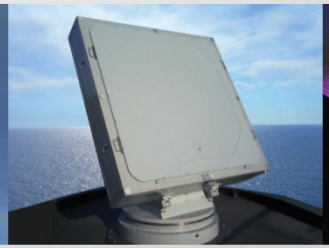
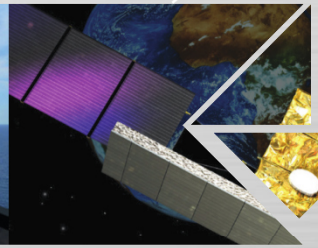
# NAM/CAR Air Traffic Services Inter-facility Data Communication (AIDC)
# North America Interface Control Document (NAM/IDC)

**Mexico City (Mexico) 8th - 11th April, 2019**



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# Air Traffic Management portfolio

**Surveillance**

A wide range of products covering PSR, MSSR, SMR, ADS-B, Multilateration including transportable solution

**Air Traffic Management**

Reliable, expandable and integrated command and control with capability of system architecture for state of art systems. Backup, Disaster & Recovery, Simulator and transportable systems complete the offer

Ground to air voice and data multi-mode communication systems, as well as datalink and AEROMACS broadband ground datalink

**Communication**

**Navigation Aids and Weather Radar**

Complete line of ground-based radio navigation and landing aids including DVOR, DME and ILS. Design, manufacture and installation of weather radar sensors and systems.

Security by design assured on all the products delivered and services for cyber prevention and analysis provided by State-of-art Security Operational Center

**Cyber ATM**

**UTM**

Unmanned Traffic Management for surveillance of U-Space with new technology and traffic management concept

# References in the ATM/Airport sector

## *OVER 300 SYSTEMS IN OPERATIONS*

- *ALBANIA*
- *ALGERIA*
- *ANTIGUA*
- *ARGENTINA*
- *AUSTRALIA*
- *AUSTRIA*
- *BAHAMAS*
- *BAHRAIN*
- *BARBADOS*
- *BELARUS*
- *BELGIUM*
- *BELIZE*
- *BOLIVIA*
- *BOTSWANA*
- *BRASIL*
- *BULGARIA*
- *CAMBODIA*
- *CAMEROON*
- *CANADA*
- *CAPE VERDE*
- *CHILE*
- *CIAD*
- *COLOMBIA*
- *CONGO*
- *COSTA RICA*
- *CROATIA*
- *CYPRUS*
- *CZECH REP.*
- *DENMARK*
- *DOMINICAN REP.*
- *ECUADOR*
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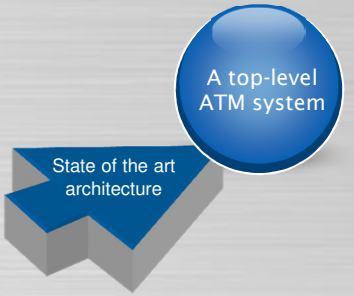
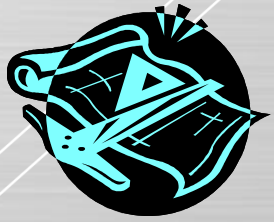
- *TUNISIA*
- *TURKEY*
- *UKRAINE*
- *U.A.E.*
- *UNITED KINGDOM*
- *U.S.A.*
- *URUGUAY*
- *UZBEKISTAN*
- *VENEZUELA*
- *VIETNAM*
- *YUGOSLAVIA*
- *ZAIRE*
- *ZAMBIA*
- *ZIMBABWE*

# State of the Art Architecture

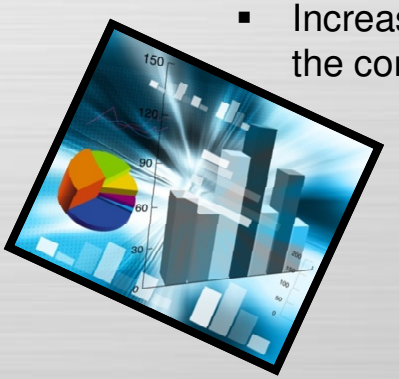



ATM is one of the most demanding domain for all the software-intensive systems. It is safety critical, near real time and highly distributed. For this reason, the new **Systems** has been designed as a distributed system with the following architectural characteristics:

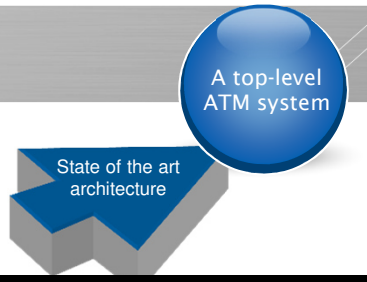


- **High Availability,** achieved by:
  - Fault Tolerance tactics through HW and SW "redundancy", and "Degraded Mode" solutions that minimize the impact of ATC operations unavailability

- **High Performance,** achieved by:
  - Increase of the efficiency through the maximum distribution of the computational load on the nodes

