

*Surveillance Seminar for the NAM/CAR/SAM Region
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Issues related to the provision of surveillance service

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ATM Surveillance Services Issues

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ATM Surveillance Services Issues

ATM Surveillance, a key enabler for Air Traffic Control

- Today, Surveillance is a very important enabler for Air Traffic Control
 - Surveillance sensors are the “eyes” of the Controller
- Although some Situation Awareness, Spacing and possibly (limited) Separation Applications (between 2 aircraft) may be implemented in certain airspace **by 2015** it is foreseen that the operational environment **of 2015-2020** will be fundamentally the same as today:
- The **Air Traffic Controller remains responsible for the separation** service and for maintaining the separation of aircraft in En-Route and TMA airspace, supported by surveillance data.

ATM Surveillance Services Issues

ATM Surveillance, a key enabler for Air Traffic Control

- Self-Separation (between all aircraft) might be implemented in some airspace **between 2020 and 2030**
- Although the objective of **Self-Separation Applications** is that the **Pilot will become responsible for separation**, the Air Traffic Controller needs to monitor the traffic, ready to intervene (if required) supported by surveillance data.

ATM Surveillance Services Issues

Primary Surveillance Radar



- Primary Surveillance Radars are expensive and consume a lot of spectrum
 - The maintenance and support lifecycle cost are high
 - **Some European Air Navigation Service Providers are considering not replacing primary radar in the future**
 - **However, PSR is a safety net in TMA**
- **EUROCONTROL is investigating the possibility of a more cost effective alternative solution for Primary Surveillance Radar**

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Secondary Surveillance Radar

- In the Core Area of Europe there is a potential risk of over-interrogation (transponder occupancy) and RF FRUIT pollution resulting in garbling and a decrease of the Probability of Detection, mainly because of the
 - Number of SSR radars (many interrogations)
 - Short Squitter (TCAS) and ADS-B Extended Squitter transmissions
 - Increase of air traffic (more squitters and replies)
- The implementation of **Mode-S** radars with selective interrogation can mitigate against this loss of detection
- The implementation of **Wide Area Multilateration** systems possibility can also mitigate this decrease of the detection of aircraft

