ALPHA
Air Traffic Control
Automation System

SHORT SYSTEM DESCRIPTION

Document Reference: 2020 ALPHA-ATM-SSD Rev 6.0

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1 INTRODUCTION

1.1 Propose

This document summaries and provides a short description of the Alpha ATC automation system product family.

Alpha ATC automation system, hereinafter referred to as the system, is an integrated system providing all the necessary functions and capacities for en-route, approach, tower, and ground Air Traffic Management, including A-SMGCS functions up to level 4 (Surveillance, Control and Safety Nets, Routing, Guidance), as well as Flight Plan Processing, Electronic Flight Strips, and Clearance management.

This document can be used for initial introduction to the product, its main features and configuration options.

1.2 Revision history

Revision	Date	Modification
0.1	15.08.2019	First draft release for internal review
1.0	01.09.2019	First release after the internal review
2.0	15.01.2020	New features were added
3.0	17.07.2020	Release after critical review
4.0	05.01.2021	Full re-release after critical review and restructuring
5.0	15.01.2021	Minor changes and editorial fixes
6.0	08.03.2021	Document restructuring

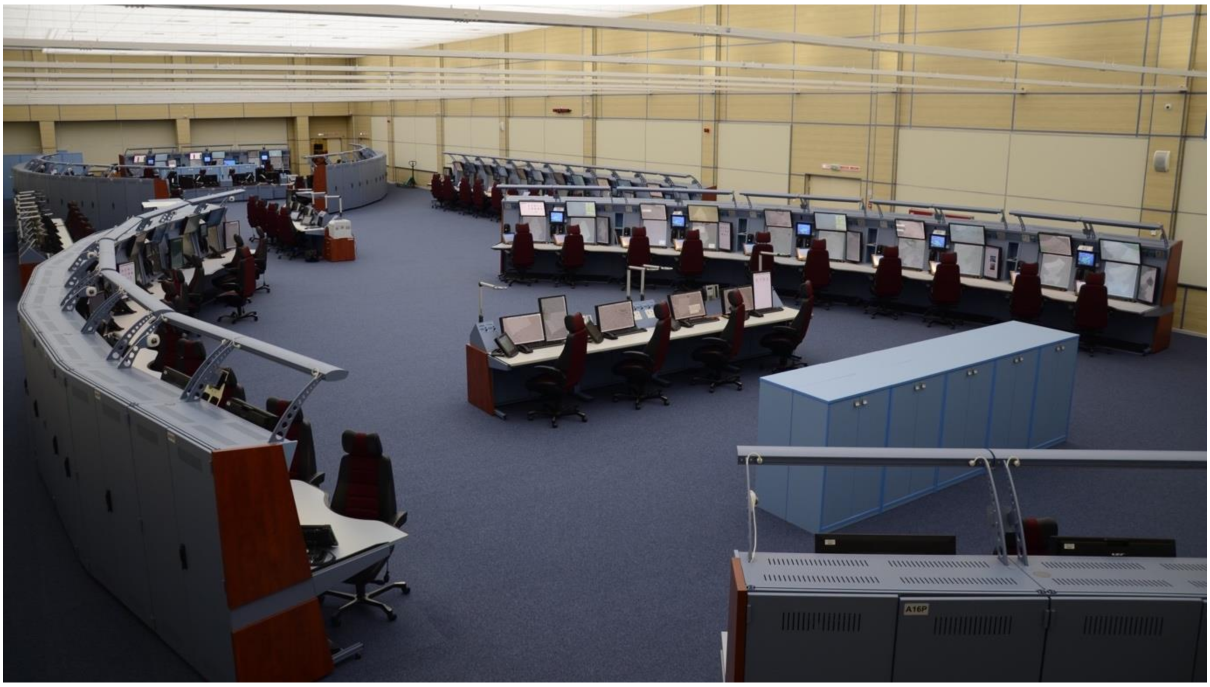
2 SYSTEM OVERVIEW

2.1 General

Alpha Air Traffic Control Automation System (hereinafter referred to as Alpha ATC system) is designed to automate the air traffic control processes and to facilitate coordination of the work of controllers in ATC units of low, medium and high air traffic intensity. It is a multi-purpose system which is based on the state-of-the-art technology to provide traffic control service during all flight phases: en-route, approach, tower and ground. Alpha ATC system provides air traffic management functionality for all ATC units, including:

- Surface movement control;
- Ground control;
- Tower control;
- Approach control;
- Area control;
- Oceanic control.

Alpha ATC system is designed in accordance with the international standards, regulations and specifications listed in section 10 References. The Human-Machine Interface is compliant with the requirements of Eurocontrol (EATCHIP PHASE III HMI, EUROCONTROL ODID IV).



Alpha ATC system performs data processing and control functions in the area of responsibility of up to 2000 x 2000 nautical miles at altitudes of up to 80,000 feet. The total number of flight plans processed by the system is up to 10,000 passive plans and up to 1000 active plans. The surveillance data processing capability of the system ensures simultaneous tracking of at least 500 targets per second.

The system provides automation of the following processes:

- Acquisition, processing, storage, display and distribution of flight plans;
- Acquisition, processing and display of air situation (surveillance) data;
- Data integrity and validity checks;
- Joint processing of flight plans and surveillance data;
- Acquisition, processing and display of weather and aeronautical information;
- Analysis of information about the current and predicted air situation;
- Display of information about the current and predicted air situation, flight plans, weather information and information about airspace restrictions;
- Safety Nets and Monitoring Aids (STCA, MSAW, MTCD, APW, TCT, RCM, CLAM, A-SMGCS alerts, etc.) with a switch-off option to show alarms for a user-defined area;
- Recording and playback of information processed by the system;
- Technical control and monitoring of the system operation;
- Interaction with adjacent systems and automated ATC systems;
- Automated coordination between adjacent ATC units in AIDC or OLDI standards;
- Control of the airspace use procedures.

The system provides acquisition, processing and display of various kinds of information, including:

- Flight plan (FPL) data in ICAO/ADEXP formats;
- Surveillance data (PSR, SSR/MSSR, Mode S radars, ADS-B, ADS-C, Multilateration systems, SMR);
- Airfield and airspace structure data;
- Air navigation data (NOTAMs, etc.);
- Weather data;
- Reference information.

The system supports radar, MLAT and ADS-B output protocols of major manufacturers (European, American, Russian).

As a basis, the system supports the following ASTERIX data formats: CAT001/002, CAT004, CAT008, CAT010, CAT011, CAT019/020, CAT021, CAT023, CAT034/048, CAT062, CAT240. Support of other data formats (including proprietary ICDs) can be provided upon request.

The following physical input interfaces are used for data reception:

- RS-232/422/485 serial interfaces;
- Ethernet LAN (TCP/UDP/IP protocols).

Depending on the availability of local surveillance sensors, the system can be configured both for non-radar and radar control.

Surveillance data received from all sources is processed together. For track generation, all available data is used (ASR, PSR, SSR, Mode S radars, ADS-B stations, Multilateration systems, SMR). Monoradar or multi-sensor fused data can be shared with external systems.

In the event that connection with data sources is lost, the system remains operable and uses last received data and data input by the operator.

All positional information used in the system is referenced to the World Geodetic System (WGS-84). Thus, the system provides a common reference point for processing and displaying data.

2.2 Main features

The system performs the following functions (depending on the configuration):

- Automatic reception of surveillance data from en-route and terminal surveillance sensors, and data processing;
- Integration (multi-radar processing and data integrity checks) of radar data supplied by several sources;
- Automatic target tracking using PSR, SSR, PSR+SSR, MLAT, ADS-B, ADS-C, SMR data;
- Seamless transition from airborne tracks to surface tracks;
- Output of fused track data to the functions within the system and to external systems (if any) in standard ASTERIX cat. 62 format;
- Automatic correlation (identification) of the current flight plan data with tracks of targets equipped with transponders (cooperative targets);
- Manual correlation of the current flight plan data with tracks of aircraft that are not equipped with transponders (non-cooperative targets);
- Display of the aircraft current position in the form if a synthetic symbol with history;
- Automatic display of track labels;
- Automatic control of WPT and transfer line passage;
- Automated transfer of control between the controllers of adjacent sectors;
- Calculation of aircraft position extrapolation vectors and display of the prediction vector for a specified time;
- Automatic informing of the controllers about the absence of positional and other information from the radars and generation of timely alerts when the system must not be used for the intended operation;
- Automatic transfer of labels of aircraft without a flight plan to the loss log when no data is supplied from the radars during the specified number of scans;
- Resumption of tracking of aircraft from the loss log when the radar starts supplying data (automatically if the aircraft is equipped with a transponder and manually if the aircraft is not equipped with a transponder);
- Automatic calculation and display of the aircraft distance and azimuth with respect to the coordinates selected before (aerodrome reference point, radar or VOR/DME position);
- Measurement of azimuth and distance between two points (geographic coordinates or tracks) with the help of the "vector/measurer" function;
- Automatic and manual scattering of track labels in case of their overlapping;
- Automatic calculation and display of geographic coordinates of any point on the screen pointed out by the marker;
- Safety Nets and Monitoring Aids;
- Integrated A-SMGCS and Airport Safety Nets functions;
- Integration with Airfield Ground Lighting (AGL) system for reception of the status and control of the stop bars, runway guard lights, taxiway centerline lights, clearance bar lights, etc. (tower controllers are able to control AGL from all the CWPs in the Tower);
- Electronic Flight Strips;
- Arrival sequencing and metering using AMAN procedures (Arrival Manager);
- Departure sequencing and metering using DMAN procedures (Departure Manager);

- Controller-Pilot Data Link Communication (CPDLC);
- Departure Clearance Service (DCL);
- Integration and data exchange with Visual Docking Guidance System (VDGS);
- Integration and data exchange with AODB in the frame of the A-CDM concept.

The system processes messages received via AFTN/AMHS/CIDIN and distributes flight plans. The main procedures for composing, receiving, sending and processing messages are automated.

The system functions related to processing and display of flight plan data include:

- Reception, processing, storage and display of flight plans;
- Automated generation of messages;
- Reception and processing of formalized ATC messages and automatic or manual correction of flight plans in accordance with received messages;
- Recording of planning information, incoming and outgoing messages;
- Reception, processing, storage and display of all correcting messages for a specific flight plan;
- Printout of flight plans in accordance with different criteria;
- Retrieval of airspace use plans stored in the system, their correction, cancellation, storage and printout;
- Automatic and manual activation of flight plans, automatic calculation of aircraft space-time trajectories depending on the flight type, the airspace structure and the aircraft performances;
- Automatic access to required planning information on the CWPs;
- Electronic Flight Strips;
- Automatic correction of planning information in accordance with automatic tracking data from the surveillance system;
- Automatic correction of planning information in accordance with messages input manually and other console inputs;
- Display of air traffic situation from the flight database in non-radar environment;
- Display of pseudo radar tracks and air situation in accordance with the aircraft's calculated space-time trajectory in case of lack (loss) of radar information or out of radar coverage ("pseudo tracking" mode);
- Automatic calculation and display of the planned track on demand;
- Reception and direct input of information about airspace restrictions and their display on the CWPs;
- Interaction with flow management services;
- Medium-term conflict alert and airspace load prediction;
- Departure Clearance service (DCL).

The system is fitted out with artificial intelligence elements that allow to detect format errors in formalized incoming and outgoing messages, analyze available limitations such as airspace use restrictions, airport opening and closing times and radio failures and to take them into account at all phases of preliminary and current planning.

The system provides storage of databases during any period of time. Data backup is performed daily.

2.3 Service life

The system is designed for continuous round-the-clock operation (24 hours a day, 365 days a year).

The service life of the system is 15 years without major overhaul, subject to regular preventive maintenance without interruption of operation according to the procedures described in the technical manuals.

2.4 Hardware platform

All servers and workstations are based on COTS products with optimal characteristics and use the state-of-the-art technology.

All components are tested to ensure that they are suitable for use in ATM systems and provide long-term trouble-free operation with the highest degree of reliability and maintainability.

All components meet industrial standards for continuous safe operation and comply with EMC and LVD Directives.

As part of obsolescence management, platform-compatible commercial components can be used throughout the entire system lifecycle for replacement purposes (for example, workstations/servers with new generation processors of the same (x86-64) architecture). In any way, the availability of proprietary equipment is ensured for at least 10 years.

2.5 Operating system

The operating system used for all workstations and servers of Alpha ATC system is the latest stable version of Oracle Linux.

As an option, Alpha ATC system can be delivered in a configuration running under the latest Microsoft Windows 10 and Windows Server operating systems.

3 SYSTEM ARCHITECTURE

3.1 Overview

The system (hardware and software) is built on a modular principle.

Identical software is installed on all workstations and the role of each workstation is defined exclusively by the current settings.

In addition to special application software, the Web Server & Clients technology is implemented in the system in order to provide access to some system data through a web-browser, without the need to run special software, for more than 5 concurrent users. Such data includes:

- Traffic Situation Display (Air and Ground);
- Flight data statistics;
- Event log and maintenance data.

All items of the system are self-restartable. The system starts automatically when the power is on. In this case, the configuration parameters from the configuration files are used. No additional actions of the personnel are required to boot the system. After booting, the system automatically goes into the operating mode. The boot time does not exceed 5 minutes.

For convenience of maintenance, all server units are installed in mounting racks and consoles on sliding rails. The units can be accessed from the front of the mounting racks or from the back of the console where there are technological doors. For access to any unit, there is no need to demount another unit.

The required maintenance procedures are performed on a running system without interrupting its operation.

The system is supplied with all necessary interface cables. All the units, connectors and interface cables have markings and keys that uniquely identify them and the corresponding connection.

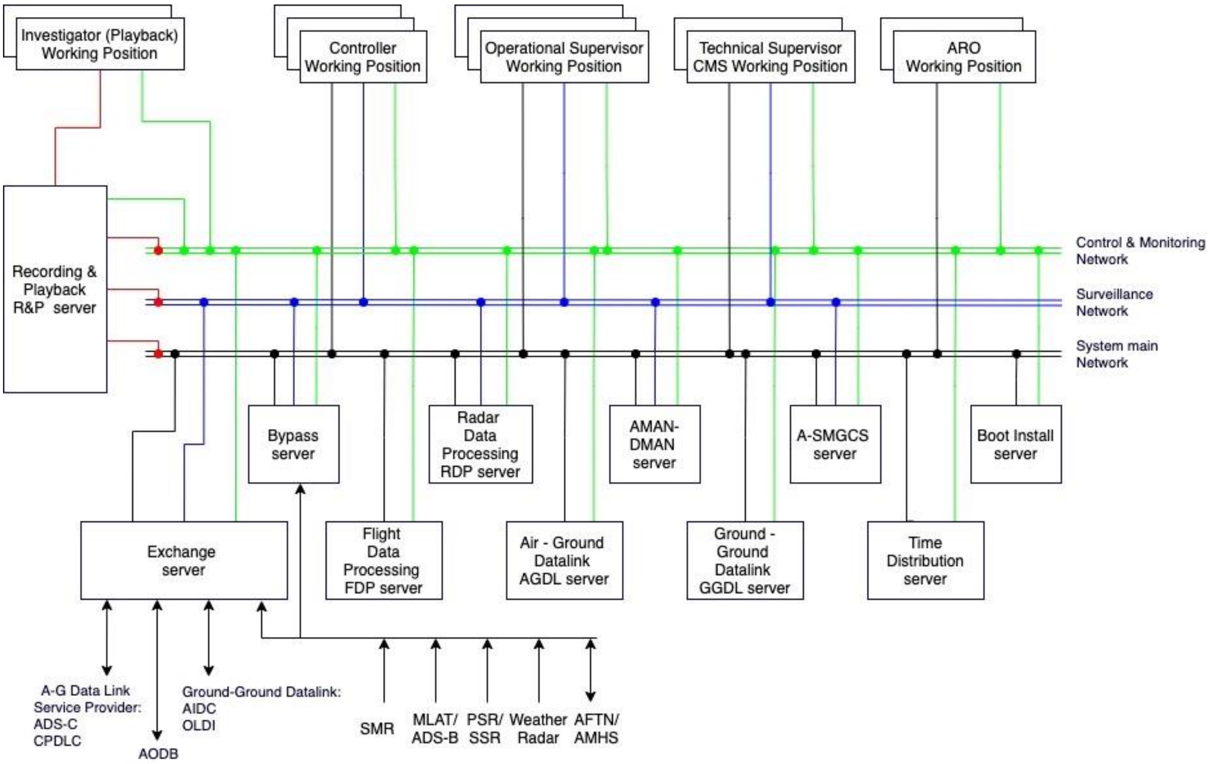
The system includes all necessary measures to protect the maintenance personnel from electric current and other exposure factors.

3.2 System structure

Alpha ATC system can be dimensioned (configured) for the needs of a particular aerodrome/FIR and can consist of the following functional elements:

- Exchange servers (EXCH servers);
- Radar Data Processing servers (RDP servers);
- Flight Data Processing servers (FDP servers);
- Ground-Ground Data Link servers (GGDL servers);
- Air-Ground Data Link servers (AGDL servers);
- AMAN/DMAN servers;
- A-SMGCS servers;
- Bypass servers;
- Boot-install servers;
- Controller Working Positions (CWP);
- Supervisor Working Positions:
- Operational Supervisor Working Positions;
- Technical Supervisor Working Positions (CMS);
- Recording & Playback subsystem:
- Recording & Playback servers (R&P servers);
- Investigator (Playback) working positions.
- Time Distribution Subsystem (servers);
- ATS Reporting Office Working Positions (ARO Workstations);
- Test subsystem.

The maximum application layer configuration is shown in the architecture diagram below.



Alpha ATC system application layer diagram

Depending on the functional requirements to an ATC system and its operating environment (area of responsibility, traffic volume, available sensors and datalinks), the required application servers can be hosted on an optimal number of physical servers (some servers can be functionally combined).

Regardless of the configuration, all physical servers are redundant and operate in hot standby mode. The minimum configuration of Alpha ATC system consists of 2 redundant ATM servers that host main functional application modules and 2 bypass servers that host fallback and service application software.

All servers are installed in 19" racks located in technical or server rooms.

Workstations of working positions are installed in consoles in the Tower and other corresponding premises of an ATC Centre.

As an option, in order to implement the "silent operation" concept, all workstations can be installed in technical or server rooms and equipped with KVM extenders for transmitting computer signals for distances of up to 10,000 m. This will allow keeping only an ATC screen, a keyboard and a mouse in the CWP console.

3.3 Scalability and modularity

All servers, workstations and network switches have a performance reserve of at least 50%.

The functionality of the system can be expanded by updating the software. If necessary, the system hardware can be upgraded or replaced with more efficient hardware (within the platform used) without changing the software. The software replacement (update) time is less than 30 minutes.

The system is easily scalable and can be expanded by adding additional servers and working positions (including remote ones) without making changes in the core application software, or additional functional components can be added to in order to expand functionality.

The system can be delivered with a test subsystem, which can be used for testing and evaluation purposes, without affecting the operation of the ATM system. The test subsystem is a miniaturized replica that covers the key hardware and software elements of the system. Its elements are fully interchangeable with the elements of the main system in operation. Refer to section 0 Test subsystem for additional details.

Also, an ATC simulator can be delivered as an integrated or stand-alone solution for training purposes.

3.4 Fault tolerance

3.4.1 Equipment redundancy

The system is fault-tolerant due to a high degree of redundancy. Failure of any single module (piece of equipment) or even complete failure of the Control and Monitoring System (CMS) will not result in the loss of basic functions or in the shutdown of the entire system.

All computers providing common services, including all servers and recording units, are duplicated. The main and standby servers and network switches are installed in two different mounting racks. Each individual computer is connected to the dual LAN. All interaction between the servers and the workstations is carried out via the dual LAN. The system switches over to the standby automatically.

Both nodes of the servers operate using the Master/Slave logic. This means that both nodes process input data continuously but only the Master outputs data to the LAN. The Slave node checks for the presence of "heartbeat messages" from the Master. In case of an error, it becomes Master, while the failed unit stops data output.

The system has the following redundancy parameters:

- Heartbeat message frequency of 0.2 sec;
- The time to switchover between the servers when heartbeat messages are no longer received is no more than 1 sec without loss of system functions.

A dual configuration allows all maintenance and setup actions to be performed on the selected channel without interrupting the system operations.

3.4.2 LAN redundancy

The system is based on a redundant local-area network. Identical information is distributed in both segments of the network (segment A and segment B); therefore, failure of one of the segments will not affect the operation of the system. Each individual computer has two Ethernet interfaces and is connected to both LAN segments.

The internal IP-ST protocol is used to transfer data within the system. IP-ST is a multicast UDP protocol that works over two or more networks with built-in packet counters and allows to recover data in case of loss. The software using the IP-ST protocol has data integrity monitoring and recovery mechanisms, which ensures delivery of necessary information.

3.4.3 Redundancy of data inputs

All external information sources and sensors (SMR, MLAT, ASR/PSR/MSSR, ADS-B) are connected in parallel to both servers in such a manner that in the event of failure or breakdown of one path, the alternative path is available automatically. The servers are completely interchangeable. If the primary server fails, the standby server starts operating automatically without delay.

3.4.4 Interchangeability of workstations

All the workstations are interchangeable. Identical software is installed on all workstations and the role of each workstation is defined exclusively by the current settings. If a working position is equipped with two workstations, each of them can perform all the functions independently, although it is still possible to distribute the functions between them (e.g. to display air traffic situation on one workstation and flight plan data on the other one).

3.4.5 Data redundancy

The following measures are taken to prevent data loss as a result of equipment or software failure and to ensure uninterrupted operation of the system:

- Hot standby of the server equipment;
- Use of RAID controllers;
- Synchronized data is available on both servers and is distributed in both LAN segments;
- All latest valid data and history are saved on the workstations;
- Data alteration and exchange between the workstations is possible when the servers are not available.

3.4.6 Resulting reliability

The solutions described above provide the following system reliability characteristics:

- Mean Time Between Failure (MTBF) of 20,000 hours;
- Mean Time to Restore (MTTR) of 30 minutes;
- System availability of 0.9999.

