ECA
ADS-SSR Control Station

INTRODUCTION

ECA, which stands for ADS-SSR Control Station, is a project of the Directorate of Systems and Facilities of Aena. Its full realization, wich will take two years, was awarded by Aena to the spanish firm INDRA in September 1996. An initial/ interim version of ECA capable of supporting basic ADS/CPDLC functionality, which will permit Aena to participate promptly in international trials with ADS Europe and FANS-1/A equipped aircraft, has been already developed.

GENERAL OBJETIVES

The project general objetives are:
Implement and evaluate the philosophy, algorithms, functions, etc., which are described in the ADS-SSR Integration Study carried out by Aena in 1994. (See ATC Magazine/Number 8, APRIL/JUNE 1996, Article "ADS+SSR: un matrimonio perfecto");

Evaluate ADS, ADS-SSR integration, CPDLC, and other data link applications in an automated ATC environment using both real and simulated data;

Develop and evaluate operational procedures and requirements for ADS, ADS-SSR integration, CPDLC, and other data link applications;

Experiment and evaluate the automatic generation and transmission of CPDLC messages and other data link messages (MET, AIS, etc.);

Participate in ADS and CPDLC real traffic trials using both SATCOM (ADS Europe and FANS-1/A trials) (See Note) and VHF data links;

Familiarize Aena's air traffic controllers and technicians with the new CNS/ATM (FANS) applications; and

Validate and fine -tune current ECA specifications in order to evolve to a safe operational system fully tested and validated which will be later on integrated in the SACTA system.

ECA MAIN FUNCTIONS

Following main functions will be developed, tested and validated in ECA:

- ADS tracking;
- ADS-SSR tracking;
- STCA based on ADS and/or ADS-SSR tracking;
- Navigation integrity monitoring (NIM);
- Pilot-induced navigational errors detection;
- Automatic update of flight plan by ADS and ADS-SSR trackers;
- Initial activation of ADS by flight plan and radar tracker;
- ADS contracts central management;
- Pilot-controller data link messages exchange (CPDLC); and
- MET-AIS data bases interrogation via data link.

ECA ARCHITECTURE

The major logical blocks of the system are as follows:

- Communications Processor (COM).
- Surveillance Data Processor (PDV).
- Flight Plan Data Processor (PPV).
- Supervision Terminal (TSV).
- Automatic Data Conversor (ADC).
- GPS Clock.
- Trials ATN Router (TAR).
- X-25 Interface.
- RS-232 Interface.--Printers.
- Two Air Traffic Control Working Positions, each made of:
- 1 Traffic Display Terminal (TPT).
- 1 Messages Display Terminal (TPM).
- 1 Data Link Terminal (TED).

Communications Processor (COM)

It is a Sun Processor ULTRA I with a 17" raster scan colour display (1280x1024 pixels). It deals with all external interfaces (Trials ATN router, X-25 interface, etc.), with the ADS-SSR data simulator, with the magnetic tape unit used for recording and play-back, and with the GPS clock.

Surveillance Data Processor (PDV)

It is a Sun Processor ULTRA I with a 17" raster scan colour display (1280x1024 pixels). It deals with ADS and SSR data processing, STCA, and other surveillance related functions.

Flight Plan Data Processor (PPV)

It is a Sun Workstation SPARC 5 with a 20" raster scan colour display (1280x1024 pixels). It deals with all flight plan related functions such as creation, modification, and cancellation of flight plans. It takes already processed flight plans from the SACTA system via the GIPV interface.

Automatic Data Conversor (ADC)

It pre-processes radar data from four SSR radar stations in the Madrid FIR. This data is then further processed by the Surveillance Data Processor.

Supervision Terminal (TSV)

It is a Sun Workstation SPARC 5 with a 20" raster scan colour display (1280x1024 pixels). It deals with all supervision functions of the ECA system.

GPS Clock

It is a Trimble GPS receiver plus a time and frequency processor. This is mainly used to accuratly time stamp incoming ADS messages so as to allow the Surveillance Data Processor to measure the transit

delay of ADS messages.

