EUROPEAN ORGANISATION
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EUROCONTROL EXPERIMENTAL CENTRE

SOFT
(**S**tudy of **O**perational **F**light-plans and **T**rajectories)
Experimental Summary

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TITLE:

SOFT

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Experimental Summary

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Abstract:

SOFT focuses on the relationship between ICAO 'filed' Flight Plans (FPLs) and Operational Flight Plans (OFPLs) prepared and delivered by AOC's.
Traditional implementations of Flight Data Processing Systems rely on a central database management system and trajectory prediction which may differ strongly from the real world.
It is proposed to develop a system linked to the appropriate service of airlines (Dispatch) which provides Operational Flight Plan Data (containing detailed aircraft data, fuel and takeoff weight etc.) to improve trajectory prediction.

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1. Introduction

The project SOFT was executed in the frame of the EATCHIP domain ODP «Operational Requirements and Data Processing Systems» to meet the requirements of DPS.ET1.ST05.

2. Objectives

The objective of SOFT was to study the possibilities to improve trajectory prediction in ATC by using operational flight-plans (OFPLs).
An OFPL is prepared by the airlines in their flight planning systems. It is composed of AOC internal data, contains the most precise TOW (take-off weight) and the requested flight profile which is given to the crew at the moment of briefing. You will find an example of such an OFPL inchapter 9.2, Operational flight plans, calculated by the Scandinavian Airlines (SAS) SYSTEM.
Other objectives were to :

- establish contact with airlines for close co-operation
- study the exchange of operational flight-plans between airlines and ATC
- study other benefits of the use of operational flight-plans

Specific objectives for the partners involved were:

- AOC :
  - improve operational flight-plans (OFPL)
- ATC :
  - improve trajectory prediction
- CFMU :
  - analyze tactical flight models
- EUROCONTROL Experimental Centre :
  - validation of aircraft performance model and improvement of quality of aircraft performance in the EEC simulators

3. Project Benefits

The long term benefits of this type of research & development are:

- increase precision of trajectory prediction (objective: 1 nautical mile deviation 20 minutes ahead)
- increase capacity, through efficient use of airspace by improving
  - conflict prediction
  - CFMU flight planning (slot allocation)
- improve quality of operational flight-plans (OFPL)

4. References

[1] (Requirements for Advanced Flight Plan Information, Ralf SCHUPPENHAUER - EEC Note 14/98)
[2] Trajectory Prediction (TP) for the ‘TP Drafting Group of ODT’, Georges MYKONIATIS

5. PHASES of the Project SOFT

5.1 Phase 1 : Contacts with Airlines and ATC

The flight planning sections of the participating airlines were contacted. All contacted partners agreed with the objectives of the project and expressed their desire to co-operate in the planned experiment.
The following airlines participated (alphabetical order):

- AIR FRANCE
- BRITISH AIRWAYS
- CONDOR
- KLM
- LUFTHANSA
- LTU
- OLYMPIC AIRWAYS
- SAS
- SWISS AIR
- TAT
- VIRGIN ATLANTIC AIRLINES

The following OFPL providers have participated:

- SITA
- JEPPESEN

The following ATC & ATM centres and authorities have participated :

- CRNA EST (Reims)
- CRNA NORD (Athis Mons)
- DFS FRANKFURT
- CFMU

A fruitful co-operation has been established with the ‘service d’exploitation’ and ‘service d’étude’ of CRNA EST and NORD.

5.2 Phase 2 : Data Collection on 17 June 1997

Data collection was successfully carried out on 17 JUNE 1997. The Airlines, ATC and other organisations transferred their data to the EEC by means of SITA lines, e-mail, floppy disc and CD-ROM. The following data were received:

RADAR data	CRNA EST: 3266 correlated flights (but only 2593 call signs) CRNA NORD: 1974 correlated flights (but only 1832 call signs) This corresponds to 250 Mbytes of radar data. The discrepancy between correlated flights and the number of call signs shows that several flights were filed with the same callsign.
FLIGHT PLANS	Airlines: approximately 1000 OFPL's This corresponds to 6 Mbytes ATC: 6700 flight plans (all flights over France) This corresponds to 3 Mbytes. CFMU: all regulated flights This corresponds to 15 Mbytes (see extract of CFMU statistics in ANNEX I)

Flights of TAP AIR PORTUGAL, who have many flights into and out of Paris, are missing. SITA did not send the corresponding data. Since this represents a significant part of the traffic it should be made sure to obtain these data in a future data collection.

