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Sponsor: EUROCONTROL	**Sponsor (Contract Authority) Name/Location:** EUROCONTROL Agency Rue de la Fusée, 96 B -1130 BRUXELLES Telephone : +32 2 729 9011

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CEATS FAST-TIME SIMULATION No. 1

Author	Date	Pages	Figures	Tables	Appendix	References
F. Dowling	04/01	viii + 59	41	-	2	-

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Abstract: The CEATS FTS1 examined sectorisation in the CEATS area above FL285 ignoring national gegraphical boundaries using traffic increased to 2007, 2010 and 2015 levels, on fixed route network ARNV3 slightly modified. It also examined controller workload based on tasks associated with the CEATS Operational Concept.

SUMMARY

The Central European Air Traffic Services (CEATS) Fast-Time Simulation No. 1 (FTS1) was conducted in the context of the CEATS Simulations Project. The purpose of this study was to define suitable airspace organisations for the CEATS airspace volume.

The CEATS area of responsibility is the airspace above Flight Level (FL) 285 and FL295 over the Czech Republic, Slovakia, Austria, Hungary, Slovenia, part of Italy (ACC Padua), Croatia and Bosnia - Herzegovina. The planned date for start of operations is 2007.

The CEATS Programme originated from the decision of seven Central European States to cooperate in the provision of air traffic services within their upper airspace to ensure maximum efficiency at minimum cost for all airspace users while safeguarding the required level of safety and to contribute to the creation of a uniform European Air Traffic Management System (EATMS).

The programme is to be implemented by EUROCONTROL under the provision of the 'Agreement relating to the provision and operation of air traffic services and facilities by EUROCONTROL at the CEATS Upper Area Control Centre (UAC)' signed in Brussels on 27 June 1997.

One 24 hour traffic sample from 10 September 1999 was supplied for the study. This traffic sample was enhanced to 2007 traffic levels and included traffic at Reduced Vertical Separation Minima levels (RVSM). The traffic sample was also alligned to the Area Route Network Version 3 (ARNV3). Some modifications were made to ARNV3 for this study.

A 12 hour period in the traffic sample, from 08.00 to 20.00, was used for the simulation. The traffic sample was further enhanced to 2010 and 2015 traffic levels. These traffic levels were tested in the final scenario with the optimum sectorisation.

One base organisation and eight proposed organisations were simulated. The base organisation used sectorisation proposed from the 1st Simulation and Analysis at a Macroscopic Level Tool (SAAM) evaluation. Some modifications were made to this sectorisation both horizontally and vertically before the initial simulation run. The base organisation simulated a total of 35 sectors.

The main objective of the CEATS Simulation Experts Group (CSEG) was to achieve an even balance in workload for both the Upper and Upperhigh sectors, while maintaining a moderate workload level for the controller. Controller workload was measured using Air Traffic Control (ATC) tasks assigned to the Executive Controller (EC) based on the principles of the CEATS Operational Concept.

As the simulation exercises progressed and initial results were examined and analysed by the CSEG it became more apparent which level splits should be used for the superimposed sectors. It also became apparent as to which sectors did not require superimposed sectorisation. The fifth organisation simulated 30 sectors and the CSEG agreed to use this final scenario for further testing at future traffic levels.

The final scenario was simulated using traffic at 2007, 2010 and 2015 levels. At 2007 traffic levels a number of military areas were simulated to assess the effect on controller workload during periods of military activity.

The exercise simulating traffic at 2015 levels was also used to simulate a « direct route » concept, where flights entering the CEATS area flew from their point of entry directly to their point of exit.

Overall the results of the study indicated the feasibility to manage the 2007 typical peak day traffic in 30 sectors. However, in the future organisations, particularly with traffic at 2015 levels, a number of sectors reached heavy and some reached severe levels of workload.

Finally, a second Fast-Time Simulation for CEATS is planned to address some of the inadequacies of the sectorisation highlighted by the first simulation and re-evaluate the area using Area Route Network Version 4 (ARNV4) for the fixed route network as well as Free Routes.

ACKNOWLEDGEMENTS

The members of the EUROCONTROL study team wish to express their appreciation for the assistance afforded them by the members of the CSEG during the course of the simulation.

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LIST OF ABREVIATIONS

ACC	Area Control Centre
ARN	Area Route Network
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATCU	Air Traffic Control Unit
CEATS	Central European Air Traffic Services
CSEG	CEATS Simulation Expert Group
CSPDU	CEATS Strategy Planning and Development Unit
CVSM	Conventional Vertical Separation Minimum/Minima
EATMS	European Air Traffic Management System
EC	Executive Controller
EEC	EUROCONTROL Experimental Centre
FDPS	Flight Data Processing System
FL	Flight Level
FLOS	Flight Level Orientation Scheme
FTS	Fast-Time Simulation
ICAO	International Civil Aviation Organisation
LoA	Letters of Agreement
OLDI	On Line Data Interchange
OPS	Operational Services, Centre of Expertise, EEC
PC	Planning Controller
R/T	Radio Telephony
RAMS	Re-Organised ATC Mathematical Simulator
RVSM	Reduced Vetical Separation Minimum/Minima
SAAM	System for Analysis and Assignment at a Macroscopic Level Tool
STATFOR	Air Traffic Statistics and Forecasts
SYSCO	System Supported Coordination
TSA	Temporary Segretated Area
UAC	Upper Area Control Centre

1. INTRODUCTION

This document details the specifications and results for CEATS FTS1 which was conducted in the context of the CEATS Simulations Project, using the Experimental Centre's simulation facilities. The purpose of the study was to define suitable airspace organisations for the CEATS airspace volume.

The project was carried out at the EUROCONTROL Experimental Centre (EEC) in Brétigny-sur-Orge, France between February 2000 and December 2000. A number of data preparation meetings were held during the execution of the simulation between representatives of the national Air Traffic Control Centres (ACCs) within the CEATS area and the EUROCONTROL study team. These representatives, from Czech Republic, Slovakia, Hungary, Austria, Slovenia, Padua, Italy and Croatia were part of the CSEG. The purpose of these meetings was, to outline the simulation methodology, define the exercises to be simulated, verify the input data, review the interim results and ensure that the objectives of the study could be achieved.

2. OBJECTIVES OF THE STUDY

2.1 OVERALL

To define suitable airspace organisations for the CEATS airspace volume as defined by the CEATS agreement.

To evaluate controller workload using tasks appropriate to the CEATS operational concept.

2.2 SPECIFICALLY

To identify the most appropriate internal CEATS sectorisation both geographically and vertically using:

Traffic volumes forecast for 2007, 2010 and 2015 adapted to RVSM

Fixed route network ARNV3 compared to direct routings from CEATS area entry point to exit point

Alternative lower limits for CEATS airspace, either FL285 or FL295, or as specified in the CEATS agreement. It was agreed to simulate a lower limit of FL285 only for this Fast-Time simulation.

3. METHODOLOGY

The methodology used in Fast-Time simulations entails the development and evaluation of a reference organisation. This organisation was based upon the output from the CEATS airspace structure 1st CEATS SAAM evaluation in order to both validate the performance of the RAMS simulator tool, and to establish a baseline against which results of proposed organisations could be measured.

The facility to be able to make such comparisons helps to identify the most/least promising of proposed organisations and can lead to supplementary exercises. Where weaknesses are identified, the appropriate remedial solutions are often obvious. Where this is not the case the findings often precipitate supplementary studies leading to an overall improvement in the results obtained when using the proposed organisation.

4. TRAFFIC SAMPLE

One 24 hour traffic sample, from 10 September 1999 and enhanced to 2007 levels by STATFOR (Air Traffic Statistics and Forecasts), was used for the study. It contained 7219 flights. The working group agreed to simulate a 12 hour period in the sample from 0800 to 2000. The traffic sample for the simulated period contained 4639 flights.

4.1 ROUTE NETWORK

The original traffic sample which was imported to the Reorganised ATC Mathematical Simulator (RAMS) from the SAAM tool, was alligned to the fixed route network ARNV3. However some modifications were made to ARNV3 in the upper airspace over Austria and Hungary as well as part of Slovenia.

4.2 INCREASING TRAFFIC LEVELS

The existing traffic sample was increased to 2010 and 2015 levels in conjunction with STATFOR.

The traffic sample for 2007 increased from 4639 flights to 5066 flights for the 12 hour simulated period to represent 2010 traffic levels.

The traffic sample for 2010 increased from 5066 flights to 5725 flights for the 12 hour simulated period to represent 2015 traffic levels.

4.3 RVSM HARMONISATION

RVSM is an International Civil Aviation Organisation (ICAO) approved concept designed to permit the reduction of vertical separation from that of Conventional Vertical Separation Minima (CVSM) figure of 2000 feet in respect of aircraft operating between FL290 and FL410 inclusive, to 1000 feet. An aircraft may only benefit from the reduced vertical separation criteria afforded by RVSM if it is RVSM approved.

The Flight Level Orientation Scheme (FLOS) chosen for this study utilised single rather than dual alternate flight levels. In the case of the single alternate flight level FLOS selected, the upper vertical limit for use of the CVSM figure 1000 feet, which is conventionally set at FL290, was raised to FL410. Hemispherical level conventions were retained, with even flight levels being allocated to westbound flights and odd flight levels to eastbound flights. However, choice of the single alternate flight level system determined that FL310, FL350 and FL390 became eastbound flight levels.

The conventions to be applied in revising the flight levels of selected aircraft in the 2007 traffic sample to ensure ready integration at the newly available RVSM flight levels were presented to and agreed by the CSEG.

No transition from RVSM to CVSM or from CVSM to RVSM were simulated.

Redistribution of Requested Flight Levels were used in accordance with the following principle

CVSM LEVEL	RVSM LEVEL	% of FLIGHTS MOVED
FL290	FL290	60%
	FL310	40%
FL310	FL300	50%
	FL320	50%
FL330	FL310	15%
	FL330	45%
	FL350	40%
FL350	FL320	10%
	FL340	40%
	FL360	40%
	FL380	10%
FL370	FL350	25%
	FL370	50%
	FL390	25%
FL390	FL380	70%
	FL400	30%

Figure 1

5. AIRCRAFT PERFORMANCE

The RAMS simulator recognises in excess of 250 aircraft types and these are grouped into different categories for performance purposes. Detailed data on climb, cruise and descent speeds, rate of climb and descent in each level band and maximum and minimum acceptable flight levels for each category of aircraft are available. The RAMS simulator can also distinguish between long, medium and short range flights.

The aircraft performance data used to construct the actual and requested profiles for each aircraft within the simulated airspace are derived from studies of actual performance, airline operating practices and particular characteristics observed by experienced controllers during previous simulations, or in the field.

Detailed information on the performance data utilised in this simulation is held by the OPS Centre of Expertise at the EUROCONTROL Experimental Centre in Brétigny-sur-Orge, France.

6. MILITARY ACTIVITY

Military activity was simulated in one exercise using 2007 traffic levels. Restricted and Temporary Segregated Areas (TSA) and Danger Areas that existed in each State at the study start time were activated. The hours of activation were furnished by each member of the working group as were the vertical dimensions.

A co-ordination task was created for every aircraft that entered a military area.

The following areas were activated during the exercise:

CZECH REPUBLIC:

Military Area	Vertical Limits	Hours of Operation
LKR1	GND - FL350	07.00 – 23.00
LKR3	GND - FL410	07.00 – 17.00 + 19.00 – 23.00
LKR4	GND - FL410	07.00 – 16.00 + 18.00 – 23.00
LKR5	GND - FL410	13.00 – 16.00
LKR5	GND – FL290	16.00 – 22.00
LKR6 + TSA54	GND – FL450	07.00 – 13.00 x 4 30mins / day

HUNGARY:

Military Area	Vertical Limits	Hours of Operation
TSA56	FL45 – FL460	07.00 – 10.00
TSA57	FL400 – FL460	07.00 – 10.00
TSA58	FL125 – FL460	07.00 – 10.00
TSA59	FL380 – FL460	07.00 – 10.00
D2B	GND – FL300	06.00 – 18.00
D3	GND – FL300	06.00 – 18.00
D19	GND – FL265	06.00 – 18.00
D22A	GND – FL340	06.00 – 18.00
D35	GND – FL340	06.00 – 18.00

SLOVAK REPUBLIC:

Military Area	Vertical Limits	Hours of Operation
LZR13	GND – FL330	04.00 – 15.00
LZR251	GND – FL330	04.00 – 13.00

ITALY:

Military Area	Vertical Limits	Hours of Operation
TSA74	GND – FL370	11.00 – 11.30
TSA78	GND – FL370	13.45 – 14.15
INDIA2	GND – FL310	08.00 – 16.00

AUSTRIA:

Military Area	Vertical Limits	Hours of Operation
DAU1	FL115 – FL300	Simulation Period
DAU2	FL115 - UNL	Simulation Period
DAU3	FL185 – FL300	Simulation Period

CROATIA:

Military Area	Vertical Limits	Hours of Operation
LDR18	GND – FL500	Simulation Period

6.1 SECTOR MANNING ARRANGEMENTS

Two ATCO positions were simulated in all sectors, those of the Executive Controller (EC) and the Planning Controller (PC). However, the ATC tasks specified concentrated only on the EC position and only the results of workload for the EC were analysed. Initial results showed the workloads recorded for the PC , with the optimum tasks to be much lower than that of the EC

6.2 ATC TASK SPECIFICATIONS

The specification and definition of tasks in the RAMS simulator is inherent to the tool's simulation event philosophy. The RAMS simulator is, in effect, an Air Traffic Control (ATC) event generator that reports its discreet events or triggers, thereby enabling the modeller to program a unique set of activities, including user defined sets of ATC tasks and ATC participants as required, to perform a simulation project. The ATC participants are those Air Traffic Control Officer (ATCO) positions described for the sector manning arrangements.

ATC task sets are grouped by category. The main categories used in the CEATS study were as follows :-

- Flight Data Management
- Co-ordination – within both the simulated Air Traffic Control Unit (ATCU) and with other concerned ATCUs
- Conflict Search – to formulate ATC clearances
- Routine Radio Telephony (R/T) Communications
- Radar – to represent radar activities such as conflict detection and resolution.

All ATC tasks are activated by a pre-defined trigger. The trigger (e.g. ATC sector entry) is the event that initiates / ensures the recording of a specific ATC task.

Each ATC task is allocated a weighting. The weighting concerned is an arbitary unit value assigned to the task's actor when triggered by a simulation event. Examples of unit values would be – time in seconds, in the case of a controller workload study, or units of cost, in a cost benefit study.

The time specified is the average time spent on the task by an experienced and fully trained controller, ignoring the extreme situations which could favourably or unfavourably affect the standard execution time.

The weighting allocated is not intended to represent the actual duration of the task, but the amount of time the controller is considered to be totally committed to the task, to the exclusion of all other tasks.

In certain cases a task may involve more than one control position, and different weightings may be allocated to each. Different weightings may also be allocated to the same task occurring in different sectors.

A time offset can be applied to each task. The time offset, defined in seconds, affords the modeller the flexibility to record a task before or after a specified trigger. Where one trigger instigates multiple activities, these can be specified to occur at different times.

All tasks are related to an object. An object is defined as the place or position where the task is recorded. This may be defined either globally for all control centres or more specifically in respect of a particular control centre, sector, airport, navigational aid etc.

The dynamic conditions of all tasks can be fine tuned to afford the highest degree of flexibility to the ATC task specification.

The specification and definition of all ATC tasks used in the study were based on the CEATS Operational Concept and developed by the CSEG and the EUROCONTROL EEC / OPS working group members. Experience from previous Real Time studies conducted at the EEC, which evaluated the operational use of electronic connections between Flight Data Processing Systems (FDPS) in adjacent centres (known as OLDI-On Line Data Interchange) and the subsequent upgrade to this original OLDI standard known as SYSCO (System Supported Coordination) helped to define these optimum tasks.

6.3 CONTROLLER PERCENTAGE LOADING

ATC tasks are allocated to controller positions in accordance with the sectorisation manning and distribution of duties specified for each sector simulated. The RAMS simulator can therefor calculate both the actual workload, and the percentage loading on each position. Results can be obtained for either the entire simulation period or for specified peak periods, as required.

Note: The analysis presented in this report is based upon three hour peak periods identified within the 12 hour simulation runs conducted for each exercise.

In general, the values used in the interpretation of controller loadings are Peak Hour Percentage Loading, and Average Percentage Loading.

Peak Hour Percentage Loading represents the total time spent by a working position on the tasks recorded by the RAMS simulator during the busiest 60 minute period for that position and is expressed as a percentage of that 60 minutes. The actual time of the peak hour varies from one position to another. Peak hour percentage loading is used to assess the workload problems on individual working positions.

Average Percentage Loading represents the total time spent by a working position on the tasks recorded by the RAMS simulator for the duration of the simulation exercise (or part thereof, in excess of one hour) and is expressed as a percentage of that time. A peak three hour duration is normally selected when simulation exercises exceed 12 hours. Average percentage loading is used primarily to assess the balance of workload between working positions, especially in sectors in the same area of airspace being simulated. It may also be used to compare results obtained from different organisations.

In order to assist in the interpretation of these loadings approximate criteria are used to describe each level as follows :-

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3 hour duration)	in excess of 50%
Heavy average loading (3 hour duration)	in excess of 40%

A full description of the task execution times applied in this study are contained in Appendix 1 of this report.

7. ORGANISATIONS SIMULATED

The CEATS area of responsibility is the airspace above FL285 over the Czech Republic, Slovakia, Hungary, Austria, Slovenia, part of Italy (Padua ACC), Bosnia - Herzegovina and Croatia.

Figure 2

One base organisation and eight proposed organisations were simulated.

The figure on the following page summarises the basic elements of the organisations simulated in this study. The basic changes introduced from organisation to organisation are highlighted in red.

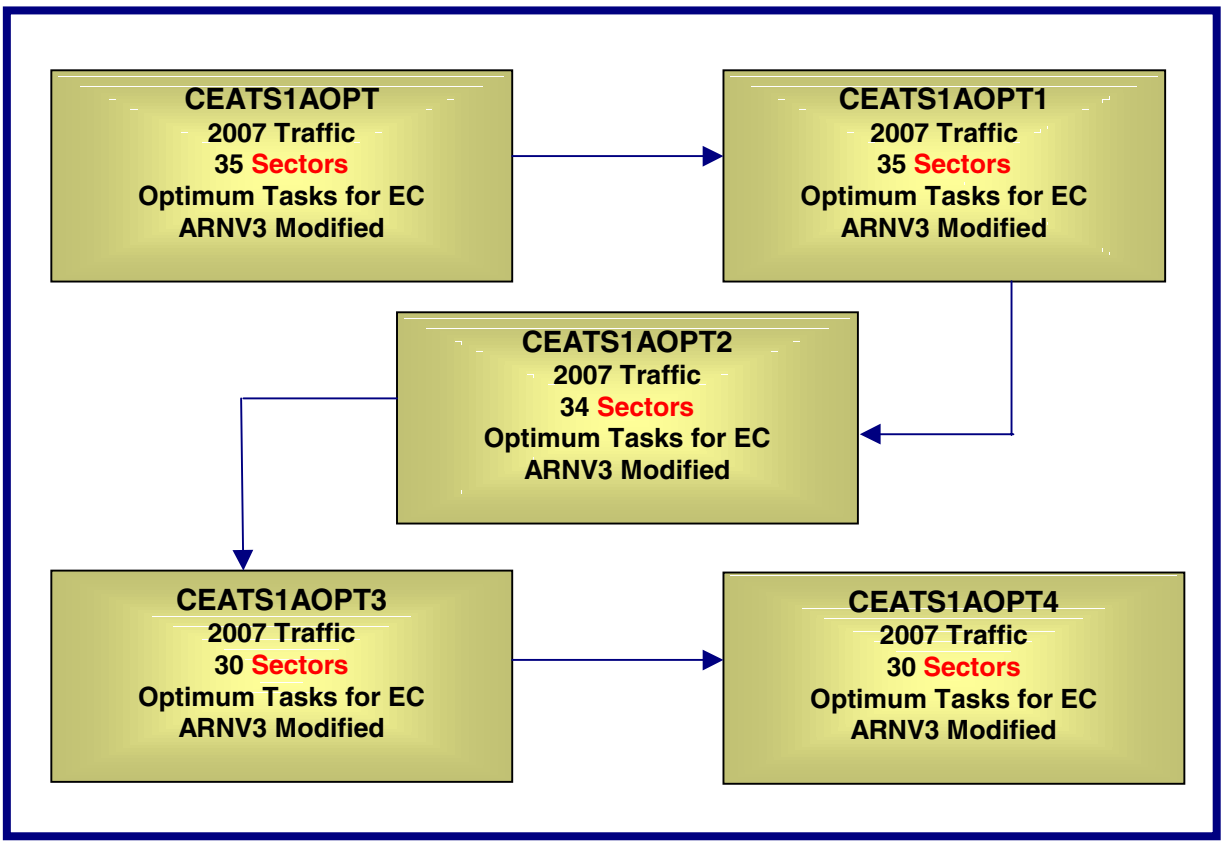

Figure 3

All the above organisations were simulated using the 2007 traffic sample on ARNV3 modified, with "optimum" tasks described for the EC as agreed by the CSEG.

