Infraestructures del
Transport Aeri

Air Traffic Flow Management (ATFM)

Xavier Prats, Luis Delgado & Marc Melgosa

October 2020 – Version 1.8

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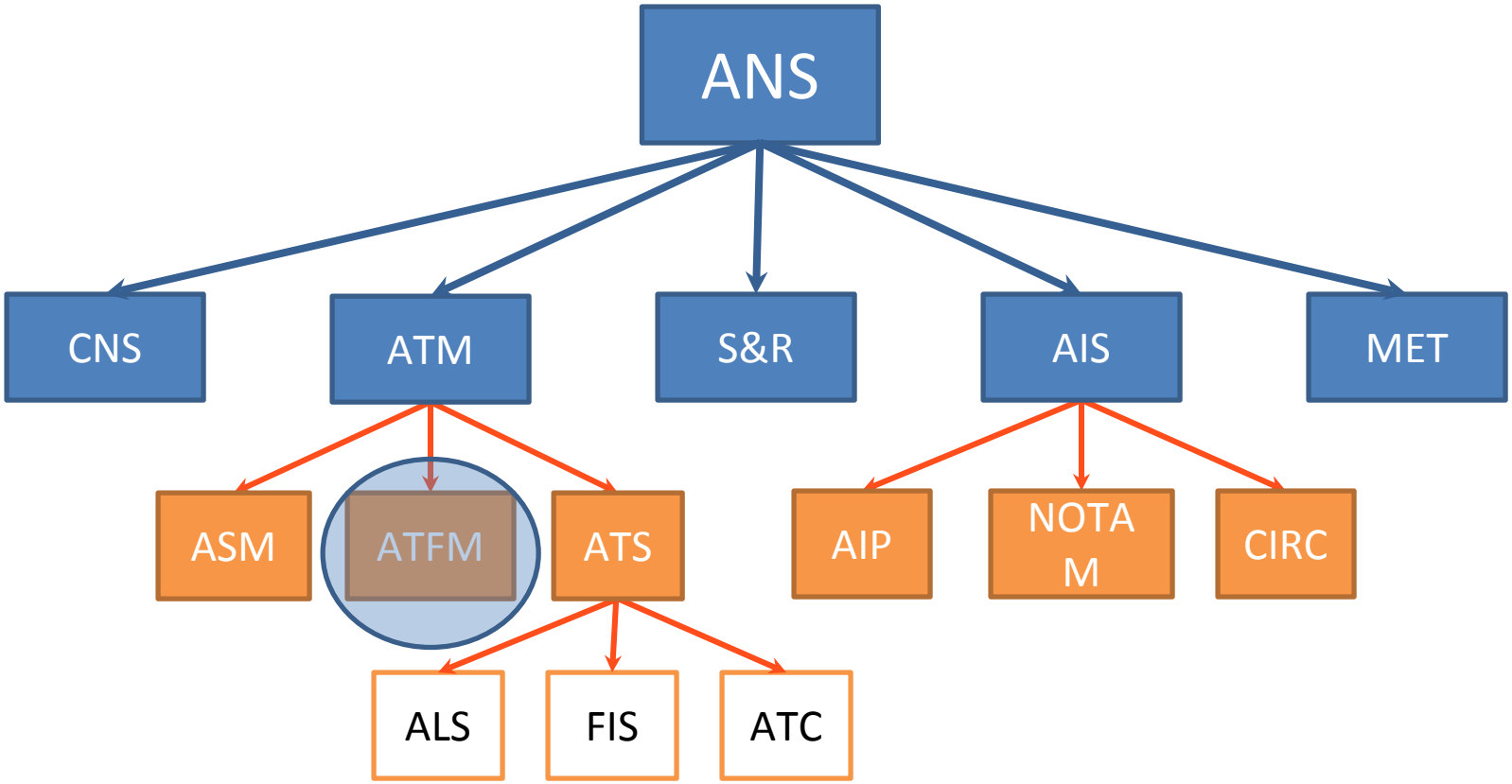
Introduction



ANS: Air Navigation Services
CNS: Communications, Navigation and Surveillance
ATM: Air Traffic Management
S&R: Search and Rescue
AIS: Air Information Services
MET: Meteorological Services

ASM: AirSpace Management
ATFM: Air Traffic Flow Management
ATS: Air Traffic Services
AIP: Aeronautical Information Publications
NOTAM: Notices to Airmen
CIRC: Circulars

ALS: Alert Services
FIS: Flight Information Services
ATC: Air Traffic Control

Introduction

Keep forecasted traffic demand* below estimated capacity in airports and airspace sectors

ATFM: Air Traffic Flow Management

Additional service to ATS aiming at improving safety, throughput and efficiency.

ATFCM : Air Traffic Flow and Capacity Management

Same as ATFM + aiming at using as much as possible ATS capacity.

* Due to their easier predictability, for ATFM purposes, only IFR flights are considered when computing demand forecasts

Introduction

ATFCM Network Situation Data

Last update 27/12/2014 12:37

Flights

Total	**17,849**
Landed	6,507 (36%)
Airborne	3,752 (21%)
Expected	7,590 (43%)

Delays (in minutes)

Cumulated	**85,616.0**
Average/Flight	4.8
En-route	20,880 (24%)
Airport	64,736 (76%)
>= 30 min	**870**

Delay Causes

Reason	Delay	Delay (%)
Weather	38099	44%
De-Icing	24308	28%
ATC Capacity	20838	24%
Aerodrome Capacity	1756	2%
Special Event	446	1%
Others	138	0%
ATC Routeings	32	0%
Accident / Incident	0	0%
Equipment non-ATC	0	0%

Introduction

Examples

Seq no	188
FMP	LECBFMP
Regulations Id	LEBL0729
Flight Level	065-
Reason	Weather
RMK	CB
	LEBL TMAT FINAL07
Seq no	150
FMP	LECPFMP
Regulations Id	LEPAA29B
Flight Level	ALL
Reason	Aerodrome Capacity
	LEPA ARRIVALS

EHAM (Amsterdam)
arrivals regulated due to VCS transition until 0720 UTC.
Moderate delays.

EBBR (Brussels)
arrivals regulated until 0830 UTC due to strong wind.
Moderate to high delays.

LEPA (Palma)
arrivals regulated with low rate until 0900 UTC due to low visibility.
High delays.

Seq no	070		
FMP	LECMFMP		
Regulations Id	LECPAU11		
Flight Level	345+		
Reason	ATC Capacity		
	LECM.PAMPLONA UPPER SECTOR		
		UNT	11/04/2015 16:40
Seq no	071	State	NEW
FMP	LECMFMP	Published	11/04/2015 13:44
Regulations Id	SAN11A	WEF	11/04/2015 15:20
Flight Level	ALL	UNT	11/04/2015 16:40
Reason	ATC Capacity		
	LECM-NORTH: SANTIAGO SECTOR		

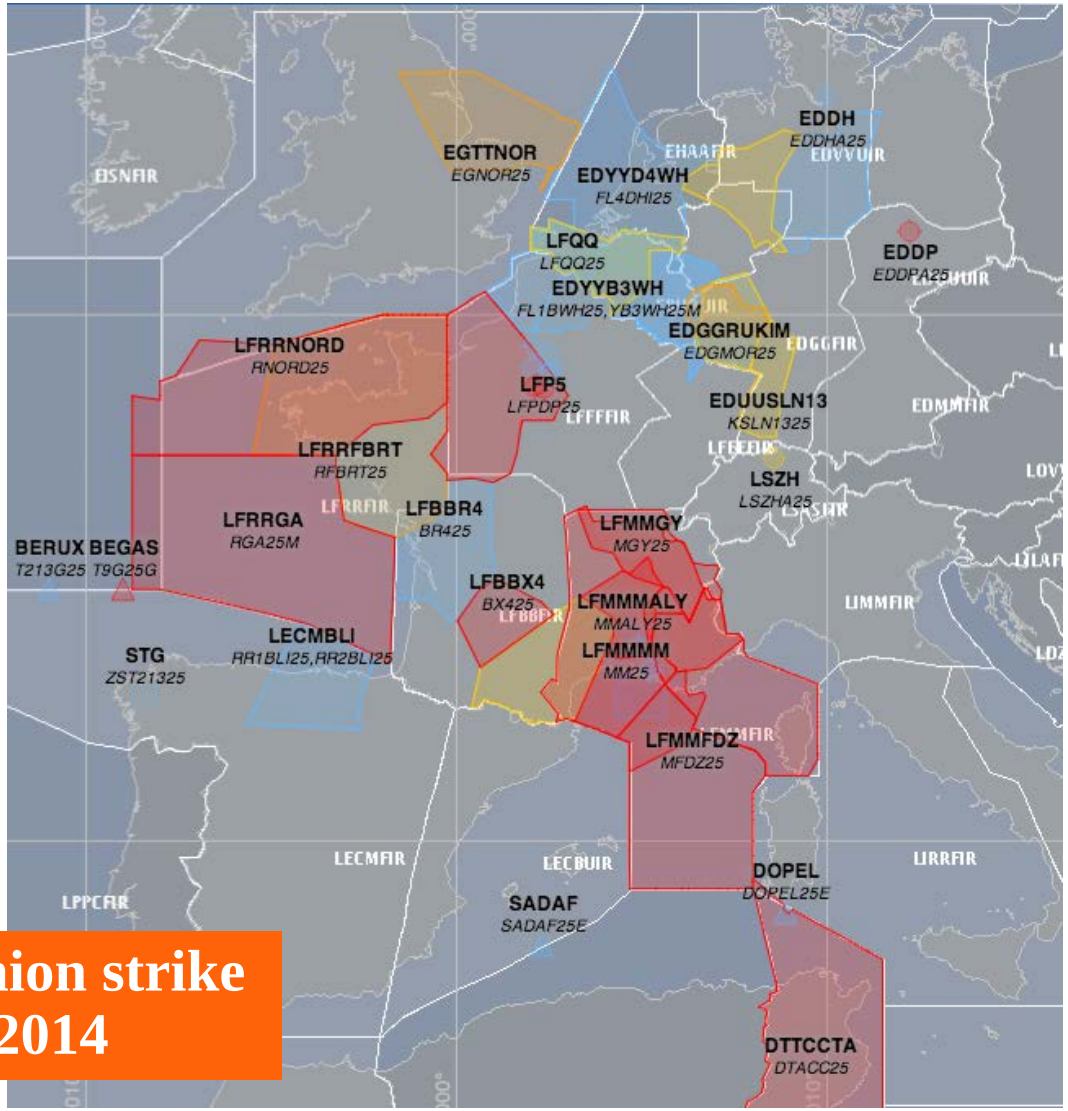
Examples

Seq no	065	**State**	NEW
FMP	LECMFMP	**Published**	17/04/2015 16:38
Regulations Id	LEMDA17	**WEF**	17/04/2015 17:00
Flight Level	ALL	**UNT**	17/04/2015 21:20
Reason	Aerodrome Capacity		
RMK	CAPACITY REDUCED DUE WIP. LEMD ARRIVALS		