Trials ATN Router (TAR)

This router (HP 9.000 computer) is needed to conect with ADS Europe aircraft via the trials ATN. The trials ATN conects with Ground Earth Stations (GES) in Goonhilly, Aussaguel, etc., which in turn conect with the INMARSAT satellites.

X-25 Interface

Used to:

- Conect with the SACTA system via the GIPV interface to receive already processed flight plans ;
- Conect with the SITA network to receive ADS data and exchange CPDLC messages from/with FANS-1/A equipped aircraft;
- Exchange information with EUROCONTROL;
- Directly link with Goonhilly or Aussaguel without using the trials ATN; and
- Conect with future VDL stations for ADS and CPDLC messages exchange.

Printers

Two will be available. A high resolution colour printer will be used to print any image being displayed at the Traffic Display Terminal, Messages Display Terminal or Data Link Terminal. A regular printer will be used for printing system messages.

Traffic Display Terminal (TPT)

Consits of the same hardware as the future SACTA control position "FOCUS". This is so in order to facilitate the future integration of the ECA new functions into the future SACTA system. The Traffic Display Terminal is a Sony 2k x 2 k (2048x2048 pixels) 20" raster scan colour workstation where aircraft positions are desplayed with appropriate simbols and labels. Different simbols will be used to differenciate between the different type of plots (ADS, SSR, ADS+SSR, extrapolation, etc.). The label, in addition to the typical information (callsign, cleared flight level, current flight level, etc.), will contain:

- accuracy/uncertainty of the displayed position
- accuracy required
- number of radars being used by the tracker
- type of ADS contract/s, if any
- time elapsed since reception of last ADS and/or SSR positional data

Also, on request of the controller, an uncertainty circle will be displayed around the aircraft position simbol, being its radious a function of the correctness (accuracy) of the aircraft's position determination.

Most of the above information, which will be used only to asses the performance of the tracking algorithms during trials and evaluations, will be disable when the system becomes operational.

Tabulars will exist for:

- Short Term Conflict Alert (STCA) based both on ADS and SSR data;
- Navigation Integrity Monitoring (NIM) Alert which is displayed when ADS and SSR positional data from the same aircraft do not match each other;
- Pilot-Induced Navigational Errors Alert which is displayed when "ADS next way-points" do not mach the flight plan; and
- CPDLC messages display.

It will be possible to select for traffic display any of the following areas of coverage: Madrid FIR (including Sevilla), Barcelona FIR, Canarias FIR, Mediterranean area, European area, and the area covered by the INMARSAT Atlantic Ocean Region East (AOR-E) satellite.

Messages Display Terminal (TPM)

It is a Sun Workstation SPARC 5 with a 20" raster scan colour display (1280x1024 pixels) which is used mainly for ADS contracts management and for flight plan management functions. A keyboard, a mouse, and an integrated touch input device on the screan, are the input devices available.

Data Link Terminal (TED)

It is a Sun Workstation SPARC 5 with a 20" raster scan colour display (1280x1024 pixels) which is mainly used por CPDLC messages exchange and for some basic ADS control functions. An integrated touch input device on the screan will permit that by means of a few finger touches CPDLC messages will be easily generated and transmitted via the data link. A mouse and a keyboard will also be available for messages input.

Note:

For information on ADS Europe and FANS-1/A trials, see ATC Magazine/Number 9, JULY/SEPTEMBER 1996, Article "Pruebas, ensayos y evaluaciones". For information on CPDLC, see ATC Magazine/Number 13, JULY/SEPTEMBER 1997, Article "Comunicaciones Controlador-Piloto por Enlace de Datos (CPDLC)". For information on ADS, see ATC Magazine/Number 7 JANUARY/MARCH 1996, Article "Un complemento indispensable del radar"

David Diez Fernandez was responsable for the development of the ECA specifications (PPT).