CEATS1AOPT4, with 30 sectors was found to be the most suitable scenario. The figure below summarises the other elements which were simulated using this scenario with the changes for each organisation also highlighted in red.

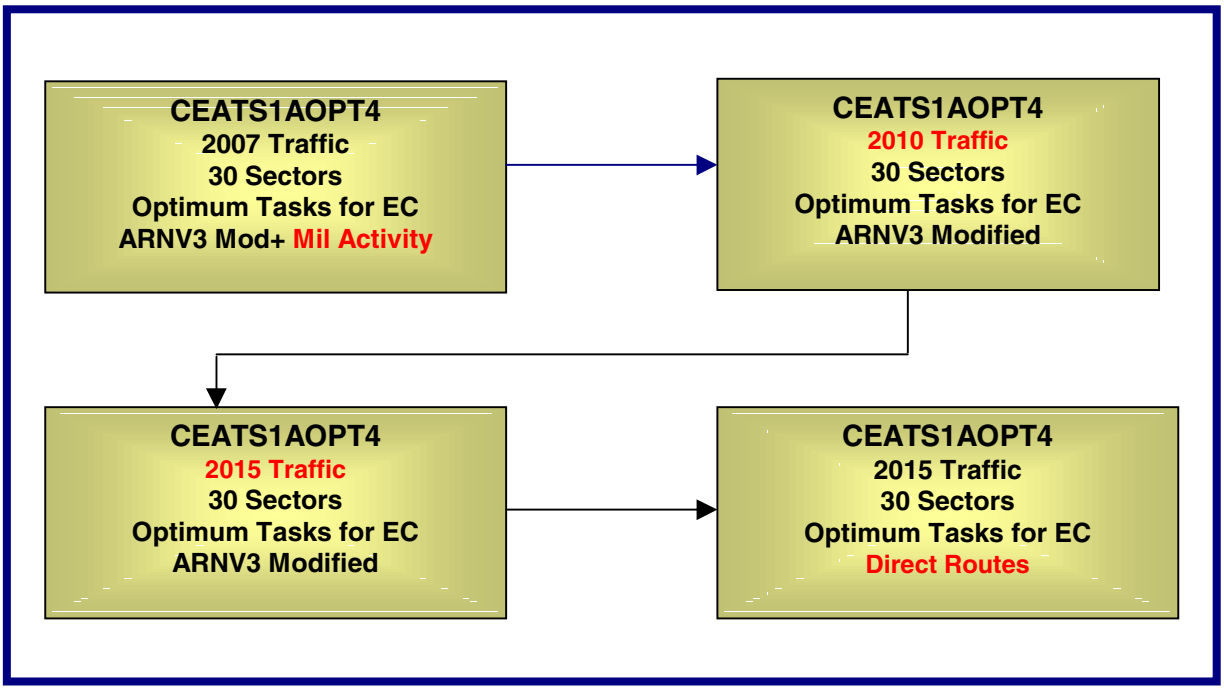

Figure 4

CEATS1AOPT :

This organisation simulated the sectorisation taken from the 1st SAAM Evaluation, scenario 1A with some changes made to the lateral dimensions of the sectors.
Sector C_2 had its eastern boundary moved further to the east.

Sector C_6 was divided into two creating a total of three sectors as opposed to the original two, C_6A extending from FL285 to UNL and C_6U and C_6UH with a vertical split at FL 345.

Sector C_10 was divided in two and also had its south/western boundary moved further west, creating a total of four sectors instead of two

Sector C_14 was also divided in two creating four sectors instead of two.

The total number of sectors simulated for CEATS1AOPT was 35.

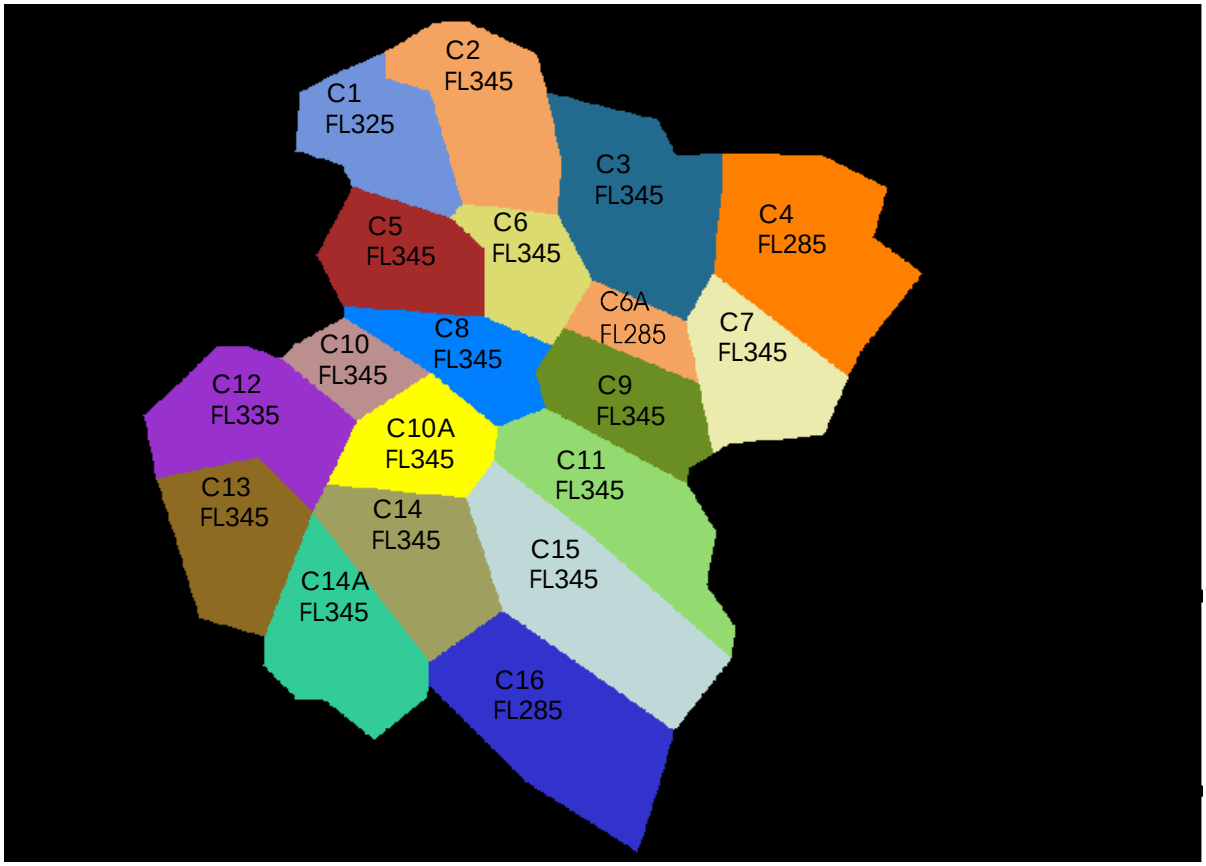

Figure 5

CEATS1AOPT1:

This scenario used the same sectorisation as CEATS1AOPT with the following modifications.

All vertical splits were moved upwards to FL355 except in sectors C_12U and C_12UH. Three superimposed sectors were introduced here with the following dimensions. C_12U from FL285 to FL325, C_12UH from FL325 to FL355 and C_12T from FL355 to UNL.

In Sector C_14 the two lower sectors were combined with the upper limit at FL345.

The total number of sectors simulated for CEATS1AOPT1 remained at 35.

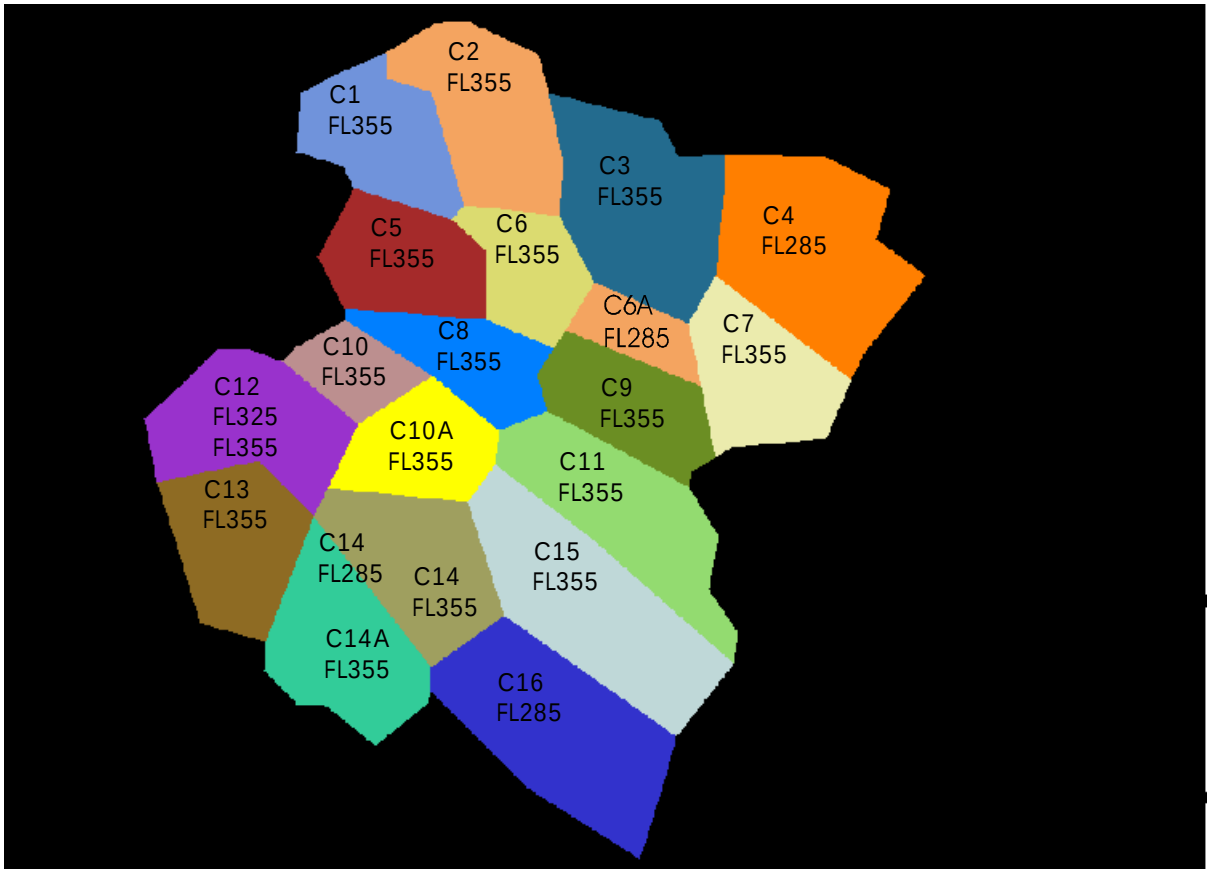

Figure 6

CEATS1AOPT2 :

This scenario changed the vertical split for the superimposed sectorisation of sector C_1 and C_2 to FL345.

The three sectors in sector C_6 were geographically combined and divided into two superimposed sectors with a vertical split at FL355.

Sectors C_11 and C_15 which were two adjacent sectors running in a north south direction were combined to form new geographical dimensions resulting in two sectors running in an east west direction with superimposed sectorisation split at FL355.

Sector C_12 was further geographically divided to form a total of six sectors with three superimposed sectors split at FL325 and FL355.

The three sector configuration in sector C_14 where there was one upper sector and two upperhigh sectors was configured as two sectors sector C_14 and C_14A both extending from FL285 to UNL.

The total number of sectors simulated for CEATS1AOPT2 was 34.

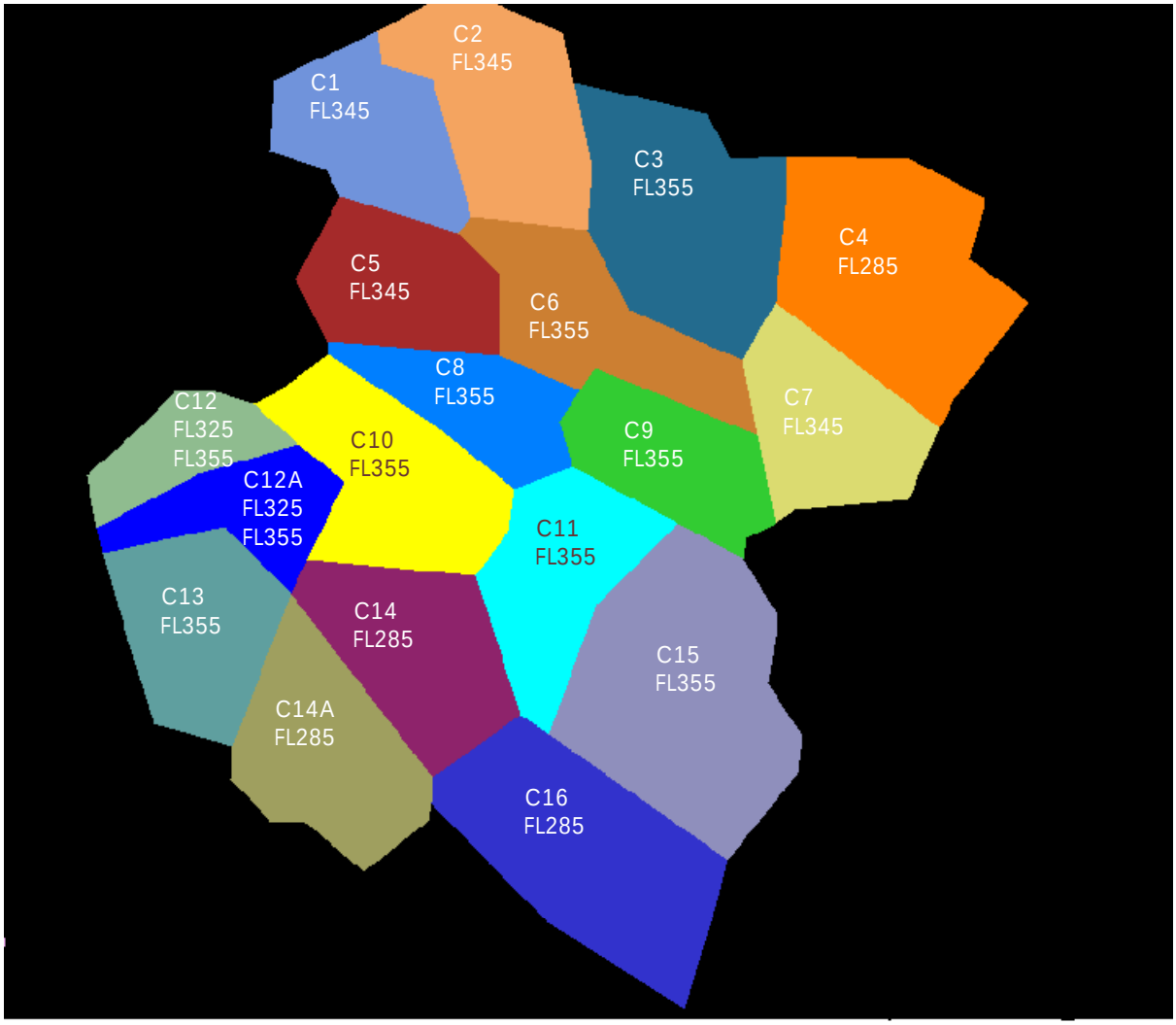

Figure 7

CEATS1AOPT3 :

This scenario examined further changes to the sectorisation examined in CEATS1AOPT2.

Sectors C_3U and C_3UH were combined to form one sector extending from FL285 to UNL.

Sectors C_11 and C_15 reverted to their original configuration in CEATS1AOPT2 running in a north south direction.

Results from the previous organisation proved it unnecessary to have six sectors in sector C_12 and so three superimposed sectors were reintroduced with splits at FL335 and FL365.

The total number of sectors simulated for CEATS1AOPT3 was 30.

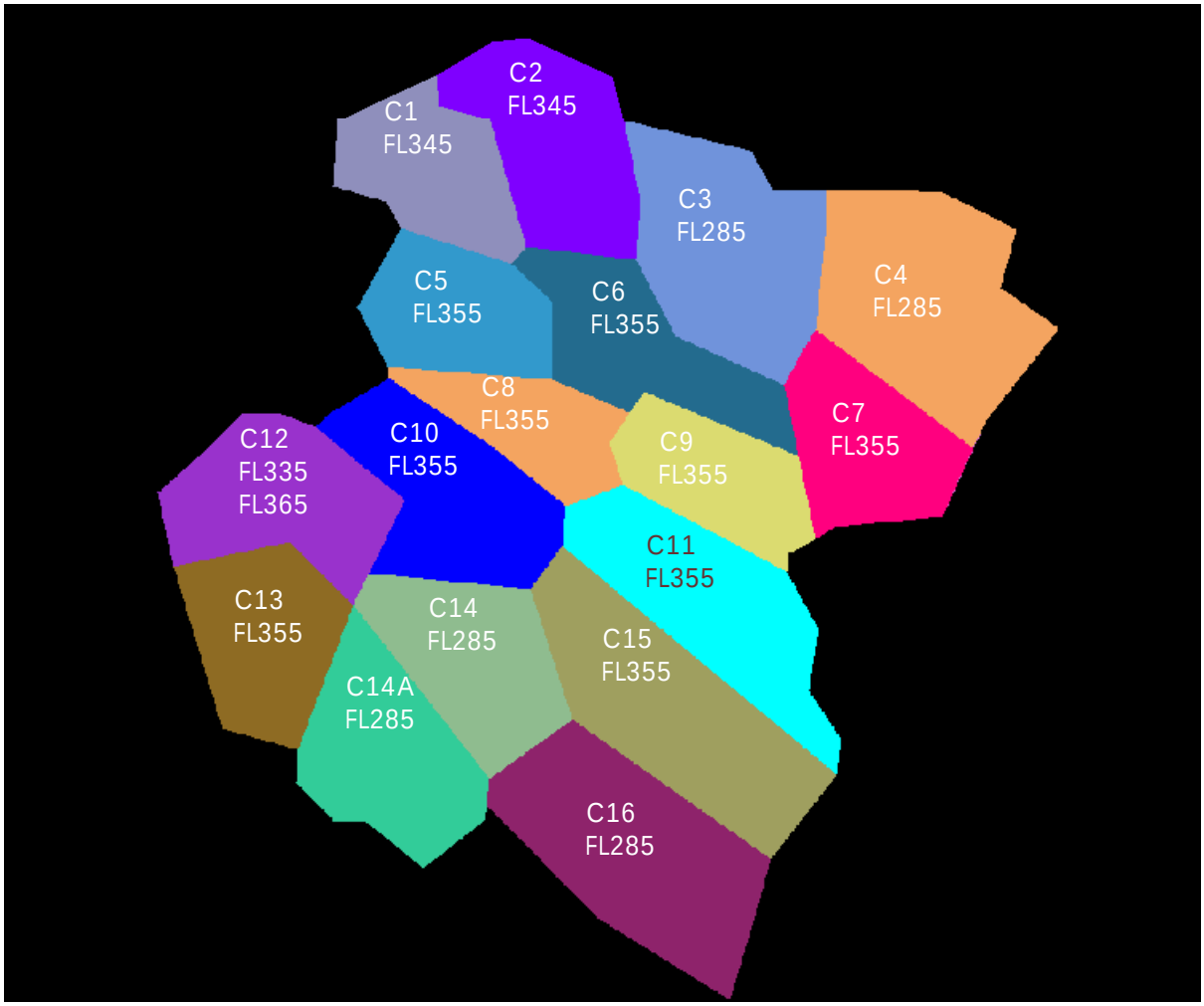

Figure 8

CEATS1AOPT4 :

This scenario remained as CEATS1AOPT3 except for one modification which changed the vertical splits in the three superimposed configuration in sector C_12 to FL325 and FL355.

This scenario, simulating a total of 30 sectors, was found to be the most suitable scenario.