ATM Surveillance Services Issues

Secondary Surveillance Radar

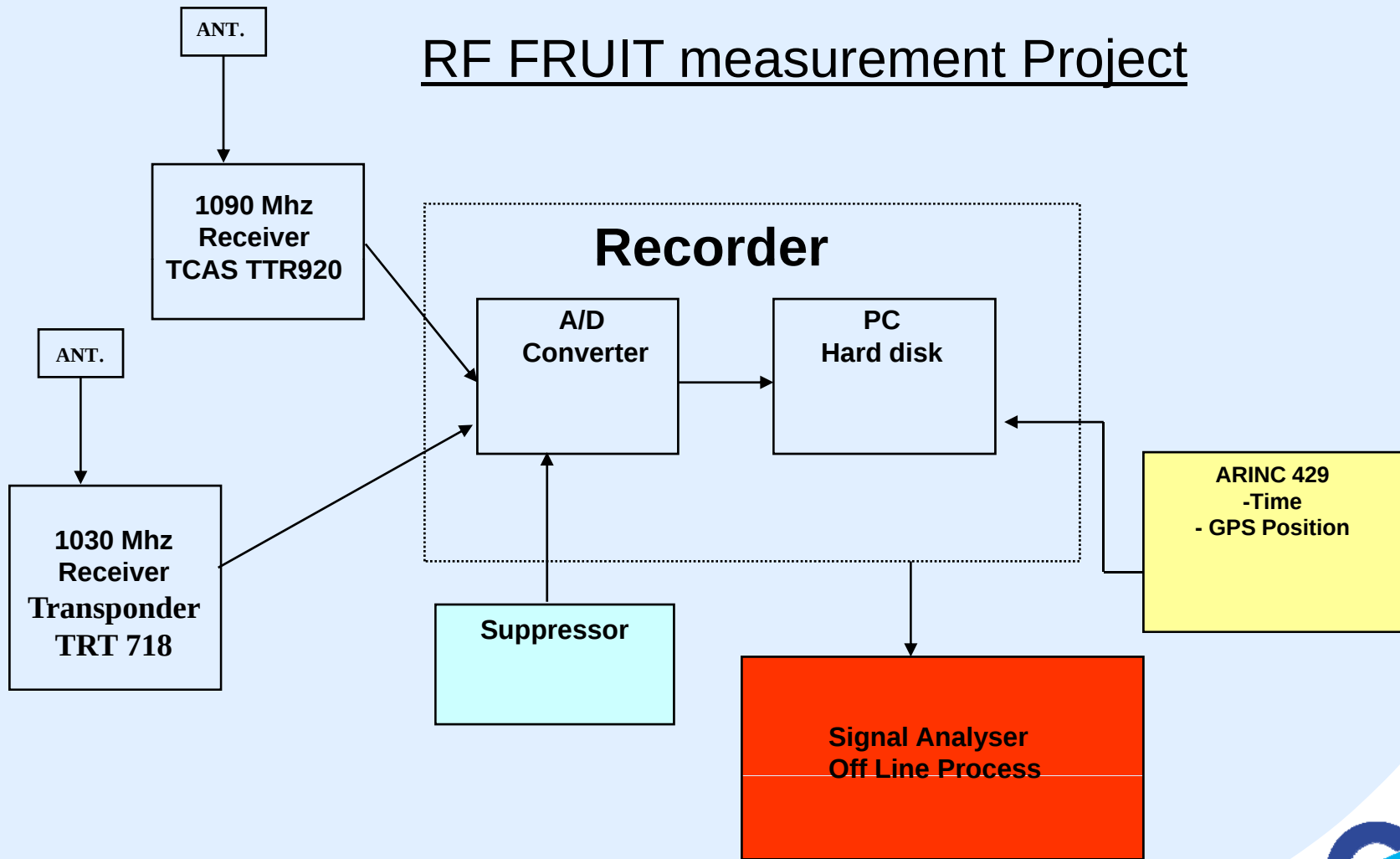
- RF FRUIT issue (continue):
- **ADS-B** can also mitigate the risk of a decreased probability of detection, but it is not foreseen as a sole means of surveillance until 2020+

- **EUROCONTROL** has developed an RF FRUIT measurement and analysis tool, to monitor the trend in 1090 and 1030 MHz occupancy in the core area of Europe.

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Secondary Surveillance Radar

RF FRUIT measurement Project



ATM Surveillance Services Issues

Mode-S

- IIMSES: “Initial Implementation of Mode S Enhanced Surveillance”
- IIMSES Strategy was agreed in 1995. It required the use of Mode S in the core-European airspace
- Approval by the ICAO Air Navigation Council in January 1999 to amend European Regional Supplementary Procedures
- Approval by the Eurocontrol Provisional Council in 1999 for Mode-S Elementary Surveillance (ELS)
- Mode S Enhanced Surveillance (EHS) implementation agreed (so far in 3 States)

ATM Surveillance Services Issues

Mode-S



IIMSES resulted in the development of the Pre-Operational European Mode-S (POEMS).

3 stations installed in 2001: one in UK, one in France and one in Germany

Implementation progressed very well through the

EUROCONTROL Mode S Programme

- Significant number of Mode S radars providing data
- 2005 Mode S EHS operational in London TMA
- 2007 Mode S ELS operational evaluation commenced in Germany (DFS), Maastricht UAC and Switzerland (Skyguide)

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Mode-S

The Airborne Monitoring Project (AMP) started in 2003.

The ADS-B 1090 MHz extended squitter is now also monitored.

- Utilises live radar data provided by ANSPs in the Mode S Airspace (core Europe) – good coverage
- Identifies problems (mainly transponder related)
- Contacts aircraft operators to notify airframes with transponder anomalies

ATM Surveillance Services Issues

Mode-S

The Airborne Monitoring Project (AMP) started in 2003.