5.3 Phase 3 : Design of a Data Base

The database has been designed in collaboration with the Technische Universität Berlin (TU). The EEC has sponsored the thesis of R. Schuppenhauer of the TU (Requirement Definition for Advanced Flight Plan Information [1]). This thesis deals with Business Objects and proposes their use in air traffic control (see Annex II, Business Objects in ATC).
The Design Tasks were :

- definition of a common structure for the data of different origin
- definition of the extended FPL (XFPL)
- merging of the Radar data from CRNA NORD and EST

5.4 Phase 4 : Processing of Data

5.4.1 OFPL data

The operational flight plans have been checked concerning their syntax, semantics and consistency.

5.4.2 System Flight Plan Data And CFMU Flight Plan Data

The system flight plans of CRNA EST and NORD and the CFMU flight plans are considered as additional information on creation and evolution of a flight (plan).

5.4.3 Radar Data

Only the radar information from participating parties were considered for use in the data base (flights from TAP, IBERIA and TWA have been handled specifically on demand of the respective station managers).

5.4.4 Problems processing received Data

- Nested flight plan data, via SITA network caused an additional programming effort.
- LIDO® Data for short haul flights were NOT for operational use.
- Operational flight plan within Airlines have not been homogenious in layout.
- Radar Data from Reims were divided in four parts due to technical reasons, re-assembling caused extra effort.
- No reliable access to Meteo Data

5.5 Phase 5 : Feedback to Participating Airlines

After a first analysis the EEC re-contacted the airlines and presented the draft results. This had a positive response. Each Airline was presented a file containing: horizontal and vertical profiles of OFPL's, system FPLs, radar data.
These profiles show:

- Flight profiles are very different from the one calculated for the OFPL. Amongst the 1000 only 15 flights could be used to improve the EEC data base of aircraft performances (BADA).
- Calculated TOC and realised TOC are different, this may be due to the fact that the trajectory is always based on the longest possible SID. In addition LIDO® OFPL's for short haul flights have been experimental and could not be taken into account.
- ATC has given clearances for routes forbidden by the TOS.
- Controllers do not always update ATC system flight plans.

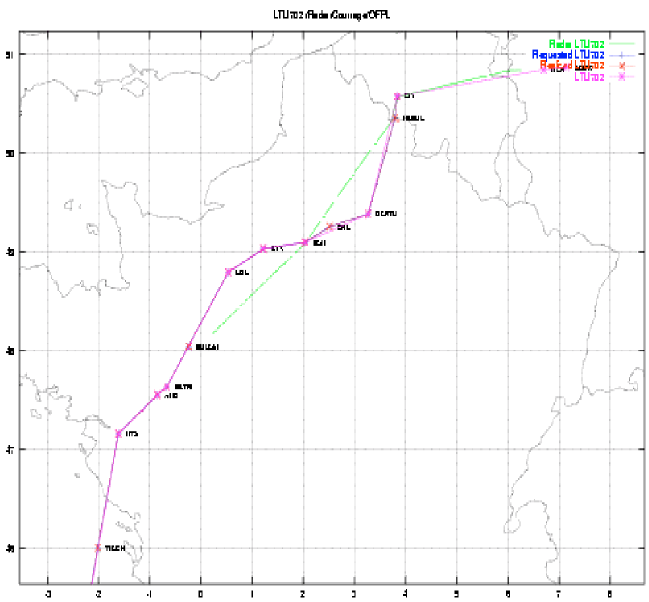

Figure 1: Example of FPL and RADAR Plots for one Flight

6. Recommendations

6.1 Forum

It is intended to organise a forum inviting all partners in order to present the results of the study. This forum will also be an opportunity to present other projects of the Experimental Centre and the IFPU 2, i.e. a Real Time Simulation, the projects RAMS and FREER and FASTER.
The Forum should intensify the contacts with the airlines and involve the airlines more closely in the definition of future ATM systems.