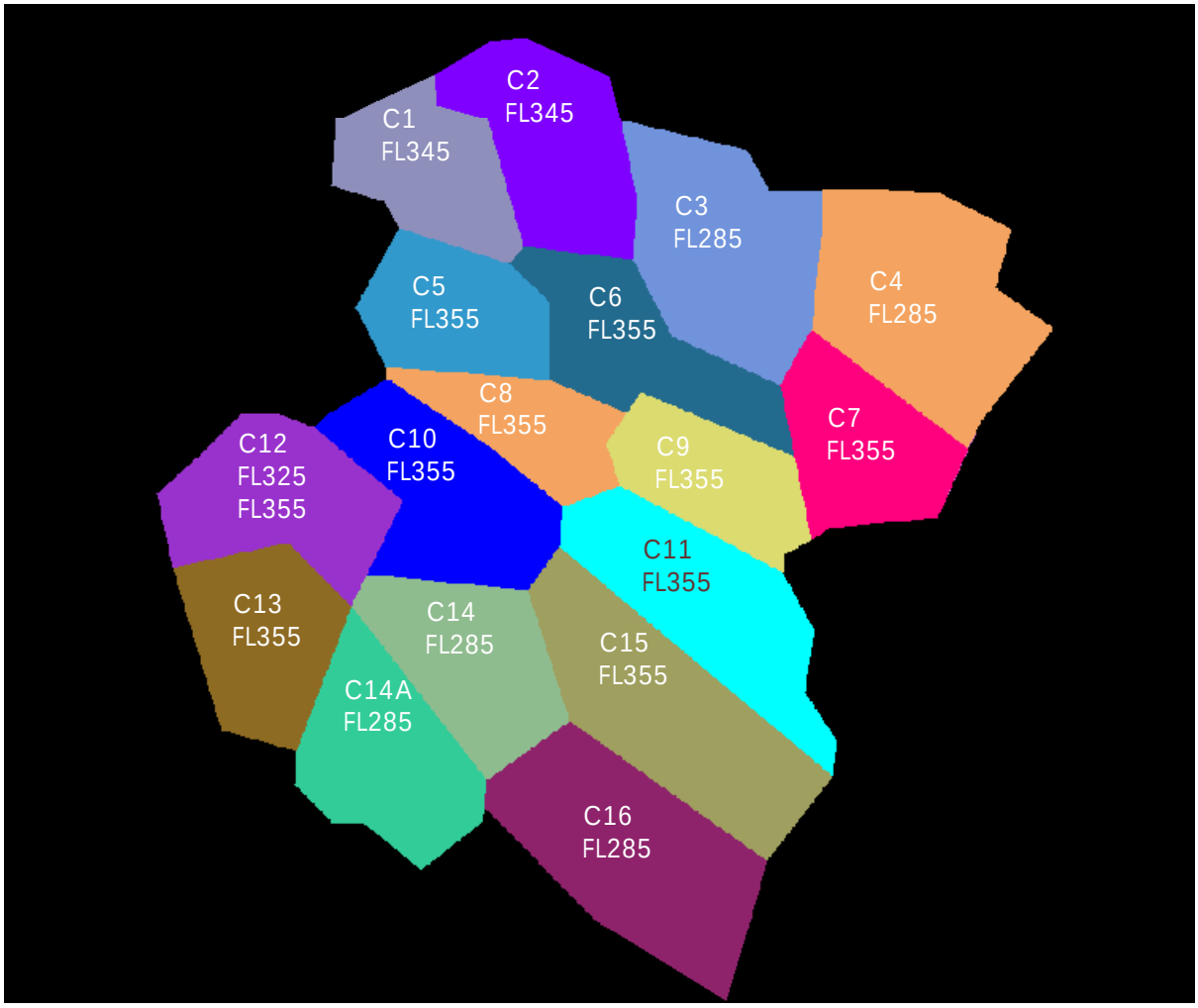

Figure 9

CEATS1AOPT4 was the scenario used to test the four remaining exercises for comparative purposes.

This scenario was used to test some Military Activity with traffic at 2007 levels (**CEATS1AOPT4_MIL**). It was also used to test the sectorisation with traffic increased to 2010 levels (**CEATS1AOPT4_10**) and 2015 levels (**CEATS1AOPT4_15**). The scenario with 2015 traffic levels was also tested using a "direct route" concept for traffic entering the CEATS area routing directly from point of entry to the CEATS area to the point of exit from the area (**CEATS1AOPT4_15DCT**).

8. RESULTS and COMPARATIVE ANALYSIS

After the initial Fast-Time simulation exercise, which was based on the sectorisation taken from the 1st SAAM Evaluation, level changes in the superimposed sectorisation were the main changes introduced to the sectorisation. Some sectors did have their geographical boundaries altered and others were geographically divided to reduce their size and therefore increased the number of sectors.

As the simulation exercises progressed and initial results were examined by the CSEG, it became more apparent which level splits should be introduced for the superimposed sectorisation and which sectors did not require vertical splits.

The working group, by introducing these changes, tried to achieve an even balance in workload for both the upper and upperhigh sectors and maintain a moderate workload level for the controller.

Some sectors managed to achieve this goal at an early stage of the simulation but others required further exercises, resulting in a total of five organisations being simulated before the most satisfactory scenario was found.

Analysis of the results obtained from the organisations conducted concentrated on controller workload criteria and were based on 2007 traffic levels. However, although some workloads recorded were moderate to low, consideration had to be given to the possible increase in workload as traffic levels were increased to 2010 and 2015 levels.

It must be stressed that all results presented in this document were measured for the peak three hour period for the EC in each sector over the simulated period (08.00 – 20.00) and were based on the CEATS Operational Concept. The RAMS tool can never reflect the day to day tasks of an air traffic controller. However, it can clearly identify where problems may or do exist.

The following graphs show the average percentage workload recorded for the Executive Controller (EC) over a three hour period in each sector for each exercise, explaining the methodology used to determine the best configuration.

SECTOR C1 UPPER / UPPERHIGH

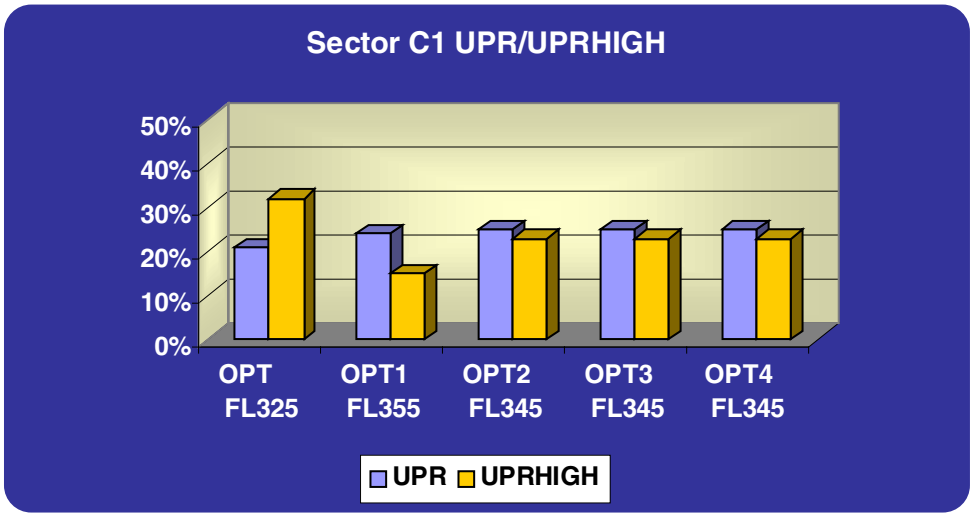

Figure 10

In the first organisation simulated with a vertical split at FL325 sector C1 recorded a moderate workload for both ECs in the Upper and Upperhigh sectors. However, an uneven balance in workload was recorded between these two sectors.

The second organisation examined superimposed sectorisation with the vertical split raised to FL355. This reversed the balance in workload between the Upper and Upperhigh sectors.

A compromise of FL345 was examined in the third organisation creating an almost perfect balance between the two and recording moderate workloads of 25% in the Upper sector and 23% in the Upperhigh sector.

This was the level split used for the remainder of the simulation in Sector C1.

SECTOR C2

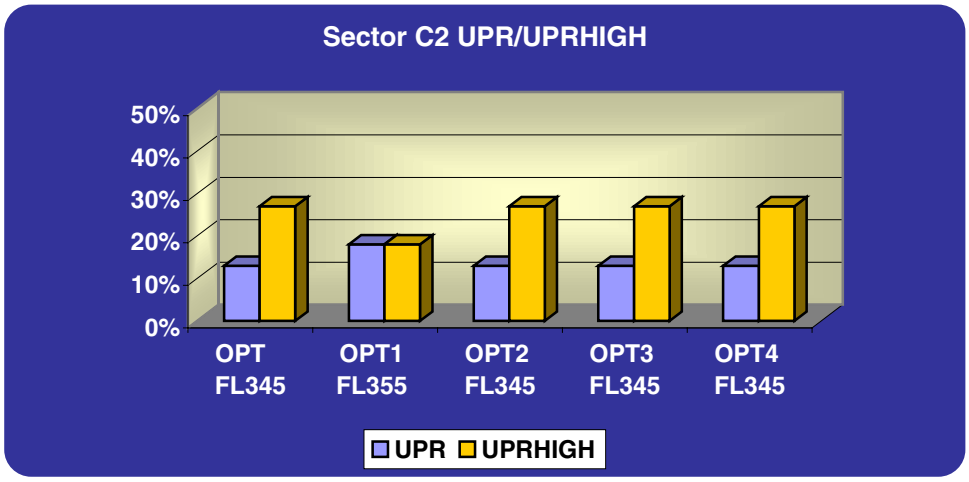

Figure 11

Sector C2 was initially simulated with superimposed sectorisation split at FL345. This recorded an imbalance in workload between the Upper and Upperhigh sector, although moderate to low workloads were recorded for both ECs.

The vertical split was raised to FL355 where a perfect balance was recorded. Nevertheless in order to maintain the same superimposed split with sector C1 which is adjacent to sector C2 the split was lowered again to the original level of FL345 in the third organisation. This recorded workloads of 13% for the EC in the Upper sector and 27% for the EC in the Upperhigh sector.

This sector configuration was used for the rest of the simulation in sector C2.

SECTOR C3 UPPER / UPPERHIGH

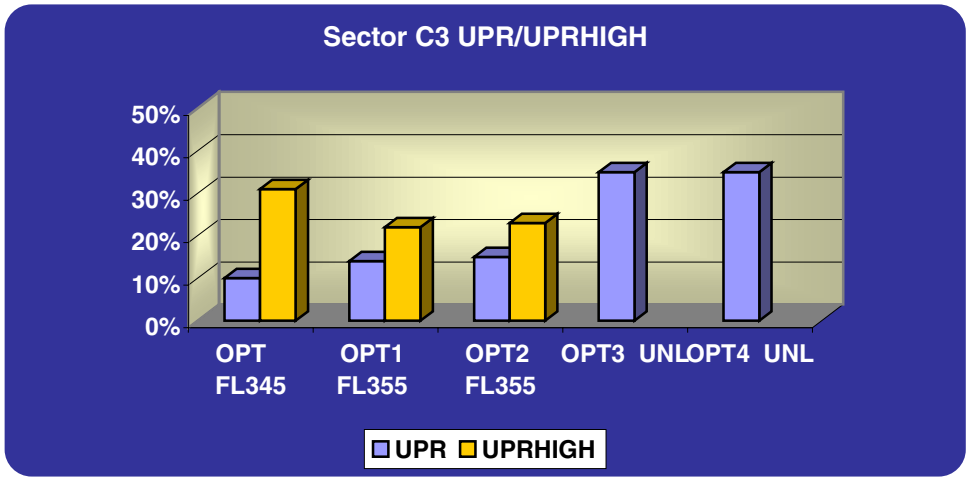

Figure 12

Sector C3 Upper and Upperhigh recorded a total imbalance in the first organisation with the superimposed split in the sector at FL345.

The second organisation examined the level split at FL355. This resulted in a satisfactory balance between the Upper and Upperhigh sectors. The split remained unchanged for the third organisation.

However, because the workloads recorded in both sectors were quite low (15% in the Upper and 23% in the Upperhigh) the working group decided to simulate a sector without superimposed sectorisation in the fourth organisation. This resulted in a moderate workload of 35% being recorded for the EC.

It was decided to examine this sector configuration for the rest of the simulation.

SECTOR C4

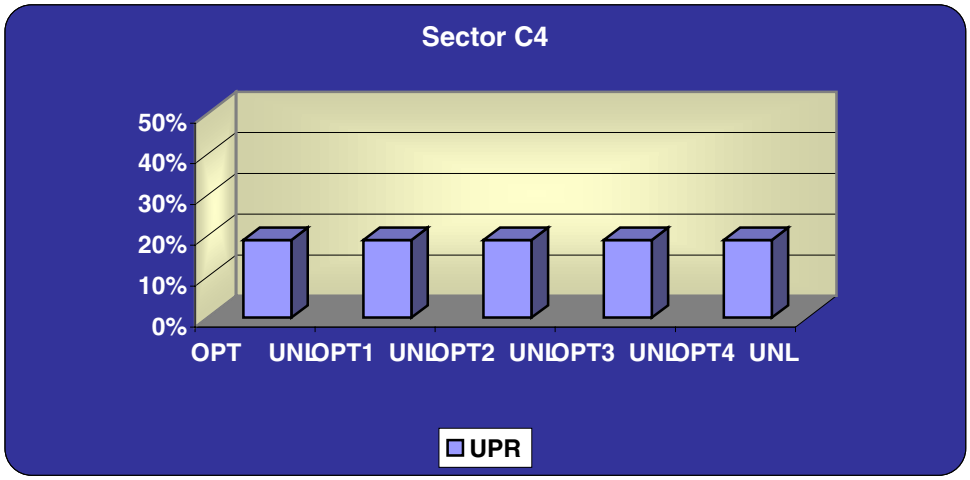

Figure 13

Results from the SAAM simulation indicated no special need for superimposed sectorisation in this area. The first organisation in the Fast-Time simulation proved this to be the case recording 19% workload and so, one sector extending from FL285 to UNL was used for this sector throughout the study.

SECTOR C5

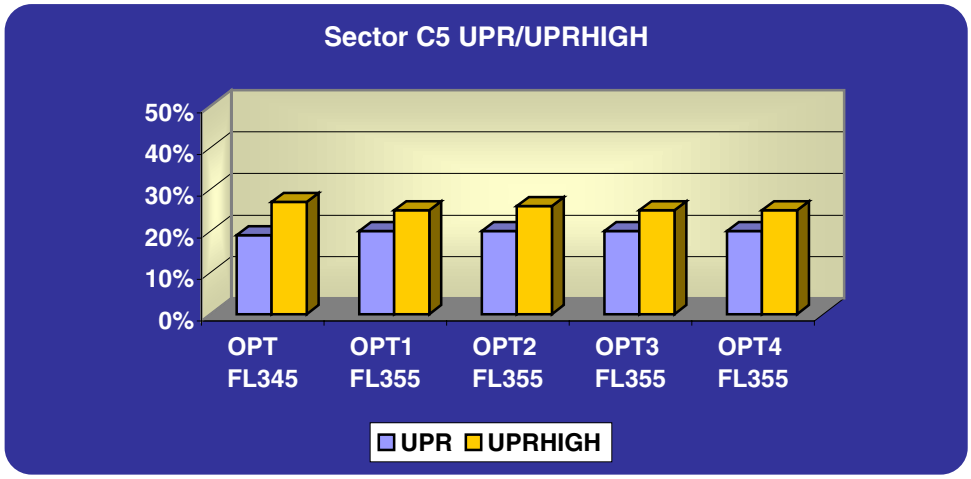

Figure 14

In sector C5, FL345 in the first organisation recorded moderate workloads for both ECs in each sector. There was a very slight imbalance recorded so the second organisation examined a split at FL355. The balance was better than the previous organisation and workloads of 20% for the Upper sector and 25% for the Upperhigh sector were recorded.

This configuration was used for C5 for the remainder of the study.

SECTOR C6 UPPER / UPPERHIGH / UNL

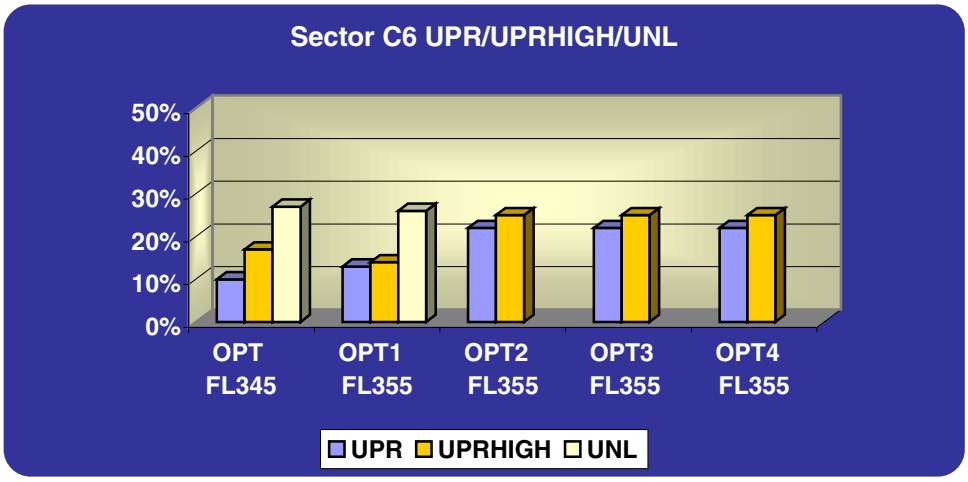

Figure 15

The configuration of sector C6 changed from that which resulted from the SAAM evaluation. In the first organisation simulated it was agreed by the working group that sector C6 should be configured as three sectors.

The southern half of C6 was configured as one sector (C6A) extending from FL285 to UNL, while the northern portion was configured as two superimposed sectors with a vertical split at FL345.

There was quite an imbalance in workload in the two superimposed sectors and in turn an imbalance in workload with sector C6A.

The second organisation left the sector C6A configuration as before but moved the vertical split between the two superimposed sectors higher to FL355. This created a greater balance in workload between the two superimposed sectors. However, the workloads recorded were quite low and so the working group decided to examine a third option where sector C6 returned to its original geographical configuration with two superimposed sectors split at FL355.

This created a good balance in workload between the two sectors and recorded moderate workloads for the ECs in both sectors. Sector C6 Upper recorded 22% while sector C6 Upperhigh recorded 25%. This configuration was used for all further organisations in the study.

SECTOR C7 UPPER / UPPERHIGH

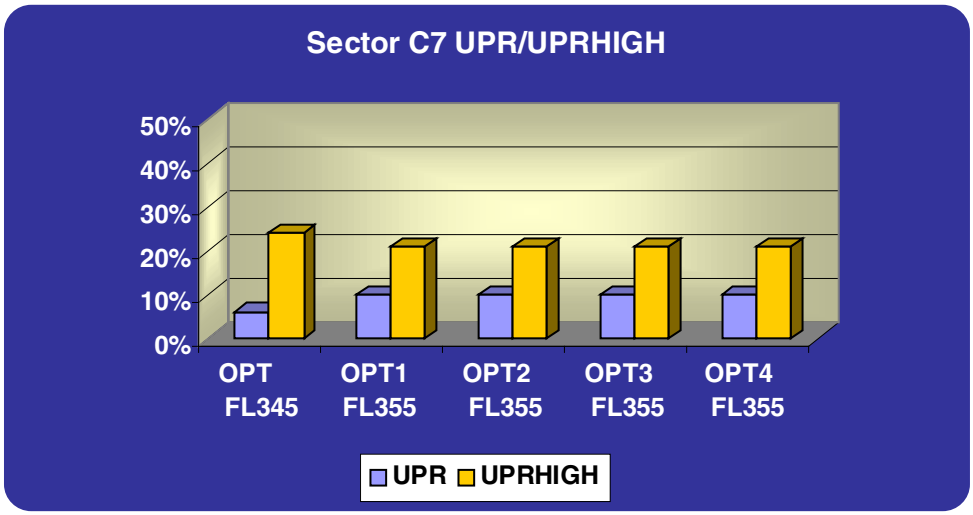

Figure 16

Sector C7 recorded a huge imbalance in workloads between the two superimposed sectors in the first organisation simulated with the vertical split at FL345. The second organisation raised the split level to FL355.

As the simulation exercises progressed it became more and more apparent that FL355 was a more appropriate split for the superimposed sectorisation in the CEATS area.

The split at FL355 in C7 reduced somewhat the imbalance between the two superimposed sectors and recorded low workloads for both ECs. It was agreed to continue the rest of the studies for sector C7 with this configuration.

