Overview of Indra's Turnkey ATM Automation System

Operational Air Traffic Management and Simulation Systems

September 2015

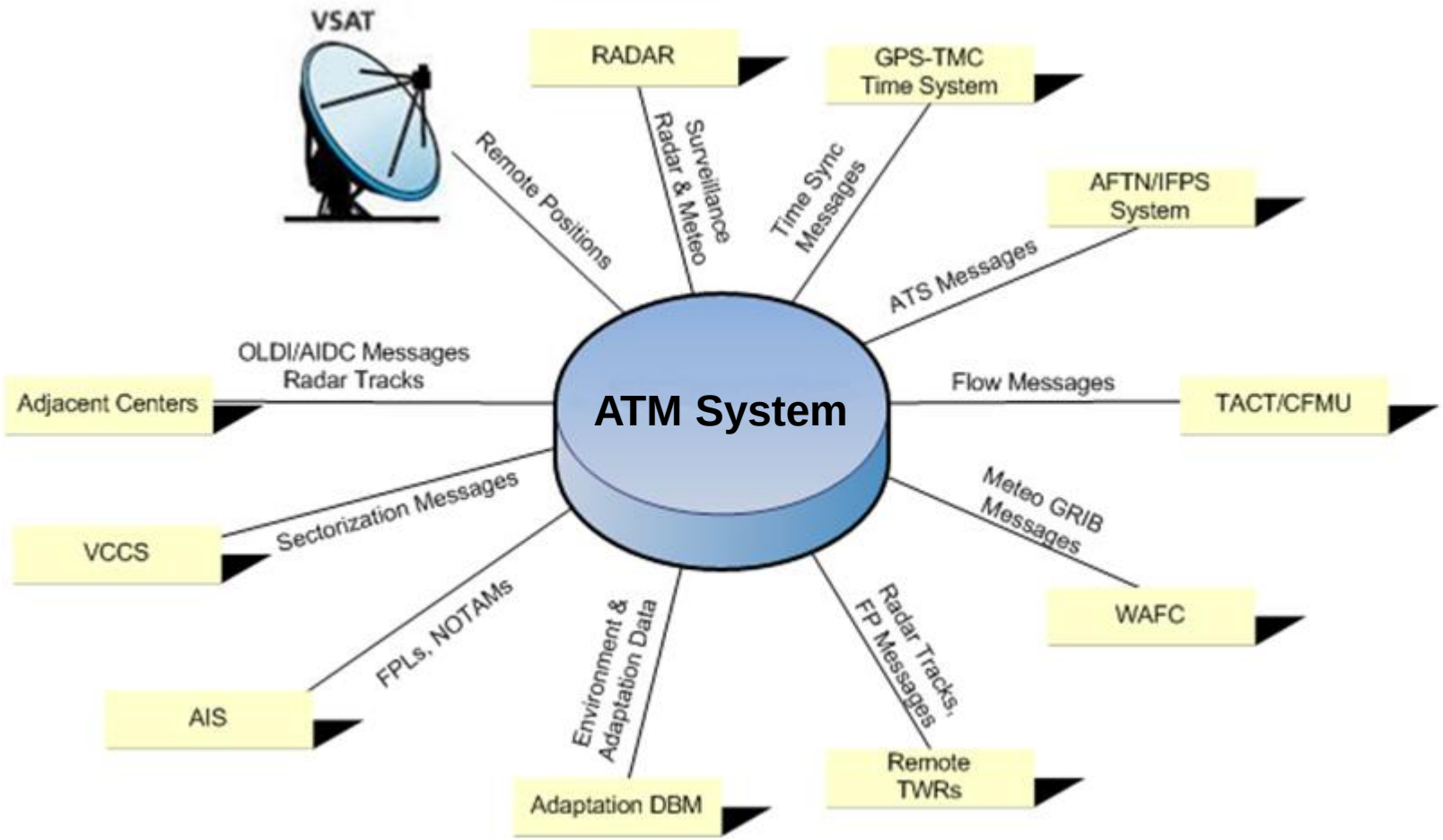
INDEX

WHAT IS INDRA ATM? – SYSTEM MISSION

- To enhance the safety of the flights by providing the controllers with information of air movements from Surveillance Sensors such as Radars, ADS-B, Multilateration Systems (WAM/MLAT) and Weather Data, Planning information such as Flight Plans, Route Availability and Flow Management and communicate control via Voice and Data Link.

- The ATM System is one of the most advanced, safe and reliable automated air traffic control system and in a continuous evolution path.
- Operating in more than 50 countries worldwide, **integrating the latest & most advanced ATC functionalities**.

INTERFACES


VSAT
RADAR
GPS-TMC
Time System
AFTN/IFPS
System
Remote Positions
Surveillance
Radar & Meteo
Time Sync
Messages
ATS Messages
OLDI/AIDC Messages
Radar Tracks
Adjacent Centers
ATM System
Flow Messages
TACT/CFMU
Sectorization Messages
VCCS
Meteo GRIB
Messages
WAFC
FPLs, NOTAMs
AIS
Environment &
Adaptation Data
Radar Tracks,
FP Messages
Adaptation DBM
Remote
TWRs

INDEX

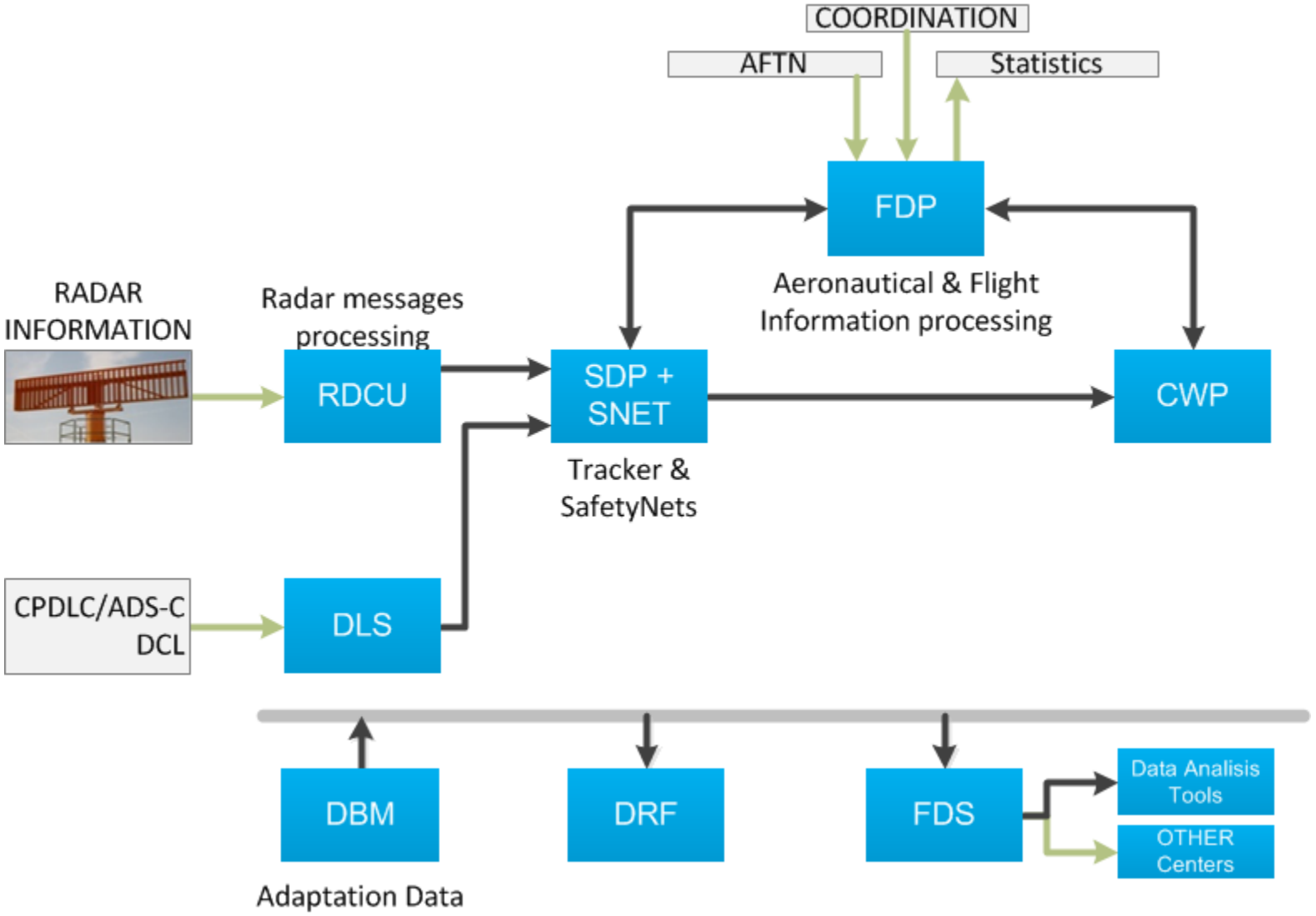
MAIN SUBSYSTEMS (I)

- Radar Data Compressor Unit – RDCU
- Surveillance Data Processor – SDP
- Flight Data Processor – FDP
- Safety Nets, Monitoring Aids & Aircraft Identification Processor – SNET
- Electronic Flight Strips – EFS
- Data Link Server – DLS
- Integrated Controller Working Position – iCWP / SDD
- Control and Monitoring Display – CMD
- Flight Data Display – FDD
- Arrival Manager – AMAN
- Flight Data Service – FDS

MAIN SUBSYSTEMS (II)

- Data Base Management System – DBM
- Data Recording Facility – DRF
- Data Analysis Tool – DAT
- Simulation Facility – SIM
  - Exercise Preparation Position – EPP
  - Session Manager – SM
  - Pseudo-Pilot Positions - PLT
- Redundant Common Time System – CTS
- Contingency Sub-string - CTC

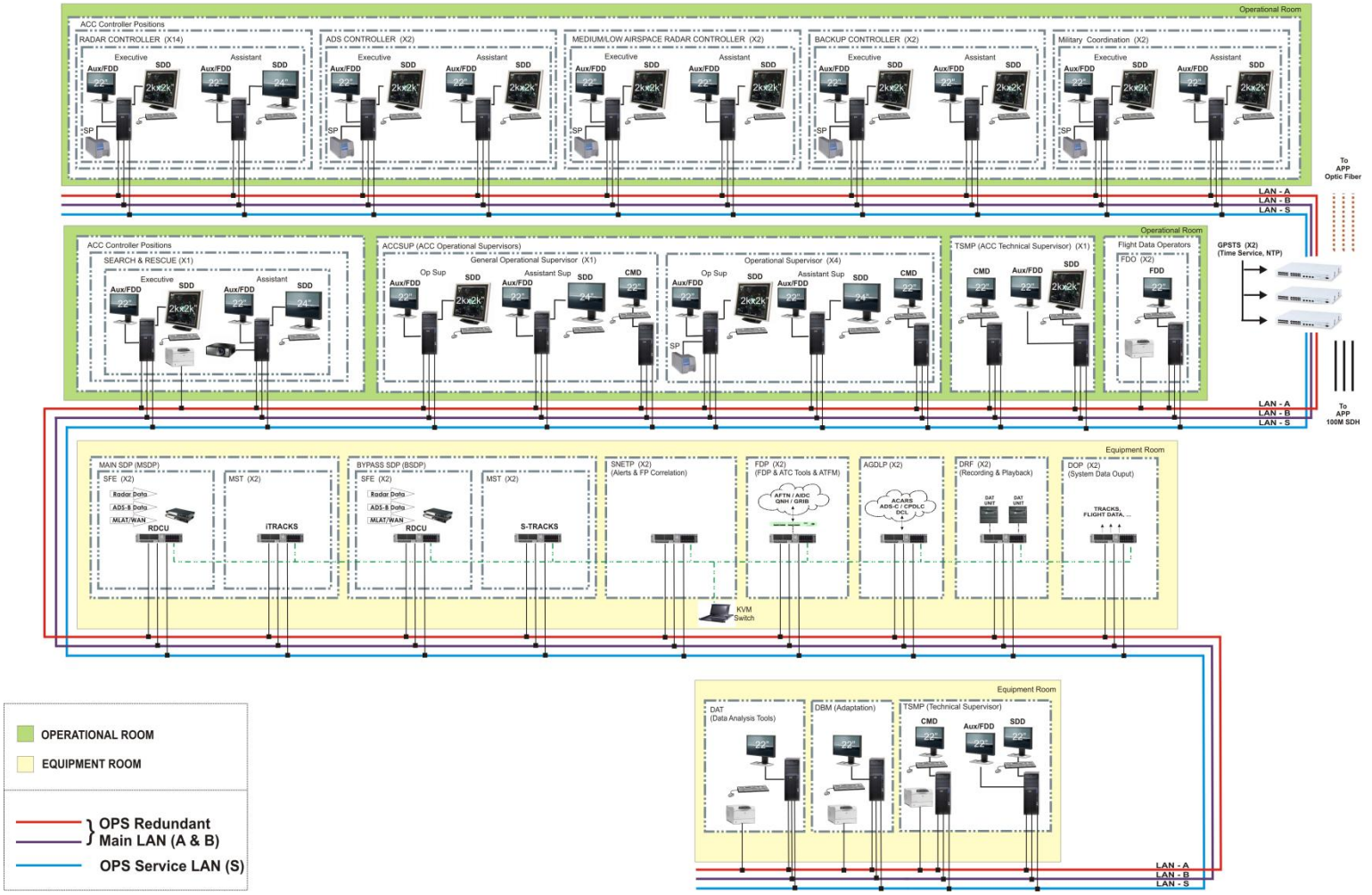
DATA FLOW


COORDINATION
AFTN
Statistics
FDP
Aeronautical & Flight Information processing
RADAR INFORMATION
Radar messages processing
RDCU
SDP + SNET
Tracker & SafetyNets
CWP
CPDLC/ADS-C DCL
DLS
DBM
Adaptation Data
DRF
FDS
Data Analisis Tools
OTHER Centers

CHARACTERISTICS AND BENEFITS

CHARACTERISTICS	BENEFITS
Based on a legacy of successfully delivered systems around the world	▪ Proven system stability and performance ▪ Reduces technical and schedule risks
Open system architecture by complying with open system standards (UNIX, Ethernet, etc)	▪ Avoids premature technological obsolescence ▪ Ensures support longevity at reasonable cost ▪ Provides cost effective growth path
Use of COTS technology from industry leaders	▪ Avoids the need for hardware or software development ▪ Simplifies maintenance and support activities
Scalable design that allow future growth	▪ Simplifies maintenance and logistics activities ▪ Streamlines controller and maintenance training
All mission critical servers are redundant with proven switchover strategy	▪ Provides a highly reliable system ▪ Reduces system downtime by providing redundancy ▪ Simplifies maintenance
Designed to allow evolutionary upgrades and future enhancements	▪ Permits midlife technology insertion without redesign ▪ New functionality can be added cost effectively

EXAMPLE OF INDRA ATM ARCHITECTURE



MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

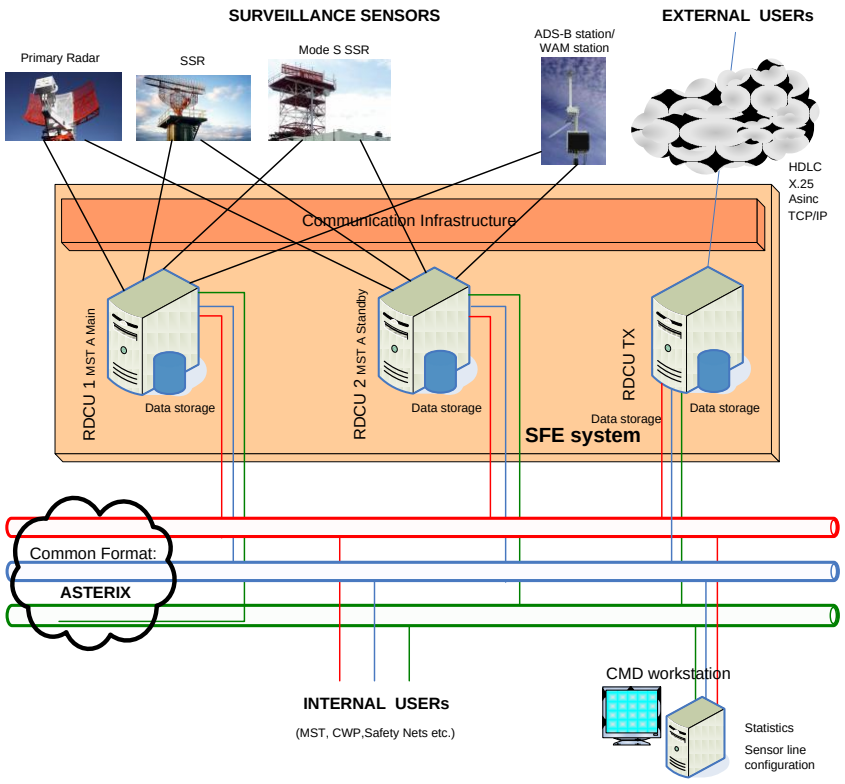
DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

RDCU – RADAR DATA COMPRESSOR UNIT MAIN FUNCTIONS

- Communications front-end for radars, ADS-B stations and MLAT.
- Provides all the functionality for Conversion and Distribution of Radar Messages.
- Validates the radar messages in radar native format.
- Converts external radar formats to ASTERIX common internal format.
- Distributes messages to internal and external users.
- Filtering policies independently configurable for every user.
- Recording of incoming data 24h / 7d.
- Generation of reports and statistics.
- Scalable to any reception and distribution of radar data needs.



RDCU – RADAR PRESENTATION MODES

MULTIRADAR MODE (DEFAULT)

- The CWP displays system tracks (multiradar + ADS) received from SDP

MONORADAR MODE

- The CWP displays monoradar tracks received from the SDP, for a radar site selected by the operator from a set of adapted radar sites.

BYPASS MODE

- The CWP displays the monoradar tracks established and maintained by its own monoradar process (located in the CWP).
- The radar data input is received directly from the RDCU. The By-Pass mode is a fall-back resource and do not provide the following functions:
  - Radar-Flight Plan correlation and associated functions;
  - STCA and RAW alerts;
  - Hand-overs.

All modes may be individually selected by the CWP operator. The By-Pass mode is initiated at all CWPs when both SDPs crash.

MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

SDP – SURVEILLANCE DATA PROCESSING MAIN FUNCTIONS

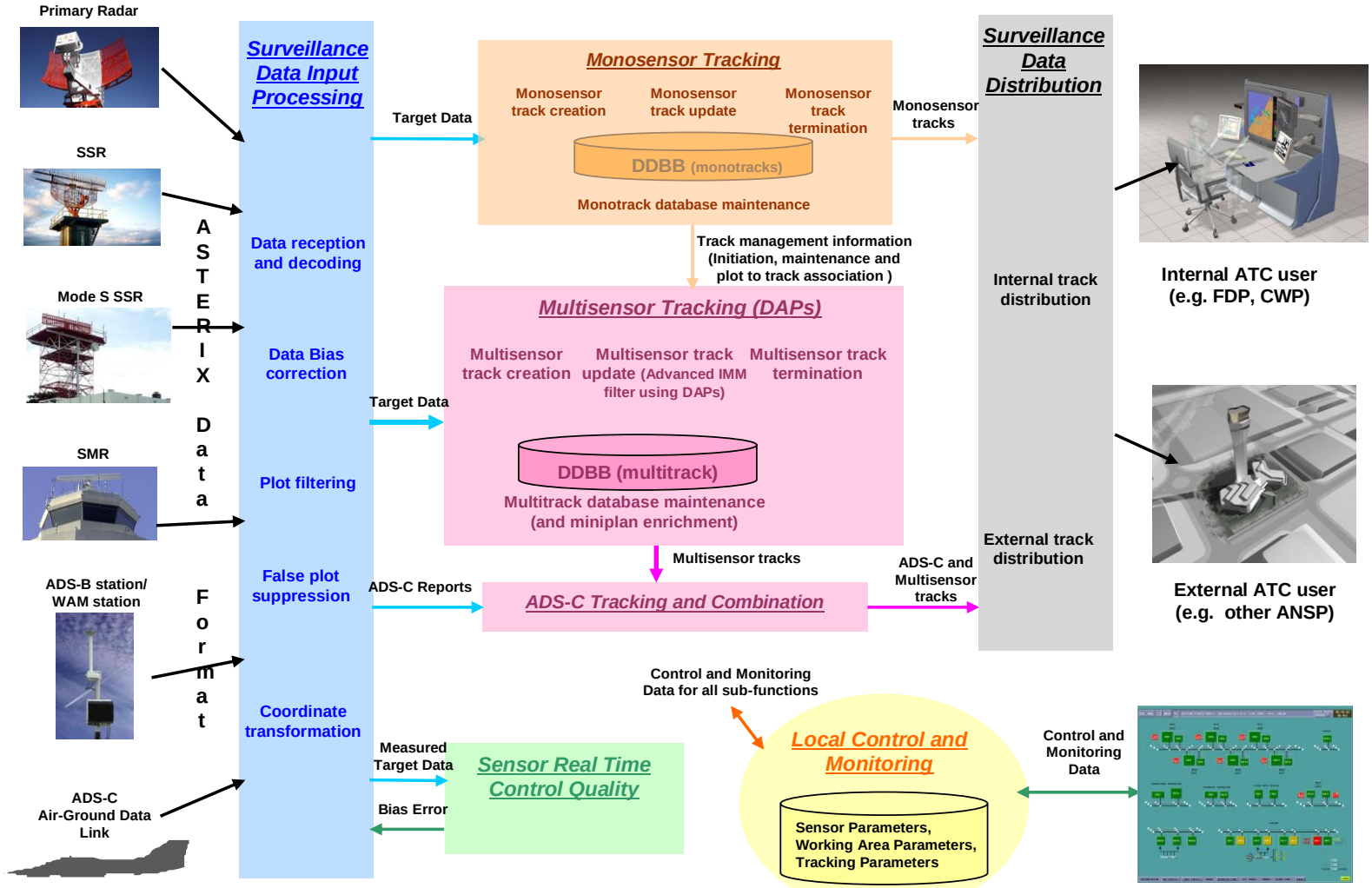
CHARACTERISTICS

- Two different systems dual redundant Primary SDP and a dual redundant Fallback SDP. Running independent and different software.
- Both having been developed independently, by different software teams.
- Both with equivalent functionality and performances.
- Immediate Switchover from Primary SDP to Fallback SDP as well as between Active and Standby within these SDPs and vice versa without any loss/ discontinuity in the air traffic situation picture on the CWPs.

MAIN FUNCTIONS

- Sensor data input processing and Real-time quality control.
- Mono-sensor and Multi-sensor tracking.
- Weather data processing.
- Distribution of System Tracks to internal users.
- Redundancy and fallback.

SDP – SURVEILLANCE TRACKING FUNCTION

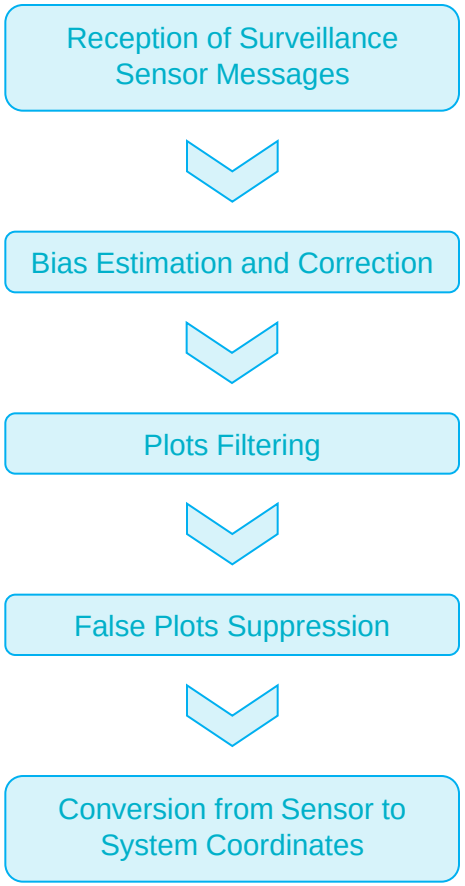


SDP – SENSOR DATA INPUT PROCESSOR (I)

- The SDP receives and processes the following surveillance information:
  - PSR, SSR, SSR Mode S, and PSR/SSR plots and tracks from radar sites.
  - MLAT/WAM reports/tracks from Multi-lateration ground stations.
  - ADS-C reports from FANS-1/A equipped aircraft through the Air-Ground Datalink Processing function.
  - Weather radar information from radar sites with weather detection capability.
  - ADS-B reports and tracks from ADS-B ground stations.
  - Mono-sensor and Multi-sensor tracks from external ATM systems.