The ADS-B 1090 MHz extended squitter is now also monitored.

- Helps to identify causes and solutions, in cooperation with avionics manufacturers, as required.
- Provides information for Mode S Programme action to coordinate major rectification action, as required, with EASA eg A0607
- Monitors rectification retrofit action progress in the aircraft fleets

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Mode-S / ground implementation

EHS Only

 2005 UK - London TMA

ELS (and EHS)

 2007 Germany Commence ELS/EHS validation phase

 2007 Switzerland Commence ELS/EHS validation phase

 2007 MUAC Commence ELS/EHS validation phase

 2008 France Commence ELS/EHS validation phase

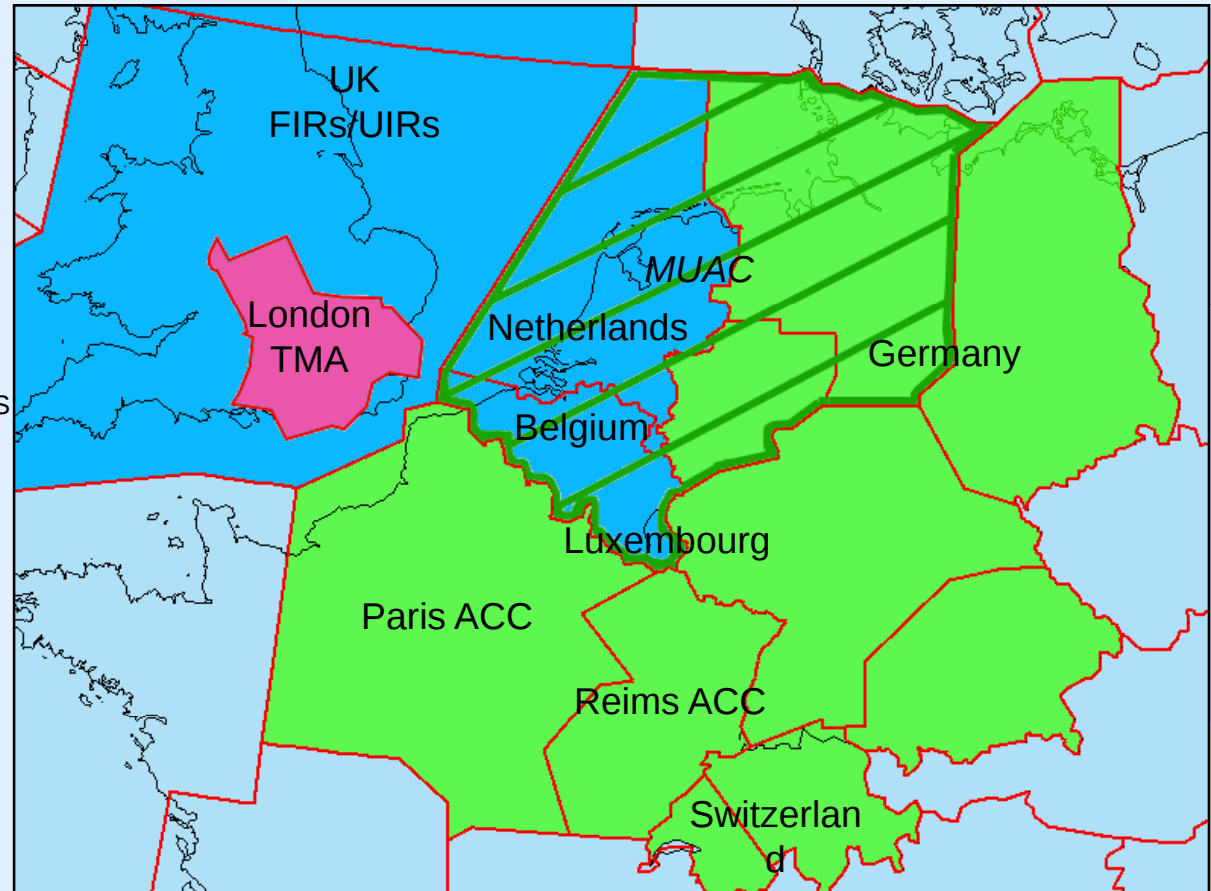
ELS Only

 2008 Netherlands Commence ELS validation phase

 2008 Luxembourg Potentially Start ELS Validation

 2012 UK - FIRs/UIRs Commence ELS validation phase

 ≈ 2010 Belgium Commence ELS validation phase

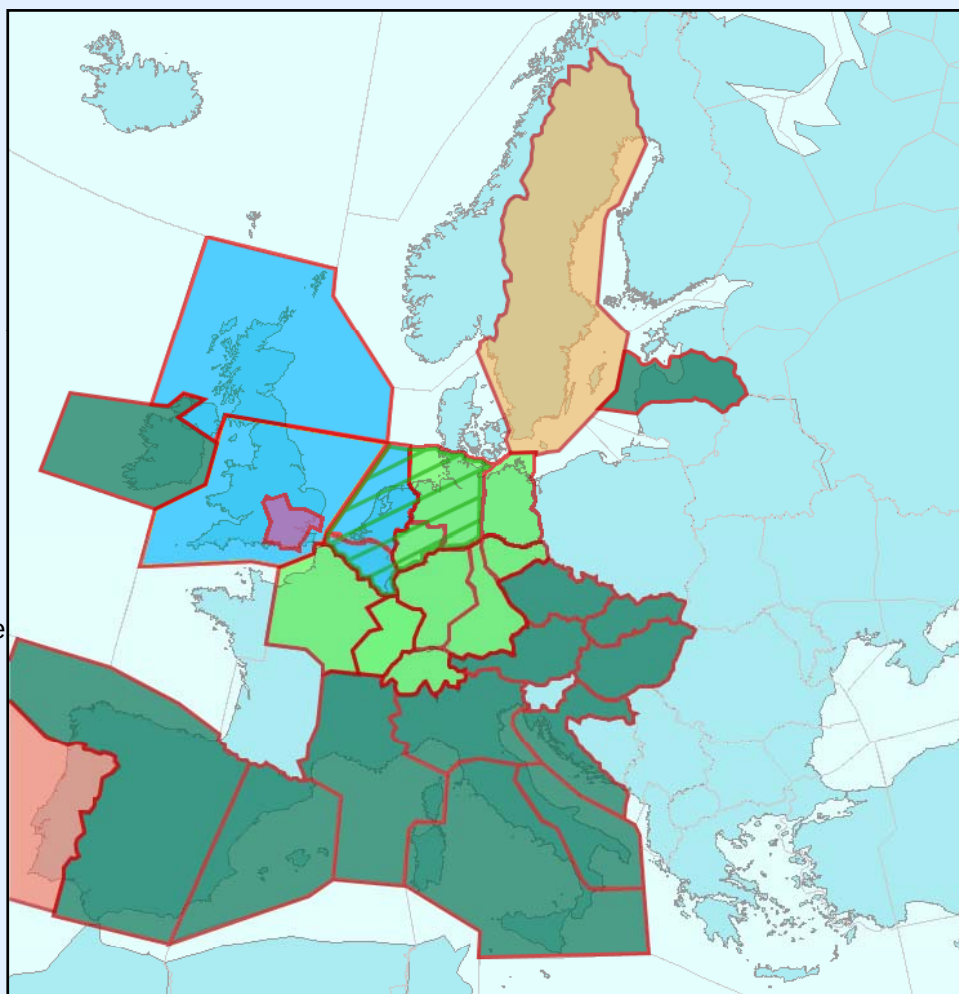


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Mode-S / ground implementation