3.5 Information security

Information security aspects were taken into account when designing the system in order to prevent unauthorized access to information and the system software.
The Information Security Subsystem provides:

- Management of access rights within the system;
- Management of user access to protected information;
- Operational control of computer users and recording of security events;
- Presentation and printout of recorded information from the security log;
- Security systems integrity monitoring;
- LAN integrity monitoring.

3.6 Networking

The system is based on a redundant Gigabit LAN with at least a 50% reserve of the network bandwidth. Enterprise-class Layer 3 managed switches are used to build the network. All external interfaces of the system are protected from cyber threats by hardware firewalls.

For data transmission, TCP/IP protocols are used. Identical information is distributed in both segments of the network (segment A and segment B).

Each individual computer (server and workstation) has at least two Ethernet interfaces and is connected to both LAN segments.

3.7 Servers

3.7.1 Radar Data Processing server

The Radar Data Processing server (RDP server) receives data from external sources, processes it and sends it to the workstations (except for information from AFTN/AMHS, which is processed by the FDP server).

The RDP server provides (if surveillance sensors are available):

- Reception and decoding of surveillance data (directly or via the Exchange server);
- Trajectory processing (Monoradar data processing);
- Fusion of surveillance data from several sources (Multi-radar data processing);
- Correlation of surveillance tracks with flight plan data;
- Transmission of information to the FDP server for adjustment of flight plan data according to surveillance data;
- Detection of violation of separation standards;
- Detection of potential conflicts between aircraft (Short-Term Conflict Alert, STCA);
- Medium-term conflict detection (MTCD) based on radar-corrected planning information;
- Detection of the possibility of an aircraft entering restricted areas and hazardous weather areas (Area Proximity Warning, APW);
- Calculation and correction of aircraft space-time 4D trajectories based on real-time surveillance data;
- Transmission of surveillance data to all workstations in the system.

The RDP server also provides (regardless of the availability of surveillance data):

- Calculation of pseudo trajectories based on flight plan data;
- Processing of additional flight information entered by the controller on the CWP;
- Transmission of trajectories to all workstations in the system;
- Reception of information from the weather radar (if available);
- Reception and processing of meteorological information from corresponding sources;
- Transmission of weather information to all workstations in the system.

3.7.2 Flight Data Processing server

The Flight Data Processing server (FDP server) provides reception, processing with format control and storage of flight plan data and other information that is received from AFTN/AMHS/CIDIN and makes this information available on the workstations.

The Oracle database provides storing of all information received via the AFTN/AMHS/CIDIN channels and user inputs.

3.7.3 Exchange server

The Exchange server (EXCH), which is the system's gateway, is a key element intended for providing integration with external systems, reception and primary processing of various types of data, such as surveillance data, meteorological data, flight plan data, etc.

System-to-system interactions are mostly based on the most widely used aviation industry practices such as ASTERIX & ADEXP standards, with firewall software protection against external threats and MAC (Medium Access Control) level security.

The basic system software provides interaction with a large number of external systems such as:

- Flight Data Processing Systems (FDPS) and other data providers;
- Airport stands management systems;
- Network Time Server (NTP) or Time Distribution systems;
- Automated weather observing (meteorological) systems;
- NAVAIDS display, “runway in use” systems, etc.;
- Voice Communication System;
- Airfield Ground Lighting system for automatic control of the airfield lighting system (ALCMS);
- Surveillance systems such as ADS-B / Mode S (Extended Squitter), radars (ASR/PSR/MSSR/SMR), MLAT;
- AODB/AOCC/A-CDM systems.

Most integration cases (integration with airport automation systems) are based on the Web Server & Clients technology and only allow operators to view, pan, zoom and rotate the traffic display in a web browser, while other functions are not available without installing dedicated or specialized application software.

For some integration cases which require operation in the AFTN network, the Exchange server can be equipped with appropriate adapters.

3.7.4 Ground-Ground Data Link server

The Ground-Ground Data Link server (GGDL server) is used for voiceless coordination and transfer of control between adjacent ATC centers.

The GGDL servers provide:

- Reception and transmission of flight data between ATC centres in the AIDC/OLDI message format;
- Automatic reception, storage, processing and transmission of AIDC/OLDI messages.

The AIDC (ATS Interfacility Data Communication) protocol is used for standardized exchange of flight information between ATC systems of adjacent ATS units. In the context of their purpose, AIDC is close to the OLDI (On-Line Data Interchange) protocol. Alpha ATC system supports both standards.

3.7.5 Air-Ground Data Link server

The Air-Ground Data Link server (AGDL server) runs FANS "Air-Ground" datalink applications over ACARS/ATN, such as:

- ADS-C;

- Controller-Pilot Data Link Communication (CPDLC);
- Departure Clearance (DCL);
- Traffic Information Service – Broadcast (TIS-B).

3.7.6 AMAN/DMAN server

The AMAN/DMAN servers perform information processing for automated formation of flows of arriving and departing aircraft using AMAN/DMAN procedures.

The AMAN/DMAN function is intended to support decision-making by the controller in the air traffic control process.

3.7.7 A-SMGCS server

The A-SMGCS servers are intended to process and store data for the A-SMGCS functions. These servers provide additional ground surveillance data processing, Airport Safety Nets, routing and guidance and AGL integration. A-SMGCS flight data statistics are also stored and processed on these redundant servers, providing a GUI for reporting.

3.7.8 Bypass server

The Bypass servers perform fallback radar data processing with alternative algorithms and are intended to provide redundancy of main data processing in emergency mode. In case of failure of the "main" surveillance data processing equipment, delivery of system tracks is automatically taken over by the Bypass servers.

3.7.9 Boot Install server

The Boot Install servers provide:

- Storage of backup copies of software of all components;
- Software recovery;
- Configuration of spare parts and accessories.

3.8 Working positions

3.8.1 Controller Working Positions

The Air Traffic Controller Working Position (CWP) is a unified working position that can be used in the ATC system for a number of tasks (refer to Section 5.1 for more information). The available functionality and the windows layout of a specific workstation depend on its role defined by the assigned configuration and selected at log-in. This ensures full interchangeability of the CWPs within the system.

Each CWP consists of one or two workstations. If there are two workstations and two screens, both sets are interchangeable. In this case, one set can be used to display air traffic situation, while the other set is used to display flight plan tables and other information (depending on the controller's choice). If one of the sets fails, the second set allows to continue carrying out all operations of the workstation.

3.8.2 Operational Supervisor Working Position

The Operational Supervisor Working Position is intended to be used by the Operations Supervisor and provides enhanced functionality compared to the Controller Working Position. However, the enhanced functionality is determined only by the role defined at log-in, while the software used is the same as in other workstations.
In contrast to an air traffic controller, a user registered with the operational supervisor rights has access to some settings that are not available to the controller, such as:

- Disabling of conflict warnings and other alarms;
- Data changing in the Supervisor information window;
- Generation of user objects (charts) available on all workstations;
- Activation/deactivation, input and deletion of bans and restrictions.

3.8.3 Technical Supervisor Working Position

The Technical Supervisor Working Position enables the technical supervisor to control and monitor the system. It provides capabilities:

- To know the current technical and operational status of Alpha ATC system;
- To control the supervised system elements;
- To ensure the reliability of the supervised system;
- To log (with time mark) and report selected information;
- To use service tools.

3.8.4 ATS Reporting Office (ARO) Working Position

Alpha ATC system offers ARO functionality in accordance with PANS-ATM Procedures for Air Navigation Services — Air Traffic Management (ICAO Doc 4444).
The ARO Working Position facilitates reception of reports concerning Air Traffic Services and flight plans submission.

3.8.5 Information Security Manager Working Position

Security functions in the system are available from the Information Security Manager Working Position. Its functions can also be combined with and performed from the Technical Supervisor Working Position.

The security subsystem is implemented on all levels (network, operational system and application levels) to provide:

- Identification, authentication and access control;
- Data flow management;
- Process recording;
- Media recordkeeping;
- Cleaning (zeroing) of disposed RAM areas of computers and external drives;
- Cyberattack alarms;
- Software and processed data integrity maintenance;
- Data protection administrator (service) availability;
- Periodic testing of the data protection facilities;
- Recovery tools for the data protection facilities.

3.9 Recording and Playback System

Voice and Data Recording and Playback System (R&PS) is a multi-channel digital system designed for use in the field of Air Traffic Management / Air Navigation Services. It provides recording, archiving, analysis and playback of audio and video data, radar data and other ATC data.

The system can be implemented both as a separate independent solution for data recording and as an integrated subsystem that is part of Alpha ATC system.

It consists of redundant servers for recording and storing data (the number of servers depends on the number and type of data streams to be recorded) and a working position for data playback and investigation purposes. The playback software can be installed on a dedicated investigator (playback) workstation, or it can be run at the Technical Supervisor Working Position.

3.10 Time Distribution Subsystem

Time Distribution Subsystem (TDS) provides timing of data received from different sources with reference to a common time source. TDS is based on a GNSS (GPS/GLONASS) receiver and performs the function of a Network Time Server (NTP).

Timing signals are distributed to all computers, and the timers of these computers are synchronized automatically.

The functions of the subsystem are as follows:

- Timing of computational processes in all systems and subsystems;
- Provide universal time for all CWPs and other workstations.

3.11 Test subsystem

In many cases, for the successful operation, maintenance, development and support of an ATC system, it is required to be able to test various hardware components, software versions and updates, configurations and user data changes, perform optimizations and trainings without a potential negative impact on the operation of the main ATC system.

For these purposes, Alpha ATC system can be fitted out with its miniaturized replica, a test subsystem which covers all types of hardware and software elements of Alpha ATC system (servers, CWP, Supervisor Working Positions, etc.). Its elements are fully interchangeable with the elements of the main system in operation. All functions work in the Test Subsystem in the same way as they do in the main operational ATC system. The same application and service software is used.

The Test Subsystem operates in a dedicated LAN with the ability to connect real surveillance sensors and interacting systems as an input interface. It is also connected to the R&PS servers for diagnostic data recording, analysis and playback.

The Test Subsystem of Alpha ATC system provides the following capabilities:

- Testing and verification of software and databases;
- Testing and validation of redundant configuration aspects (change-over procedures, master/slave roles, etc.)
- Stress-testing of the system stability, performance and functionality;
- Testing and evaluation of user data (charts, maps, airspace structure, airport layout, etc.) and changes of parameters (alert parameters, safety rules, system settings, user-defined parameters);
- Testing of integration with adjacent systems, surveillance sensors and external systems;
- Testing, optimization and calibration of data processing, including mixed processing of real data (surveillance, FDPS, meteorological data, etc.) and replayed or simulated data;
- Analysis and investigation of failures and anomalies;
- Development and validation of maintenance procedures;
- Training in the operation and maintenance of Alpha ATC system, both for ATC personnel and for technical personnel (technical supervisors, system administrators, maintenance engineers, etc.);
- Serving as a source of tested and pre-configured spare parts for the main system.

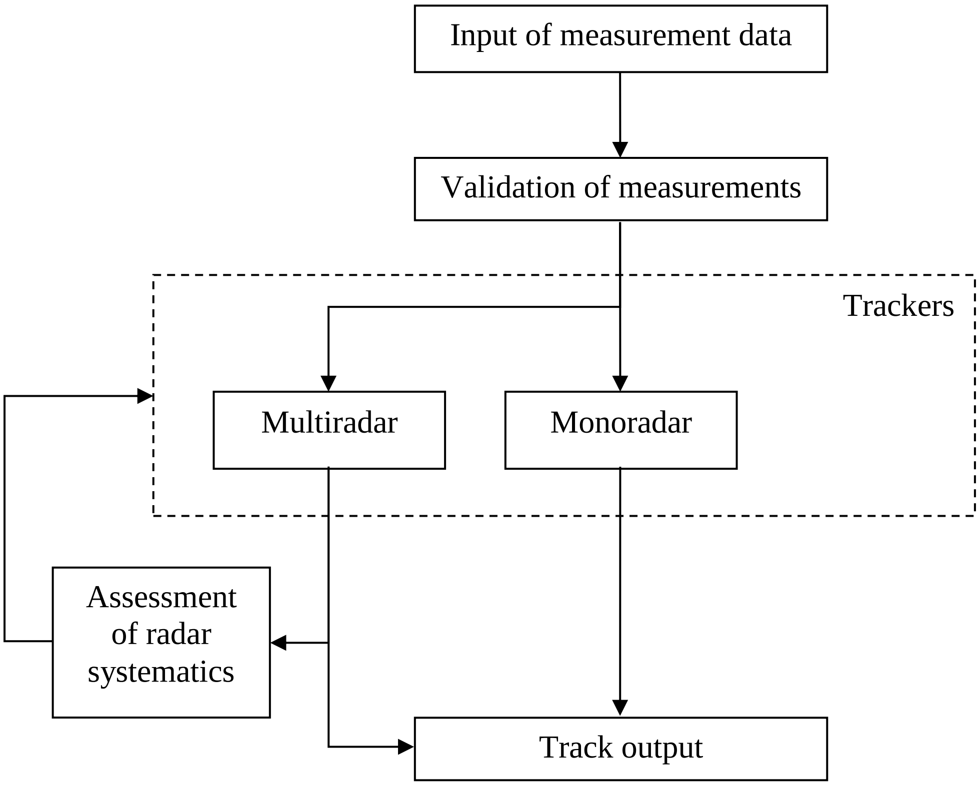
4 FUNCTIONALITY

4.1 Multi-Radar Tracking

Radar reports of different types are received for processing in the system. After the initial validity and integrity check, reports are distributed among the trajectory processors (trackers) of two types: multi-radar and mono-radar processor.

Each of the trackers identifies tracks (by comparing a received target report with known aircraft positions) and updates them on the basis of identified reports (performs validation and smoothing of positional data, validation of secondary radar data), creates new tracks, deletes tracks that have not been updated for a long time and resolves identification conflicts. Obtained multi-radar and mono-radar tracks are provided to the CWPs, Safety Nets and other functions of the system. Multi-radar processing data is also used for assessment of systematic radar errors.

The Multi-Radar Tracking workflow is given in the figure below.



Multi-Radar Tracking process diagram

Note: Input data is recorded prior to validation and application of systematic error correction.

The key points in Multi-Radar Tracking are the following:

- A multi-radar track is created on the basis of measurements but not on the basis of mono-radars tracks (plot-to-track);
- Calculations are performed using geographic coordinates in the WGS-84 system. Movement along an orthodromic path is considered to be rectilinear;
- Smoothing of positional data is done using the Interacting Multiple Model (IMM) filter;
- Multi-radar processing data is additionally used for assessment of systematic errors of the radars on the basis of range and azimuth.

4.2 Flight Data Processing

The flight plan data processing functions include:

- Reception, processing, storage and display of flight plans;
- Automated generation of messages;
- Reception and processing of formalized ATC messages and automatic or manual correction of flight plans in accordance with received messages;
- Recording of planning information, incoming and outgoing messages;
- Reception, processing, storage and display of all correcting messages for a specific flight plan;
- Printout of flight plans in accordance with different criteria;
- Retrieval of airspace use plans stored in the system, their correction, cancellation, storage and printout;
- Automatic and manual activation of flight plans, automatic calculation of aircraft space-time trajectories depending on the flight type, the airspace structure and the aircraft performances;
- Automatic access to required planning information on the CWPs;
- Electronic Flight Strips;
- Automatic correction of planning information in accordance with automatic tracking data from the surveillance system;
- Automatic correction of planning information in accordance with messages input manually and other console inputs;
- Display of air traffic situation from the flight database in non-radar environment;
- Display of pseudo radar tracks and air situation in accordance with the aircraft's calculated space-time trajectory in case of lack (loss) of radar information or out of radar coverage ("pseudo tracking" mode);
- Automatic calculation and display of the planned track on demand;
- Reception and direct input of information about airspace restrictions and their display on the CWPs;
- Interaction with flow management services;
- Medium-term conflict alert and airspace load prediction;
- Departure Clearance service (DCL).

The system is fitted out with artificial intelligence elements that allow to detect format errors in formalized incoming and outgoing messages, analyze available limitations such as airspace use restrictions, airport opening and closing times and radio failures and to take them into account at all phases of preliminary and current planning.

4.3 Calculation of the space-time (4D) trajectory

When a radar track is correlated with a flight plan, the flight plan data is added to the trajectory.

The 4D trajectory of an aircraft is generated using route data of the flight plan, SID/STAR and runway data. Based on the current speed of the aircraft, weather data and other information, the following time parameters are calculated:

- Estimated time over (ETO) for the next waypoints;
- Time of SID/STAR;
- Inbound/outbound time;
- Estimated time of arrival (ETA).

When a radar track is updated, the landing runway, the SID/STAR or the route is changed or when there are other changes, the system re-calculates the times with indication of respective information in the electronic strips and/or flight plan table and reprints the paper strip (if applicable).

Inbound lists are generated based on the calculated time of entry into a sector. The time of appearance in the inbound list (the time before entering the controlled area) is an adjustable parameter.

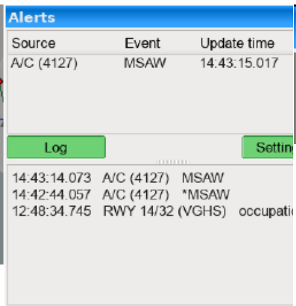
4.4 Safety Nets

Ground-based Safety Nets are an integral part of the system that helps prevent hazardous situations using all available data.

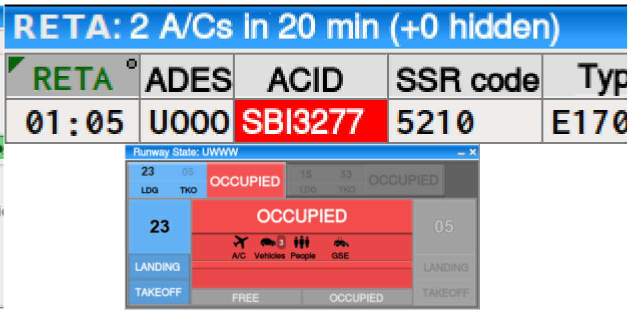
Air traffic controllers are expected to take immediate action upon the receipt of an alert. Alerts are delivered visually, with color indication of the callsign in the track label, in the plan lists, in the alert list and the "Alerts" window, etc., and audibly. The system distinguishes between alarms acknowledged manually by a controller’s click and unacknowledged alarms.

The "Alerts" window (alert list) is a prime widget to show alerts. It is displayed when the first alert appears and is hidden automatically when there are no more active alerts and when all acknowledgeable alerts have been acknowledged. An alert is considered acknowledged when the controller has clicked on it. The "Alerts" window (alert list) cannot be displayed or hidden manually.

Alert in a track label



Alerts window



Visual indication of alerts

4.4.1 HIJ/RAD/EMG/SPI alerts

In the event of receiving transponder codes SSR 7500, 7600, 7700, the system automatically sets the corresponding emergency sign in the track label.

4.4.2 Short-Term Conflict Alert (STCA), Medium Term Conflict Detection (MTCD)

The system provides calculation of potential conflicts in accordance with ICAO separation standards for each type of airspace sector (TWR, APP, ACC).

For analysis of conflict situations around an aircraft, a protection volume is built according to the mentioned separation standards. If another aircraft enters the protection volume (including cases of intersection, climb/descent and others), a conflict is detected.

Two methods are used in the system to calculate potential conflicts:

- Based on history;
- Based on Flight Plan Data.

In both cases, a protection volume is built around the predicted trajectory of an aircraft. If another aircraft enters the protection volume (including cases of intersection, climb/descent and others), a potential conflict is detected (depending on the time of occurrence of STCA or MTCD events).

4.4.3 Minimum Safe Altitude Warning (MSAW)

With the availability of the aircraft's actual altitude (via information from SSR and ADS), the descent of an aircraft to the minimum safe altitude or lower is detected and the system automatically sets the emergency sign in the track label.

The minimum safe altitude value is defined when the database of the airspace structure is made. The system also checks whether the aircraft is on the glide path, and no warning is generated in this case.

4.4.4 Area Proximity Warning (APW) and Temporary Danger Area (TDA)

The Area Proximity Warning (APW) capability ensures that any aircraft infringing or predicted to infringe APW areas is detected.

The system performs the APW function at each system track update cycle. The prediction vector is defined as a vector in a straight line between the current position of the system track and its predicted position. The system computes the intersection of the prediction vector of an aircraft with a particular APW area.

The APW processing consists of the following steps:

- APW areas that will be crossed by the aircraft within the look-ahead time are determined;
- For each APW area, it is checked whether the aircraft is in its volume. If so, a conflict exists;
- In the opposite case, the time interval in which the aircraft will be inside the polygon of the area and the time interval in which the altitude of the aircraft will be between the lower and the upper altitude of the area are computed. If the two time intervals overlap, then there is a risk of a conflict. The time of the conflict is determined.

Temporary Danger Area (TDA) informs the responsible controller if an aircraft is going to or has infringed one of such areas.

4.4.5 Airport Safety Nets

4.4.5.1 General overview

The basic package of Airport Safety Nets contributes to airside operations as a safety improvement, enabling controllers to prevent hazards/incidents resulting from deviations or operational errors of controllers, flight crews or vehicle drivers.

The Airport Safety Nets system supports controllers by:

- Anticipating potential conflicts (e.g. hazardous situations between aircraft or aircraft and vehicles);
- Detecting conflicts and incursions;
- Detecting mobiles that are not following given clearances;
- Providing alerts.

The Airport Safety Nets algorithms take into account surveillance data, flight plans, airspace layout, configuration parameters, type of traffic, speed and direction of traffic (linear and non-linear track prediction), speed and braking performance, proximity to certain areas of the movement area where the risk of conflict is high (e.g. runway holding positions and runway intersections), landing and take-off directions, non-LVP/LVP procedures and corresponding rules, etc.

Airport Safety Nets consists of the following functional components:

- Runway Incursion Monitoring System (RIMS);
- Conflicting ATC Clearances (CATC);
- Conformance Monitoring Alerts for Controllers (CMAC).

Runway Incursion Monitoring System (RIMS) is a short-term conflict alerting tool that monitors movements on or near the runway and detects conflicts between an aircraft and another mobile. It uses surveillance data and predefined rules and parameters.

