORTH LOW SECTOR	245-	INF	193	214
LSAZ	NORTH LOW SECTOR	245-	INF	62	63
LSAZ	WEST LOW SECTOR	245-	INF	407	463
ALL Swiss				**2274**	**2267**

Center	Sector	Level	Airspace	Reg Flight Before level change	Reg Flight After level change
LSAG	LOWER NORTH	265-	INF+SUP	7	16
LSAG	LOWER SOUTH	265-	INF+SUP	26	33
LSAG	LOWER SOUTH	265-	INF+SUP	17	41
LSAG	KINES	185+	INF+SUP	185	142
LSAZ	LSAZ UAC (TRA/ZUE)	245+	SUP	400	195
LSAZ	EAST LOW SECTOR	245-	INF	155	191
LSAZ	NORTH LOW SECTOR	245-	INF	110	178
LSAZ	NORTH LOW SECTOR	245-	INF	42	35
LSAZ	WEST LOW SECTOR	245-	INF	244	297
ALL Swiss				**1186**	**1128**

Center	Sector	Level	Airspace	Mean delay Before level change (min)	Mean delay After level change (min)
LSAG	LOWER NORTH	265-	INF+SUP	0,8	5,7
LSAG	LOWER SOUTH	265-	INF+SUP	3,7	7,3
LSAG	LOWER SOUTH	265-	INF+SUP	2,0	11,5
LSAG	KINES	185+	INF+SUP	6,1	3,2
LSAZ	LSAZ UAC (TRA/ZUE)	245+	SUP	4,4	1,5
LSAZ	EAST LOW SECTOR	245-	INF	6,3	12,0
LSAZ	NORTH LOW SECTOR	245-	INF	12,5	45,0
LSAZ	NORTH LOW SECTOR	245-	INF	14,7	11,5
LSAZ	WEST LOW SECTOR	245-	INF	15,0	25,5
ALL Swiss				**7,6**	**12,7**

The results for France are given below :

Center	Sector	Level	Airspace	Delay Ref Before Level change	Delay after level change
LFFF	SDS	195-	INF	156	247
LFFF	TC	245-	INF	226	357
LFFF	TC	245-	INF	340	324
LFFF	TE	245-	INF	3210	7167
LFFF	TP	245-	INF	149	143
LFEE	UR	245-340	SUP	1282	469
LFEE	UE	195+	INF+SUP	3030	1623
LFEE	E	195-	INF	320	307
LFEE	E	195-	INF	51	82
LFMMUAC	T2	320+	SUP	749	300
LFMMUAC	K (K1+K2)	195+	INF+SUP	161	88
LFMMUAC	K (K1+K2)	195+	INF+SUP	1861	753
LFMMUAC	MF1 (M1+F1)	195-320	INF+SUP	3264	3639
LFMMUAC	WT1 (T1+W1)	195-320	INF+SUP	2645	7484
LFMMLAC	LO	195-	INF	6	6
LFMMLAC	ST TROPEZ	195-	INF	572	597
All France				**18022**	**23586**

Center	Sector	Level	Airspace	Load Before level change (nb of traffic)	Load After level change (nb of traffic)
LFFF	SDS	195-	INF	40	43
LFFF	TC	245-	INF	33	36
LFFF	TC	245-	INF	46	47
LFFF	TE	245-	INF	386	412
LFFF	TP	245-	INF	65	73
LFEE	UR	245-340	SUP	427	385
LFEE	UE	195+	INF+SUP	382	372
LFEE	E	195-	INF	71	71
LFEE	E	195-	INF	43	39
LFMMUAC	T2	320+	SUP	173	133
LFMMUAC	K (K1+K2)	195+	INF+SUP	89	84
LFMMUAC	K (K1+K2)	195+	INF+SUP	87	77
LFMMUAC	MF1 (M1+F1)	195-320	INF+SUP	174	171
LFMMUAC	WT1 (T1+W1)	195-320	INF+SUP	343	373
LFMMLAC	LO	195-	INF	44	45
LFMMLAC	ST TROPEZ	195-	INF	66	67
All France				**2469**	**2428**