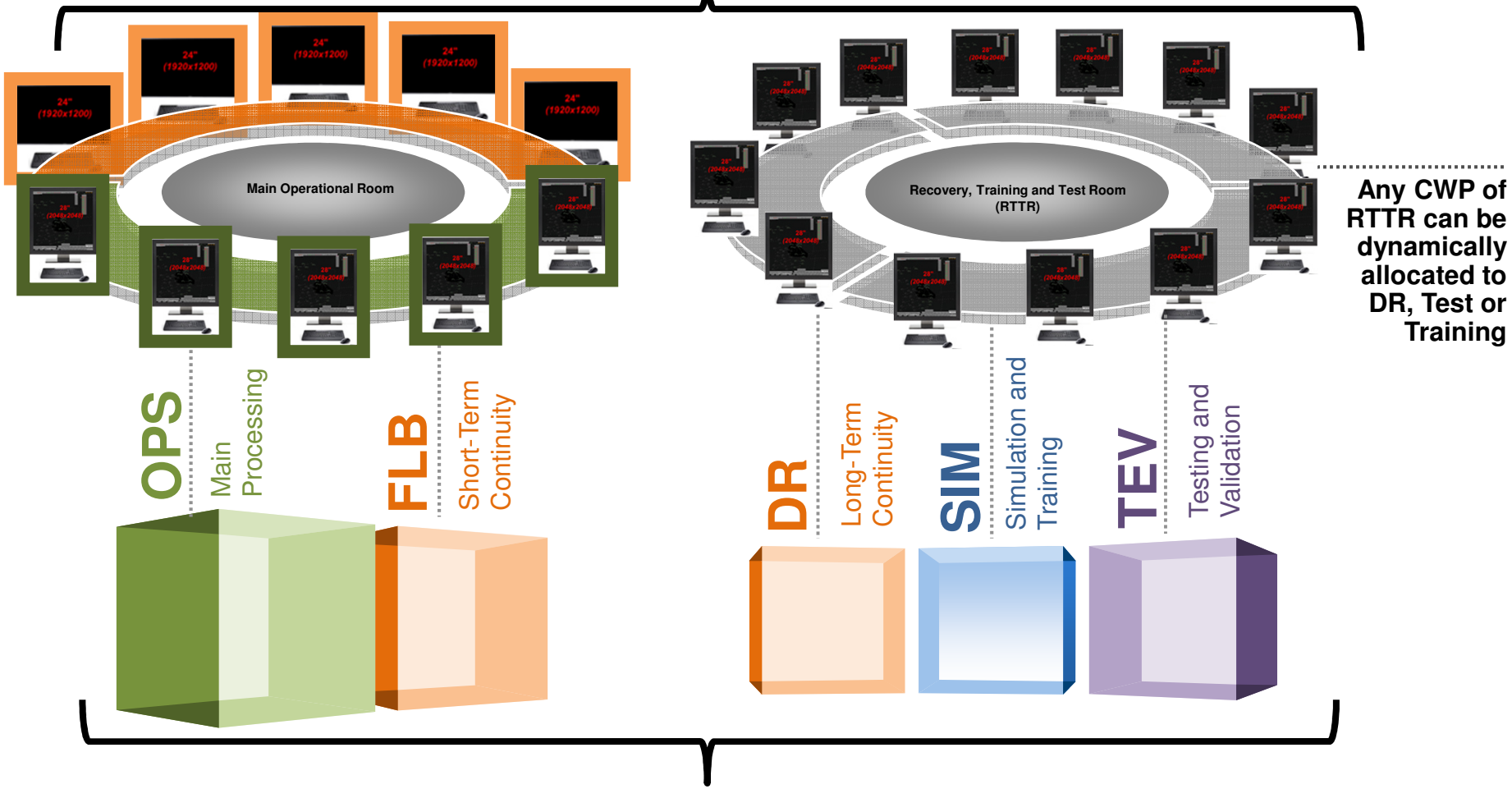


- **Modifiability/Scalability and Usability,** achieved by:
  - Separation of the ATC business applications from the general purpose ones (e.g. middleware) with well defined responsibility and interfaces, thus reduced "ripple effect"




# State of the Art Architecture

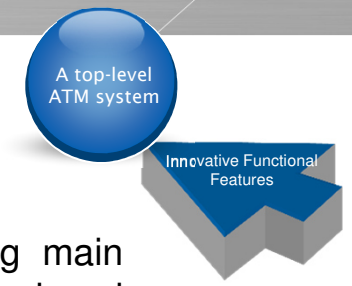
**Two Operational Rooms allowing flexible allocation of positions to services**




**Any CWP of RTTR can be dynamically allocated to DR, Test or Training**

**Five Processing Layers with dedicated HW partitions**

# A comprehensive ATM system




The suite of LEONARDO ATM System products and tools provides the following main capabilities and functions, which can be highly customized depending on Operational and Environmental needs:

- Heterogeneous surveillance data integration
- Accurate trajectory prediction
- Advanced ATC tools
- Air-ground data exchange
- Two-ways interoperability for civil and military missions
- Advanced operational display with Human Machine Interface improvements
- Improved safety and performance through integration of SESAR solutions (i4D, ASAS, TBS, AMAN, Safety nets)

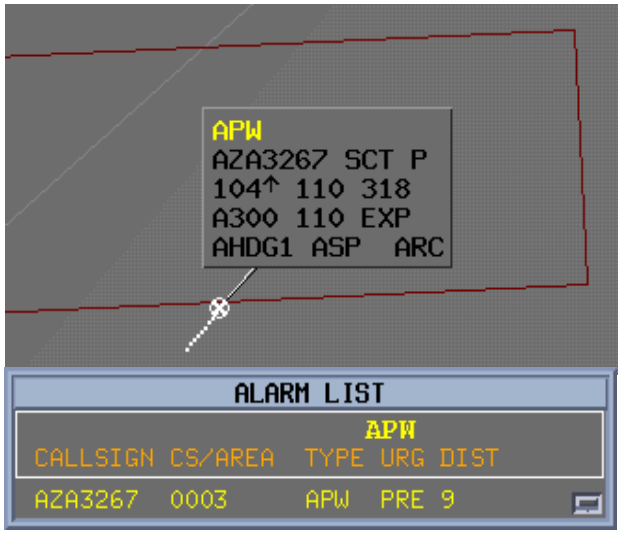

# Innovative Functional Features

## Safety Nets – Enhanced with a multi-hypothesis algorithm based on Mode-S data

Monitoring traffic for:

- CA Warning: Conflict analysis for possible separation loss between aircraft
- LA Warning: Low Altitude alert warning
- RA Warning: Reserved Airspace conflict analysis