The detection of RIMS conflicts takes into account the following:

- Layout and runway configuration of the aerodrome;
- Associated procedures;
- Position and type of mobiles according to the set time parameters and their relative speeds and positions when within or about to enter the Runway Protected Area;
- Aircraft in the vicinity of the runway (e.g. on final approach, climb-out and helicopters crossing);
- Meteorological conditions.

Conflicting ATC Clearances (CATC) provides an alert when the controller inputs an electronic clearance which, according to a set of locally agreed rules, is not permitted from an operational and safety point of view when compared to any other previously input electronic clearance. The detection of CATC provides an early prediction of a situation that, if not corrected, would end up in a hazardous situation. In the case where the controller does not resolve a CATC situation associated with the runway, this would normally be detected by the RIMS function.

Conformance Monitoring Alerts for Controllers (CMAC) provides controllers with appropriate alerts when the A-SMGCS detects the non-conformance to procedures or clearances of mobiles on runways, taxiways and in the apron/stand area. The integration of electronic clearance input with information such as flight plans, surveillance, routing, published rules and procedures allows the system to detect inconsistencies and alert the controller.

For the CATC and CMAC alerts to function correctly, it is important that the system receives the controller's electronic clearances; therefore, such services must be implemented on site.

4.4.5.2 Runway conflicts

The basic package of the runway conflict detection function of Airport Safety Nets detects the following conflicts:

- An aircraft arriving to or a departing aircraft on a closed runway;
- Arriving or departing aircraft with traffic on the runway (including aircraft beyond the runway holding positions);
- Arriving or departing aircraft with moving traffic to or on a converging or intersecting runway;
- Arriving or departing aircraft with opposite-direction arrival to the runway;
- Arriving or departing aircraft with traffic crossing the runway;
- Arriving or departing aircraft with taxiing traffic approaching the runway (predicted to cross the runway holding position);
- Arriving aircraft exiting the runway at a high speed with converging taxiway traffic;
- Arriving aircraft with traffic in the sensitive area (when protected);
- Aircraft exiting the runway at unintended or non- approved locations;
- Aircraft approaching the area restricted for maintenance. Unauthorized traffic approaching the runway;
- Unidentified traffic approaching the runway;
- Alert for simultaneous departure from dependent runways.

4.4.5.3 Taxiway conflicts

The basic package of the taxiway conflict detection function of Airport Safety Nets detects the following conflicts:

- Aircraft on a closed taxiway;
- Aircraft approaching stationary traffic. Aircraft overtaking same-direction traffic;
- Aircraft with opposite-direction traffic;
- Aircraft approaching taxiway intersections with converging traffic;
- Aircraft taxiing with excessive speed;
- Aircraft exiting the taxiway at unintended or non-approved locations;
- Unauthorized traffic on the taxiways. Unidentified traffic on the taxiways;
- Crossing of a lit stop bar.

4.4.5.4 Apron and stand area conflicts

The basic package of the apron and stands area conflict detection function of Airport Safety Nets detects the following conflicts:

- Aircraft movement with conflicting traffic during taxi or pushback;

- Aircraft movement with conflicting stationary objects;
- Aircraft exiting the apron/stand/gate area at unintended or non-approved locations;
- Unidentified traffic in the apron/stand/gate area.

4.4.5.5 Additional measures

Airport Safety Nets provides constant and continuous analysis of predefined and monitored area when an aircraft is approaching touchdown (the default time is 30 sec) and gives alerts in the following situations:

- An aircraft is approaching touchdown (the default time is 15 sec) and there is any target in the predefined/monitored area;
- A departure flight is closely followed by an arrival flight on the same runway;
- For departures where two or more targets are detected within the monitored area at the same time, an alert will be raised to remind controllers that more than one aircraft or vehicle occupies the runway. The alert remains until only one target is on the runway, or when one target reaches a predefined speed and it can be assumed that it is taking off. In this case, the area in front of the departure is monitored and any target found generates an alert;
- Loss of wing-tip spacing due to maneuvering;
- Head-on conflicts;
- Incursions (unauthorized entry onto a taxiway or apron, or failure to comply with an instruction to hold or give way);
- An aircraft deviates from the glide slope and the localizer.

The alert system differentiates between VFR and visibility conditions, including minimum separation times between aircraft.

Alerts are also generated when there are objects/tracks in the ILS critical and sensitive areas both in the VFR and visibility conditions; and the alert conditions are more stringent for LVP (CAT -II/III) conditions.

4.4.6 Tactical Controller Tool (TCT)

Tactical Controller Tool (TCT) aims to provide air traffic controllers with information similar to that of the MTCD tool but with a shorter look-ahead time and using a system trajectory that is updated more often and that takes into account the rejoin manoeuvre of the aircraft if it is deviating from the planned route. There is also an extended STCA warning if two aircraft are on a collision heading, within a configurable look-ahead time. The tool may also show warnings of conflicts that could occur in the following situations:

- Standard Instrument Departure (SID) mismatch;
- The aircraft does not follow the planned route;
- More than one aircraft has the same plan;
- One aircraft has multiple plans;
- Aborted departures.

4.4.7 NTZ Tool

NTZ Monitoring tool with safety net provides to assist Parallel Runway Operations.

4.5 Monitoring Aids (MONA)

The Monitoring Aids system (MONA) of Alpha ATC system detects aircraft deviations from the planned route or clearances and notifies this information to the controller. It provides reminders of the aircraft routine actions to be performed and keeps the calculated aircraft trajectory actual. MONA consists of the following tools:

- Cleared Level Adherence Monitoring (CLAM), which provides a warning when a flight deviates from the cleared flight level;
- Route Adherence Monitoring (RAM), which provides a warning when a flight deviates from the current flight plan route;
- Approach Path Monitoring (APM), which monitors the approach path of the aircraft that must be consistent with the descent profile, and determines the lateral deviation with respect to the runway axis;
- Departure Path Monitoring (DPMW), which monitors the departure path of the aircraft that must be consistent with the climb profile, and determines the lateral deviation with respect to the runway axis;
- Missed Position Report (MPR), which provides a warning when a position report has not been received for a mandatory reporting point;
- Conflict Probe (CP), which determines whether a proposed flight plan trajectory comes into conflict with another trajectory during a specified period of time;
- ADS-C Route Conformance Warning (ARCW): which provides an alarm for the responsible controller when, the aircraft intent data down linked from an ADS-C connected flight deviates from the planned route, stored in the flight plan database.
- Estimated Time over Discrepancy (ETO): which provides an alarm to the responsible controller of discrepancies between reported and FDP calculated, times at navigational or reporting points;
- Missed Position Report (MPR): which provides an alarm to the responsible controller that a position report has not been received for a mandatory reporting, point;
- Coordination Failure: which provides an alarm to the responsible controller that automatic system coordination had failed, and manual interaction is, required;
- DUP Code: which provides an indication on the display a warning to show Duplicate aircraft SSR code or Mode-S aircraft id. The system shall generate, duplicate code alert on the CWP;
- Similar Callsign Advisory (SCA): which provides visual alerts in a list display on detection of similar ACID of two or, more aircrafts.

4.6 Recording and Playback

4.6.1 General

Voice and Data Recording and Playback System (R&PS) is a multi-channel digital system designed for use in the field of Air Traffic Management / Air Navigation Services. It provides recording, archiving and playback of voice communications carried out over air-ground and ground-ground radio and telephone communication channels, synchronous recording of information of the ATC system, including radar data, direction-finder (DF) data, flight plans, weather data, alerts, fault signaling, logs, messages, windows, operator actions, etc. (on any system workstation), information from IP cameras (both video and audio) and other ATC data.

The system can be implemented both as an independent solution for data recording and as an integrated subsystem that is part of Alpha ATC system.

The R&PS equipment does not interfere with the operation of Alpha ATC system or other associated systems.

Regardless of the implemented solution, R&PS failure does not have any impact on the operation of Alpha ATC system.

R&PS provides:

- Simultaneous synchronized recording/playback of:
- Voice data in digital and analogue channels;
- VoIP data;
- Surveillance data (PSR, SSR, MLAT, ADS-B/ADS-C, SMR);
- Data from direction finders;
- ATC data (FPL, weather, console operations, conflict and potential conflict logs, other logs, technical control and monitoring, etc.);
- Video streams from IP cameras and workstation displays;
- Storage of records for at least 90 days (user-defined parameter) before erasing;
- Unlimited time of data storage on removable media without data loss;
- Advanced user interface;
- Playback of synchronized data records in different modes (in any combinations);
- Possibility to replay recorded surveillance data into the multi-radar data processing (fusion) loop (for the Test subsystem only);
- Investigation and analysis of accidents in passive (observer) mode and interactive mode (with full-featured CWP HMI environment and tools);
- Assembly of fragments for a specific time interval and their export to external media with data integrity checks;
- Data export to standard audio and video formats (WAV, AVI, etc.) to enable playback of exported files on a standard PC without data quality degradation;
- Control and monitoring of the recording system;
- Data protection (users cannot delete any data until the storage period has expired);
- User identification with access control providing protection against unauthorized interference;
- Automatic log maintenance;

- 100% redundancy of the hardware and records;
- Modular structure enabling repair of the equipment by replacing faulty units;
- Long service life and high reliability due to a small number of mechanical devices;
- Possibility to upgrade the recording system in operation by updating software and/or hardware without interrupting the recording process.

R&PS is based on COTS hardware. Recorded data is stored on high-capacity hard-disk drives. For long-term storage, removable disks are used, which can be ejected without interrupting the recording process.

The recording unit receives analog audio in digital format from analog-to-digital converters (ADC) via a separate network interface. Voice data from digital channels, radar data, video and other types of information are received over the LAN from the switches of the voice communication system, the ATC system, IP cameras, etc.

4.6.2 Specifications

Parameter	Value
Number of voice recording channels	up to 128 per one unit
Number of recorded surveillance sensors	unlimited
Main recording medium	high-capacity hard drive array
Removable media	External USB device
Input signal level adjustment range	60 dB
Voice frequency band	300 - 3400 Hz
Inter-channel separation	60 dB
Voice signal compression methods	PCM (G.711, 64 Kbit/sec) ADPCM (G.721, 32Kbit/sec) GSM 6.10
Number of audio channels listened simultaneously	6
Number of video channels for synchronous playback	4

4.6.3 Supported data

The following data can be recorded from relevant sources:

- Analog audio signals with the following characteristics:
- Amplitude of 20 mV to 12 V;
- Frequency of 300 to 3400 Hz;
- Digital audio data (VoIP);
- Radar (PSR, SSR, PSR+SSR, SMR) data, including low-level sensor messages;
- MLAT data;
- ADS-B and ADS-C data (VDL mode 4 and ES1090);
- Processed radar data (mono- and multi-radar tracks);
- System events, safety net alerts, user actions, messages, debug data, etc.;
- Flight Plan data;
- Direction finder data;

- Weather information;
- Screen data from the workstations (CWP, Supervisor Working Positions, etc.);
- CCTV cameras.

4.6.4 Playback workstation

Recorded data can be reproduced simultaneously to allow analysis of specific situations (e.g. incident investigation, statistical analysis, system parameters verification, reporting, training purposes) on a dedicated playback workstation or any workstation within the system without involving the maintenance staff.

The playback function based on recorded data (such as CWP screens, tracks, alerts, controllers' actions, etc.) has two modes:

- Passive mode (observer mode),
- Interactive mode.

In passive mode, the playback workstation replays the operations and the screen (including all elements, windows, information, etc.) as seen by the controller at the time of recording of the selected CWP together with associated synchronized audio. The playback speed control, stop and go commands are available.

In interactive mode, playback of recorded data is provided and the user can interact with the CWP, selecting any commands for data representation and using all functions, features and tools available. The playback speed is selectable both in passive and interactive mode.

The R&PS utilities provide a graphical user interface with indication and control elements and enable administrator access to the functional windows and menus.

Please refer to Section 5.4 for additional information.

4.7 Statistical tool

The statistical tool is used to collect, store and present information on completed flights, airport movements, system events, console operations, changes in planned data, maintenance data, etc.

The tool is available in a web browser and presents requested statistics/measures in the "Statistic" window.

The basic set of measures includes:

- Safety measures:
- Frequency of runway incursions;
- Duration of runway incursions;
- Frequency of longitudinal conflicts for aircraft on approach;
- Duration of longitudinal conflicts for aircraft on approach;
- Frequency of conflicts for aircraft on simultaneous parallel approach;
- Duration of conflicts for aircraft on simultaneous parallel approach;
- Frequency of intrusions into restricted airspace;
- Duration of intrusions into restricted airspace;
- Frequency of conflict alerts;
- Closest point of approach (CPA) for each conflict;
- Horizontal separation at the CPA time;
- Vertical separation at the CPA time;
- Capacity measures:
- Number of flights handled;
- Number of landings;
- Number of departures;
- Number of handoffs received;
- Number of handoffs given;
- Maximum number of aircraft controlled at same time;
- Efficiency measures:
- Frequency of controller push-to-talk communications;
- Duration of controller push-to-talk communications (cumulative);
- Average time an aircraft spent under controller's control;
- Average time interval between landing aircraft;
- Average time interval between departing aircraft;
- Number of missed approaches.

The system tailored to operate as A-SMGCS has specific sets of statistics/measures:

- For departing flights (take-off roll time, line-up time, push-back, start of taxiing, crossing of the holding point, final run start time, airborne time, recent departures, etc.);
- For arriving flights (threshold crossing time, touch-down time, runway leaving time, start of taxiing, stand reaching, recent arrivals, etc.);
- For both types of flights (waiting time during taxiing, waiting time on the apron taxi area, taxi time, apron taxi time, etc.).

The system can be configured to collect and measure other statistical data upon demand.

All data is stored in a GUI-based SQL database and is available for at least one year. Data can be viewed from any node on the network using a web application. Report generation and print-out of data is provided.

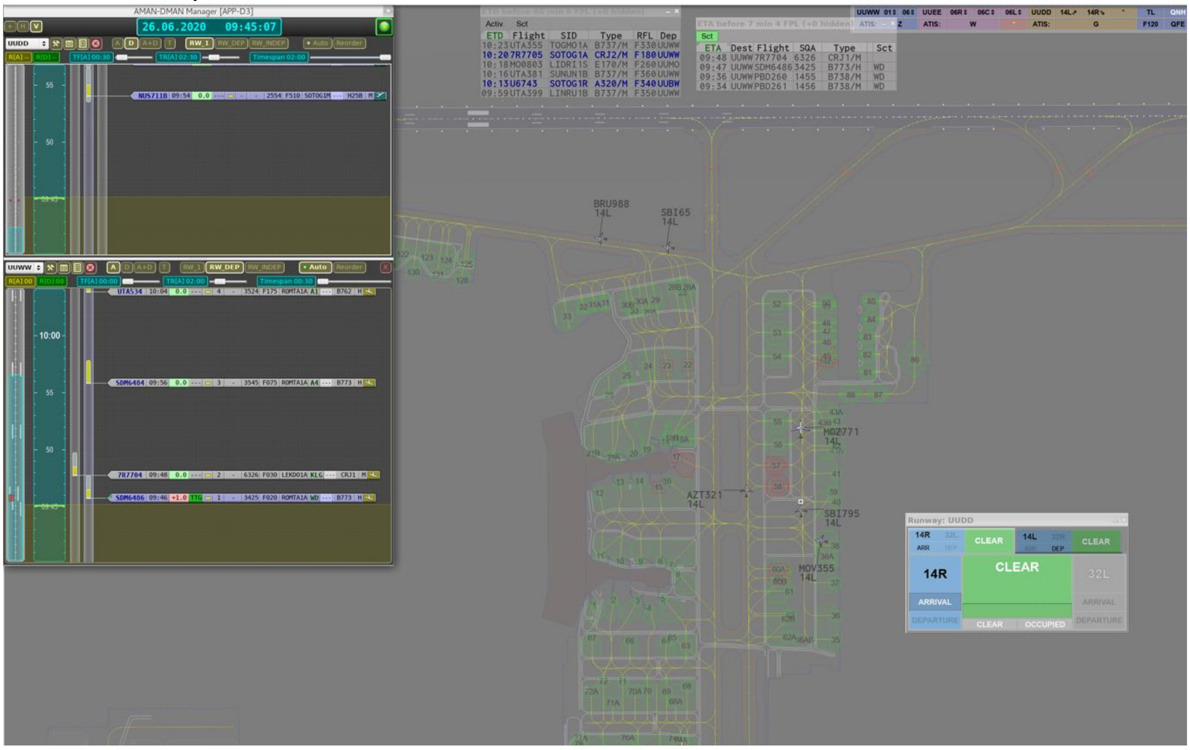
4.8 Advanced Surface Movement Guidance and Control System (A-SMGCS) functions

The A-SMGCS subsystem is an ATM constituent as defined by EUROCONTROL and EUROCAE. It is a modular tool easily adaptable to the needs of different aerodromes. Its purpose is to enhance safety and efficiency of ground operations under Advanced Surface Movement Guidance and Control and to maintain the airport capacity (number of operations) in all weather and traffic conditions. It is intended for users such as tower runway controller, tower ground controller, tower clearance delivery controller and apron manager and allows to increase the situational awareness and reduce the workload of the controllers.

The A-SMGCS subsystem delivers a synthetic image that corresponds to the actual traffic on the airport surface (maneuvering area, aprons, stands) and in close airspace (final approach). It provides:

- Airport layout (map) presentation and definition (runway area, runway access area, holding area, taxiway area, apron area, stand area);
- Setting of the required coverage volume (final approach, maneuvering area, aprons, stands, etc.);
- Surface surveillance and traffic management in the airport maneuvering area for all vehicles and aircraft within the required coverage volume in all weather, visibility and traffic conditions;
- Determination, with the required accuracy, of the positions of mixed detected cooperative and non-cooperative targets;
- Identification of detected non-cooperative and cooperative targets;
- Flight data management with vast presentations of the target label, list/table view, electronic flight strips;
- Airport Safety Nets with detection of conflicts with two-stage alerting (an INFORMATION alert in case of a potential hazardous situation and an ALARM alert in case of a critical situation requiring immediate action), audio and visual warning and the following alert priorities:
  - Runway conflict – highest priority;
  - Taxiway conflicts – medium priority;
  - Apron/stand/gate conflicts – low priority;
- Validation of positional information and aircraft identification with Safety Nets;
- Routing and guidance according to ICAO Doc. 9830 with an option of manually updating the taxi routing;
- Assignment of Standard Airport Taxi Routes (a SATR is composed of a number of taxiways) and Stands to an aircraft (arriving and departing) and delivery of an alert to the controller when there is a conflict;
- Highlighting of the assigned Standard Airport Taxi Routes and Stands (each SATR is highlighted with a different colour);
- Advice on the best option for conflictless Standard Airport Taxi Routes and Stands;
- Clearance management with conflict detection (refer to Section 4.4.5.1 Airport Safety Nets);
- Normal Visibility Procedures (up to cat. I conditions) and Low Visibility Procedures (LVP) (Cat. II & III conditions) management based on weather conditions;

- Integration with Airfield Ground Lighting (AGL) system (status and control: stop bars, runway guard lights, taxiway centerline lights, clearance bar lights) and its automatic control based on the selected visibility conditions and runway in use;
- Customizable statistical analysis and reporting (refer to Section 0 Statistical tool);
- Friendly and intuitive HMI.



4.9 Arrival Manager / Departure Manager (AMAN/DMAN)

The AMAN/DMAN application is intended for sequencing the aircraft flows in the specified airspace segments and providing decision support to by the controller in the air traffic control process.

The main task of AMAN is to provide automated assistance to air traffic controllers in managing the flow of arriving aircraft:

- In a certain airspace (for example, points of arrival along the route);
- At certain flow management points (for example, runway threshold).

The main task of DMAN is to provide automated assistance for planning and sequencing of departures at an airport. The DMAN system allows:

- To reduce possible delays in departures from the parking;
- To execute taxiing and take-offs without delays.

The AMAN/DMAN application analyzes flight plans and radar information, based on which a 4D trajectory is calculated. This gives an updated prediction of the aircraft movement. The passage of waypoints controlled by the AMAN-DMAN server, the destination aerodrome, the estimated time of passage of the controlled points, the selected arrival and departure procedures (SID, STAR) are taken into account.

For each of the monitored waypoints or aerodromes, a time-ordered flow of aircraft for arrival and departure is formed, with indication of violation of the specified time intervals. If the set intervals are less than the safe ones, the AMAN-DMAN module calculates and displays the safe intervals, depending on the aircraft turbulence category, the modes of parallel runways, etc.

4.10 Air-Ground Datalink

4.10.1 Controller-Pilot Data Link Communication (CPDLC)

The Alpha CPDLC application allows the air traffic controller to transmit non-urgent 'strategic' messages to an aircraft as an alternative to voice communication. The application provides exchange of clearance/information/request messages which correspond to the voice phraseology used in the air traffic control procedures.
The controller can issue ATC clearances such as flight level, heading, speed, give frequency and other assignments, send information requests and respond to requests from aircrews. Correspondingly, the application provides reception of aircrew responses to ATC clearances and reception of other requests.
Messages are provided in a standard uplink and downlink format. In addition, "Free text" and "Urgent text" capabilities are provided for exchange of information that does not conform to the defined formats.

4.10.2 Departure Clearance (DCL)

The CPDLC application also supports Departure Clearance (DCL) message capabilities for direct communication between aircrews and the air traffic controller in accordance with a standard protocol. DCL is a means of automated assistance for air traffic controllers in delivering initial and revised departure clearances to aircrews.
Typically, CPDLC-DCL message elements are the following:

- Callsign;
- Destination;
- Route;
- RWY and SID;
- Cleared Altitude / Flight Level;
- Squawk;
- Next frequency.

The DCL function provides:

- Clearance request check vs the existing flight plan;
- Display of activated pre-departure flight plans;
- Display and check of received DCL requests;
- Clearance preparation and validation;
- Display of issued clearances;
- Readback/timeout status indication;
- Display of DCL data errors.

The system allows automatic or manual updating of DCL information.

4.11 Ground-Ground Data Link

4.11.1 Coordination with adjacent ATC units

The Ground-Ground Data Link application server provides data exchange between adjacent ATC centres.