Seq no	054	**State**	NEW
FMP	LECMFMP	**Published**	03/05/2015 04:58
Regulations Id	LEMDA03M	**WEF**	03/05/2015 07:40
Flight Level	ALL	**UNT**	03/05/2015 09:20
Reason	Aerodrome Capacity		
RMK	WIP ON THE RWY LEMD ARRIVALS		
Seq no	067	**State**	NEW
FMP	LECMFMP	**Published**	03/05/2015 07:48
Regulations Id	LEMDA03	**WEF**	03/05/2015 10:40
Flight Level	ALL	**UNT**	03/05/2015 13:20
Reason	Aerodrome Capacity LEMD ARRIVALS		

WIP (Work in Progress) in Madrid: RWY closed for maintenance

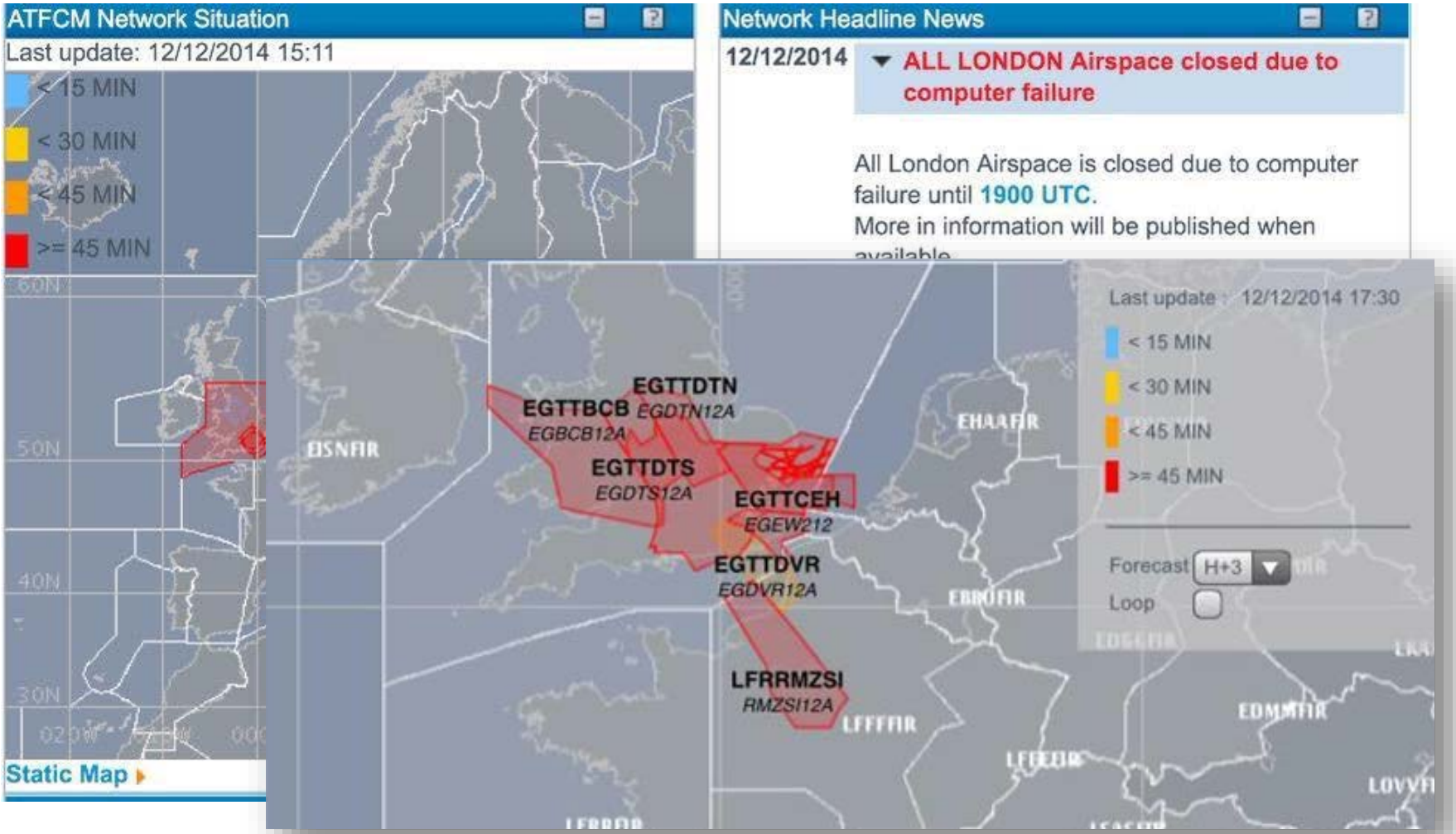
Examples



French ATC union strike
25th June 2014

Introduction

Examples



ATFCM Additional Objectives

- **Management of network systems infrastructure**
- **Monitoring of the network operations**
- **Keep the Network Operations Plan updated**
- **Not only slot allocation but also optimization of network capacity**
- **Maximize the use of available resources and coordination (CDM)**

It needs to be implemented in a wide area with multilateral agreements involving typically several states

If demand exceeds capacity...

1- Try to change sector/airport configuration or increase open sectors

and if demand/capacity imbalance persists, then:

2- Apply an ATFM initiative (regulation)

- **Ground stop**
- **Call for release**
- **Miles in Trail (distance based metering)**
- **Air holding (time based metering)**
- **Tactical re-routering**
- **Level Capping (Tactical cruise flight level change)**
- **Ground Holding**

Ground delays are "cheaper" than air delays (re-routing or air holding)!!

Some flights might be excempted from ATFM measures

ATFM regulations

If airport capacity/demand imbalance:

- **The regulation affects only aircraft inbound the congested airport.**

If airspace capacity/demand imbalance:

- **The regulation affects only aircraft flying into the congested airspace sector (#aircraft in sector, #departures/arrivals in TMA,…) or airway (flow in a given waypoint/airway,…)**

ATFM regulations

Europe:

Airport or airspace congestion:

- **Network Manager (NM) - Regulations**

United States of America:

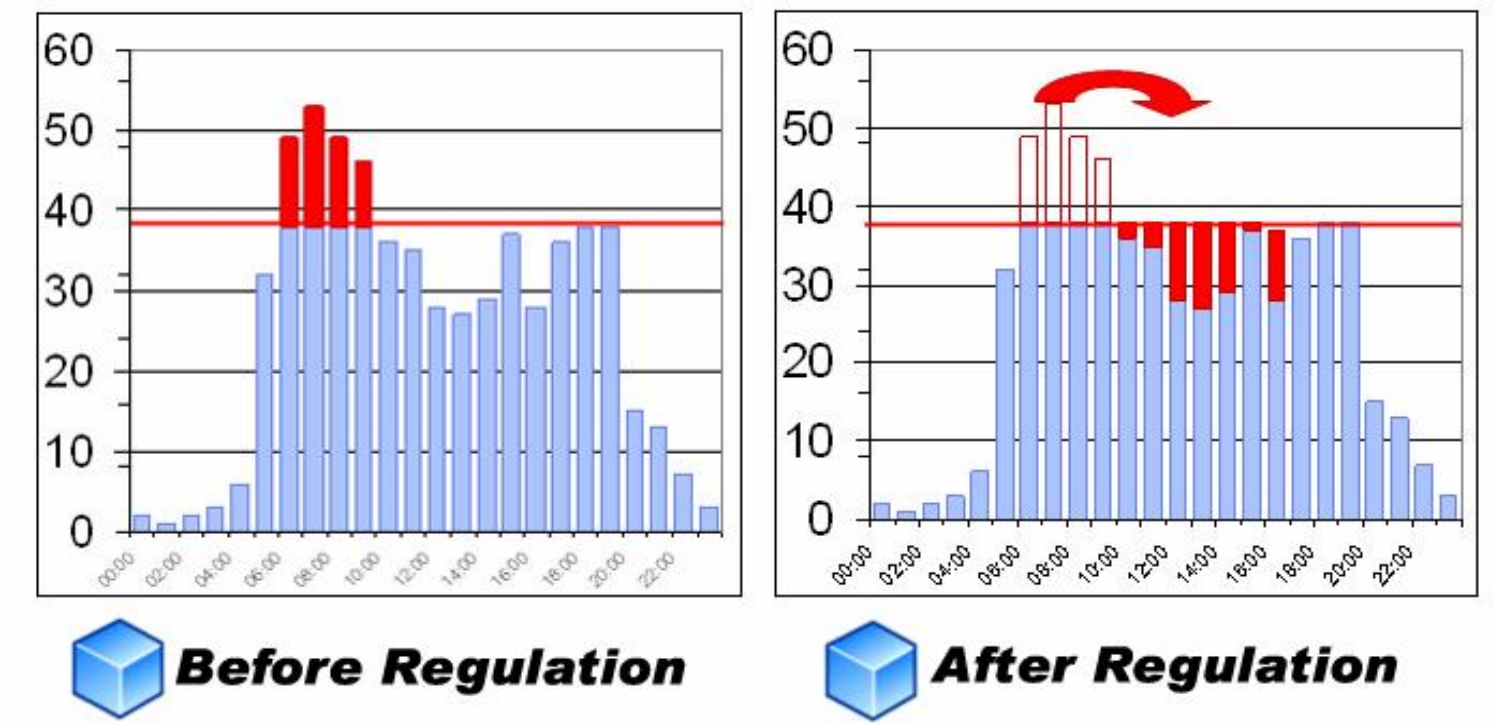
Airport congestion:

- **Ground Delay Program (GDP) with Collaborative Decision Making (CDM)**

Airspace congestion:

- **Airspace Flow Program (AFP)**

Ground Holding



Ground Holding

Delayed Departure ← **Departure Slot**

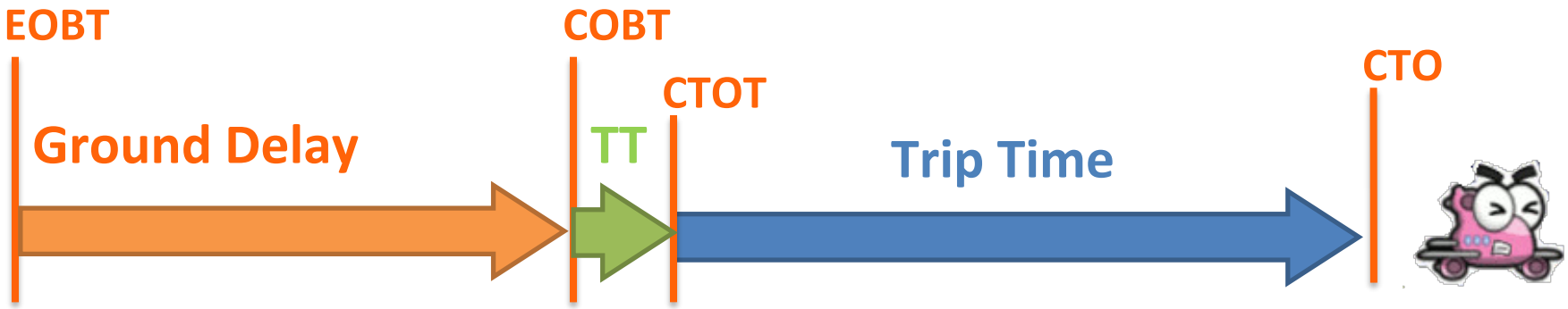
Origin airport

Trip Time

If **demand > capacity** → Regulation → **Arrival Slots**

Congested airport
(or congested airspace sector)