4.4.4 Conclusion

The set of simulations undertaken using TACOT (Tact Automated Command Tool) bought significant support at a stage of the programme.
Nevertheless, some results of the ATFM simulations were difficult to interpret as the Centre of Expertise FDR was not involved in the beginning of the study. Airspace Restrictions and Aircraft Operator segregation were imposed on the 7 th October with the support of the CFMU.
The restrictions proved essential in the launching by mitigating risks during the period of transition.

4.5 Transfer of Frankfurt ACC (September 1999)

4.5.1 Objective of the study

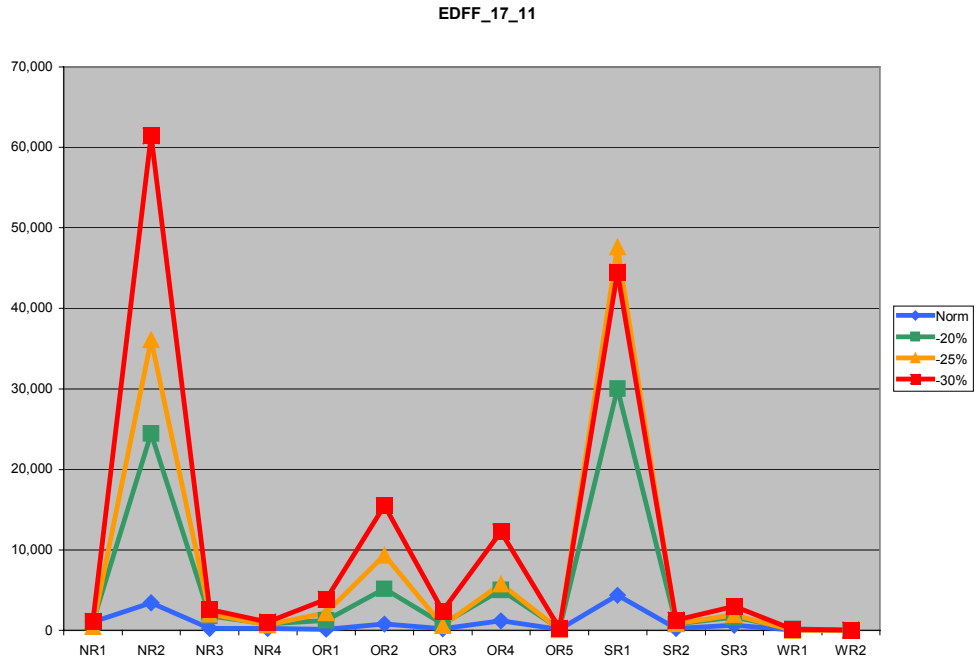
The objective of this study was to evaluate the delays linked to the transfer of Frankfurt ACC to a new location in Langen and the implementation of the new P1 ATM system.

4.5.2 Study approach

Two simulation schemes were built and run with AMOC for the following days Tuesday 17th of November 1998 and the Saturday 21st of November 1998 using the real existing CFMU regulations for those days. The traffic sample were increased by 5 to 7 % (STATFOR forecast) to represent the right amount of traffic for a Tuesday and a Saturday in November 1999.
New capacities were applied, and different reduction of capacities of 20, 25 and 30% were simulated.