SDP – SENSOR DATA INPUT PROCESSOR (II)

- Reception of Surveillance Sensor Messages
- Bias Estimation and Correction
  - Radar Range and Azimuth Error Correction
  - ADS Bias Estimation and Correction
  - ADS Integrity Test
  - MLAT Bias Estimation and Correction
- Plots Filtering
  - Filter Activation and Inhibition
  - Temporal Filter
  - Geographical Filter
  - Saturation Filter
- False Plots Suppression
  - Suppression of SSR Reflections
  - SSR Split
- Removal of duplicate ADS-B reports
- Conversion from Sensor to System Coordinates
  - Slant-Range Correction

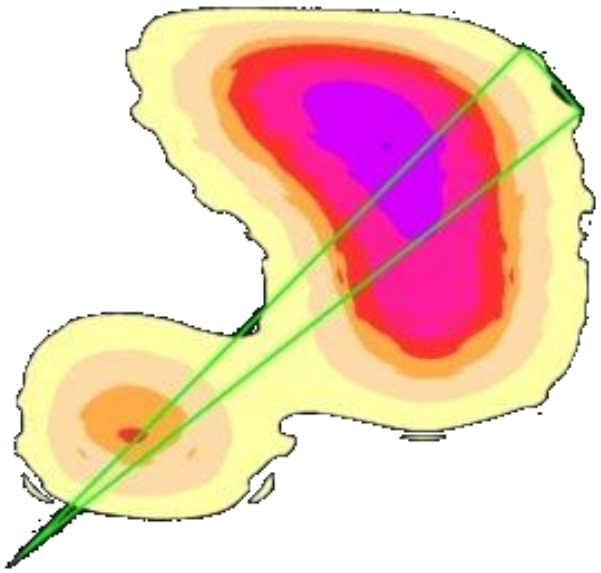


SDP – PSR WEATHER DATA PROCESSING

This function is responsible for:

- Acquiring weather data from the PSR radar source.
- Merging this data into a composite image.
- Converting it into a displayable form and buffering it for release to displays.

A weather image from one radar consists of radial lines of up to eight possible intensity values, representing low or high intensity weather along each radial.



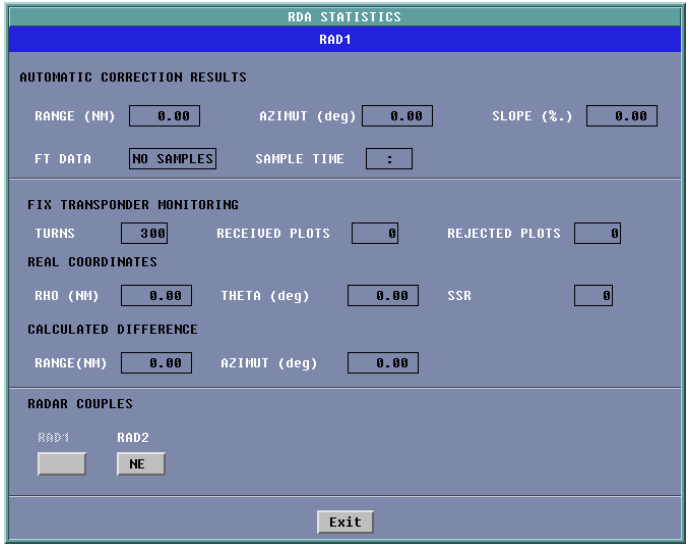
SDP – RADAR REAL TIME QUALITY CONTROL (RTQC)

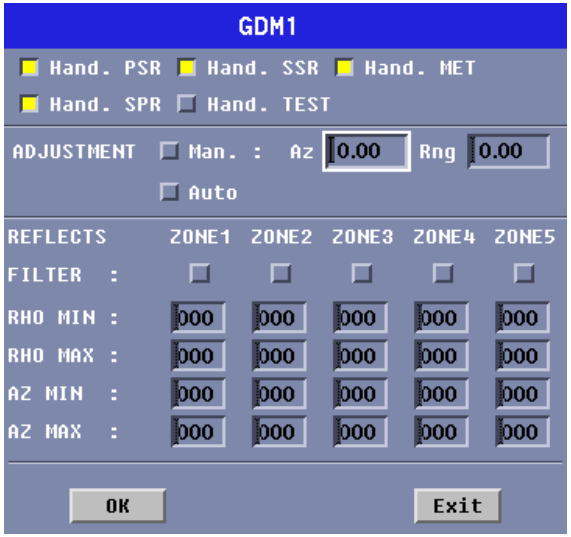
STANDARD FEATURES

- Radar Data Count Monitoring
- Radar Status and Revolution Period Monitoring
- Radar Plot Delay Monitoring
- Test Target and Fixed Transponder Monitoring
- Systematic Radar Errors Estimation
- Radar Error Monitoring and Control

ADDITIONAL (CUSTOMIZED) FEATURES

- Control & Monitoring of Radar Site Characteristics through specific messages





SDP – MULTI-SENSOR TRACKING

- Mono-sensor tracks are used for the initiation of multi-sensor tracks and for the updating of multi-sensor tracks items, excepting the multi-sensor state vector.

- When a target plot is associated to a mono-sensor track which is associated to a multi-sensor track, it is sent to multi-sensor vertical and horizontal filters to update the state vector (time of information, horizontal position, speed, heading, transversal and longitudinal intentionality, altitude, rate of climb/descent and vertical intentionality) of its multi-sensor track.

- For horizontal multi-sensor tracking, two tracking filters are implemented:

  1. Interacting Multiple Model (IMM) algorithm that comprises four Kalman filters (uses only position data)
  2. Kalman Filter with control input, which exploits the additional information (mainly kinematics), if available, provided by Downlink Aircraft Parameters (DAPs):

Magnetic heading.
Indicated airspeed and Mach number.
Selected altitude.
Track angle rate.

Vertical rate.
Roll angle.
Ground speed.
True track angle.

SDP – SSR MODE-S/ADS-B DAP DATA

This function is responsible for acquiring Mode-S data from the SSR Mode-S Enhanced radar source along with ADS-B DAPs.

The iCWPs shall be capable of displaying for the controllers the following information:

- Aircraft Address (233233)
- Selected Altitude (240)
- Heading (-176)
- IAS (357)
- Match (M83 :100 Match)
- TAS (500)
- Ground Speed (500)
- Inertial Vertical Velocity (feet/min) (0)
- Barometric Vertical Velocity (feet/min) (0)
- Track Angle rate (degrees/second) (0)
- Roll Angle (-90º <-> 90º) (0)
- True Track Angle (degrees) (-178)

These parameters shall be displayed as an extension to classical data block on demand.

MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

FDP – FLIGHT DATA PROCESSING. SUMMARY (I)

- Reception and processing of AFTN/AMHS/ADEXP messages.
- Validation and processing of flight plans entered from the AFTN/AMHS/IFPS or from the controller workstations.
- Management of flight plan (FPL) database and support of operator's actions.
- Analysis of flight plan routes and calculation of flight trajectory and estimated times.
- Assignment of SSR codes (domestic flights) – (ORCAM), SID and STAR procedures.
- Distribution of flight plans to the EFS, controller workstation, strip printers and adjacent ATC centres.
- Handoff management.
- Inter-centres coordination (OLDI, AIDC).
- Management of the SFPL and RPL databases.

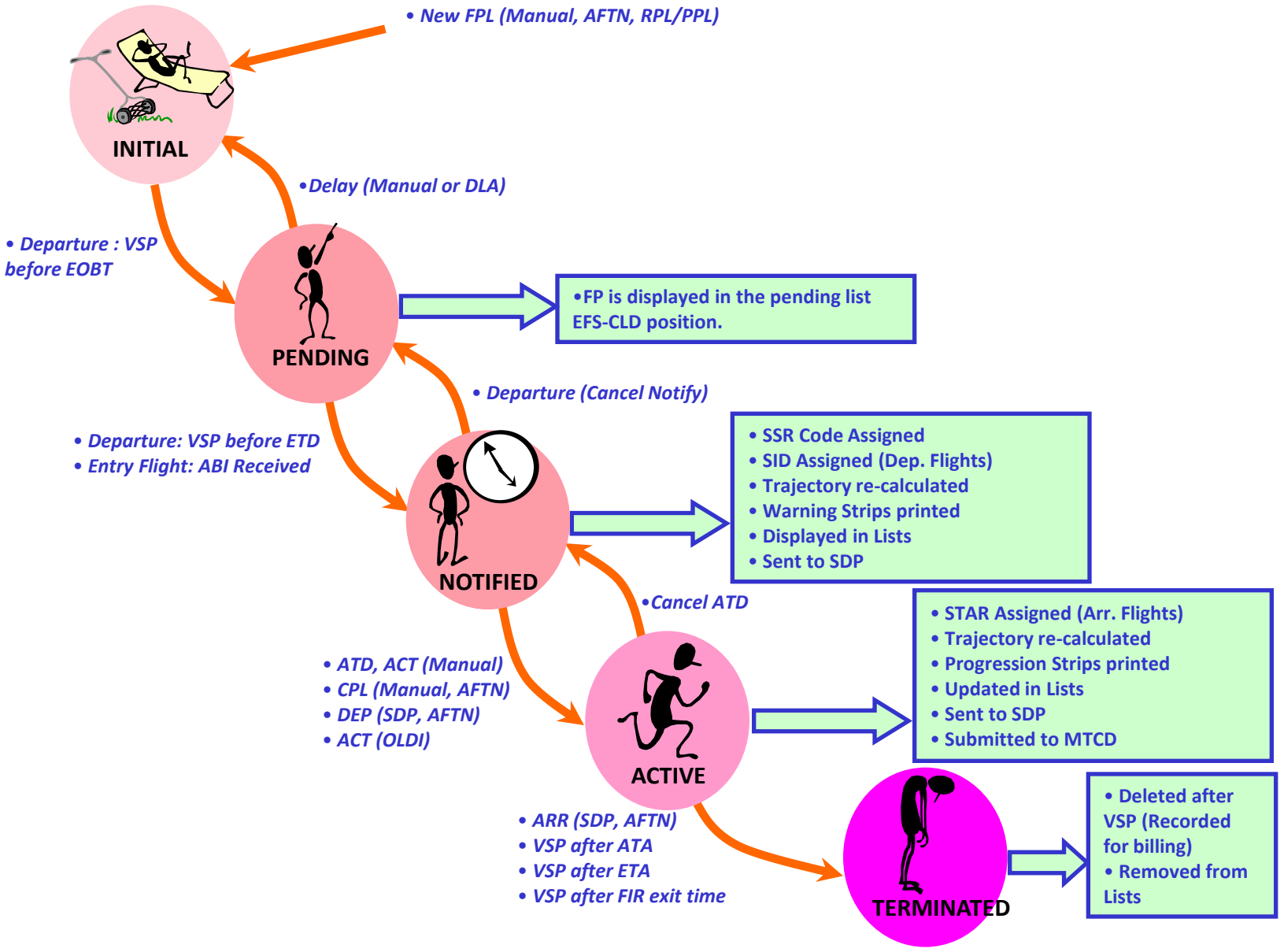
FDP – FLIGHT DATA PROCESSING. SUMMARY (II)

- Issue and transmission of AFTN messages.
- Update of flight plan estimates with information provided by the Radar Data Processing.
- FDP Fallback – Autonomous mode in the iCWP
- Support to ATC tools
  - Detection and identification of potential conflicts in standard separations of flight plans: Medium Term Conflict Detection (MTCD).
  - Forecasting of potential intrusion into restricted areas.
- Air Traffic Flow Management - Flow Planning, Flow Statistics, Arrival Manager.
- Meteorological and Aeronautical Information management.
- Recording of flight plans for further use in billing calculation and statistics.

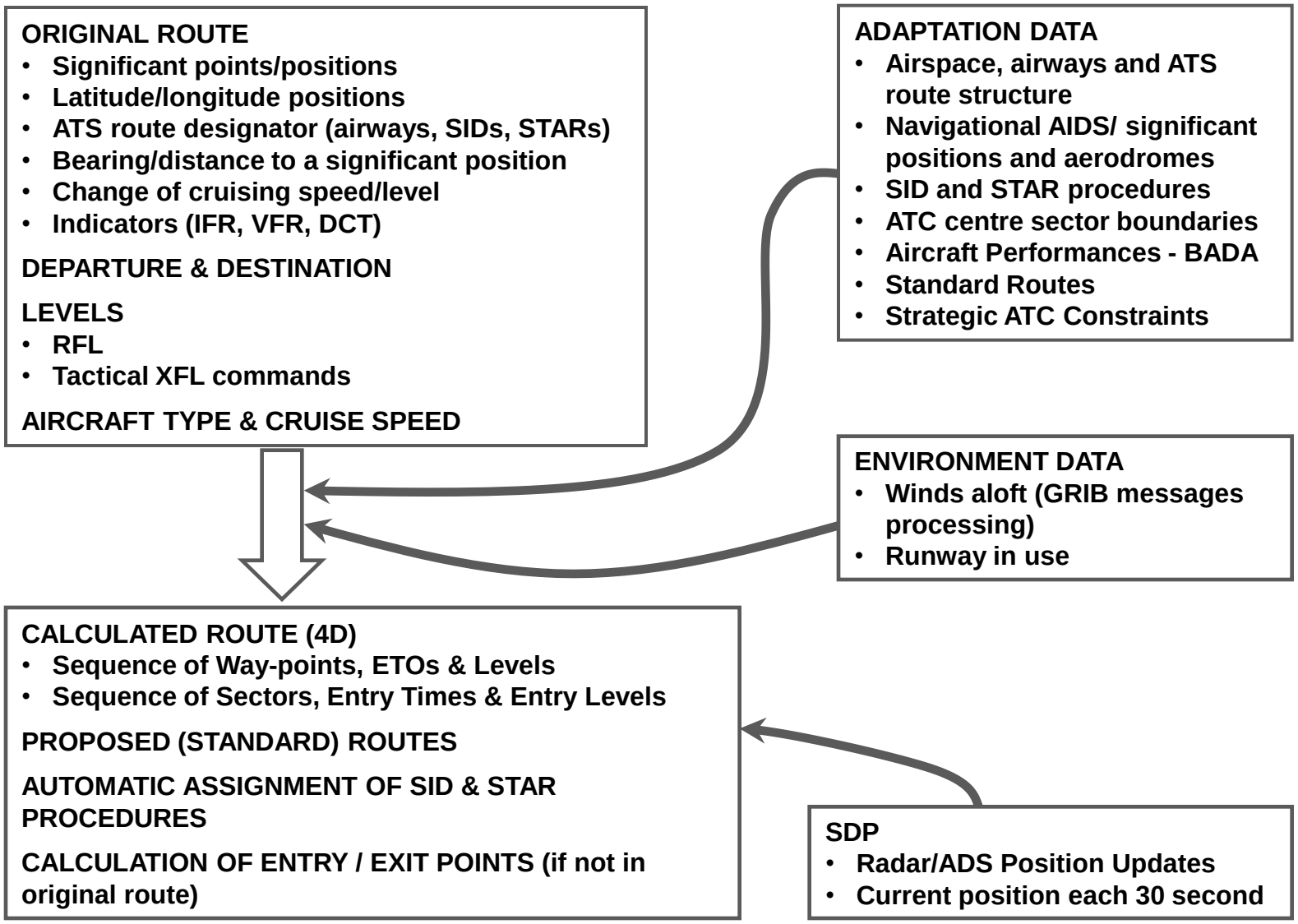
FDP – FLIGHT DATA PROCESSING. SUMMARY (III)

- Validation and processing of NOTAMs entered from the AFTN or from selected workstations.
- Management of restricted areas.
- Management of Flow restrictions and slots, with processing of TACT messages (SAM, SRM, SLC) (for EUROCONTOL member countries)
- Identification of flight plans as “RVSM equipped flight”, “8.33 equipped flight”, RNAV capable flight”, “RNP capable flight”, “Data Link equipped flight.
- PIP navigation window to display pictures, maps, etc. between working positions (via Intranet).

FDP – FLIGHT PLAN STATES

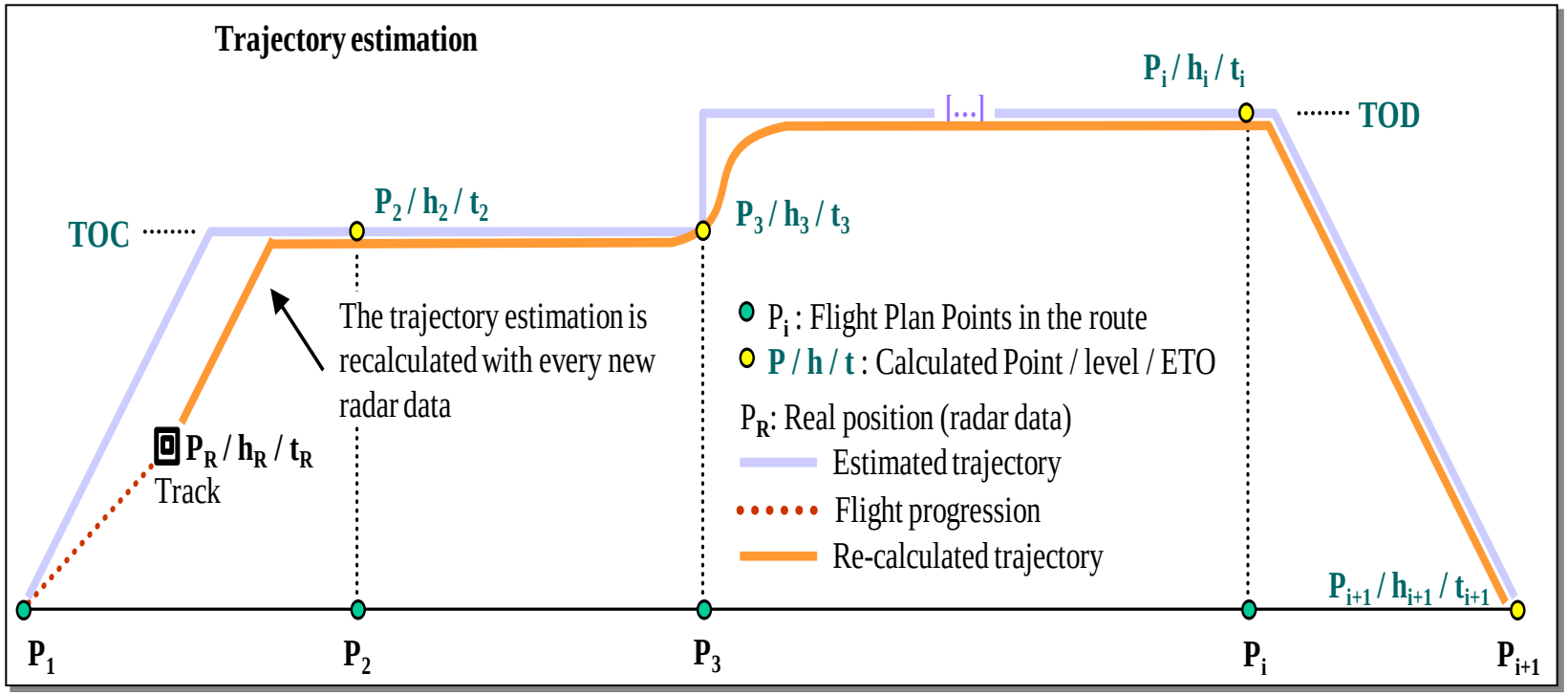


FDP – TRAJECTORY CALCULATION (I)



FDP – TRAJECTORY CALCULATION (II)

- Each sample comprises:
  - **State information:** 3D position, Time, Distance, Ground Speed, TAS, Mach, Heading, Track.
  - **Point characteristics:** Constraint, Top of Climb, Top of Descent, Speed Change.



FDP – ATC TOOLS (I)

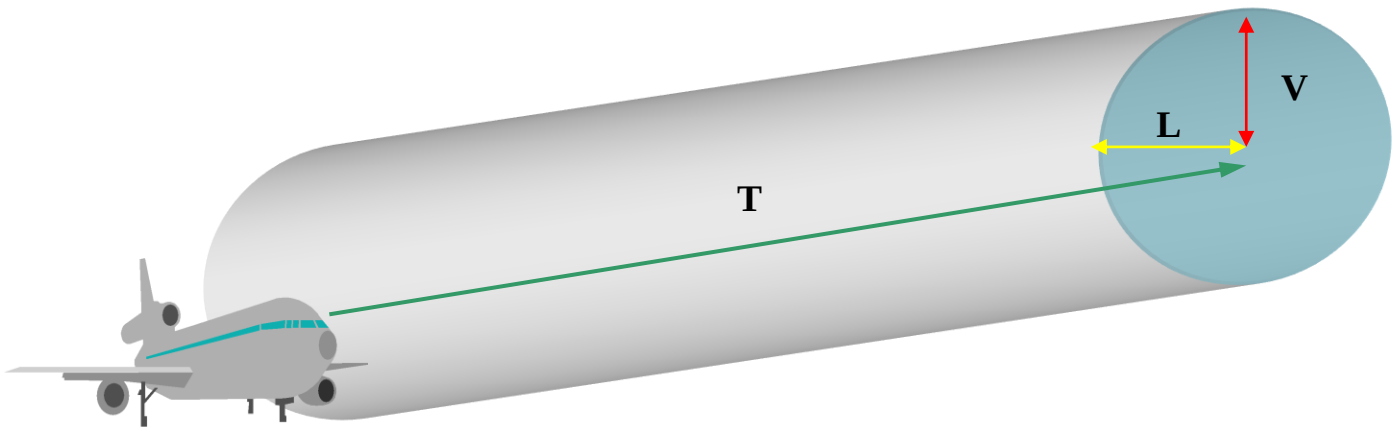
FDP Supports the operation of the controller providing the following Air Traffic Controller Tools:

- **Medium-Term Conflict Detection (MTCD):** Automatic Flight Plan conflict detection and identification of potential conflicts for Flight Plans in standard separations (Medium Term Conflict Detection, MTCD) and in reduced vertical separations (RVSM MTCD) based on latest Flight Plan information.
- **Restricted Area Warning (RAW):** Automatic detection and identification medium term warning of potential incursion in restricted area based on latest Flight Plan information.
- **Conformance Monitoring (CMON):** monitor the Flight Plans tracking and the Flight Plan route to advice in case of deviation from their planned route or clearance, and keeping updated the trajectories with the progress of the flights:
  - Route Adherence Monitoring (RAM)
  - Cleared Level Adherence Monitoring (CLAM)
  - Heading Alert
  - SSR Code Conformance
- **Conflict Probe:** allow testing possible conflicts in advance

FDP – ATC TOOLS (II)
MEDIUM TERM CONFLICT DETECTION (I)

SAFETY VOLUME

- The function considers each eligible flight plan surrounded by a safety volume (corridor)

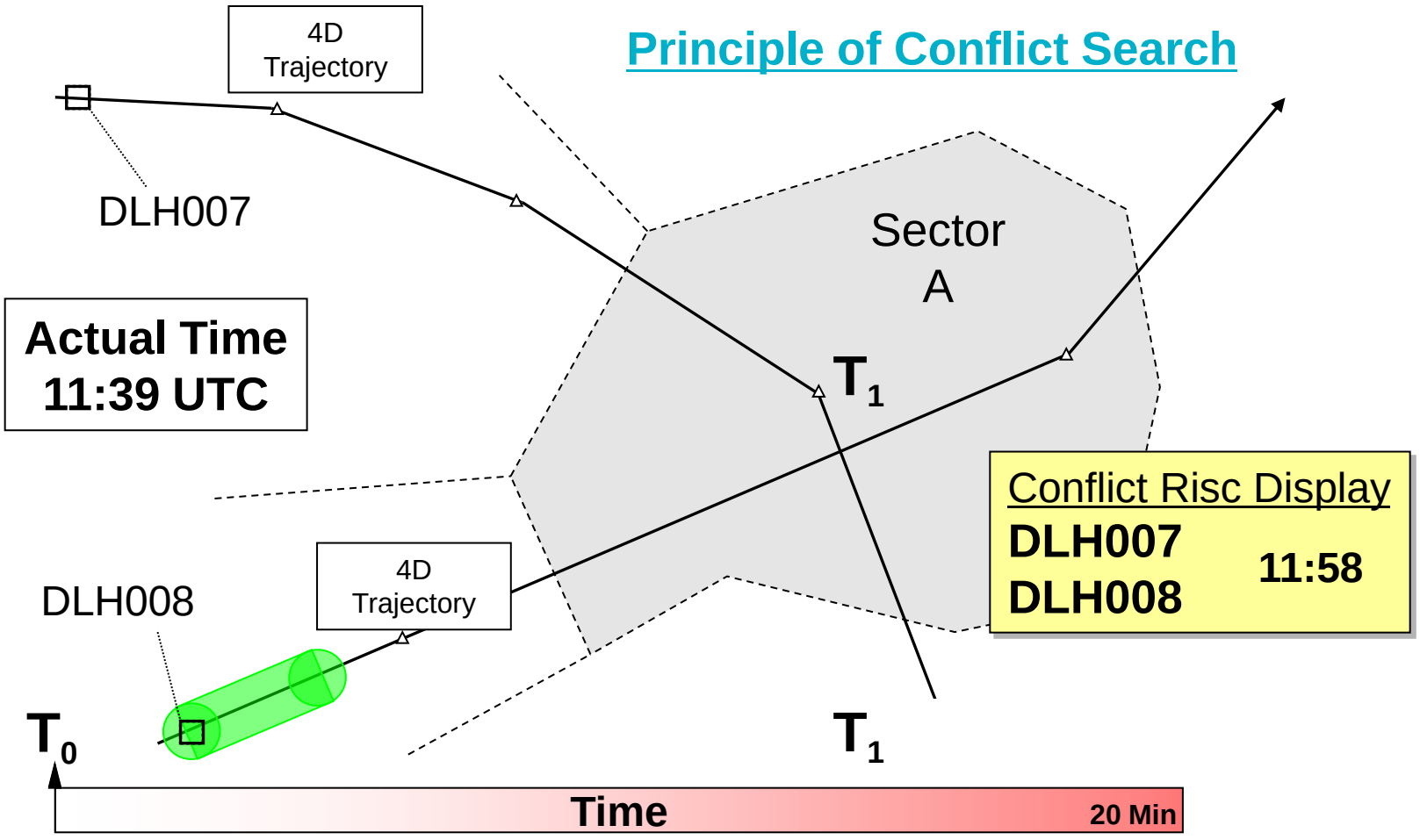


V: Vertical separation (hundreds of feet)