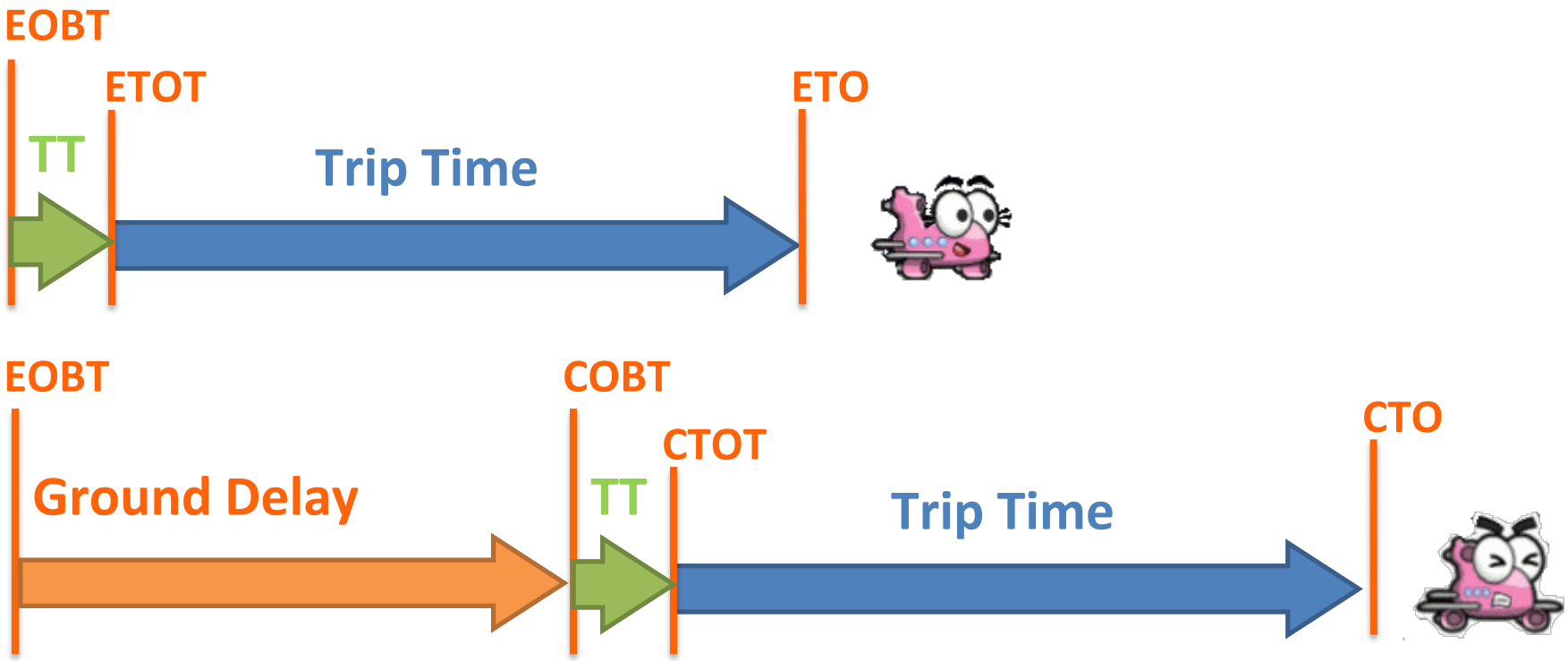
Ground Holding



EOBT: Estimated Off-Block Time
ETOT: Estimated Take-Off time
ETO: Estimated Time Over
TT: Taxi Time

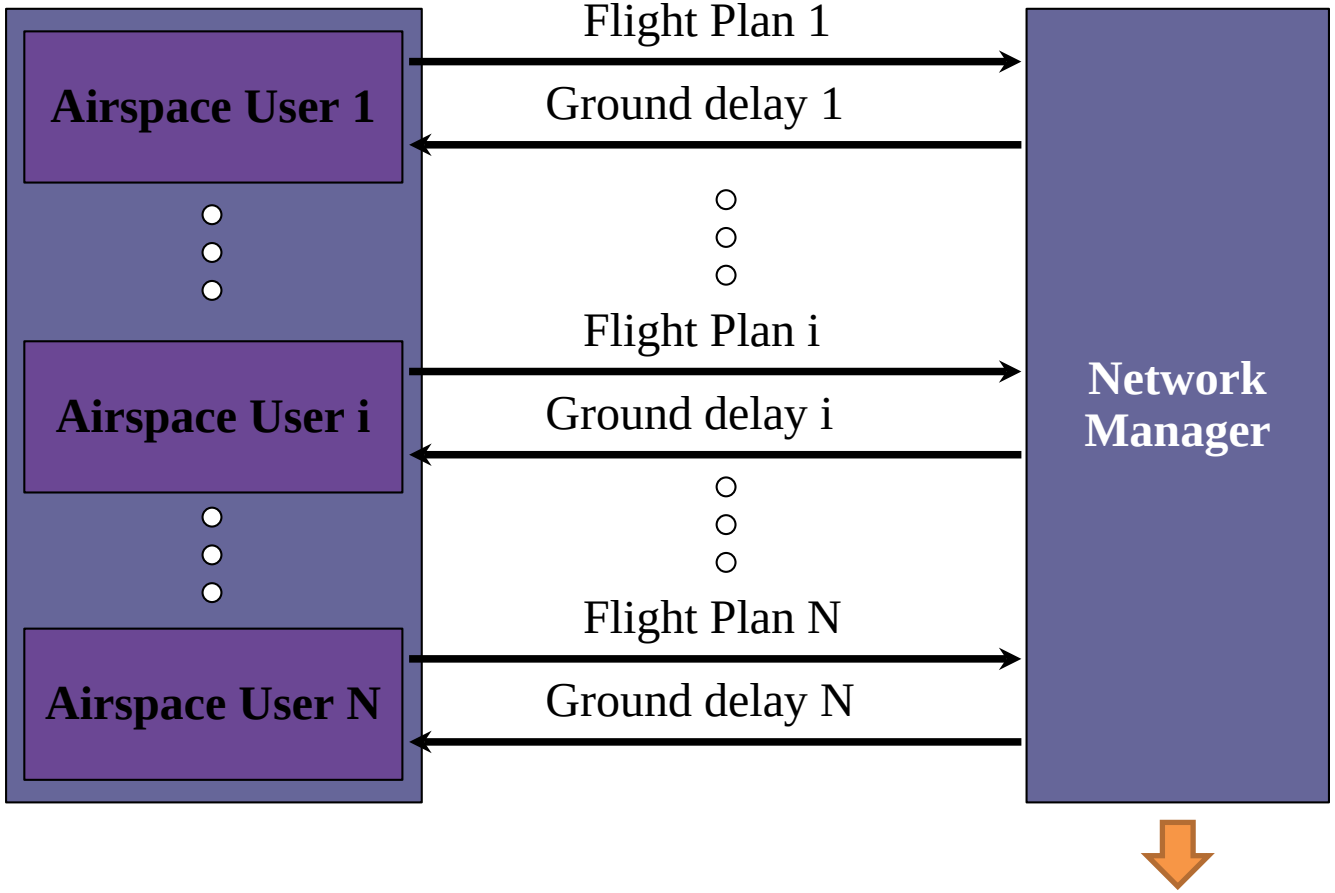
COBT: Calculated Off-Block Time
CTOT: Calculated Take-Off Time
CTO: Calculated Time Over

Ground Holding



- Actual Take-off between [CTOT-5 min, CTOT+10 min]
- TWR controllers will enforce take-off within time limits

Computer Assisted Slot Allocation



Slot Allocation algorithm: Ration by Schedule -- Minimises total system delay

Slot Allocation Algorithm (example)

Flight	ETO
F1	10:00
F2	10:06
F3	10:07
F4	10:10
F5	10:12
F6	10:18

ETO computed based on flight schedule

10:00	Slot 1
10:05	Slot 2
10:10	Slot 3
10:15	Slot 4
10:20	Slot 5
10:25	Slot 6
10:30	Slot 7

Regulated Sector

ETO: Estimated Time Over

Slot Allocation Algorithm (example)

Flight	ETO
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10:20	Slot 5
10:25	Slot 6
10:30	Slot 7

Regulated Sector

ETO: Estimated Time Over

Slot Allocation Algorithm (example)

Flight	ETO	Delay
F1	10:00	0 min
F2	10:06	0 min
F3	10:07	3 min
F4	10:10	5 min
F5	10:12	8 min
F6	10:18	7 min

10:00	Slot 1 → F1
10:05	Slot 2 → F2
10:10	Slot 3 → F3
10:15	Slot 4 → F4
10:20	Slot 5 → F5
10:25	Slot 6 → F6
10:30	Slot 7

Regulated Sector

ETO: Estimated Time Over

IATA slots

ATFM slots are NOT airport schedule (or IATA) Slots!!!

In European airports seasonal schedule slots (or IATA slots) are enforced:

- **Assuming a "worst case" IFR capacity**
- **Considering *grand-father* rights**
- **Renewing schedule slots 2 times per year.**

1 Slot in Madrid (LEMD)
≈ 1M Eur / year

USA airports do not implement this measure (with few exceptions such as LGA airport).

In USA GDPs are very frequent!

In Europe aircraft are "bigger" and flight frequencies are smaller than the USA !!

Thank you!!

Gràcies!!

Air Traffic Flow Management (ATFM)