6.2 Future Data Collection

It appears that a one-day experiment is not sufficient (please refer to conclusion in the next paragraph. It is recommended that a new data collection be carried out covering two weeks, one in spring (which is generally a quieter time) and one in summer.
During a future data collection KLM could also provide FMS data downlinked via the ACARS system.
Currently trajectories are published on the Intranet . The presentation of the project and this note are available on Internet (http://www.eurocontrol.fr).

NOTE : For legal reasons Radar data may **NOT** be displayed on the external Web.

7. CONCLUSION

Good contacts with airlines have been established and need to be maintained and expanded.
The collected data have been used by other projects of EUROCONTROL, especially the Trajectory Prediction (TP) for the 'TP Drafting Group of ODT' [2] and for the validation of aircraft performances of BADA.
Only 1.5 % of the data could be used for the improvement of the aircraft performance data (see Annex III). It is recommended that a new data collection be carried out covering two weeks, one in peak season and one in a low traffic season. This would provide significant flight data including CFMU data, system FPLs, operational flight plans and radar tracks to improve the aircraft performance data in BADA and thus in trajectory prediction in ATC.

8. SOFT Team Members

Ralf SCHUPPENHAUER TU-BERLIN (presentation of thesis on 14 November 1997), Arjan BOS (APO), CoE MON (P. BOSMAN, Yvan CORDILLET), André MARAYAT, Christophe LABOUISSE, Georges MYKONIATIS, Arnaud PODDANY.

9. GLOSSARY

9.1 FPL: The ICAO filed flight plan format

RPL FILED: SAS561 MD80M ENFB0605
-N0438F350 UB88 VES UA7 EEL UR1 PAM/N0442F330 UB31
NEBUL DCT TARIM DCT BSN DCT

Table 1 : ICAO Filed Flight Plan Data

Item name	Description
Message type	Filed Flight Plan
Aircraft Identification	ICAO designator for the aircraft.
Flight rules	I (IFR), V (VFR), Y (IFR first), or Z (VFR first)
Type of flight	Scheduled, Non-scheduled, general, military, other.
Number	Number of aircraft, if more than one.
Type of aircraft	ICAO appropriate designator.
Wake turbulence category	Heavy, Medium, or Light
Equipment	Radio communication, navigation, and approach aid equipment, including SSR equipment.
Departure aerodrome	The ICAO four-letter location indicator.
Time	The estimated off-block time in UTC.
Cruising speed	True air speed in km/h, machnumber, or knots.
Level	Cruise flight level in feet*100.
Route	The departure aerodrome followed by a list of ATS route segments, or significant points.
Destination aerodrome	The ICAO four-letter location indicator.
Total EET	Estimated elapsed time in four digits.
Altn. aerodrome	The ICAO four-letter location indicator of the first alternative aerodrome.
2nd altn. aerodrome	The ICAO four-letter location indicator of the second alternative aerodrome.
Other information	