Mode S Radar Coverage

-  **France** Marseille ACC: Upgrade all radars to Mode S **End 2007 to Early 2009**
-  **Hungary** Mode S coverage **end 2007**
Use of ACID
-  **Spain** First Mode S radar validation phase - **2008**
2009 onwards - further installations
-  **Czech Republic** **2008** - Prague TMA & West sector Mode S capable (*possible* use of ACID)
2010 Mode S radars introduced within remaining airspace
-  **Italy** Mode S radar installation underway
2009 - Implement ELS
2010 to 2011 - Implement EHS
-  **Latvia** **End 2009** - Riga FIR full Mode S radar coverage
Long-term plan to use ACID
-  **Slovakia** **Around 2010** - Mode S radar deployment
No plan yet for ATC upgrade
-  **Ireland** Mode S radar replacement programme underway
2011 Expect to implement ELS and use ACID
-  **Croatia** **Mid-End 2007 - 2008** Mode S radar upgrade
End 2011 - Full implementation (ATC system upgraded)
-  **Austria** MSSR sites upgraded to Mode S A/R
2012 Expect to implement ELS



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Mode-S

Some detected Transponder anomalies:

Anomaly	Problem Identification	Current Action
Partial detection issue	Identified	Maintenance issue
Total Non detection issue CL604	Identified	AD issued for immediate Workaround SB pending (late 2007)
Intermittent failure	Identified	Retrofit in progress
XPDR revert to Stand By	Identified	AD issued Retrofit progressing
Undemanded 0607 squawk	Identified	Regulatory action- Retrofit complete
Intermittent Selected Alt	Identified	Regulatory action- Retrofit in progress
Selected Alt not available	Identified	Regulatory action. Retrofit schedule to be agreed
Mode A chg not detected	Under investigation	Open
Ghosting between 0-5 Nm	Under investigation	Open
Ghosting at about 9 Nm	Identified	Replace antique transponder model!
SSR reflection on Mode-S	Identified	Open
All Call replies on ground	Under investigation	Regulatory action in progress
Changing Aircraft ID	Identified	Regulatory action- SB pending
Corrupt Mode C	Identified	Regulatory action - AD pending
Erroneous RA downlink	Identified	SB pending

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Mode-S

AMP overview **April 2007 (Amsterdam – Schiphol as an example):**

Summary of the detection anomalies <u>April 2007</u>										
April 2007 <i>Total nbr of fls: 697515</i>	Number of Flights	Flight Ratio	Number of Aircraft						In Amsterdam - Schiphol <i>151.689 Flights</i>	
<i>Tot. undetected</i>	56	0.00008	17						13 Flights	
<i>Part. undetected</i>	36	0.00005	10						11 Flights	
Total anomalies	92	0.00013	26						24 Flights	
Synthesis's Cases/hour	0.03/H								0.03/h	

There are still some detection anomalies, but the number is decreasing steadily.