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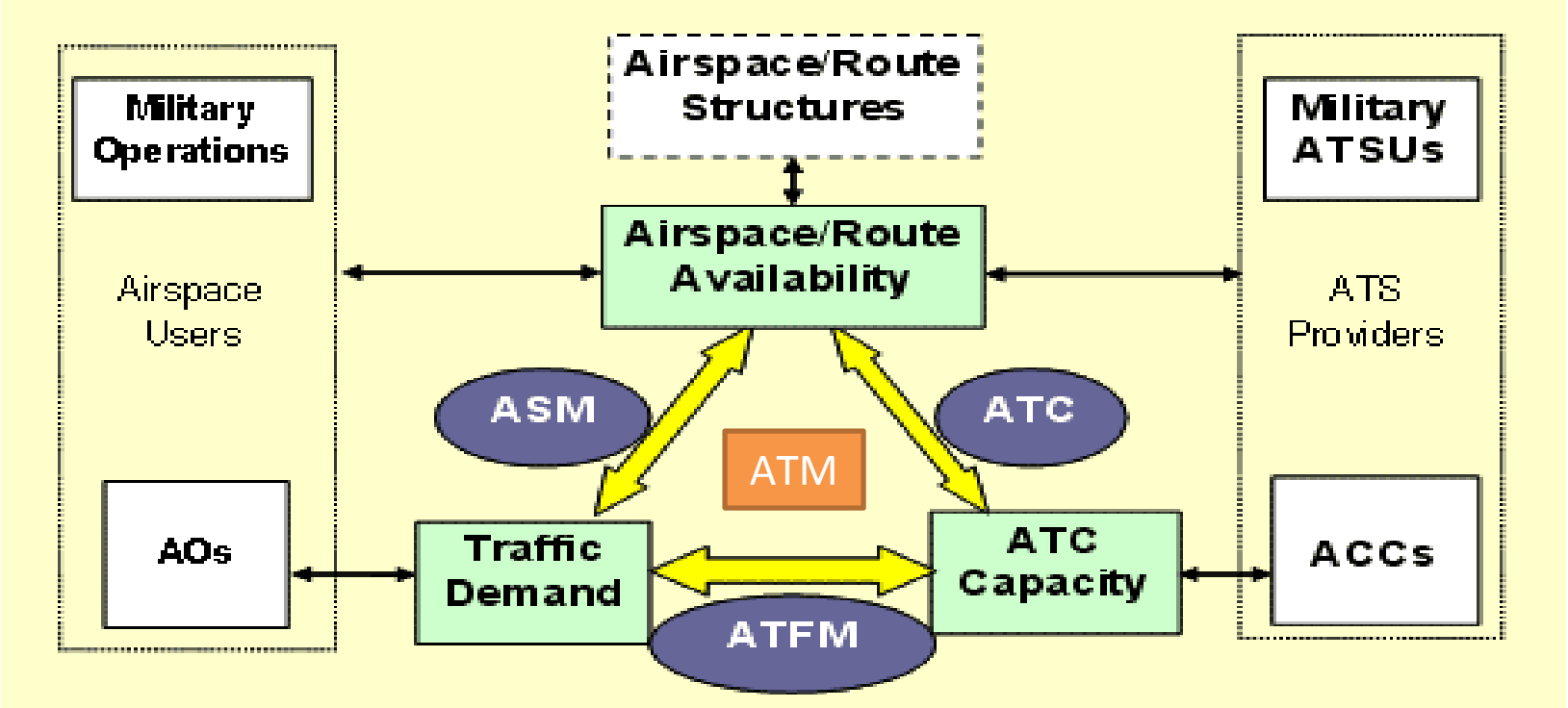
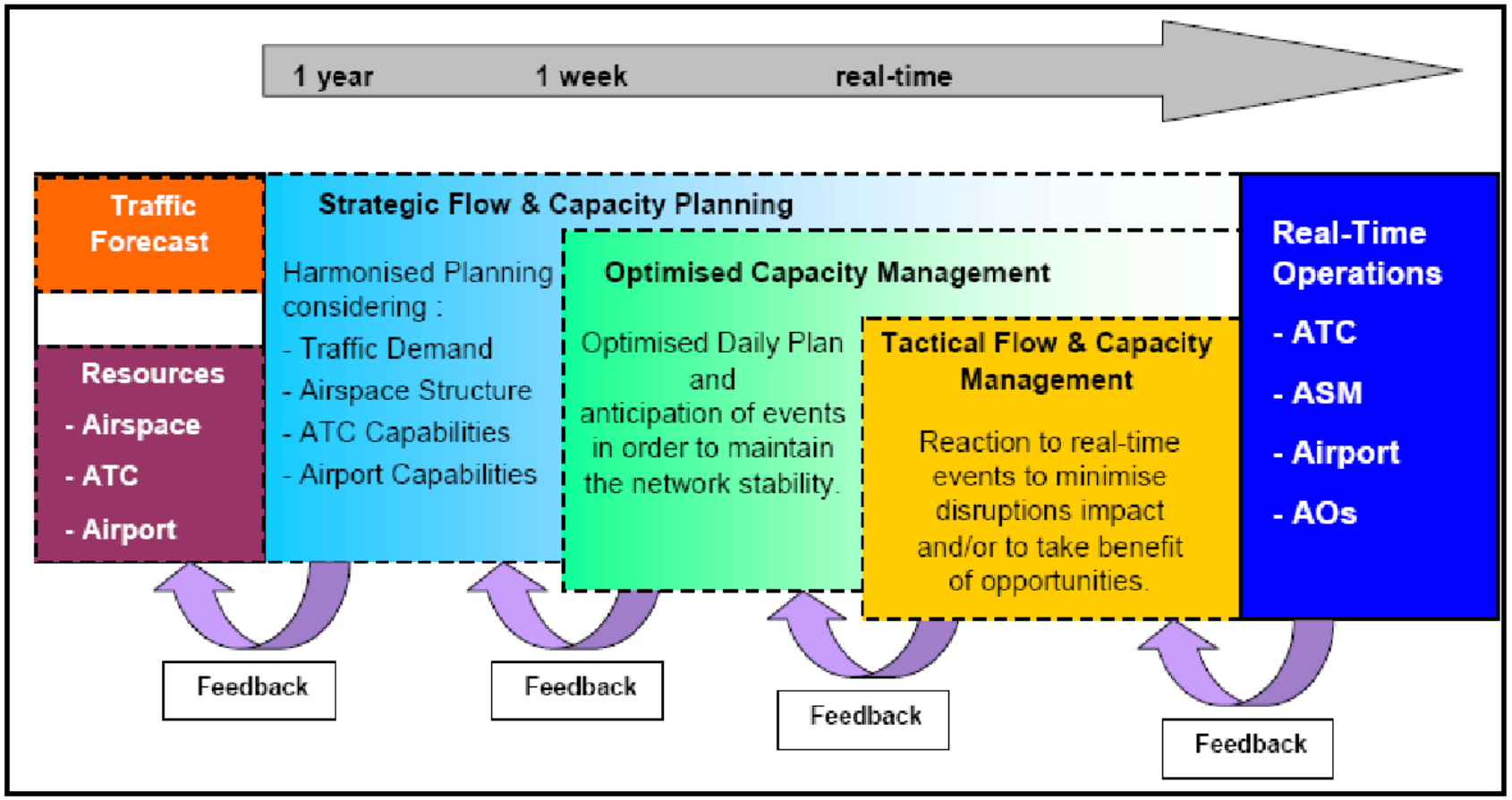
ATFM as a piece of ATM

ATM
- ASM: AirSpace Management
- ATFM: Air Traffic Flow Management
- ATS: Air Traffic Services

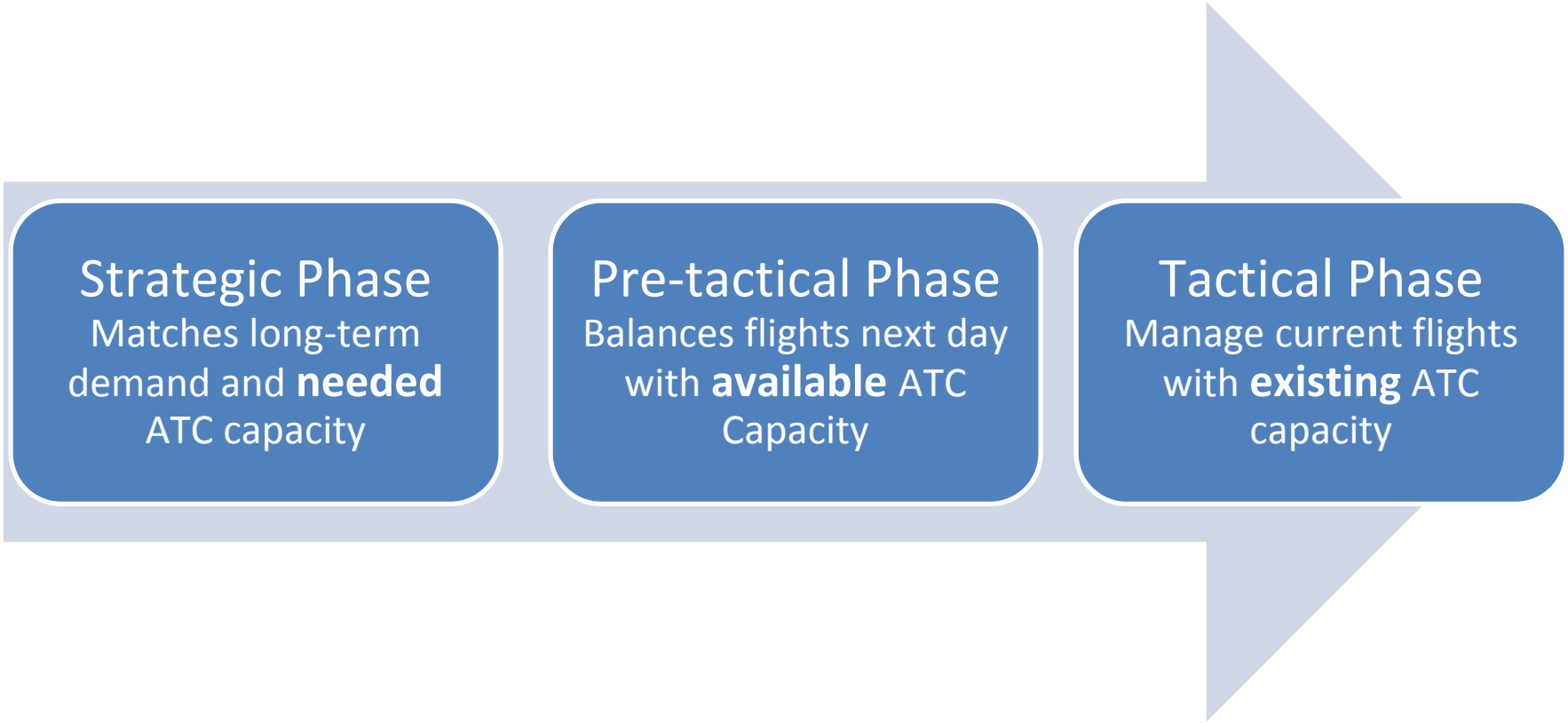


References:
http://www.eurocontrol.int/articles/what-air-traffic-management#airspacemanagement
http://www.eurocontrol.int/articles/air-traffic-management-atm-explained