9.2 OFPL: Operational flight plans

Sample Skandinavian 561

```
SK561              PROG  1706               TTL FUEL  8.1 LFPO 2.2   1
17JUN97 ENFB-LFPG-10    LN-RMJ/M82  BLFP  AMT 204  WC  -8 ISA DEV +5
        FL350/PAM/370                                 358/09  195/04

PSGR..../.../...ZFW41.2/.....TOW49.1/.....LW43.9/....LI....MACZ.. ..

ATIS..........................................QNH....MACT.. ..
AWY   REP           FREQ  CS TIME ETO/RTO/ATO   FUEL   WIND   AMT   D

              SKED DEP 0605 OFF BLOCK  .. ..

OFF   OSLO-FORNEBU       (54FT) TKOF   .....  7.9/. ..
      N59 53.8 E010 37.1
SID   BABIN                  22 .../.../....  6.2/....           137
                         0:22
UB88  (VESTA)    D116.6  VES 20 .../.../....  5.5/....       194 141
                         0:42
UA7   (TUSKA)                 5 .../.../....  5.3/....       203  39
                         0:47
UA7   (WELGO)                 6 .../.../....  5.0/....       202  45
                         0:53
UA7   (JUIST)                 7 .../.../....  4.8/....       202  47
                         1:00
UA7   EELDE      D112.4  EEL  3 .../.../....  4.6/....       202  26
                         1:03
UR1  +PAMPUS     D117.8  PAM 11 .../.../....  4.2/....       230  76
                         1:14
UB31  (LEKKO)                 4 .../.../....  4.1/....       207  27
                         1:18
UB31  (LARAS)                 1 .../.../....  4.0/....       207   6
                         1:19
UB31  (WOODY)                 4 .../.../....  3.9/....       207  29
                         1:23
UB31  NICKY      D117.4  NIK  2 .../.../....  3.8/....       207  16
                         1:25
UB31  (CHIEVRES) D113.2  CIV  5 .../.../....  3.6/....       203  38
                         1:30
UB31  (NEBUL)                 2 .../.../....  3.5/....       189  13
                         1:32
      TARIM                   8 .../.../....                 188  53

      BOURSONNE   112.5  BSN  4 .../.../....                 236  28

IAL   PARIS-DE GAUL  (387FT) 14 .../.../....  2.7/....            23
      N49 00.6 E002 32.9 1:58                            TTL D  721
              SKED ARR 0820   ON BLOCK   ....  DIV FUEL/FL 2.7/FL090

ATIS.....................................FCST QNH....ACT QNH. ..
SENT
QX PAREE7X CPHOUSK
*****************************************************************************
***
QX PAREE7X
.CPHOWSK 161813
SK561    FL350/PAM/370                                             2/2
                                            TAXI           0.2/ 0:00
WINDS                                       TRIP  WC  -8   5.2/ 1:58
```

```
FL370  261/21                                 RTE RES 6       0.5/ 0:14
FL236  256/15                                 LFPO/R  +2      1.1/ 0:24
FL183  247/11                                 FINAL RES       1.1/ 0:30
FL099  083/04                                 COMP            0.0/ 0:00
FL048  013/10                                 EXTRA           0.0/ 0:00
               APPROVED BY ............... TTL FUEL/TIME  8.1/ 3:06
                                              ACT FUEL        .../ . ..
FUEL INFO FOR OPTIONAL ALTN:
ALTN    WC  ALTN FUEL  DIV FUEL/FL  TTL FUEL/TIME
LFQQ    +0  1.3/0:29  2.9/FL130        8.3/ 3:11
LFOB/R  -1  1.0/0:22  2.6/FL080        8.0/ 3:04
EBBR    +8  1.7/0:39  3.3/FL180        8.7/ 3:21
LFSD/R  +4  1.6/0:36  3.2/FL170        8.6/ 3:18
ELLX/R +17  1.7/0:39  3.3/FL210        8.7/ 3:21
EBOS/R  +1  1.9/0:43  3.5/FL230        8.9/ 3:25
CORR PARAMETERS                       BURN/ TIME
LW   43T FL310/PAM/330                +300/+0:01
LW   43T FL350/PAM/330                +200/+0:01
LW   46T/42T                          +200/ -100
WC  +20KT                             -100/-0:04
WC  -20KT                             +200/+0:06


RPL FILED: SAS561 MD80M ENFB0605
-N0438F350 UB88 VES UA7 EEL UR1 PAM/N0442F330 UB31
NEBUL DCT TARIM DCT BSN DCT
```

The previous example shows a sample operational flight plan from Scandinavian Airlines (SAS). This OFPL contains the following items that are of interest:

- Flightnumber: SK561 callsign of the aircraft.
- Date: 17JUN97 date of flight.
- City Pair: ENFB-LFPG departure and arrival airport in ICAO code.
- Registration: LN-RMJ aircraft registration.
- Type: M82 aircraft type (MD 82).
- ISA DEV: +5 deviation from international standard atmosphere.
- FL: 350 planned cruise flight level in feet * 100.
- ZFW: 41.2 zero fuel weight in kg *1000.
- TOW: 49.1 take-off weight in kg *1000.
- LW: 43.9 landing weight in kg *1000.
- SKED DEP: 0605 scheduled departure time in UTC.
- SKED ARR: 0820 scheduled arrival time in UTC.
- AWY: UB31 name of an airway.
- REP: BOURSONNE name of a radar beacon or a reporting point.
- FREQ: D117.8 radar frequency emitted by a beacon.

