Surveillance Strategy

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EUROCONTROL
Pillars of ATM Ground Based Surveillance

**Non-Cooperative Independent Surveillance:**
Determines the (2D) position without reliance on aircraft avionics
- Primary Surveillance Radar (PSR)

**Cooperative Independent Surveillance:**
Provides the calculated aircraft position and processes other aircraft avionic data (Mode A/C/S, DAPs or ADD)
- (Monopulse) Secondary Surveillance Radar (SSR), SSR Mode S, Airport Multilateration (MLAT) and Wide Area Multilateration (WAM)

**Cooperative Dependent Surveillance:**
Provides the aircraft derived position (GPS or INS) and other aircraft avionic data to broadcast “air-ground” and “air-air”
- ADS-B (Out and In)
Surveillance Strategy

3 pillars of mutually interoperable and compatible technologies

- Primary Radar
- MSSR (SSR Mode S)
- ADS-B (Out)
- MLAT
- WAM

Surveillance Data Processing Systems
Choice for Ground Based Surveillance

The Surveillance Strategy for ECAC does not mandate the implementation of any of these surveillance technologies or techniques, but leaves the choice for ground based surveillance systems to the (ANSP) surveillance provider, depending on:

- Operational requirements
- Safety assessment
- The business case (geography, cost, topology, preference, integration risk, redundancy, integrity, etc).

- This relies on the availability of a suitable transponder.
The draft *Surveillance Performance and Interoperability Implementing Rule* (SPI IR) will specify the performance and interoperability requirements for Surveillance, for 3/5nm separations.

The transponder must therefore support all forms of ground based surveillance as well as enabling the air-to-air surveillance applications.

All aircraft flying IFR/GAT will require SSR Mode S Elementary Surveillance (ELS) capability, and

Aircraft >5,700Kgs or >250Kts airspeed will require SSR Enhanced Surveillance (EHS) capability, including Extended Squitter for ADS-B.
The current EUROCONTROL Surveillance Standards specify two independent layers of co-operative surveillance. (e.g. 2 separate SSRs)

The SPI IR will require each ANSP to generate a safety case to demonstrate the required level of redundancy, depending on density of airspace, separation and service requirements.

Similarly, the current standard requires PSR in major TMAs as a safety fallback. In future the specific safety case will determine whether or not a “non-co-operative independent surveillance” requirement exists.

This will give ANSPs greater flexibility in providing safe, cost effective surveillance solutions.
For safety or security reasons, Non-Cooperative Independent Surveillance is implemented, if required:

Until 2020+, at least one layer of ATM ground surveillance should be a co-operative independent surveillance to meet safety requirements:

**Layer 1**
- MSSR/SSR Mode S
- MSSR/SSR Mode S
- MSSR/SSR Mode S
- WAM

**Layer 2**
- MSSR/SSR Mode S
- WAM
- ADS-B
- ADS-B

**Status:**
- Available
- Operational
- Operational
- Planned
- Foreseen
For safety reasons, Non-cooperative Independent Surveillance is implemented, if required:

<table>
<thead>
<tr>
<th>Airport Surveillance</th>
<th>Status:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMR</td>
<td>- Available at most airports</td>
</tr>
<tr>
<td>Multilateration (MLAT)</td>
<td>- Operational at many major European airport</td>
</tr>
<tr>
<td>ADS-B</td>
<td>- Planned at secondary airports</td>
</tr>
</tbody>
</table>
The evolution for the ground based surveillance infrastructure for En-Route and TMA applications is shown below:

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary Surveillance Radar</td>
<td>SSR or SSR Mode-S infrastructure</td>
<td>Wide Area Multilateration using 1090 MHz (SSR Mode A/C/S and ADS-B)</td>
<td>ADS-B Ground based surveillance using 1090 MHz Extended Squitter</td>
</tr>
</tbody>
</table>

**Purpose / Applications:**
- Independent surveillance for Non-Cooperative targets where and when required
- Ground based position calculation
- Aircraft Derived Data (ADD) delivery to the ground systems and users

*Ground based surveillance infrastructure for En-Route and TMA*
The evolution of the **Airport surveillance infrastructure** is shown below:

**Surveillance Strategy for ECAC**

<table>
<thead>
<tr>
<th>Year</th>
<th>Surface Movement (Primary) Radar</th>
<th>(Airport) Multilateration and/or ADS-B</th>
<th>(Airport) Multilateration and/or ADS-B TIS-B (or equivalent)</th>
<th>Surveillance Data Processing and Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Purpose / Applications:**

- **A-SMGCS level I and II (including ADS-B-APT)**
- **A-SMGCS level III and IV (including ATSA-SURF)**
## Transponder Monitoring

The Airborne Monitoring Programme is also used to track the airborne transponder equipage: Mode-S and ADS-B

<table>
<thead>
<tr>
<th>Elementary surveillance Statistics – ELS</th>
<th>January 2009</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of the flights with SI code capability (bds1,0)</td>
<td>98.73 %</td>
<td>↑</td>
</tr>
<tr>
<td>Percentage of the flights with aircraft ID capability (bds1,0)</td>
<td>99.11 %</td>
<td>↑</td>
</tr>
</tbody>
</table>

| Enhanced surveillance Statistics – EHS (bds1,0 bit25=1)       |             |       |
| Percentage of the flights with enhanced surveillance capability| 94.20 %     | ↑     |

| ADS-B: Extended Squitter capability – ES (bds 1,0)            |             |       |
| Percentage of flights with Extended Squitter capability       | 79.28 %     | ↑     |

| Flights with aircraft ID confirmed correct                     | 93.15 %     | ↑     |

In the European Core area  
January 2009 data
SSR Mode S and WAM

- Mode S Programme – coming to completion end 2009, successful operational introduction of Mode S transponders and ground stations ELS and EHS. Transponder anomalies being chased.

- Some WAM systems already in operational use, however Standards not yet generally available.

- EUROCAE WG 70 “WAM MOPS” due 2009.

- Certification was based on comparison with the SSR Standards; shows performance equal to or better than SSR.

- Generic WAM Safety Statement, available.

- Guidelines for Approval and Introduction into service, available.
ADS-B Out & In

- **Ground Surveillance Applications (ADS-B Out)**
  - In a non-radar environment
  - In a radar environment
  - On the airport surface

- **Airborne Surveillance Applications (ADS-B In)**
  - Airborne situational awareness
  - Visual separation on approach
  - In Trail Procedure
  - Situational awareness on the surface
Pioneer Aircraft
Absolute Position Error

Average of TPE_95

5NM = 926m

TransponderMake
GNSSMMRMake
- XpM1 - GM1
- XpM1 - GM2
- XpM1 - GM3
- XpM1 - GM4
- XpM2 - GM1
- XpM2 - GM2
- XpM2 - GM3
- XpM3 - GM1
- XpM3 - GM2
- XpM3 - GM3

TransponderMake
GNSSMMRMake
- XpM1 - GM1
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- XpM1 - GM4
- XpM2 - GM1
- XpM2 - GM2
- XpM2 - GM3
- XpM3 - GM1
- XpM3 - GM2
- XpM3 - GM3

Phase | Operator | CAO Type
--- | --- | ---
XpM1 - GM1 | XpM1 - GM2 | XpM1 - GM3
XpM1 - GM4 | XpM2 - GM1 | XpM2 - GM2
XpM2 - GM3 | XpM3 - GM1 | XpM3 - GM2
XpM3 - GM3 |
Pioneer Aircraft Latency (95 % Bound)

Average of L_95

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<th>GNSSMMRMMake</th>
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</tr>
<tr>
<td>XpM1 - GM3</td>
<td>XpM1 - GM4</td>
</tr>
<tr>
<td>XpM2 - GM1</td>
<td>XpM2 - GM2</td>
</tr>
<tr>
<td>XpM2 - GM2</td>
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</table>

1,5 secs
Pioneer Aircraft Latency (99.9 % Bound)
Pioneer Aircraft
FOM/NUCp Distribution

Phase 1 & 2 FoM/NUCp Distribution
>145 Million Reports

Percentage % of FoM/NUCp reports distribution.
Pioneer Aircraft Results

- Compared to ED-126 (NRA requirements)
  - 100% of the aircraft meet the absolute position accuracy requirement (<926 m) (95%).
  - 98.7% of the aircraft meet the latency requirement (<1.5 seconds) (95%).
  - 100% of the aircraft meet the latency requirement (<3 seconds) (99.9%).
  - 98.92% of the reports meet the integrity requirement FOM ≥4.
  - Some anomalies detected, currently under investigation.