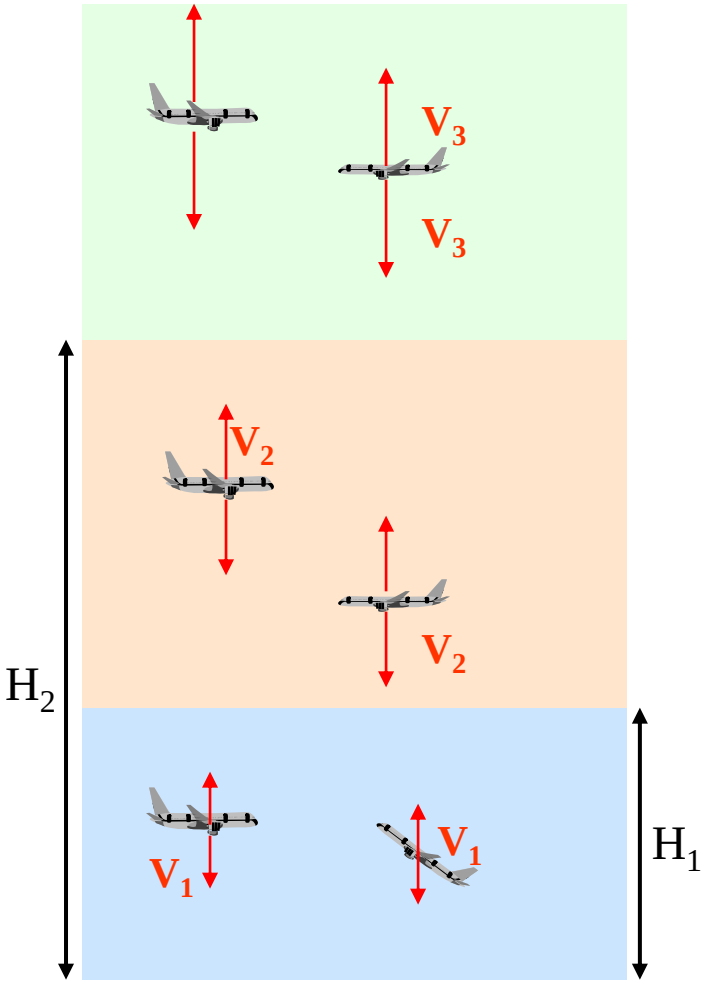
L: Lateral separation (NM)

T: Longitudinal separation (minutes)

FDP – ATC TOOLS (III)
MEDIUM TERM CONFLICT DETECTION (II)



FDP – ATC TOOLS (IV)
MEDIUM TERM CONFLICT DETECTION (III)



VERTICAL SEPARATION

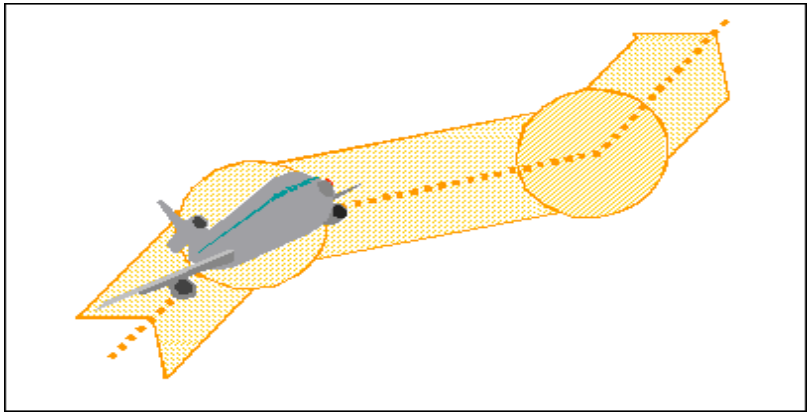
- Three layers can be defined with different vertical separation criteria.
- Layers limits (H1, H2) and Vertical Separations (V1, V2, V3) are VSP.
- A different set of separation criteria can be defined for RVSM flights.

FDP – ATC TOOLS (V)
CONFORMANCE MONITORING – CMON (I)

- Monitors the Flight Plans tracking and the Flight Plan route to advice in case of deviation from their planned route or clearance.
- Updates the trajectories with the progress of the flights.
- Uses the flight plans tracking performed using information from Surveillance data Processing (PSR, SSR, Mode-S SSR, ADS-B, ADS-C, MLAT) trajectory prediction, CMON configuration parameters (VSP) and Flight Data Processing to monitor the conformance and trajectory prediction in order to generate alerts.

Route Conformance and Adherence Monitoring (RAM)

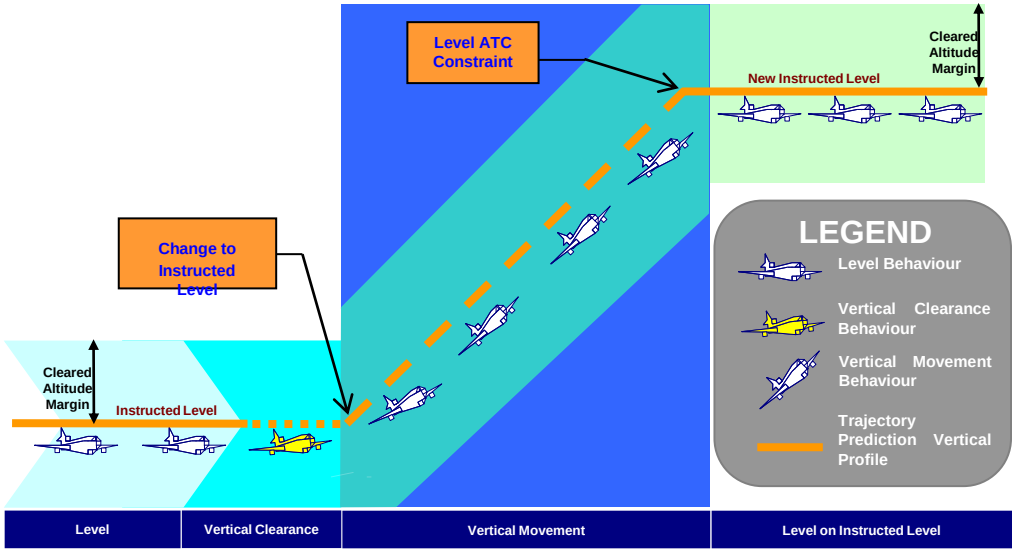
- Estimated time over fix monitoring (longitudinal conformance).
- Positional route monitoring (lateral conformance).
- Vertical profile monitoring (vertical conformance).



FDP – ATC TOOLS (VI)
CONFORMANCE MONITORING – CMON (II)

Cleared Level Adherence Monitoring (CLAM)

- Conformance of actual flight level (Mode C) with last assigned level (CFL).



Heading Alert analyzes the conformance of the actual track heading against the latest heading assigned by the controller.

SSR Code conformance alerts Controllers when the correlation between the track and the Flight Plan is maintained by means of a different SSR code with respect to the current SSR code established in the Flight Plan correlated with the track.

FDP – ATC TOOLS (VII)
RESTRICTED AREA WARNING – RAW

The Restricted Area Warning (RAW) function represents the aircraft to airspace encounters in the medium term detection and performing the automatic detection and identification medium term warning of potential incursion in restricted or reserved area based on latest Flight Plan information.

Warnings to the controller will be provided in two phases:

Phase 1

During the creation or modification of a Flight Plan its route is checked against all configured airspace restrictions. As a result of this test, areas traversed by the route shall be presented to the FP entering position in tabular form with an indication of the route segments affected by these areas.

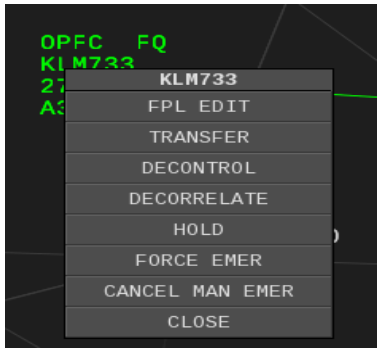
Phase 2

Warnings are provided to be displayed in its track label when a Flight Plan is detected to pass through a restricted area created statically or dynamically by the Airspace Management (ASM) in the Flight Data Display.

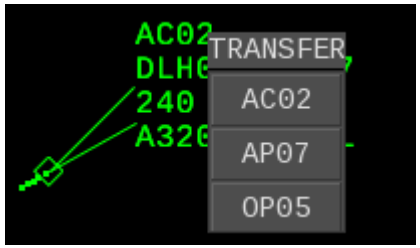
FDP – COORDINATION: INTERNAL COORDINATION

- Coordination process transparent for controllers.
- Remarked with colours in track label:
  - In Controlled position: marked with **ORANGE** colour.
  - In Future position: marked with **RED** colour.

Transfer to next sector in route:

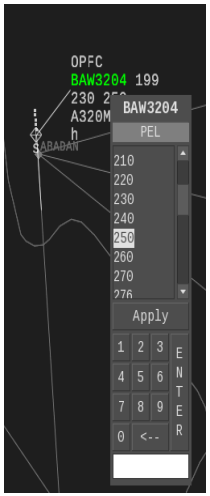


Transfer to any sector:



Request of Frequency:

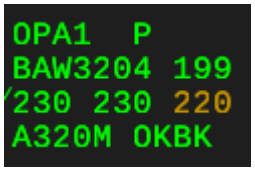
1: Transfer level request



Request of Transfer Level:

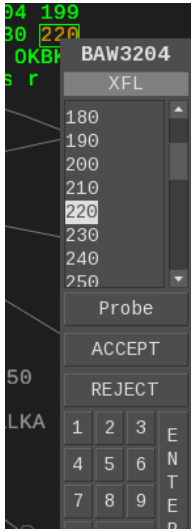
2: Colours in track label

Controlled position



Future position

3: Negotiation process

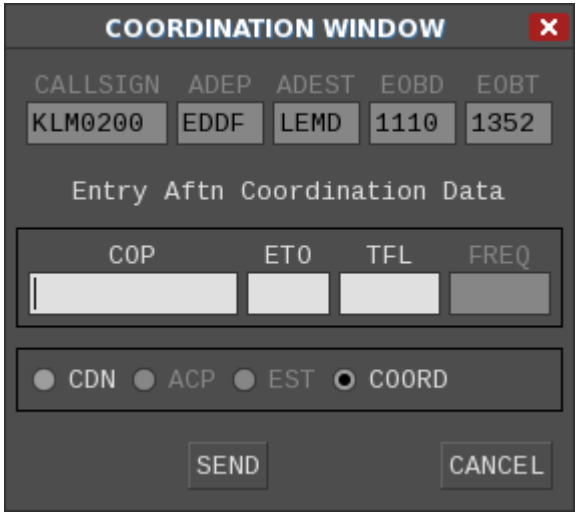


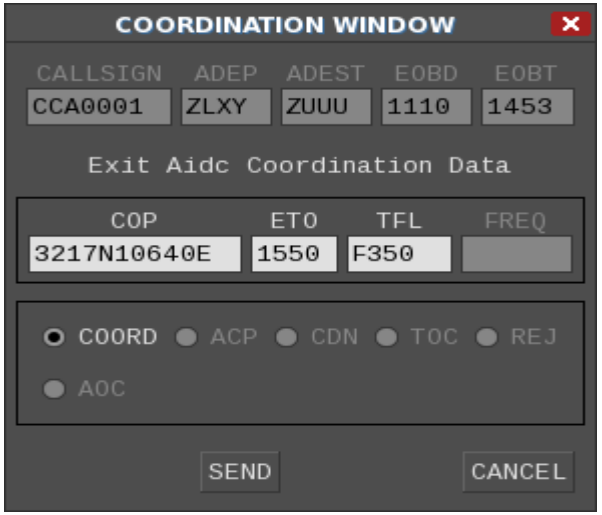
FDP – COORDINATION: EXTERNAL COORDINATION

- Coordination process transparent for controllers. Supported both AFTN and OLDI/AIDC coordination with external centres.

- Automatic Windows for external entry/ exit pending coordination dialogue.

- Windows for manual Coordination process accessible from flight plan lists.





FDP – AFTN & IFPS RECEPTION AND PROCESSING

AFTN HEADER PROCESSING

- Low level processing of the AFTN protocol, ensuring the integrity of the received and transmitted information in the event of malfunctioning of the communication link (SVC messages)

AFTN/ ADEXP TEXT PROCESSING

- Automatic processing with fields extraction of messages FPL/IFPL, CPL, CHG/ICHG, DLA/IDLA, CNL/ICNL, ARR/IARR, EST, DEP/IDEP, ACP, CDN, APR, RQP/RQS/IRQS, SPL/ISPL updating the Flight Plan Database
- Erroneous messages queued to operator for correction
- NOTAM messages (NOTAMN, NOTAMR, NOTAMC) queued to operator for confirmation
- MET messages (METAR, SPECI, TAF, SIGMET, AIRMET, GAMET, SNOWTAM, ASHTAM) update MET database

OTHER EXTERNAL SOURCES

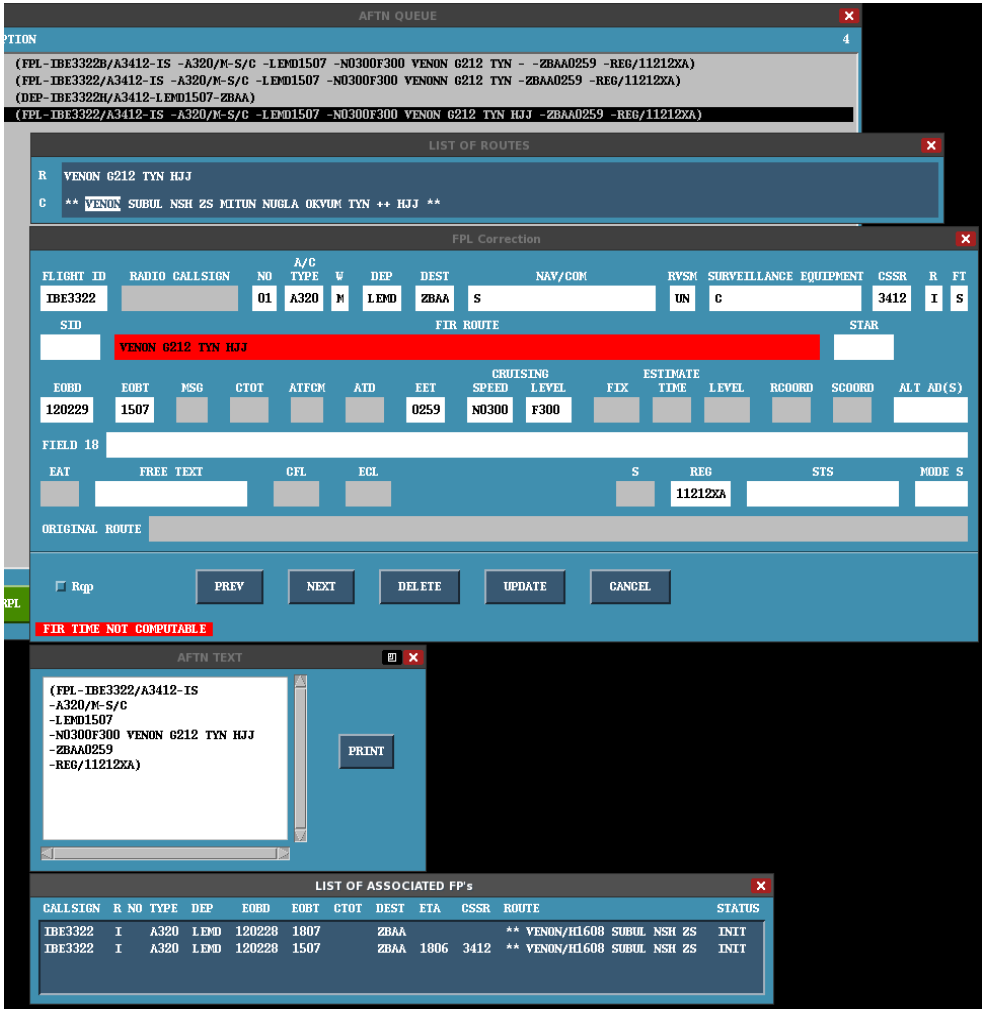
- TACT, OLDI and AIDC messages

FDP – MESSAGE QUEUES

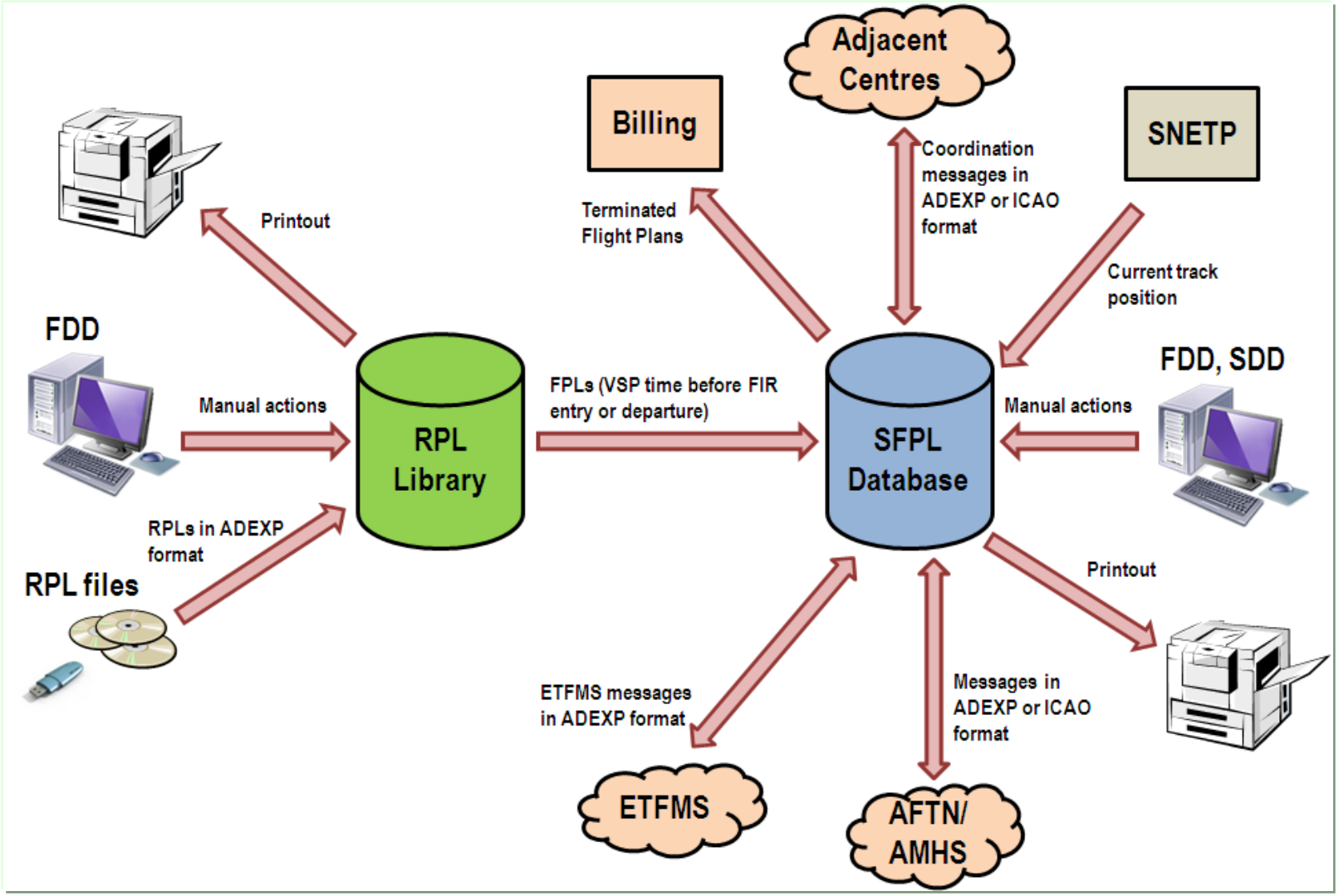
- FDD Queues (displayed depending on the selected role):

- **ALR**: AFTN/AMHS flight plan related messages with priority SS
- **AFTN**: AFTN/AMHS flight plan related messages without priority SS
- **COOR**: Coordination messages
- **EAH**: Messages with erroneous content in their heading

- Option to filter by sector (AFTN and COOR queues)

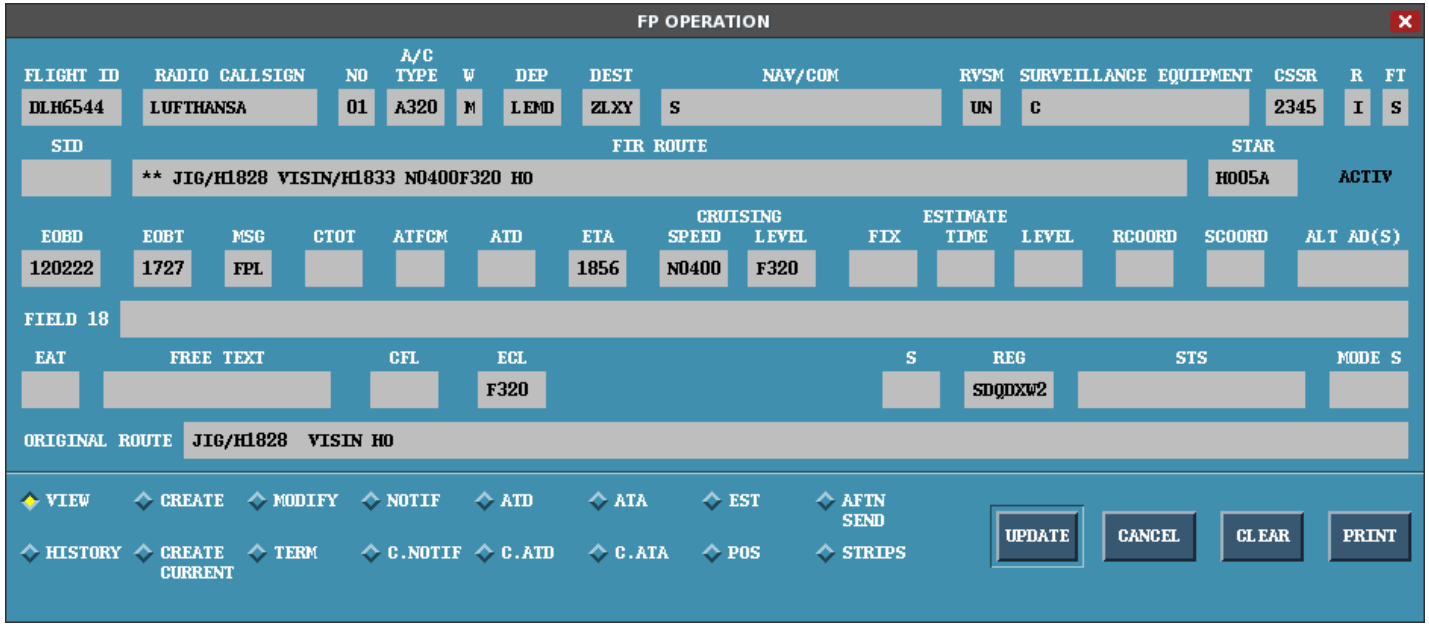


FDP – FLIGHT PLAN DATABASES



FDP/FDD – FLIGHT PLAN OPERATION WINDOW

- Template to perform actions on flight plan fields.
- Available both in controller iCWP, and assistant controller FDD positions.
- Automatic detection and display of any erroneous input, and display of auxiliary help windows for errors in FIR route field:
  - Valid routes (Suggested and Standard ones);
  - Restricted areas intrusion.

