Future Role of Radars in ATM Surveillance
SUMMARY

- Surveillance Criteria
- Surveillance Means and Sensors
- Radar Types
- Radar Current Technology
- The Greenfield Study
- Surveillance Trends
- Conclusion
Surveillance Criteria

1. Coverage Volume
   - The volume of airspace in which the sensor operates respectively to the specifications

2. Accuracy
   - The difference between the elaborated and the true position of an aircraft

3. Update Rate
   - The rate at which the aircraft position is provided to the end user

4. Integrity
   - The level of validity of the provided sensor information

5. Reliability
   - The probability that the sensor continues to operate within a defined period respectively to the specifications

6. Availability
   - The percentage of total operating time during which the sensor is performing the specifications
Procedural Separation

Radars

Wide Area Multilateration (WAM)

ADS-B

ADS-C
Surveillance Sensors

- Independent Surveillance Sensor (PSR)
- Cooperative Independent Sensor (MSSR / Mode S)
- Cooperative Independent Sensor (WAM)
- Dependent Surveillance Sensor (ADS-B)
- Dependent Surveillance Data Link (ADS-C)

Detection + Identity

Position + Identity

Data Fusion
Pros

Trustworthy aircraft position for 5 to 3 nm aircraft separation
Does not require Aircraft equipment (PSR)
Independent Cooperative surveillance on very large airspace with Modes A/C/S services (MSSR/Mode S)
Qualified for very high traffic and RF interference environment

Cons

Expensive to install and maintain
Require optimum site with unobstructed view to aircraft
Not accurate enough for airport surface application
Pros

Lower cost than radar
Higher accuracy and higher update rate than radar
Transition path to ADS-B

Cons

Not yet endorsed by ICAO
Multiple sites and communication links needed
Limited interrogation range
Pros

- Very low cost
- Very high accuracy performance and update rate on large airspace
- Simple ground station design

Cons

- Dependent on aircraft avionics
  - Equipage rate relatively low (at this stage)
- Confidence in reported message needs to be enhanced
- Might not be suitable in dense areas as sole mean
Pros

Replace tedious HF voice reporting in oceanic areas
Automatic system allows to reduce oceanic separations
Many long haul aircraft are equipped

Cons

Still long latency due to ACARS data link
Expensive when using Satcom
THALES Sensors Portfolio

THALES Sensors in operation worldwide

- MSSR and Mode S (RSM 970 S)
  - En-Route and Approach control

- S Band Primary S band Radar (STAR 2000)
  - Large TMA and Approach control

- Long Range Primary L Band Radar (TRAC 2000)
  - En-Route and large TMA

- ADS-B receiver (AS 680) > All airspaces
- Multilateration Air Ground Surveillance (MAGS)
  - Airport and Approach
Optimized for Long Range En-Route Surveillance
• 256 nm (475kms) range at 4 s rpm for more than 1000 aircraft
• MSSR or Mode S configurable
  • Mode S Radar complies with ICAO standard and is EUROCONTROL qualified (EMS specs) compatible with all type of transponders:
    • Conventional mode A/C or level 1 up to level 5
Dedicated for Approach and large TMA Control
• 60 to 80 nm typical range with 4 s update rate.
• Primary Solid State design with fail soft capability provides extremely high availability (99.999%)
• Low Transmitted power limits interference level
• MSSR Co-mounted solution widely selected
Dedicated for En-Route Aispace

- Up to 220 nm typical range with 10 s update rate.
- Primary Solid State design with fail soft capability provides extremely high availability (99.999%)
- MSSR Co-mounted solution widely selected
Modern Radar Technology

Modular Transmitter and Digital Receiver

Signal Processing, Monitoring & Control, Display System
Housed in COTS PCs

* COTS: Commercial Off The Shelf

Large Use of Digital Techniques and COTS
Area unequipped with surveillance sensors

Possible requirements:

a) Detection down to 10000 ft amsl on the whole territory

b) Oceanic FIR covered up to 460 kms (250 nm) at the maximum

c) TMA of Cayenne shall be covered
Solution 1

2 MSSR/Mode S Radars

a) Radar in Cayenne to cover TMA and Oceanic FIR

b) Radar in Maripasoula for central and south part
Solution 2

1 MSSR Radar + 1 WAM

a) Radar in Cayenne to cover TMA and Oceanic FIR

b) WAM in southwest
Solution 1:
The two radars solution meet and even exceed the requirement as unnecessary detection coverage is achieved on Brazil and Suriname. This solution is also rather costly and a contributing WAM solution shall be considered.

Solution 2:
The Cayenne SSR covers a large range of the Oceanic FIR, the TMA of Cayenne and some part of the Guiana territory. The WAM cluster in the south takes advantage of a minimum infrastructure as the sensors could be installed on the higher spots while using solar panels for standalone energy powering.

Note: 1 low cost ADS-B receiver can also be fitted in the Cayenne radar cabinet taking advantage of installed infrastructure (Energy, tower, COMs…)

Radar + WAM Hybrid Solution
Hybrid Surveillance Solution

Selection of the Most Appropriate Technique
## Surveillance Trends

### Airspace Density

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<th>2020</th>
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<tr>
<td>Low density Continental</td>
<td>Procedures /ADS-C Multilateration (WAM) ➔ ADS-B</td>
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<tr>
<td>Medium density</td>
<td>MSSR Multilateration (WAM) ➔ ADS-B</td>
<td>MSSR Multilateration (WAM) ➔ ADS-B</td>
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<tr>
<td>High density</td>
<td>MSSR Multilateration (WAM) (double coverage ECAC area)</td>
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<td>Overall</td>
<td>PSR Long Range + MSSR (homeland security)</td>
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### APPROACH

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<td>Medium density</td>
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<td>High density</td>
<td>ASR (PSR + MSSR) (ECCM/GCA for military/civilian)</td>
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### AIRPORT

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**THALES**

Air Systems Division
Conclusion (1)

• The Radar is still the reference tool to ensure surveillance in nowadays.

• Radar technology has been largely qualified and tested and has proven its full capability to ensure the stringent requirements of ATM in terms of availability, reliability, continuity of service and safety.

• The primary radar remains the only system able to detect any flying object in an independent way even if aircraft equipment is missing or faulty.

• SMR remains the sole way to detect any moving target on the airport

• Approach primary radar will remain the mandatory system in TMA to guarantee arrival and departure safety in high traffic density

• Long range primary radar is selected by ANSPs to perform ATM and SAR missions or security missions as detection and tracking of non-SSR transponder-equipped aircraft.
• Secondary radars have been recently enhanced with the Mode S processing for down linking airborne parameters, bringing a noticeable improvement for the controller operation.

• Mode S/SSR radar equipment electronics is now designed with modular transmitters and receivers interfaced with COTS PC providing sophisticated algorithms to operate in the busiest flights environment with high level of RF pollution as FRUITs.

• Mode S/MSSR has an unsurpassable long range detection capability due to its powerful transmission and antenna selectivity.
Conclusion (3)

• Hybrid WAM/ADS-B/MSSR solution could be foreseen in lower density and smaller airspace to obtain an optimum and cost effective surveillance solution that provides the right level of performance.

• ADS-B will certainly become a primary mean of surveillance when current concerns are overcome. This includes level of aircraft equipage and unquestionable confidence on satellite based surveillance.

• Australia upper airspace ADS-B will be a pioneer operational application for this technology, while major programs in Europe and the USA are being implemented.

ADS-B – The Future of Surveillance
Thank you for your attention

Dominique Le Meil
Business Development Manager
dominique.lemeil@thalesatm.com

Air Systems Division