

Si ATM SDPS

”The Si ATM stand-alone Surveillance Data Processing System”

The Si SDPS is derived from Si ATMSys, which supports Air Traffic Management operations for En-route (ACC), Approach (APP) and Tower (TWR) control. Si ATMSys was launched for operational use 1999 and has been incrementally enhanced with new techniques and functionality. The Si ATMSys is in accordance with Eurocontrol criteria categorized as a very advanced ATM system.

Si SDPS has been designed for and proven to be a system

- for production of high quality system tracks by an advanced true multi-sensor tracker
- that is flexible and configurable for most sizes of ATC systems
- with high redundancy and fault tolerance in hardware and software
- with cost effective life-cycle

Input

Sensor data processing

10 sensors, extendable to e.g. 16

Formats: Asterix Categories 1, 2, 34, 48, 19, 20 and 21

PSR, SSR and Combined radars, WAM/MLAT, full Mode S and ADS-B.

3D radars can be handled

Plot preprocessing

Blanking areas for PSR and non-PSR plots can be defined

Time stamping using plot, north or sector time

Conversion to internal coordinate system, WGS84,

Transverse Mercator (exact Riemannian curved geometry; zweibein formulation)

Squint error correction

Triangulated height estimation in absence of Mode C

Bias compensation of plots, see below

Clutter map estimation for each radar

Single Radar Tracking

Parallel Kalman filters for uniform motion and maneuvers.

Stable design.



Output

Tracks are distributed periodically in batches in direction East-West or South-North for radar operator positions.

Direction and period of distribution are defined by parameters

Track output format: Asterix Category 62

Bias Calculation

Track correlation. Correlates single radar tracks belonging to the same target

Bias Estimation. Bias values are periodically calculated using system Bias errors:

- Position Error
- Range offset and gain
- North alignment error
- Tilting antenna axis
- Time offset

Target dependent range error compensation, i.e. variation in test transponder delays.

System Capacity

500 System tracks (can be extended to 800)

400 Single radar tracks per radar

Vertical Tracking

State update using recursive Bayesian estimation with z-measurement pdf realistically described by a uniform distribution, due to discreteness of Mode C

Exact state prediction of pdf by using Fokker-Plank equation

Multi Sensor Tracking

Track Initiation

Initiation by credibility; likelihood that track is real
Tracks stages, Possible, i.e. low credibility -> Tentative -> Firm, i.e. high credibility
Primary track initiation takes into account clutter density
Areas with special initiation criteria:

- Normal initiation
- Fast initiation
- Restricted initiation
- No initiation

Track-plot association

Maximum likelihood used to find associated track-plot pairs
Primary plot-track association takes into account clutter density, via Neyman-Pearson tests
Mixed-Gaussian pdf, used for describing the predicted track position, avoids track swaps
Handling to eliminated reflections and side-lobes
Fragmentation and formation handling

Track state estimation

Multiple model method used described by a discrete time Markov jump-linear system.
Tracking Algorithm: Generalized pseudo-Bayesian of second order (GPB2), which is identical to second order Interactive Multiple Model (IMM2).
Kinematical models used:

- Uniform motion, Linear Kalman filter
- Coordinated Turn, Extended Kalman filter
- Uniform acceleration. Linear Kalman filter
- Turn with speed change. Extended Kalman filter
- Fast maneuvers. Linear Kalman filter

Ellipsoidal gating used to minimize effect of outliers
State vector: Position, velocity, linear acceleration, turn rate

Technical Terminal

Parameter handling
Online update of parameters
System Monitoring and control
Track and plot load, bias values
Error logging

Technical Features

Modern open system architecture

Commercial hardware

- UNIX workstations
- Fault-tolerant servers
- Redundant LAN

Standard protocols are used and the application software is in C, C++ and ADA

Unix operating system

- Platform dependant, AIX, DEC Unix, Lynx OS, LINUX
- X Windows / MOTIF

Working position equipment

- Working positions with dual or single displays, selectable in size and resolution
- High-intensity TWR monitor
- Standard keyboard and mouse

General Design aspects

- Client/server concept
- ADA, C and C++
- Distributed processing
- Fault-tolerant and/or redundant hardware
- Fault-tolerant software
- Non-dedicated workstations

System Redundancy Concept

The system can be delivered with various redundancy levels:

1. Hardware redundant on server level and on network level, through the use of fault tolerant computers and dual networks
2. Redundancy in data communication between sensors and SDPS through serial lines and network connections
3. System redundancy on hardware and functional level, through processing blocks in Master/Standby configurations



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