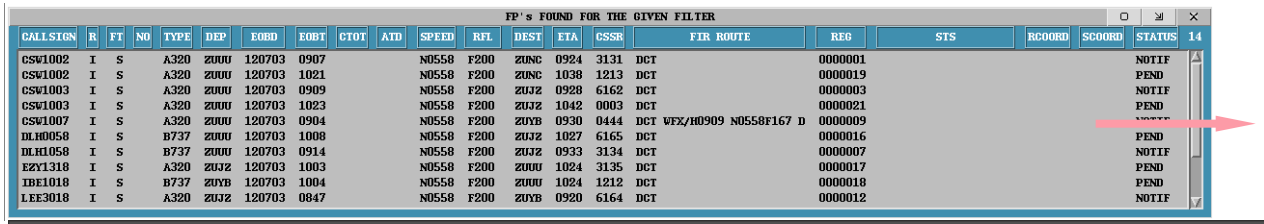


FDP/FDD – FLIGHT PLAN VALIDATION

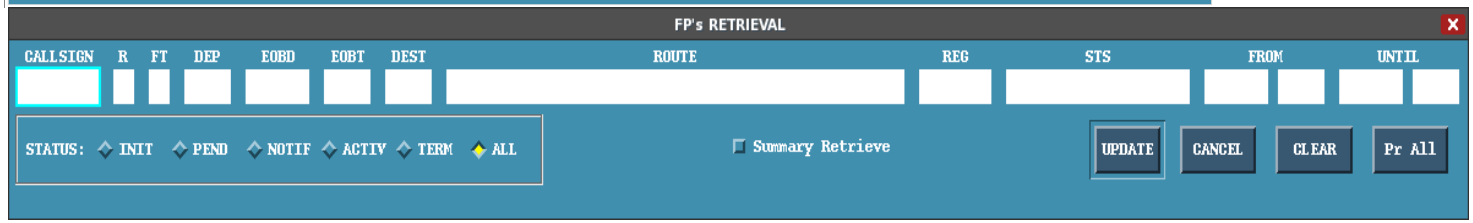
- All Flight Plans, entered manually or from AFTN are checked for:
  - The five key fields: Callsign, Origin, EOBD, EOBT, Destination
  - Format errors
  - Syntax errors
  - Previous receipt of the same flight plan
  - Compatibility, with respect to conformance according to the aircraft type, speed, flight level/altitude, EET, departure aerodrome, route within the defined route system and destination
  - Compatibility between the action on the flight plan and its state
  - Validity time
  - RVSM capability versus Airspace requirements
  - Identification of flight plans as “8,33 equipped flight”, “RNAV capable flight”, “RNP capable flight”, “Data Link equipped flight”
  - Compatible with new ICAO 2012 Flight Plan and previous formats
- Validity checks conform to ICAO regulations
- Any error detected during the validity checks will be highlighted to the control position where the data are entered. Along with the highlighted field, a message will report the type of error.

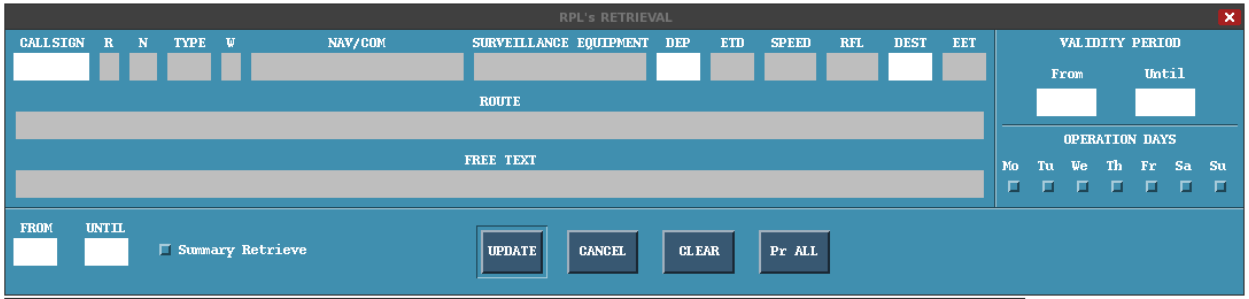
FDP/FDD – MULTIPLE RETRIEVE

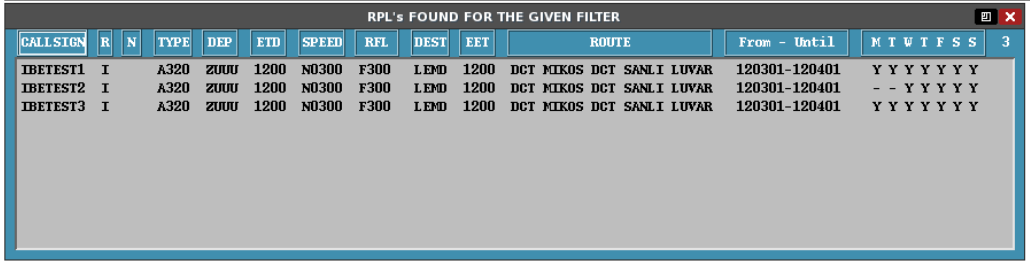
- Request of **FPL** (from iCWP and FDD Working Positions) and **RPL** (from FDD Working Positions) meeting introduced searching criteria (A/C Carrier, Origin, Destination, Route, Times, Operating Days, etc).



The complete plan can be accessed directly by clicking twice on the line







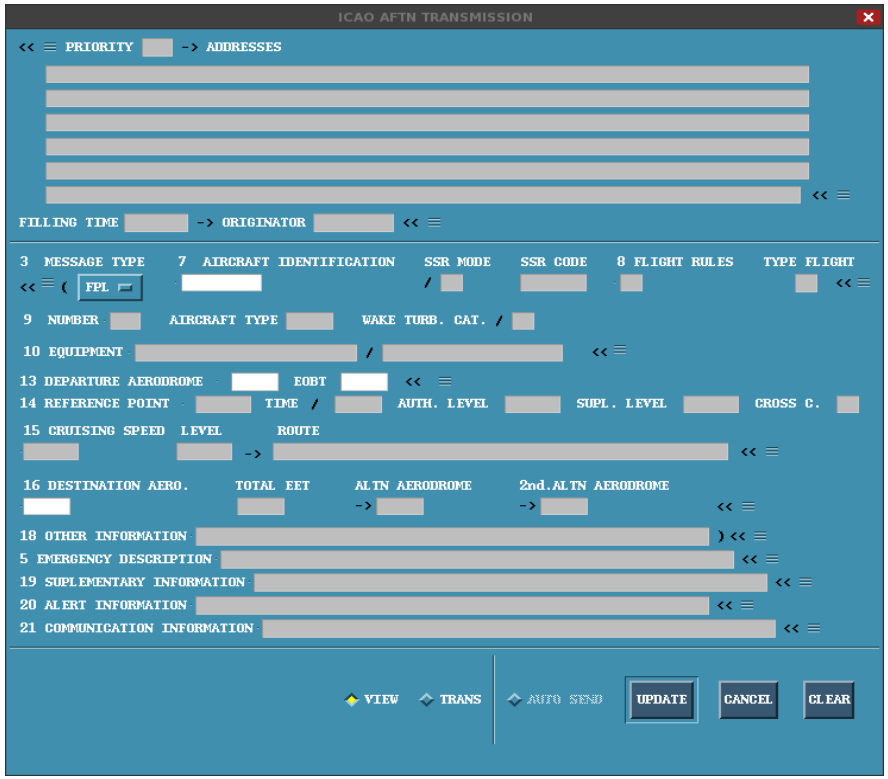
FDP/FDD – AFTN/IFPS MESSAGE TRANSMISSION

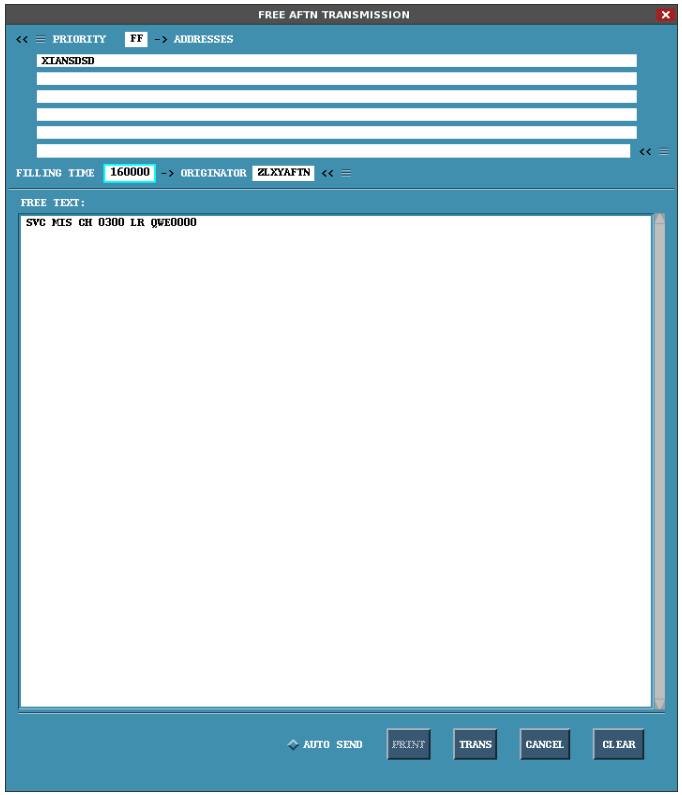
AUTOMATIC

- DEP (For controlled departing flights)
- ARR (for controller arriving flights)
- CNL, DLS, EST, CPL, etc.

MANUAL

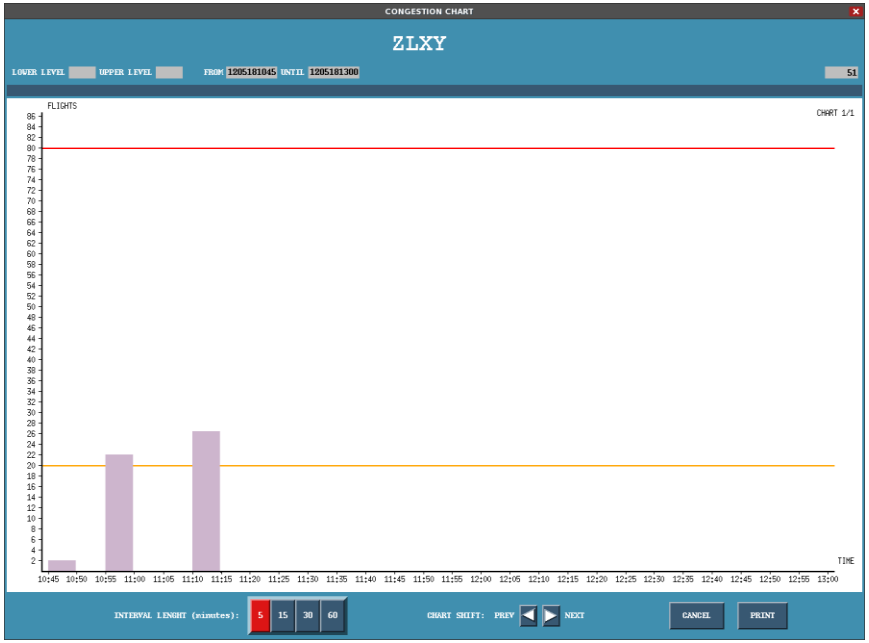
- Any type
- Also free-text (not defined types)





FDP/FDD – FLOW PLANNING

- Shows all traffic during a TIME FRAME over an airspace ELEMENT.
- The operator may select as analysis ELEMENTS:
  - Aerodromes
  - Reporting Points
  - Sectors
  - Route Segments
  - Runway
- The Flow Planning tool provides:
  - Traffic Lists
  - Congestion Charts
  - Flow Manager: to set peak values



FDP/FDD – MANAGEMENT OF ENV. DATA

ENVIRONMENT DATA

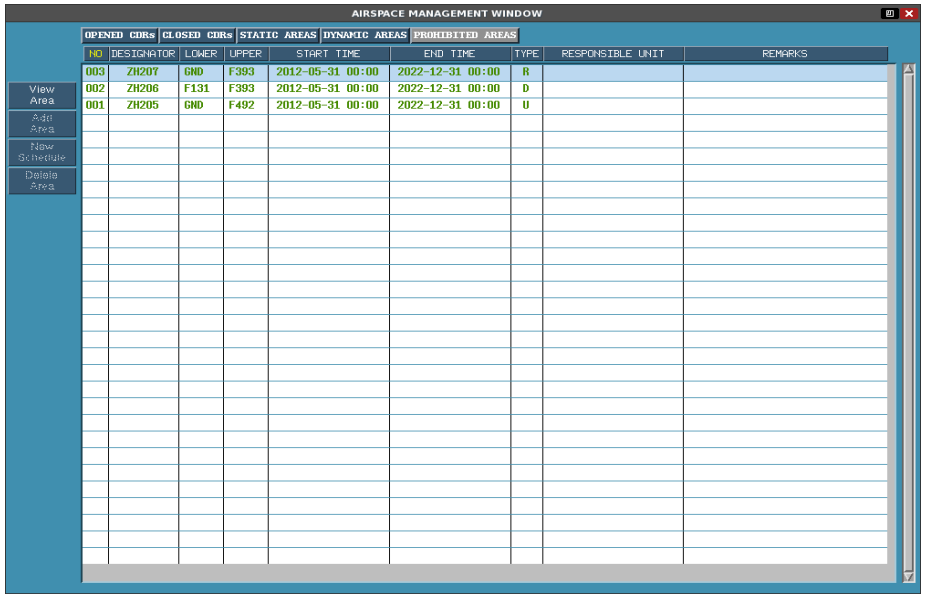
- **Winds Aloft wind**
  - Current & Forecasted conditions.
  - Obtained form standard GRIB message.
  - Used in FP Trajectory Calculation.

- **QNH/QFE - Transition Level**
  - Up to 50 QNH zones.
  - Used by SDP in Mode C correction and displayed to controller.

- **Runways in Use**
  - Used for SID/STAR allocation.

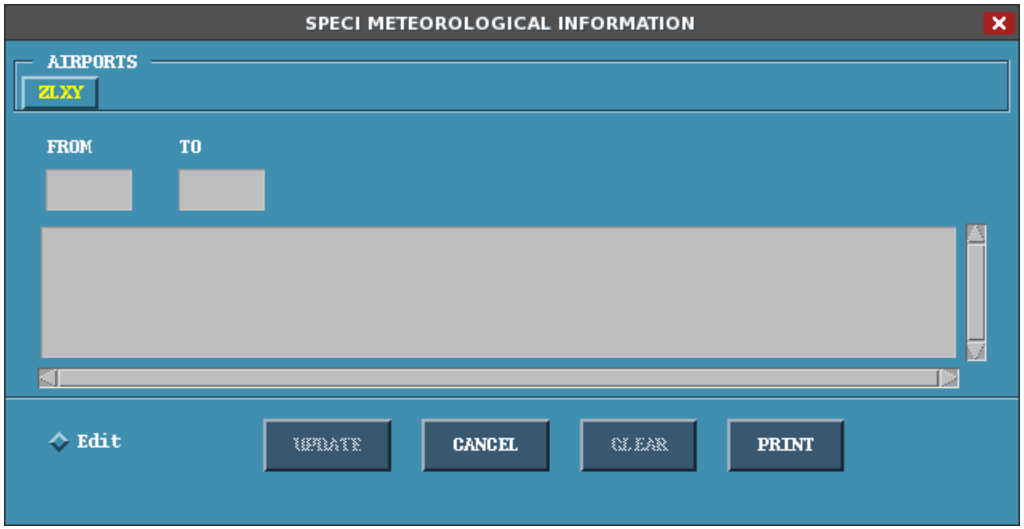
FDP/FDD – RESTRICTED AREAS

- Some restricted areas categories.
- Circles and polygons.
- Upper and lower levels.
- Removed after validity period expires.
- Activated on daily or weekly basis or in predefined time intervals.
- Displayed to Controllers (iCWPs).
- Can be used to inhibit STCA function (Military Manoeuvre Areas).
- Intrusion check in advance for every created/modified FP.
- Detection of intruding flights (tracks).



FDP/FDD – MET ATS MESSAGES

- Message Types:
  - METAR
  - SPECI
  - TAF
  - SIGMET
  - AIRMET
  - ATIS
  - SNOWTAM
  - ASHTAM



- Received from AFTN.
- Deleted after validity period expires.
- Associated to adapted airports.
- Can be printed out.

FDP CONTINGENCY: iCWP AUTONOMOUS MODE

- In the case of an FDP catastrophic failure or loss of communication, the system provides the following capabilities to the iCWP controller:
  - Handover and accept of controlling right;
  - Maintain and continue the correlation between track and flight plan;
  - Maintain and update the QNH in the airport zones;
  - Manually add global flight plan;
  - Process all existing flight plans;
  - Essential flight strips printing (e.g. callsign, SSR, departure airport, destination airport, aircraft type, fix points) by using local strip printer;
  - Support for CLAM, STCA, MSAW, APW, SSR Emergency and other alerts;
  - Maintenance the display of the flight plan lists and electronic flight strip with the previous content.
- After recovery, the FDP system shall retrieve the changes from the safety nets centralized database and it synchronizes with the own FDP database, in order to have the same data in all functions

MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

SNET (SAFETY NETS, MONITORING AIDS & AIRCRAFT IDENTIFICATION) (I)

SYSTEM TRACK DISTRIBUTION

- Distribution of system tracks to internal (CWPs) and external users.

AIRCRAFT IDENTIFICATION

- Identification by aircraft address (via Mode S / ADS-B) or SSR code (Mode A).
- Correlation/De-correlation of Flight Data and Track.
- Distribution of flight plan and track correlation information.
- Creation and evolution of simulated tracks based on flight data only (synthetic tracks).

SHORT TERM CONFLICT ALERT (STCA)

- Detection of potential violations of the separation standards.
- Takes into account both horizontal and vertical motion, speed and level.
- Two levels of conflict: **Prediction** (forecast) and **Violation** (de facto conflict).
- A different set of separation criteria can be defined for RVSM flights.
- RVSM Alert Condition Detection (any non correlated track or any track correlated with a non RVSM equipped flight plan and located inside the RVSM airspace defined in the DBM).

SNET (SAFETY NETS, MONITORING AIDS & AIRCRAFT IDENTIFICATION) (II)

RESTRICTED AREA WARNING (RAW)

- Detection of potential intrusion into Restricted or Dangerous Areas.
- Two levels of warning: **Prediction** and **Violation** (de facto conflict) for each area type.

NON-TRANSGRESSION ZONE ALERT (NTZ)

- Non-Transgression Zones defined by ICAO as a safety concept for parallel runway operations. They are processed in the system in a fashion similar to that for Restricted Areas. The system provides a Non-Transgression Zone (NTZ) alert safety net by monitoring tracks to detect actual or predicted intrusions of tracks into active Non-Transgression Zones.

MINIMUM SAFE ALTITUDE WARNING (MSAW)

- Checking of AFLs below pre-defined safe altitude of pre-defined areas.
- Special treatment of landing/takeoff profiles to ensure additional accuracy.

SELECTED ALTITUDE ALERT

- This alert is only for Mode S tracks, and it is triggered when the controller inputs a CFL value for the track that differs from the pilot Selected Altitude for the same track.

SNET (SAFETY NETS, MONITORING AIDS & AIRCRAFT IDENTIFICATION) (III)

APM Alert

- This alert is for tracks that are in the final approach phase of flight at internal aerodromes. It monitors the actual profile followed by the track with a predefined (offline adapted) Final Approach Zone.

DPM Alert

- This alert is for tracks that are in the initial climbing phase of flight at internal aerodromes. It monitors the actual profile followed by the track with a predefined (offline adapted) Initial Climbing Zone.

Position Report

- Tracks report their position at route fix points for safety reasons. These reports must be sent at the expected time for the fix point overflown, being defined in the system a VSP tolerance time. If the report is not sent on time + VSP tolerance time, Position Report Alert is triggered.

SNET – OTHER ALERTS (I)

SSR Code Distress and SPI

- Special processing & warning of 7500, 7600, 7700 codes and SPI indicator.

Duplicated Mode 3/A Code Warning

- Warning after detection 2 or more equal Mode 3/A Codes

Duplicated ADS-B/Mode S Callsign Warning

- Warning after detection 2 or more equal Callsigns via ADS-B / Mode S

RVSM Alerts

- The System will extract RVSM information from the corresponding field in the flight plan messages. As a result, flight plans is identified as “RVSM Equipped”, “RVSM Non-Equipped”, “RVSM Unknown”, or “RVSM Exempted” flights. Several RVSM alerts are included for correlated tracks, according to RVSM layers and distinguishing Military from Civil tracks.

8.33 ALARM

- Alert displayed when a not 8.33 equipped aircraft is over a specific level defined in the Data Base.

UHF ALARM

- Alert displayed for military flights with UHF equipment and with a CFL over a specific value defined in the Data Base.

SNET – OTHER ALERTS (II)

NIC Alert

- NIC Alert is raised for ADS-C Tracks with discrepancy between the own ADS-C track and the radar track.

RIE Alert

- In ADS contracts, it might be requested to include the next two waypoints. The system compares this information with the predicted route from the flight plan and reports any mismatch with the pilot route insertion error (RIE) alert.

FOM Alert

- ADS reports include a value for indicating the figure of merit (FOM) of the report. The iCWP shall display an alert when this FOM decreases (i.e. worse quality) compared to the previous report.

ROF Alert

- Downstream controller can request, at any moment, for the frequency (Request on frequency). The controllers affected are warned with ROF indicator.

MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

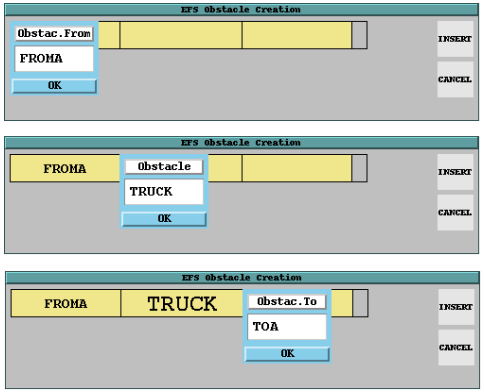
DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

EFS – ELECTRONIC FLIGHT STRIP
TOWER ELECTRONIC FLIGHT STRIP

- CWP Windows (EFS, Flight List and Main Display).
- Management of the Tower Flight Plan Data Base (TFPDB)
- Interaction with FDP
- Flight Plan Management and distribution (Tower FP state management and Electronic Flight Strip management)
- Handling of tower controller actions, particularly clearances



MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

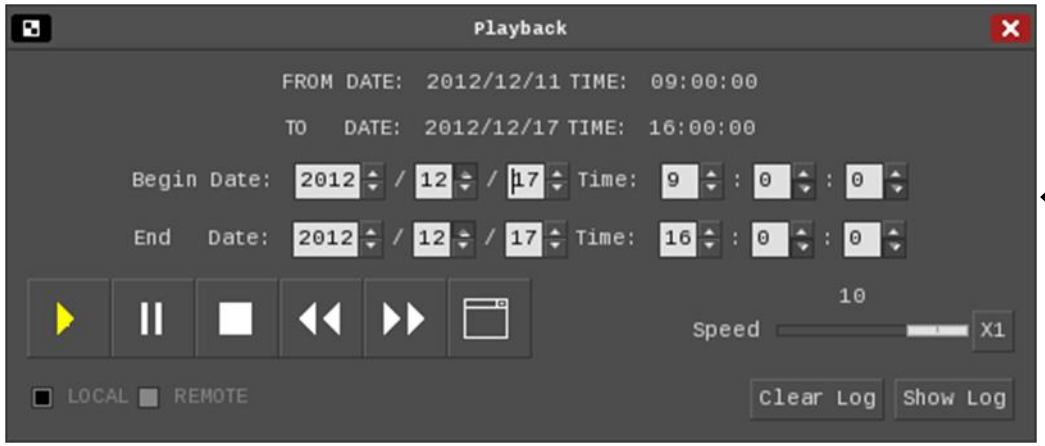
DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

DRF – DATA RECORDING FACILITIES & PLAYBACK

- The last 30 days are recorded in the local iCWP disk, being available for immediate playback.
- DRF central servers carry out global recording of radar, FP and ADF data as well as CWP status of all iCWPs.
- DRF saves recorded data in local disk and DDS tapes, and allows the export to other external devices.
- Playback can be effected in any non-sectorized iCWP.
- Voice and Data are synchronized for playback.
- Passive and Interactive playback toggle.



- Very friendly HMI to control playback.
- Time frame (initial and final DD:MM:YY hh:mm:ss.
- Reproduction speed (from 0.1 to 5 times).
- Rewind, Fast Forward, Stop, Pause.

MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

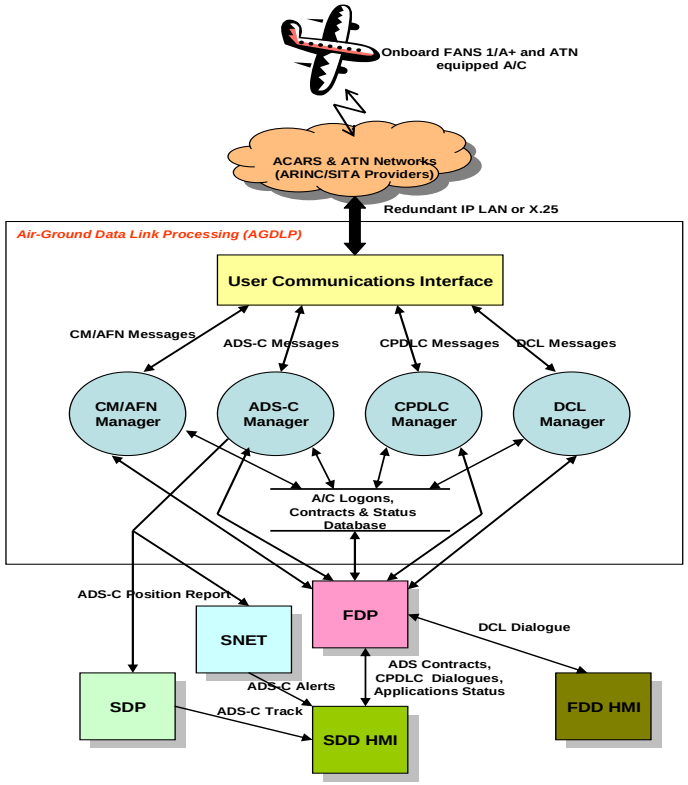
DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

DLS – DATA LINK SERVER

- Interfaces to the air segment for all Air Ground Data Link (AGDL) services regarding ADS, CPDLC, DCL and FANS Communication interface.
- Organizes the data link message exchange between ATM subsystems and the network (SITA/ARINC).
- Determines the assignment of messages to the appropriate CWP, the SDP, or FDP/EFSS.
- Monitors the status of the data link connection to each flight and the operational procedures concerning specific flights.
- Manages the communication with the external world by storing aircraft addresses, and conversion and formatting of messages.



MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

iCWP – CONTROL WORKING POSITION. SUMMARY (I)

- Display of system tracks (radar/ADS-C), radar plots, ADS-C reports and weather contours.
- Display of Flight Plan lists.
- Display and graphic modification of Flight Plan route.
- Display of coast, hold and alerts/ conflicts lists.
- Display of aeronautical maps and restricted areas.
- Display of graphic tools (RBLs, local maps).
- Display of auxiliary information (time, QNH, controlled sectors, sector assignation to other CWP, etc).
- Display of MET information.
- Access to flight plan database (Retrieve, Creation, Modification, Cancellation).
- Support of controllers actions (clearances, ATD, ARR, EST)
- Save/Restore of user preferences.
- Control features of the local display (filters, off centering, range).
- Printout of flight strips (for non “strip-less” environments) and flight plan lists.

iCWP – CONTROL WORKING POSITION. SUMMARY (II)

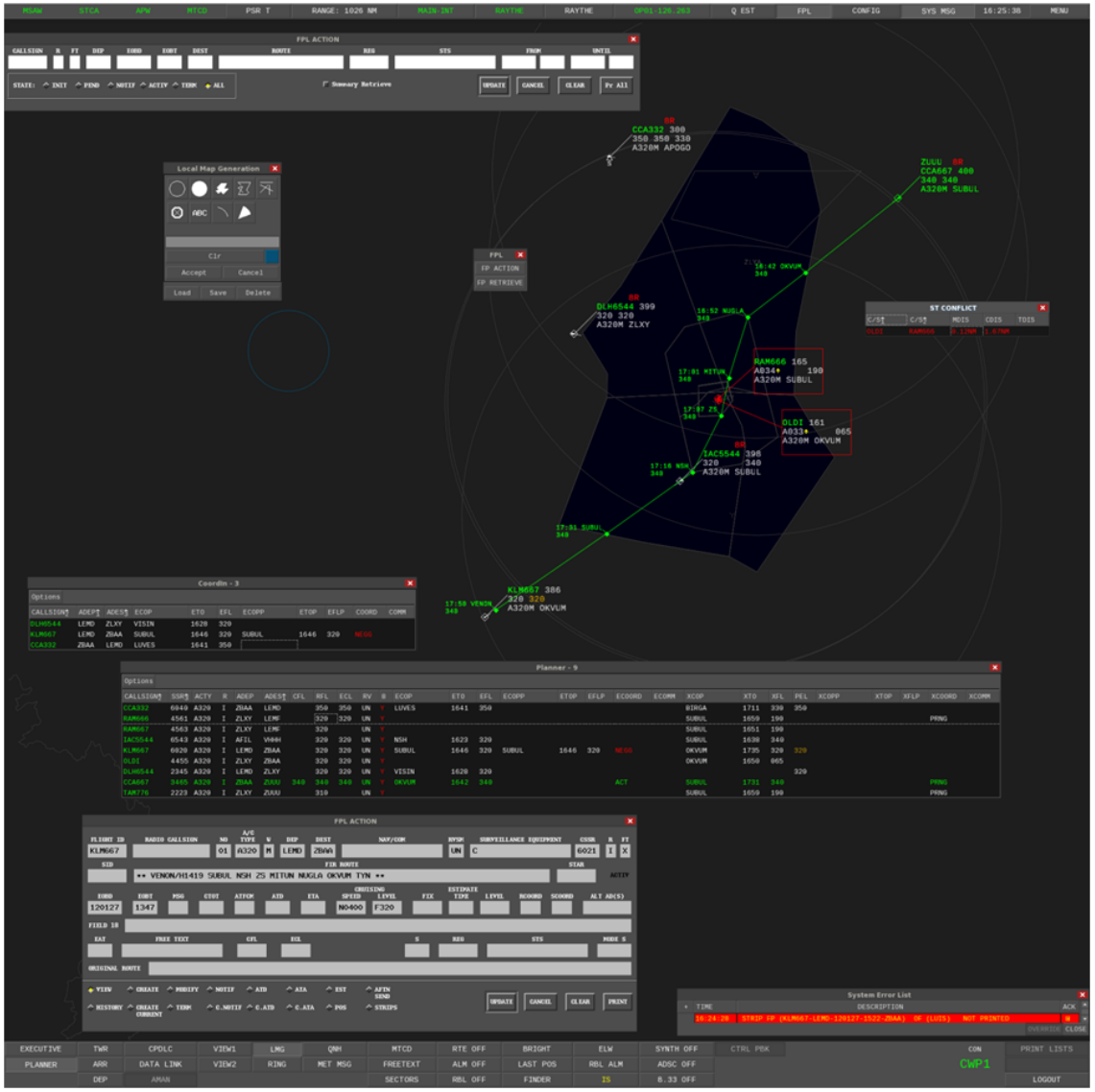
- Display Alerts generated by Safety Nets and ATC Tools: Short Term Conflict Alerts (STCA), Minimum Safe Altitude Warnings (MSAW), Restricted Area Warnings, CFL Conformance Alarms (CLAM), Area Proximity Warning (APW), Route Adherence Monitoring (RAM) and others.
- Display of conflict situations (MTCD).
- Inter-console marker and Free text communication channels.
- Track location by SSR code Callsign, Airport, Fix point, Lat/Long coordinates or mouse location input. And last position of a lost track.
- Local Display Control Features as 3D Filter, SSR code filter, display off-centring and movement, range changes, tracks and position finder, ...
- Autonomous monoradar tracking in case of failure of the SDP servers (Emergency mode), with radar selection.
- Autonomous basic FDP capability in case of redundant FDP (catastrophic) failure.
- Significant points/ elements finder.
- Local recording and playback in the same iCWP of the last month traffic (tracks, flight plans, display status).
- Playback of recorded data (Playback mode) – Interactive or passive mode.

iCWP – CONTROL WORKING POSITION. SCREEN

INFORMATION WINDOW

MAIN WINDOW

MAIN MENU WINDOW



iCWP – DESIGN CHARACTERISTICS

- Incorporates the features derived from the EUROCONTROL studies (ODID III and IV) on HMI (Human Machine Interface) for air traffic controllers.
- Uses High Resolution Monitors (2Kx2K, 1600x1280, 1Kx1K).
- Includes standard input devices (keyboard, mouse).
- Integrates all information (radar, FP, maps, MET, ADS/CPDLC, ATC Tools, Safety Nets, AMAN, etc), able to be accessed selectively.
- Designed for both radar (executive) and procedural controllers.
- Colours are used to distinguish flight's ownership, emphasize alarms, distinguish objects.
- User can configure desired colours, symbols, etc.

iCWP – TRACK DISPLAY

- Track label fields are totally off-line configured: in its situation in label, in its colour and in its sensitive actions.

TRACK LABEL LINES (example)

Line 0: a) Assigned Sector
b) Distress indicator (HI, CO, EM, AD)
c) MSAW (MS) / MTCD (FP) / STCA (PR & VI) / RAW (OO & WI) indicators
Line 1: a) Callsign / ICAO SSR Code
b) Aircraft Type
c) Turbulence
Line 2: a) Mode C Attitude (1 symbol : ↑ or ↓ or space)
b) CFL level entered by the radar controller and CLAM alert indication
c) Lost indicator
d) Ground speed / vertical speed
Line 3: a) Heading
b) Assign Speed
c) Route Adherence Monitoring indicator (RAM)
d) ADES (Airport / Destination)
Line 4: Free text

TRACK SYMBOLS

Symbol	Track Type
	Primary
	Secondary
	Secondary Combined with Primary
	Correlated
	ADS-C (only ADS-C detection)
	Synthetic
	Tracks with Special SSR Code (2000 and 7000)
	ADS-B
	ADS-B Combined with Primary
	ADS-B Combined with Secondary
	ADS-B Combined with Primary and with Secondary

iCWP – RADAR PRESENTATION MODES

- **Multiradar Mode (default)**
  - The iCWP displays system tracks (multirsensor + ADS) received from the SDP.
- **Monoradar Mode**
  - The iCWP displays monosensor tracks received from the SDP, for a selected sensor by the operator from a set of adapted sensor sites.
- **Emergency (By-Pass) Mode**
  - The iCWP displays the monoradar tracks established and maintained by its own monoradar process (located in the iCWP).
  - The radar data input is received directly from the RDCU. The Emergency mode is a fall-back resource and do not provide the following functions:
    - Radar-Flight Plan correlation and associated functions.
    - STCA and RAW alerts.
    - Hand-overs.
- **All modes may be individually selected by the iCWP operator. The Emergency mode is automatically initiated at all iCWPs when both SDPs crash.**

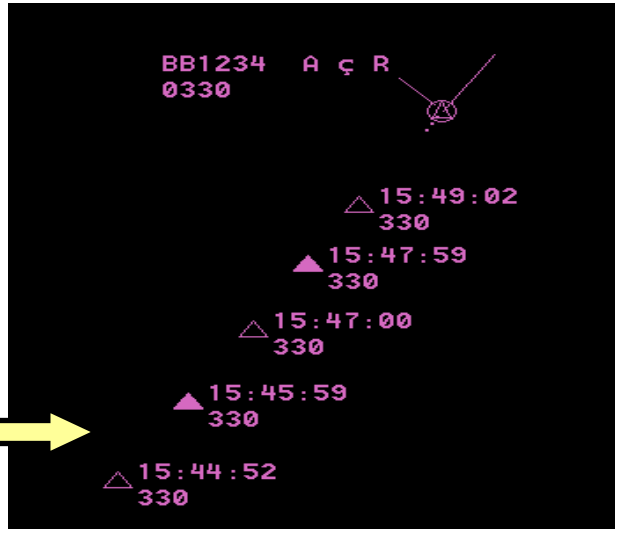
iCWP – ADS-C INFORMATION

ADS-C INFORMATION IN THE TRACK LABEL

- ADS-C capability/ ADS-C connection established indicators.
- CPDLC capability/ CPDLC connection established indicators.
- Navigation Integrity Control (NIC) Indicator.
- ADS Emergency mode indicator.
- Predicted Route (two next waypoints) from ADS, available.
- Message used protocol (ACARS)
- ADS event indicator: Whenever any of the requested events of the ADS contract are fulfilled, this circumstance is indicated until acknowledged by the operator:
  - Altitude Range (AR);
  - Vertical Rate (VR);
  - Lateral Deviation (LD);
  - Waypoint Change (WP).

OTHER ADS INFORMATION

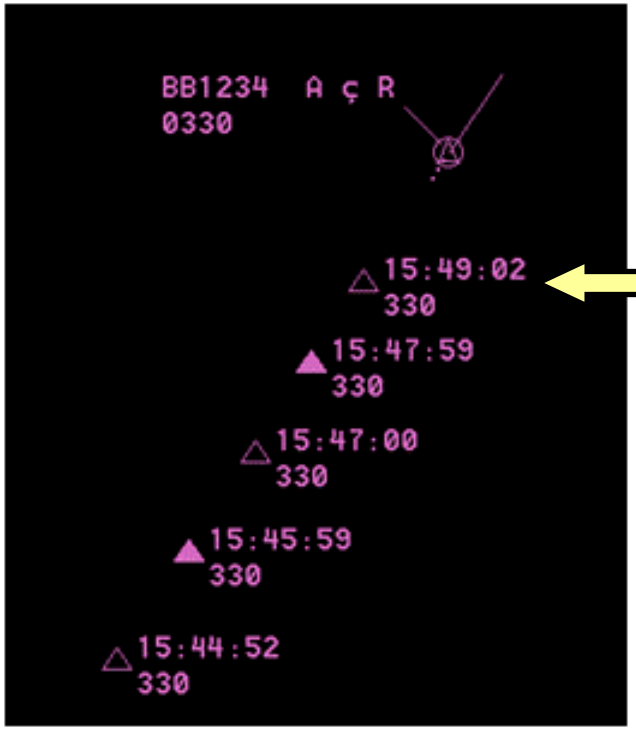
- Position Reports;
- Next Waypoints (predicted route).



iCWP – ADS-C AND CPDLC POSITION REPORTS

TYPES OF POSITION REPORTS

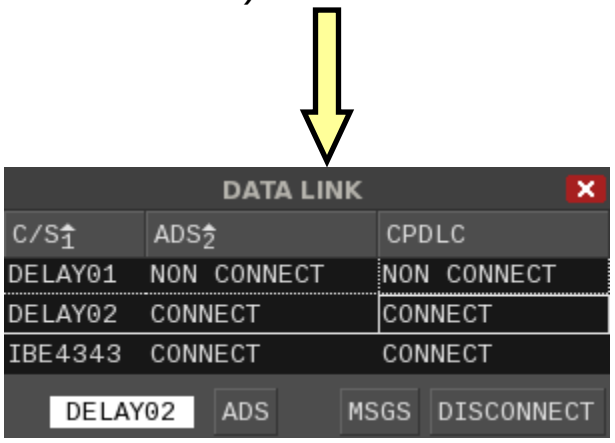
- ADS Basic (without speed information)
- ADS Extended (with speed information)
- CPDLC Basic (without speed information)
- CPDLC Extended (with speed information)

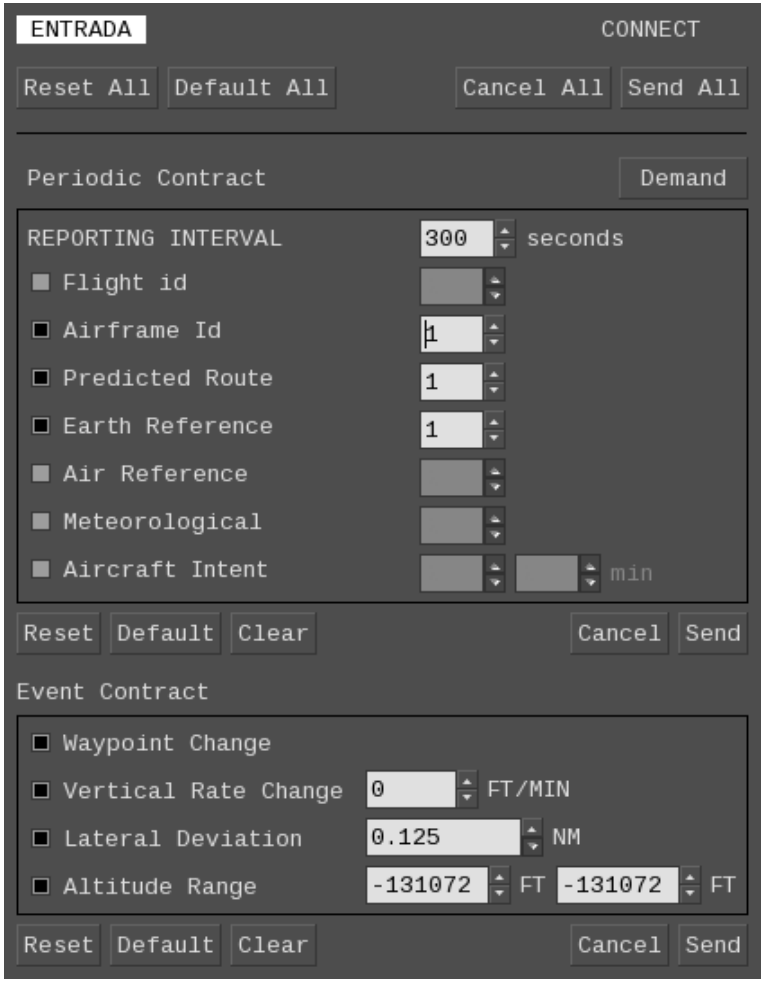


Each position report has its time-stamp (hh:mm:ss) and reported level

iCWP – ADS-C CONTRACTS. PERIODIC / EVENT CONTRACTS

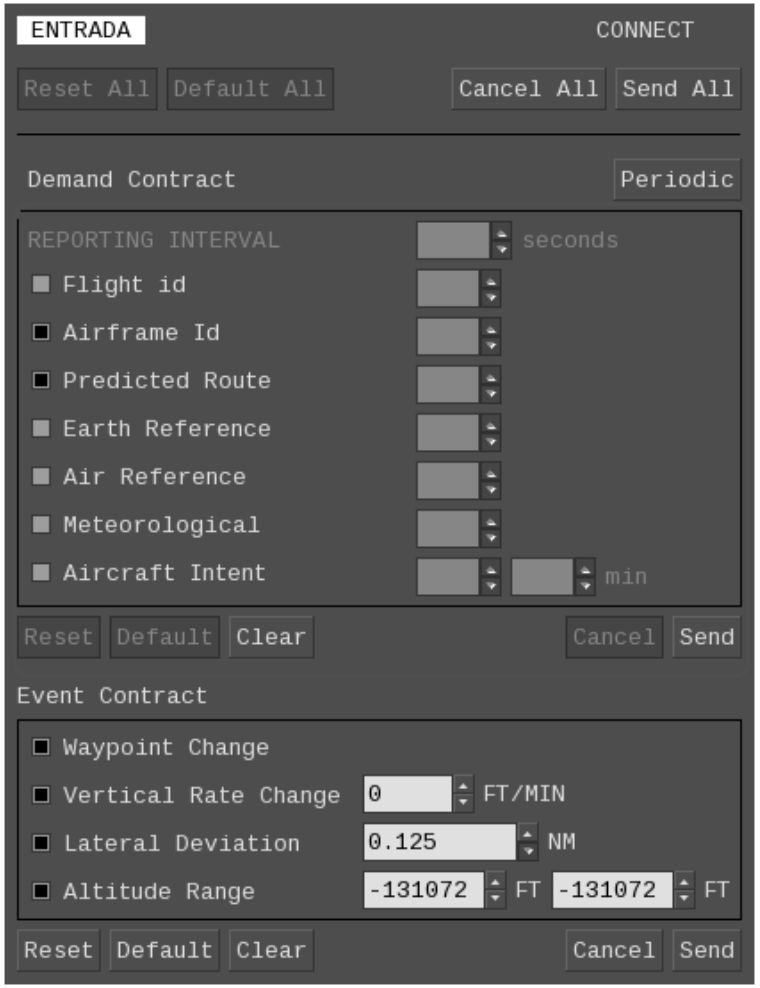
- The ADS Contracts window is displayed when clicking on the indicator “ADS Capacity/ADS Connection Established” displayed on the label of the ADS track or on the FP list.
- It is used for creation, modification or cancellation of ADS contracts (for all contracts or individually selected contract).



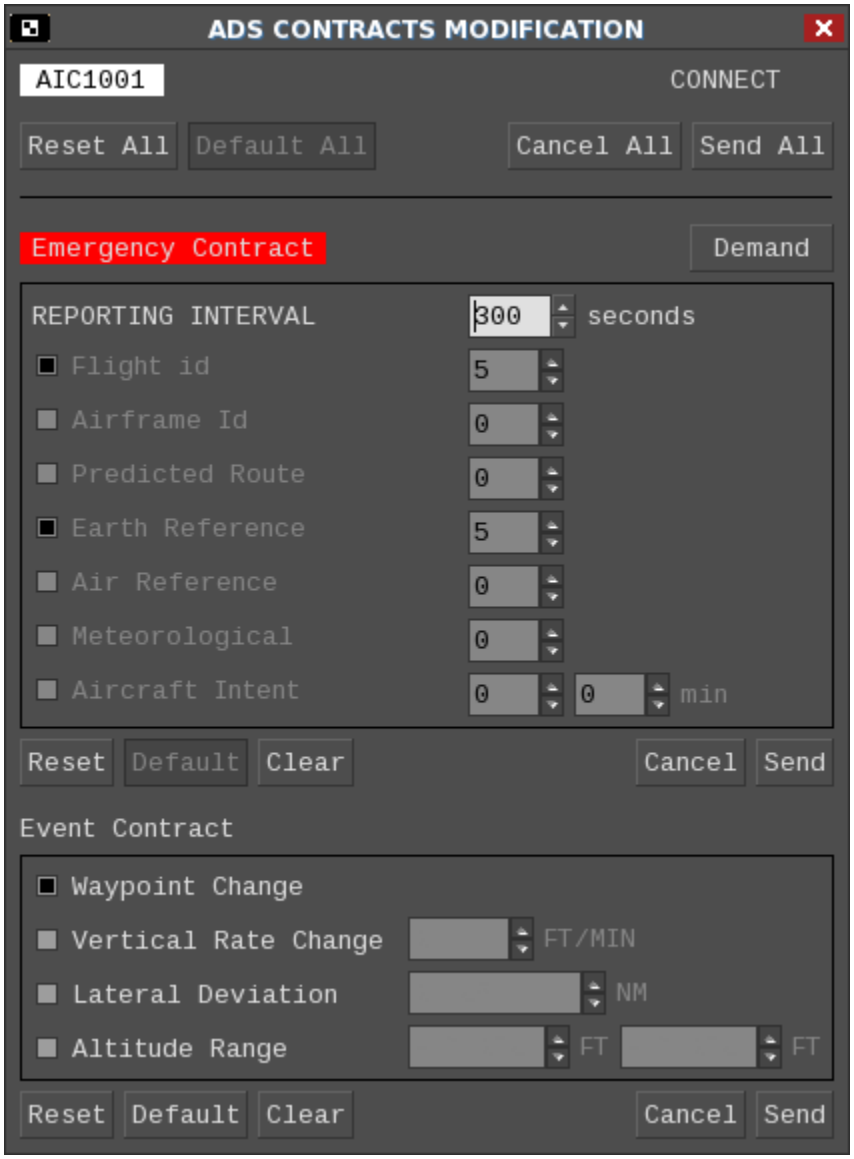


iCWP – ADS-C CONTRACTS. DEMAND CONTRACT

- This kind of contract is similar to the Periodic Contract but without periodicity.
- The frequency of the message it is not necessary because the aircraft sends the requested information only once, when it receives the Demand Contract message.