SECTOR C8 UPPER / UPPERHIGH

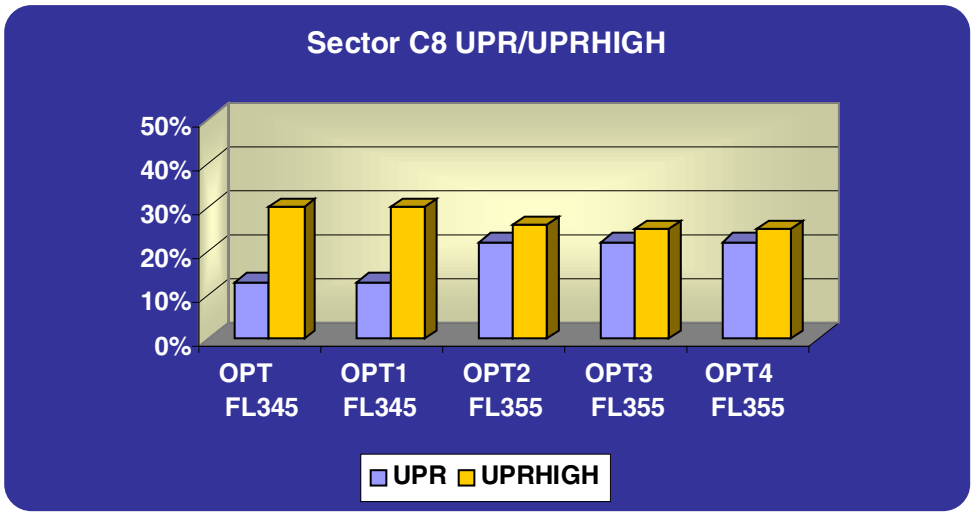

Figure 17

Sector C8 Upper and Upperhigh were configured with a vertical split at FL345 for the first two organisations. The imbalance in workload between the two sectors confirmed the trend to move the vertical split higher between the Upper and Upperhigh sectors.

The third organisation simulated a vertical split at FL355 which created a much better balance recording moderate to low workloads of 22% in the Upper sector and 26% in the Upperhigh sector.

This configuration was used for the remainder of the organisations.

SECTOR C9 UPPER / UPPERHIGH

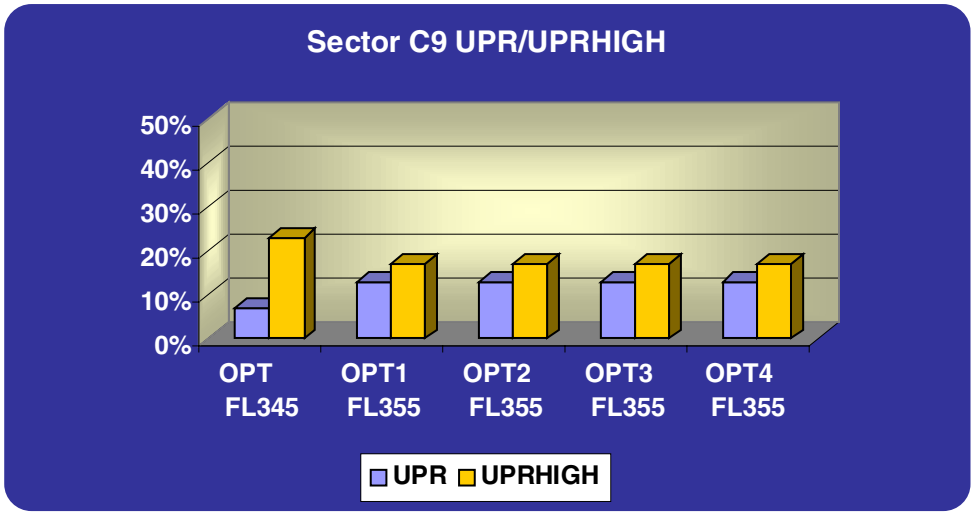

Figure 18

Sector C9 used the same vertical split between the Upper and Upperhigh sector in the first organisation as sector C8, FL345. This showed an imbalance in workloads between them both and so as the trend suggested the split was moved upwards to FL355 in the second organisation to create a better balance.

Moderate to low workloads were recorded in both sectors for the ECs, 13% in the Upper sector and 17% in the Upperhigh sector. Although these workloads may appear to be low the objective was to achieve a correct balance and level of workload for the superimposed sectorisation to allow further examination at increased traffic levels.

This configuration in C9 was used for this purpose.

SECTOR C10

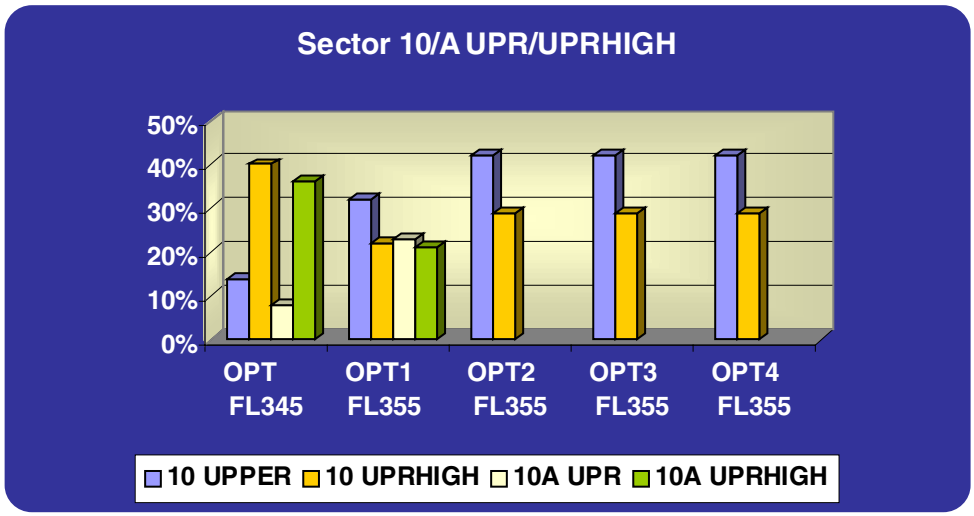

Figure 19

The working group agreed that the geographical dimensions proposed by the SAAM evaluation for sector C10, because of its location in the CEATS area, might create a sector which was too busy. The sector was divided geographically into north and south with each division retaining superimposed sectorisation with a split at FL345.

After the first organisation exercise it was clear that FL 345 was inappropriate to create a good balance between the sectors and so the organisation examined the split for the sectors at FL355.

This resulted in a better balance overall and recorded moderate to low workloads in all four sectors.

The third organisation examined the possibility of returning to the original geographical dimensions and leaving the split at FL355, thus returning to a two sector configuration. The Upper sector recorded a heavy workload of 42%, while the Upperhigh recorded a moderate workload of 29%.

This configuration was examined in all the following exercises.

SECTOR C11

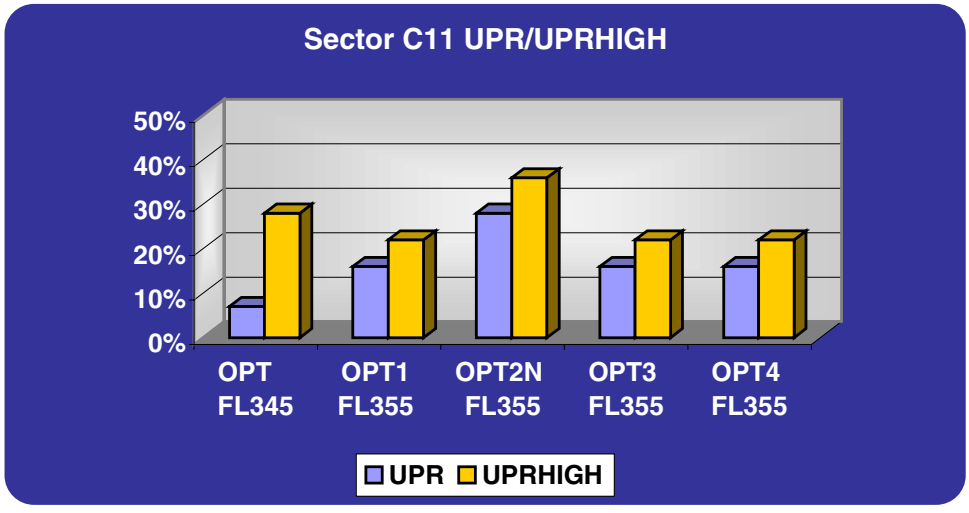

Figure 20

The first organisation examined a superimposed scenario for sector C11 with a split at FL345. This, as with other sectors, proved incorrect to achieve a balance between the two superimposed sectors and so the level split was raised to FL355 for the second organisation. This created a good balance recording low workloads in both sectors.

Sector C11 in the original configuration of the CEATS sectors was running in a north/south direction adjacent to sector C15. After the simulation exercise from the second organisation the working group decided to change the configuration of these two sectors to run in a west/east direction in order to examine the results, with sectors C11 Upper and Upperhigh north of sectors C15 Upper and Upperhigh.This is represented on the graph as organisation CEATS1A**OPT2N**, where 'N' indicates sector C11 as the northerly sector.

This resulted in a good balance in the sectors concerned. However, as can be seen from the graph on the previous page the workload increased by over 10% in both sectors and as will be seen later when examining sector C15, workload also increased in this sector.

It was agreed to revert to the previous option of these two sectors running in a north/south direction with a level split of FL355 for the superimposed sectors.

SECTOR C12

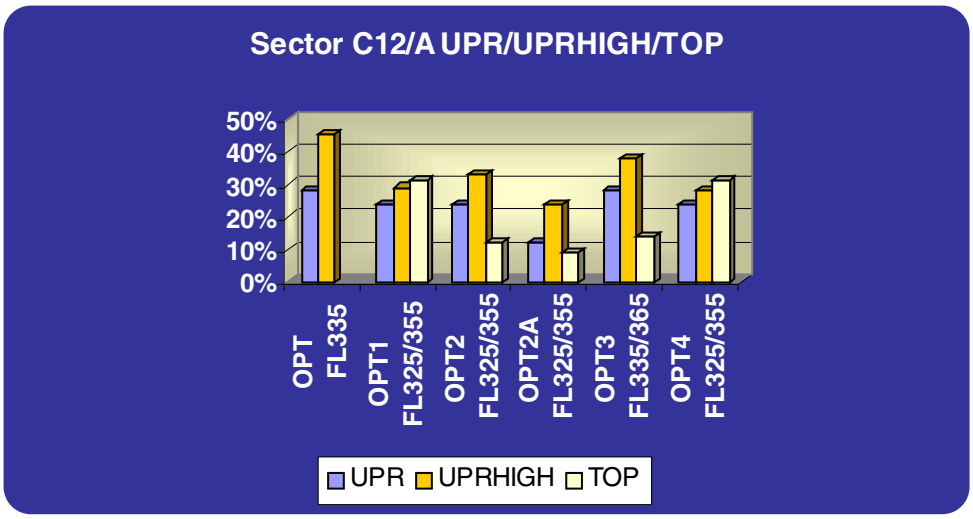

Figure 21

The first organisation examined a superimposed split of sector C12 at FL335. This not only created an imbalance between the two sectors but was already recording heavy to severe workloads at 2007 traffic levels.

The second organisation examined a three sector configuration with splits at FL325 and FL355. This option created a good balance recording moderate workloads in each sector. However because of the complexity surrounding the BZO area it was agreed to examine a further option of creating six sectors by geographically dividing the existing sector C12 into two, north and south and maintaining the three sector split in each one. This is represented on the graph as OPT2, which represents the three northern sectors and OPT2A, which represents the three southern sectors.

This resulted in workloads being reduced in the Top sectors but had little effect on the Upper and Upperhigh sectors due to the extra co-ordination which was caused by the extra sectors.

In the fourth organisation the working group decided to examine this area further by reverting to the original geographical configuration and changing the vertical splits for the three superimposed sectors to FL335 and FL365.

The workloads recorded showed an increase in workload for the Upper and Upperhigh sectors from the previous three sector configuration and a large reduction in workload for the Top sector. The working group decided to examine the future traffic levels and direct routings with the three sector superimposed configuration split at FL325 and FL355.

SECTOR C13

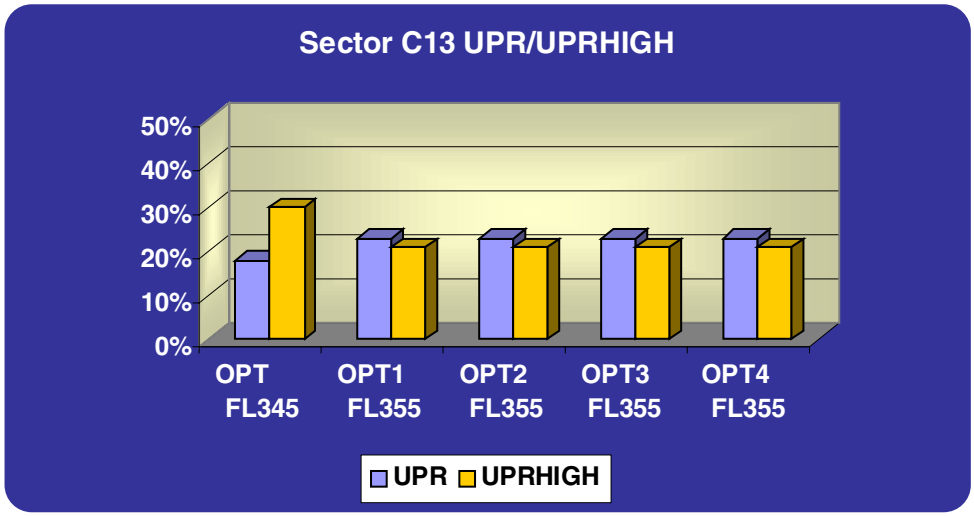

Figure 22

Sector C13 was simulated with a split at FL345 between the Upper and Upperhigh sectors in the first organisation. Although the workloads recorded were moderate to low it was agreed to move the split higher in order to achieve a better balance between the two sectors.

FL 355, which was simulated in the second organisation, proved to be the correct level creating an almost perfect balance and recording moderate to low workloads in both sectors.

SECTOR C14

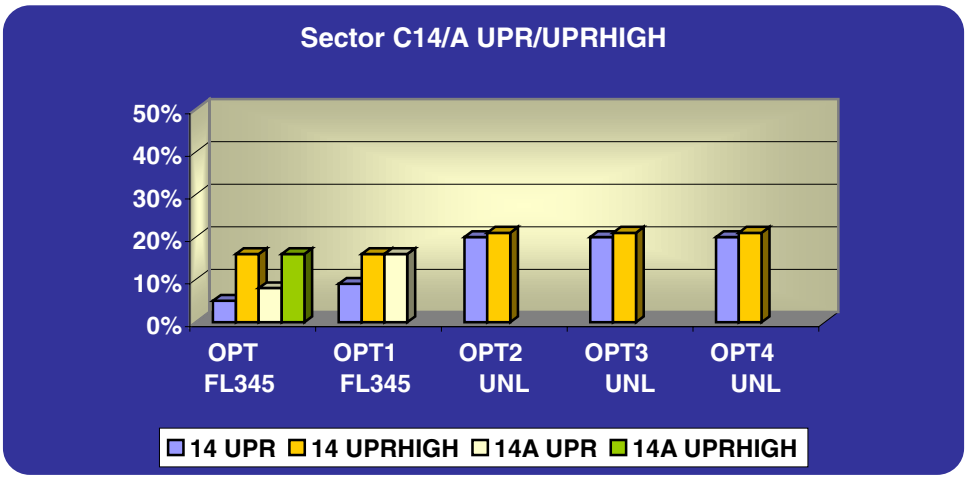

Figure 23

Sector C14 was geographically divided in two creating four sectors with a vertical split at FL345. Sector C14 lying to the north of sector C14A.

These four sectors recorded very low workloads and also recorded imbalances between the superimposed sectors.

The second organisation examined the possibility of combining the two Upper sectors to create a total of three sectors for sector 14. The Upper sector with a vertical limit of FL345 covered the original geographical area of C14 with two Upperhigh sectors. Even with the combination of the two Upper sectors the sector workload increased only slightly and still recorded very low workloads. The two Upperhigh sectors remained the same also recording low workloads.

The working group decided to examine a two sector scenario for sector 14 with the two adjacent sector configuration being used with no superimposed sectorisation. This resulted in moderate to low workloads being recorded in both sectors. This scenario was used to further examine the sector at future traffic levels and with direct routes.

SECTOR C15

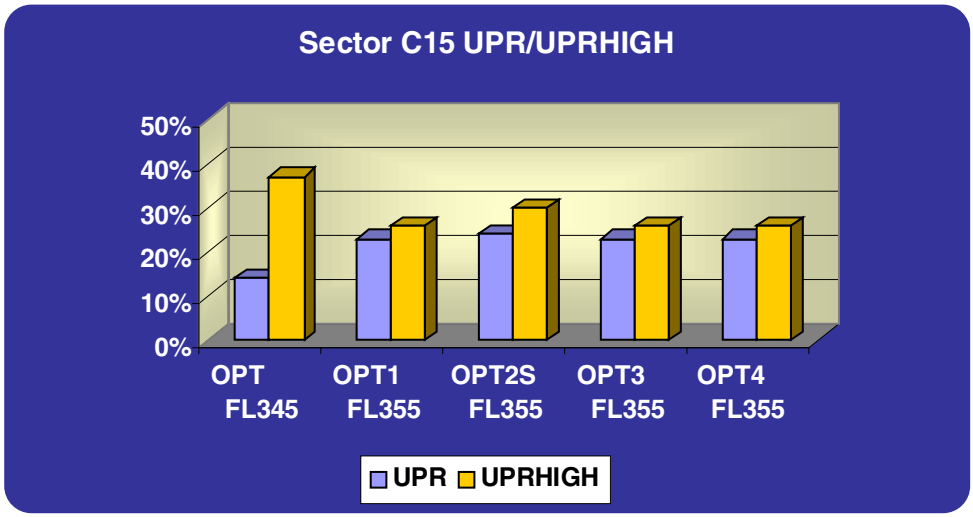

Figure 24

Sector C15 was first examined as two superimposed sectors split at FL345. This resulted in a heavy workload being recorded in the Upperhigh sector and a low workload being recorded in the Upper sector.

The second organisation moved the split in the sectorisation up to FL355 resulting in moderate workloads being recorded in both sectors.

As was previously explained when examining sector C11, which was adjacent to sector C15, the third organisation examined a change in configuration to both of these sectors, where C15 would now run in a west/east direction south of C11 as opposed to a north/south direction, west of C11. This scenario is represented on the graph as CEATS1AOPT2S, where 'S' indicates sector C15 as being the southern sector.

As with the results of C11 in this organisation, the workload increased slightly in each of the superimposed sectors and it was agreed to revert to the previous configuration running north/south with a split at FL355. This scenario was used for the remaining organisations of the study.

SECTOR C16

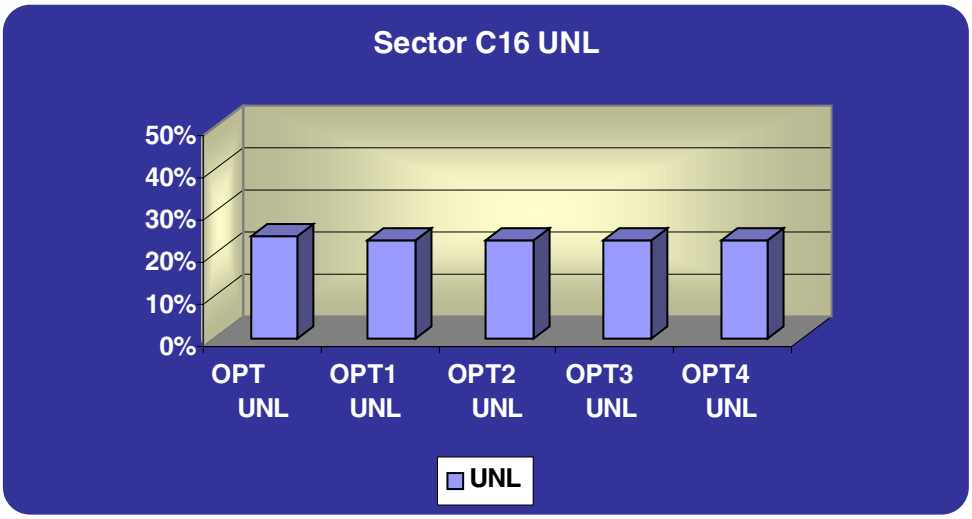

Figure 25

Having studied the aircraft count figures from the SAAM evaluation the working group decided to simulate sector C16 as one sector without any superimposed sectorisation. This resulted in a moderate workload being recorded for the EC and this was used as the configuration for all subsequent exercises.