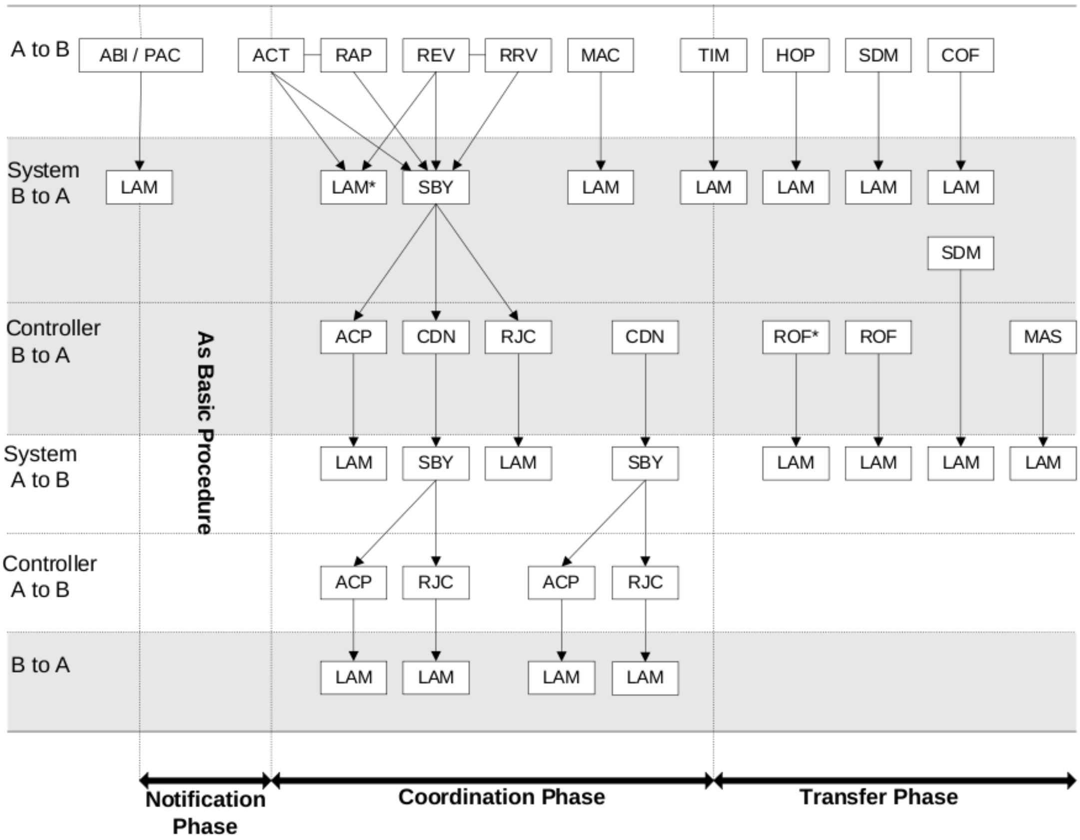
The inter-centre coordination is a procedure for coordination and transfer of flight data between adjacent air traffic control units intended to automate the coordination and data exchange process and to ensure timely delivery of standard messages according to the requirements of the following protocols:

- OLDI (On-Line Data Interchange);
- AIDC (ATS Interfacility Data Communications).

Three different categories of messages are implemented:

- Category 1: Transfer of Communication;
- Category 2: Coordination;
- Category 3: Notification.

The sequence of messages in the form of a diagram is presented below.



4.12 SSR code assignment

Alpha ATC system supports three methods of SSR code assignment:

- Manual: the controller assigns SSR codes manually;
- ORCAM: the system proposes an SSR code for assignment as part of the FPL activation procedure following the ICAO Originating Region Code Assignment Method (ORCAM);
- CCAMS: an SSR code is proposed for assignment by Centralized Code Assignment & Management System (CCAMS) via European network.

The controller can monitor the current code allocation in the "SSR codes" window that shows a list of SSR codes and their status ("free", "assigned", "not available").

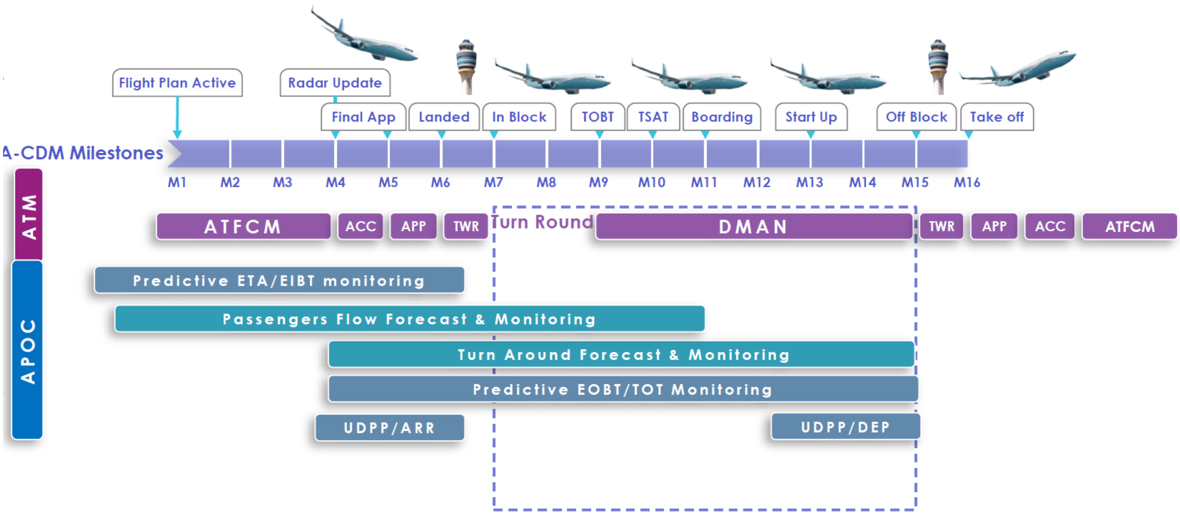
SSR codes				
2757	- - -			The SSR code is free and available.
2762	- - -			
1513	DLH3234	17:47	18:11	The SSR code is free but not available yet.
1552	AFL1123	18:02	18:20	
4665	SBI3443	18:12	--:--	The SSR code is assigned.
4246	KLM3434	18:09	--:--	

4.13 A-CDM capabilities

Alpha ATC system has been integrated with Airport Systems (AODB), and several functionalities are included in the product to address the exchange of airport data. This data is mostly used by Alpha ATC system (and the AMAN/DMAN function) to calculate more accurate times (TTOT, EOBT, TSAT, etc.) and/or to provide auxiliary information to Airport Operations Centre (APOC). In the other direction, Alpha ATC system is able to provide information back to the airport systems, contributing to the optimization of operations in the airport and to the airlines.

With the introduction of A-CDM (and AOP/APOC) systems, a new centralized approach is introduced instead of relying on siloed connections that are very costly and system-dependent.

Below is presented a small graph with an example on how we expect that the ATM and APOC systems might interact.



ATM-APOC interaction framework

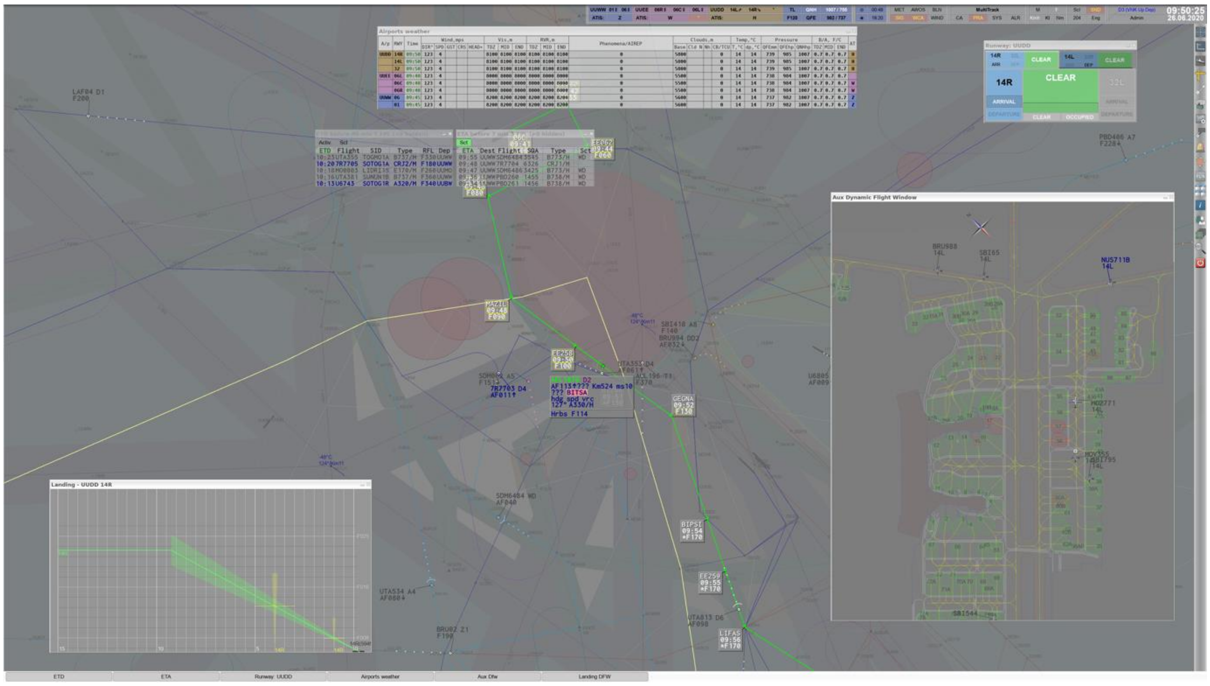
The list of supported Departure Planning Information (DPI) and Flight Update Messages (FUM) is provided in the Appendix 2.

5 WORKING POSITIONS

5.1 Controller Working Position (CWP)

The Controller Working Position provides:

- Combined display of several information layers:
- Cartographic information;
- Aircraft symbols and track labels;
- Direction-finder information (numeric values and bearing lines);
- Flight plan data (flight plan tables, additional functional windows for procedural control);
- Meteorological information (weather hazards);
- Prohibited and restricted areas;
- Other information necessary for controllers, presented in transparent windows;
- On-line configuring of information layers;
- On-line adding and editing of user-defined map elements;
- Screen zooming and re-centering;
- Possibility to open supplemental air situation display windows (one supplemental air situation display window and one vertical profile window) and also supplemental procedural (functional) windows;



Example of the CWP HMI

- Automatic adjustment of aircraft labels for a specific control area pre-configured by the controller;

- Concurrent display of the aircraft plot and the corresponding label containing additional fight data and calculated parameters such as:
- Call sign (flight number);
- SSR code (squawk);
- Controlling unit indication;
- Current flight level;
- Climb/descent tendency;
- Cleared flight level;
- Destination;
- Requested flight level;
- Azimuth and range;
- Latitude and longitude;
- Indication of non-update of position and altitude data, activation of the "flight plan track" function;
- Monitoring of the following events for each aircraft (warning is provided by displaying special symbols and by highlighting relevant information fields with colour):
- Distress signals sent by an aircraft (Emergency, Hijack, Radio Failure);
- Safety Nets and MONA alerts and warnings;
- Duplicated SSR codes;
- SSR code different from that in the flight plan;
- Aircraft not correlated with a flight plan, etc.;
- Prediction of the aircraft position for a specified time (up to 20 minutes) in the form of a velocity vector, taking into account the planned aircraft trajectory;
- Warning about conflicts between aircraft, in case when both RDP servers are not available;
- Warning about potential conflicts between aircraft based on prediction data, in case when both RDP servers are not available;
- Calculation of the protection volume (for conflict detection) taking into account the positions of aircraft relative to each other and their wake turbulence category, in case when both RDP servers are not available;
- Warning about conflicts of aircraft with obstacles, area proximity warning (APW) or weather area proximity warning (WAPW), in case when both RDP servers are not available;
- Minimum Safe Altitude Warning (MSAW);
- Detection of deviations from the route and the cleared flight level (RAM and CLAM);
- Indication of aircraft with identical SSR codes present in the control area;
- Automatic analysis and recalculation of the altitude value received via the SSR channel in the terminal control area for aircraft flying below the transition level;
- Display of planned and existing prohibited and restricted areas;
- Display of DF data as bearing lines and numeric values (up to 32 channels simultaneously);
- Display of hazardous weather areas, trajectories of radiosondes and current aerodrome weather in the combined picture provided in the air situation display window;

- Display of weather data (METAR, SPECI, TAF, SIGMET, GAMET, AIRMET) in a separate window;
- Procedure for transfer of control between adjacent control sectors;
- Automated procedure for electronic coordination of the conditions for transfer of control at the boundary between adjacent control sectors;
- Calculation and display of polar and geographic coordinates of a point selected manually with the help of the cursor;
- Range and azimuth measurement between two points or tracks;
- Display of an aggregate flight plan table with a set of filters;
- Display, creation and adjusting of flight plan elements;
- Manual correlation of flight plans with radar data;
- User authentication, access rights assignment, customized settings;
- RVSM-capability indication;
- Functions for stripless procedural control;
- Manual activation of the "flight plan track" function and interactive adjustment of parameters of aircraft plots simulated according to the flight plan data;
- Semi-transparent supplemental functional windows;
- Minimized console operations for accessing and adjusting flight plan parameters;
- Other controller functions.

The CWP displays only validated data to the controller and continues to display available processed data until it is considered reliable in the event of sensor or data source failure.

Screen snapshots and console inputs from the working positions are sent to the R&P servers of the recording subsystem.

5.1.1 Air Situation Display

The Air Situation Display (ASD) provides display of the airspace structure, RDP and FDP data, DF data, weather, reference and other necessary information in the main situation window showing graphical information in a number of layers: geographical maps, radar video, tracks, menus, status icons, date and time, current role, etc.

** Remark: the approach window displays the final approach area (20 NM) through the integration of the surface surveillance system with the existing Approach/Airport Surveillance Radar (ASR) available at the respective airport. It has a zoom range other than that in the ground movement windows, has a different collection of maps, shows ADS-B-equipped aircraft above a certain flight level and displays aircraft track labels as aircraft are detected by the ASR.*

The ATC display is multi-functional and is intended to be used for ACC, APP, Tower and Ground radar control and non-radar control. The scope of information presented on the screen, as well as the way in which it is presented correspond to the current activities accomplished by the controller. The last 20 display actions (panning, zooming) can be undone/redone for each traffic window.

The multi-window graphic user interface conforms to the Eurocontrol requirements (EATCHIP PHASE III HMI, EUROCONTROL ODID IV).

Information displayed on the workstations is supplied from the servers via a local-area network (LAN). Any changes made in any CWP are immediately sent to all other CWPs.

The sources of air traffic situation can include flight plan data and all types of primary and secondary radars, as well as satellite navigation systems and systems based on GNSS data (ADS-B VDL mode 4, ES 1090, ADS-C). The system provides multi-sensor processing and combined display of information derived from several sources.

The Air Situation Display is a highly-automated monitoring system that requires the operator to actively interact with displayed data and focus on the constantly changing air situation. A user can control the Display by panning, zooming and rotating.

The ASD user interface is designed in compliance with Eurocontrol documents on the human-machine interface (Human-Machine Interface Catalogue for EATCHIP Phase III), where it is pointed out that any operator actions (data input, voice coordination, data transmissions, etc.) that distract their attention from the air situation on the screen are undesirable.

Therefore:

- All functional windows use the same colour concept provided by selecting the most suitable colour scheme;
- Standard, unified solutions are used for supplemental functions.

To call supplementary functions for all track labels and information windows (flight plan table and other flight plan windows, etc.), the following solutions are used:

- Fields supporting supplementary functions have a dark-red background. A function can be called by a right click;
- Fields supporting transition to other modes of operation have a bright white outline. The transition is effected by a left click.

5.1.1.1 Main Situation Window

The Main Situation Window (MSW) is the major ASD element. It appears on the screen after loading of the ATC software, without any login.

The information in the MSW can be divided into static and dynamic.

Static information includes:

- Airspace chart;
- Aircraft parameters;
- Control areas and aerodromes;
- Regulatory and reference information;
- Control sectors;
- Airways and routes;
- User objects and annotations (in free test, visible in all open traffic windows on the CWP, may contain multiple lines).

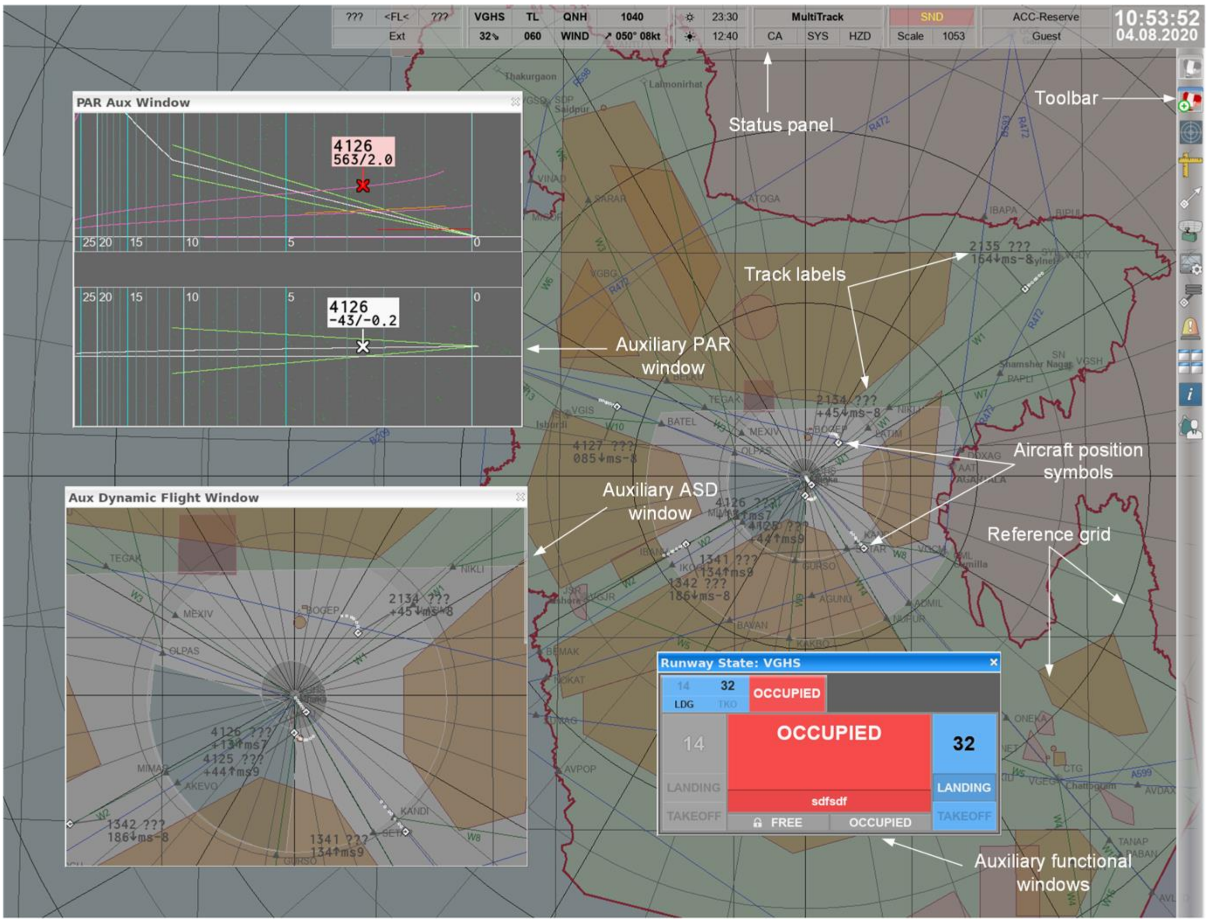
Dynamic information includes:

- Aircraft positions and flight data;

- DF data;
- Vector/measurer (Range and Bearing Line) information;
- Flight plans and other FDP information;
- Weather information;
- Prohibited and restricted areas;
- OLDI/AIDC messages.

The map information describes a way of visualization of all airspace objects such as waypoints, aerodromes, airways, etc.

Users can save preferable HMI settings (zoom range, display centre, selected maps, alert types, etc.) as a user profile and can select colour and font for adjustable items on the display.



Main Situation Window

The airspace chart contains the following elements:

- Airspace sector boundary shown by colour;
- Boundaries of adjacent sectors;
- Waypoints, airways, routes, SIDs, STARs, etc., displayed on the screen with colours of different intensity;
- Navaids (NDB, VOR/DME, radars, etc.);
- Military zones and restricted areas;
- Aerodromes and TMAs;
- Contours of geographical objects (rivers, lakes, shore lines, mountains, state borders, cities and towns, etc.).

Two types of range scale are supported in the ASD:

- Polar scale:
- Azimuth lines;
- Range rings;

- Geographical grid:
- Parallels;

- Meridians.

The controller can adjust the view, step and brightness of the range scale. The step can be selected from the pre-set values.

Current status information about the ASD is indicated in the status panel. The status panel can be also used by the controller for configuring some operating parameters.

Adjustment and setting of the ASD parameters (speed vector size, history dots, choice of maps, supplementary windows, etc.) are performed with the help of the toolbar. The toolbar is located on the right side in the main window as vertically arranged icons.

The aircraft symbols include:

- Actual aircraft position symbol (there are different symbols for tracks according to the flight plan, PSR, SSR, PSR+SSR, MLAT and ADS-B data);
- History dots (previous positions), with the history length selected by the operator;
- Speed vector, with the length of the vector selected by the operator.

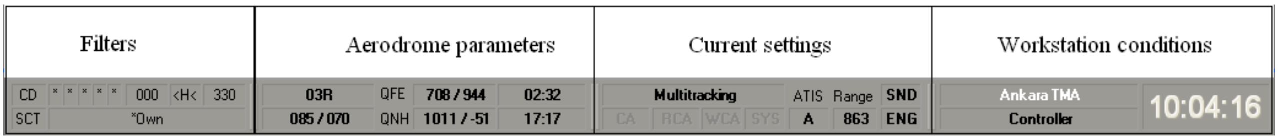
A track label can have three layouts (Standard, Selected and Extended). Track labels are connected with the corresponding aircraft symbol by a leader line.

In case of overlapping, track labels are automatically scattered. It is possible to change the position of a track label manually (the angle and length of the leader line).