ATFCM process



ATFCM process



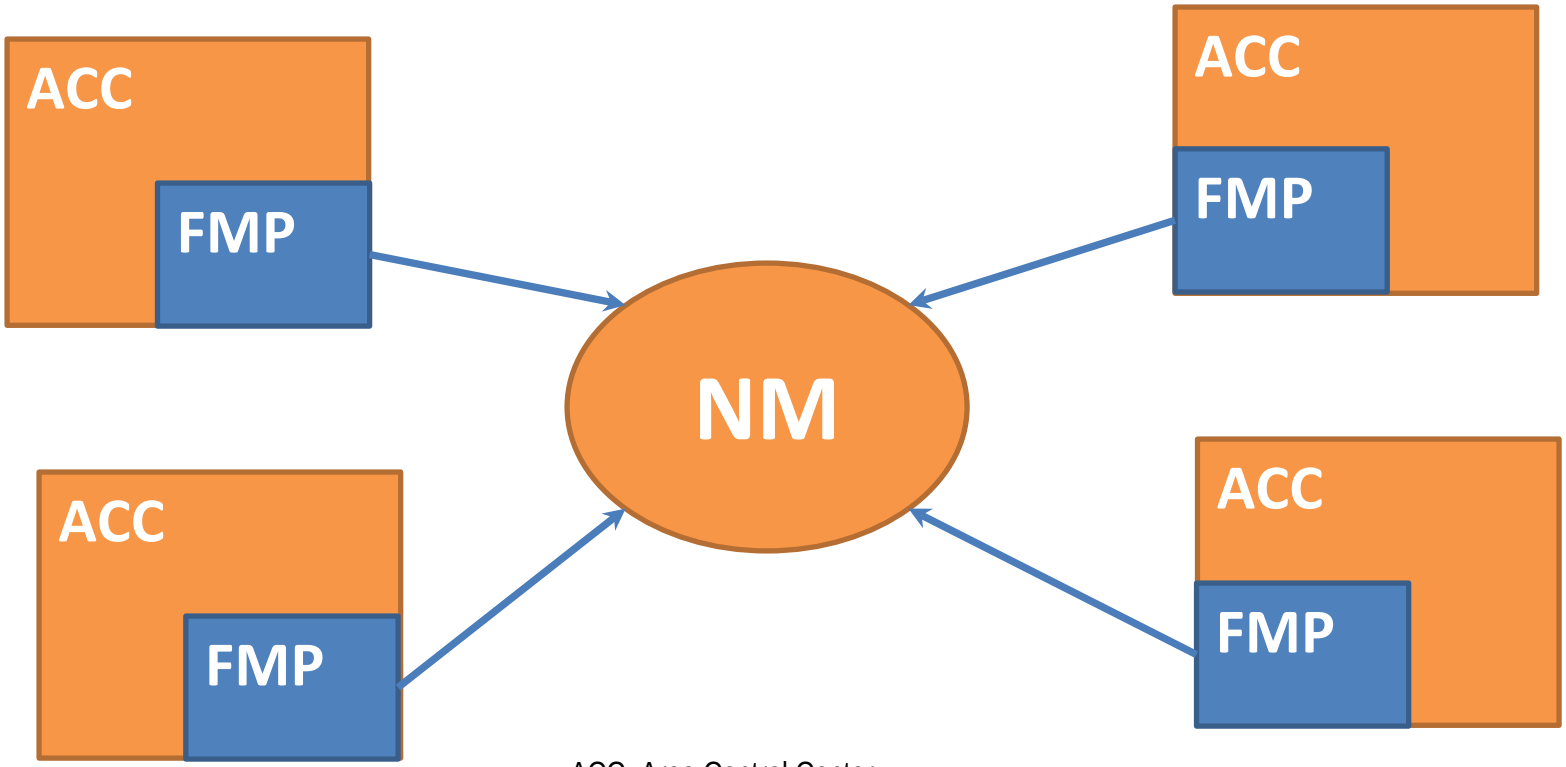
https://www.eurocontrol.int/articles/air-traffic-flow-and-capacity-management

Check the ATFCM Users Manual in *Atenea* Reference documents folder!!

Provide ATFCM services throughout ECAC airspace

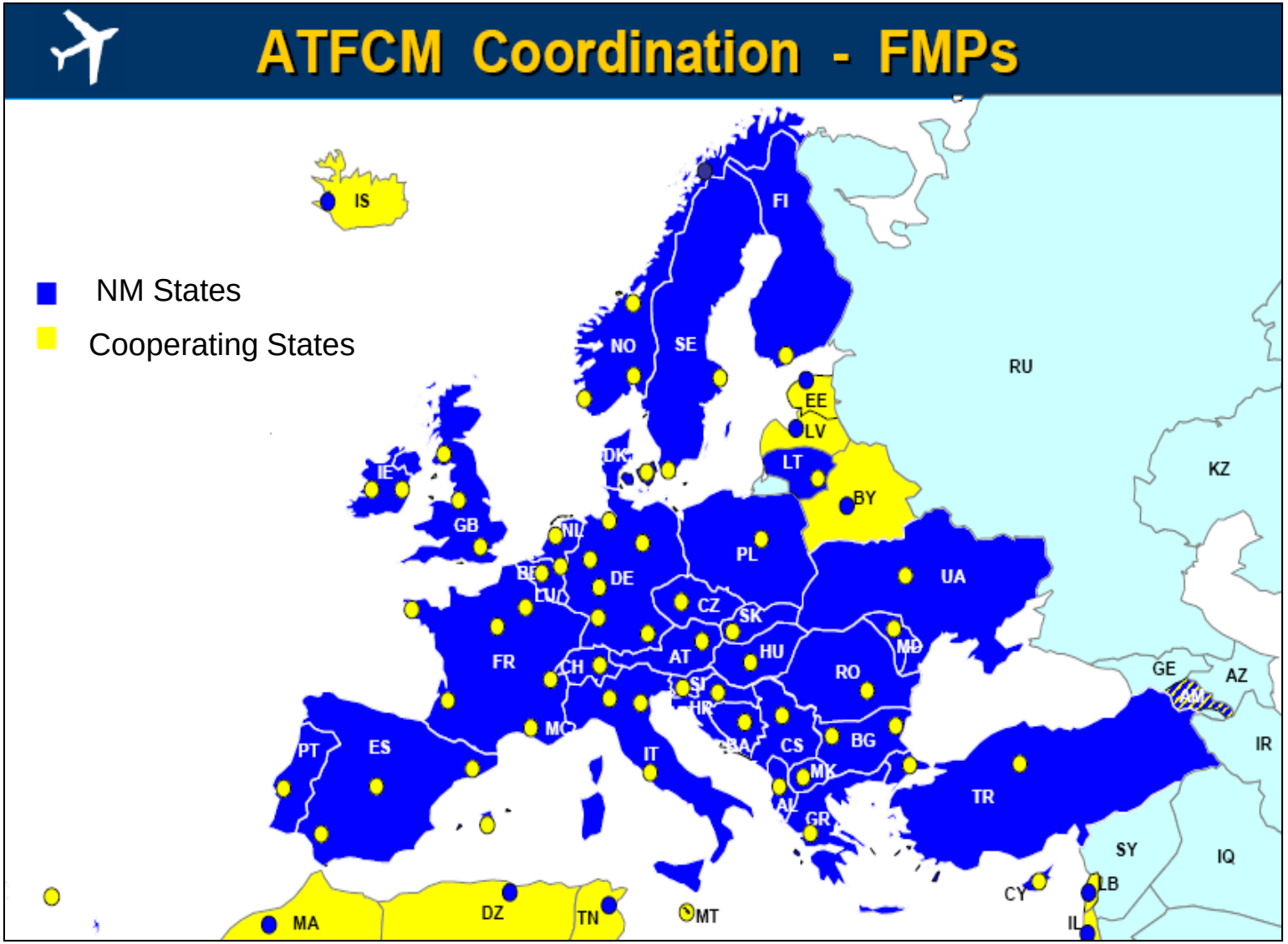
http://www.eurocontrol.int/network-operations
https://www.ecac-ceac.org/

CFMU is based on ICAO Centralised Traffic Management Organisation (CTMO)



ACC: Area Control Center
FMP: Flow Management Position

Network Manager



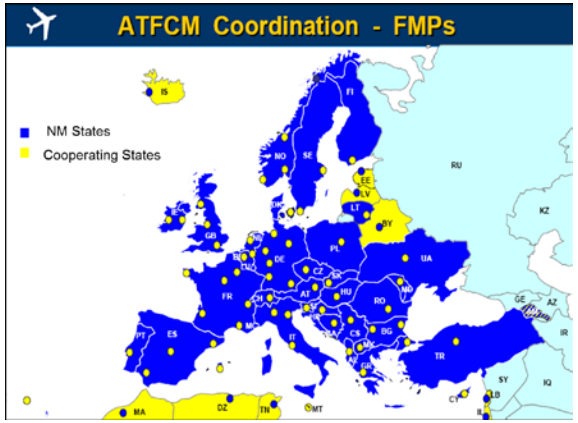
Network Manager

The NM may apply ATFM measures to flights which :

a) take place within the ATFCM area

b) depart from within the ATFCM area to a destination in the eastern part of the ICAO EUR region (non-ATFCM area), or to another ICAO region

c) enter the ATFCM area after departing from a flight information region part of the ATFCM adjacent area