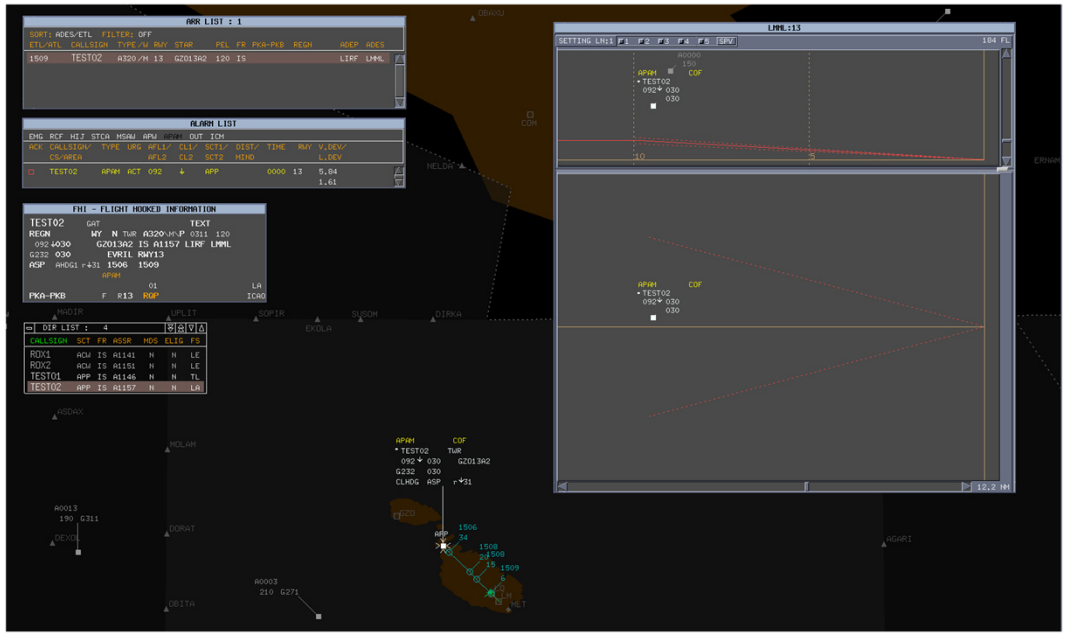




# Innovative Functional Features

## Safety Nets – Approach Path Monitoring

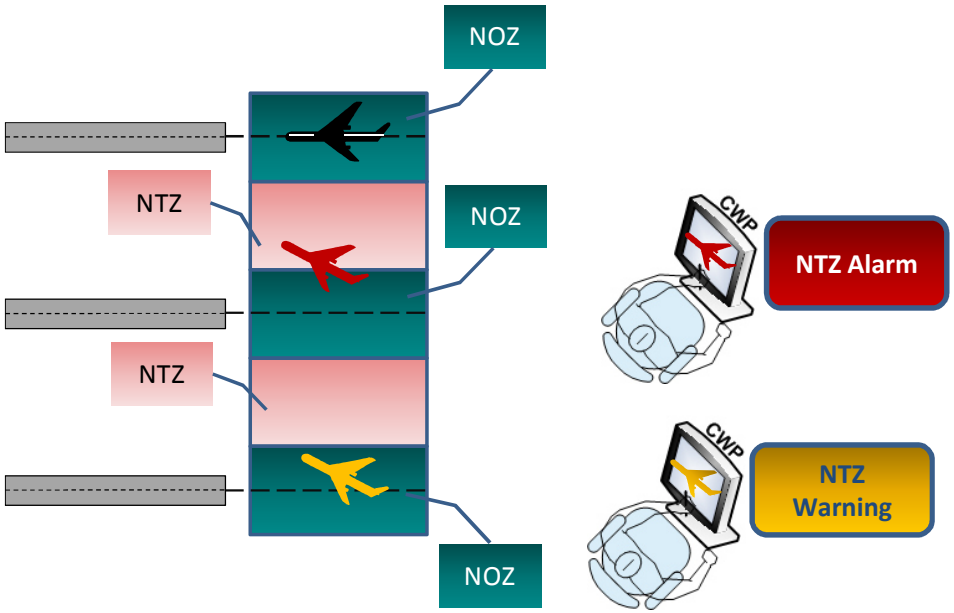
The Approach Path Monitoring function is a ground based safety net which assists controllers in the prevention of controlled flight into terrain accidents by generating an alert of a deviation from the nominal approach path.

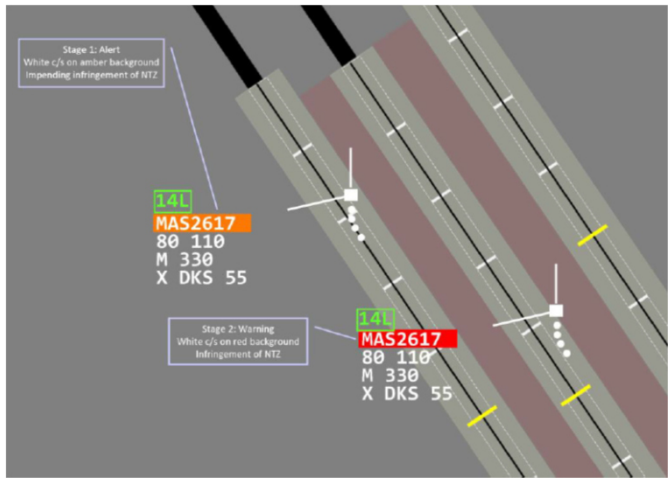


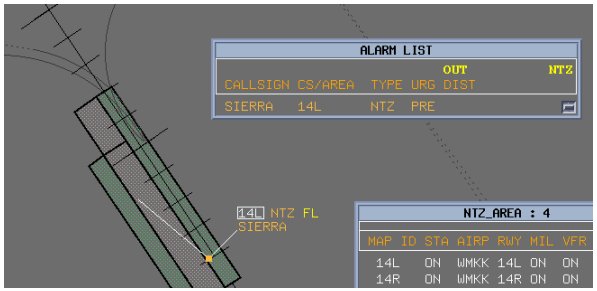

According to the destination airport and the landing runway a glide path cone is defined. The APM function generates a conflict if the position of an aircraft is in deviation (vertical or lateral) with respect to the nominal descending angle. The condition of deviation is calculated taking into account to different thresholds: one for lateral deviation and one for vertical deviation.

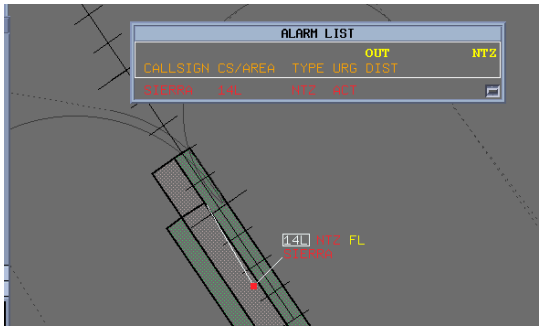
# Innovative Functional Features

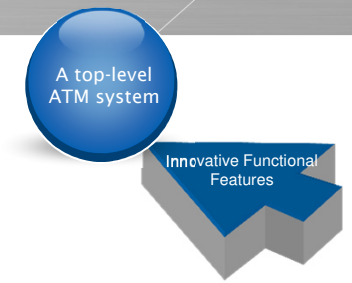
## Safety Nets – Simultaneous Parallel Approach-NTZ