All of these prefered configurations were simulated together in Organisation CEATS1AOPT4 using 2007 traffic levels. They were further simulated with:

1) military activity at 2007 traffic levels

2) 2010 traffic levels

3) 2015 traffic levels

4) Direct routing with 2015 traffic levels

RESULTS and COMPARATIVE ANALYSIS CEATS1AOPT4

CEATS1AOPT4 proved to be the optimum scenario for further examination with military activity and increased traffic levels to 2010 and 2015. It was also used to simulate direct routings within the CEATS area at 2015 traffic levels.

CEATS1AOPT4 simulated 30 sectors.

The following graphs show the comparisons of the percentage workload recorded for the Executive Controller (EC) over a three hour period in each sector for CEATS1AOPT4 with the organisations which simulated the same sector configuration but included military activity, increased traffic levels and direct routings.

CEATS1AOPT4 / MILITARY ACTIVITY

In order to simulate the military activity it was agreed to allocate a task of co-ordination to the EC for every aircraft which penetrated a military area which was active. This co-ordination task was allocated a weighting of 10 seconds.

As the CEATS Fast-Time simulation used the ARNV3 network modified in places and the existing military restricted, danger and prohibited areas most of the routes failed to penetrate these areas. As a result the existing military areas were « by-passed » by the new routes and thus failed to trigger the task of co-ordination.

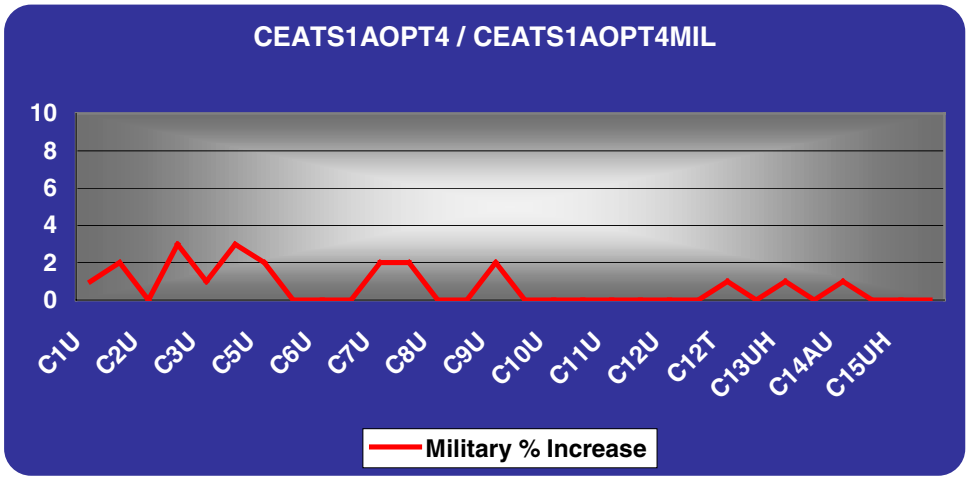

Figure 26

The results on the graph above show the percentage increases in workload for the EC across the sectors. The biggest percentage increase recorded in workload was 3% in the sectors C3 and C5.

These percentage increases do not reflect the co-ordination work required by the ECs during periods of military activity and it is therefore recommended that military activity is examined in greater detail in any subsequent simulation studies.

CEATS1AOPT4 2007 / 2010 / 2015 TRAFFIC

The following graphs show the comparisons of controller workload for each sector as traffic levels were increased from 2007 levels to 2010 and 2015 levels.

SECTORS C1 + C2

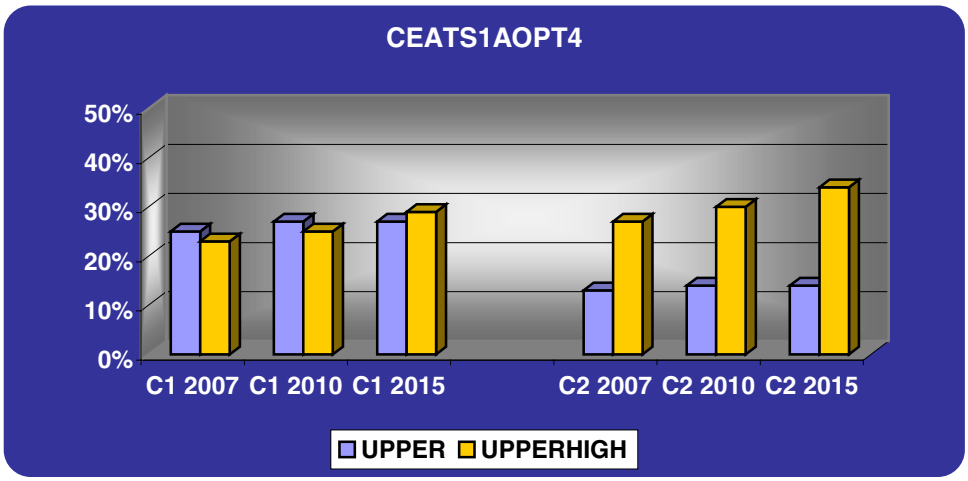

Figure 27

The graph above shows the percentage increase recorded for the ECs in C1 Upper, C1 Upperhigh, C2 Upper and C2 Upperhigh as traffic was increased from 2007 levels to 2010 levels and finally 2015 levels.

The graph indicates a slight increase in workload for both Upper sectors between 2007 and 2010 but no increase in the workload in the Upper sectors between 2010 and 2015.

The Upperhigh sectors show a steady increase from 2007 levels through 2010 levels to 2015 levels, indicating that the main traffic increase was above FL345.

Sector C1 Upper and Upperhigh recorded moderate workloads at 2015 levels while sector C2 Upperhigh recorded moderate to heavy workloads at these traffic levels.

SECTORS C3 and C4

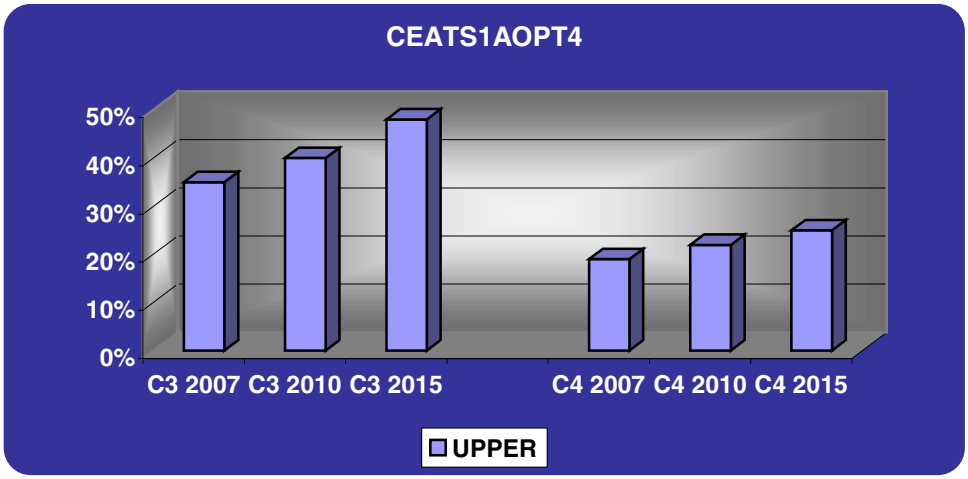

Figure 28

In sectors C3 and C4, which had no superimposed sectorisation, the percentage workload increased at a steady rate with the increased traffic levels.

At 2015 levels sector C3 recorded heavy to severe workload while C4 recorded moderate to low workload.

SECTORS C5 and C6

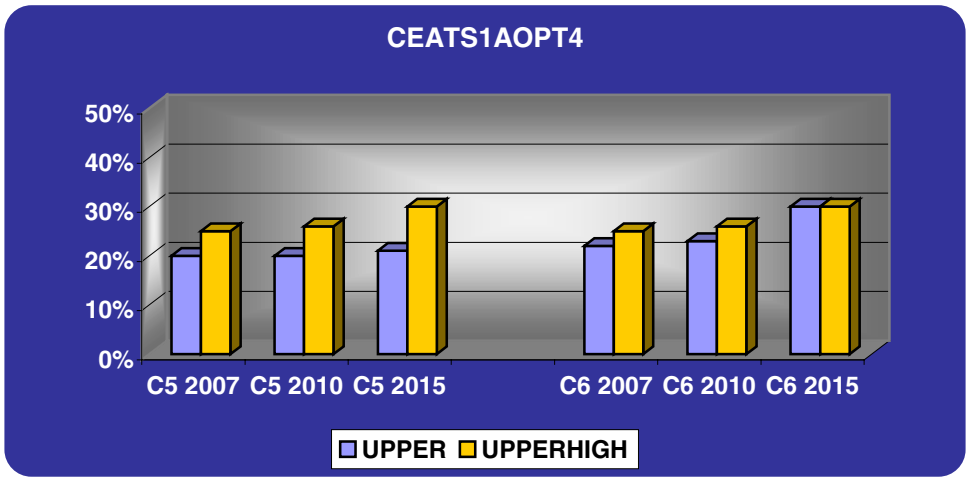

Figure 29

The percentage workload recorded for C5 increased more in the Upperhigh sector than the Upper sector. However both sectors did not exceed a moderate workload.

In sector C6 the increase in workload was greater in the Upper sector than the Upperhigh sector resulting in a moderate workload being recorded in both sectors.

SECTORS C7 and C8

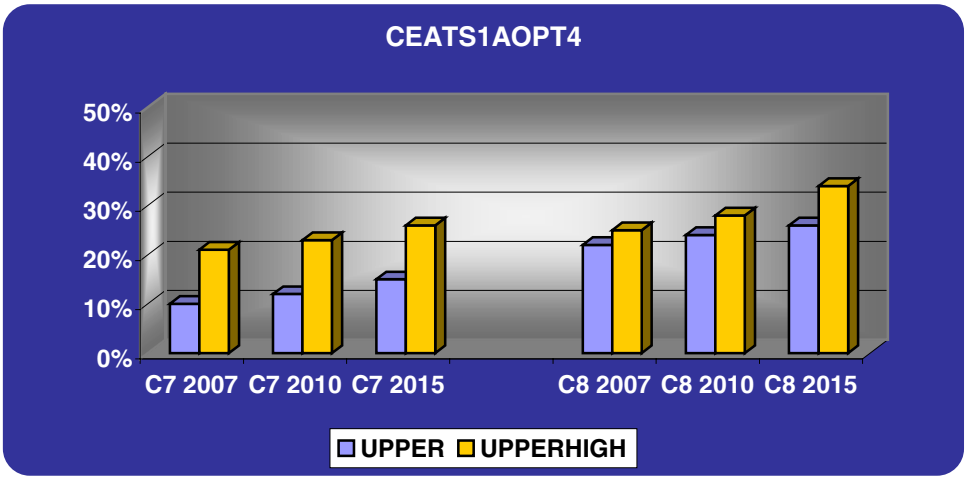

Figure 30

Sector C7, which had recorded low percentage workloads at 2007 traffic levels, did show an increase in percentage workload recorded as traffic was increased. However, the workloads did not exceed a moderate level in the Upperhigh sector at 2015 traffic levels and remained low in the Upper sector.

Sector C8 had a good balance in workload between the Upper and Upperhigh sectors at 2007 traffic levels and recorded workloads in the moderate to low level. With the increased traffic levels the percentage workload increased to moderate in the Upper sector and moderate to heavy in the Upperhigh sector.

SECTORS C9 and C10

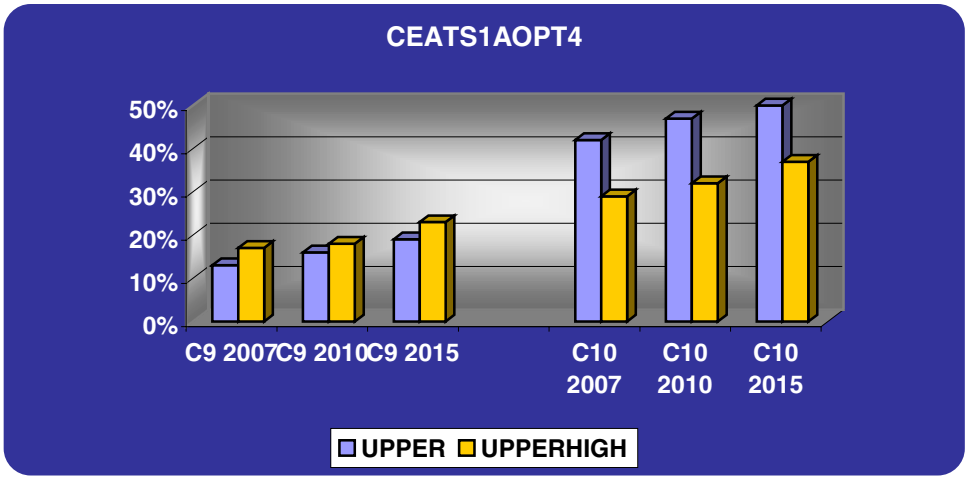

Figure 31

Sector C9, which started off with low levels of workload being recorded at 2007 levels increased the percentage of workload recorded with the increase of traffic but remained at a percentage level which would still be considered low.

Sector C10 already had recorded a heavy to severe workload for the EC in the Upper sector at 2007 traffic levels and moderate to heavy in the Upperhigh sector. With the traffic increase to 2015 levels the percentage workload recorded increased to a severe level in the Upper sector and heavy to severe in the Upperhigh sector.

This is a sector which should be re-examined in any subsequent simulations.

SECTORS C11 and C12

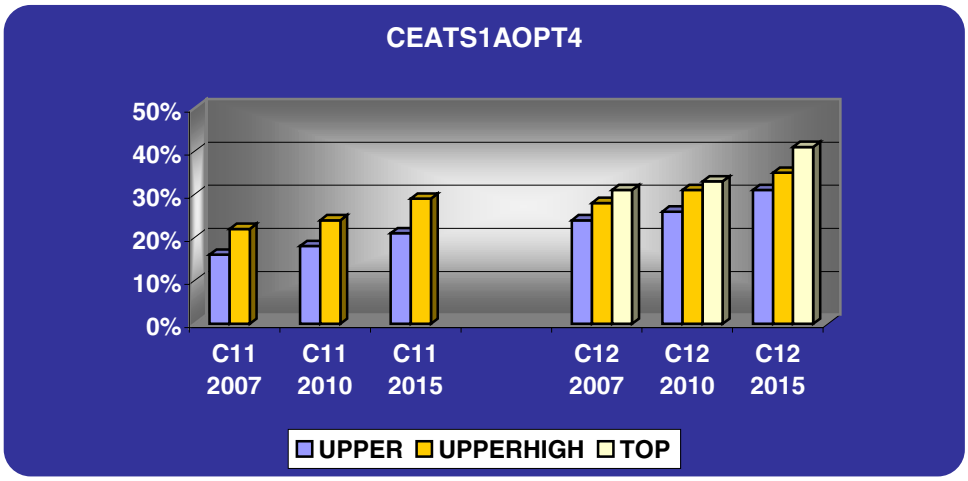

Figure 32

Sector C11 recorded moderate workloads in the Upperhigh sector at 2015 levels and moderate to low workloads for the EC in the Upper sector. At 2007 traffic levels these sectors both recorded low workloads. The increase in traffic did not overload the sectors.

2007 traffic levels recorded moderate workloads for the ECs in the three superimposed sectors of C12. There was a slight increase in percentage workload in all three sectors with the increase of traffic to 2010 levels. However, with the introduction of 2015 traffic levels all sectors increased the percentage workload to moderate to heavy levels with sector C12 Top recording heavy to severe levels.

SECTORS C13 and C14

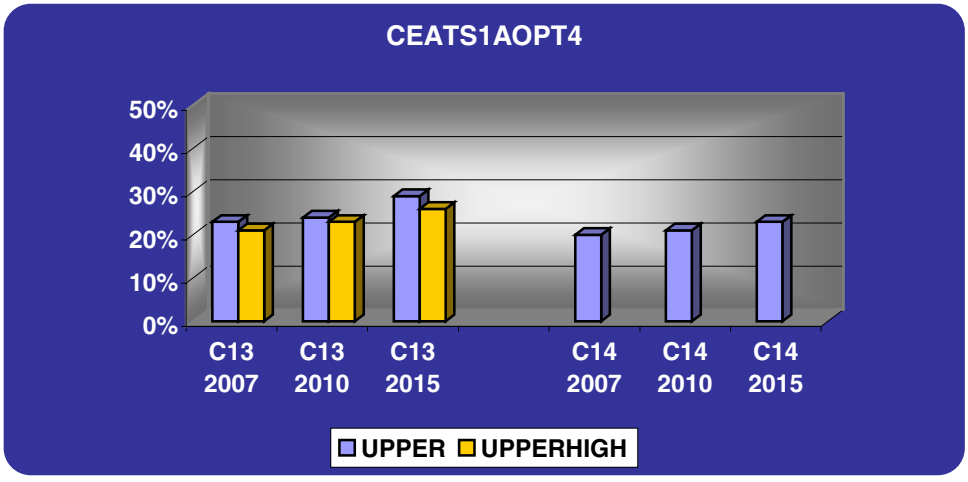

Figure 33

Sector C13 did not pose a problem with the workloads recorded at 2007 traffic levels. As the traffic increased to 2015 levels the workload did increase. However, it remained at moderate to low levels in the two superimposed sectors.

Sector C14, which was the northern portion of the original geographical configuration of C14 and had no superimposed sectorisation remained at a low workload level for the EC, even at 2015 traffic levels.

SECTORS C14A and C15

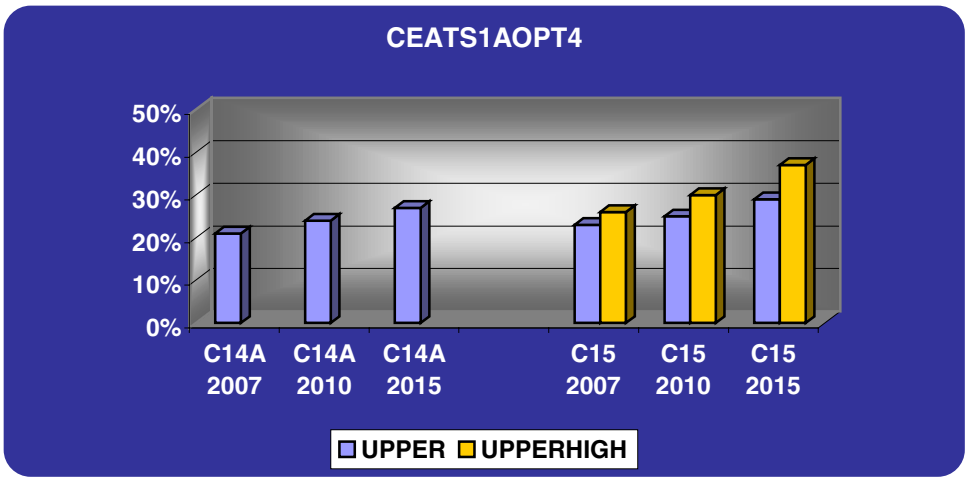

Figure 34

Sector C14A, which was the southern portion of the original configuration of C14 also remained at low to moderate levels for the EC with traffic increased to 2015 levels.

Sector C15 recorded moderate workload for the EC in the Upper sector but moderate to heavy workload in the Upperhigh sector.

SECTOR C16

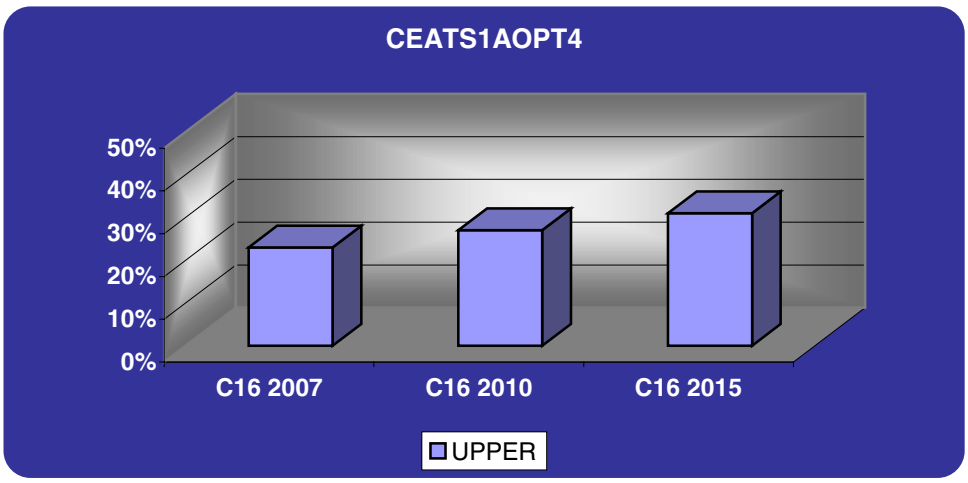

Figure 35

Finally, sector C16, which posed no problem from the beginning regarding workload with traffic levels at 2007 increased slightly to record moderate to low working levels for the EC at 2015 traffic levels.