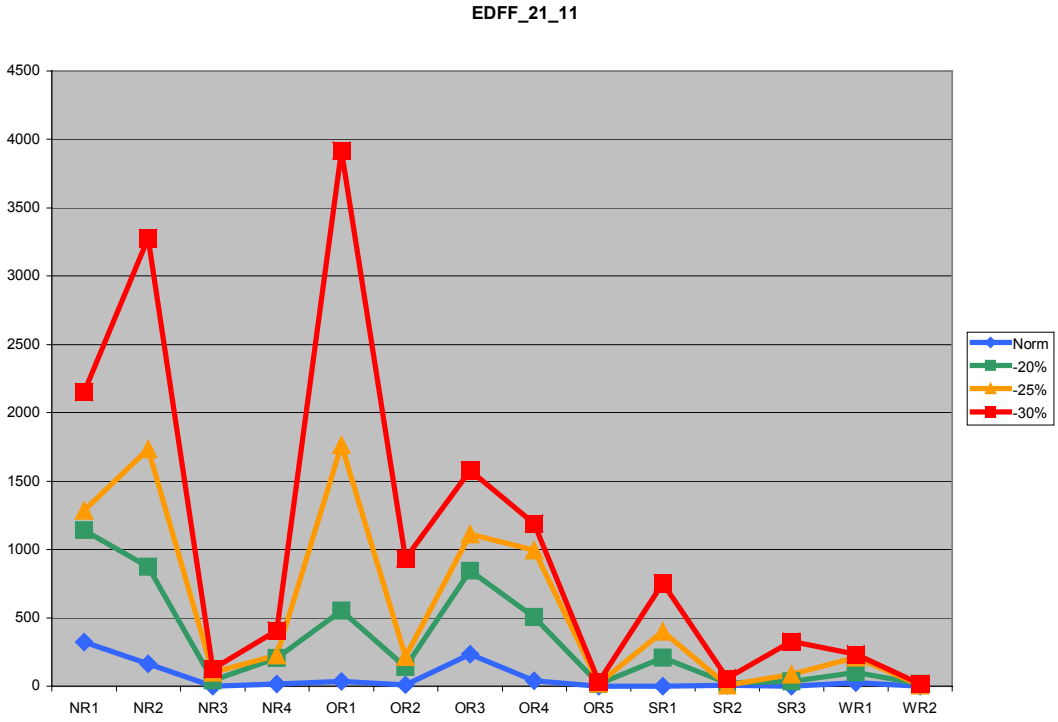
4.5.3 Results for the 17th November

	Norm	-20%	-25%	-30%
NR1	1 062	1 011	520	1 133
NR2	3 441	24 442	36 114	61 464
NR3	238	1 796	2 059	2 609
NR4	240	787	720	1 027
OR1	133	1 223	2 195	3 865
OR2	819	5 156	9 344	15 529
OR3	178	774	578	2 453
OR4	1 183	5 000	5 784	12 261
OR5	131	179	78	224
SR1	4 357	30 024	47 626	44 510
SR2	225	796	849	1 268
SR3	639	1 619	1 922	3 003
WR1	36	223	24	130
WR2	0	0	12	64
TOTAL	12 682	73 030	107 825	149 540



4.5.4 Results for the 21st of November

	Norm	-20%	-25%	-30%
NR1	324	1142	1285	2151
NR2	163	873	1735	3280
NR3	0	43	99	126
NR4	17	203	227	407
OR1	36	553	1765	3918
OR2	11	140	215	934
OR3	232	844	1112	1578
OR4	37	506	995	1189
OR5	0	16	20	31
SR1	0	209	401	754
SR2	5	22	5	57
SR3	0	35	87	327
WR1	25	98	210	232
WR2	0	16	6	15
TOTAL	850	4700	8162	14999



4.5.5 Conclusions

The different simulations related to the reduction of capacity of 20, 25 and 30% led to significant increase of the delays. As a result of those simulations, the transfer of Frankfurt ACC to a new location in Langen and the implementation of the new P1 ATM system were postponed till the end of 1999.