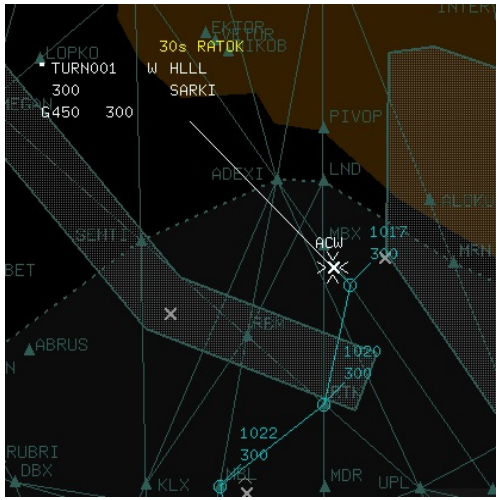






# Innovative Functional Features

## ATC Tools – Monitoring Aids (MONA)

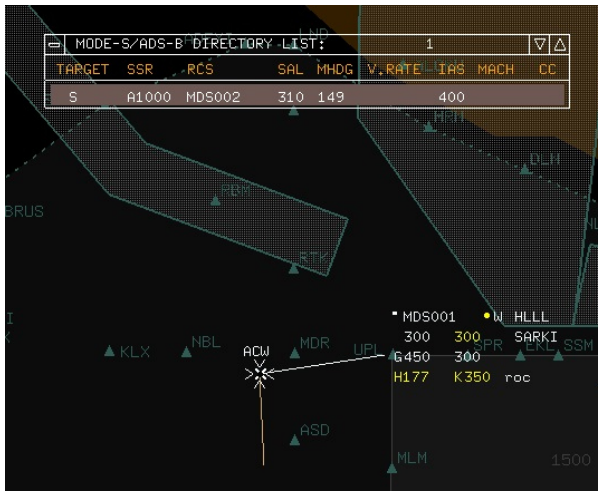
TURN REMINDER: upon a rerouting order, VSP seconds before the next point to be reported, a turn reminder is displayed to the operator.




LATERAL DEVIATION Left/Right with respect to the SFPL trajectory.


MODE S WARNINGS:

- received callsign
- received IAS
- received SAL
- received magnetic heading

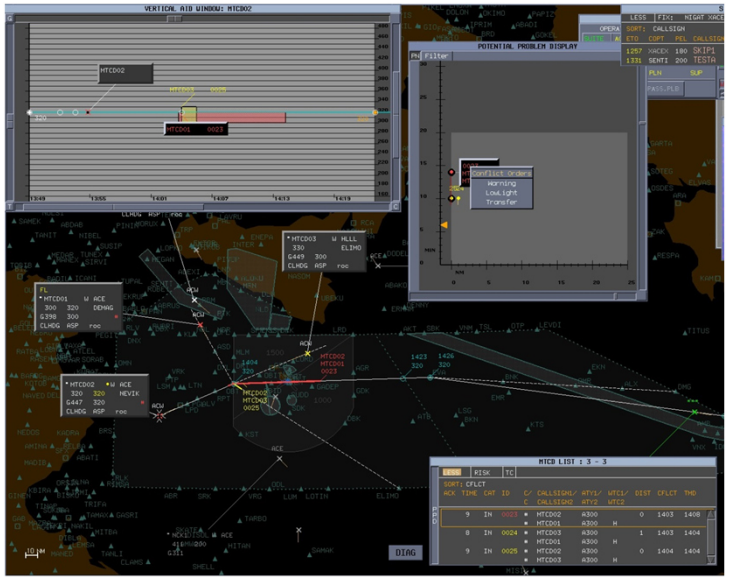


# Innovative Functional Features

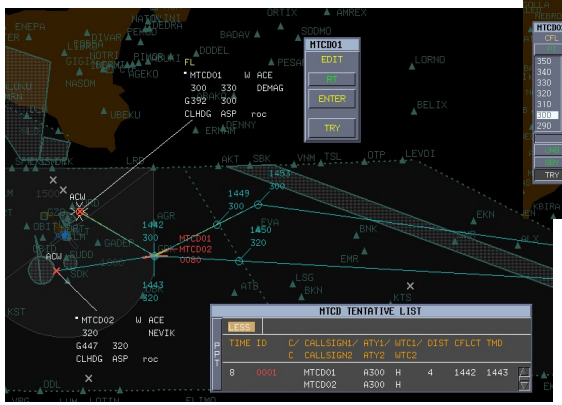
## ATC Tools – Medium-Term Conflict Detection (MTCD)

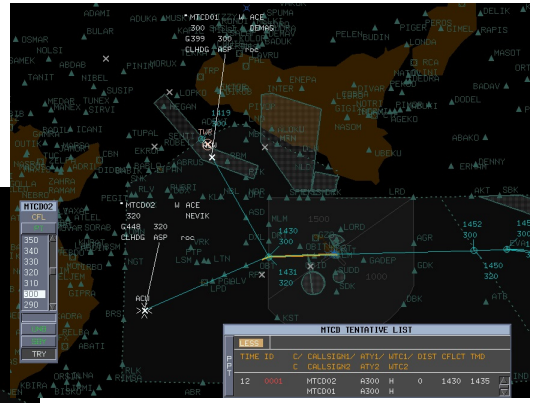
Detection of:
- Conflict
- Risk of conflict
- Context traffic

Transfer of conflict from PLN to EXE:
- Manual
- Automatic



PROBE function to find tentative encounters:
- XFL/PEL
- Rerouting (TRY order)



# Innovative Functional Features

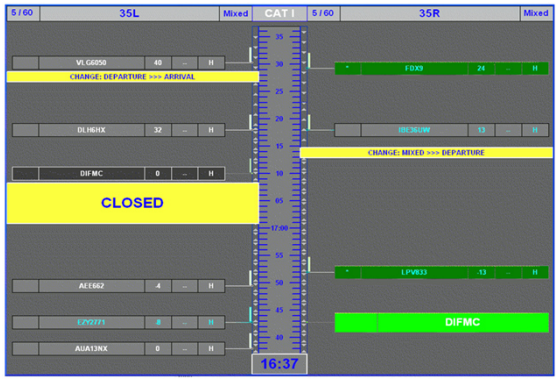
## ATC Tools – Arrival Manager (AMAN)

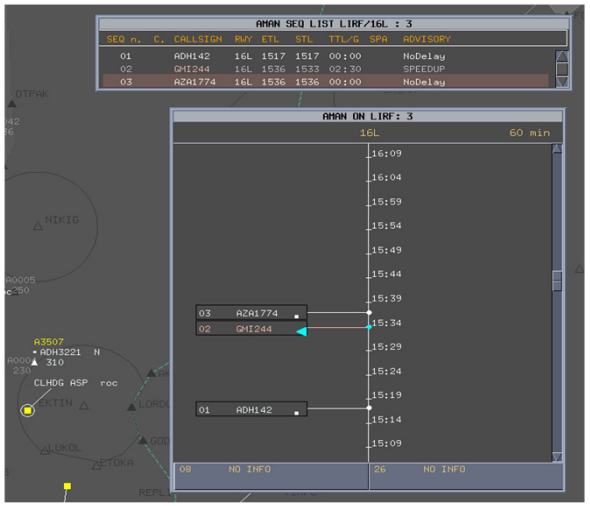
### Main functional features:

- Sequences based on system flight trajectories and updates thereof
- Sequences calculation on Fixes and Runways
- Configuration parameters: Active and Frozen Horizon, Holding Fixes, Linked RWYs
- Comprehensive Advisories
- Multi Runway Management
- Load Balancing among available runways
- Supporting the new SESAR concept of AMAN Extended horizon (E-AMAN)
- Support for procedures based on Point Merge System (short-term)

### Main HMI features:

- Arrival sequence number, TTL/TTG and advisories (e.g. Holding) available on track label and flight strip
- Comprehensive presentation: Graphical Window and List
- Arrival sequences lists configured on main window or on secondary screen
- Controllers' orders available through track label, flight strip and arrival sequences lists
- Integrated flight hooking to/from arrival sequences lists



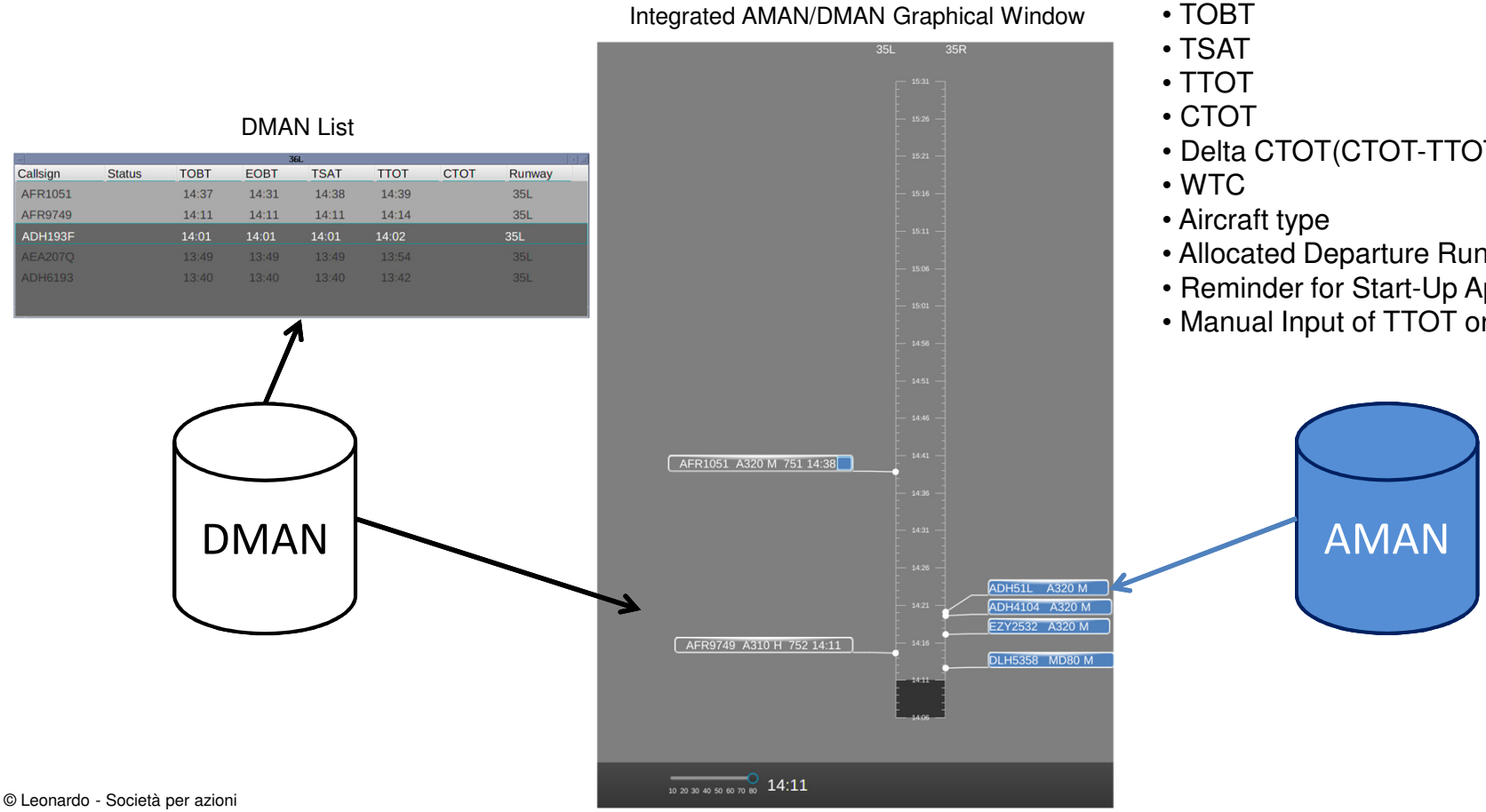
# Innovative Functional Features

## ATC Tools – Departure Manager (DMAN)

Renewed java-based HMI integrating AMAN-DMAN sequences for a comprehensive and optimal usage of resources (runway and TMA). The graphical window can be customized to display only AMAN, only DMAN or mixed sequences.

DMAN List

| Callsign | Status | TOBT | EOBT | TSAT | TTOT | CTOT | Runway |
|---|---|---|---|---|---|---|---|
| AFR1051 | | 14:37 | 14:31 | 14:38 | 14:39 | | 35L |
| AFR9749 | | 14:11 | 14:11 | 14:11 | 14:14 | | 35L |
| ADH193F | | 14:01 | 14:01 | 14:01 | 14:02 | | 35L |
| AEA207Q | | 13:49 | 13:49 | 13:49 | 13:54 | | 35L |
| ADH6193 | | 13:40 | 13:40 | 13:40 | 13:42 | | 35L |