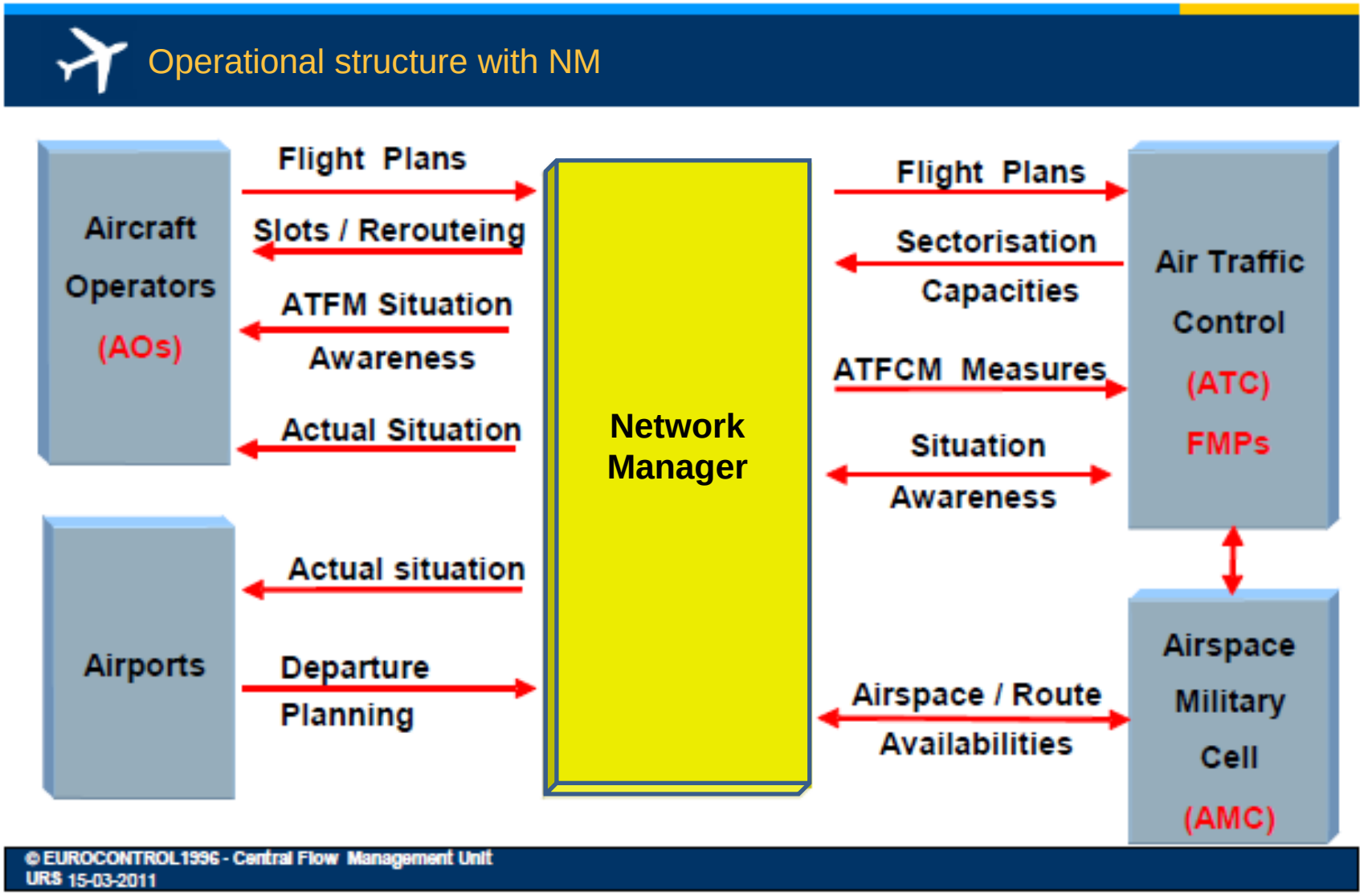


NM Phases

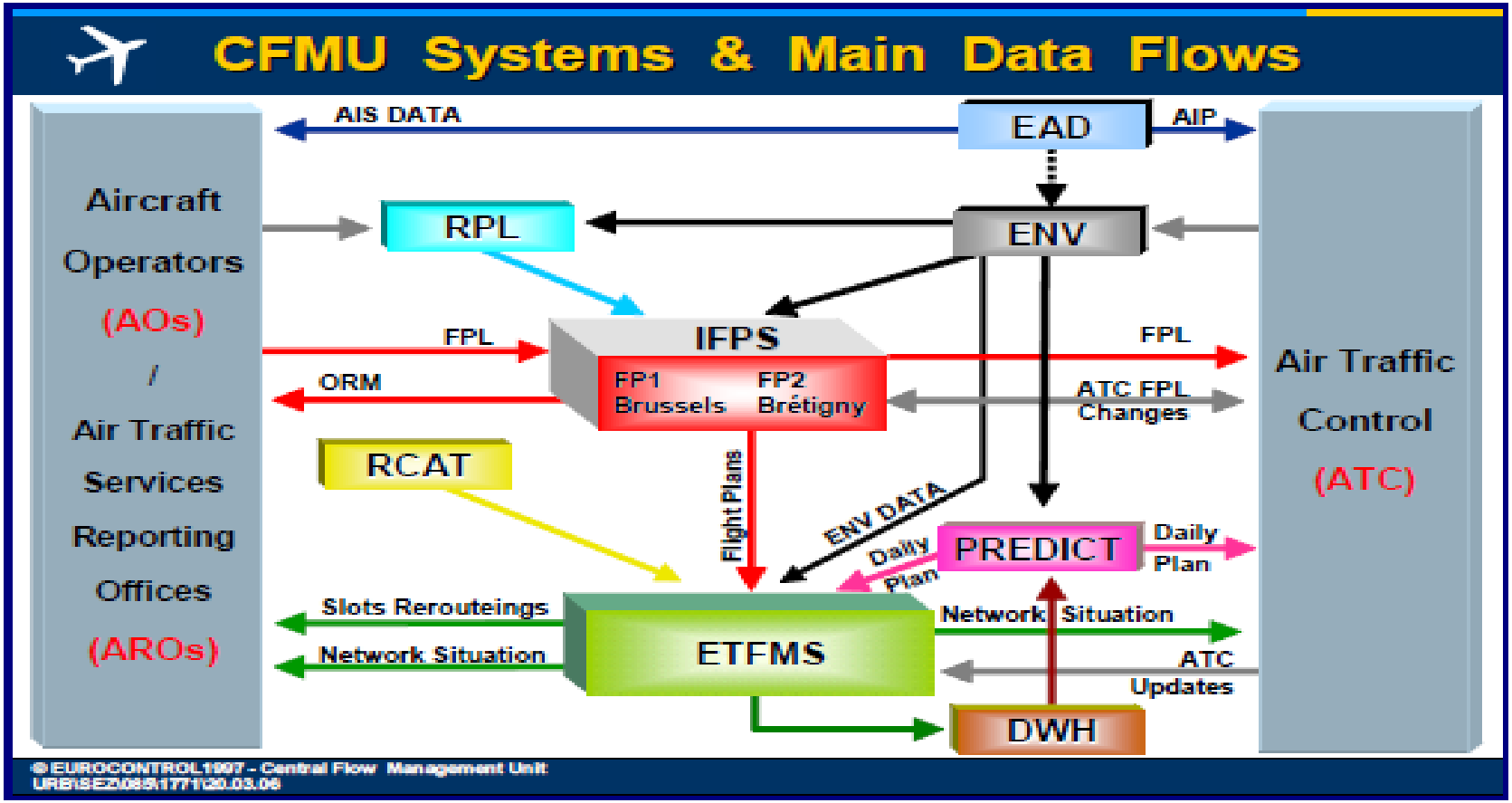
Note the different timescales for the 3 phases

< D - 7	D-6 to D-2	D-1 and D
STRATEGIC ATFM	**PRE-TACTICAL ATFM**	**TACTICAL ATFM**
BASED ON : ARCHIVES and SIMULATIONS / TACT		
Traffic forecasts + RPL Special events (strikes…) Archived & statistical data Contingency routes ATC capacities	Plan from previous phase Information from FMPs Archived & statistical data (previous experience, ref. Days…) Teleconf. with AOs and FMPs	Plan from previous phase Flight plans & updates Messages from AOs Messages from ATC
RESULTS		
ATFM Plans for the pre-tactical Phase (route & level capping) RAD Possible AIP ammendments	ATFM Notification Message (ANM) ATC Organisations (optimim sector configs. and likely capacities Identify critical areas and agreed routing scenarios	Slot Allocation (CTOT) Ad-hoc Rerouteings or level capping CTOT updates