- TIME: 22 - 0:22 total time since take-off in hours:minutes, and in between beacons.
- FUEL: 7.9 remaining fuel in tons.
- WIND: wind heading in degrees and magnitude in knots.
- AMT: 194 magnetic track.
- D: 137 distance between waypoints in nautical miles.
- TTL D: 721 total distance flown in nautical miles.
- WINDS: FL370 261/21 wind information in knots/heading for different flight levels.
- RPL FILED: information about a repetitive flight plan.

9.3 SFPL: System Flight Plans of the contacted Area Control Centres

Sample system flight plan SK561 in the COURAGE format:

```
05
11
20 SAS561 ENFB LFPG 3868 +0 MD80
21 366 330 442
31 NIK CIV NEBUL TARIM BIBOP BSN BSN2 PGNR
32 456 461 463 471 472 475 475 480
33 330 296 250 240 240 110 110 40
41 EY UR TE RB
42 451 453 458 458
43 456 463 473 483
44 490
12
20 =
21 365 350 444
31 SFD RO DPE DPE2 SOKMU MERUE PGNR
32 491 495 499 499 504 507 516
33 350 350 260 240 190 150 40
41 EG TP RB
42 486 486 486
43 491 494 515
44 516
50 32 402 ENFB
51 TPPG17E EGCLW17 EGNOR17
```

Table 2 : Format of a system flight plan

Line No.	Description
00	Comment line
01	Current version of data format
02	Date on which the plans were archived
03	Date
04	Number of flight plans contained in the file
05	Indicates beginning of plan description
11	Indicates beginning of description type DEMANDED
20	Aircraft ID-departure aerodrome-arrival aerodrome-No CAUTRA-relative date (in days, relating to reference day)-aircraft type
21	Departure time UTC (in minutes)-RFL-ground speed
31	List of beacons ordered according to followed route
32	Time over each beacon (in minutes)
33	Flight level for each beacon
41	List of traversed sectors ordered according to followed route
42	Strip entry time for every sector (in minutes)
43	Geo entry time for every sector (in minutes)
44	Exit time of last sector (in minutes)
50	Delay ATC-time allocated (in minutes)-point of allocation
51	List of regulations concerning the flight
12	Indicates beginning of description type REALIZED. The rest is identical to the DEMANDED plan, if the data is identical there is a '=' sign in the corresponding line

9.4 RADAR DATA: Radar data Description

Table 3 : Example of radar data

NM-x	indic	Vitesse	FL	Heure	CAUTRA X	CAUTRA Y	GM - LAT	GM - LONG
1	AFR1466	000 kts	000Õ	23h59:31.0	5828	4186	47N03Õ55	05E12Õ30
2	PNR601	490 kts	350Õ	01h06: 3.0	4531	5875	50N41Õ52	01E25Õ10
3								

¥ NM-x: Line number; irrelevant for the project.

¥ Indic: Callsign of the aircraft.

¥ Vitesse: Ground speed in knots.

¥ FL: Flight level in feet * 100.

¥ Heure: Time UTC at which the aircraft passes over a given point.

¥ CAUTRA X: Coordinate point in the CAUTRA format.

¥ CAUTRA Y: Coordinate point in the CAUTRA format.

¥ GM LAT: Latitude coordinate in format WGS 84.

¥ GM LONG: Longitude coordinate in format WGS 84.

We have collected radar data from the CRNA Nord in Athis-Mons and the CRNA Est in Reims. Every CRNA carries out its recordings in the same format. The position of each flight is recorded every eight seconds by radar, so that one receives a very precise trajectory recording with all the above information.

9.5 METEO: Meteorological Data

The collected meteorological data is provided by Meteo France. There is an updated set of weather information every three hours UTC time about the outside air temperature (in degrees Kelvin), the wind heading (in degrees) and the wind magnitude (in metres/second). The measurements are taken at intervals of 10,000 feet up to an altitude of 50,000 feet; these altitudes are not expressed as flight levels but as air pressure (in Isobars).
Latitude and longitude co-ordinates together with the altitude form a point in space. For each latitude value there are ten longitude values in steps of 15 minutes. The latitude values are also separated in steps of 15 minutes.
In order to find out the actual weather conditions for a given radar track, it will be necessary to interpolate between different values obtained from Meteo France.