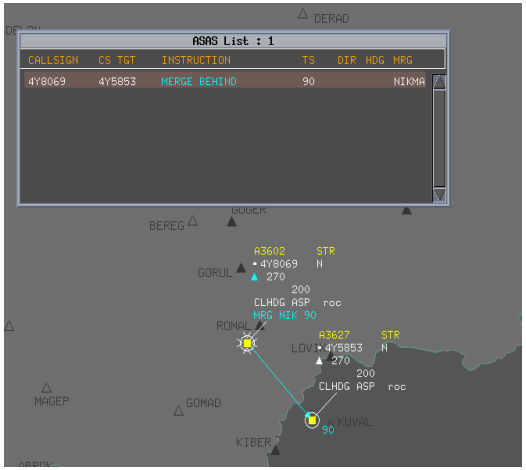


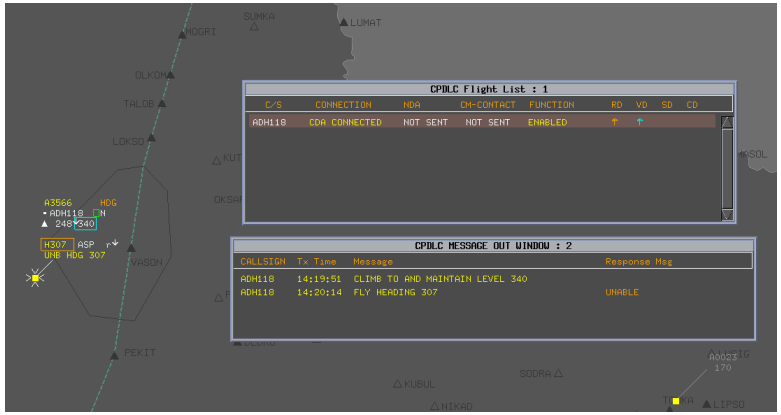

- Call-Sign
- TOBT
- TSAT
- TTOT
- CTOT
- Delta CTOT(CTOT-TTOT)
- WTC
- Aircraft type
- Allocated Departure Runway
- Reminder for Start-Up Approval
- Manual Input of TTOT or TSAT

# Innovative Functional Features

## ATC Tools – Airborne Separation Assistance Systems

ASAS supports ground controllers during initiation, execution and termination of a set of procedures that enable the controller to instruct an aircraft (via Air-Ground communication) to achieve and maintain a given time spacing from a preceding aircraft.



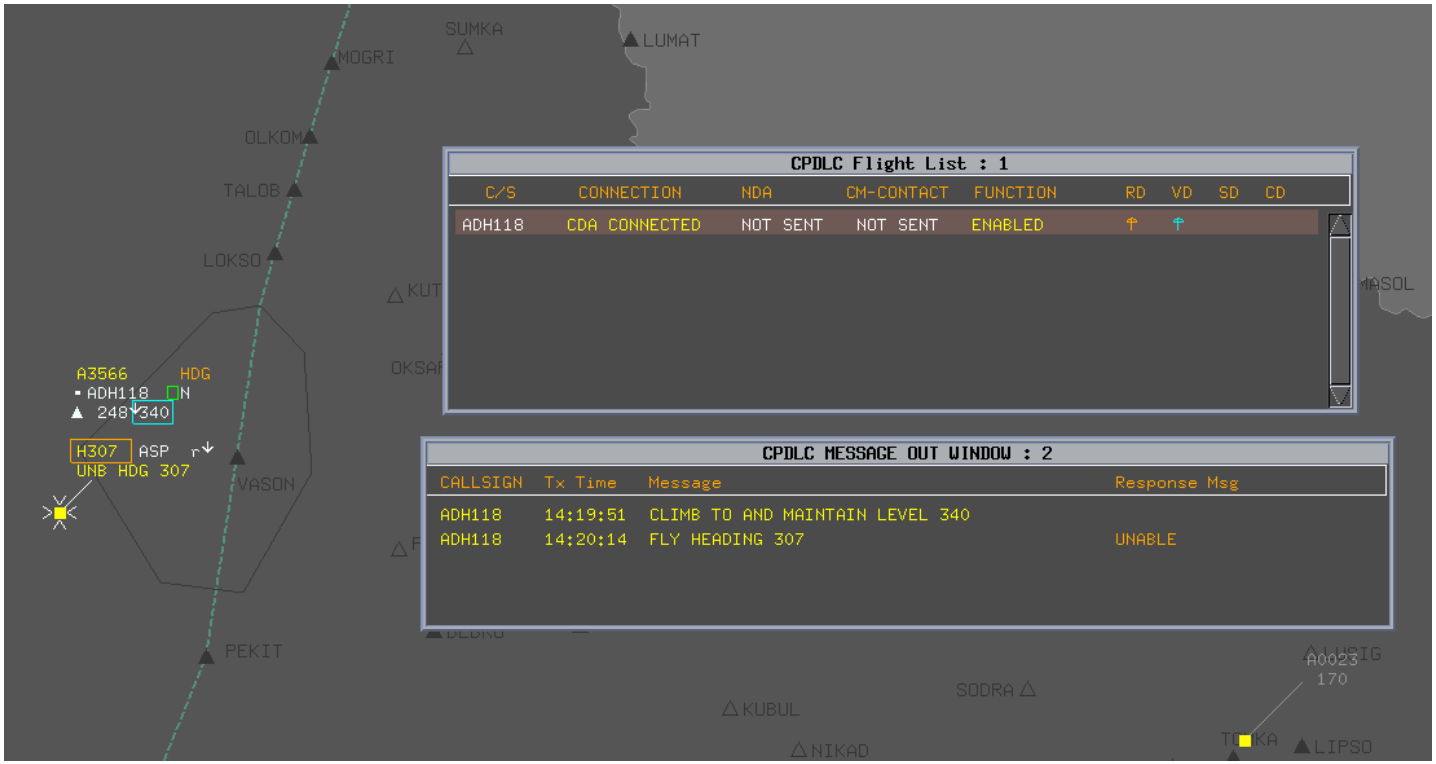



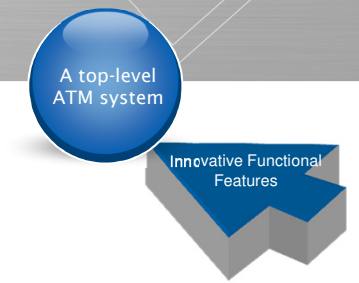

I4D capability to support the sharing of 4D trajectory between ground and air systems, the provision of time constraints at a specific point (e.g. during the descent/approach phase) and the monitoring of the aircraft behavior respect to the assigned constraint.