4.6 Datalink 2000+ (September 1999)

The LINK2000+simulation showed controller workload reductions of respectively:

- for 50% datalink equipage - **16%** workload reduction
- for 75% datalink equipage - **22%** workload reduction
- for 100% datalink equipage - **28%** workload reduction

It can be safely assumed (according to the CAPAN) that this led to sector capacity increases of respectively:

- for 50% datalink equipage – **8%** capacity increase
- for 75% datalink equipage - **11%** capacity increase
- for 100% datalink equipage - **14%** capacity increase

These results were used for the ATFM simulations made with COSAAC

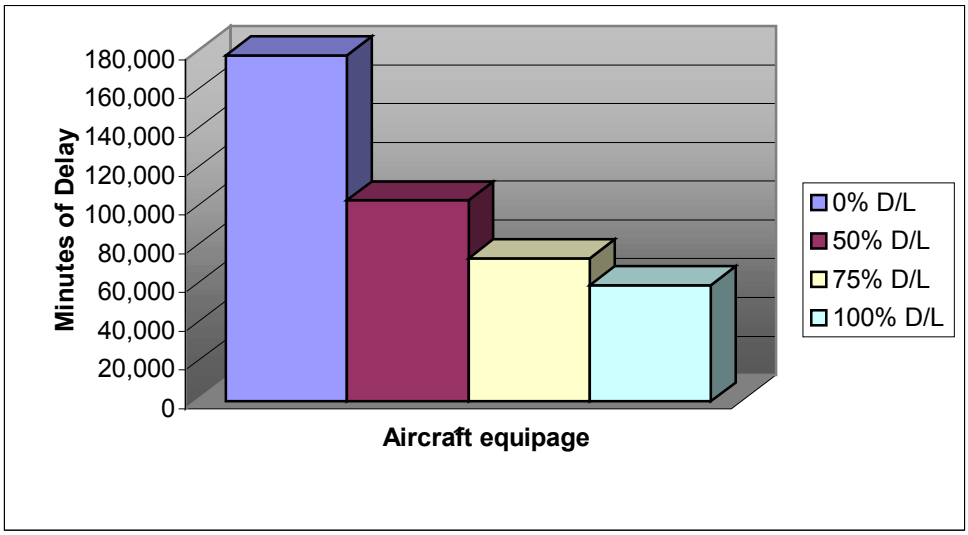
For such a study, a reference simulation was done first with the standard capacities, and then with the different capacity increases: +8%, +11% and +14%.
The reference day was the 16/04/1999 with 25319 flights. The regulation scheme was quite the same than the one applied on that day by CFMU/CEU.
The capacity increase is only applied on the requested geographical zone and only on sectors capacities (no change for restriction applied on aerodromes).

Here are the global results:

If the capacity increases per 8%, the delay decreases per 45%.
If the capacity increases per 11%, the delay decreases per 58%.
If the capacity increases per 14%, the delay decreases per 66%.

The impact of the increase of capacities led to the following delay reductions (LINK 2000+ area is in red):

A/C Equipage	0% datalink	50% datalink	75% datalink	100% datalink
Capacity Gain	0%	8%	11%	14%
	DELAY (minutes)			
BELGIUM	2226	1552	1552	1121
GERMANY	2916	2770	817	510
MAASTRICHT	46779	41713	32142	29049
UNITED KINGDOM	2014	1125	644	553
NEDERLANDS	96	96	96	90
NORWAY	10	1	0	0
SWEDEN	5	0	0	0
CANARIAS	78	36	15	15
SPAIN	20739	8332	3857	3561
FRANCE	37837	19161	14178	12193
ITALY	25231	13872	9849	7384
CZECH	1933	519	396	294
PORTUGAL	18	0	0	0
SWITZERLAND	38601	14607	9661	4045
TOTAL	178483	103784	73207	58815
Total for LINK2000+ geographical scope:	176517	103264	72811	58521
Decrease of Delay by:		41%	59%	67%



5 CONCLUSIONS

This note presents the results for the main studies conducted by the Centre of Expertise Flight Data Research. Nevertheless, others studies were conducted on behalf of the Central Flow Management Unit or external clients; the list of the different studies conducted is given below :