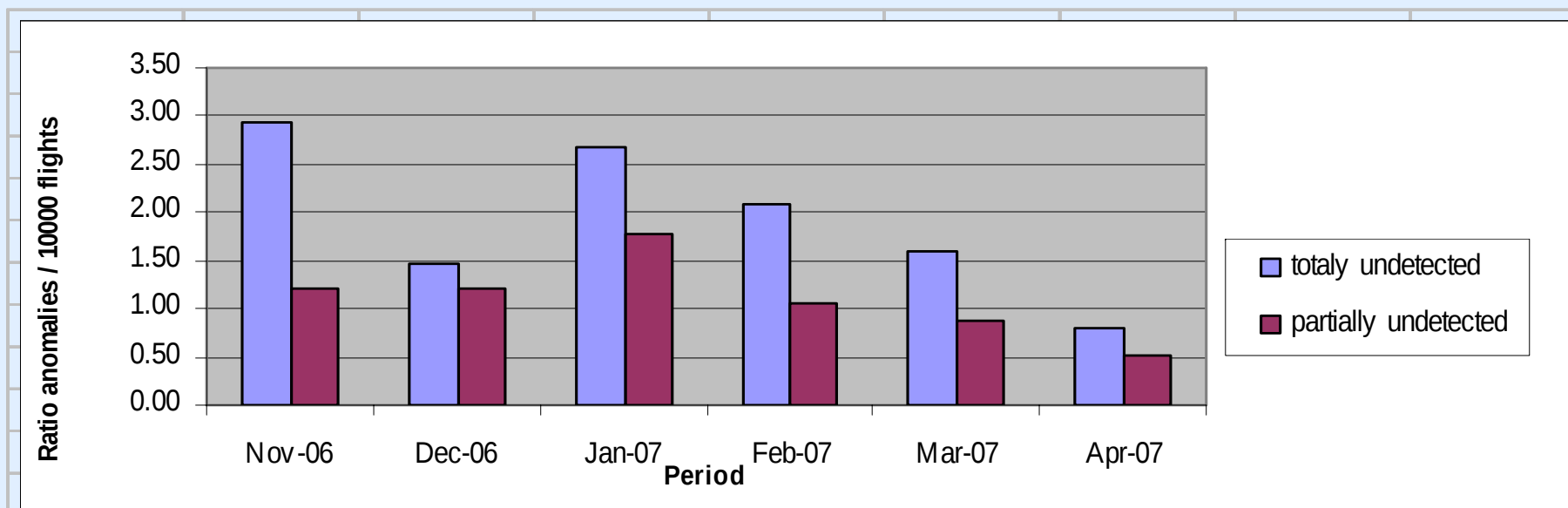
ATM Surveillance Services Issues

Mode-S

AMP overview April 2007:

Ratio of anomalies / 10.000 Flights is about 1 out of 10.000 flights

Safety case target: 1 out of 10.000 flights



ATM Surveillance Services Issues

Mode-S

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

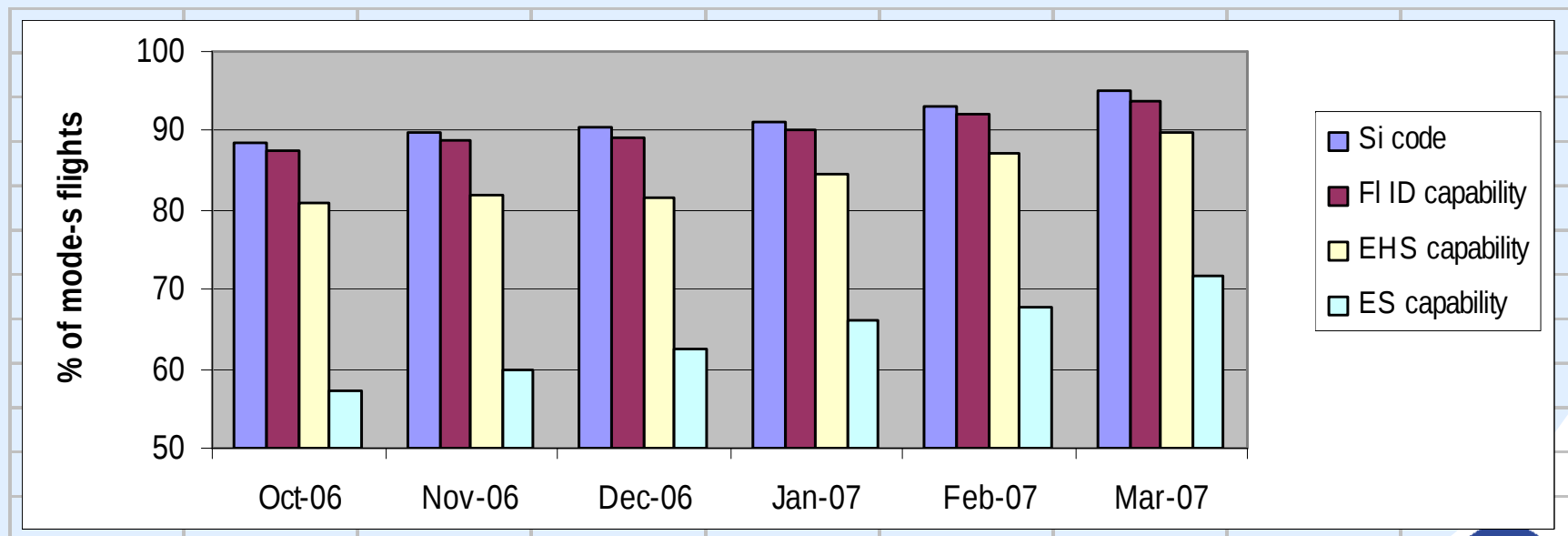
Elementary surveillance Statistics – ELS		March 2007	Trend
Percentage of the flights with SI code capability (<i>bds1.0</i>)		95.00 %	↑
Percentage of the flights with aircraft ID capability (<i>bds.10</i>)		93.89 %	↑
Enhanced surveillance Statistics – EHS (<i>bds1.0 bit25=1</i>)			
Percentage of the flights with enhanced surveillance capability		89.84 %	↑
ADS-B: Extended Squitter capability – ES (<i>bds 1.0</i>)			
Percentage of flights with Extended Squitter capability		71.67 %	↑
Flights with aircraft ID confirmed correct		89 %	↑