¥ **Temperature: Parameter «T»**

LONGITUDE 3500 LATITUDE 5000 VALEUR 275.718750

LONGITUDE 3250 LATITUDE 5000 VALEUR 275.687500

LONGITUDE 3000 LATITUDE 5000 VALEUR 275.750000

LONGITUDE 2750 LATITUDE 5000 VALEUR 275.781250

.....

¥ **Wind heading: Parameter «DD»**

LONGITUDE 3500 LATITUDE 5000 VALEUR 162.619049

LONGITUDE 3250 LATITUDE 5000 VALEUR 162.097092

LONGITUDE 3000 LATITUDE 5000 VALEUR 156.841644

LONGITUDE 2750 LATITUDE 5000 VALEUR 151.066879

.....

¥ **Wind magnitude: Parameter «FF»**

LONGITUDE 3500 LATITUDE 5000 VALEUR 7.378403

LONGITUDE 3250 LATITUDE 5000 VALEUR 6.102624

LONGITUDE 3000 LATITUDE 5000 VALEUR 4.472177

LONGITUDE 2750 LATITUDE 5000 VALEUR 3.377075

.....

9.6 CFMU Data

Sample of an All_Flights plan SK561 (the field separator is ‘;’):

ENFB;LFPG;SAS561 ;SAS;MD80;9706170630;AA10356769;9706170605;FPL;
SAS561 ;350;NEXE;NEXE;N;N;N;9706170637;9706170605;TE;SI;NS;000566266
;_;_;_;_;N;TPPG17E ;4;0;RDY;CHG;SAM;_;PFD;FPL;_;_;_;0610:ENFB:ENFBSKI1A:0
0615:GRS:ENFBSKI1A:076 0623:SKI:UA7:203 0635:SVA:UA37:347 0645:DANKO:UA37:350
0656:GARNA:UA37:350 0701:DANDI:UA37:350 0707:ABSIL:UA37:350 0713:SAMON:UA37:350
0716:MULIT:UA37:350 0720:BEENO:UA37:350 0722:SITKO:UA37:350 0722:KOMIK:UA37:350
0727:SPRAT:UA37:350 0730:BASAV:UA37:350 0731:GABAD:UA37:350 0734:LOGAN:UR1:350
0737:TRIPO:UR1:350 0739:MANGO:UR1:350 0740:WESUL:UR1:350 0742:LAM:UR1:350
0748:MID:UB39:330 0753:SFD:UA47:337 0755:WAFFU:UA47:297 0756:HARDY:UA47:275
0757:*LFG2:UA47:250 0802:DPE:LFPGDPE1P:190 0806:*2CRL:LFPGDPE1P:150
0808:*1CRL:LFPGDPE1P:150 0809:MERUE:LFPGDPE1P:142 0818:LFPG:LFPGDPE1P:0 ;
0610:ENOSTMA:0619 0619:ENOSSW:0627 0627:ENOSUPP:0645 0645:EKDKUSN:0701
0701:EGTTBNH:0729 0729:EGTTCLE:0733 0733:EGTTCW1:0740 0740:EGTTLUE:0746
0746:EGTTLUW:0751 0751:EGTTWOR:0757 0757:LFFTP:0809 0810:LFFZDAW:0817

Table 4 : Description of the ALL_FT file

Field no.	Description
1	ADEP
2	ADES
3	Aircraft_ID
4	Aircraft_Operator
5	Aircraft_Type_ICAO_ID
6	AOBT
7	IFPS_ID
8	IOBT
9	Flight_Data_Quality # FPL, RPL
10	Flight_ID
11	First_Requested_Flight_Level
12	Exemption_Reason_Type
13	Exemption_Reason_Distance
14	Late_Filer
15	Late_Updater
16	North_Atlantic
17	COBT
18	EOBT
19	Flight_Status # TE (terminated), CA (cancelled), AA (ATC-activated), FI (filed), FS (filed and slot issued), TA (TACT activated)
20	Status_Previous_To_Activation # FI (filed), SI (slot issued), NE (not exempted)
21	Suspension_Status # NS (not suspended), SM (slot missed), TV (trafic volume condition)