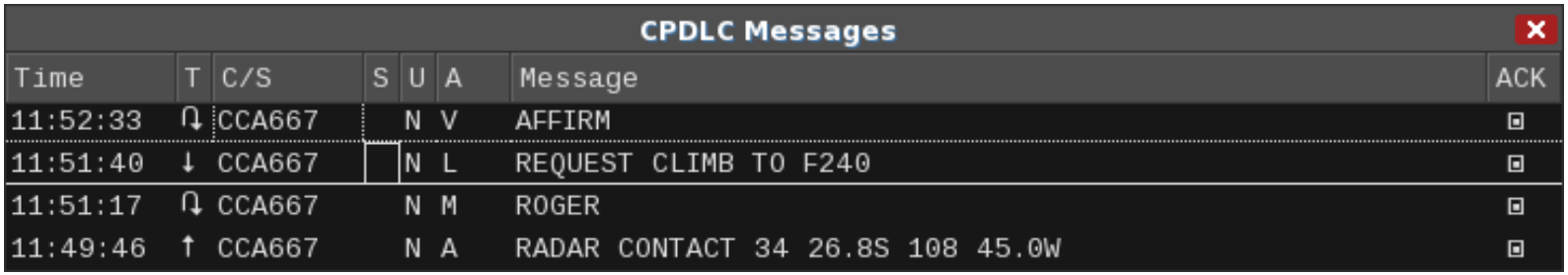


iCWP – ADS-C CONTRACTS. EMERGENCY CONTRACTS



iCWP – CPDLC MESSAGES WINDOW

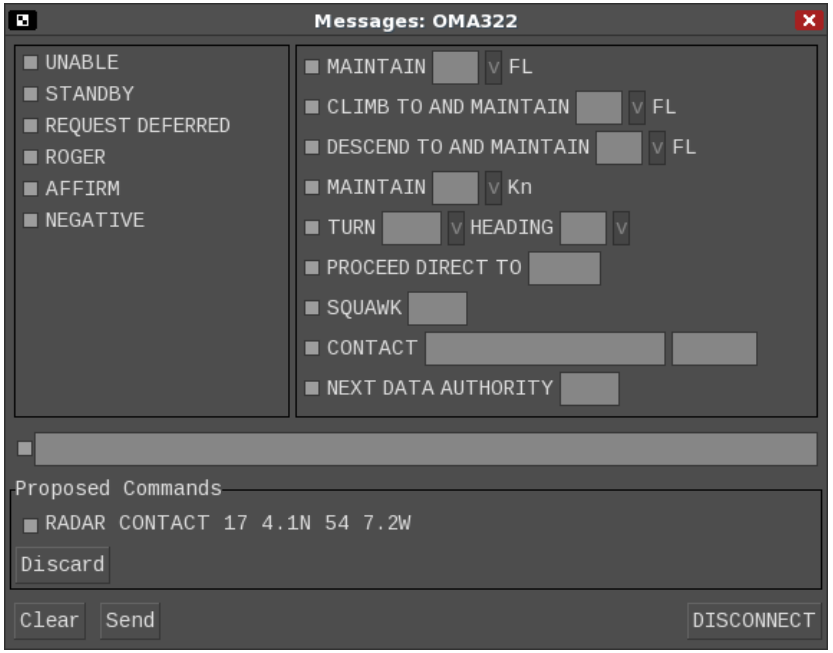
- This two-message window contains the last received and sent CPDLC messages from/to aircraft controlled by the iCWP.
- This windows shows the following information:
  - Time of the Message.
  - Message Direction (Uplink / Downlink).
  - Callsing.
  - Attributes: message status, message urgency, alert status.
  - Message contents.
  - Message acknowledge field.
- The messages are displaying in the sequence of the dialogue, sorted by time.
- Clicking with the mouse in the received messages which require response, the Edition & Transmission Message Window is automatically opened.



iCWP – EDITION & TRANSMISSION OF CPDLC MESSAGES WINDOW

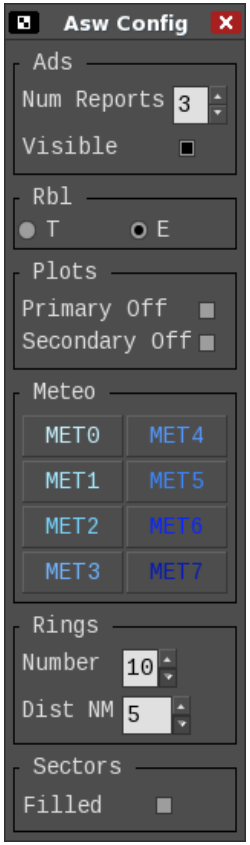
This window contain three sections:

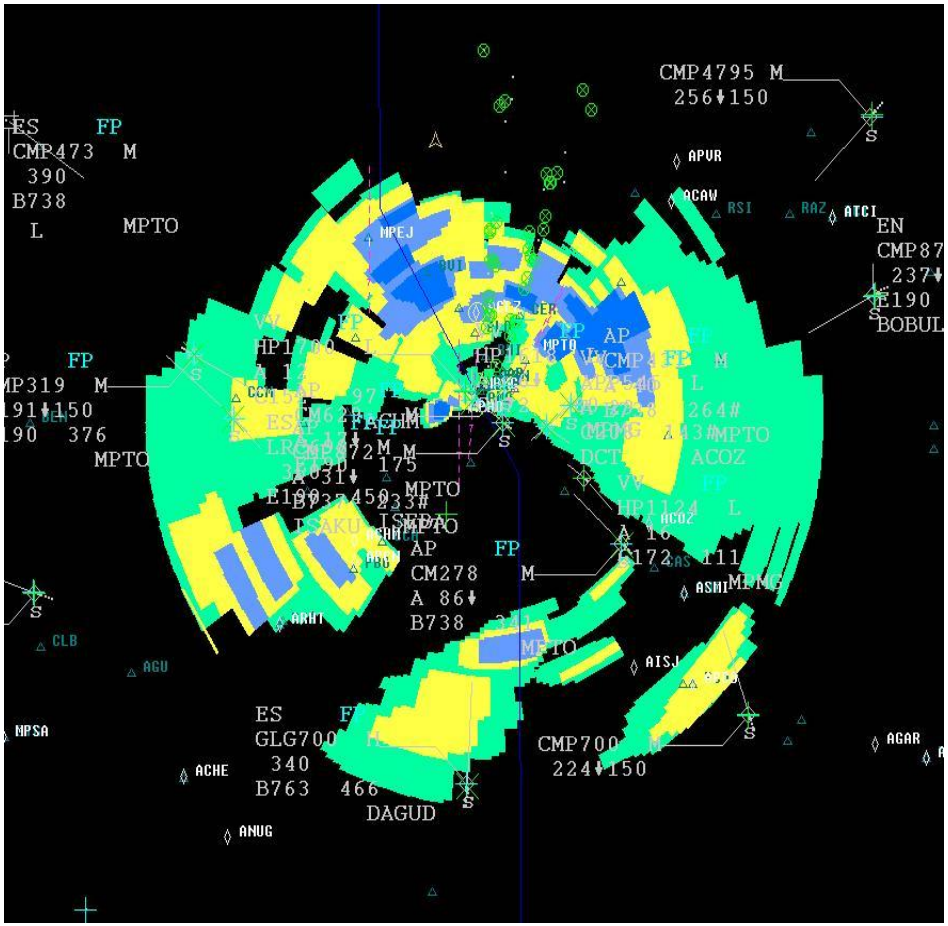
- **Preformatted Messages**
  - This section is used to select and send the most common CPDLC Messages used.
  - The type of available messages are configured. The value of the variable fields of the messages are selected in the menus opened when the field is selected.
- **Free Text Messages**
  - This section is used to edit and send free text messages to aircraft without FANS-1 (Aircraft without ADS and/or CPDLC properties) but with ACARS property.
- **Proposed Messages**
  - This one includes CPDLC messages automatically proposed by the system on significant events



iCWP – DISPLAY OF RADAR WEATHER INFO (I)

- Weather Information received from PSR radars are displayed as net-pattern shapes.
- Up to 8 intensity levels processed and distinguished by different colours.





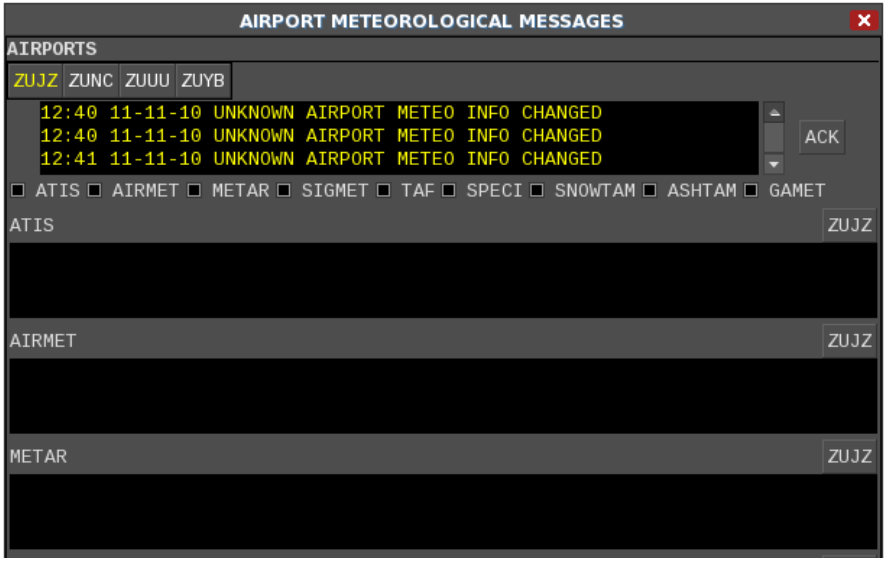
iCWP – DISPLAY OF RADAR WEATHER INFO (II)

Meteorological Radar Weather Information

- The system process weather information received from an external system which issues data from meteorological radars.
- The iCWP displays a more detailed information on weather phenomena hazardous for aviation. This information includes:
  - Weather contour.
  - Top of clouds.
  - Observation Time.
  - Tendency (speed & direction).
  - Type of phenomenon (heavy shower, thunderstorm, hail, squall, whirlwind, dust whirls, etc).

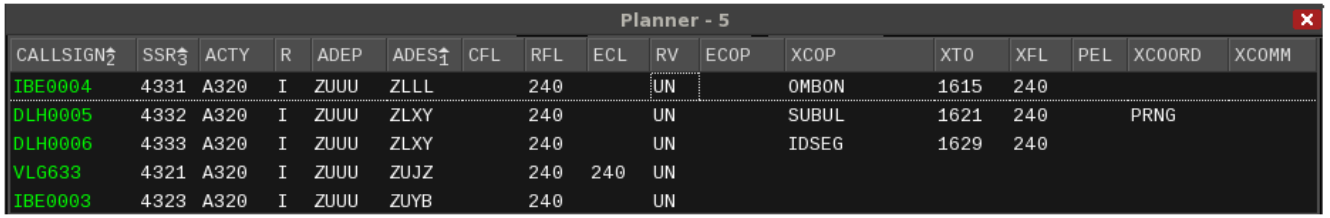
Meteorological Messages Display

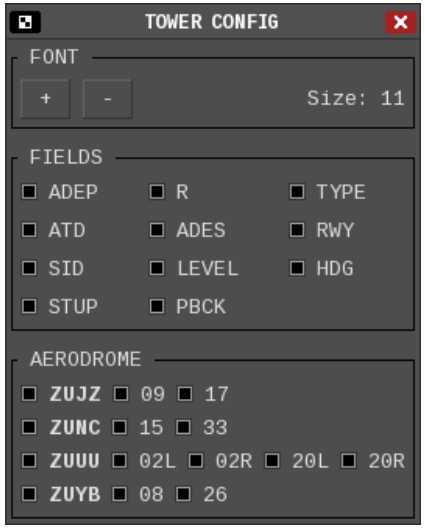
- Meteorological messages are managed in a clear way; these messages are classified to be displayed by type of message and airport.



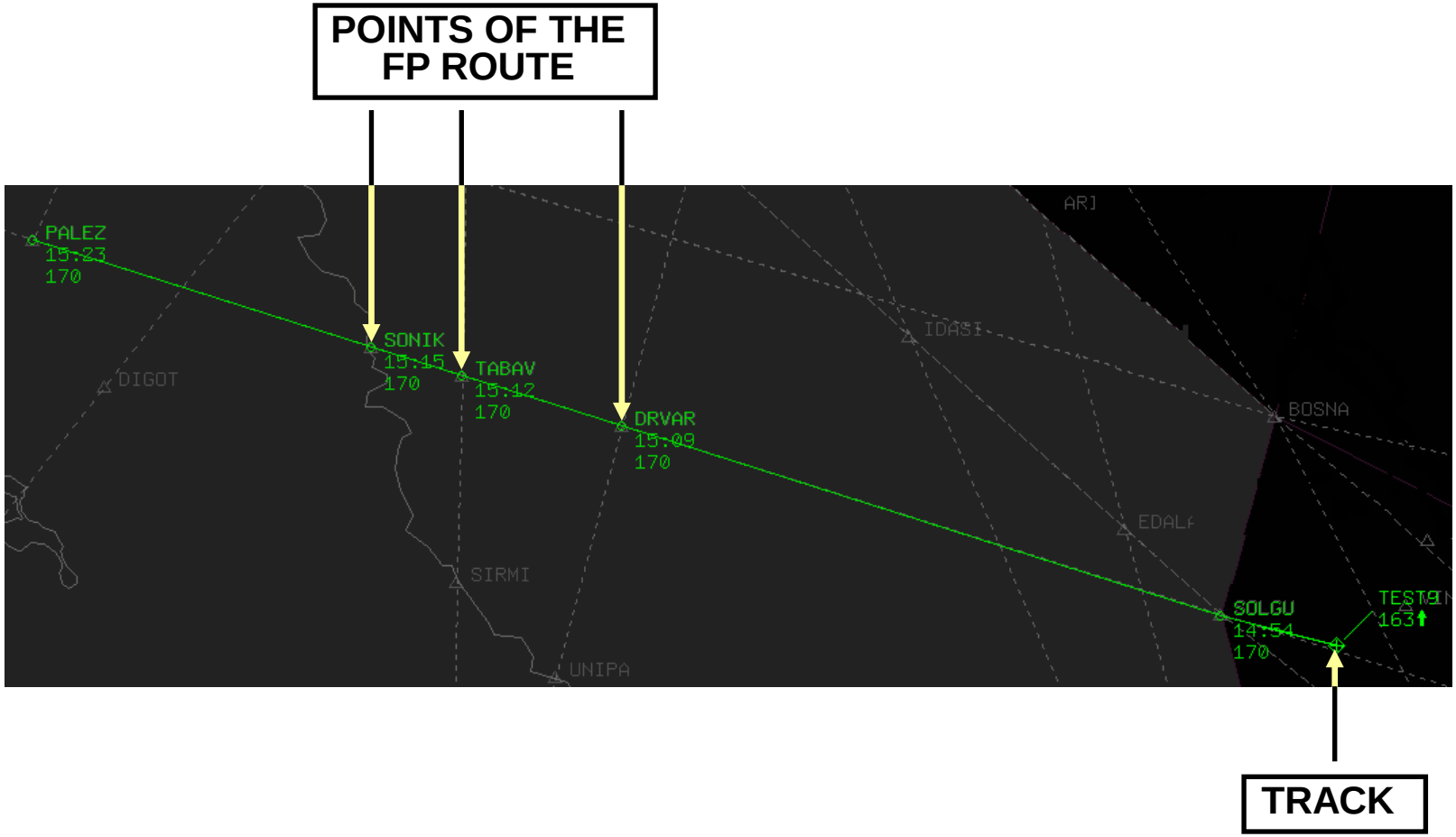
iCWP – FLIGHT PLAN LISTS

- Different Lists for different flight types:
  - Controlled,
  - Advanced,
  - Departures,
  - Arrivals,
  - Coast,
  - Holding status,
  - Inhibition,
  - Coordination (IN/ OUT),
  - Tower flights (EFS related),
  - CPDLC messages exchange,
  - Flights in MTCD/ APW/ STCA/ MSAW conflicts.
- Straightforward access from FP line to complete flight plan.
- Access to coordination windows and to related menus.
- Fields set off-line and adjusted on-line.
- Configuration Window to adjust font size, the fields in the list and to filter data by aerodrome/ runway.





iCWP – GRAPHIC DISPLAY OF FP ROUTE

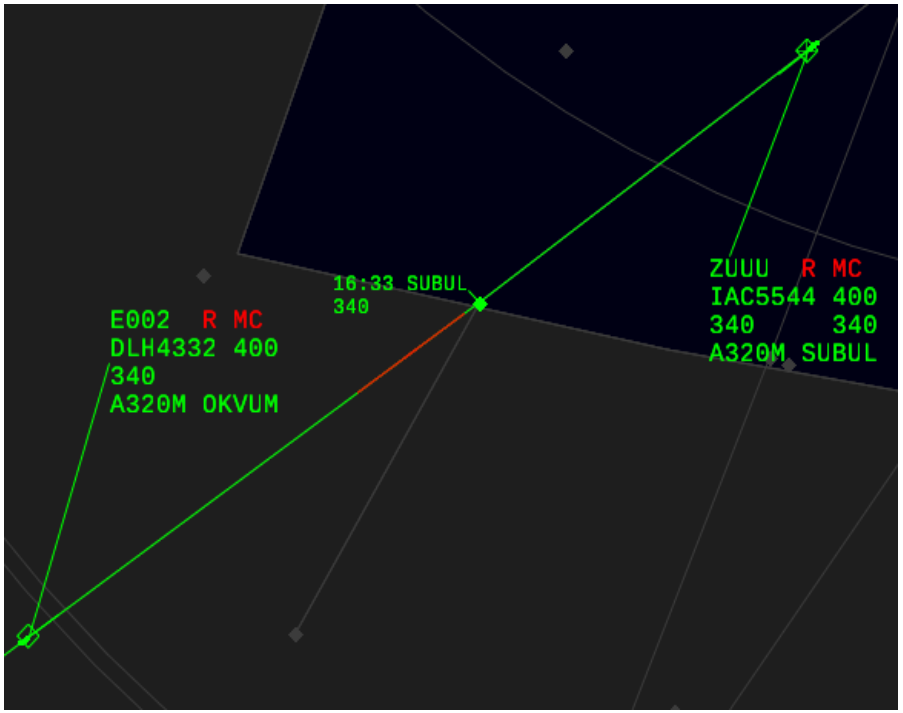


iCWP – GRAPHIC MODIFICATION OF FP ROUTE

iCWP – CONFLICT RISK DISPLAY (MTCD)

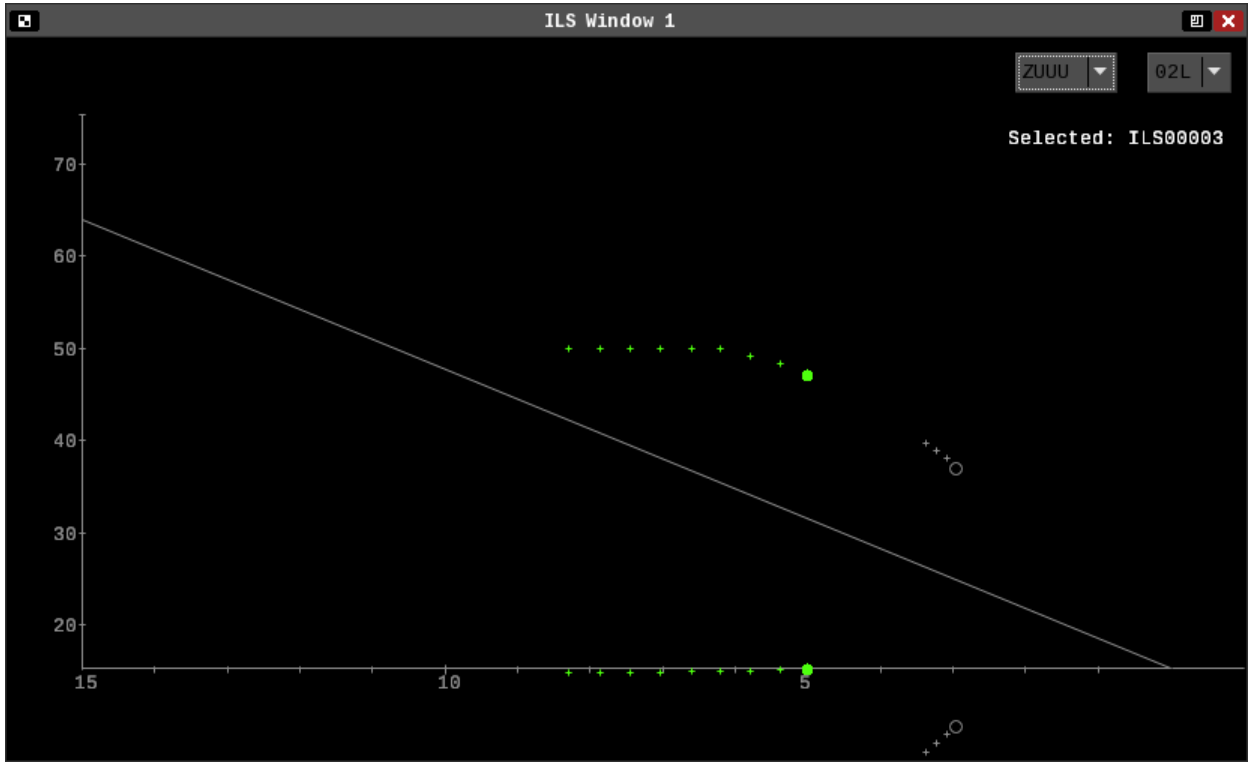
MTCD display at the iCWP

- Red segments indicate the route segments in conflict.
- Routes for flights in conflict are clearly differenced.
- Measure segment marks are included in both routes.
- Time labels, located at the end of the red segments, inform of the start and end times of the conflict.
- Functionality to momentarily background the rest of air traffic.



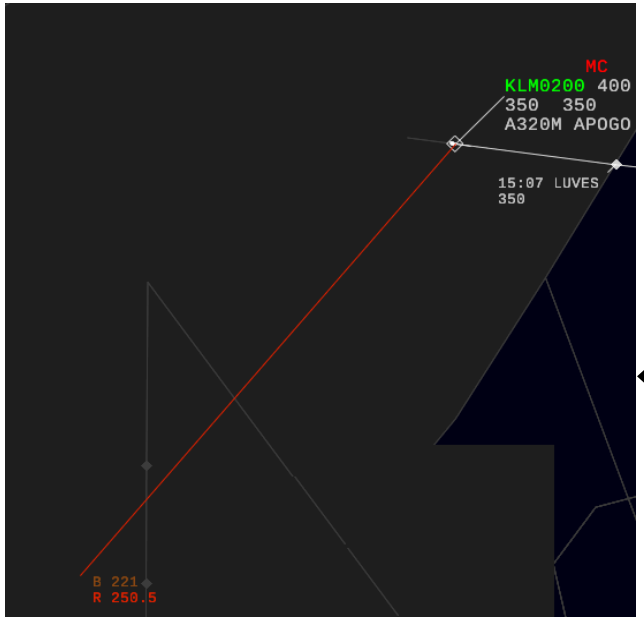
iCWP – INSTRUMENTAL LANDING SYSTEM WINDOWS

- Two independent ILS windows to display the progression of flights near to land, along the glide slope and localizer.
- Display the glide slope (vertical separation)/ horizontal separation.
- Allow to select the airport and runway.



iCWP – RANGE AND BEARING LINES

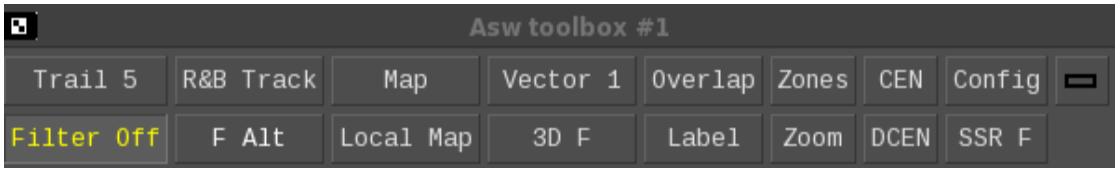
- Up to 16 RBL can be activated, linking two tracks together, or a track to a fixed position, or two positions.
- RBL label displays updated azimuth, bearing, distance, estimated minimum distance between targets and estimated time for the minimum distance.
- RBL also display geographic position (LAT/LONG) of any point of the airspace.