It should be noted that the traffic sample of 2007 was increased by city pairs using forecast traffic levels compiled by STATFOR. The traffic sample was not increased globally by a percentage which would account for some sectors recording larger increases in workload than others.

CEATS1AOPT4 2015 TRAFFIC ARNV3 / DIRECT ROUTES

A final exercise was run using the CEATS1AOPT4 sector configuration of 30 sectors, with traffic increased to 2015 levels and using direct routing for aircraft from point of entry to CEATS area to point of exit.

The following graphs compare the percentage workloads recorded for ECs in each sector using the ARNV3 at 2015 traffic levels and the direct route concept at 2015 traffic levels.

It should be noted that as aircraft in the direct route concept were no longer adhering to a fixed route network all LoAs which had been implemented for the exercises using the modified ARNV3 were suspended. This ruling was applied because flights in the direct route concept were no longer routing via navaids associated with the current LoAs and therefore, the current LoAs were no longer relevant.

Depending on the position of the sector within the airspace, some sectors will have more flights entering the sector in a direct route concept and possibly record more conflicts as a result, thus increasing workload. Other sectors may have a reduction in the number of flights entering the sector, or the same number of flights entering. However, because of the direct route concept these flights will “by-pass” navigation aids, which before were intersection points on the fixed route network and areas of conflict, thus reducing the workload recorded.

It should also be stressed that the sectorisation simulated in the direct route scenario had been developed for a fixed route network, based on concept and criteria for medium term European Route Network and associated airspace. However, concept and criteria for direct route / free route sectorisation will be developed on one of the next CEATS simulations.

SECTORS C1, C2 and C3

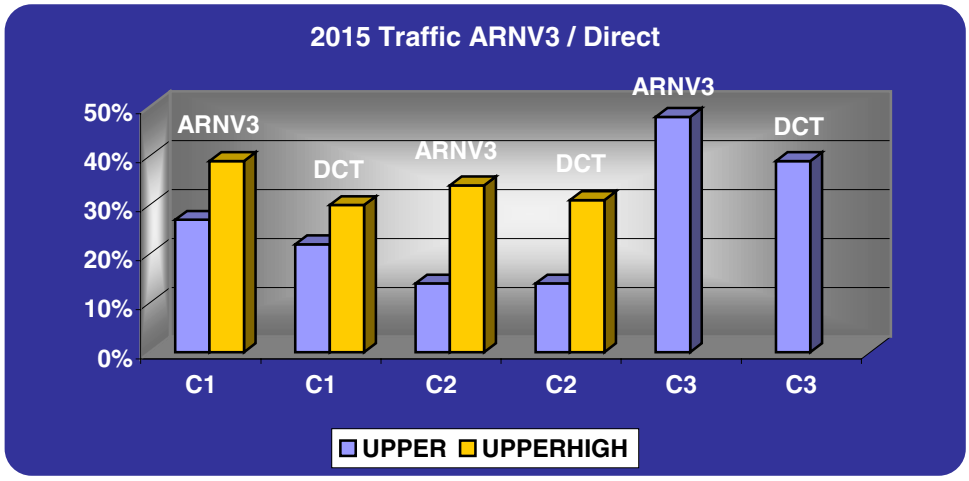

Figure 36

Applying the direct rule concept actually decreased the workload recorded for the EC in sectors C1, C2 and C3. Although the number of aircraft entering these sectors remained virtually the same, the flights were no longer flying to the same points or navaids in these sectors thus reducing the number of conflicts recorded.

SECTORS C4, C5 and C6

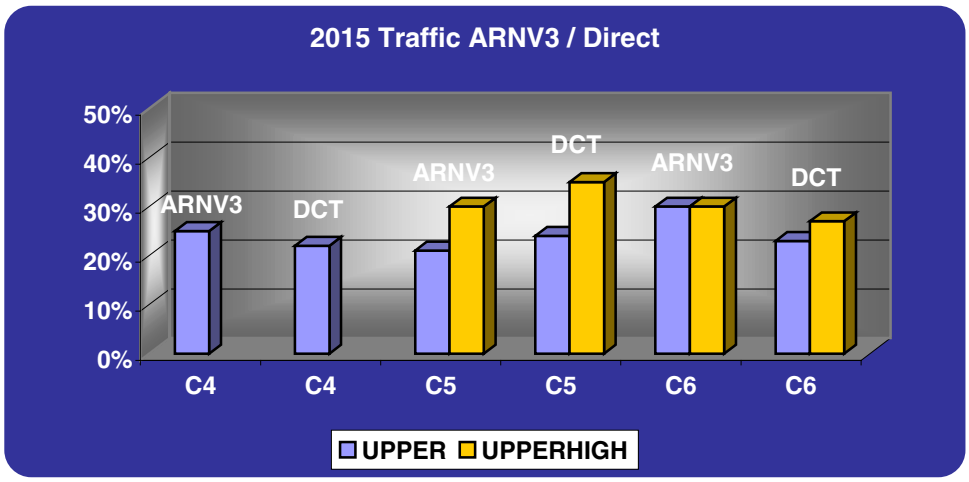

Figure 37

Sectors C4 and C6 also recorded reduced levels of workload for the EC with the introduction of direct routes, while sectors C5 Upper and Upperhigh recorded a slight increase in percentage workload for both ECs.

Comparitively, sector C5 Upperhigh recorded 351 flights entering the sector during the simulated period and recorded 43 conflicts while the same sector recorded 378 flights entering the sector with the direct route concept and 49 conflicts.

SECTORS C7, C8 and C9

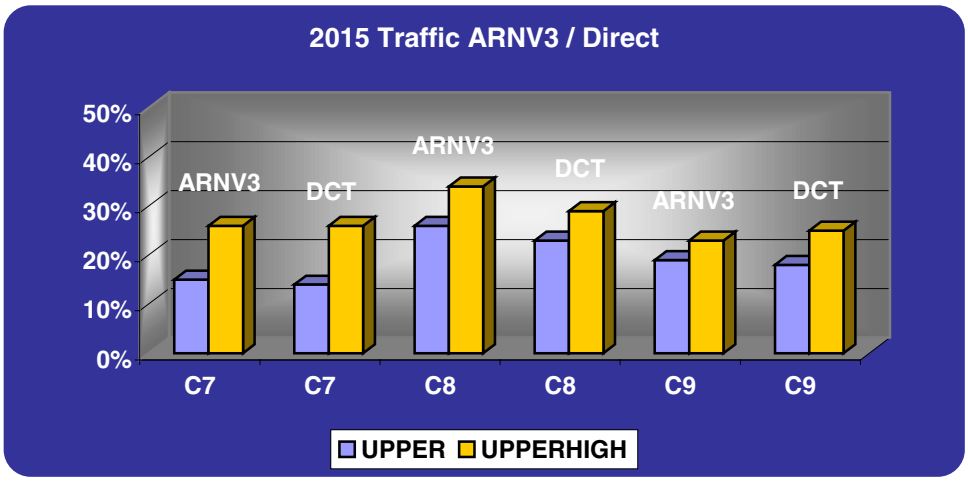

Figure 38

Sector C7 recorded the same level of workload in both the Upper and Upperhigh sectors with the introduction of direct routes.

Sector C8 recorded a slight decrease in workload in both sectors while sector C9 recorded a slight increase.

SECTORS C10, C11 and C12

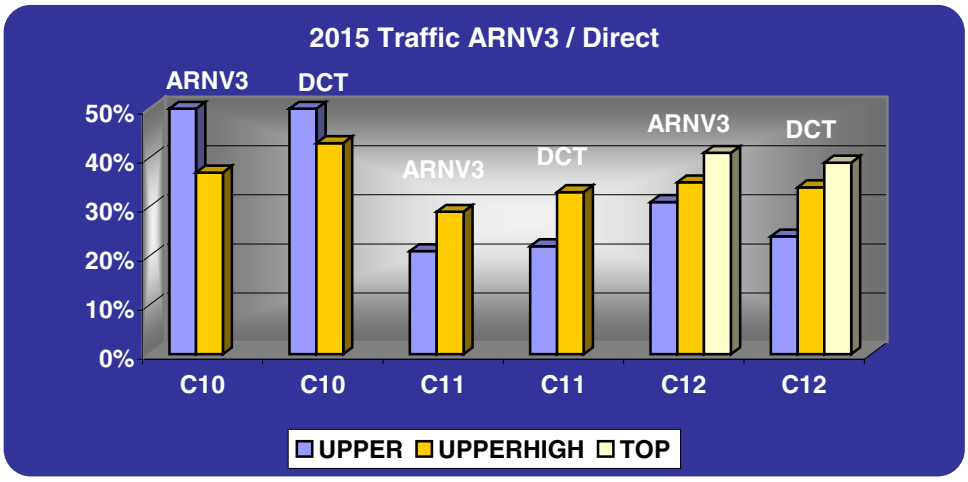

Figure 39

Sector C10 Upper recorded no change in the level of workload recorded for the EC. However the Upperhigh sector recorded an increase in workload changing the loading from moderate/heavy to heavy/severe.

Sector C11 recorded slight increases in both sectors while the three superimposed sectors in C12 recorded a slight reduction in workload for the ECs.

SECTORS C13, C14 and C14A

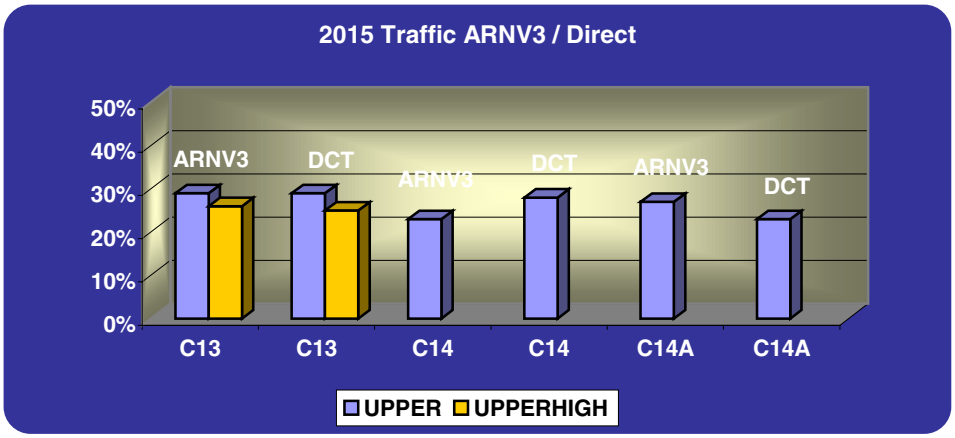

Figure 40

The workloads recorded for C13 Upper and Upperhigh in the ARNV3 scenario remained unchanged with the introduction of the direct route concept.

Sector C14 (the north/eastern sector of 14) recorded a slight increase in workload while sector C14A recorded a slight decrease.

SECTORS C15 and C16

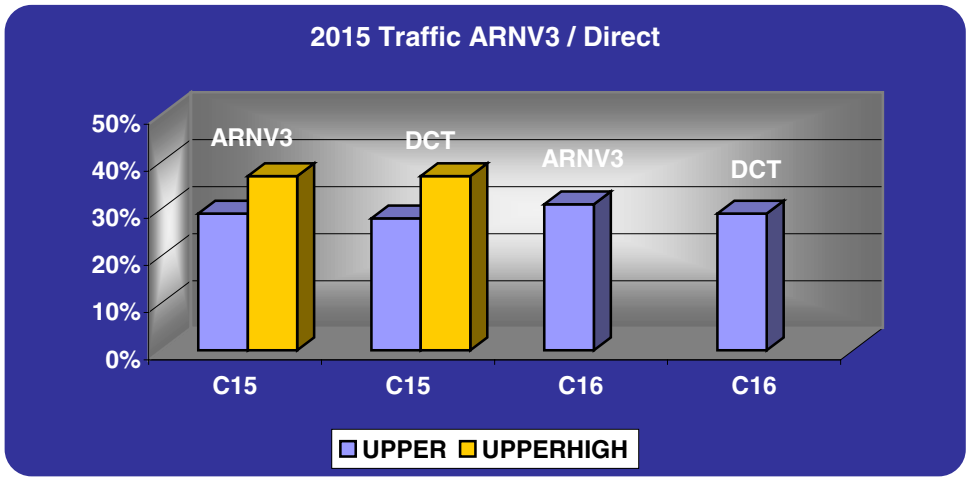

Figure 41

Sectors C15 Upper and Upperhigh remained virtually unchanged with the introduction of direct routes while their introduction actually recorded a slight decrease in workload for sector C16.

9. CONCLUSIONS and RECOMMENDATIONS

The following points should be noted regarding the results achieved.

Throughout the simulation it was presumed that all adjacent ACCs and ACCs underlying the CEATS area would be compatible with CEATS and therefore no special inter centre co-ordination tasks were recorded in the simulation.

Letters of Agreement (LoA) which existed at the start time of the study were implemented as part of the simulation. These LoAs were drawn up between states based on operational procedures, sectorisation and the route network within the states at the start time of the study. The simulation used a new route network (ARNV3 modified) with new operating procedures and different sectorisation.

Evaluation of the civil/military co-ordination principles was performed to a limited extent. Military restricted, prohibited and danger areas which existed at the start time of the study were used to simulate military activity in the CEATS area. During this exercise these military areas were « activated » to analyse the effect on controller workload. To achieve this end a co-ordination task was assigned to the Executive Controller for every flight which penetrated these military areas.

As the CEATS FTS1 was using ARNV3 modified route network different to that in use in the Upper airspace at the start time of the study most flights did not penetrate these military areas. It should also be noted that the « weighting » assigned to this co-ordination task was 10 seconds. This co-ordination task should probably have carried a heavier weighting.

In order to simulate the exercise with « direct » routes, all LoAs which had been included in the previous exercises were suspended as flights within the CEATS area were no longer complying to a fixed route network.

Traffic was increased by STATFOR (EUROCONTROL HQ) based on city pairs. The traffic was not increased globally by a percentage and therefore some sectors within the CEATS area experienced a greater increase in traffic than others This explains why in some sectors the percentage increase in workload during exercises with the increased traffic levels was not very dramatic.

9.1 CONCLUSIONS

When applying the principles of the CEATS Operational Concept results indicated feasibility to manage the 2007 typical peak day traffic in 30 sectors. All sectors recorded moderate workloads for the Executive Controller except in sector C3, which recorded moderate/heavy and in sector C10 Upper, which recorded heavy/severe workloads for the Executive Controller.

At 2010 traffic levels the main area of concern was sector C10 Upper, which recorded severe workload over a three hour period for the Executive Controller. Sectors C3, C12 Top, and C10 Upperhigh recorded moderate to heavy workloads.

With traffic increased to 2015 levels the main areas of concern were again in sectors C10 Upper, and C3. These sectors recorded severe workloads. Sectors C12 Top, C10 Upperhigh, C15 Upperhigh, and C12 Upperhigh all recorded heavy workloads.

The « Direct Route » scenario simulated with 2015 traffic increased the workload for sector C10 Upperhigh by 6% resulting in a heavy to severe workload being recorded. It also increased the workload in sectors C5 Upperhigh resulting in a moderate workload being recorded. Sectors C12 Top, C10 Upper and C15 Upperhigh and C12 Upperhigh remained unchanged.

The workload in sector C3 was reduced by 8% with the introduction of direct routes. However, this sector still recorded heavy workloads.

9.2 RECOMMENDATIONS

It is recommended that for CEATS Fast-Time simulation 2 the following points should be examined and analysed:

The possibility of some constrained tasks existing between the CEATS UAC and ACCs adjacent to and underlying the CEATS area.

More detailed examination of civil/military procedures and co-ordination within the CEATS area.

Examination of the impact of « Arrival Managers » at major European airports.

Further modification of sectors, where heavy or severe workloads were recorded.

CEATS FRAC as stand alone in the CEATS airspace volume and as an extension of 8 States FRAC.

TRADUCTION EN LANGUE FRANÇAISE DU RESUME, DE L'INTRODUCTION, DES OBJECTIFS, DES CONCLUSIONS ET RECOMMANDATIONS

RÉSUMÉ

La première simulation mathématique (FTS1) des services de la circulation aérienne pour l'Europe centrale (CEATS) a été réalisée dans le cadre du projet "Simulations CEATS", qui vise à définir des organisations appropriées pour le volume d'espace aérien du CEATS.

L'espace aérien qui relèvera du CEATS est celui, situé au-dessus du FL 285 et du FL 295, qui s'étend au-dessus de la République tchèque, de la Slovaquie, de l'Autriche, de la Hongrie, de la Slovénie, d'une partie de l'Italie (CCR de Padoue), de la Croatie et de la Bosnie-Herzégovine. Son exploitation devrait commencer en 2007.

Le Programme CEATS est né de la décision de sept États d'Europe centrale de coopérer en matière de fourniture des services de la circulation aérienne dans leur espace aérien supérieur, afin d'offrir à tous les usagers de l'espace aérien une efficacité maximale à moindre coût, sans que la sécurité ne s'en trouve compromise, et de contribuer à la mise en place d'un système européen uniforme de gestion de la circulation aérienne (EATMS).

Le programme sera mis en œuvre par EUROCONTROL conformément aux dispositions de l'"Accord relatif à la fourniture et à l'exploitation d'installations et de services de la circulation aérienne par EUROCONTROL au Centre de contrôle de région supérieure (UAC) du CEATS", signé à Bruxelles, le 27 juin 1997.

L'étude se fonde sur un échantillon de trafic de 24heures, du 10 septembre 1999. Cet échantillon a été porté aux niveaux de trafic de 2007 et inclut des vols aux niveaux RVSM (minima réduits de séparation verticale). Il a également été aligné sur la Version 3 du Réseau de routes ATS (ARNV3), légèrement modifiée pour les besoins de la présente étude.

Une période de 12 heures, de 08 heures à 20 heures, a été utilisée pour la simulation. Cet échantillon a ensuite été porté aux niveaux de trafic de 2010 et 2015. Ce sont ces niveaux qui ont été testés, dans le scénario final, avec la sectorisation retenue.

La simulation a porté sur une organisation de base et huit organisations proposées. L'organisation de base, qui simulait au total 35 secteurs, reposait sur la sectorisation proposée à la lumière de la 1ère évaluation SAAM (système d'assignation et d'analyse macroscopique) et légèrement modifiée dans les plan horizontal et vertical, avant le début de la simulation.

Le principal objectif du Groupe d'experts en simulations du CEATS (CSEG) était d'équilibrer la charge de travail des secteurs Upper et Upperhigh, tout en maintenant la charge de travail des contrôleurs à un niveau modéré. Cette dernière a été mesurée à la lumière des tâches ATC assignées au contrôleur exécutif (EC) selon les principes du Concept opérationnel du CEATS.

A mesure que les exercices de simulation progressaient et que le GSEG en examinait et analysait les premiers résultats, les niveaux de démarcation à utiliser pour les secteurs superposés sont apparus plus clairement. Les secteurs ne nécessitant aucune sectorisation superposée sont également apparus clairement. La cinquième organisation, qui simulait 30 secteurs, est celle que le CSEG a retenue pour réaliser des essais supplémentaires aux niveaux de trafic futurs.

Le scénario final a été simulé sur la base des niveaux de trafic de 2007, 2010 et 2015. Aux niveaux de trafic de 2007, plusieurs zones militaires ont été simulées pour évaluer l'incidence des périodes d'activité militaire sur la charge de travail des contrôleurs.

L'exercice simulant les niveaux de trafic de 2015 a également servi à simuler un concept de "routes directes", selon lequel les vols entrant dans la zone CEATS sont acheminés directement de leur point d'entrée à leur point de sortie.

D'une manière générale, il ressort de l'étude qu'il est possible de gérer une journée typique de grand trafic de l'an 2007 avec 30 secteurs. Toutefois, dans les organisations futures, notamment lorsque le trafic atteint les niveaux de 2015, plusieurs secteurs connaissent une charge de travail lourde, voire très lourde.

En conclusion, il est prévu de réaliser une deuxième simulation mathématique du CEATS pour régler certaines imperfections de la sectorisation mises en lumière par la première simulation et réévaluer la région en utilisant la Version 4 du Réseau de routes ATS (ARNV4) pour le réseau de routes fixes ainsi que pour les routes libres.

