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Aurora Air Traffic Management System

White Paper
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1 Introduction

Adacel’s AURORA ATM system offers a complete solution to your ATM operational requirements.

Aurora provides a global ATM system that manages all types of airspace and domains from the Oceanic, Enroute, Terminal or Approach sectors to the Control tower unit.

Our advanced automation technology is scalable and configurable to your present and future requirements. Should you need an advanced ATM system which integrates any or all of today and tomorrow’s surveillance technologies (Radar, ADS-B, Multilateration, ADS-C, CPDLC), our ATM Business Unit will work with you at every step of the project for:

- In depth analysis of your Operational and Technical requirements.
- System design and Integration
- Operational and Technical training
- Online customer support
- Field Service support
- Billing system solutions

Adacel is a leading developer of advanced automation technology and software development services for air traffic management. Our reputation is built on a track record of successful project delivery.

2 The Aurora Solution

Aurora offers a complete solution by incorporating the latest CNS/ATM technologies in surveillance, communications, and air traffic management automation, as summarized below:

- Processing route and intent information from flight plans, ADS reports, and downlink requests, and generating internal 4-dimensional flight profiles used for conformance monitoring, conflict probes, and clearances.

- Implementing reliable communication and data link systems such as CPDLC, and supporting various implementations of communications protocols and standards.

- Incorporating all available surveillance sources, such as radar, ADS-B, Multilateration, ADS-C, CPDLC and voice position reports, providing a seamless ATM environment for complex airspaces which include radar, transition, and non-radar environments.
• Updating internal flight profiles with position information from the surveillance data and performing conformance monitoring.

• Supporting all derived Radar and ADS-B safety nets such as: Short Term Conflict Alert (STCA), Area Proximity Warning (APW), Wake Turbulence Category (WTC) and Minimum Safe Altitude Warning (MSAW).

• Supporting automatic (AIDC) and manual exchange of flight data with external ATC units for flight planning, coordination, and transfer of control.

• Supporting the collaborative decision making process by providing automatic data exchange with external systems such as airlines, airports, traffic management systems, billing systems, meteorological systems, etc.

• Reducing controller workload through automation of manual processes thus increasing safety.

Along these lines, Aurora brings a set of important benefits to both the air navigation service provider and the airspace users:

• More aircraft fly preferred, fuel saving routes over long haul flights.

• Increased surveillance, predictability, and system reliability.

• Greater flexibility and responsiveness to in-flight requests through timely, reliable satellite data communications.

• Streamlines intensely manual processes freeing controllers to respond to pilot requests.

• Implementation of common procedures and systems at a regional level.

• Market growth — the result of increased airspace capacity and efficiency through reduced separation standards.

3 System Overview

Adacel’s AURORA product is an advanced, highly configurable Air Traffic Management system that has been proven in operation in the New Zealand, Iceland and Portugal airspaces, and in operation in US oceanic and offshore airspaces since 2005. The US Federal Aviation Administration, under the Advanced Technologies and Oceanic Procedures (ATOP) program, uses the AURORA ATM software in the FAA’s control centres in Oakland, New York, and Anchorage to control all oceanic and offshore traffic in those airspaces.

The AURORA system’s advanced automation tools assist the controller in providing safe and efficient air traffic services in procedural airspaces and radar/ADS-B procedural transition sectors. The system performs the following functions:

1. Flight time calculations: automatic calculation of estimated flight and fix times for all flight operations, both on and off airways.

2. Advanced conflict determination and report:

• Aircraft-to-aircraft conflict detection: The system alerts the controller if an aircraft’s cleared flight profile is not separated from the protected airspace of all other flights within the airspace.
Aircraft-to-airspace conflict detection: The system alerts the controller if the cleared flight profile is not separated from all reserved fixed or mobile airspaces.

Airspace-to-airspace conflict detection: The system alerts the controller if the reserved airspaces are not properly separated.

The main attribute of AURORA is the unique Conflict Detection system that analyses the aircraft equipment and airspace in which it is operating; it calculates the airspace to be protected for that aircraft and projects the profile of the aircraft (4D) on its route while detecting conflicts with other aircraft or restricted fixed and mobile airspaces.