The composition of data displayed in the track label for a terminal area and an area control center is different.

5.1.1.2 Status panel

The status panel displays the current role of the workstation and information about the ATC sector and. It is possible to edit data from the status panel.



Status panel

The following functions can be accessed on the status panel:

- User logging;
- Audio alarm setting;
- System log;
- Display of the window for working with prohibited and restricted areas;
- Display of the window for working with weather data;
- Manual setting of the actual ATIS code;
- Language selection (English or local);
- Display of the runway window;
- Display of the aerodrome information window.

Information in the status panel includes four groups:

Track label filters:

- By squawk code;
- By altitude;
- By sector.

Aerodrome parameters:

- Runways and their state (FREE, OCCUPIED, ARR, DEP, MIX, NOT USED, CLOSED, etc.);
- Transition level;
- QNH and QFE values (the controller can change the value manually).

Current settings:

- Selected radar source;
- Indication of current operating modes (conflict/risk of conflict, weather areas, prohibited and restricted areas, system messages, actual ATIS code, selected language, audio alarm mode).

Workstation condition:

- Current user;
- Role (controlled sector name);
- Mode of operation (main, bypass, simulator);
- Current time.

5.1.1.3 Toolbar

The toolbar is located in the main window and consists of a number of vertically placed icons. The toolbar is used by the operator to perform necessary operations, to call functions and to adjust the ASD parameters.

5.1.1.4 Track labels

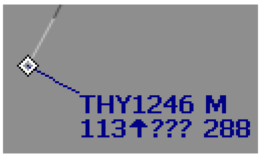
Information about aircraft (from the flight plan and/or surveillance sources) is presented in track labels in the main situation window and supplementary situation windows with automatic and manual labelling of all tracks throughout the coverage area. The track label layout and colour depend on the track type and the track status, with a layout defined using the label editor.

The composition of track labels displayed in the situation windows complies with the recommendations and requirements of the Eurocontrol documents (EATCHIP PHASE III HMI Catalogue, ODID IV). A track label may have different presentations:

- Standard or Normal label**:** the default state of a track label (when no actions are performed in it by the controller), it shows the most important label fields;
- Selected or Focus label**:** a track label is automatically changed to this layout when the mouse cursor is passed over it;
- Extended label**:** triggered manually by the controller to get additional information for a particular aircraft;

- Quick-look label: stays on the screen until the mouse is moved away from the label;
- Fixed-look label: opens in a separate window and stays on the screen until it is closed by clicking the close button.

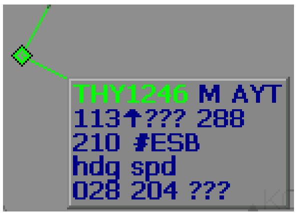
Information in a track label can be displayed with the help of different colours. The colour of text in a track label depends on the flight status of the aircraft (arrival track, departure track, tow track, vehicle track, other tracks (unidentified, e.g. SMR-only)).



Standard track label

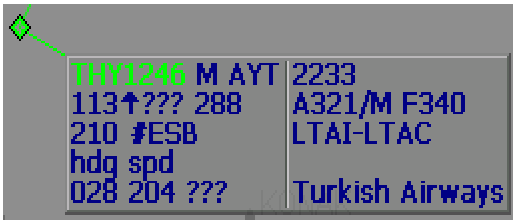
When selected, a track label is displayed as a semi-transparent window. Such track label allows the controllers to interact with the system without additional operations.

To avoid flashing of a track label when moving the cursor on the screen, the system has a delay for displaying an active track label (100 ms, user defined parameter). An active track label does not change its position on the screen. If the cursor on an active track label has not changed its position for a specified time, the system automatically closes this label and it returns to the non-active state.



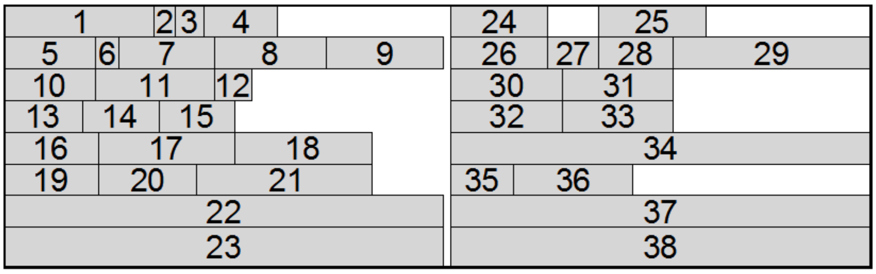
Selected track label

To extend a track label, it is necessary to click on the "Callsign" field. The extended track label makes all necessary information related to a given flight available on the screen. All functional fields in the track label are shown.



Extended track label

The information fields of a track label are shown in the figure and the table below.



Track label fields

Table 1

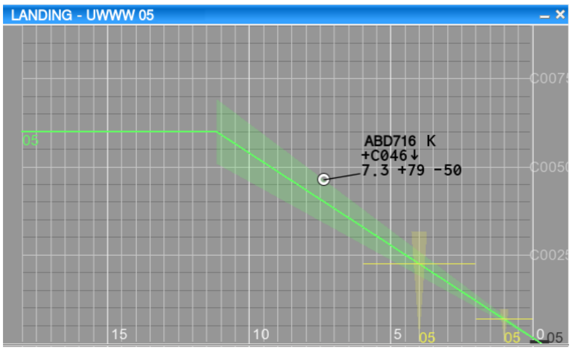
Field	Content
1	Callsign or SSR code
2	Extrapolation sign
3	STCA/MTCD sign
4	Sector identifier
5	Actual flight level
6	Climb/descent sign
7	Cleared flight level
8	Ground speed
9	Vertical speed
10	Transfer flight level
11	Transfer WPT or destination airport
12	Transfer time
13	Assigned heading
14	Assigned indicated air speed
15	Assigned vertical speed
16	AMAN information: number in the arrival sequence

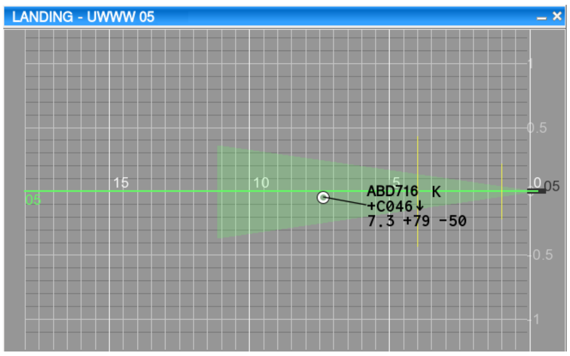
17	AMAN information: time to lose or time to gain
18	Length of route to landing
19	System track
20	Aircraft type
21	Airport of departure, airport of arrival or exit WPT, SID, STAR
22	Note (free text)
23	Alert area
24	SSR code
25	Tail number
26	Aircraft type
27	Turbulence category
28	RVSM, 8.33 kHz radio, RNAV signs
29	Requested flight level
30	Airport of departure ICAO code
31	Airport of arrival ICAO code
32	Departure time
33	Arrival time
34	Airline callsign
35	Next sector identifier
36	Next sector frequency
37	Airport of departure
38	Airport of arrival

5.1.1.5 Supplementary functional windows

Four types of supplementary functional windows can be displayed in the main window:

- Supplementary situation windows:
  - Supplementary air situation window;
  - Vertical Aid Window;
  - Glidepath and course window (approach path monitor);
- Flight plan windows:
  - Flight plan table;
  - FPL editor;
- Other supplementary windows:
  - Tower information;
  - Runways;
  - Supervisor information;
- Service windows:
  - Clock;
  - Lost tracks;
  - SSR code (squawk) assignment.



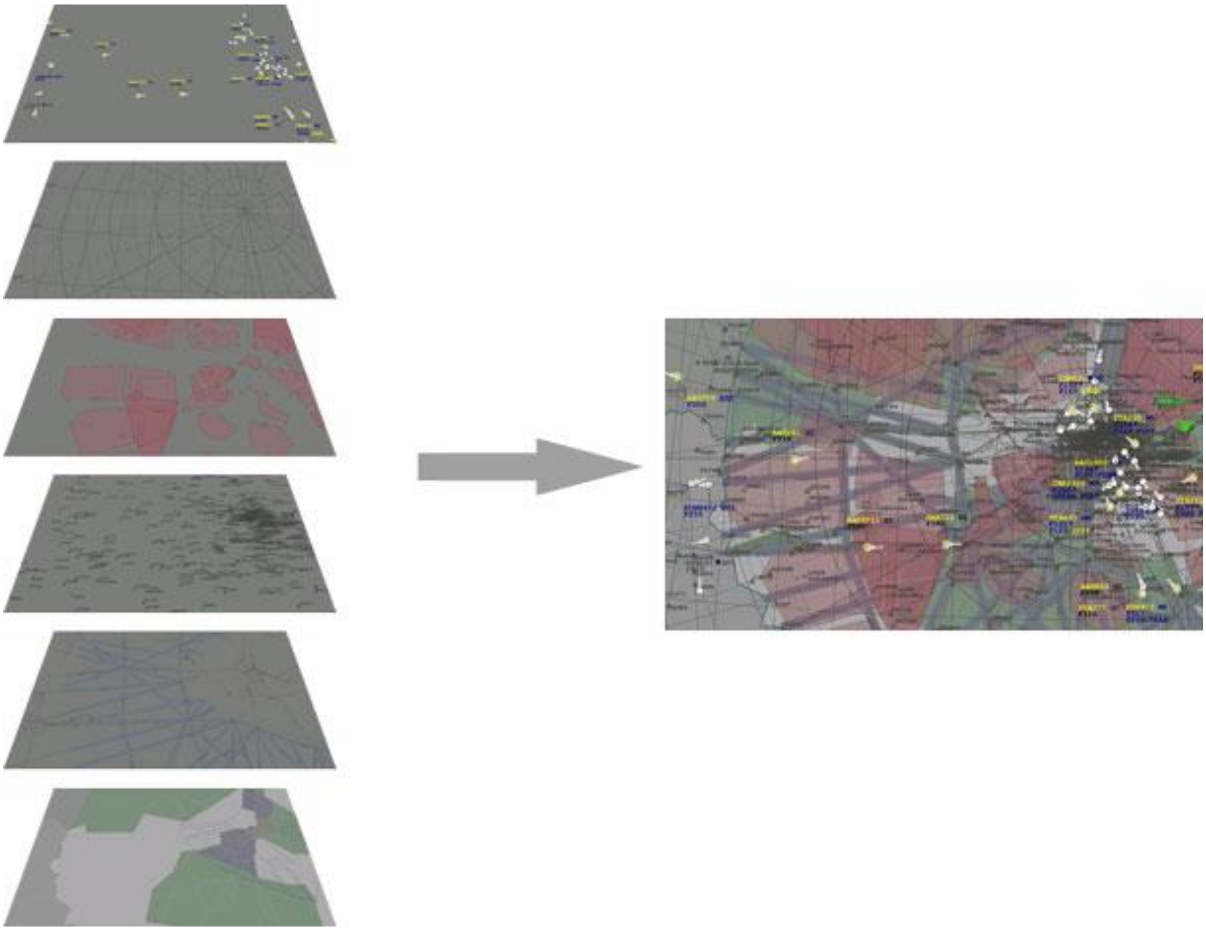


These windows will always be displayed on top of the situation window. The controller can adjust the layout of supplementary windows.

5.1.2 Information data

5.1.2.1 Maps and aeronautical information

Presentation of graphical information (background, maps, radar video, annotations, tracks, dialogue windows and lists) is based on layered display, i.e. higher-level layers cover lower-level layers. An example of information layers presented on the ASD screen is given below.



Example of information layers presented on the ASD screen

A priority level is assigned to each group of information according to the importance of this group for the air traffic controller. Priority levels define the order in which groups of information are presented on the screen. The ASD picture consists of multiple layers, where the most important elements are presented in front. The sequence of information layers is as follows:

- Elements of cartographic information;
- Azimuth/range grid and geographic grid;
- User-defined elements;
- Semi-transparent windows;

- Aircraft labels and the measuring tool (measures the bearing and the distance between two positions with the result shown in the measurement line and the label);
- Non-transparent windows.

The displayed image is generated in accordance with the controller's choice with the content mapped in the following order (from bottom to top):

- Default background maps;
- Selected maps displayed in the listed order. Annotations;
- Radar video;
- Track data, including labels. Lists and dialogues.

The system allows to display different predefined maps.

In addition to the graphic map, other graphic elements can be created in the ASD window.

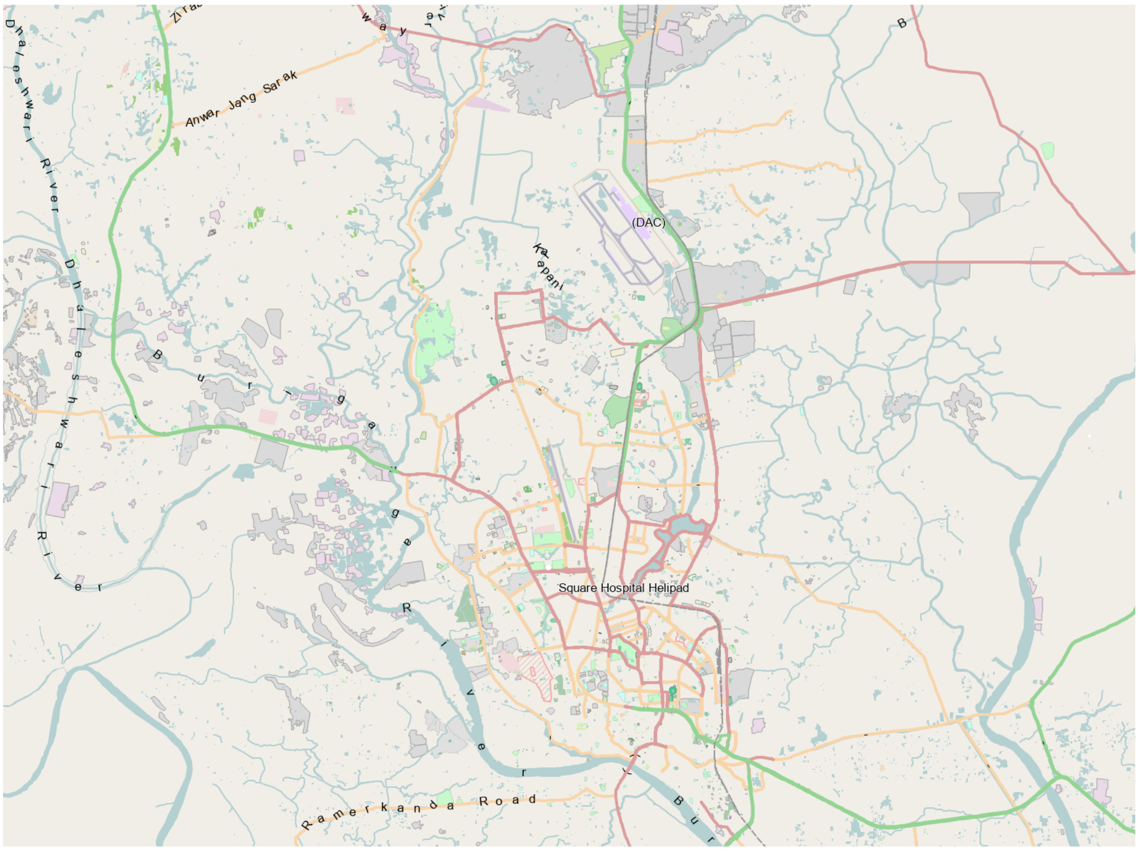
**Remark*: the composition of groups can be adjusted in accordance with the customer needs, e.g.:

- Airport maps: displaying areas at the airport, such as taxiways, stands, buildings, roads, etc. These are only intended for visual reference;
- Emergency maps: maps that are displayed on all operational positions when the emergency button is pressed on any operational position;
- Local free map: one local free map is available on the CWP at the control tower. This map can be edited by the controller, typically for local remarks.

A possible composition of charts is listed below (but is not limited to this):

- Terrain map;
- FIR boundaries;
- Areas of responsibility of sectors;
- UTA, CTA, TMA, CTR;
- TIZ, ATZ;
- Prohibited, restricted and dangerous areas;
- TRA, TSA;
- ATS routes;
- COP;
- SIDs / STARs;
- NAVAIDs;
- Special airspace;
- Runways, runway centerlines;
- Radar vectoring areas;
- Aerodrome locations;
- Aerodrome layouts;
- Surveillance sensor sites and coverage areas;
- Range rings;
- Emergency map.

The composition of maps that can be selected and displayed in the ASD window on each workstation is defined in the "Schemes" tab menu. Groups of map elements are specified in the list (tree view). When an item is selected from the list, the corresponding group of elements will be displayed in the ASD window.



Example of terrain map display

Example of terrain map display

Predefined maps can be created using the "Airspace editor" and "Map generator" tools. These tools provide import/export of aeronautical data to/from a local or centralized aeronautical information database in ARINC-424 and AIXM 5.1 formats.

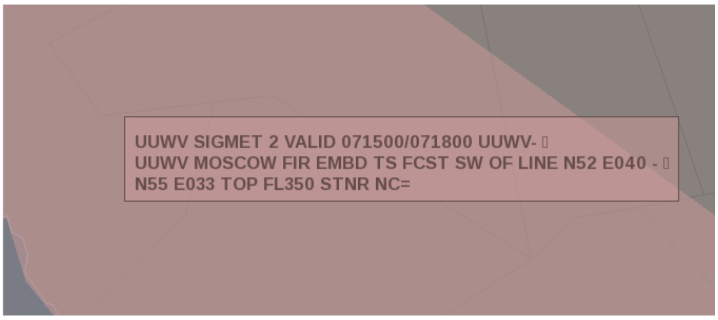
5.1.2.2 Weather data presentation

The CWP can process the following weather data:

- Local routine reports (MET REPORT) and local special reports (SPECIAL) (for a terminal ATM system);
- Routine reports (METAR) and special reports (SPECI);
- Terminal aerodrome forecasts (TAF);
- SIGMET and AIRMET;
- Hazardous weather formation boundaries (including weather contours based on combined data from several radars);
- Wind and air temperature at different altitudes with amendments;
- Estimated trajectories of weather radiosondes;
- Wind and air temperature at airways with amendments;
- Warnings for aerodromes and wind shift warnings;
- Information about volcanic ash clouds not reported yet in SIGMET message;
- Emergency information about radioactive emissions;
- Special airborne reports.

The main air situation window displays the following weather data:

- Text information in weather coding (METAR, TAF, SIGMET, etc.) in semi-transparent windows;
- Contours of hazardous weather formations;
- Trajectories of weather balloons with track labels;
- Wind data for flight levels.

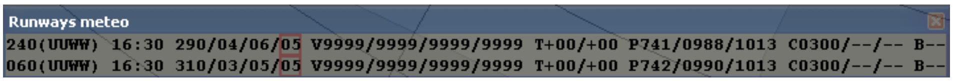


The Weather Data window provides:

- Display of all weather data;
- Acknowledgement of essential weather data reception;
- Selection of weather data to be displayed in the main air situation window;
- Transmission of requests for weather information;
- Reception of requested weather information.

Updating of essential information is displayed in the window and is accompanied by a sound alarm.

The "Runways meteo" window displays information about the weather at aerodrome runways in a semi-transparent window.



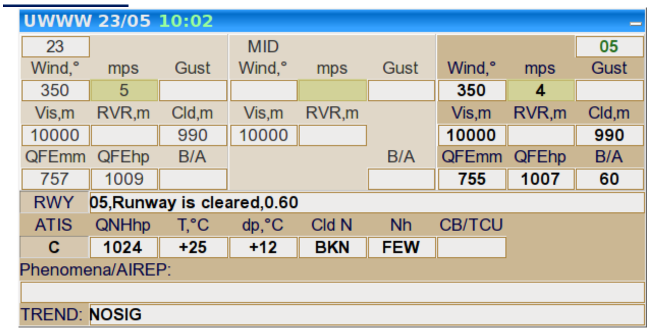
"Runways meteo" window

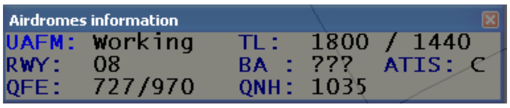
The information is displayed as text. Weather data for each runway is presented in a line with the following sequence of fields:

- Runway name;
- Weather data time;
- Wind: direction / speed / gusts / side force;
- Visibility: weather visibility / at RWY1 / at RWY2 / at RWY3;
- Temperature: temperature / dew point;
- Pressure: QFE(mmHg) / QFE(hPa) / QNH(hPa);
- Clouds: ceiling / volume / low-level volume;
- Friction coefficient.

Updated data is displayed against a blue background. In case of hazardous values (strong side wind, etc.), weather data is displayed in a red frame.

The "Aerodromes information" window is semi-transparent and displays information for specified aerodromes.