Field no.	Description
22	TACT_ID
23	SAM_CTOT
24	SAM_SENT
25	SIP_CTOT
26	SIP_SENT
27	Slot_Forced
28	Most_Penalizing_Regulation
29	Nr_Of_Regulations_Affected_By
30	Nr_Of_Regulations_Excluded_From
31	Last_Received_ATFM_Message
32	Last_Received_Msg
33	Last_Sent_Msg
34	FIELD_34
35	Original_Flight_Data_Quality # FPL, PFD, RPL
36	Source
37	FIELD_37
38	FIELD_38
39	Min_To
40	Point_Profile ::= TimeOver:Point:Route:Level
41	Sector_Profile ::= EntryTime:Sector:ExitTime

ANNEX ICFMU - ATFM Daily Summary

Tuesday, 17 June 1997

Traffic Demand:	23435	flights
Total Number of Regulated Flights:	6656	flights
Total Number of Delayed Flights:	4128	flights
Total CASA Delay:	77643	minutes
Mean Delay of Delayed Flights:	18.81	minutes
Mean Delay of Regulated Flights:	11.67	minutes
Mean All Flights:	3.31	minutes
Number of Regulations:	133	

Traffic Demand in CFMU Area. The number of flight plans having been activated in TACT.
Number of (All) Regulated Flights: Number of flights passing through one or more regulations protecting the country or the ACC.
Number of (most Penalising) Regulated Flights: Only the flights for which the regulation is the most penalising are taken in account.
Number of Delayed Flights: Number of flights delayed by a regulation, i.e. for which CTOT - ETOT > 0.
Total ATFM Delay: The sum of the delays calculated from the CASA regulations.
Mean Delay per Delayed Flight: The Total ATFM Delay divided by the Number of Delayed Flights.
Mean Delay per Regulated Flight: The Total ATFM Delay divided by the Number of Regulated Flights.
Mean Delay for the Traffic Demand: The Total ATFM Delay divided by the Traffic Demand.

ANNEX II Business Objects in ATC

It is intended to find a means for optimisation of the existing ATC system by defining common, modular and reusable business objects as a design option for future systems. Following the ideas of Oliver Sims [Sim94] the ATC domain can be decomposed into prototypical business objects. Focusing on flight plans, as the central information source for pilot intentions, requirements for the definition of such business objects have to be detected.
The shift in paradigm from monolithic systems to reusable independent components will result in new architectures for industry-scale systems. The central objective of this thesis is the definition of a common and reusable business object to be used in a distributed architecture for the ATC domain. The ATC domain can be decomposed into prototypical BOs. With special regard to flight plans, requirements for the definition of business objects have to be elicited. This raises the following questions:

- How should the various requirements of the clients be classified?
- What sources of information are relevant for the definition of ATC BOs?
- How can the different data formats be adequately reflected in future BOs
- Which aspects concerning the operational environment of the BO may influence its design?

Consequently, this thesis shall propose business objects for the ATC domain with special regard to flight plans. On the basis of the «CFPS/SOFT» project, existing data sources have to be evaluated and their relationships to requirements defined by a set of clients/actors have to be studied. The available information sources, e.g. operational flight plans provided by different airlines, have to be analysed with respect to their structure and semantics. Relating the requirements of individual actors/clients to the available information analysed in the previous phase will outline the structural requirements for the BO.

ANNEX III

«The following is an explanation of what has been done with regard to the analysis of the radar data and the problems that were encountered:

- Some 800 radar trajectories in total were available.
- The OFPL was available for some of these flights (no exact number). Of those flights for which both radar and OFPL data was available only a limited number had a complete coverage of the climb or descent trajectory (to or from approximately. 1500 ft). Within this group some of the actual cruise levels did not match the levels indicated in the OFPL, making a good comparison between OFPL and radar data quite hard.
- Only 15 - 20 flights from the total of 800 could be used to compare the radar , OFPL and BADA data. The BADA data is used to see if the knowledge of parameters like weight, speeds accurate wind and temperature could lead to a more accurate trajectory prediction.

Another exercise over a longer period of time is required and it is imperative that this time all the correct OFPLs are collected. With approximately 100 useable flights a proper statistical analysis can be made.»