3. Monitoring of conformance of a flight path to its cleared trajectory in terms of current position, time, altitude, and future intentions.

4. Minimum safe altitude warning: The system ensures that the IFR flights in the system are planned at levels/altitudes above the minimum safe altitude and that any clearances entered also provide adequate terrain clearance.

5. Display of flight data and aircraft position data on high-resolution controller displays, including automatic maintenance of flight strip data.

6. Integration of Automatic Dependence Surveillance-Contract (ADS-C) and Controller Pilot Data Link Communications (CPDLC)


8. Automatic coordination between adjacent sectors and centres.

9. Recording and playback of all operations, resulting in benefits for training, operational analysis and investigation of incidents.

AURORA is based on a distributed architecture concept. The system can be fully redundant in order to provide the very high level of availability required for an operational system.

AURORA also includes a fully integrated training and simulation mode.

AURORA consists of the following main components:

The operational system includes the core flight data processing and conflict prediction functions, the user interface at the controller workstations, and the surveillance gateway functions that interface AURORA to a SDPS. The operational system also includes communication interfaces that link the system to:

- External air traffic facilities, airlines, and other destinations through the Aeronautical Fixed Telecommunication Network (AFTN) or Aeronautical Message Handling Systems (AMHS)
- Meteorological data sources (GRIB Data)
- Data link service providers for ADS-C/CPDLC communication.

The operational system also includes system monitoring and control, and operational data recording.
The adaptation data management system includes adaptation data entry, and generation of the operational adaptation database.

The training system provides high fidelity training by re-using the operational software with built-in simulation capabilities.

4 System Configuration

As shown in the hardware architecture diagram in Figure 1, AURORA is a distributed system consisting of powerful workstations communicating over a redundant network.

![Operational System Hardware Configuration](image)

The processors are identified as either servers or processors: servers provide a centralized set of functions used by other components of the system. Servers are always deployed in a redundant pair with automatic switchover mechanisms so that when an active server fails, the corresponding backup takes over.

Processors support the user interface at a working position. These processors are not paired for redundancy; to recover from a processor failure at a controller workstation, the affected sectors can be moved to a spare position, or consolidated with sectors on another workstation using the system’s sectorization functions.

The controller workstations can have dual graphics cards to drive high-resolution displays for the ASD and flight data display.
5 Concept of operation

The operational system provides automation functions for several operational roles, including the air traffic controller, the supervisor, and support roles.

**Air Traffic Controller:** The controller's interface to the AURORA system consists of two (2) display screens, a keyboard and a mouse. The screens display situation data to the controller in the form of Electronic Flight Strips (EFS), an Aircraft Situation Display (ASD), a geographical view of aircraft position symbols with associated data blocks showing flight data for the aircraft and an IDS (Information Display System) that provides essential operational information such as: NOTAM, Weather, Maps, Emergency procedures etc.

The screens also display a variety of dialogue windows that may be invoked by the controller in order to interact with the system's functions.

**Supervisor:** At the workstation configured as the supervisor position, a user who is logged on with supervisor privileges has access to system functions that handle airspace reservations, setting of certain Variable System Parameters (VSPs), sector consolidation and de-consolidation, re-assignment of control sectors to balance workload or after a workstation failure.

**Flight Data Repair:** This role can be assumed by an air traffic controller or a supervisor, or it can be an exclusive role on a dedicated workstation. It is responsible for processing incoming system messages, such as flight plans, that contain errors that prevent the system from successfully handling the message. Corrects the errors and resubmits the message to the system.

**Maintenance and Control Positions MCP:** The system operator manages the configuration and makes all decisions concerning system availability. Monitors the system, isolates failures, and initiates repair actions. The system operator performs system start-up and shutdown, manages distribution of system releases, and performs user management function.

**ATM Business Continuity System/Training BCST:** The BCST/Training system can be used for several operational roles:

1. as a back-up to the main system,
2. as a test bed to verify new software delivery or any local adaptation change prior to loading the Operational system,
3. as a training platform operating with or without a pilot position.