REMERCIEMENTS

Les membres de l'Équipe d'étude EUROCONTROL tiennent à remercier les membres du CSEG de l'assistance qu'ils leur ont apportée pendant la simulation.

1. INTRODUCTION

Le présent document expose les spécifications et les résultats de la première simulation mathématique du CEATS (CEATS FTS1), réalisée sur les installations de simulation du Centre expérimental, dans le cadre du Projet "Simulations du CEATS". L'étude visait à définir des organisations appropriées pour le volume d'espace aérien du CEATS.

Le projet s'est déroulé au Centre expérimental d'EUROCONTROL (CEE), à Brétigny-sur-Orge, (France) de février 2000 à décembre 2000. Les représentants des centres de contrôle nationaux (CCR) situés dans la zone CEATS et les membres de l'équipe d'étude d'EUROCONTROL ont tenu plusieurs réunions de préparation des données pendant l'exécution de la simulation. Ces représentants, qui venaient de République tchèque, de Slovaquie, de Hongrie, d'Autriche, de Slovénie, d'Italie (Padoue) et de Croatie, faisaient partie du CSEG. Les réunions avaient pour objet d'établir la méthodologie de simulation, de définir les exercices à simuler, de vérifier les données à saisir, d'examiner les résultats intermédiaires et de veiller à ce que les objectifs de l'étude puissent être atteints.

2. OBJECTIFS DE L'ÉTUDE

- **OBJECTIFS GÉNÉRAUX**

- définir des organisations appropriées pour le volume d'espace aérien du CEATS, tel qu'il est défini dans l'accord CEATS ;

- évaluer la charge de travail des contrôleurs sur la base de tâches conformes au concept opérationnel du CEATS.

- **OBJECTIFS SPÉCIFIQUES**

- déterminer la sectorisation CEATS interne la plus appropriée sur le plan géographique et vertical, sur la base :

- des niveaux de trafic prévus pour 2007, 2010 et 2015, compte tenu du RVSM ;

- du réseau de routes fixes ARNV3 et de routes directes entre le point d'entrée dans la zone CEATS et le point de sortie ;

de différentes limites inférieures pour l'espace aérien du CEATS, comme le FL 285 ou le FL 295, ou comme spécifié dans l'accord CEATS. Il a été convenu de fixer la limite inférieure au FL 285 pour les seuls besoins de la présente simulation mathématique.

3. CONCLUSIONS ET RECOMMANDATIONS

Les résultats obtenus doivent se lire à la lumière des observations ci-après.

Toute la simulation repose sur l'hypothèse que les CCR adjacents et ceux situés en-dessous de la zone CEATS seraient compatibles avec le CEATS ; aucune tâche spéciale de coordination entre centres n'a donc été enregistrée pendant la simulation.

Les Lettres d'accord qui existaient au début de l'étude ont été mises en œuvre en tant que partie intégrante de la simulation. Ces lettres d'accord ont été conclues par les Etats sur la base des procédures opérationnelles, de la sectorisation et du réseau de routes qui existaient chez eux au début de l'étude. La simulation a utilisé un nouveau réseau de routes (ARNV3 modifié) avec de nouvelles procédures d'exploitation et une sectorisation différente.

Les principes de coordination civile-militaire ont été évalués dans une mesure limitée. Les zones militaires restreintes, interdites et dangereuses qui existaient au début de l'étude ont été utilisées pour simuler l'activité militaire dans la zone CEATS. Pendant la simulation, ces zones militaires ont été activées pour en analyser les incidences sur la charge de travail des contrôleurs. Dans cette perspective, le contrôleur exécutif s'est vu attribuer une tâche de coordination pour tout vol pénétrant dans ces zones militaires.

Comme la simulation FTS1 CEATS utilisait le réseau de routes ARNV3 modifié, qui est différent de celui utilisé dans l'espace aérien supérieur au début de l'étude, la plupart des vols n'ont pas pénétré à l'intérieur ces zones militaires. Il y a également lieu de noter que la "pondération" assignée à la tâche de coordination correspondante était de 10 secondes, alors qu'elle aurait dû probablement être plus importante.

Pour la simulation des routes "directes", toutes les lettres d'accord incluses dans les précédents exercices ont été suspendues, puisque les vols effectués au sein de la zone CEATS ne suivaient plus un réseau de routes fixes.

L'augmentation du trafic a été réalisée par le Groupe STATFOR (Siège d'EUROCONTROL), sur la base de paires de villes. Le taux d'augmentation utilisé n'étant pas le même dans l'ensemble de la zone, certains secteurs de la zone CEATS ont vu leur trafic augmenter plus que d'autres. Ce qui explique pourquoi, dans certains secteurs, le taux d'accroissement de la charge de travail n'a pas été considérable pendant les exercices avec des niveaux de trafic élevés.

- **CONCLUSIONS**

Il ressort de la simulation que, si l'on applique les principes du Concept opérationnel du CEATS, il est possible de gérer une journée typique de grand trafic de l'an 2007 avec 30 secteurs. Dans tous les secteurs, la charge de travail du contrôleur exécutif s'est révélée modérée, sauf dans le secteur C3, où elle était modérée à lourde, et dans le secteur C 10 Upper, où elle était lourde à très lourde ("severe").

Aux niveaux de trafic de 2010, la principale zone de préoccupation était le secteur C10 Upper, où la charge de travail est demeurée très lourde pendant trois heures. Les secteurs C3, C12 Top et C10 Upperhigh ont enregistré des charges de travail modérées à lourdes.

Lorsque le trafic a été porté aux niveaux de 2015, les principales zones de préoccupation étaient, à nouveau, les secteurs C10 Upper et C3, où l'on a enregistré des charges de travail très lourdes. Toutes les charges de travail enregistrées dans les secteurs C12 Top, C10 Upperhigh, C15 Upperhigh et C12 Upperhigh étaient lourdes.

Le scénario "routes directes" aux niveaux de trafic de 2015 a accru de 6 % la charge de travail du secteur C10 Upperhigh, qui s'est donc révélée lourde à très lourde. Il a également accru la charge de travail du secteur C5 Upperhigh, qui est devenue modérée. Les secteurs C12 Top, C10 Upperhigh, C15 Upperhigh et C12 Upperhigh sont restés inchangés.

La charge de travail du secteur C3 a diminué de 8% du fait de l'instauration de routes directes, mais demeure encore très lourde.

- **RECOMMANDATIONS**

Il est recommandé d'examiner plus avant et d'analyser les points suivants pour la deuxième simulation mathématique du CEATS :

- l'existence éventuelle de certaines tâches contraignantes entre l'UAC du CEATS et les CCR situés à côté et en-dessous de la zone CEATS ;

- les procédures civiles/militaires et la coordination au sein de la zone CEATS ;

- l'incidence de "sequenceur d'arrivées" dans les grands aéroports européens ;

- de nouvelles modifications des secteurs dont la charge de travail est lourde ou très lourde.

- le FRAC en tant que concept indépendant dans le volume d'espace aérien du CEATS et le FRAC étendu aux États adjacents.

APPENDIX 1

Re – Organised ATC Mathematical Simulator

CEATS Fast – Time Simulation No. 1

ATC TASK SPECIFICATIONS

CEATS Optimum Tasks		
FLIGHT DATA MANAGEMENT TASKS		
Task Description	**Execution Time (seconds)**	
	Planning Controller	**Executive Controller**
Check sector inbound list	4"	N/A
Input new level in label window	N/A	2"
CONFLICT SEARCH TASKS		
Task Description	**Execution Time (seconds)**	
	Planning Controller	**Executive Controller**
Monitor conflict window	1"	N/A

ROUTINE R/T TASKS		
Task Description	**Execution Time (seconds)**	
	Planning Controller	**Executive Controller**
First call from an aircraft entering the first sector of an ACC	N/A	6"
First call from an aircraft entering another sector of the same ACC	N/A	6"
Instruction to an aircraft to avoid a military area	N/A	10"
Report from an aircraft on passing or reaching a specified level	N/A	6"
Instruction to an aircraft to comply with a new planning clearance (level change, start of climb or descent)	N/A	6"
Last message to an aircraft leaving a sector	N/A	5"

CO-ORDINATION TASKS		
Task Description	**Execution Time (seconds)**	
	Planning Controller	**Executive Controller**
Input of revised co-ordination request (new level)	3"	N/A
Verbal co-ordination between PC and TC	2"	N/A

RADAR TASKS		
Task Description	**Execution Time (seconds)**	
	Planning Controller	**Executive Controller**
General radar surveillance of aircraft while in a sector	N/A	10"
General radar surveillance of aircraft while in sectors C-4; C-8U; C-8UH	N/A	11"
General radar surveillance of aircraft while in sectors C-3; C-10U; C-10UH	N/A	12"
General radar surveillance of aircraft while in sectors C-6U; C-6UH; C-11U; C-110UH; C-16	N/A	15"
General radar surveillance of aircraft while in sectors C-15U; C-15UH	N/A	16"
Conflict resolution by radar intervention (vectoring)	N/A	60"
Conflict resolution by radar intervention (level change)	N/A	10"
Conflict resolution by radar intervention (speed control)	N/A	10"
Instruction to and vectoring of aircraft to avoid military area	N/A	10"

RESOLUTION TASK		
Task Description	**Execution Time (seconds)**	
	Planning Controller	**Executive Controller**
Planning conflict found, resolution by checking MTCD and proposing new level (at entry or exit)	10"	N/A

APPENDIX 2

Re – Organised ATC Mathematical Simulator

CEATS Fast – Time Simulation No. 1

TABLES OF RESULTS

CEATS1AOPT 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL325	29% (14:50 - 15:50)	21% (13:00 - 16:00)
C_1UH - FL325 - FL999	37% (17:10 - 18:10)	32% (11:20 - 14:20)
C_2U - FL285 - FL345	19% (19:00 - 20:00)	13% (17:00 - 20:00)
C_2UH - FL345 - FL999	32% (10:20 - 11:20)	27% (08:50 - 11:50)
C_3U - FL285 - FL345	12% (13:40 - 14:40)	10% (11:50 - 14:50)
C_3UH - FL345 - FL999	42% (10:10 - 11:10)	31% (10:10 - 13:10)
C_4 - FL285 - FL999	23% (12:20 - 13:20)	19% (16:40 - 19:40)
C_5U - FL285 - FL345	27% (14:00 - 15:00)	19% (14:00 - 17:00)
C_5UH - FL345 - FL999	38% (12:30 - 13:30)	27% (12:10 - 15:10)
C_6A - FL285 - FL999	36% (11:50 - 12:50)	27% (10:30 - 13:30)
C_6U - FL285 - FL345	14% (15:50 - 16:50)	10% (14:20 - 17:20)
C_6UH - FL345 - FL999	24% (12:10 - 13:10)	17% (10:30 - 13:30)
C_7U - FL285 - FL345	8% (16:00 - 17:00)	6% (14:00 - 17:00)
C_7UH - FL345 - FL999	30% (10:10 - 11:10)	24% (10:10 - 13:10)
C_8U - FL285 - FL345	17% (15:40 - 16:40)	13% (14:30 - 17:30)
C_8UH - FL345 - FL999	37% (11:50 - 12:50)	30% (11:40 - 14:40)
C_9U - FL285 - FL345	9% (12:30 - 13:30)	7% (10:20 - 13:20)
C_9UH - FL345 - FL999	29% (11:30 - 12:30)	23% (10:50 - 13:50)
C_10AU - FL285 - FL345	11% (10:30 - 11:30)	8% (09:10 - 12:10)
C_10AUH - FL345 - FL999	51% (10:20 - 11:20)	36% (09:10 - 12:10)
C_10U - FL285 - FL345	21% (10:20 - 11:20)	14% (09:40 - 12:40)
C_10UH - FL345 - FL999	46% (10:10 - 11:10)	40% (09:10 - 12:10)
C_11U - FL285 - FL345	9% (16:10 - 17:10)	7% (09:50 - 12:50)
C_11UH - FL345 - FL999	35% (17:00 - 18:00)	28% (16:40 - 17:40)
C_12U - FL285 - FL335	34% (10:40 - 11:40)	28% (09:20 - 12:20)
C_12UH - FL335 - FL999	54% (14:50 - 15:50)	45% (14:30 - 15:30)
C_13U - FL285 - FL345	25% (15:00 - 16:00)	18% (15:00 - 18:00)
C_13UH - FL345 - FL999	36% (17:40 - 18:40)	30% (13:20 - 16:20)
C_14AU - FL285 - FL345	11% (15:10 - 16:10)	8% (14:00 - 17:00)
C_14AUH - FL345 - FL999	20% (10:20 - 11:20)	16% (09:00 - 12:00)
C_14U - FL285 - FL345	7% (11:40 - 12:40)	5% (11:20 - 14:20)
C_14UH - FL345 - FL999	18% (12:00 - 13:00)	16% (12:10 - 15:10)
C_15U - FL285 - FL345	24% (11:30 - 12:30)	14% (11:30 - 14:30)
C_15UH - FL345 - FL999	48% (10:00 - 11:00)	37% (10:00 - 13:00)
C_16 - FL285 - FL999	27% (12:10 - 13:10)	24% (10:00 - 13:00)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT1 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL355	35% (14:50 - 15:50)	24% (14:50 - 17:50)
C_1UH - FL355 - FL999	22% (17:20 - 18:20)	15% (11:20 - 14:20)
C_2U - FL285 - FL355	24% (09:50 - 10:50)	18% (09:50 - 12:50)
C_2UH - FL355 - FL999	24% (17:30 - 18:30)	18% (08:50 - 11:50)
C_3U - FL285 - FL355	18% (10:30 - 11:30)	14% (11:50 - 14:50)
C_3UH - FL355 - FL999	28% (10:10 - 11:10)	22% (08:50 - 11:50)
C_4 - FL285 - FL999	22% (12:20 - 13:20)	19% (15:20 - 18:20)
C_5U - FL285 - FL355	27% (14:00 - 15:00)	20% (12:40 - 15:40)
C_5UH - FL355 - FL999	33% (12:10 - 13:10)	25% (12:10 - 15:10)
C_6A - FL285 - FL999	34% (11:50 - 12:50)	26% (10:30 - 13:30)
C_6U - FL285 - FL355	17% (12:10 - 13:10)	13% (10:20 - 13:20)
C_6UH - FL355 - FL999	19% (15:20 - 16:20)	14% (12:10 - 15:10)
C_7U - FL285 - FL355	15% (13:20 - 14:20)	10% (09:20 - 12:20)
C_7UH - FL355 - FL999	27% (14:40 - 15:40)	21% (14:20 - 17:20)
C_8U - FL285 - FL345	17% (15:40 - 16:40)	13% (14:30 - 17:30)
C_8UH - FL345 - FL999	37% (11:50 - 12:50)	30% (11:40 - 14:40)
C_9U - FL285 - FL355	17% (11:10 - 12:10)	13% (10:30 - 13:30)
C_9UH - FL355 - FL999	20% (11:30 - 12:30)	17% (12:00 - 15:00)
C_10AU - FL285 - FL355	34% (10:10 - 11:10)	23% (09:40 - 12:40)
C_10AUH - FL355 - FL999	27% (10:20 - 11:20)	21% (09:10 - 12:10)
C_10U - FL285 - FL355	41% (10:10 - 11:10)	32% (09:40 - 12:40)
C_10UH - FL355 - FL999	25% (10:50 - 11:50)	22% (09:10 - 12:10)
C_11U - FL285 - FL355	23% (16:20 - 17:20)	16% (16:10 - 19:10)
C_11UH - FL355 - FL999	25% (13:40 - 14:40)	22% (11:50 - 14:50)
C_12U - FL285 - FL325	29% (10:40 - 11:40)	24% (09:20 - 12:20)
C_12UH - FL325 - FL355	37% (15:00 - 16:00)	29% (13:00 - 16:00)
C_12T - FL355 - FL999	36% (14:50 - 15:50)	31% (14:40 - 17:40)
C_13U - FL285 - FL355	31% (15:00 - 16:00)	23% (15:00 - 18:00)
C_13UH - FL355 - FL999	27% (17:30 - 18:30)	21% (13:50 - 16:50)
C_14CU - FL285 - FL345	12% (15:10 - 16:10)	9% (14:00 - 17:00)
C_14AUH - FL345 - FL999	19% (10:20 - 11:20)	16% (09:00 - 12:00)
C_14UH - FL345 - FL999	18% (12:00 - 13:00)	16% (12:10 - 15:10)
C_15U - FL285 - FL355	30% (11:30 - 12:30)	23% (10:10 - 13:10)
C_15UH - FL355 - FL999	30% (10:00 - 11:00)	26% (09:50 - 12:50)
C_16 - FL285 - FL999	27% (12:10 - 13:10)	23% (10:00 - 13:00)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT2 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL345	32% (14:50 - 17:50)	25% (14:50 - 17:50)
C_1UH - FL345 - FL999	27% (11:20 - 12:20)	23% (11:20 - 14:20)
C_2U - FL285 - FL345	19% (19:00 - 20:00)	13% (17:00 - 20:00)
C_2UH - FL345 - FL999	32% (10:20 - 11:20)	27% (08:50 - 11:50)
C_3U - FL285 - FL355	19% (10:10 - 11:10)	15% (11:50 - 14:50)
C_3UH - FL355 - FL999	28% (10:10 - 11:10)	23% (10:30 - 13:30)
C_4 - FL285 - FL999	23% (12:20 - 13:20)	19% (16:40 - 19:40)
C_5U - FL285 - FL355	27% (14:00 - 15:00)	20% (12:40 - 15:40)
C_5UH - FL355 - FL999	33% (12:10 - 13:10)	26% (12:10 - 15:10)
C_6U - FL285 - FL355	29% (16:00 - 17:00)	22% (10:10 - 13:10)
C_6UH- FL355 - FL999	36% (12:00 - 13:00)	25% (12:00 - 15:00)
C_7U - FL285 - FL355	15% (13:20 - 14:20)	10% (11:10 - 14:10)
C_7UH - FL355 - FL999	27% (14:40 - 15:40)	21% (14:20 - 17:20)
C_8U - FL285 - FL355	26% (16:30 - 17:30)	22% (14:30 - 17:30)
C_8UH - FL355 - FL999	32% (11:50 - 12:50)	26% (11:40 - 14:40)
C_9U - FL285 - FL355	17% (11:10 - 12:10)	13% (10:30 - 13:30)
C_9UH - FL355 - FL999	20% (11:30 - 12:30)	17% (12:00 - 15:00)
C_10U - FL285 - FL355	58% (10:10 - 11:10)	42% (09:40 - 12:40)
C_10UH - FL355 - FL999	36% (10:20 - 11:20)	29% (09:10 - 12:10)
C_11UN - FL285 - FL355	37% (17:00 - 18:00)	28% (10:00 - 13:00)
C_11UHN - FL355 - FL999	40% (11:30 - 12:30)	36% (10:20 - 13:20)
C_12U - FL285 - FL325	30% (10:40 - 11:40)	24% (10:40 - 13:40)
C_12UH - FL325 - FL355	42% (14:50 - 15:50)	33% (13:40 - 16:40)
C_12T - FL355 - FL999	18% (11:10 - 12:10)	12% (14:30 - 17:30)
C_12AU - FL285 - FL325	16% (10:20 - 11:20)	12% (09:20 - 12:20)
C_12AUH - FL325 - FL355	28% (13:10 - 14:10)	24% (13:40 - 16:40)
C_12AT - FL355 - FL999	12% (11:20 - 12:20)	9% (14:40 - 17:40)
C_13U - FL285 - FL355	31% (15:00 - 16:00)	23% (15:00 - 18:00)
C_13UH - FL355 - FL999	27% (17:30 - 18:30)	21% (13:50 - 16:50)
C_14 - FL285 - FL999	25% (11:50 - 12:50)	20% (12:10 - 15:10)
C_14A - FL285 - FL999	26% (10:20 - 11:20)	21% (09:00 - 12:00)
C_15US - FL285 - FL355	33% (17:10 - 18:10)	24% (10:10 - 13:10)
C_15UHS - FL355 - FL999	35% (11:20 - 12:10)	30% (09:40 - 12:40)
C_16 - FL285 - FL999	27% (12:10 - 13:10)	23% (10:00 - 13:00)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT3 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL345	32% (14:50 - 15:50)	25% (14:50 - 17:50)
C_1UH - FL345 - FL999	27% (11:20 - 12:20)	23% (11:20 - 14:20)
C_2U - FL285 - FL345	19% (19:00 - 20:00)	13% (17:00 - 20:00)
C_2UH - FL345 - FL999	32% (10:20 - 11:20)	27% (08:50 - 11:50)
C_3 - FL285 - FL999	46% (10:10 - 11:10)	35% (10:10 - 13:10)
C_4 - FL285 - FL999	23% (12:20 - 13:20)	19% (16:40 - 19:40)
C_5U - FL285 - FL355	27% (14:00 - 15:00)	20% (12:40 - 15:40)
C_5UH - FL355 - FL999	33% (12:10 - 13:10)	25% (12:10 - 13:10)
C_6U - FL285 - FL355	29% (16:00 - 17:00)	22% (10:10 - 13:10)
C_6UH - FL355 - FL999	36% (12:00 - 13:00)	25% (12:00 - 15:00)
C_7U - FL285 - FL355	15% (13:20 - 14:20)	10% (11:10 - 14:10)
C_7UH - FL355 - FL999	27% (14:40 - 15:40)	21% (14:20 - 17:20)
C_8U - FL285 - FL355	26% (14:50 - 15:50)	22% (14:30 - 17:30)
C_8UH - FL355 - FL999	32% (11:50 - 12:50)	25% (11:40 - 14:40)
C_9U - FL285 - FL355	17% (11:10 - 12:10)	13% (10:30 - 13:30)
C_9UH - FL355 - FL999	20% (11:30 - 12:30)	17% (12:00 - 15:00)
C_10U - FL285 - FL355	58% (10:10 - 11:10)	42% (09:40 - 12:40)
C_10UH - FL355 - FL999	36% (10:20 - 11:20)	29% (09:10 - 12:10)
C_11U - FL285 - FL355	25% (17:00 - 18:00)	16% (16:10 - 19:10)
C_11UH - FL355 - FL999	25% (13:40 - 14:40)	22% (11:50 - 14:50)
C_12U - FL285 - FL335	35% (10:40 - 11:40)	28% (09:20 - 12:20)
C_12UH - FL335 - FL365	46% (14:50 - 15:50)	38% (13:40 - 16:40)
C_12T - FL365 - FL999	21% (11:10 - 12:10)	14% (14:30 - 17:30)
C_13U - FL285 - FL355	31% (15:00 - 16:00)	23% (15:00 - 18:00)
C_13UH - FL355 - FL999	27% (17:30 - 18:30)	21% (13:50 - 16:50)
C_14 - FL285 - FL999	25% (11:50 - 12:50)	20% (12:10 - 15:10)
C_14A - FL285 - FL999	26% (10:20 - 11:20)	21% (09:00 - 12:00)
C_15U - FL285 - FL355	29% (11:30 - 12:30)	23% (10:00 - 13:00)
C_15UH - FL355 - FL999	30% (10:00 - 11:00)	26% (09:50 - 12:50)
C_16 - FL285 - FL999	27% (12:10 - 13:10)	23% (10:00 - 13:00)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT4 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL345	32% (14:50 -15:50)	25% (14:50 - 17:50)
C_1UH - FL345 - FL999	27% (11:20 - 12:20)	23% (11:20 - 14:20)
C_2U - FL285 - FL345	19% (19:00 - 20:00)	13% (17:00 - 20:00)
C_2UH - FL345 - FL999	31% (10:20 - 11:20)	27% (08:50 - 11:50)
C_3 - FL285 - FL999	46% (10:10 - 11:10)	35% (10:10 - 13:10)
C_4 - FL285 - FL999	22% (12:20 - 13:20)	19% (16:40 - 19:40)
C_5U - FL285 - FL355	27% (14:00 - 15:00)	20% (12:40 - 15:40)
C_5UH - FL355 - FL999	33% (12:10 - 13:10)	25% (12:10 - 15:10)
C_6U - FL285 - FL355	29% (16:00 - 17:00)	22% (10:10 - 13:10)
C_6UH - FL355 - FL999	36% (12:00 - 13:00)	25% (12:00 - 15:00)
C_7U - FL285 - FL355	15% (13:20 - 14:20)	10% (11:10 - 14:10)
C_7UH - FL355 - FL999	27% (14:40 - 15:40)	21% (14:20 - 17:20)
C_8U - FL285 - FL355	26% (16:30 - 17:30)	22% (14:30 - 17:30)
C_8UH - FL355 - FL999	32% (11:50 - 12:50)	25% (11:40 - 14:40)
C_9U - FL285 - FL355	17% (11:10 - 12:10)	13% (10:30 - 13:30)
C_9UH - FL355 - FL999	20% (11:30 - 12:30)	17% (12:00 - 15:00)
C_10U - FL285 - FL355	58% (10:10 - 11:10)	42% (09:40 - 12:40)
C_10UH - FL355 - FL999	35% (10:20 - 11:20)	29% (09:10 - 12:10)
C_11U - FL285 - FL355	24% (17:00 - 18:00)	16% (16:10 - 19:10)
C_11UH - FL355 - FL999	25% (13:40 - 14:40)	22% (11:50 - 14:50)
C_12U - FL285 - FL325	29% (10:40 - 11:40)	24% (09:20 - 12:20)
C_12UH - FL325 - FL355	37% (15:00 - 16:00)	28% (13:10 - 16:10)
C_12T - FL355 - FL999	36% (14:50 - 15:50)	31% (14:40 - 17:40)
C_13U - FL285 - FL355	31% (15:00 - 16:00)	23% (15:00 - 18:00)
C_13UH - FL355 - FL999	27% (17:30 - 18:30)	21% (13:50 - 16:50)
C_14 - FL285 - FL999	25% (12:00 - 13:00)	20% (12:10 - 15:10)
C_14A - FL285 - FL999	26% (10:20 - 11:20)	21% (09:00 - 12:00)
C_15U - FL285 - FL355	29% (11:30 - 12:30)	23% (10:00 - 13:00)
C_15UH - FL355 - FL999	30% (10:00 - 11:00)	26% (09:50 - 12:50)
C_16 - FL285 - FL999	27% (12:10 - 13:10)	23% (10:00 -13:00)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT4_10 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL345	32% (14:50 - 15:50)	27% (14:50 - 17:50)
C_1UH - FL345 - FL999	31% (11:20 - 12:20)	25% (01:20 - 14:20)
C_2U - FL285 - FL345	20% (19:00 - 20:00)	14% (17:00 - 20:00)
C_2UH - FL345 - FL999	34% (10:20 - 11:20)	30% (08:50 - 11:50)
C_3 - FL285 - FL999	49% (10:10 - 11:10)	40% (10:10 - 13:10)
C_4 - FL285 - FL999	30% (11:50 - 12:50)	22% (11:50 - 14:50)
C_5U - FL285 - FL355	27% (14:00 - 15:00)	20% (12:40 - 15:40)
C_5UH - FL355 - FL999	33% (12:10 - 13:10)	26% (12:10 - 15:10)
C_6U - FL285 - FL355	32% (16:00 - 17:00)	23% (10:10 - 13:10)
C_6UH - FL355 - FL999	36% (12:00 - 13:00)	26% (12:00 - 15:00)
C_7U - FL285 - FL355	15% (11:20 - 12:20)	12% (11:10 - 14:10)
C_7UH - FL355 - FL999	29% (08:20 - 09:20)	23% (08:20 - 11:20)
C_8U - FL285 - FL355	29% (10:50 - 11:50)	24% (10:30 - 13:30)
C_8UH - FL355 - FL999	33% (12:30 - 13:30)	28% (11:40 - 14:40)
C_9U - FL285 - FL355	21% (11:10 - 12:10)	16% (10:30 - 13:30)
C_9UH - FL355 - FL999	20% (11:30 - 12:30)	18% (12:00 - 15:00)
C_10U - FL285 - FL355	63% (10:10 - 11:10)	47% (09:40 - 12:40)
C_10UH - FL355 - FL999	39% (11:10 - 12:10)	32% (09:10 - 12:10)
C_11U - FL285 - FL355	28% (16:50 - 17:50)	18% (15:50 - 18:50)
C_11UH - FL355 - FL999	26% (13:40 - 14:40)	24% (11:50 - 14:50)
C_12U - FL285 - FL325	31% (14:50 - 15:50)	26% (09:20 - 12:20)
C_12UH - FL325 - FL355	38% (15:00 - 16:00)	31% (13:00 - 16:00)
C_12T - FL355 - FL999	40% (14:50 - 15:50)	33% (14:40 - 17:40)
C_13U - FL285 - FL355	32% (11:30 - 12:30)	24% (10:50 - 13:50)
C_13UH - FL355 - FL999	28% (17:30 - 18:30)	23% (13:20 - 16:20)
C_14 - FL285 - FL999	28% (11:50 - 12:50)	21% (12:10 - 15:10)
C_14A - FL285 - FL999	28% (11:50 - 12:50)	24% (09:50 - 12:50)
C_15U - FL285 - FL355	32% (11:30 - 12:30)	25% (10:10 - 13:10)
C_15UH - FL355 - FL999	36% (10:00 - 11:00)	30% (09:50 - 12:50)
C_16 - FL285 - FL999	36% (12:20 - 13:20)	27% (10:20 - 13:20)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT4_15 0800 - 2000 Fin