"Aerodromes information" window

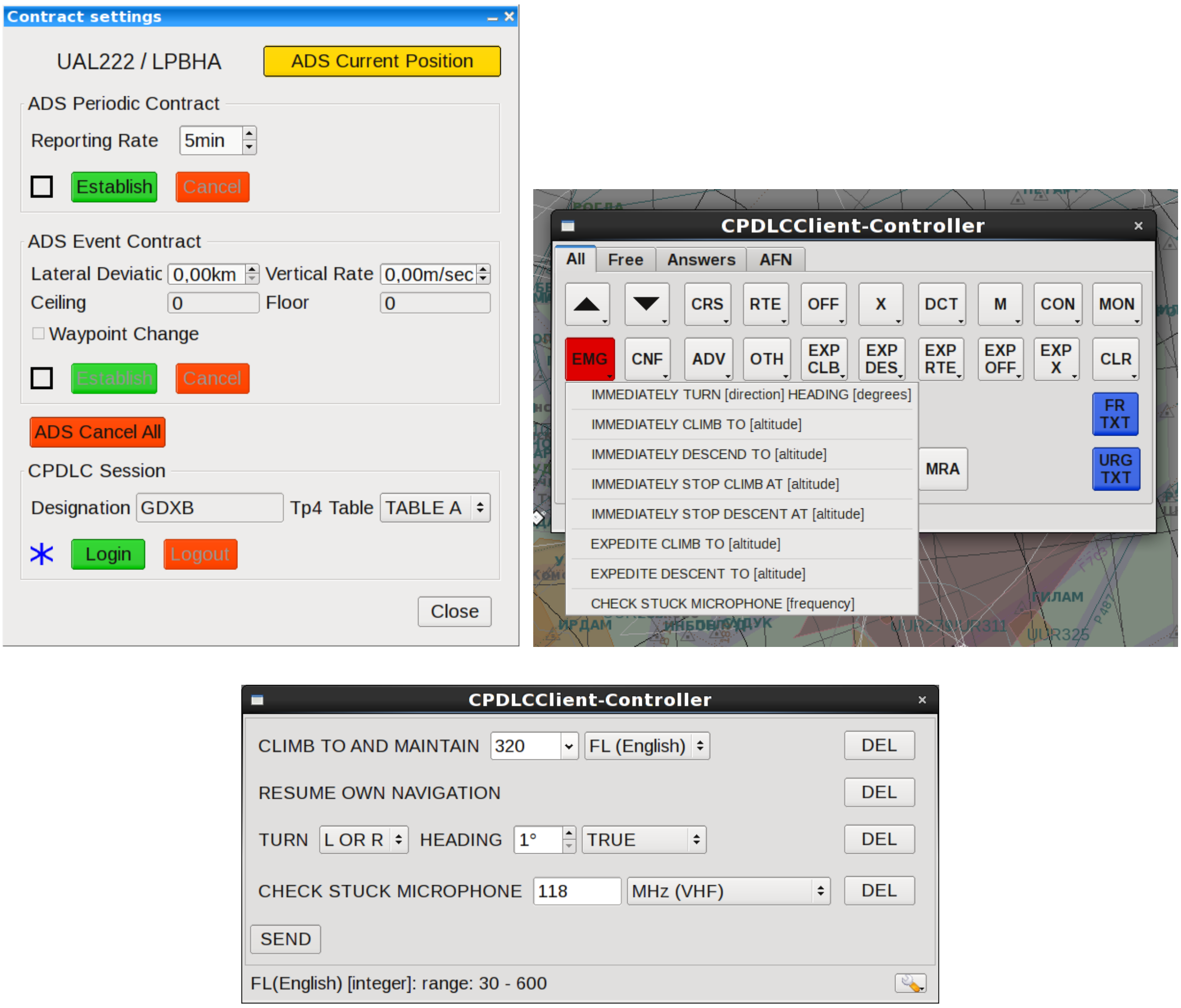
5.1.3 Controller-Pilot Data Link Communication and Departure Clearance

Controller-Pilot Data Link Communication (CPDLC) is a means of communication between the controller and aircraft crews that provides the capability to assign altitude, speed, radio frequency, constraints, lateral deviations, route changes and clearances, as well as to send "free text".

The CPDLC icon (

) on the controller's toolbar opens the CPDLC window used for transmission and reception of CPDLC messages.
The CPDLC client application provides user interface for Air-Ground Data Link Communication functions, such as:

- ADS-C;
- CPDLC;
- CPDLC-DCL.



Air-Ground Data Link Communication tool HMI

Departure Clearance (DCL) is a means of communication between the controller and aircraft crews that provides issue of departure clearances with start-up and departure information.
In the DCL window, the controller creates and sends DCL messages with the following information:

- Callsign;
- Departure airport;
- Destination airport;
- Runway;
- Exit point;
- SID (Standard Instrument Departure);
- Squawk code;
- ADT (Approved Departure Time);
- Next frequency;
- Optional current ATIS information.

ETD	In	Out	Message	ACID	CODE	TYPE/W	ADEP	ADES	SID	CTOT	RWY	Gate	ATIS
15:00	CDA	CLD	CLEARANCE CONFIRMED	AFR1695	A4105	A319/M	ULLG	EVRA	ASAR 2A	15:05	28R	A35	A
15:10	RCD	FSM	RECEIVED	BAW879		A320/M	ULLG	EGNK				A37	A
15:20	CDA	FSM	FLIGHT PLAN NOT HELD	SDM119		A320/M	ULLG	UUEE				A39	A

Example of the DCL window

5.1.4 AMAN/DMAN Manager

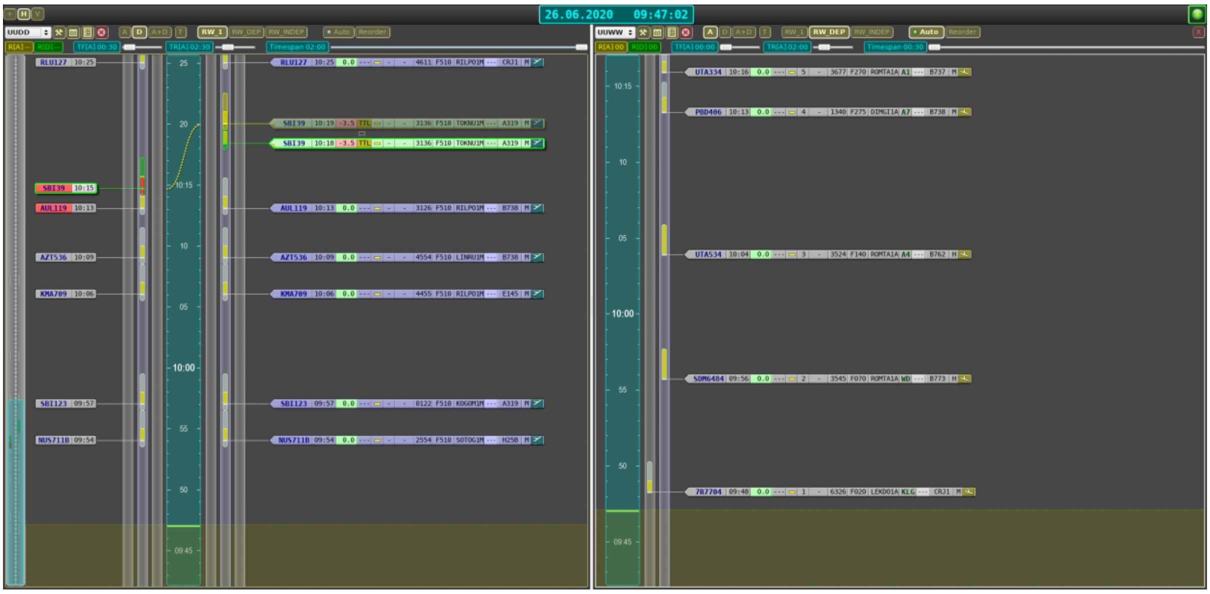
AMAN-DMAN Manager sequences and schedules arriving and departing flows of flights for each determined control point or runway with continuous calculation of safe intervals, taking into account the 4D trajectory, current airspace structure and airport layout, with alerting about violation of time intervals via the AMAN-DMAN widget, planning lists, electronic strips and aircraft labels.

The AMAN-DMAN Manager provides:

- Graphical representation of the calculated sequence;
- Advisories for aircraft flow control to implement this sequence.

Advisories displayed by the AMAN system for aircraft flow control may include:

- Time To Lose (TTL);
- Time To Gain (TTG);
- Trajectory change recommendations (CHT).

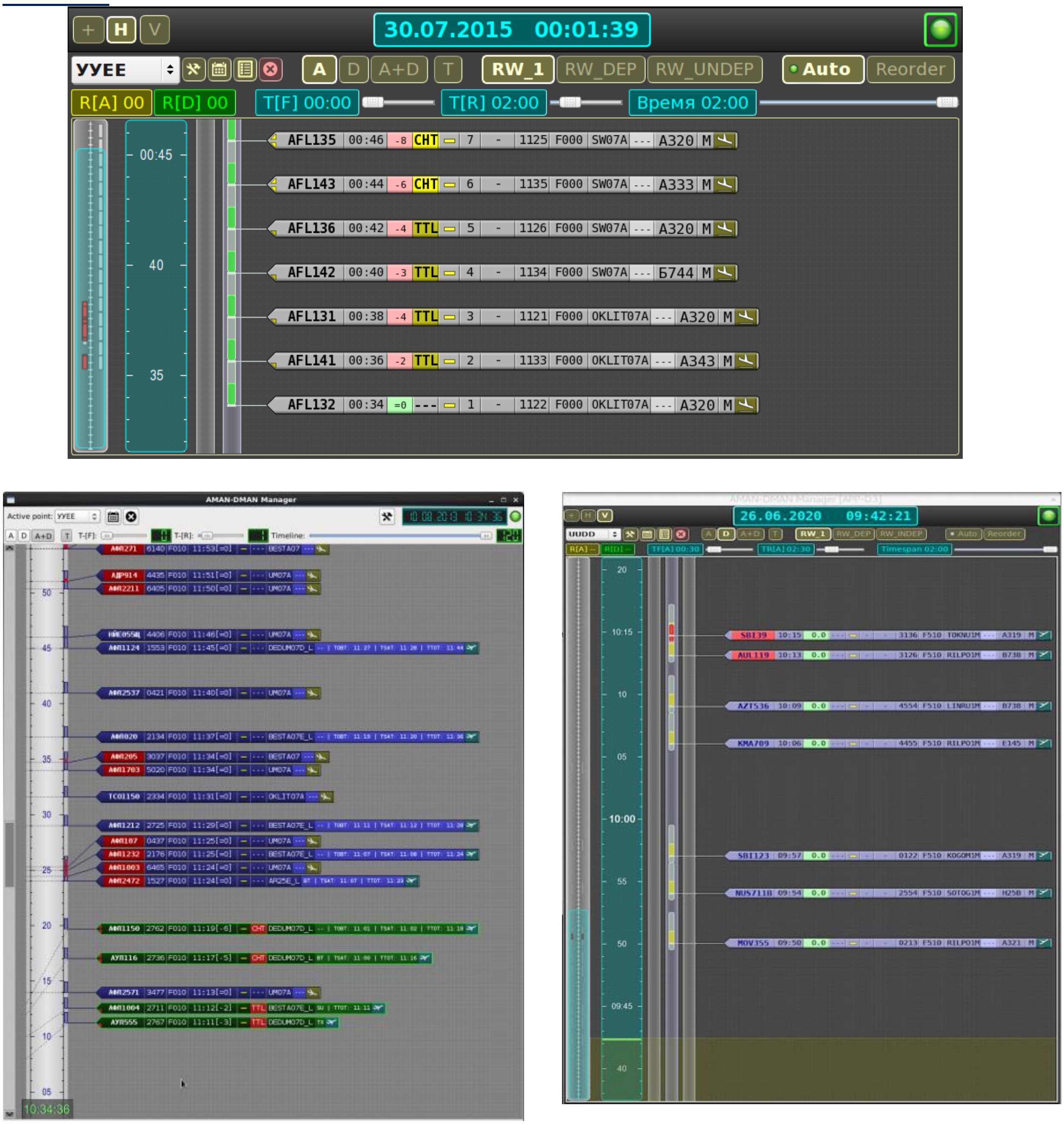


For regulating the flow of departing aircraft, the DMAN system performs the following calculations:

- Calculation of the Target Off-Block Time (TOBT);
- Calculation of the Target Start-Up Approval Time (TSAT);
- Calculation of the Target Take-Off Time (TTOT).

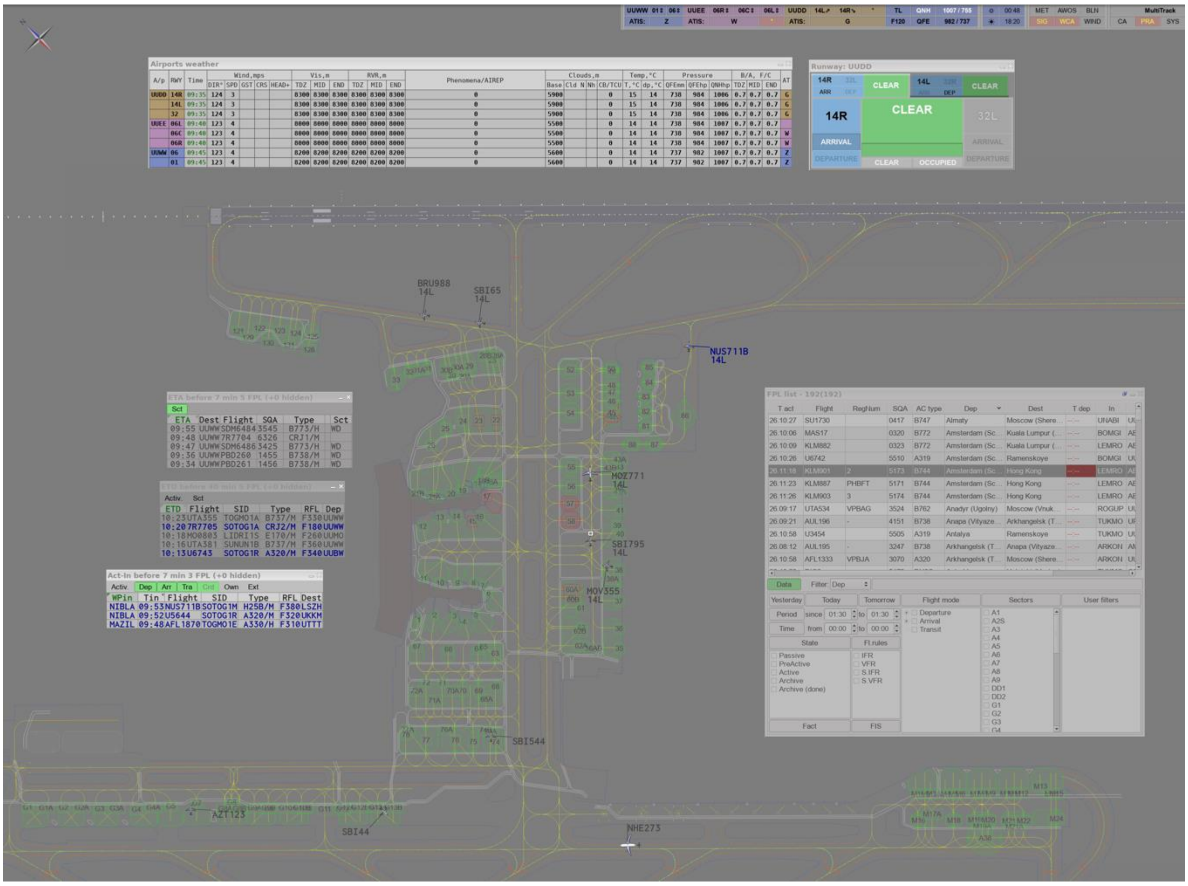
The main AMAN-DMAN HMI element is the AMAN-DMAN widget consisting of the following elements:

- Time scales;
- Actual arrival / departure sequence;
- Calculated arrival / departure sequence.



AMAN/DMAN Manager widget HMI

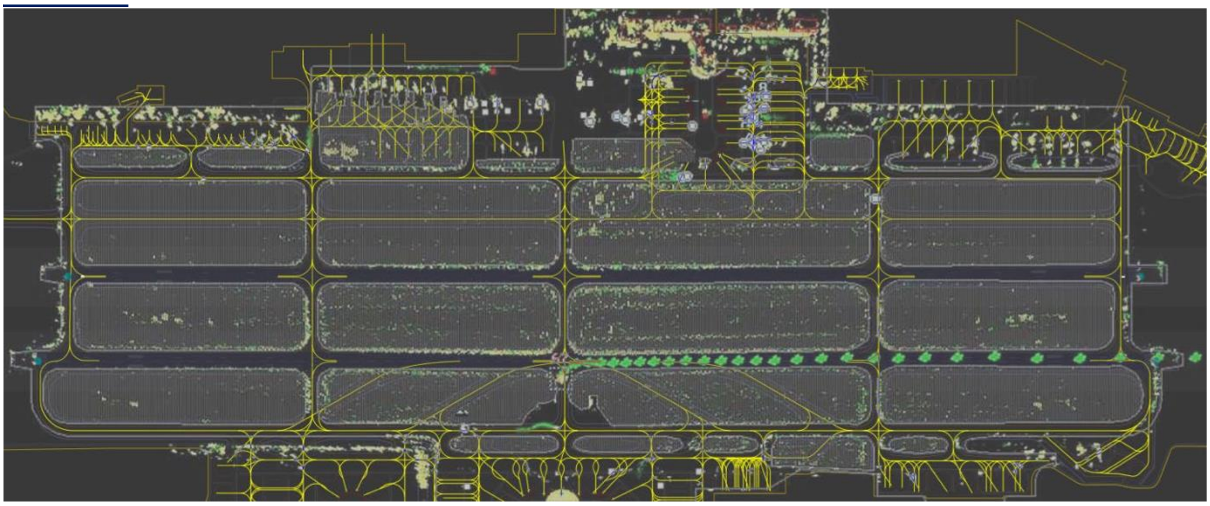
5.1.5 A-SMGCS user interface



Surface Movement Control display (A-SMGCS function)

The A-SMGCS subsystem provides:

- Display of the airport map;
- Display of air and ground traffic situation;
- Display of the digitalized radar video;
- Display of identification data for each identified surveillance target;
- Display of various traffic lists and flight plan tables;
- Display of video from SMR sensors in the traffic window with the history of the radar raw video and the capability to detect undesired objects in the movement area;
- Selection of visibility conditions;
- Display of Airport Safety Nets alerts (see Section 4.4.5) generated according to the selected visibility conditions;
- Presentation and management of different tools (timers, notes, measurement tools, etc.);
- Display of additional information, such as approach path monitor window, runway status, local weather, ATIS letter, QNH, Navigation Aids Systems status, etc.;
- Interaction with other system functions such as Routing and Guidance Management, Departure Manager, etc.

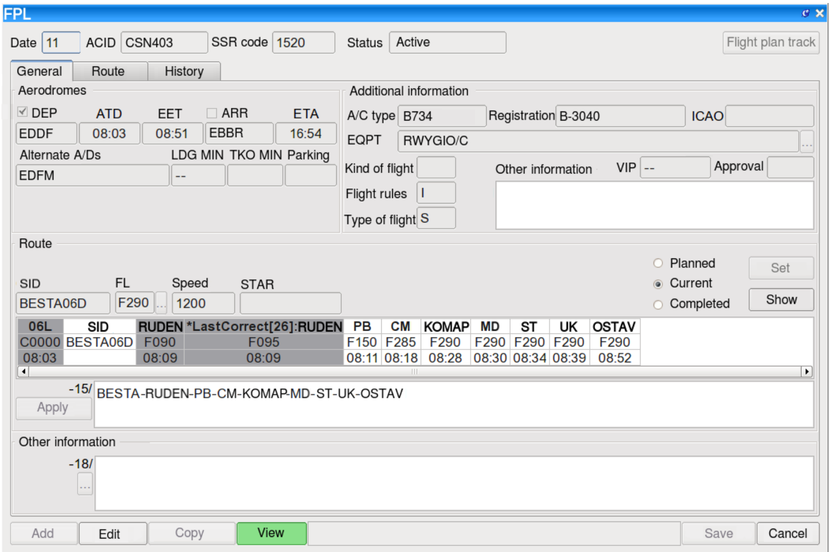


Display of raw SMR video with history

5.1.6 Flight plan data and Electronic Flight Strips

The Alpha ATC system HMI provides presentation of flight plan data with a tool for interaction between the controller and the system by means of flight plan tables and Electronic Flight Strips (EFS) that can be adjusted according to the customer needs in terms of view, content, types, colour scheme, etc.

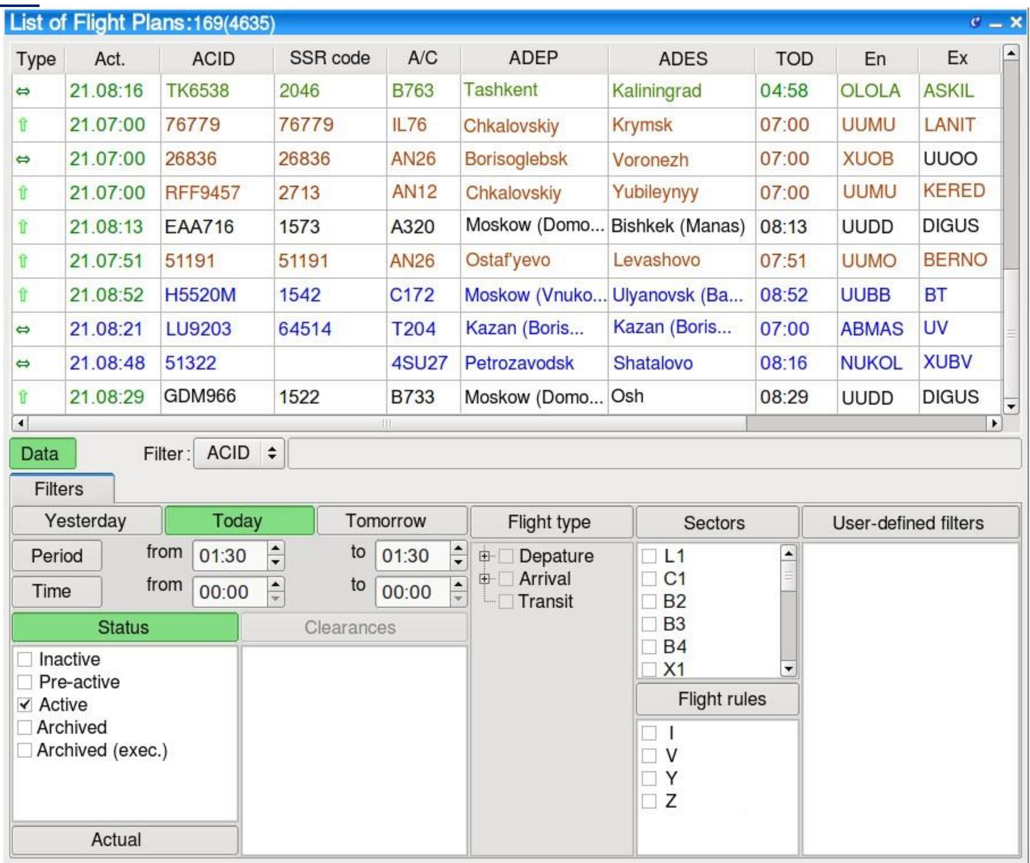
The flight plan windows and lists contain tables with the parameters of corresponding flights. They allow to divide all flight plans into separate groups in accordance with the phase of flight and show alarms, arrivals, departures, vehicles, tows, lost identifications (coast), Time to Threshold (TTT) and Distance to Threshold (DTT).