6 External Interfaces

AURORA uses the Aeronautical Fixed Telecommunication Network (AFTN) and Aeronautical Message Handling System (AMHS) as the principal interfaces with neighbouring FIR's, aircraft operating agencies and weather offices. AFTN and AMHS protocol conforms to ICAO Annex 10 Volume 2 as applicable to an automated centre.

AURORA uses the ACARS network (e.g. SITA), to provide an ACARS character-oriented interface to the aircraft to implement the FANS protocol, including CPDLC, ADS-C and ATC facility notification (AFN).

AURORA receives GRIB data from the meteorological office.
Messages received from external links are validated, logged, and routed to the appropriate system function. Incorrect messages are placed in a correction queue. Messages generated by the system are logged before being sent on the appropriate link.

AURORA receives radar, ADS-B and Multilateration tracks from the Surveillance Data Processing System.

6.1 Message Sets Supported

The following message sets are supported:

a) Standard ATS message set as defined in ICAO PANS/RAC Document 4444 or as amended in agreement with the customer.

b) ARINC radio operator and Air radio operator AFTN messages as reviewed with the customer.

c) ADS-C and CPDLC messages.

d) AIDC or On-Line Data Interchange (OLDI) message set, using the AFTN or dedicated links as agreed with the customer.

e) NOTAM and weather messages, received on the AFTN, as agreed with the customer.

f) Special messages and data links, as agreed with the customer, e.g. interface to a billing system, processing ACARS position reports, co-ordination, hand-off between adjacent ACC’s.

g) GRIB format meteorological data in World Meteorological Office (WMO) format.

h) ADEXP format messages

7 Human Machine Interfaces (HMI)

Most functions of the operational system directly or indirectly support the situation display and flight-data display of the controller interface, including the many dialogue windows that provide access to operational functions.

The Controller Workstation is equipped with a Controller Workstation Processor (CWP), a main display monitor primarily used for an ASD (Air Situation Display), a second monitor displaying the EFS (Electronic Flight Strip) and, optionally, a third monitor displaying an IDS (Information Display System).

Other sets of tabular display windows provide the controller with additional data, planning tools and functionality. Most of these windows are available on request, and they can be moved around the screen and overlaid temporarily on other windows or the situation display.

The system will automatically pre-fill window fields based on most of the aircraft of interest, to minimize keyboard entries by the controller.

Some examples of the main Human Machine Interfaces are presented below.
7.1 **Oceanic, En-route & Approach system**

7.1.1 **Aircraft Situation Display**

The ASD display is the principle means for the Air Traffic Controllers to maintain situation awareness on his sector.

The menu bar on top of the screen offers a selection of functionalities like Maps, Target, Brightness, Filters, Lists, Tools, etc.

Multiple sources of surveillance data are being used, as described earlier and are graphically displayed by different APS (Aircraft Position Symbol) on the ASD.

Many other windows and functions are accessible through the APS and data block.

![Airspace Situation Display](image)

Figure 2: Airspace Situation Display
7.1.2 Strip Bay Window (Electronic Flight Strips)

For the Oceanic, Enroute and Approach sectors, the strips are sorted by flight level and displayed under posting headers for selected flight-levels. Airspace reservation strips affecting the sector are displayed in the bottom of the flight-strip bay.

The strips are automatically updated by the system to reflect clearances, revised estimates, coordination events, position reports, etc.
7.1.3 Conflict Windows

- Conflict Summary Window: lists all aircraft-aircraft and aircraft-airspace conflicts which affect a particular sector.

![Conflict Summary Window](image)

Figure 4: Conflict Summary Window

- Conflict Report window: provides the detail of a conflict selected in the Conflict Summary Window.

![Conflict Report Window](image)

Figure 5: Conflict Report Window
7.2 Tower system

7.2.1 Tower Air Situation Display

The Tower ASD is essentially the same as in the Oceanic/Enroute/Approach sectors.

The MAPS are adapted to reflect the geographical environment of the control zone.