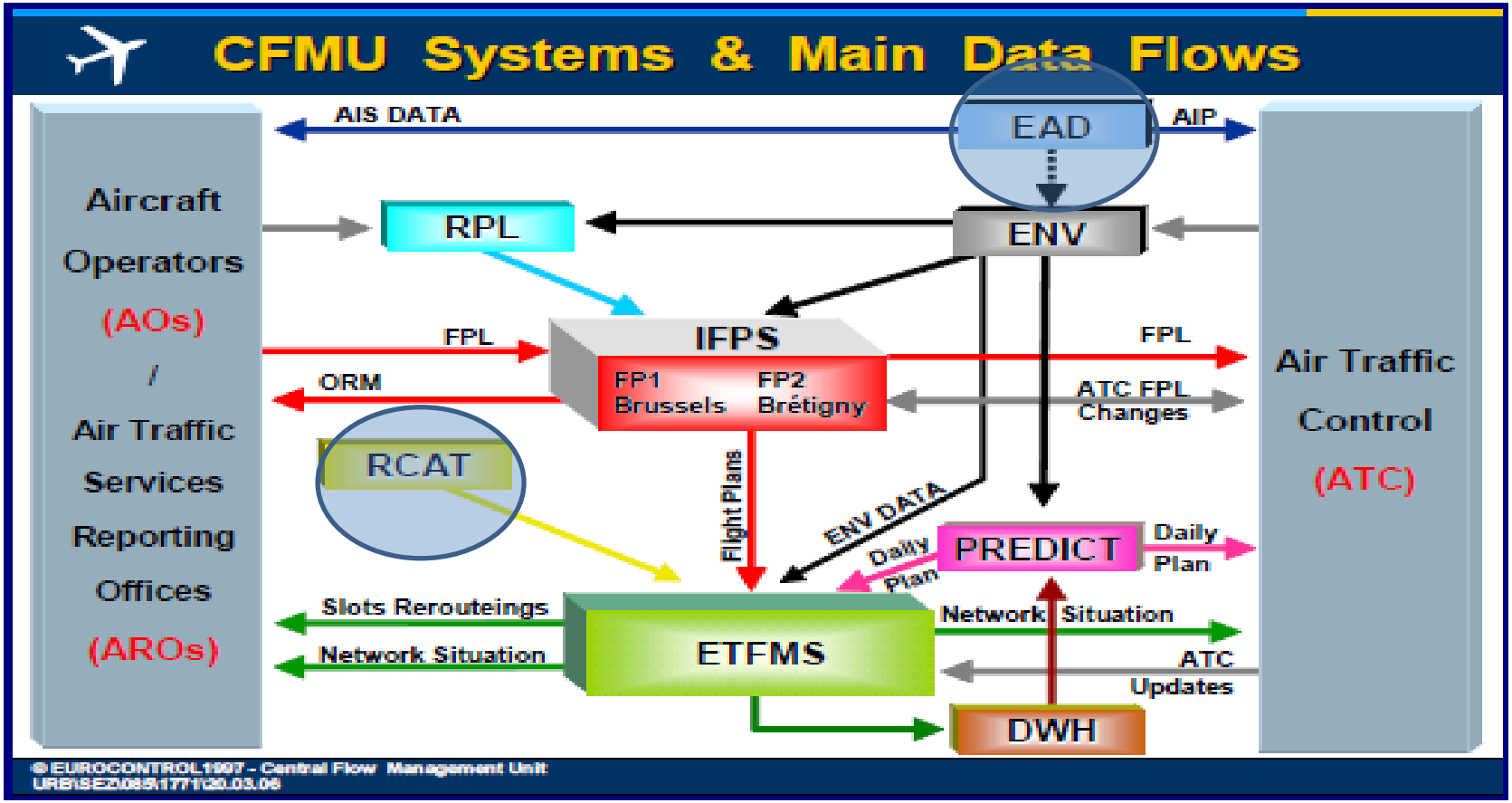
NM operational structure



NM systems and data flows



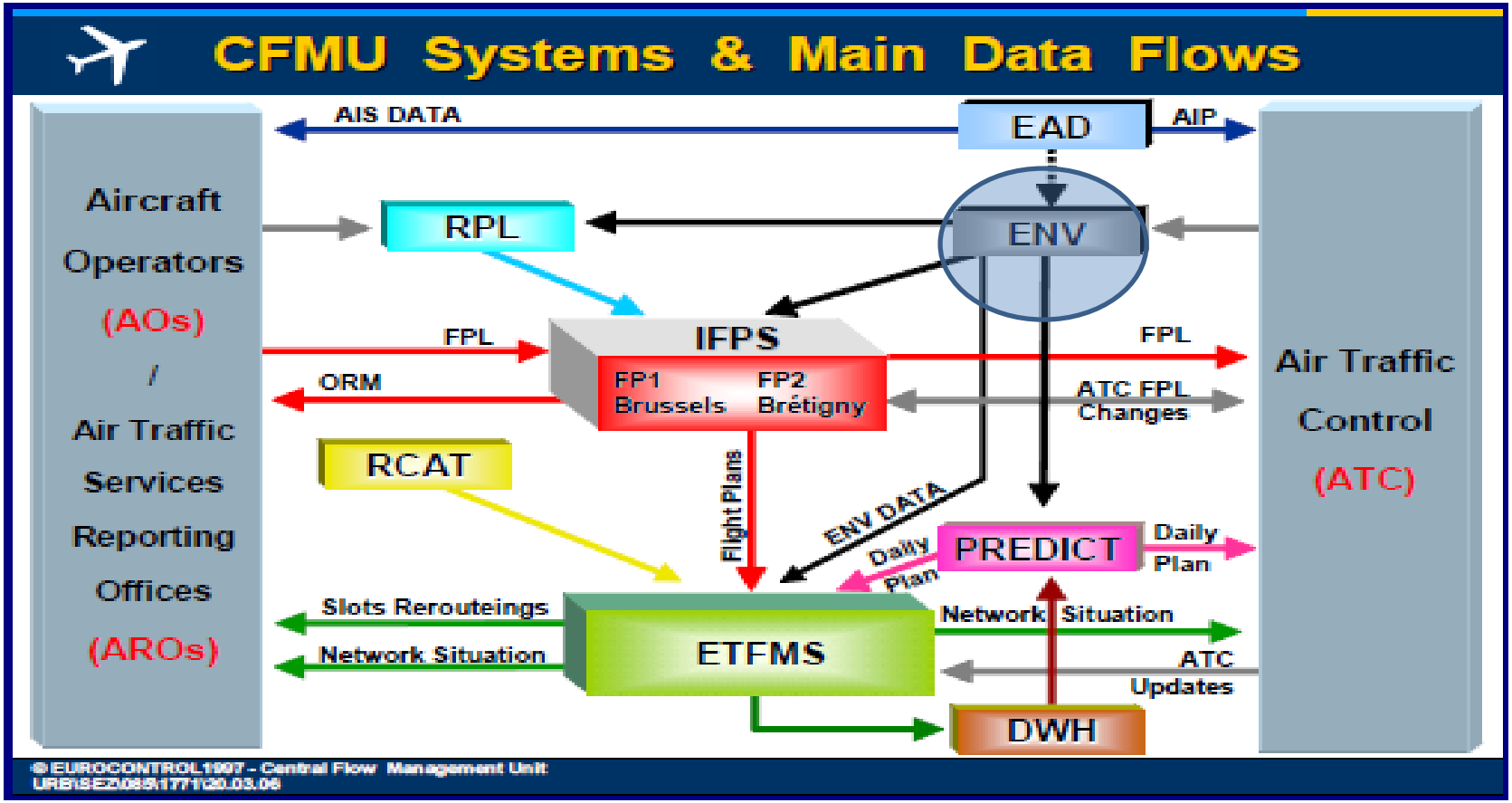
NM systems and data flows



EAD: European AIS Database

RCAT: Route Catalogue

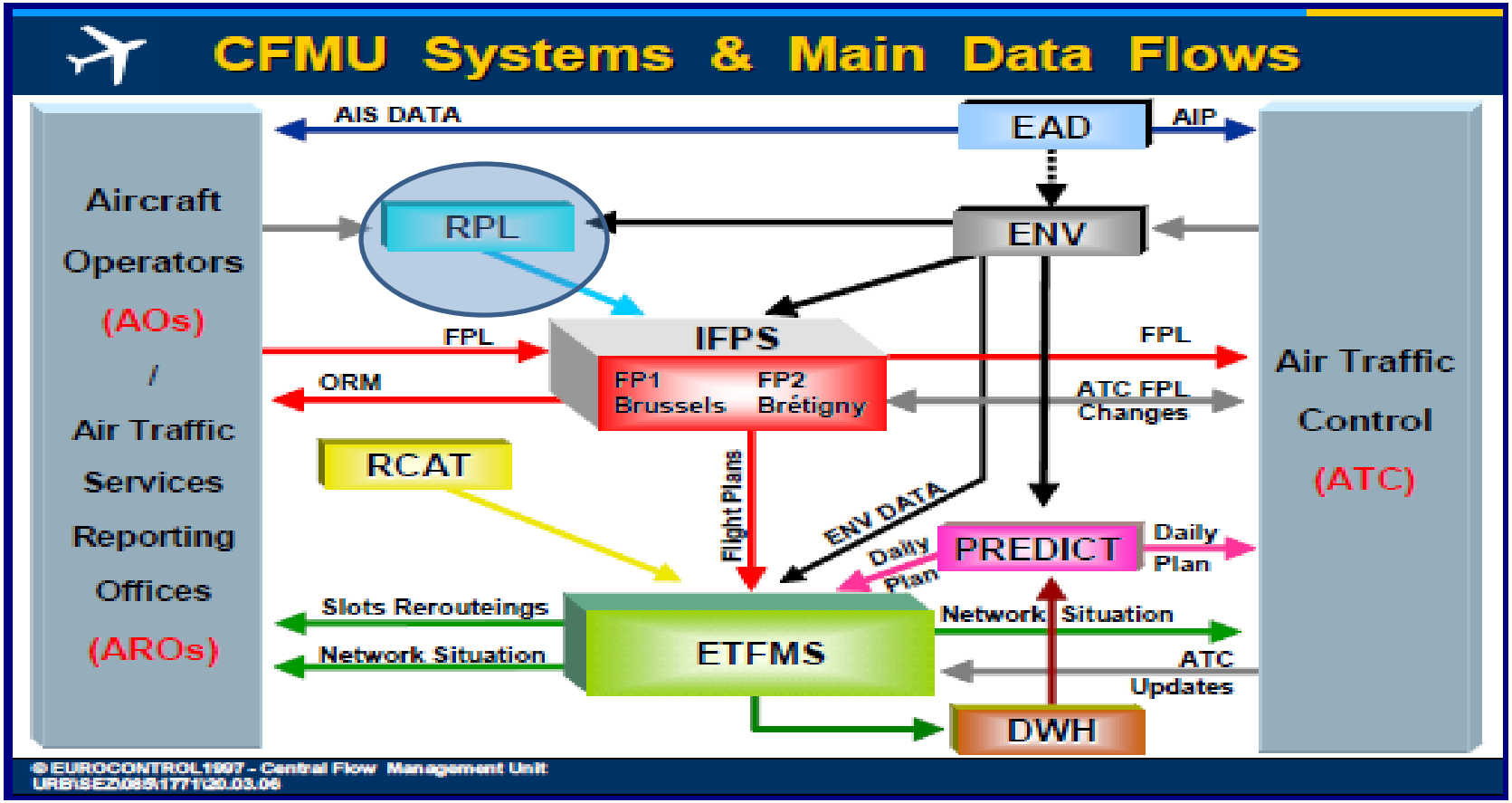
NM systems and data flows



ATS Environment System (CACD) , (former ENV)

- **Provides accurate ATM "environment" data to other NM components.**

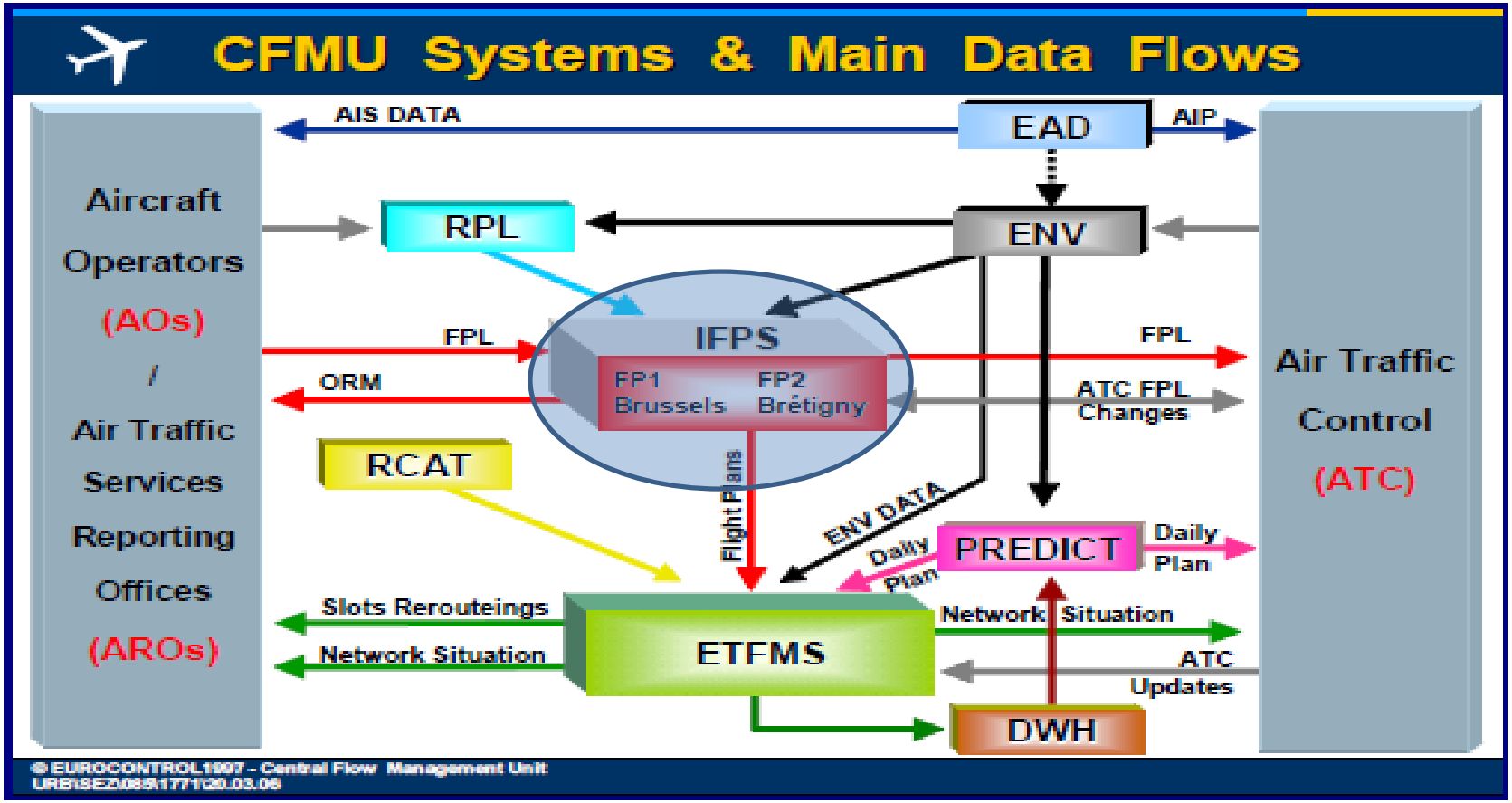
NM systems and data flows



Repetitive Flight Plan System (RPL)