Example of the FPL window

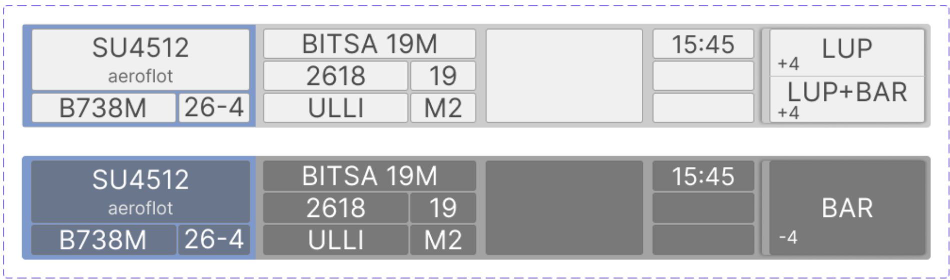
The main FPL windows are:

- Daily Plan: all daily flight plans;
- IN: incoming flights to the area of responsibility;
- Controlled: flights under control;
- Holding: flights in holding areas;
- ETD/RETD/ATD**:** show departing tracks that appear in the departures list 60 minutes before their ETD. The ETD can be changed manually;
- RETA/ATA: show arriving tracks that appear in the arrivals list 60 minutes before their ETA. The ATA can be changed manually. The Time to Threshold (TTT) and Distance to Threshold (DTT) lists are incorporated to the arrival lists;
- STAND: parking list;
- COAST: lost tracks within the identification area any items from the coast list can be used to manually identify tracks;
- Vehicles: shows known vehicles and is used to manually identify vehicles. Controllers can add or delete temporary vehicles to or from the list. The tow list is incorporated to the vehicle list (the controller can add or delete tows to or from the list).



Daily Plan table

EFS provides capabilities to change the flight status and input electronic clearances.



EFS examples

Some flight plan fields are available for manual modification (as defined by the configuration).

5.2 Supervisor Working Positions

5.2.1 General

The Operational Supervisor and Technical Supervisor Workstations have identical software and are interchangeable. The functionality of these workstations is defined at the user rights level at logon.

The Supervisor Working Positions are provided with the following application software:

- CWP software (running constantly);
- Technical control and monitoring software (running constantly);
- Service programs and utilities.

5.2.2 Operational Supervisor

In contrast to an air traffic controller, a user registered with the operational supervisor rights has access to some settings that are not available to the controller, such as:

- Disabling of conflict warnings and other alarms;
- Data changing in the Supervisor information window;
- Generation of user objects (charts) available on all workstations;
- Activation/deactivation, input and deletion of bans and restrictions.

A user registered in the system on the Supervisor Workstation with the technical supervisor rights has no access to the above settings.

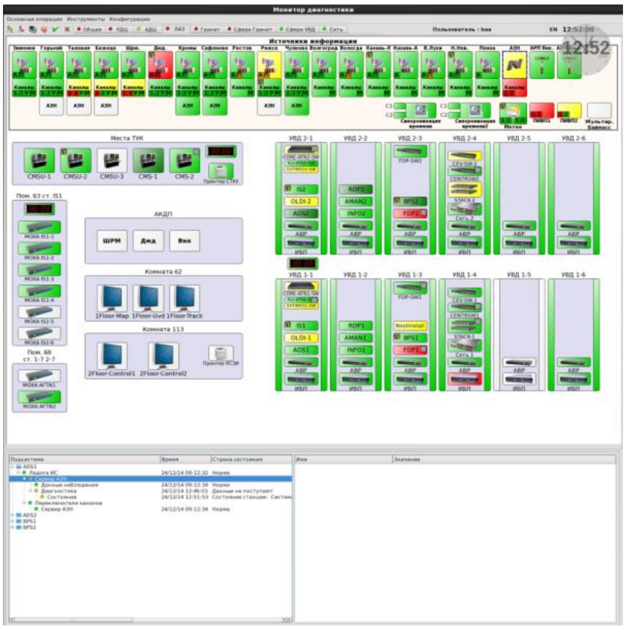
Technical Supervisor Working Position with the CWP and CMS displays

5.2.3 Technical Supervisor (Control and Monitoring System, CMS)

The Technical Supervisor Working Position provides the technical supervisor with facilities for controlling and monitoring the system. The Technical Supervisor Working Position provides:

- Display of the same CWP application software as that intended for the ATC personnel but with limited (disabled) control functions which is used for monitoring purposes only;
- Acquisition of diagnostic information from the components of the system (RDP, FDP, EXCH, GGDL, AGDL, AMAN-DMAN, A-SMGCS, Boot Install, CWP, CMS, R&PS, TDS, etc.) down to LRU level on a real-time basis;
- Diagnostics of the LAN and its individual devices (switches, cables, etc.);
- Remote control of the operation of each system unit: restart/shutdown of the equipment, launch/restart/shutdown of the application software;
- Real-time local and remote control and monitoring of the system performance and parameters, status of the system components, fault diagnostics, audio and visual indication of warnings and alerts signalling;
- Indication of the sensor status in the dropdown panel showing external interfaces with all interacting subsystems such as FDPS, MLAT, ADS-B, SMR, ASR/PSR/MSSR, etc.
- Indication of the generalized status (normal/failure) of the associated interacting systems;
- Off-line and on-line (real-time) reports of :
- Statuses of the system and its elements;
- Reliability KPIs;
- Failure KPIs,
- User activity;
- Holding capacity indicators;
- etc.
- Configuration of the system, editing of all system parameters, variables and settings;
- Utility software for editing the airspace structure, charts, maps, airport layout, etc.;
- Tools for maintenance purposes;
- User management (roles, access rights and functional limitations, etc.);
- Database management;
- Reporting of significant failures to all working positions within the user-specified time;
- Collection of system events and maintenance data and their storage in a redundant database for further analysis and reporting;
- Analysis of recorded diagnostic data and statistics, and generation of reports;
- Retrieval, filtering, printout and export of the system log and diagnostic reports in standard formats (xml, txt, docx, xlsx, etc.).

The Control and Monitoring System application software is adaptable to the exact structure and configuration of the operational system through configurable parameters.



The system diagram shows groups of objects to be diagnosed. It includes main objects (systems) and nested objects (subsystems). Clicking on a system object displays its subsystems at the bottom of the diagram. A subsystem may be a physical object or a program diagnosed and can also contain nested objects.

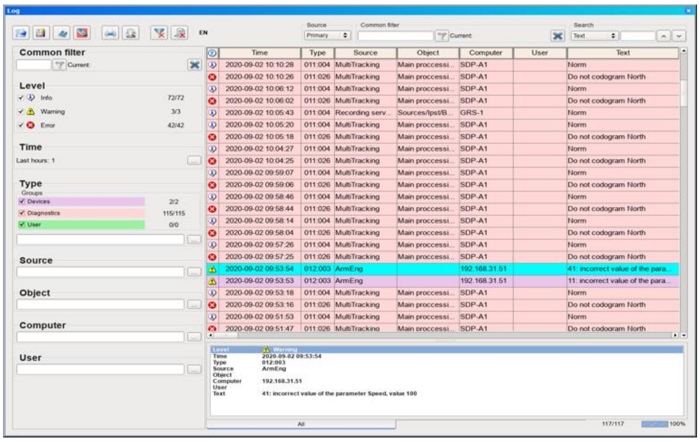
The sensor status is shown with a pop-up menu when the status is 'not available'.

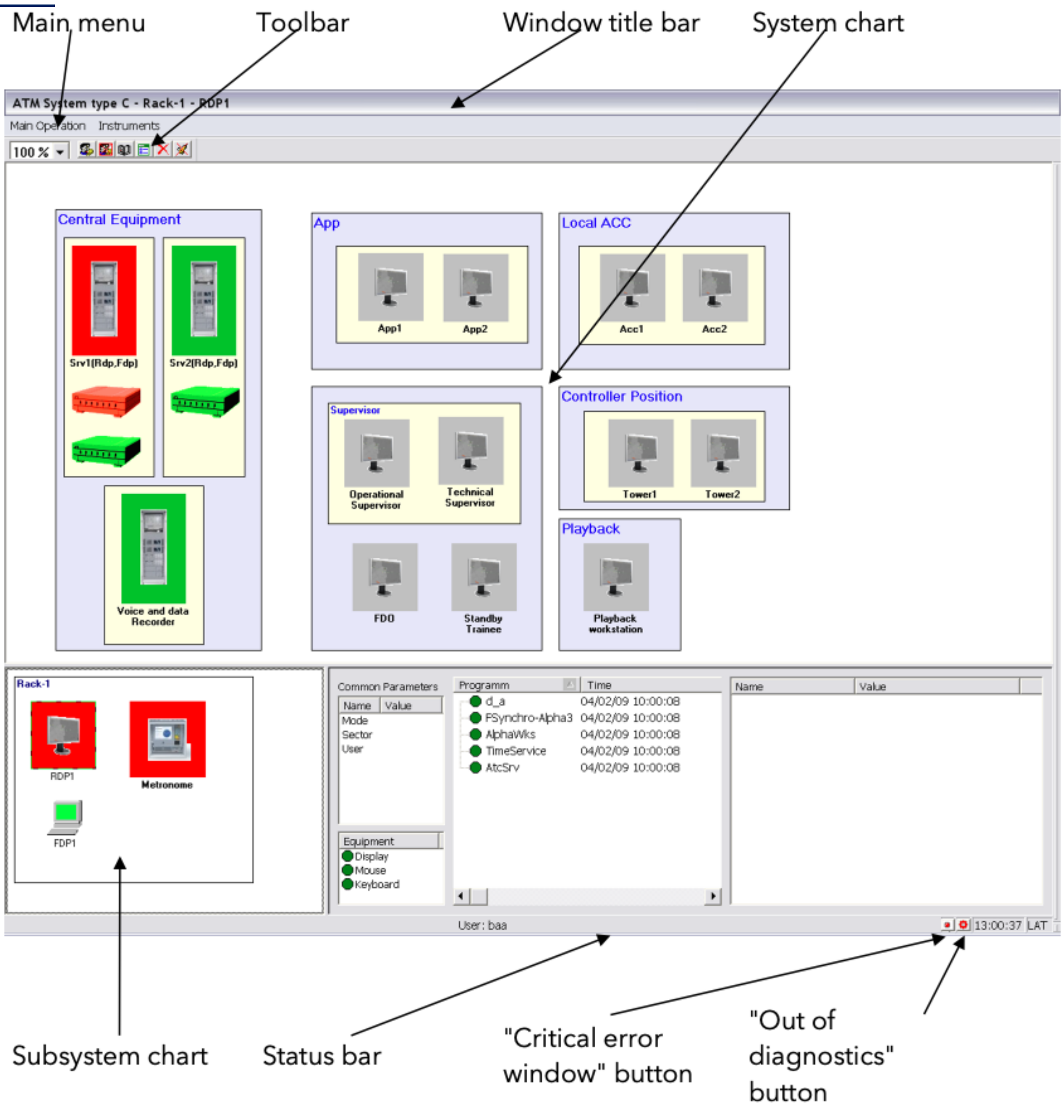
The sensor status can show a missing interface or missing data (e.g. radar video or plots).

All elements of the subsystems are displayed as widgets of different colors. The color indicates the general state of the system.

Each object is provided with a context menu used to control it (enable/disable diagnostics) and to display information about it.

All events are stored in the log for at least one month (configurable parameter). They are listed chronologically and can be filtered by attributes. For each event, the date, time, source name and description of event are displayed. The log is stored in a redundant database and can be used for statistical analysis and reporting.





Main window of the Control and Monitoring System (CMS)
on the Technical Supervisor Working Position

5.2.4 Utility software

The Supervisor Working Positions provides access to the following tools:

- Airspace database editor and chart editor: these applications are available only to users with the supervisor rights;
- System configuration and settings editor: this application is available to users with the supervisor rights;
- User rights editor: this application provides user management, including password management, and is available to users with the technical supervisor rights;
- Utilities for database management: these applications are available to users with the technical supervisor rights;
- Utilities for different versions of system configuration files, charts, aircraft/airports data, backup, storage and distribution: these applications are available to users with the technical supervisor rights.

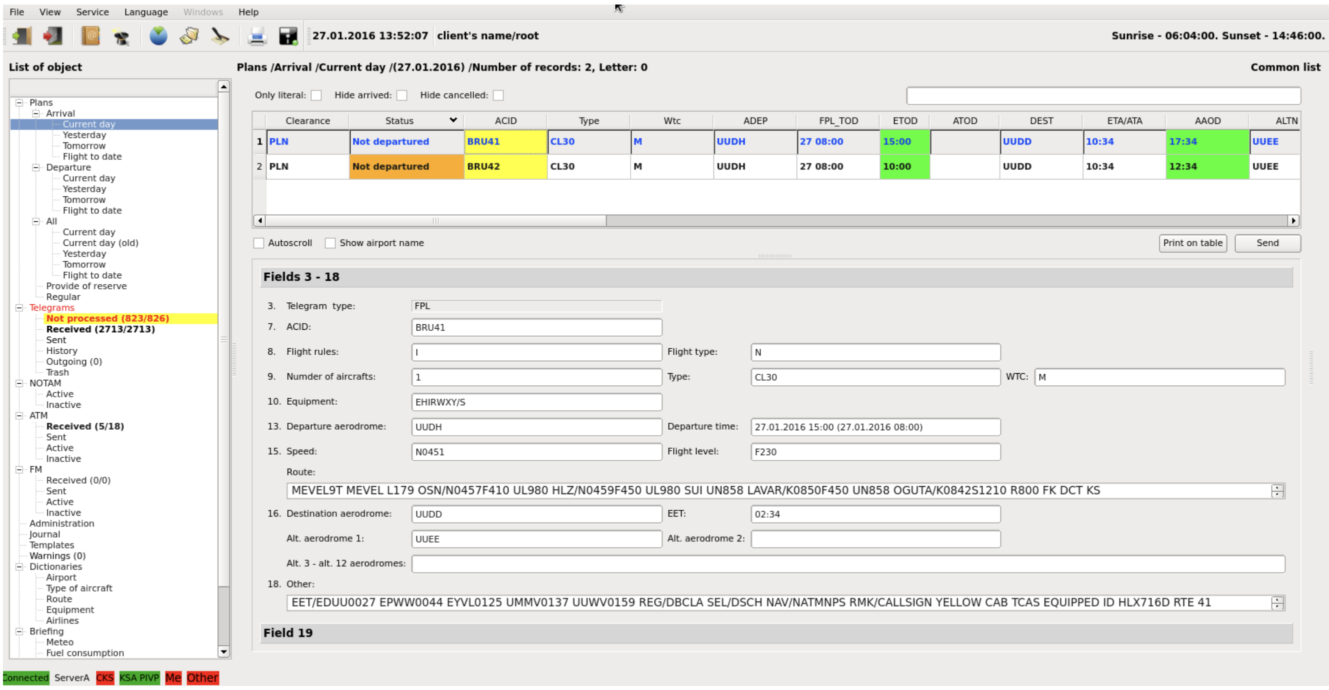
The Supervisor Working Positions provides data export to an external billing system. It extracts billing information, from actual system events involving flights physically operating within the area of interest.

5.3 ATS Reporting Office Working Position

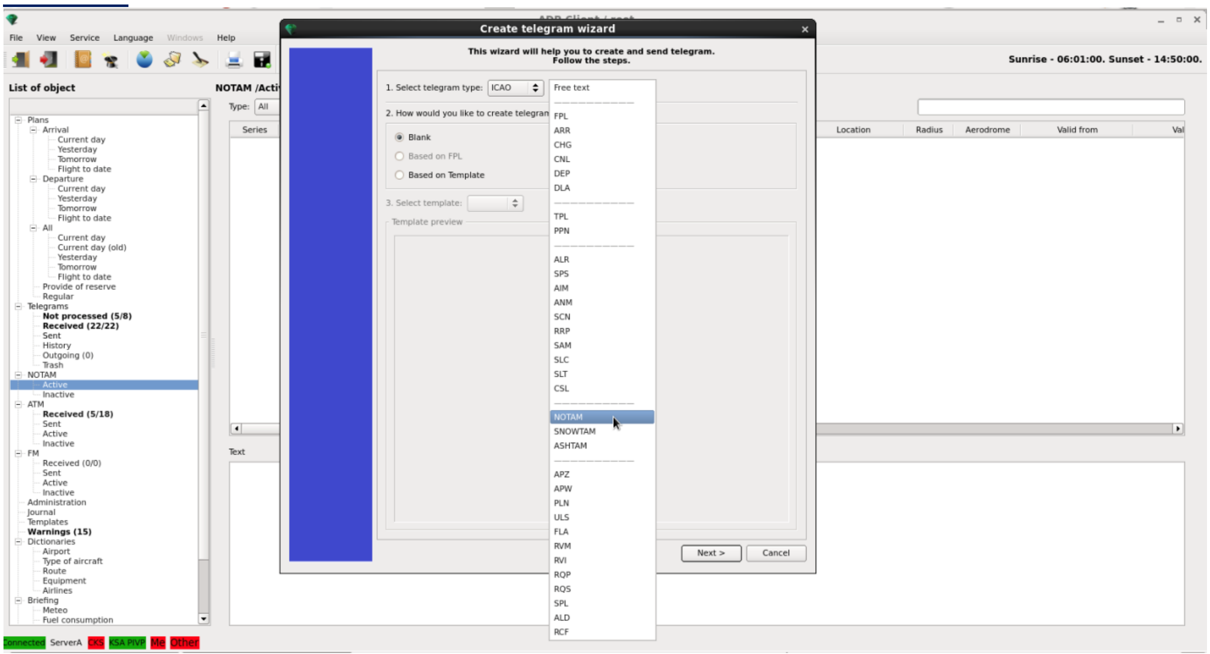
The ARO Workstation HMI provides a convenient layout and high-quality presentation of flight plan data and enables handling of flight plans and related information in the system. The workstation processes, presents and distributes FPL-related information to all AFTN/AMHS users.

The ARO Workstation provides:

- Creation, validation and distribution of flight plans and FPL-related messages;
- Management of repetitive flight plans;
- Management of client information and AFTN addresses;
- Identification of different FPL statuses;
- Management of incoming/outgoing messages;
- Reception and display of meteorological data (NOTAM, SIGMET, METAR, TAF);
- Reception of FPL data;
- Generation of statistical data records;
- Generation of bills to be paid for Air Navigation Charges;
- Monitoring of the real traffic situation (on demand).



Examples of the ARO Workstation HMI



Examples of the ARO Workstation HMI

5.4 Investigator (Playback) Working Position

The Investigator Working Position HMI is based on the Controller HMI and provides a convenient layout and high-quality representation of reproducible multiple-source data of various types.

The HMI allows investigation and analysis of accidents in passive (observer) mode and in interactive (investigator) mode (with full-featured CWP HMI environment and tools).

Investigator mode provides advanced features and control of displayed data.

The Investigator playback application software provides:

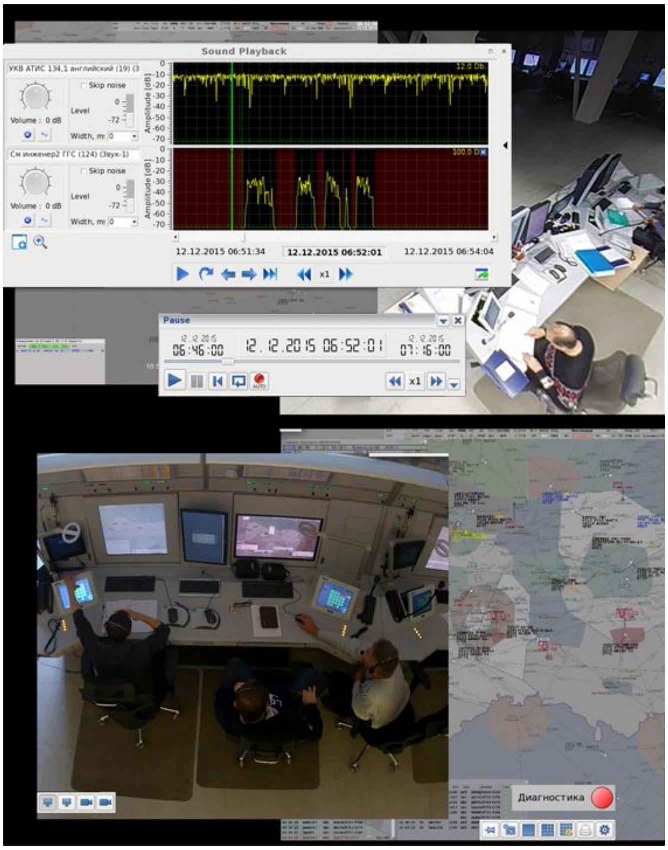
- Compilation of different recordings that are necessary for incident reconstruction into one set (audio, video, AFTN/AMHS, AICD/OLDI, CPDLC and other messages, windows, list appearances, pop-ups, alerts, display settings, graphical information, user's interactions with the system such as actions with the situational monitor buttons, electronic strips, keyboard, mouse and touch screen, etc.);
- Arrangement of recordings of a compiled set or fragments in the chronological order, grouped at the discretion of the Investigator;
- Synchronous playback of all types of information;
- Conversion of the incident reconstruction into a computer image and text and their transfer to other media;
- Playback of recorded data related to the event almost immediately as it is selected for playback;
- Graphic representation of data of the selected source in real time or for any selected past time period;
- Display of separate, overall or selectively grouped reproducible data in a timescale;
- Editing, cutting, copying and pasting of audio and video files;
- Playback of radar video records in passive or interactive mode with the following functions:
- Play, stop, pause, return, loop;
- Playback speed control (videos can be played at different speeds: 0.5, 1, 2, 3, 4, 6, 10);
- Quick selection of the time scale (slider);
  with clear presentation of the playback status in the playback control window;
- Measurement of trajectories and parameters of moving objects (horizontal and vertical velocity, direction of movement, etc.), horizontal and vertical distance and separation between targets (target-target, target-object, target-area, etc.);
- Interaction with the CWP HMI in investigator mode, selecting any commands for data presentation and using all functions, features and tools;
- Determination of the start and end times and values of separation minima infringements;
- Investigator playback mode provides analysis of incidents and system performance.