# Innovative Functional Features

## ATC Tools – I4D

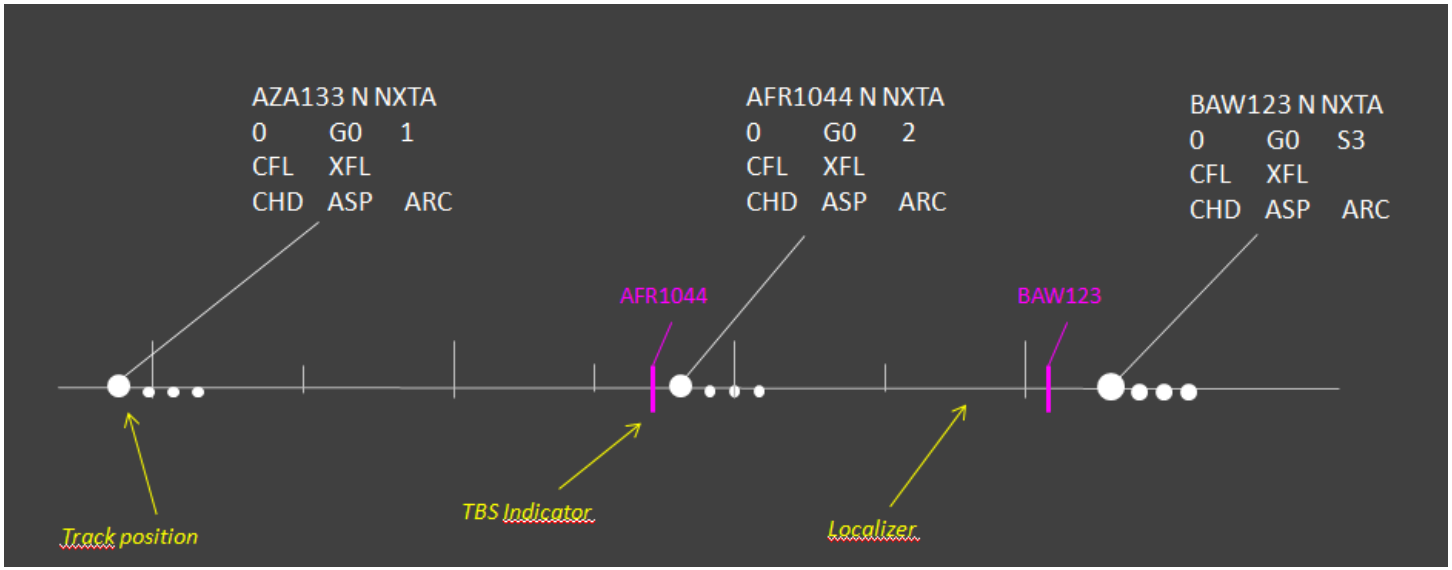
I4D capability to support the sharing of 4D trajectory between ground and air systems, the provision of time constraints at a specific point (e.g. during the descent/approach phase) and the monitoring of the aircraft behaviour respect to the assigned constraint.






# Innovative Functional Features

## ATC Tools – Time Based Separation tool




- Support to the final approach controller, through the use of spacing indicators, in applying **time based wake turbulence separation rules**

- Spacing indicators for each flight in the arrival sequence (within a configured time/space horizon) representing the spacing value provided by the TBS algorithm, are visualized respect to the reference position of the preceding aircraft.

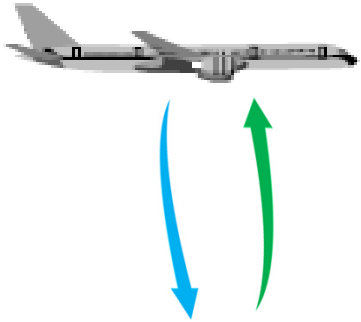
- Enhanced stabilisation of the overall time spacing between arrival aircraft by improving the landing rate resilience to headwind conditions on final approach.

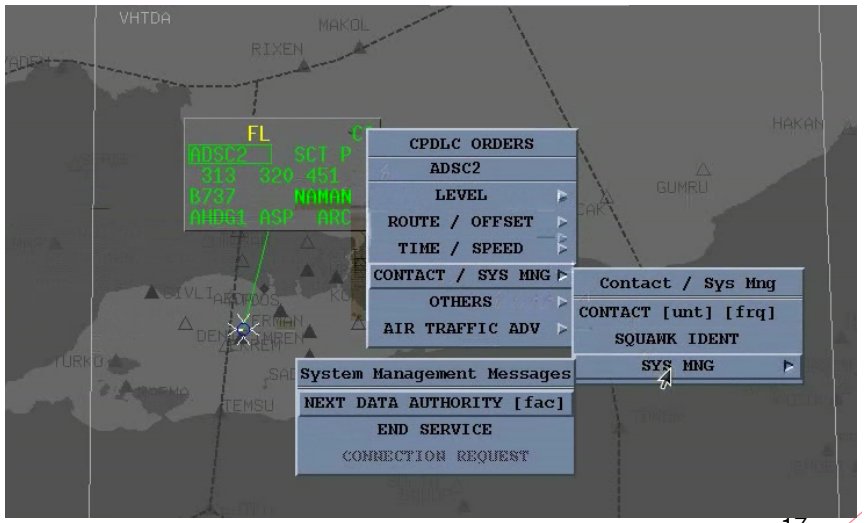
# Innovative Functional Features

## Air-Ground Data Link (AGDL)

**LeadInSky fully integrates the following datalink applications regulated by international standards, to support air ground communication:**

- **AFN** (ATS Facility Notification) / **CM** (Context Management) Application:
  - Management of the link to ACARS/ATN Service Provider network
  - Management of Logon and Contact functions (through the DLIC service)
- **CPDLC** (Controller Pilot Data Link Communication) Application:
  - Management of Connection/Disconnection, Transfer of aircraft control between sectors/FIRs, Uplink/Downlink message handling, Dialogues and Archiving (through ACM and ACL services)
  - Messages to support the ASAS and I4D concepts of operation
- **ADS-C** (Automatic Dependent Surveillance-Contract) Application:
  - Management of ADS-C contracts (periodic, event, on-demand)
  - Performing of ADS-C tracking
- **DCL** (Departure Clearance) Application:
  - Management of ACARS DCL messages (RCD, CLD, CDA and FSM)
  - Performing of DCL input commands/interactions on CWP
- **D-ATIS** (Datalink-Automatic Terminal Information Service) Application:
  - Management of contract request (demand and update mode)
  - Transmitting ATIS information via data-link





# Innovative Functional Features

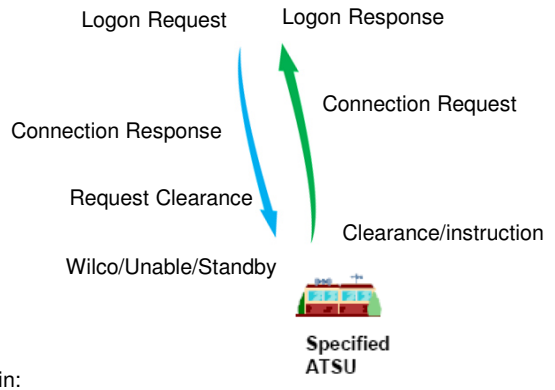
## Air-Ground Data Link (AGDL)

Controller-Pilot Data-Link Communication (CPDLC) and AFN (ATS Facility Notification) / CM (Context Management) Application

The CPDLC application provides the CNS/ATM system with data link communications services, i.e. clearances, expected clearances, requests, reports and related ATC information. A "free-text" capability is also provided to exchange information not conforming to defined formats.