- **Receives, processes and store repetitive flight plans.**

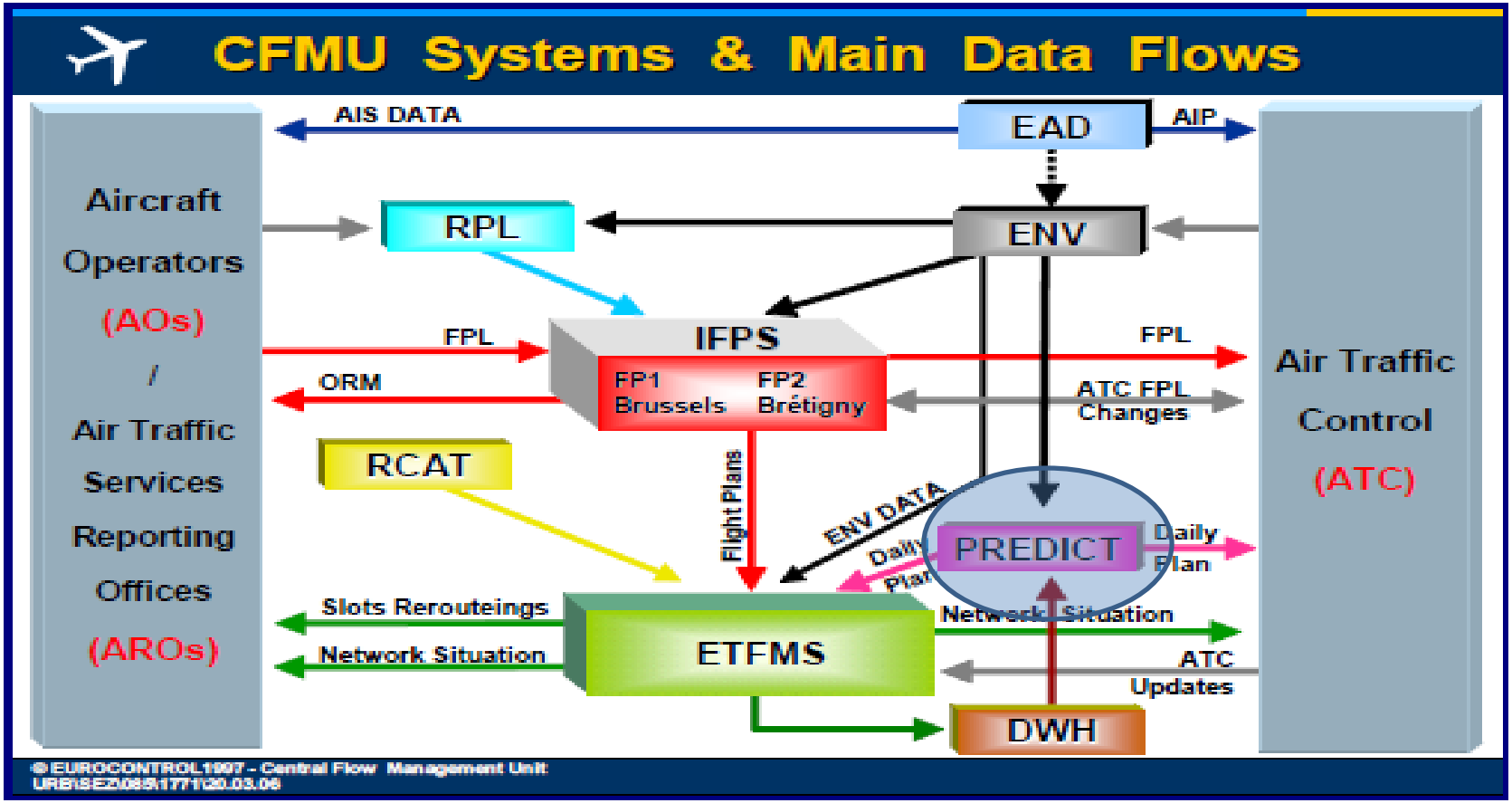
NM systems and data flows



Integrated Flight Plan System (IFPS)

- **Provides a centralised flight planning system for the States**
- **Provides RPL and filed flight plan (FPL) data for ATFCM purposes**

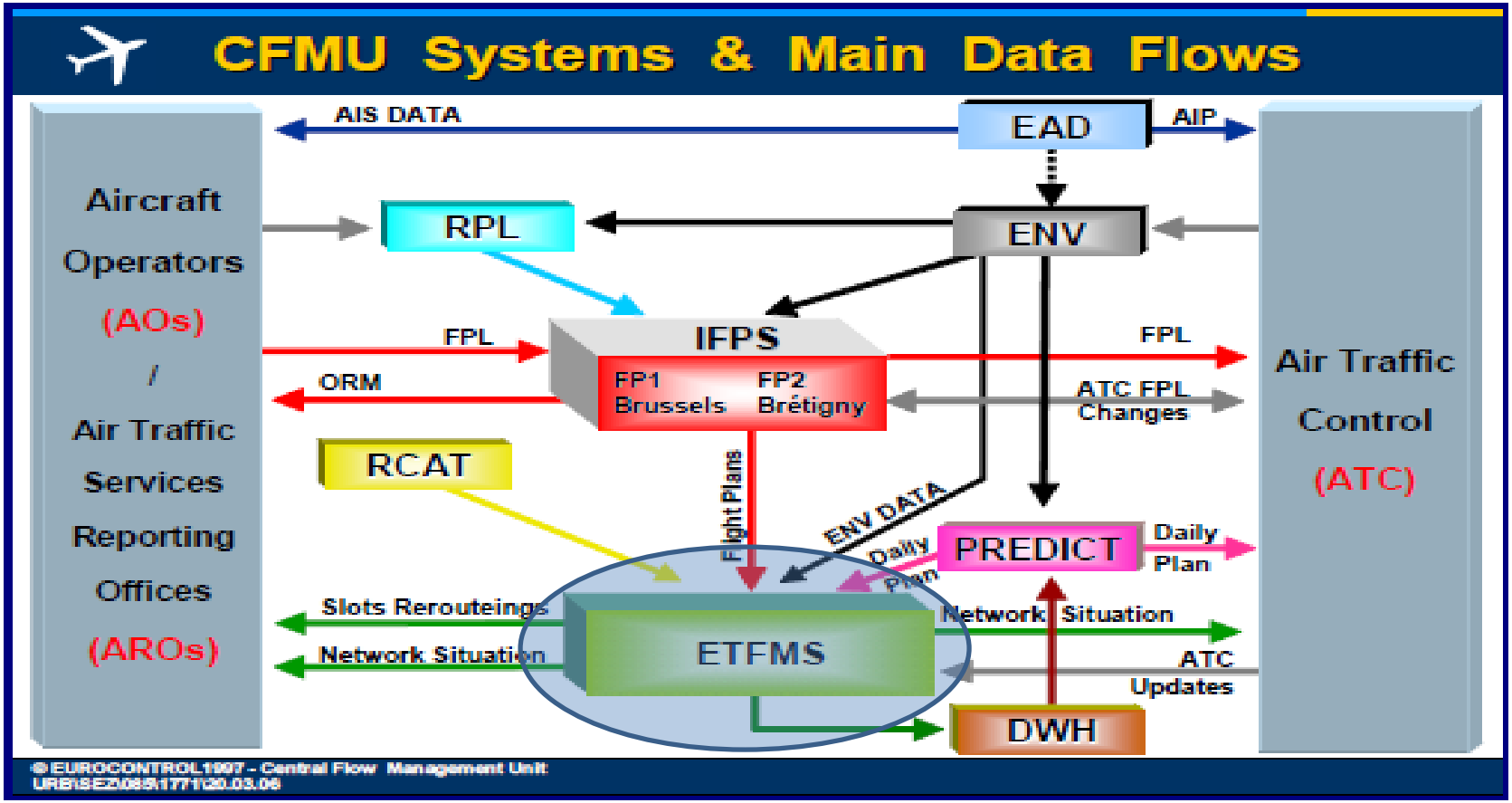
NM systems and data flows



Pre-tactical system (PREDICT)

- **Defines regulation plan during pre-tactical phase**
- **Can test regulations and flow re-routings to assess their impact**

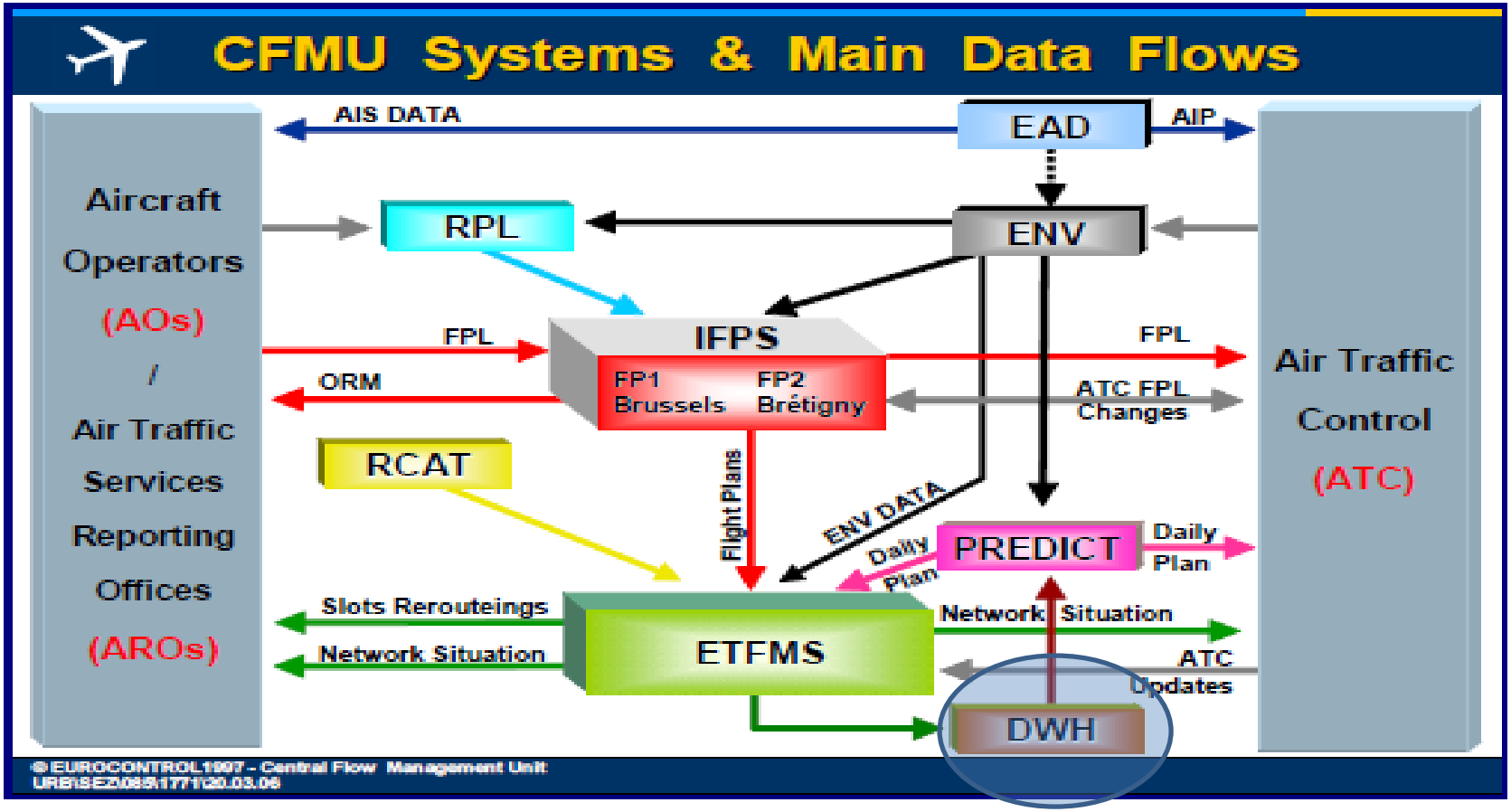
NM systems and data flows



Enhanced Tactical Flow Management System (ETFMS)

- **Presentation of capacity and demand indicators**
- **Provision of the Computer Assisted Slot Allocation (CASA) algorithm**
- **Assessment of re-routings**

NM systems and data flows



Data Warehouse (DWH)

- **Provide an assessment of ATFCM performance by comparing the ATFM plan and actual situation**
- **Provide forecast demand based on historical data**

Thank you!!

Gràcies!!