Also, the R&P software on the playback or CMS workstation allows to perform:

- Remote control of the recording process:
- Starting and restarting the equipment;

- Starting and stopping the recording process;
- Indication of recording;
- Indication of the buffer disk space;
- Indication of warnings and alarms;
- Indication of events on the recording equipment;
- Indication of user logging;
- Remote control of audio recording and setting-up of analog inputs:
- Indication of the state of each audio channel;
- Test listening of channels and display of recording level graphs;
- "Hot" setting-up of recording modes and parameters;
- Observation of radar data recording on the local software module:
- Indication of the state of data sources on the diagnostic page;
- Remote control of data archiving on removable media:
- Indication of the state of removable disks;
- Indication of archiving with time check;
- Transfer of recorded data;
- Remote adjustment of the system settings:
- Control of the list of registered users;
- Preparation of disks for data storage;
- Configuring and synchronization of audio channels for recording;
- Display of the system log:
- Display of events;
- Keyword searching;
- Printout of filtered data;

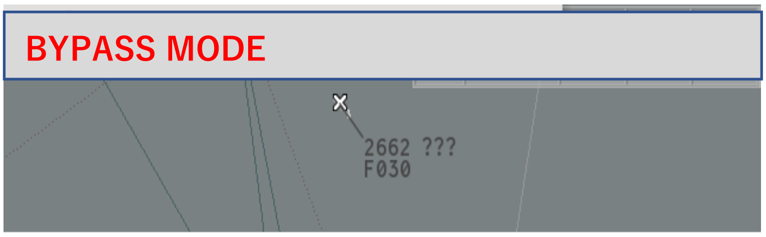
- Control of the event filter;
- Work with fragments:
- Display of information about fragments with their characteristics and the compilation log;
- Representation of the structure and composition of fragments;
- Indication of the state of the disks for fragments;
- Compiling, copying, deletion and archiving of fragments;
- Playback of audio and generation of text documents:
- Selection of fragments for playback;
- Selection of audio channels for synchronous playback (6 channels can be selected);
- Setting-up of channel playback modes;
- Presentation of data in graphs (dB signal level);



- Control of the playback process;
- Use of the text editor;
- Loading and saving of text documents and templates;
- Text typing, editing and formatting;
- Use of the substitution base;
- Printout of text documents;
- Data export into standard media file formats;
- Playback of video:
- Selection of fragments for playback;
- Selection of video channels for synchronous playback (4 channels can be selected);
- Setting-up of video playback modes;
- Control of the playback process;
- Writing of screen captures into standard media file formats;
- Printout of a screen area.

6 BYPASS MODE

Bypass or DARD (Direct Access Radar Data) mode is a system feature that provides stand-alone multi-source trajectory processing (independently of the system) and presentation of air situation in case of failure of the Radar Data Processing server. When bypass mode is applied, a corresponding notification (BYPASS MODE) appears on the air situation displays.



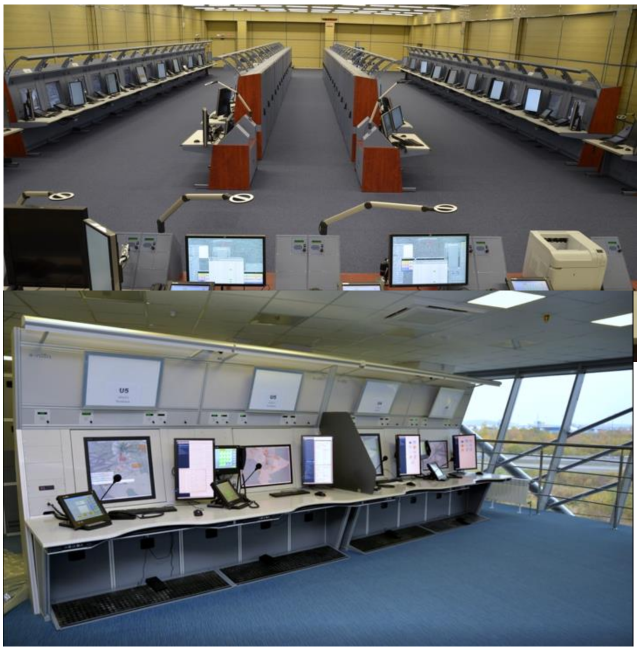
Air Situation Displays in Bypass or DARD mode

For isolation of the system functions, bypass or DARD mode is limited by operator functions and provides only the following:

- Callsign assignment;
- Flight level or height assignment;
- Transfer level assignment;
- Destination appointment.

7 SYSTEM TAILORING

Due to its modular design, the system can be easily adapted to the needs of different airports / ATC centres and various functionalities can be implemented.



For example, same generation and version of Alpha ATC system can be used in ACC to manage an airspace with more than 2500 flights per day and over 65 ATC sectors and can also be used in a regional airport with peak hour traffic of less than 15 movements.

In both cases, the application software does not require any significant change or additional rework due to the following:

- Source data is separate from software modules;
- The system configuration, the number of workstations and their functionality are adjustable;
- The structure of the airspace controlled by a respective ATC centre is defined in a special database.

The following aspects can be tailored to a particular airport / ATC centre during implementation or at later stages:

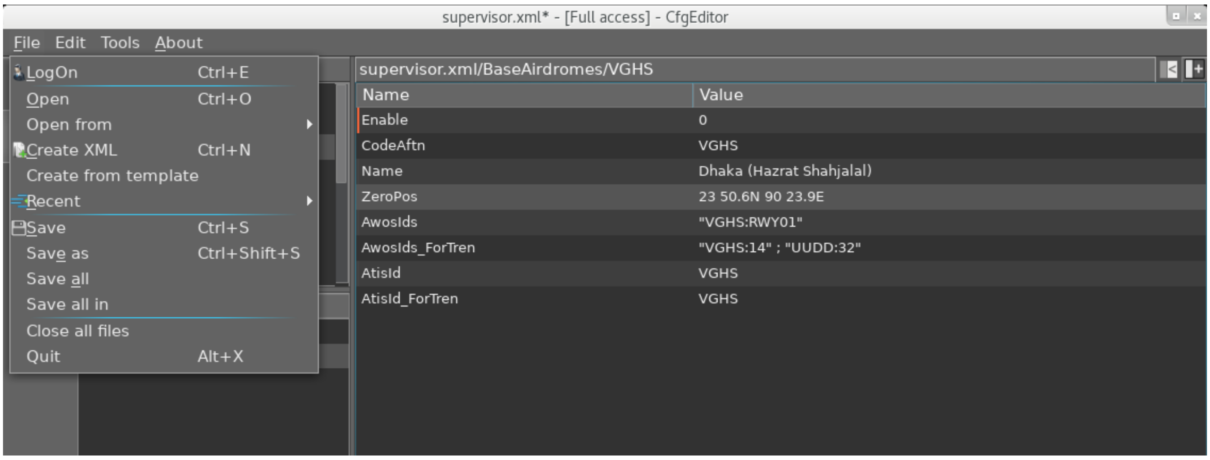
- Number of working positions / sectors;
- External interfaces, communication links and ICDs with surveillance sensors, Flight Data Processing Systems, and other data sources;
- External interfaces, communication links and ICDs with adjacent systems;
- Airspace structure and charts;
- Airport layout and configuration (runways, taxiways, aprons, stands, etc.);
- Safety Nets parameters and rules for alert detection;
- User roles and access rights;
- System variables and configuration settings.

For initial installation and further modification, the following instrumentation is delivered together with the system:

- Airspace structure editor;
- Chart editor;
- System configuration and settings editor;
- User access manager;
- Utilities for database management;

- Utilities for different versions of system executable and configuration files, charts, aircraft/airport data, as well as utilities for backup, storage, distribution and version control.

The "Settings editor" tool described in the system administrator manual allows changing all available system parameters via a friendly HMI.



8 DOCUMENTATION

The system is delivered with technical documentation (the scope of documents to be delivered must be agreed). A set of documents may include the following:

- Maintenance manual. It is intended for engineering and technical personnel who use and maintain the system and describes the system composition, intended use, dataflows, reliability indicators and established service life, cybersecurity, safety measures, personnel qualification requirements, maintenance procedures, actions in case of malfunctions and emergencies, etc.
- Technical personnel training book. It provides guidelines based on the maintenance manual, a training program and other materials to organize technical personnel training;
- Air Traffic Controller manual. It is intended for operational users (ACC, TMA, Tower controllers) and describes use cases, functions, HMI, functional workflows, data circulation, Safety Nets criteria and parameters for all visibility conditions, etc.
- Air Traffic Controller training book. It provides guidelines based on Air Traffic Controller manual, a training program and other materials to organize operational personnel training;
- System administrator manual. It is intended for technical personnel and describes how to configure the system, change parameters, perform user management and database management tasks, update software, set up cybersecurity, etc.;
- System administrator training book. It provides guidelines based on the system administrator manual, a training program and other materials to organize system administrator training;
- Aerodrome and airspace structure editor manual;
- Operation manuals for commercial products (hardware);
- Interface Control Documents describing the interfaces to the system;
- System specification (parts list);
- Spare parts specification.

9 PROJECT DELIVERY MODEL

The delivery model that was taken as a baseline in this document is the standard delivery model for the Alpha ATC system project, with an initial phase of system specification and the delivery of the full-fledged system to a customer, and following the usual project lifecycle with the corresponding milestones such as Critical Design Review, Factory Acceptance Testing, Site Acceptance Testing & commissioning.

This is based on the assumption that additional features (if any) that are required to be developed under the project will be properly defined at the beginning of the contract.

The verification activities will be an on-going process that extends from the conception of the system up to and including its acceptance by the customer.

The verification process includes design reviews, inspections and relevant tests. As the realization of the system progresses, tests will be performed at increasingly higher levels of items. Test procedures will be worked out for units, subsystems and the complete system under the contract.

Design reviews will be held at appropriate points in the design and development phase in order to verify compliance with the requirements in the product specification.

Completion of the design reviews will result in the release of preliminary acceptance test procedures. Preliminary acceptance test procedures will be made available to the customer.

The customer's representative will be given complete insight in the supplier's and any sub-supplier's manufacturing and QA activities. Should the customer's representative so wish, they will be entitled to carry out their own verification tests and reviews, with full assistance from the supplier's staff.

Acceptance tests are of vital significance for the customer. Every acceptance test will be performed in the presence of the customer, who will sign the acceptance documentation upon successful completion of the tests.

Acceptance tests will be divided into Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT).

Before the actual Factory Acceptance Testing, a full-scale internal preliminary test (pre-FAT) will be arranged according to the specification.

FAT is a test in the supplier's facilities, which is conducted in accordance with the agreed FAT specification. The customer will be entitled to witness the test and will be notified about the FAT in advance. The FAT will be run to verify whether the system, before delivery, satisfies the functional requirements and technical specifications defined in the contract.

Theoretical training will take place before the FAT so that the customer’s representatives can familiarize themselves with the system.

SAT is a test at the customer's premises, which is conducted in accordance with the agreed SAT specification. The objective of the Site Acceptance Test is to confirm that the system, after installation on site, is compliant with all the specifications set out in the contract and detailed in its annexes.

During the SAT, a test record will be completed. Every recording, listing, print-out, etc. created during the SAT will be added to the test report as evidence.

The customer shall witness the test and shall sign the test protocol upon successful completion of the test.

After passing the practical training at the customer's premises and successful completion of the SAT, all passwords for accessing the system will be transferred to the customer’s representative.

There are, however, other delivery models that could be proposed if they can be better adapted to the customer needs or requirements.

10 REFERENCES

- ICAO Doc 4444 Procedures for Air Navigation Services – Air Traffic Management, Sixteenth edition, 2016;
- ICAO Doc 9694 Manual of Air Traffic Services Data Link Applications
- ICAO Doc 9830 Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual, First Edition, 2004;
- ICAO Doc 9869 Performance-based Communication and Surveillance (PBCS) Manual, Second Edition, 2017;
- ICAO Doc 9870 Manual on the Prevention of Runway Incursions, First Edition, 2007;
- ICAO Doc 10037 Global Operational Data Link (GOLD) Manual, First Edition, 2017;
- EATCHIP PHASE III HMI, EUROCONTROL ODID IV SIMULATION REPORT: HMI aspects of an advanced stripless ATC system;
- EuroCAE ED-87D – MASPS for A-SMGCS including new Airport safety Support Service Routing Service and Guidance Service;
- EuroCAE ED-109A – Software Integrity Assurance Considerations for Communication and Navigation and Surveillance and Air Traffic Management (CNS/ATM) Systems;
- EuroCAE ED-128 – Guidelines for Surveillance Data Fusion in Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Levels 1&2;
- EuroCAE ED-137C – Interoperability Standards for VoIP ATM Components;
- EuroCAE ED-141 – Minimum Technical Specifications for Airport Collaborative Decision Making (Airport-CDM) Systems;
- EuroCAE ED-145 – Airport-CDM Interface Specification;
- EuroCAE ED-146 – Guidelines for Test and Validation Related to Airport CDM Interoperability;
- EuroCAE ED-153 – Guidelines for ANS Software Safety Assurance;
- EuroCAE ED-154A – Future Air Navigation System 1/A (FANS 1/A) – Aeronautical Telecommunications Network (ATN) Interoperability Standard;
- EUROCONTROL Specification Spec-0100. Flight Message Transfer Protocol (FMTP);
- EUROCONTROL Specification Spec-0101. Initial Flight Plans (IFPL);
- EUROCONTROL Specification Spec-0106. On-Line Data Interchange (OLDI);
- EUROCONTROL Specification Spec-0108. Short-Term Conflict Alert (STCA);
- EUROCONTROL Specification Spec-0116. Controller-Pilot Data Link Communication (CPDLC);
- EUROCONTROL Specification Spec-0136. Air Traffic Services Message Handling System (AMHS);
- EUROCONTROL Specification Spec-0142. Monitoring Aids (MONA);
- EUROCONTROL Specification Spec-0143. Trajectory Prediction;
- EUROCONTROL Specification Spec-171. Advanced-Surface Movement Guidance and Control System (A-SMGCS) Services;
- EUROCONTROL Guidelines GUID-159. Short-Term Conflict Alert (STCA);
- EUROCONTROL Guidelines GUID-160. Area Proximity Warning (APW);
- Commission Regulation (EC) No 1033/2006;

- ASTERIX CAT. 1 – EUROCONTROL STANDARD DOCUMENT FOR RADAR DATA EXCHANGE Part 2a Transmission of Monoradar Data Target Reports (SUR.ET1.ST05.2000-STD-02a-01);
- ASTERIX CAT. 2 – EUROCONTROL STANDARD DOCUMENT FOR Radar Data Exchange Part 2b Transmission of Monoradar Service Messages (SUR.ET1.ST05.2000-STD-02b-01);
- ASTERIX CAT. 4 – EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 17 Category 004 Safety Net Messages (EUROCONTROL-SPEC-0149-17);
- ASTERIX CAT. 8 – EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 3 Category 008 Monoradar Derived Weather Information (EUROCONTROL-SPEC-0149-3);
- ASTERIX CAT. 10 – EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE Part 7: Category 010 Transmission of Monosensor Surface Movement Data (SUR.ET1.ST05.2000-STD-07-01);
- ASTERIX CAT. 11 – EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE Part 8: Category 011 Transmission of A-SMGCS Data (SUR.ET1.ST05.2000-STD-08-01);
- ASTERIX CAT. 19 – EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE Part 18: Category 019 Multilateration System Status Messages (SUR.ET1.ST05.2000-STD-18-02);
- ASTERIX CAT. 20 – EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE Part 14: Category 020 Multilateration Target Reports (SUR.ET1.ST05.2000-STD-14-02);
- ASTERIX CAT. 21 – EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 12 Category 21 ADS-B Target Reports (EUROCONTROL-SPEC-0149-12);
- ASTERIX CAT. 23 – EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE Part 16: Category 23 CNS/ATM Ground Station and Service Status Reports (SUR.ET1.ST05.2000-STD-16-01);
- ASTERIX CAT. 34 – EUROCONTROL STANDARD DOCUMENT FOR SURVEILLANCE DATA EXCHANGE Part 2b Transmission of Monoradar Service Messages (SUR.ET1.ST05.2000-STD-02b-01);
- ASTERIX CAT. 48 – EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 4 Category 048 Monoradar Target Reports (EUROCONTROL-SPEC-0149-4);
- ASTERIX CAT. 62 – EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Part 9 Category 62 SDPS Track Messages (EUROCONTROL-SPEC-0149-9);
- ASTERIX CAT. 240 – EUROCONTROL Specification for Surveillance Data Exchange ASTERIX Category 240 Radar Video Transmission (EUROCONTROL-SPEC-0149-240).

11 APPENDIXES

Appendix 1 – Basic training plans for ATCOs and technical personnel

This section describes a basic training approach.
The training program can be flexibly tailored to the customer's requirements in terms of duration, composition, etc. (upon request).

Air Traffic Controller basic training program

Item	Subjects of the course	Total hours	Hours	
			Theory	Practice
1.	System design and composition	**1**	1	-
2.	Console. Built-in equipment	**1**	0.5	0.5
3.	HMI. Presentation of surveillance data, direction finding, meteorological, planning, cartographic and other types of information	**2**	1	1
4.	HMI. Color scheme. Status panel. User settings. User measurement tools.	**6**	3	3
5.	HMI. Main situation window (MSW), auxiliary windows	**2**	1	1
6.	Meteorological information	**2**	1	1
7.	Flight planning. Planning workflow. HMI windows, lists, EFS	**2**	1	1
8.	Main functions. Activation, transferring, track mode, route modification, AIDC coordination	**4**	2	2
9.	Safety nets	**6**	2	4
10.	Typical arrival and departure workflows	**4**	4	2
11.	Bypass mode	**2**	0.5	1.5
12.	Q&A Test	**4**	2	2
	Total:	**36**		

Prerequisites:
Work experience as an ATC controller for at least 2 years.

Technical personnel basic training program

Item	Subjects of the Course	Total hours	Hours	
			Theory	*Theory*
1.	System design and composition System high-level design Specification. Hardware overview Dataflow Sources of information, interfaced systems, protocols	**4**	4	-
2.	Central server equipment. Maintenance and replacement Consoles and peripherals. Maintenance and replacement Time distribution system	**4**	2	2
3.	System power supply. Equipment layout Maintenance and replacement	**4**	2	2
4.	Network. Characteristics and topology. Equipment layout Network equipment. Maintenance and replacement	**4**	2	2
5.	Monitoring and control Start, restart, shutdown (system and specific equipment) Logs and equipment diagnostics Boot-install server	**4**	2	2
6.	System support and maintenance	**4**	2	2
7.	Recording and playback	**6**	3	3
8.	Troubleshooting	**5**	-	5
9.	Q&A Test	**1**	0.5	0.5
	Total:	**36**		

Prerequisites:
Good theoretical knowledge of computer technology is expected as well as certain experience in the ATM/CNS domain.

System administrator basic training program

Item	Subjects of the Course	Total hours	Hours	
			Theory	Theory
1.	System design and composition System high-level design Sources of information, interfaced systems, protocols	**2**	1	-
2.	User and recourse management	**2**	1	1
3.	System configuration Log system System parameters System software update	**4**	2	2
4.	Airspace editor	**12**	2	10
5.	Cyber security Security measures, access control, firewalls, intrusion detection Vulnerability management Hardware protection mechanisms Secure operating system	**8**	4	4
6.	Troubleshooting	**4**	-	4
7.	Q&A Test	**4**	2	2
	Total:	**36**		

Prerequisites:
Good theoretical knowledge of computer technology is expected as well as certain experience in the ATM/CNS domain.

Appendix 2 – A-CDM framework messages

Departure Planning Information (DPI) and Flight Update Messages (FUM)

ACZT	Actual Commencement of De-icing Time
A-DPI	ATC - Departure Planning Information message
AEZT	Actual End of De-icing Time
AIBT	Actual In-Block Time
ALDT	Actual Landing Time
AOBT	Actual Off-Block Time
ARDT	Actual Ready Time
ARZT	Actual Ready for De-icing Time
ASAT	Actual Start- Up Approval Time
ASBT	Actual Start Boarding Time
ASRT	Actual Start-Up Request Time
ATOT	Actual Take Off Time = ATD–Actual Time of Departure
C-DPI	Cancel - Departure Planning Information message
CTOT	Calculated Take Off Time
EDIT	Estimated De-icing Time
E-DPI	Early - Departure Planning Information message
EIBT	Estimated In-Block Time = ETA Estimated Time of Arrival
ELDT	Estimated Landing Time
EOBT	Estimated Off-Block Time
ETOT	Estimated Take Off Time ETOT=ETD Estimated Time of Departure
ETTT	Estimated Turn-round Time
EXIT	Estimated Taxi-In Time
EXOT	Estimated Taxi-Out Time
MTTT	Minimum Turn-round Time
SOBT	Scheduled Off-Block Time
T-DPI	Target - Departure Planning Information message
TSAT	Target Start-Up Approval Time
TTOT	Target Take Off Time

Appendix 3 – User roles

User roles and access rights

Alpha ATC system supports advanced user management capabilities that differentiate functionality and access for individual users or group of users.

User management tools are available on the Supervisor Working Positions.

Below is given an example of user roles that can be configured for a specific implementation:

Tower Controller	This role allows performing operational inputs required by the Tower Controller.
Surface Movement Controller	This role allows performing operational inputs required by the Surface Movement Controller.
Tower Supervisor	This role allows centralized controlling of ATC controller functions in the Tower Display.
Monitoring at approach control	This role allows only observing the traffic. No interaction with the traffic display other than local presentation is allowed.
Maintenance	This role allows no operational inputs but only commands for controlling presentation on all working positions. Tools are provided to change and distribute items like maps, colour settings and label definitions. Also, tools are provided for archiving, replay, data processing and radar control. The Technical Supervisor Working Position is configured in this mode for the maintenance engineer.
Playback	This role allows replaying historical data of the system on a traffic display that is configured for playback. For this purpose, traffic data is recorded continuously and archived automatically.