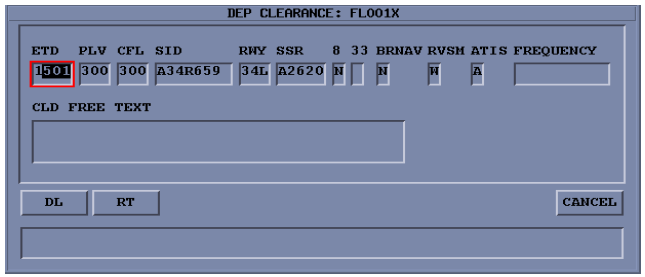

**Enabled CPDLC Airspace**

**Two ways communication**




**Departure Clearance via Data-Link (DCL)**

- Reception and handling of the DCL datalink requests (RCD)
- Handling and sending of the datalink responses (CLD,FSM)
- Reception and handling of the pilot's acknowledgment (CDA




The controller can select if execute the order in:

- RT (Via **Voice**) or
- DL (**Datalink**)

# ATM FDPS Data Base - Main Features

LEONARDO LeadInSky ATM systems are based on a relational data base to store, collect and protect information related to the ATC system operation and data management

Two DB engines are currently handled by the LeadInSky ATM baseline:

- **ORACLE** – based upon a cluster of servers sharing the mass memory storage
- **PostgreSQL** – based upon self-consistent machines pool balancing the load in transparent way

Both of them make available the following characteristics:

- Triggers management - to handle automatic notifications and tables alignment
- Immediate data consistency – prevent from data loss and information corruption
- SQL – standard access rights

Both the solutions are applied “of-the-shelf” therefore the vendor configuration is applied during the installation phase. The suggested parameters are normally left in place, among those both the engines can be configured in terms of user’s contemporary access by:

- Number of connections
- Number of processes

Both the solutions are currently available and can be chosen depending on the following considerations

- Customer’s preferences
- Hardware needs / expectations
- Economical aspects

# ATM FDPS Data Base – Stored Information

The Data Base capacity is designed (from both HW and SW aspects) on the ATM system requirements in terms of traffic and operational environment

LEONARDO LeadInSky ATM system is designed with the following main capacities:

- Flight Plan dimension in DB up to 8 Kb each
- Data Base information capacity up to 2 Gb

The Flight Plans management is the core of the modern ATM systems. The capacity to correctly handle high volumes of traffic supporting ATCOs with all the necessary functions stem on the quick availability of a large amount of data such as:

- **Static data management** : geographical / operational environment
- **Dynamic data management** : trajectory calculation and flight progress monitoring
- **History and statistical purposes** : playbacks, billings, traffic statics

A specific highlight has to be set on the aircraft performances  data stored in he DB. By those data the LEONARDO LeadInSky ATM system is able to:

- Calculate the FPL initial trajectory – based upon specific True Air Speed, nominal climb / descending rates
- Monitor the flight progress – updating the trajectory
- Calculate possible conflicts – separation lost, minimum altitude infringement

The Aircraft Performances Data are the data on witch the system bases the trajectory initial profile calculation and time estimations s well as flight progress monitoring and kinematics extrapolation. The correction of those data is mandatory as well as any eventually update due to either new  aircraft models issues or changes /adptations of the current models in service

# ATM FDPS Data Base – Maintenance

Both the DB engines available are installed and configured following the vendor instructions and advices.

The DBs themselves provide data integrity logics and information protection and redundancy algorithms witch respond to SW safety requirements.

LEONARDO LeadInSky ATM systems supports the end users with specifically written programs in order to perform:

- **DB Export procedure**: to be used to save a copy of the entire Data Base to be used for possible system recovery
- **DB Import procedure**: to be used to recover a previous version of the data base

FDPS DB supports the handling of AIXM 5.1 (Aeronautical Information Exchange Model) for automatic import of geographical environments objects (basically AIPs data)

Note that while the export procedure can be performed while the ATM system is running (no interferences with the operations) the import procedure is a ‘cold’ procedure meaning that non DB users have to be running while attempting to execute it.

# ATM FDPS Data Base – Contingency

In the unlike events of a fatal DB failure the Flight Data Processing sub-system of the LeadInSky ATM platform cannot run any longer since basic data for its processing are no more available.

The LEONARDO ATM system reacts to this occurrence with a different levels of operational redundancies:

- **Surveillance continuity**: the radar targets and their information are not affected by the failure of the Data Base. All the FPL / Track correlations are kept alive on all the available CWP
- **Target Identification continuity**: is still possible to identify targets by entering a reduced set of information (basically not involving trajectory – Field 15)
- **DB recovery**: targets identified during the DB absence can be easily re inserted as soon as the DB comes back in service by clearance orders. The FDPS shall check the condition of the FPL verifying its trajectory and eventually updating the fligth progress in accordance with the target position

# Data Base – Operational Reflection

Out of the surveillance data, the flight plans information management, together with other correlated data (such as weather) is the basis for the provision of ATC service in terms of both :

- Strategical traffic management: ATM flow management, trajectory prediction, long and medium term de-conflicts
- Tactical traffic handling: Intra FIR coordination, Inter-sector coordination, tactical constraints, clearance delivery….

The commonality of information is getting more and more fundamental moving toward ever more uniform and automated skies

The possibility to increase traffic flows among different entities keeping safety at highest, lies mainly in the ability to speak the same language i.e.: to interpret the same data with the same logic.

Therefore having a common data-base not only means to rely on the same kind of data typing (as is abundantly described in the various international standards) but also to submit these data to the same processing logics , thus granting an homogeneous result throughout different ATC provisioning areas.

# Innovative Functional Features

## International Standards

**Among others, the main standards the Leonardo ATM system complies to are:**

**Asterix protocols for Surveillance, Meteo and Alerts**
**GRIB1/2 format for Meteo Data**
**OLDI 4.2 and AIDC 3.0 for Coordination and Transfer**
**AFTN/AMHS standard**
**ICAO and ADEXP formats compliant to:**

- **ICAO Doc 4444-PANS ATM/501/15th ed., plus Amendment 1**
- **Regional Supplementary Procedures (ICAO Doc 7030, 5th edition, Amendment 2)**
- **EUROCONTROL Standard for ATS Data Exchange Presentation Released Edition 3.1**
- **ICAO Asia Pacific Regional Interface Control Document for AIDC version 3.0.**
- **ICAO Annex 10 Vol. 1-2-3-4-5 Title "Aeronautical Communications" (latest edition)**

THANK **YOU** FOR YOUR ATTENTION

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