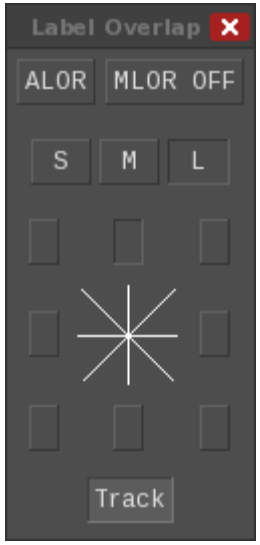


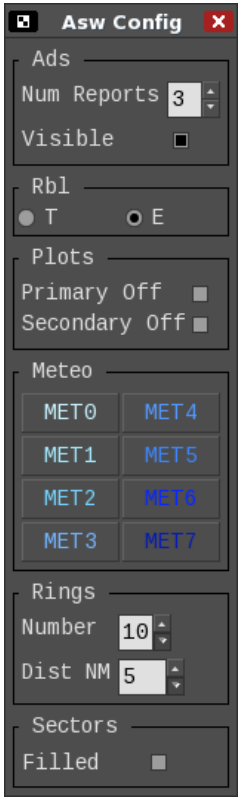
- Alarms can be programmed for each one of the RBL label displayed values.
- Users may program alarms indicating thresholds (maximum and minimum limits) and condition (greater than, less than, within or beyond limits).

iCWP – DISPLAY CONTROLS (I)

- A Toolbox includes most used display elements, including:
  - 3 D Filter
  - RBL initiation
  - Zoom display
  - Filter SSR Code
  - Display centring
  - Display de-centring
  - Configuration Window
  - Altitude filter adjustment
  - Map Display
  - Local map creation
  - History positions adjustment
  - Velocity vector adjustment
  - Overlap tool (automatic/ manual overlap and label orientation)
  - Display of Restricted Zones and CDRs





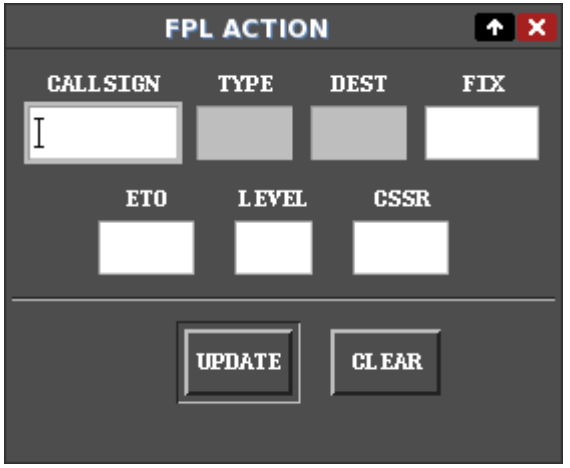


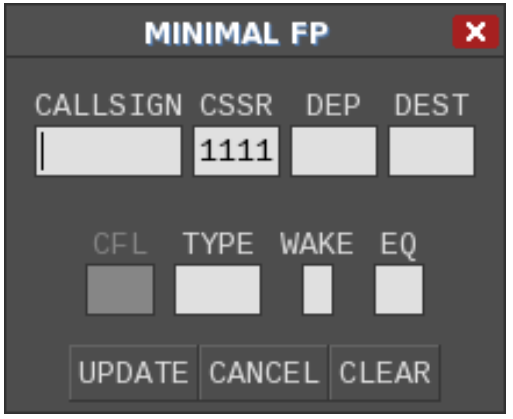
iCWP – DISPLAY CONTROLS (II)

- Bright & Contrast for different elements and different maps can be graduated through a special window.

iCWP – CONTROL COMMANDS ON FLIGHTS

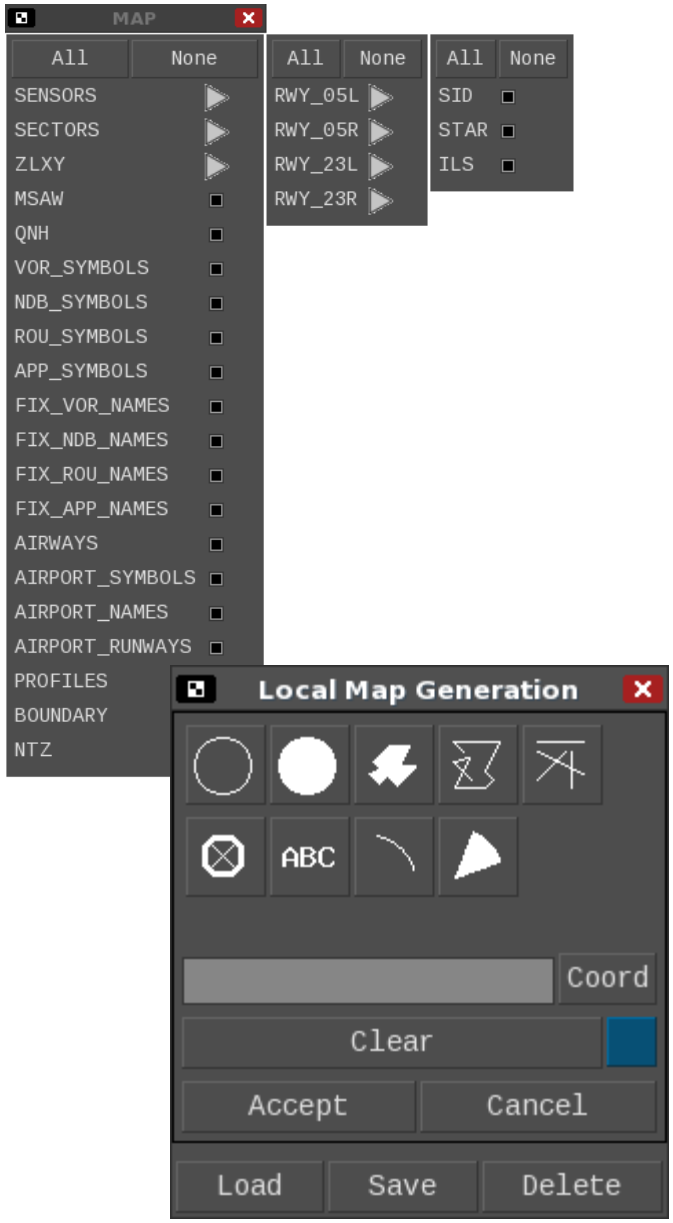
- Very friendly input of control commands:
  - CFL/ XFL/ RFL/ ECL/ PEL/ SPD/ HDG/ VR… assignation
  - Estimate Time & Level
  - Handoffs
  - Manual Correlation
  - Minimal FP
  - …





iCWP – MAPS

- Pre-defined maps can be selected trough pop-up menus.
- Selection of all/ none maps by a single action
- The DBM provides tools to automatically generate maps based on the adapted data (airways, sectors, fix points, aerodromes, etc.).
- DBM also allows to include the maps to display in iCWP Map Menu and the level.
- Other specific maps can be added by the user. Only a text editor is required.
- Additionally, a graphic tool allows creating local maps by the iCWP operator.
- Different shapes can be easily drawn and grouped in up to 4 local maps.
- Import of external map formats.



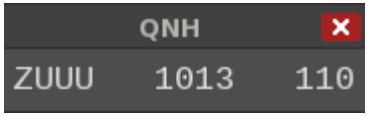
iCWP – ELECTRONIC FLIGHT STRIPS

- iCWP includes functionality to display flight plan related data in Strip format. This format is similar than paper strips.
- iCWP Electronic Flight Strips are displayed in a window by each fixpoint.
- Controller can select at change at any time the fixpoints to display iCWP EFS. Several EFS windows can be simultaneously displayed.
- Controller can select the sorting criteria by each fixpoint at any time.
- Controller can adjust several values in the FP through the iCWP EFS.
- Fields in iCWP electronic strips can be off-line adjusted.
- Controller can select EFS format between Expanded or Reduced.
- The iCWP shall allow the controller to mark electronic strips (cocked-out) by an horizontal displacement of it.

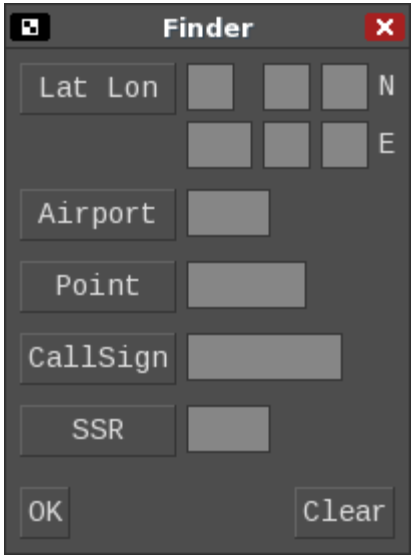
iCWP – MISCELLANEOUS

- Inter-console Marker.
- Status (ON/OFF) of Alert Functions (MSAW, STCA).
- Assigned Sector Turn off aural alarms.
- Transition Level.
- Track finder with several criteria.
- Clock and Alarm

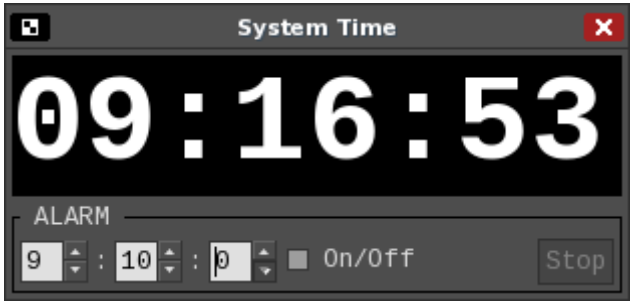
QNH



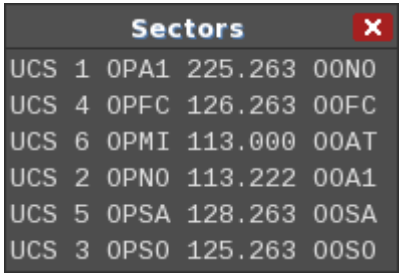
Display location by Lat/Long, Mouse Position, Airport, Fix point, Callsign or SSR Code



Clock

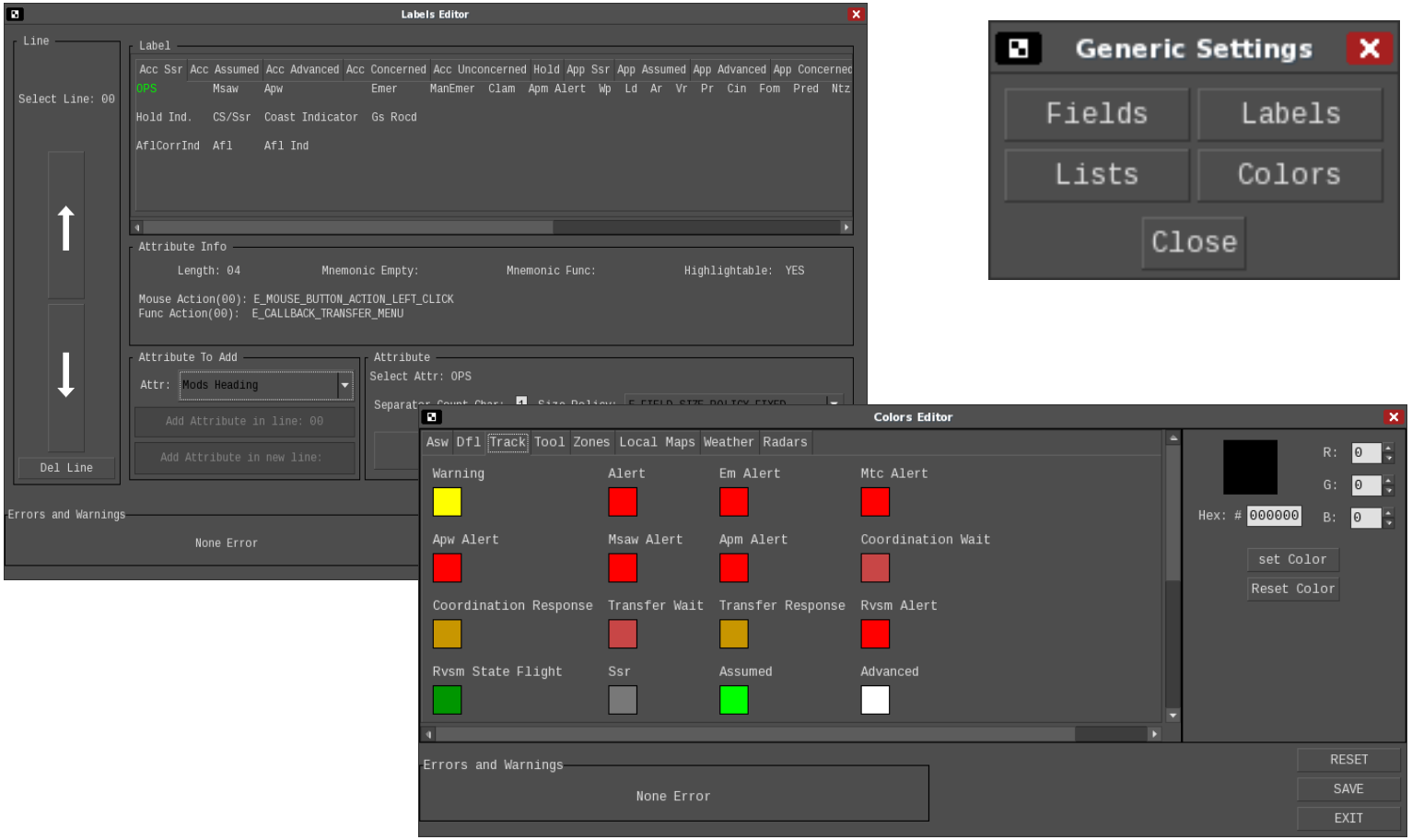


Sectors to CWP assignation



iCWP – iCWP CONFIGURATION TOOL

- Graphic tool designed in order to create fields and to set them in labels and flight plan lists, as well as to set colours to the elements.
- The elements set in each list/ label can be adjusted by each role



MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

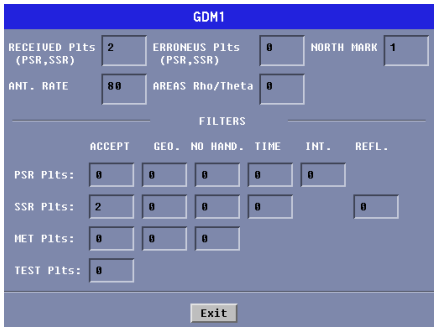
DBM
- Data Base Management System

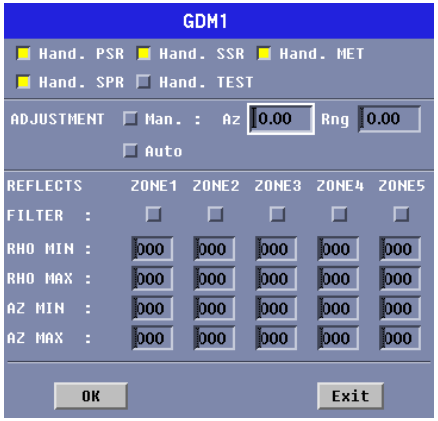
FDS
- Flight Data ServerSystem

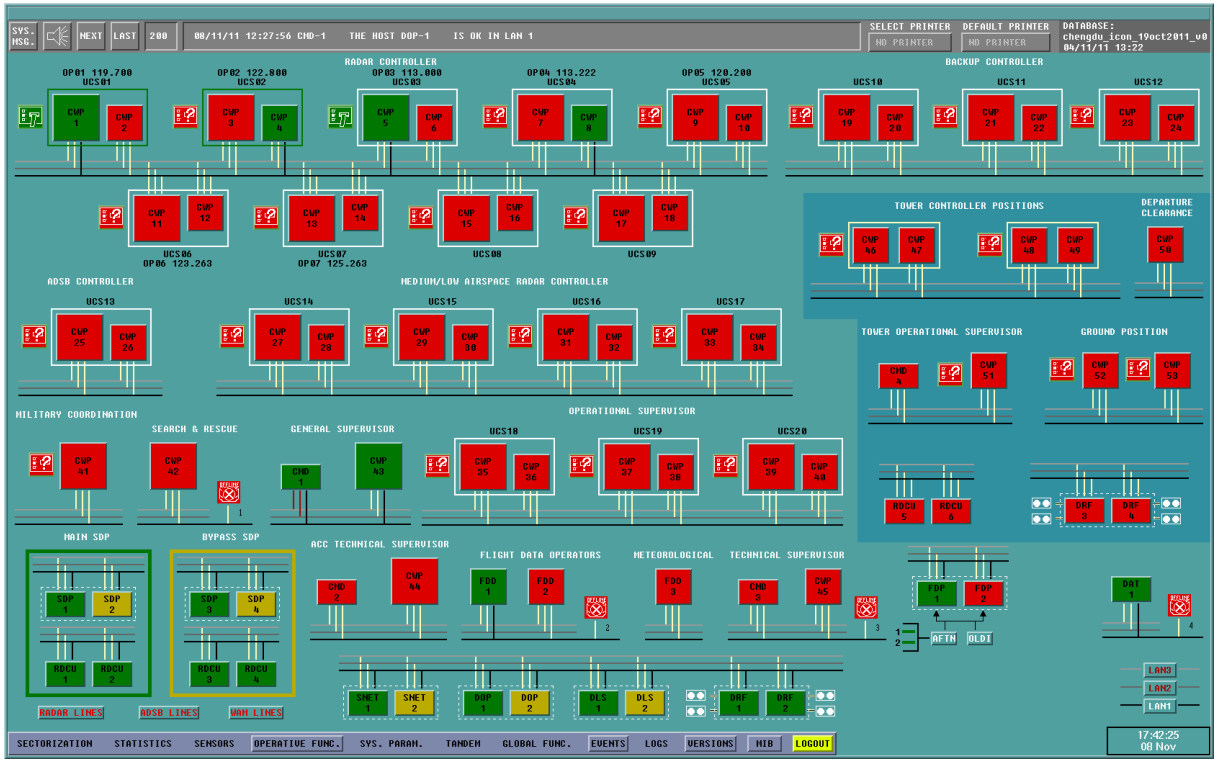
DAT
- Data Analisys Tool

CMD – CONTROL & MONITORING DISPLAY

- CMD is intended for Technical Supervisor, Operational Supervisor or both combined.
- To increase the system availability, a redundant configuration is recommended.
- Access to the corresponding functions are restricted by username & password.







CMD – SUMMARY OF FUNCTIONS (I)

- Issues a graphical display of the system layout, including external systems.
- Sub-Systems monitoring, following a colour code.
- Sectors Re-Assignation.
- Sensors monitoring and Management (Radars, ADS-B, WAM)
- Lines monitoring and Management (AFTN, AMHS, AIDC, OLDI, SITA, FDS, Radar, ADS-B, WAM).
- Hardware performances monitoring.
- System messages display, print and store on disk.
- Provides a list of logged users.
- Complemented with a iCWP configured to monitoring the raw plots and tracks received from different radar sites.
- CMD provides configuration data to the Voice Communication System (VCS) upon sector reconfiguration such that the VCS and ATM system may be reconfigured in one action.

CMD – SUMMARY OF FUNCTIONS (II)

- Radar Configuration and Radar Statistics (RTQC of radar data).
- System Statistics.
- Configuration of system functions.
- Change of VSP parameters.
- Global Monitoring Display
- Online change of QNH and Transition Altitude values.
- System partial/global shutdowns/startups.
- Equipment switchovers.
- Events and logs retrieve.

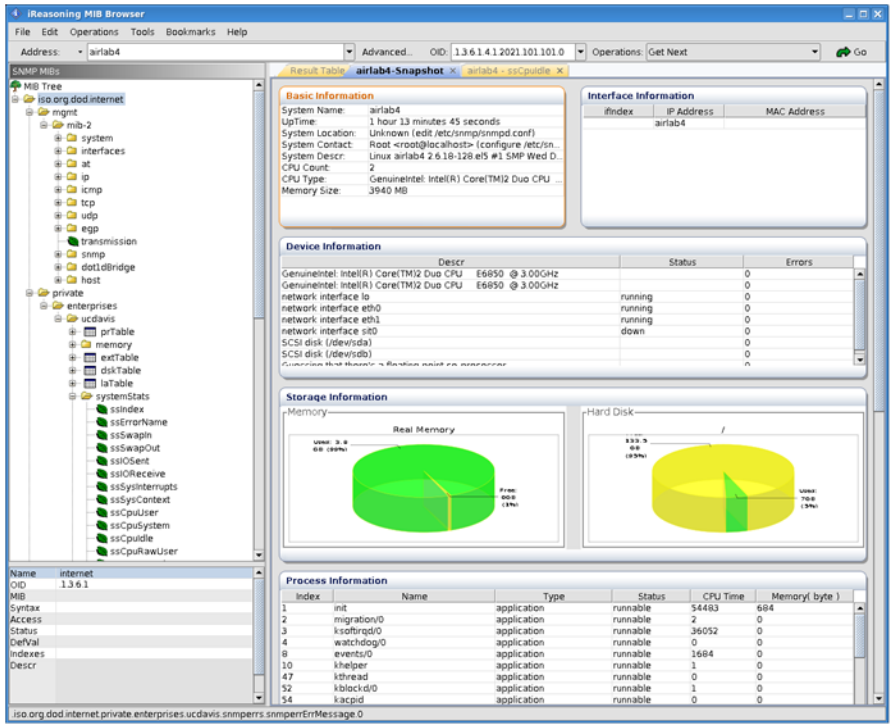
CMD – GLOBAL MONITORING DISPLAY

GMD provides a high level monitoring function for the global system, including: the state of the different Automation systems in their different locations, WAN network equipment

MAIN FEATURES

- Architecture fully based on standard SNMP solution
- Scalability: Systems that implement SNMP protocol can be easily added

This function monitors and displays information such as monitored elements identification, processes running on a server, memory used, status of the CPUs, status of the network interface cards, use of the different storage media, identification of components of the servers, IP addresses, fault management, performances management, etc.



MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

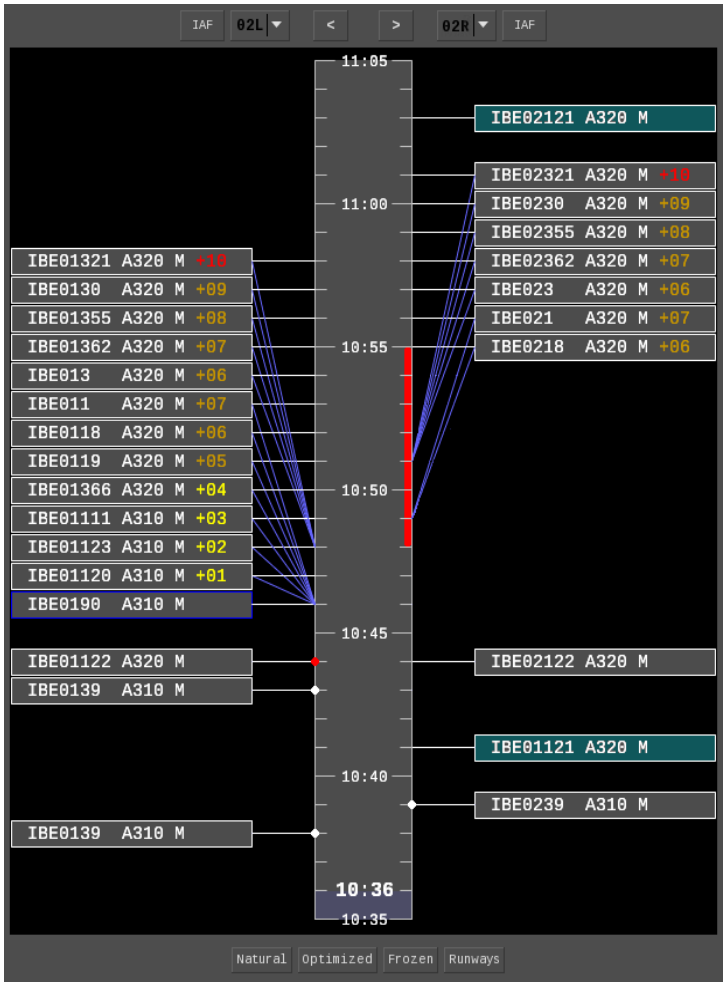
DAT
- Data Analisys Tool

ARRIVAL MANAGER (I)

- Multiple runways in multiple configurations (parallel runways, crossing runways, mixed mode of operations, dependant runways, etc.)
- Early landing runway assignation based on users' preferences, IAF point, aircraft type, runway configuration and load balancing.
- It provides stable landing sequence and associated advisories (Time-To-Lose/Time-To-Gain and holding).
- Tabular and graphical presentation of landing sequence and advisories at ACC, APP and TWR positions.
- Flexible commands for changing the proposed arrival sequence on unexpected situations. Available for authorised controller roles.
- Fully integrated with Flight Data Processor and supporting facilities (e.g. TP, SDP, Datalink, other flow features and tools, data recording, etc.)
- AMAN information displayed in surveillance display in track labels (including sequence number, TTG/TTL and holding advisories).

ARRIVAL MANAGER (II)

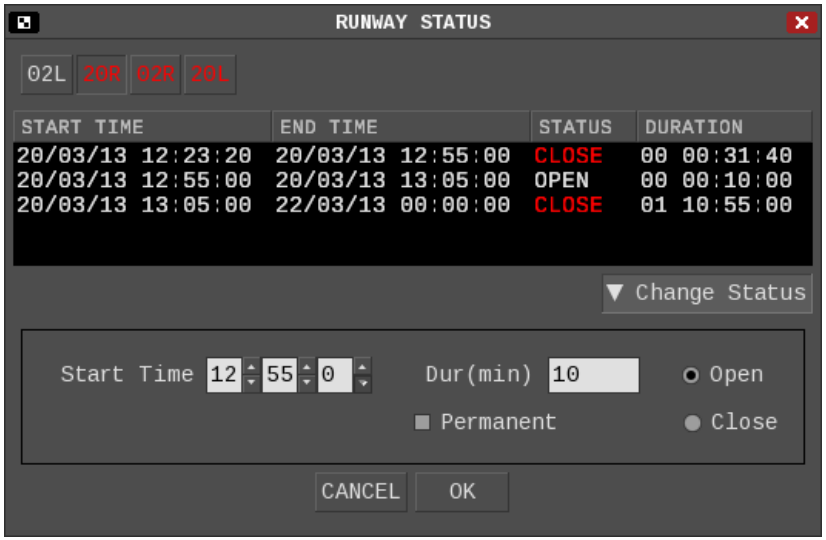
- Arrival sequence displayed in timeline window.
  - Arrival, departing, manually inserted, automatically and manually frozen flights distinguished by icons and colours.
  - Ordered by Computed Time of Arrival. ETA also displayed.
  - Coloured advisories.
  - Controller actions accessible directly from flight labels.
  - Runway Management and graphical presentation of runway configuration.
  - Access to flight lists per sequencing point (e.g. TMA entry point).
  - One or Two runways displayed. Multiple windows.
  - Adjustable timescale.