The Geographical map offers a selection of overlays such as:

- Runways
- Localizer markers
- Fixes
- SID
- STAR
- Satellite airfields
- Lists
- Airways
7.2.2  Tower EFS (Electronic Flight Strips)

The Tower EFS are different from the Oceanic/Enroute/Approach system. The Tower system also replaces the paper strips but provides for intuitive manipulation of flight strips for IFR, VFR traffic and vehicles.

![Figure 7: Tower EFS](image)

- The EFS automatically displays, from the AURORA FDP, the pertinent Flight plans (IFR or VFR) on a flight progress strip adapted for control tower use.
- The EFS allows for online creation of other strips (VFR no flight plan, Emergency vehicles, Airport vehicles, etc).
- The EFS provided the controller with a color coded strips for Arriving and Departing aircraft either VFR or IFR and vehicle traffic.
- The EFS reproduces the visual appearance and functionality of the actual control tower paper strip board.
- The EFS is displayed on a touch-screen display and are manipulated using an adapted pen.

7.3  IDS (Information Display System)

The IDS provides each operational and training working position with the following graphical display of essential airport, terminal and enroute/oceanic operational information:

- Wind, Altimeter, Runway in use, Approach in use,
- NOTAMS,
- Weather information (SIGMET, TAF, etc),
- Maps (IFR, VFR),
- Approach plates,
- Operational procedure manual,
- Holding procedures,
- Emergency procedures,
- Sector plan,
- Telephone list,
- Frequency list, etc.

8 Adaptation Data Management

Adaptation data is used to tailor the operation of the AURORA system to the specific geography, airspace, and procedures of a particular FIR. Adaptation also includes unique site-dependent data required by the operational software at system initialization and provides default settings for state data.

For AURORA, adaptation includes the system configuration, environmental, airspace, geographic, system parametric and other site unique data necessary for operational air traffic control at a particular control centre.

Adaptation data is maintained by the Environmental Data Management (ENVT) component of the system. The ENVT application uses the Sybase RDBMS and text data-entry forms in a GUI interface. It provides the user interface and a number of utilities for preparing the adaptation database and for performing adaptation-related processing.

9 Site Training System

AURORA supports high-fidelity training by using the operational hardware and software in combination with simulation-specific components that provide a simulated external environment for the operational components.

A typical training configuration consists of a Training Server (TRNS), as many CWP’s as desired, an MCP, and one or more Pilot Position Processors (PPP’s).

The TRNS is the training configuration of the Flight Data Processing Server (FDPS), which also hosts the simulation software component (SIM). SIM is driven by simulation scenario files containing scripted external messages and flight plans, and injects scripted external messages (inter-facility and air-ground data link messages) into the system for distribution to the appropriate operational system component.

The Pilot Position Processor (PPP) hosts software that allows the user to assume the role of a pilot (e.g., to participate in CPDLC dialogues, and to control flight trajectories) or of an adjacent facility (e.g., to participate in online coordination dialogues).

The Exercise Preparation (EXPREP) component of AURORA provides tools for the creation of exercise scenarios.
10 Operational and Technical training

Adacel provides an in depth Train the Trainer program to air traffic controllers proficient in the control of OCS, ENR, APP and/or TWR and to technicians. Training is provided at the factory and/or on site. The training is conducted using the most efficient and effective teaching techniques.

11 Online customer support

Adacel provides a 365/24/7 customer support line. Tier 1 support is provided via phone line or web access controlled by the customer.

12 Field Service representative

Adacel can provide the services of a Technical Field Representative to assist in maintaining the system and to train the appointed technicians on the AURORA system.

The FSR will provide on-site software and database support, development, test, integration, and implementation support for the air traffic management software systems.

13 Billing system

The system collects and processes traffic data and generates billing reports to be sent to airspace users. The billing system is configurable to address your requirements.

For more information about the Aurora Air Traffic Management System, please visit www.adacel.com or contact Bill Lang, Adacel’s Vice President of Adacel's Air Traffic Management division at bill.lang@adacel.com or at 1-514-636-6365.