- Analyse of delays in 1999 evaluation of capacity
- Analyse of the load on sector GA from Brest UAC
- Canadian capacity shortfall impact on transatlantic flights
- Impact of Airport constraints on departure management
- Impact of global Traffic Volume on the Lower sectors of Zurich ACC
- Impact of LECB(Barcelona) regulations on LFMM (Marseilles)sectors
- Impact of shortfall of capacity for Greek aerodromes
- Impact on delays of the implementation of new equipment , 8__33
- Microscopic study delay vs. capacity, evaluation of capacity
- New opening sectors scheme for Bordeaux ACC/UAC
- New regulation scheme on CTL/PON/PTV area
- New sectorisation for Barcelona and Marseilles in the framework of CHIEF
- re-orientation of traffic from a centre (Karlsruhe) to another one (Munchen)
- Shortfall of capacities linked to the implementation of ARNV3
- Shortfall of capacity on Traffic Volumes LSAZUA14, WSL and NSL – Zurich
- Simulation of exchange of messages when all flights are in RDY status, Studies to assist the ATFM Working Group
- Simulation of increase of capacity for sectors LFEE (Reims), LFEUE and LFEUR
- Simulation of re-routing for INS, KINES (Geneva sectors)
- Study of the exemption of arrivals/departures to/from LIMC from the Milano regulations
- Transfer of Frankfort ACC to Langen
- translation of the R/T workload reduction in capacity increase for the Data Link 2000+
- Update of the departure rates Contingency plan evaluation
- Usability of the routes generated by CARAT Operational Evaluation of the Quality of CARAT Generated Routes

In 1999, 46 simulations were conducted in regard to the 7 simulations conducted in 1997 or the 17 simulations made in 1998; this was due to the availability of the tools, less failures of TACOT for example and the quality of technical and operational people.

This document described only the main results, more detailed results of the different studies can be asked to the Head of Flight Data Research or representatives.

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6 ABBREVIATIONS

ACC	**Area Control Centre**
AMOC	**Atfm Modelling Capability**
ARC	**CFMU Archives System**
ARN	**ATS Routes and associated Navigation means**
ASCOT	**Airport Slot Compliance Tool**
ATC	**Air Traffic Control**
ATFM	**Air Traffic Flow Management**
ATM	**Air Traffic Management**
CARAT	**Computer Aided Route Allocation Tool**
CASA	**Computer Assisted Slot Allocation**
CEU	**Central Executive Unit**
CFMU	**Central Flow Management Unit**
COHOR	**Comité des Horaires**
COSAAC	**Common Simulator to Assess ATFM Concepts**
ENV	**CFMU Environment Database**
SRS	**Standard Route Scheme**
TACT	**CFMU TACTical system**
TACOT	**TACT Automated Command Tool**

7 CONTACTS

Flight Data Research
Eurocontrol Experimental Centre
BP15 – 91222 Brétigny sur Orge CEDEX – France

Antoine Vidal	+33(0)1 69 88 75 53	antoine.vidal@eurocontrol.fr
Roger Guerreau	+33(0)1 69 88 74 31	roger.guerreau@eurocontrol.fr
Marc Bisiaux	+33(0)1 69 88 76 43	marc.bisiaux@eurocontrol.fr
Bernard Kerstenne	+33(0)1 69 88 76 53	bernard.kerstenne@eurocontrol.fr
Jérome Lebreton	+33(0)1 69 88 76 04	jérome.lebreton@eurocontrol.fr
Frédéric Croq	+33(0)1 69 88	Frederic.croq@eurocontrol.fr
Nicolas Bunoz	+33(0)1 69 88 78 42	nicolas.bunoz@eurocontrol.fr
Nicolas Dufour	+33(0)1 69 88	Nicolas.dufour@eurocontrol.fr