ARRIVAL MANAGER (III)

Controller manual actions:

- Request for modification of sequence flight position.
- Manual reservation/Freeing of a slot to a flight in the sequence.
- Request for flights order swapping.
- Freeze the sequence from a flight onwards.
- Change of runway preference for a flight.
- Removal/Re-insertion of flights from the sequence (e.g. go-around and miss approach).
- Assignation/Freeing of a slot to a flight not in the sequence (e.g. departure, VFR and pop-up flights).
- Change of flight priority.
- Reservation/Freeing of a empty slots.
- Closure/Opening of a runway.
- Change of runway capacity.



MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

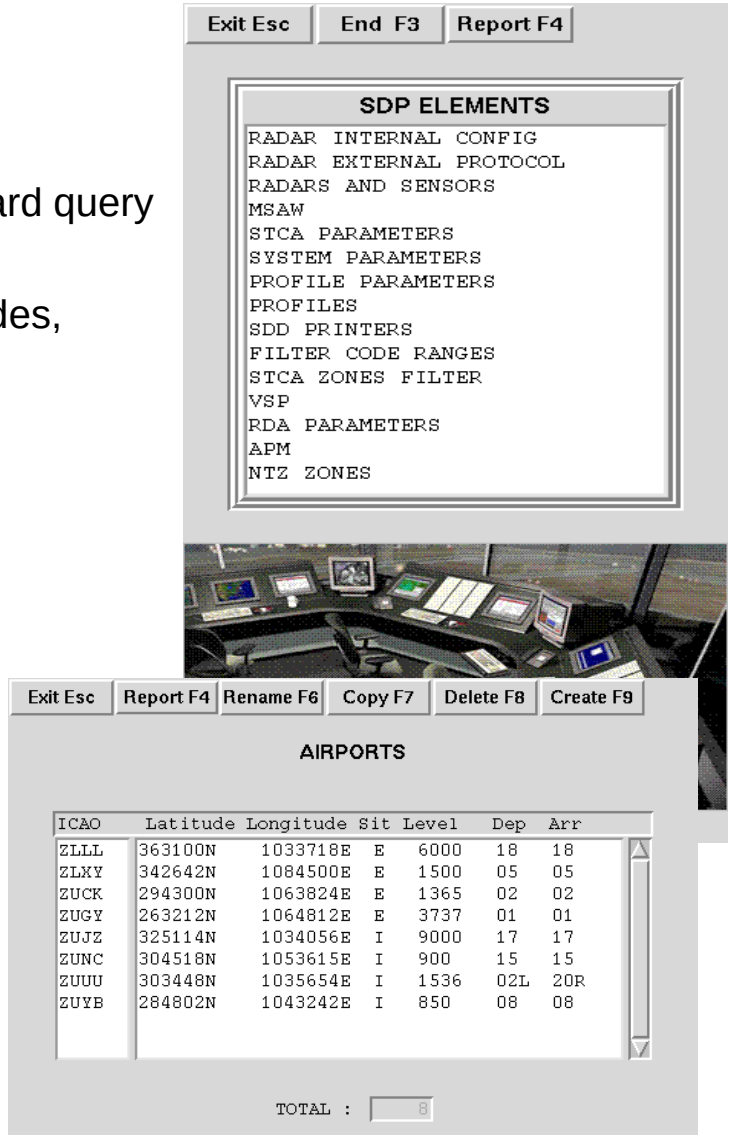
DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

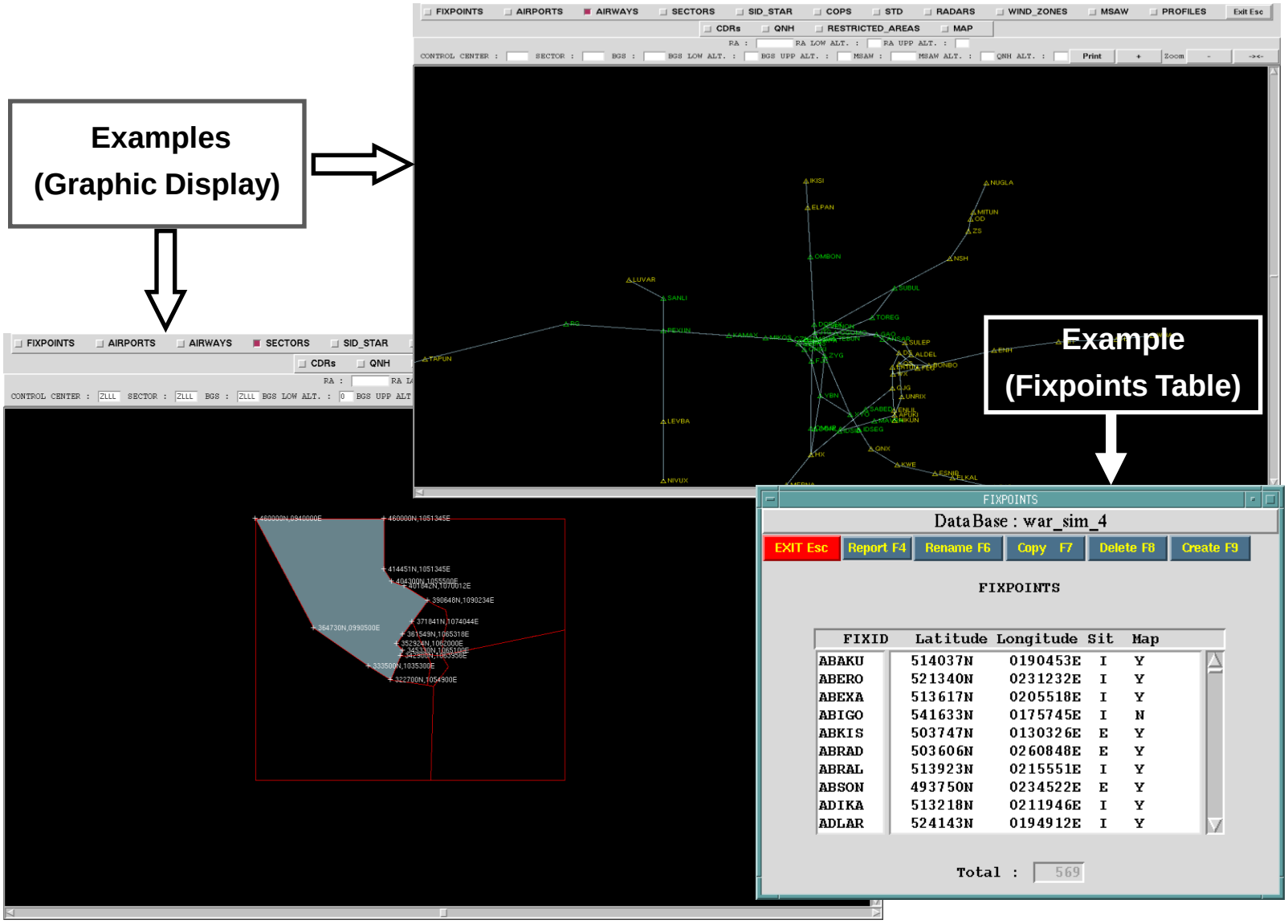
DBM – ADAPTATION DATA BASE MANAGEMENT (I)

- Define Database with data adapted to the peculiarities of the ATS unit:
  - Use of commercial Databases and standard query languages (SQL, 4GL).
  - Aeronautical elements (Sectors, SSR Codes, Airports, Restr. Zones…).
  - Navigation Aids.
  - System Parameters Adjustment.
  - Automatic Import of CSV and BADA data.
  - Sensors Configuration.
  - Graphic Display of Parameters set in DBM (Map mode).
  - Conflict Parameters and SSR Codes Exclusion.
  - Definition of APM Profiles and NTZ Zones.
  - Adjustment of DSL and FDS Parameters.
  - iCWP Map tree configuration.



DBM – ADAPTATION DATA BASE MANAGEMENT (II)

Examples (Graphic Display)



Example (Fixpoints Table)

FIXPOINTS

DataBase : war_sim_4

EXIT Esc | Report F4 | Rename F6 | Copy F7 | Delete F8 | Create F9

FIXPOINTS

FIXID	Latitude	Longitude	Sit	Map
ABAKU	514037N	0190453E	I	Y
ABERO	521340N	0231232E	I	Y
ABEXA	513617N	0205518E	I	Y
ABIGO	541633N	0175745E	I	N
ABKIS	503747N	0130326E	E	Y
ABRAD	503606N	0260848E	E	Y
ABRAL	513923N	0215551E	I	Y
ABSON	493750N	0234522E	E	Y
ADIKA	513218N	0211946E	I	Y
ADLAR	524143N	0194912E	I	Y

Total : 569

MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

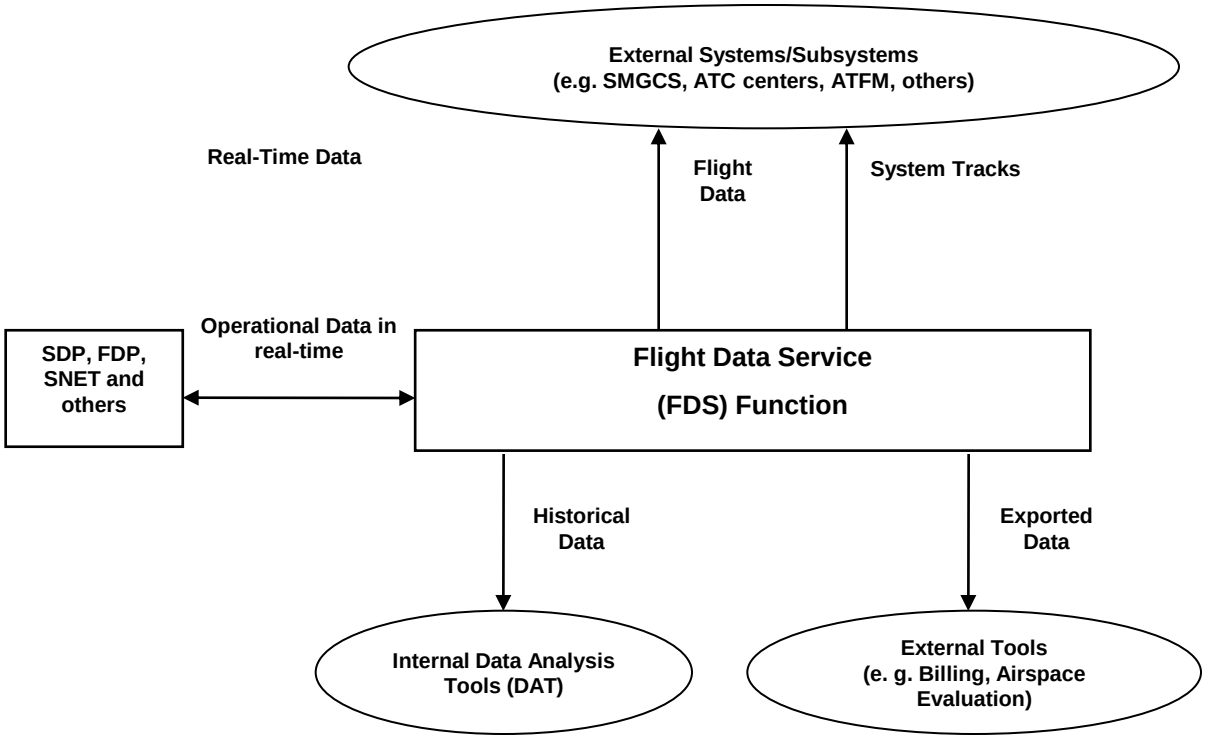
DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

FDS – FLIGHT DATA SERVICE

- The Flight Data Service **stores**, **collects** and **sends** system real-time data to external subsystems (e.g. SMGCS, other ATC centres, etc.) and external tools (e.g. billing and airport FIDS) as well as historic data to be used by internal data analysis tools (e.g. traffic statistics, data test and verifying, events & log).



MAIN SUBSYSTEMS

RDCU
- Radar Data Compressor Unit

SDP
- Surveillance Data Processor

FDP
- Flight Data Processor

SNET
- Safety Nets

EFS
- Electronic Flight Strips

DRF
- Data Recording Facility

DLS
- Data Link Server

CWP
- Control Working Position

CMD
- Control and Monitoring Display

AMAN
- Arrival Manager

DBM
- Data Base Management System

FDS
- Flight Data ServerSystem

DAT
- Data Analisys Tool

DAT – DATA ANALYSIS TOOL

- DAT encloses a set of functions for the analysis and study of the system data (e.g. traffic statistics, data test and verifying, events & log) based on historic data provided by the Flight Data Service (FDS) function.
- The DAT provides the following data analysis tools:
  - **Statistics Function:**
    - Traffic Statistics Reports. They contain information on the historical traffic situation.
    - Operational Statistics Reports. They contain information on flight actions and messages incoming to the ATM system.
    - Flow Statistics.
  - **Tests and Verifying Tools:**
    - Operation Events and Status Log File Management.
    - Surveillance Data Errors Analysis.

INDEX

MAIN CHARACTERISTICS OF ATM SYSTEM (HW AND SW)

- Open Architecture conforming with ISO/OSI.
- Commercial RISC processors.
- TCP/IP and UDP communications protocol.
- LINUX operating system.
- High Resolution Displays (2Kx2K, FHD, 2560x1600).
- Use of open and commercial Data Bases and standard query languages: PostgreSQL, MySQL, 4GL.
- Use of high-level languages: ADA and C.
- Use of standard graphics: X-Window and Motif.
- The ATM System network is based in the Ethernet standards. All servers and workstations have connection to, at least, the double Operational LAN.

LAN TOPOLOGY

- The ATM System network is based in the Ethernet standards. All servers and workstations have connection to the double Operational LAN for system data and to an additional LAN for surveillance by-pass, system management and maintenance through independent Ethernet boards.
- This connection is usually 100/1000BaseT, with twisted pair wiring. If necessary (e.g. for workstations situated in the control tower far from the servers) fiber optic cable is used.
- The network has a star topology, with the use of hubs or switches, depending on the user requirements.

AVAILABILITY AND RECOVERY (I)

- Failures of any of the redundant elements of the system (RDCU, SDP, FDP, DRF, SNET, FDS, DLS) trigger an immediate switchover to the corresponding standby unit. Switchovers can also be performed manually. Switchover on the FDP will be performed without loss of the existing messages, or information stored in the flight plan, MET and NOTAMs databases.
- Any failure detected in any of the LAN cables will result in getting the information through the supplementary LAN cable (all messages are distributed twice, once for each LAN).
- Tools for installation, update and backup/restore the whole system are provided with and user-friendly HMI.
- In the event of a total failure of the SDP (both operational and stand-by servers) the iCWPs provide monoradar processing Emergency (By-Pass) mode.

AVAILABILITY AND RECOVERY (II)

- In the event of a total failure of the FDP, it can be restarted either without any lost of the data existing prior to the failure (Warm Start) or without data (Cold Start).
- The System have the capacity to be endowed with several CMDs (for the Technical and Operational Supervisors), in order to provide redundancy in the Control and Monitoring function.
- Following a power failure of any or all the elements of the system, when restarting the element, the last adaptation and configuration parameters existing prior to the failure are used.
- These characteristics, along with the use of highly available COTS equipment, allow to keep a:

System Availability > 0.9999

INDEX

SCENARIO EMULATOR COMPONENT

- **Air Traffic Generator (ATG)**: provides all movements of aircraft, and all necessary radar data, ADS tracks, the management of the data link applications (AFN, ADS and CPDLC), and flight plan messages for the ACC/APP/TWR Control Operational system replica, for both pilot and controller, derived from the settings and commands during a training session. This element also supports the maintenance of the simulation exercises library.
- **Exercise Preparation Operator (EPP)**: to design and produce the exercises library, which is used by the ATG to initiate an exercise into training session.
- **Session Manager Operator (SM)**: interacts with the ATG for positions configuration. This position has the capability to modify exercise data and exercise control during the training session. Also, when the user selects a training exercise then the air situation picture corresponding to selected exercise is displayed and updated in real time as for pilot and the control of background flights is available.
- **Pilot Operator (PP)**: interacts with the ATG for the control of aircraft. It comprises the display of the radar situation in air, weathers and session info and of Terminal of Data Link (presentation / edition of CPDLC messages, established ADS contracts monitoring). This position also has the capability to modify exercise data and exercise control during the training session.

INTERFACE BETWEEN AIR/GROUND TRAFFIC GENERATION AND REAL ATM SYSTEM

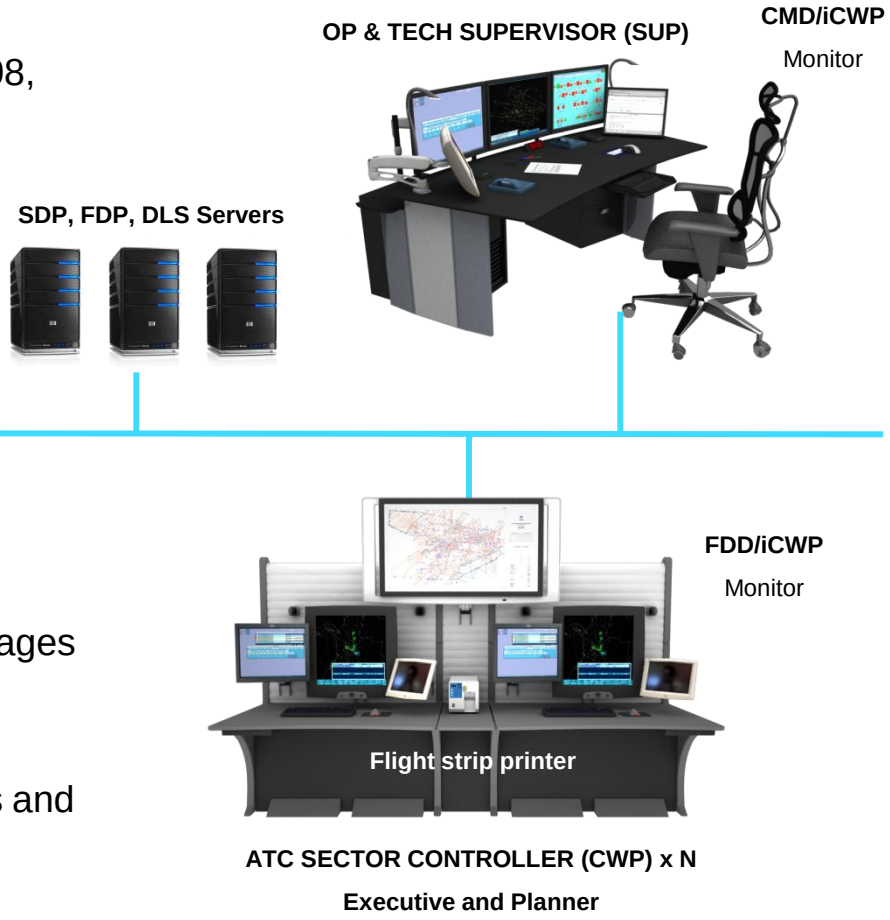
From ATG

- Mono-radar data messages (target and weather in ASTERIX format, Cat 01, 02, 08, 48, …) and ADS-B reports (ASTERIX cat 21).
- AFTN/IFPS Flight plan and Meteo & Aeronautical messages (ICAO & ADEXP formats).
- Exercise Time and control message.

From / To ATG

- OLDI/AFTN Adjacent Coordination messages (AFTN ICAO & ADEXP formats).
- Air-Ground Datalink Messages: ADS-C reports and contracts, CPDLC clearances and pilot responses.

ATM System Replica



TOWER SIMULATOR (I)

The Tower Simulator is a complete reproduction of a real Aerodrome Control Tower, displaying both 2D and 3D visual environments, being an expansion integrated with the ATM Simulator.

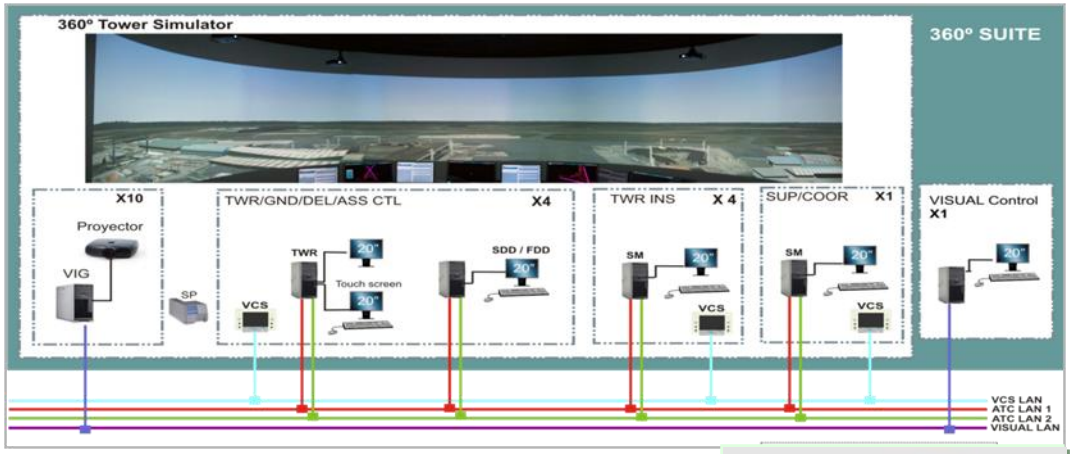
MAIN FEATURES

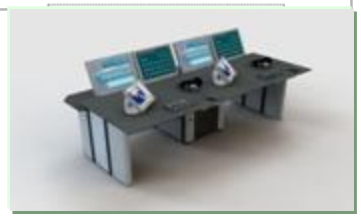
- System aims at enhancing training of TWR/APP/ACC Controllers
- Provides with 2D information of air/ground movements from :
  - Radars
  - ADS
  - Flight plans
  - External centres
  - CPDLC messages
  - Meteorological and aeronautical info
  - 3D images of aerodrome
- Simultaneous TWR/APP/ACC on 2D/3D Aerodrome and Airspace
- Provides up to 360º scene

TOWER SIMULATOR (II)

VISUAL FEATURES

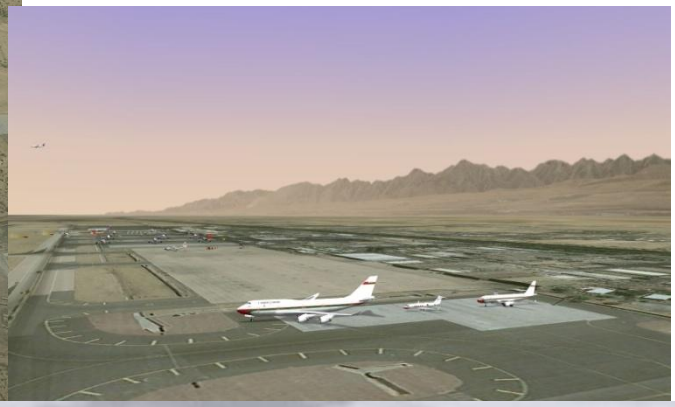
- Panoramic and selectable points of view (binocular tracking, pilot, zenith)
- Sun light updated and gradual change from daylight to darkness
- Atmospheric effects: fog variable, haze, rain, snow
- Aircraft / vehicle position lights, anti-collision lights and landing lights
- Helicopter and aircraft propellers in rotation
- Collision effect between landing aircraft and aircraft/vehicle on the runway

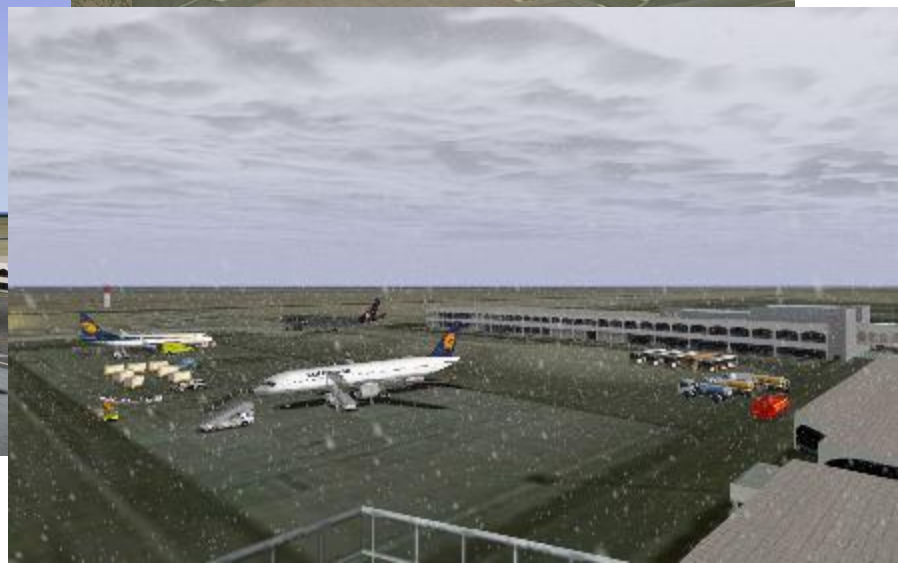




TOWER SIMULATOR (III)

EXAMPLES OF 3D SCENES





Av. Bruselas 35
28108 Alcobendas,
Madrid - España
T +34 91 480 6004
F +34 91 480 6041
www.indra.es