ANNEX
ECA MAIN FUNCTIONS

ADS tracking

A real time adaptable ADS tracking algorithm will be implemented in ECA. The most outstanding feature of this algorithm is its capability to adapt in real time ADS contracts (ARINC 745 compliant) established with the aircraft to a given accuracy previously defined by the system supervisor (by means of a mosaic) for a part or whole airspace, or for a particular aircraft itself.

Also a non-adaptable ADS tracking algorithm capable of processing both ADS-C and ADS-B type of data, and an adaptable (ADS-C)-(ADS-B) integration tracking algorithm will be developed.

ADS tracking supported by SATCOM data link will be implemented within all airspace covered by the INMARSAT AOR-E satellite. VHF data link (VDL) supported ADS tracking will be implemented within the area to be covered in the future by VDL stations.

ADS-SSR tracking

A real time adaptable tracking algorithm which will integrate into one common track ADS data (ADS-C and ADS-B) and SSR data (from up to four radars) will be developed. The most outstanding feature of this integration algorithm is its capability to adapt the ADS-C contracts (ARINC 745 compliant) to a given accuracy and availability/redundancy previously defined by the system supervisor for a part or whole aispace (by means of a mosaic), or for a particular aircraft itself. This is very cost-effective since ADS-C is only activated when really needed to meet the accuracy and availability/redundancy requirements set by the supervisor.

Non-adaptable ADS-SSR tracking algorithm will also be developed.

ADS-SSR tracking will be implementd within the Madrid FIR, where ADS data (received via SATCOM and VHF data links) will be integrated with SSR data received from four radar stations.

STCA based on ADS and/or ADS-SSR tracking

Short term conflict alert based on ADS and/or ADS-SSR tracking will be depeloped. The STCA module itself will be capable of adapting in real time ADS-C contracts to its own requirements.

Short term conflict alert based on ADS data will be implemented within the Spanish responsability airspace.

Short term conflict alert based on the integration of ADS and SSR will be implemented within the Madrid FIR. This will enhance the classic STCA to significantly reduce the number of false alerts.

Navigation integrity monitoring (NIM)

A function will be developed to cross-check ADS positional data [derived from the aircraft navigation system (GPS, VOR, etc.)] with SSR positional data of the same aircraft, to enable the ATC to detect errors of the navigation system being used by the aircraft and therefore control its integrity. The time between cross-checks will be set by the ATC. This function will be implemented within the Madrid FIR.

Pilot-induced navigational errors detection

The availability of the next two waypoints, as provided by ADS-C, will permit the ground system (ATC) to cross-check this data with the flight plan data stored in the Flight Plan Data Proccessor (PPV) in order to detect possible incorrect waypoint data insertion before a dangerous situation may arise. The time between cross-checks will be set by the ATC. This function will be implemented within the Madrid FIR.

Automatic update of flight plan by ADS and ADS-SSR trackers

A function of this type will be developed. The update rate may be adapted by the ATC. This function will be implemented within the Madrid FIR.

Initial activation of ADS by flight plan and by SSR tracker

When an aircraft is bound to enter the Spanish airspace, the Flight Plan Data Proccessor (PPV) will trigger the activation of an ADS initial contract. Ones a track (ADS or ADS-SSR) has been initiated, the tracker takes over, adapting the ADS-C contract to its own needs.

In airspaces covered by radar the ADS activation may be triggered directly by the SSR or ADS-SSR trackers.

ADS contracts central management

This capability to be implemented in ECA, establishes, changes and cancels ADS-C contracts taking into account the needs (requests) of the different system modules (Trackers, STCA, NIM, FPDP, Operator, etc.). This will allow the number of ADS transactions to be minimized by preventing redundant or overlaping contracts to be established with aircraft.

Controller-Pilot data link messages exchange (CPDLC)

Controller-Pilot data link messages exchange will be supported by both SATCOM and VHF data links within its respectives areas of coverage.

MET-AIS data bases interrogation via data link

This will be supported by both SATCOM and VHF data links.