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL345	30% (14:50 - 15:50)	26% (14:20 - 17:20)
C_1UH - FL345 - FL999	36% (11:20 - 12:20)	29% (09:50 - 12:50)
C_2U - FL285 - FL345	20% (19:00 - 20:00)	14% (11:00 - 14:00)
C_2UH - FL345 - FL999	42% (10:20 - 11:20)	34% (09:40 - 12:40)
C_3 - FL285 - FL999	53% (10:30 - 11:30)	47% (10:10 - 13:10)
C_4 - FL285 - FL999	30% (11:50 - 12:50)	25% (17:00 - 20:00)
C_5U - FL285 - FL355	28% (14:00 - 15:00)	21% (12:40 - 15:40)
C_5UH - FL355 - FL999	34% (12:50 - 13:50)	30% (12:10 - 15:10)
C_6U - FL285 - FL355	34% (12:10 - 13:10)	30% (10:00 - 13:00)
C_6UH - FL355 - FL999	37% (12:10 - 13:10)	30% (12:00 - 15:00)
C_7U - FL285 - FL355	17% (11:20 - 12:20)	15% (09:20 - 12:20)
C_7UH - FL355 - FL999	31% (10:20 - 11:20)	26% (08:50 - 11:50)
C_8U - FL285 - FL355	36% (14:50 - 15:50)	26% (14:50 - 17:50)
C_8UH - FL355 - FL999	42% (12:30 - 13:30)	34% (12:30 - 15:30)
C_9U - FL285 - FL355	22% (16:40 - 17:40)	19% (10:30 - 13:30)
C_9UH - FL355 - FL999	25% (12:50 - 13:50)	23% (12:00 - 15:00)
C_10U - FL285 - FL355	63% (10:10 - 11:10)	51% (09:40 - 12:40)
C_10UH - FL355 - FL999	44% (10:50 - 11:50)	37% (09:10 - 12:10)
C_11U - FL285 - FL355	29% (16:50 - 17:50)	21% (16:10 - 19:10)
C_11UH - FL355 - FL999	33% (12:50 - 13:50)	29% (11:50 - 14:50)
C_12U - FL285 - FL325	39% (10:40 - 11:40)	31% (09:20 - 12:20)
C_12UH - FL325 - FL355	41% (15:00 - 16:00)	35% (14:30 - 17:30)
C_12T - FL355 - FL999	51% (14:40 - 15:40)	41% (14:30 - 17:30)
C_13U - FL285 - FL355	41% (11:30 - 12:30)	29% (10:50 - 13:50)
C_13UH - FL355 - FL999	30% (13:20 - 14:20)	26% (13:20 - 16:20)
C_14 - FL285 - FL999	29% (11:50 - 12:50)	23% (12:10 - 15:10)
C_14A - FL285 - FL999	33% (10:10 - 11:10)	27% (09:50 - 12:50)
C_15U - FL285 - FL355	38% (11:30 - 12:30)	28% (10:00 - 13:00)
C_15UH - FL355 - FL999	48% (10:10 - 11:10)	37% (10:00 - 13:00)
C_16 - FL285 - FL999	41% (12:20 - 13:20)	31% (10:20 - 13:20)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT4_15DCT 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL345	26% (14:50 - 15:50)	22% (14:20 - 17:20)
C_1UH - FL345 - FL999	35% (11:20 - 12:20)	30% (11:10 - 14:10)
C_2U - FL285 - FL345	21% (19:00 - 20:00)	14% (17:00 - 20:00)
C_2UH - FL345 - FL999	39% (19:00 - 20:00)	31% (09:40 - 12:40)
C_3 - FL285 - FL999	43% (16:00 - 17:00)	39% (10:30 - 13:30)
C_4 - FL285 - FL999	26% (11:50 - 12:50)	22% (17:00 - 20:00)
C_5U - FL285 - FL355	29% (14:10 - 15:10)	24% (12:40 - 15:40)
C_5UH - FL355 - FL999	47% (12:30 - 13:30)	35% (12:10 - 15:10)
C_6U - FL285 - FL355	27% (15:40 - 16:40)	23% (10:00 - 13:00)
C_6UH - FL355 - FL999	33% (12:00 - 13:00)	27% (10:10 - 13:10)
C_7U - FL285 - FL355	19% (13:30 - 14:30)	14% (11:10 - 14:10)
C_7UH - FL355 - FL999	31% (10:20 - 11:20)	26% (09:10 - 12:10)
C_8U - FL285 - FL355	29% (10:30 - 11:30)	23% (10:30 - 13:30)
C_8UH - FL355 - FL999	42% (12:50 - 13:50)	39% (11:50 - 14:50)
C_9U - FL285 - FL355	23% (10:30 - 11:30)	18% (10:30 - 13:30)
C_9UH - FL355 - FL999	30% (14:00 - 15:00)	25% (12:10 - 15:10)
C_10U - FL285 - FL355	64% (10:00 - 11:00)	50% (09:40 - 12:40)
C_10UH - FL355 - FL999	57% (11:00 - 12:00)	43% (11:00 - 14:00)
C_11U - FL285 - FL355	27% (10:30 - 11:30)	22% (16:50 - 19:50)
C_11UH - FL355 - FL999	38% (12:10 - 13:10)	33% (11:40 - 14:40)
C_12U - FL285 - FL325	31% (14:50 - 15:50)	24% (16:40 - 19:40)
C_12UH - FL325 - FL355	39% (10:40 - 11:40)	34% (10:50 - 13:50)
C_12T - FL355 - FL999	49% (14:40 - 15:40)	39% (14:40 - 17:40)
C_13U - FL285 - FL355	42% (11:00 - 12:00)	29% (10:50 - 13:50)
C_13UH - FL355 - FL999	29% (15:40 - 16:40)	25% (15:30 - 18:30)
C_14 - FL285 - FL999	33% (11:50 - 12:50)	28% (09:50 - 12:50)
C_14A - FL285 - FL999	31% (10:10 - 11:10)	23% (09:40 - 12:40)
C_15U - FL285 - FL355	33% (10:10 - 11:10)	28% (09:50 - 12:50)
C_15UH - FL355 - FL999	44% (09:50 - 10:50)	37% (09:50 - 12:50)
C_16 - FL285 - FL999	36% (12:10 - 13:10)	29% (10:20 - 13:20)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

CEATS1AOPT4MIL 0800 - 2000 Final

EXECUTIVE CONTROLLER WORKING POSITION	HIGHEST PERCENTAGE LOADING IN ANY PERIOD OF	
	1HOUR	3 HOURS
C_1U - FL285 - FL345	33% (14:50 -15:50)	26% (14:50 - 17:50)
C_1UH - FL345 - FL999	31% (11:20 - 12:20)	25% (11:20 - 14:20)
C_2U - FL285 - FL345	19% (19:00 - 20:00)	13% (17:00 - 20:00)
C_2UH - FL345 - FL999	36% (10:20 - 11:20)	30% (08:50 - 11:50)
C_3 - FL285 - FL999	47% (10:10 - 11:10)	36% (10:10 - 13:10)
C_4 - FL285 - FL999	26% (12:20 - 13:20)	22% (16:40 - 19:40)
C_5U - FL285 - FL355	30% (14:00 - 15:00)	22% (12:40 - 15:40)
C_5UH - FL355 - FL999	33% (12:10 - 13:10)	25% (12:10 - 15:10)
C_6U - FL285 - FL355	29% (16:00 - 17:00)	22% (10:10 - 13:10)
C_6UH - FL355 - FL999	36% (12:00 - 13:00)	25% (12:00 - 15:00)
C_7U - FL285 - FL355	16% (13:20 - 14:20)	12% (11:10 - 14:10)
C_7UH - FL355 - FL999	29% (14:40 - 15:40)	23% (14:20 - 17:20)
C_8U - FL285 - FL355	26% (16:30 - 17:30)	22% (14:30 - 17:30)
C_8UH - FL355 - FL999	34% (11:50 - 12:50)	27% (11:40 - 14:40)
C_9U - FL285 - FL355	17% (11:10 - 12:10)	13% (10:30 - 13:30)
C_9UH - FL355 - FL999	20% (11:30 - 12:30)	17% (12:00 - 15:00)
C_10U - FL285 - FL355	58% (10:10 - 11:10)	42% (09:40 - 12:40)
C_10UH - FL355 - FL999	35% (10:20 - 11:20)	29% (09:10 - 12:10)
C_11U - FL285 - FL355	24% (17:00 - 18:00)	16% (16:10 - 19:10)
C_11UH - FL355 - FL999	25% (13:40 - 14:40)	22% (11:50 - 14:50)
C_12U - FL285 - FL325	29% (10:40 - 11:40)	24% (09:20 - 12:20)
C_12UH - FL325 - FL355	37% (15:00 - 16:00)	28% (13:10 - 16:10)
C_12T - FL355 - FL999	37% (14:50 - 15:50)	32% (14:40 - 17:40)
C_13U - FL285 - FL355	32% (15:00 - 16:00)	23% (15:00 - 18:00)
C_13UH - FL355 - FL999	27% (17:30 - 18:30)	22% (13:50 - 16:50)
C_14 - FL285 - FL999	26% (12:00 - 13:00)	20% (12:10 - 15:10)
C_14A - FL285 - FL999	26% (10:20 - 11:20)	22% (09:00 - 12:00)
C_15U - FL285 - FL355	29% (11:30 - 12:30)	23% (10:00 - 13:00)
C_15UH - FL355 - FL999	30% (10:00 - 11:00)	26% (09:50 - 12:50)
C_16 - FL285 - FL999	27% (12:10 - 13:10)	23% (10:00 -13:00)

Severe peak hour	in excess of 70%
Heavy peak loading	in excess of 55%
Severe average loading (3Hrs)	in excess of 50%
Heavy average loading (3Hrs)	in excess of 40%

NUMBER OF FLIGHTS PER SECTOR (DURING SIMULATED PERIOD)

The table on the following page indicates the number of flights which entered each sector, for the simulated period (08.00 – 20.00). It shows the number of flights for the optimum organisation with all traffic levels (2007, 2010 and 2015) and also the “direct route” scenario at 2015 traffic levels.

Generally there is an increase in traffic for each sector as the traffic levels are increased. However, in the direct route scenario some sectors show a decrease in traffic. The most noticeable of these is Sector C1Upper. At 2015 traffic levels, 383 flights were recorded entering the sector but with the direct route scenario 310 flights were recorded, a reduction of 73 flights.

This is because the LoAs which were in force for the fixed route network were removed for the direct route scenario and flights which had to descend (e.g. flights landing LOWW) to comply with the LoAs were forced into the Upper sector form the Upperhigh sector. Once the LoAs were removed the flight descended according the optimum flight profile and therefore did not penetrate the Upper sector.

In other cases, where sectors were in the middle of the CEATS area, direct routes changed the directional profile of the flights and so they bypassed some sectors they had original penetrated on the fixed route network.

Number of Flights per Sector During Simulated Period				
SECTOR	**2007**	**2010**	**2015**	**2015DCT**
C1U	326	358	383	310
C1UH	318	346	384	375
C2U	178	187	186	197
C2UH	341	375	243	424
C3	472	516	577	586
C4	268	298	330	315
C5U	232	242	257	297
C5UH	303	317	351	378
C6U	251	267	341	273
C6UH	269	283	328	321
C7U	148	159	185	172
C7UH	273	295	338	341
C8U	264	290	331	298
C8UH	277	299	350	444
C9U	166	181	225	204
C9UH	244	258	296	316
C10U	432	468	524	559
C10UH	350	385	428	454
C11U	162	178	216	227
C11UH	244	269	315	365
C12U	322	356	403	351
C12UH	374	415	475	448
C12T	343	377	442	456
C13U	297	331	381	368
C13UH	251	275	319	323
C14U	262	282	313	439
C14AU	336	364	405	377
C15U	222	250	273	291
C15UH	265	299	338	369
C16U	262	292	330	321