EVOLUTION OF AERONAUTICAL SURVEILLANCE

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Aeronautical Surveillance

Identification
Position (at what time?)
Additional info (e.g. velocity)

Airborne Surveillance

Ground Surveillance
Use of Surveillance

Separation application

Procedure → people → Equipment

Surveillance → Communication, Navigation, other...

Voice Position Reporting

Simple but slow
Only for certain uses (e.g. oceanic areas)
Primary surveillance radar (PSR)

* Detects all flying objects - A/C equipage not an issue
* Doesn’t provide A/C identity, altitude or other information
* Rather expensive to install and maintain – high power needed for long range is an environmental hazard
* Low update rate (once every 4 to 12 S)
* Vulnerable to interference, noise and clutter

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Secondary surveillance radar (SSR)

Interrogation

* Requires A/C transponder
* Needs less power (than PSR)
* Provides information on A/C identity and pressure altitude (through Modes A and C)
* Not affected by noise and clutter
* Can suffer from garbling/FRUIT
More on SSR (Modes A and C)

Interrogations

Replies

Garbled replies

Replies

FRUIT

SSR Mode S

Mode S: The answer to garbling and FRUIT (mainly in high density areas)

Aircraft can be selectively interrogated

* Can resolve closely spaced targets

A/C identity and altitude protected against errors

* Can provide altitude in 25 ft increments

* Can provide much more A/C information

* Needs Mode S transponder (needed for ACAS)

* More complex to set up and operate
The Mode S Transponder has 256 registers

Registers (00 to FF\textsubscript{HEX}) contain A/C information

Mode S transponder

Registers enable downlinking (and broadcasting) of A/C data

Mode S Transponder is an integral part of ACAS
Automatic Dependent Surveillance – Contract (ADS-C)

* A data link application
* Needs FANS1/A or ATN (avionics and ground infrastructure)
* Mostly for oceanic surveillance

Comm. Network

Report Position every T Sec

I am at XYX (T)

Automatic Dependent Surveillance – Broadcast (ADS-B)

(1090 ES, VDL M4 or UAT)

ADS-B OUT

ADS-B IN

Airborne Surveillance

Ground Surveillance

* High update rate
* Cheaper than radar
* A/C equipage required
* Immune to multipath
* May need independent verification of the authenticity of the reports
**Multilateration system**

* Uses SSR replies from the A/C
* Can be passive or active
* High update rate
* Needs a number of RX sites
* Susceptible to multipath
* Can be combined with ADS-B (can then check authenticity)

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**Status of Standardization**

<table>
<thead>
<tr>
<th></th>
<th>PSR: Not standardized</th>
<th>SSR: Mature, SARP in Annex 10</th>
<th>ADS-C: Forms part of ATN SARP and related data link applications (FANS-1/A not done by ICAO)</th>
<th>ADS-B: VDL Mode 4: SARP in Annex 10</th>
<th>UAT: SARP part of Amendment 82 (Nov. 07)</th>
<th>1090 ES: Version 0 (Amendment 77 in 02)</th>
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<tbody>
<tr>
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<td>Version 1 (Amendment 82 (Nov 07))</td>
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<td>Note: Data formats for both versions are included in Doc 9871</td>
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<td>Version 2 (being developed for 2012)</td>
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<td>MLAT:</td>
<td>SARPs in Annex 10 (Amendment 85, Nov. 2010)</td>
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Relevant ICAO Technical Documents

*Annex 10 – SARPs
*Manual on the SSR Systems (Doc 9684)
*Manual on Testing of Radio Navaids (Doc 8071), Vol III
  (Testing of Surveillance Radar Systems)
*Manual on Mode S Specific Services (Doc 9688)
*ACAS Manual (Doc 9863)
*Technical Provisions for Mode S Services and Extended Squitter
  (Doc 9871 – under publications)
* Manual on UAT (Doc 9861 – under publication)
* Manual on VHF Digital Link (VDL) Mode 4. (Doc 9816)

Note: Documents shown in red are to be replaced with the new Aeronautical Surveillance Manual (Doc 9924)

Traditional ICAO approach: Define the signal in space for various technical systems to ensure interoperability and leave to States to decide which system (s) should be implemented in their airspace.

PSR
ADS-B
SSR (Mode A/C and/or S)
MLAT

What is the decision based on?
Sensor characteristics
Operational requirements
Regional agreements
Cost considerations
Aircraft equipage
Other factors

An ideal situation?
Operational scenario
Identification of application(s)

Determination of Performance requirements

Other factors
Regional issues

Choice of surveillance system(s)
Thank You for Your Attention