EVOLUTION OF AERONAUTICAL SURVEILLANCE

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Aeronautical Surveillance

Airborne Surveillance

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

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
secondary surveillance radar (SSR)

* 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
SSR Mode S Transponder

Can house some registers

Registers (00 to FF_{HEX}) contain A/C information

Identity

Track and Turn Report

Heading and Speed Report

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-B)

* A data link application

* Needs FANS1/A or ATN (avionics and ground infrastructure)

* Mostly for oceanic surveillance

I am at XYX (T)

Report Position every T Sec

Comm. Network
Automatic Dependent Surveillance – Broadcast (ADS-B)

(1090 ES, VDL M4 or UAT)

ADS-B OUT

I am at XYX (T)

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)
## Status of Standardization

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>PSR:</strong></td>
<td>Not standardized</td>
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<tr>
<td><strong>SSR:</strong></td>
<td>Mature, SARPs in Annex 10</td>
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<tr>
<td><strong>ADS-C:</strong></td>
<td>Forms part of ATN SARPs and related data link applications (FANS-1/A not done by ICAO)</td>
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<td><strong>ADS-B:</strong></td>
<td>VDL Mode 4 : SARPs in Annex 10</td>
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<tr>
<td><strong>UAT:</strong></td>
<td>SARPs part of Amendment 82 (Nov. 07)</td>
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| **1090 ES:** | Version 0 (Amendment 77 in 02)  
Version 1 (Amendment 82 (Nov 07)) |

**Note:** Data formats for both versions to be included in Doc 9871

**Multilateration:** Being standardized (1\textsuperscript{st} draft in late 08)
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)

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.

What is the decision based on?
An ideal situation?

Operational scenario

Identification of application(s)

Determination of Performance requirements

Other factors

Regional issues

Choice of surveillance system(s)
A framework has been developed for the required surveillance performance (RSP) which has a set of values (e.g. from A1 to A10) each of which is associated with set figures for:

- **Accuracy**
  - **Availability**
    - **Integrity**
      - **Latency**
        - **Update rate**
          - **Continuity**
            - **Coverage**
Aeronautical Surveillance Panel

The ICAO body of experts responsible for the upkeep and the development of surveillance-related provisions such as:

* SSR (all modes)
* 1090 MHz extended squitter (for ADS-B)
* ACAS
* Multilateration
* Required Surveillance Performance (RSP)
* Airborne surveillance applications
Thank You for Your Attention