In the European Core area

ATM Surveillance Services Issues

Mode-S

The Airborne Monitoring Programme is also used to track the transponder **capabilities for Mode-S station Interrogator Code** (Interrogator Identifier (II) and Surveillance Identifier (SI)) and the Flight ID capability.



ATM Surveillance Services Issues

Mode-S Interrogator Code

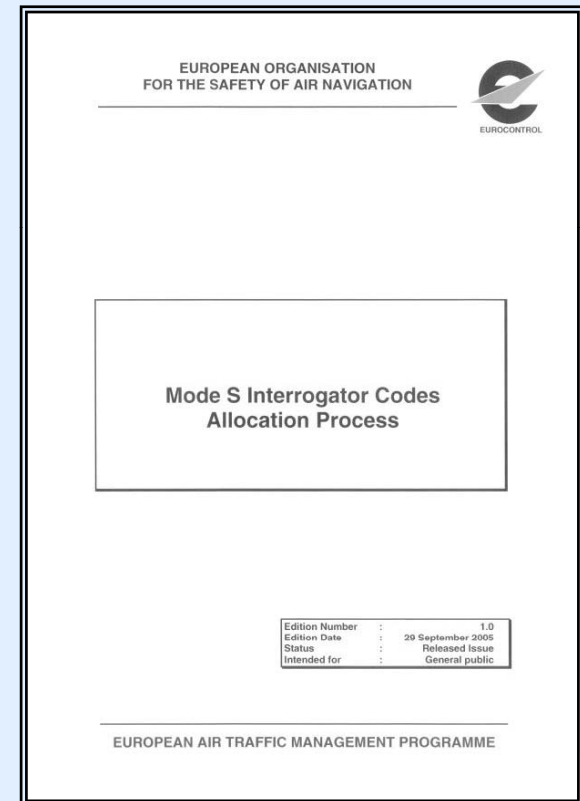
- Whilst traditional Secondary Surveillance Radar (SSR) stations continuously interrogate all aircraft within their range, **Mode S establishes addressed interrogations** with aircraft within its coverage.
- In order to avoid ambiguity in the operation of the system it is essential that each **Mode S interrogator is allocated an Interrogator Code** (IC) and is protected from interference by other Mode S interrogators operating in coincident or contiguous airspace.
- Interrogator Codes can be either Interrogator Identifiers (II) or Surveillance Identifiers (SI). The design of the Mode S system limits the number of Interrogator Codes available (excluding zero) to 15 II codes and 63 SI codes.

ATM Surveillance Services Issues

Mode-S Interrogator Code

The Mode-S Interrogator Code Allocation procedure exists already in Europe and is currently applied under the responsibility of ICAO that delegated its practical implementation to EUROCONTROL.

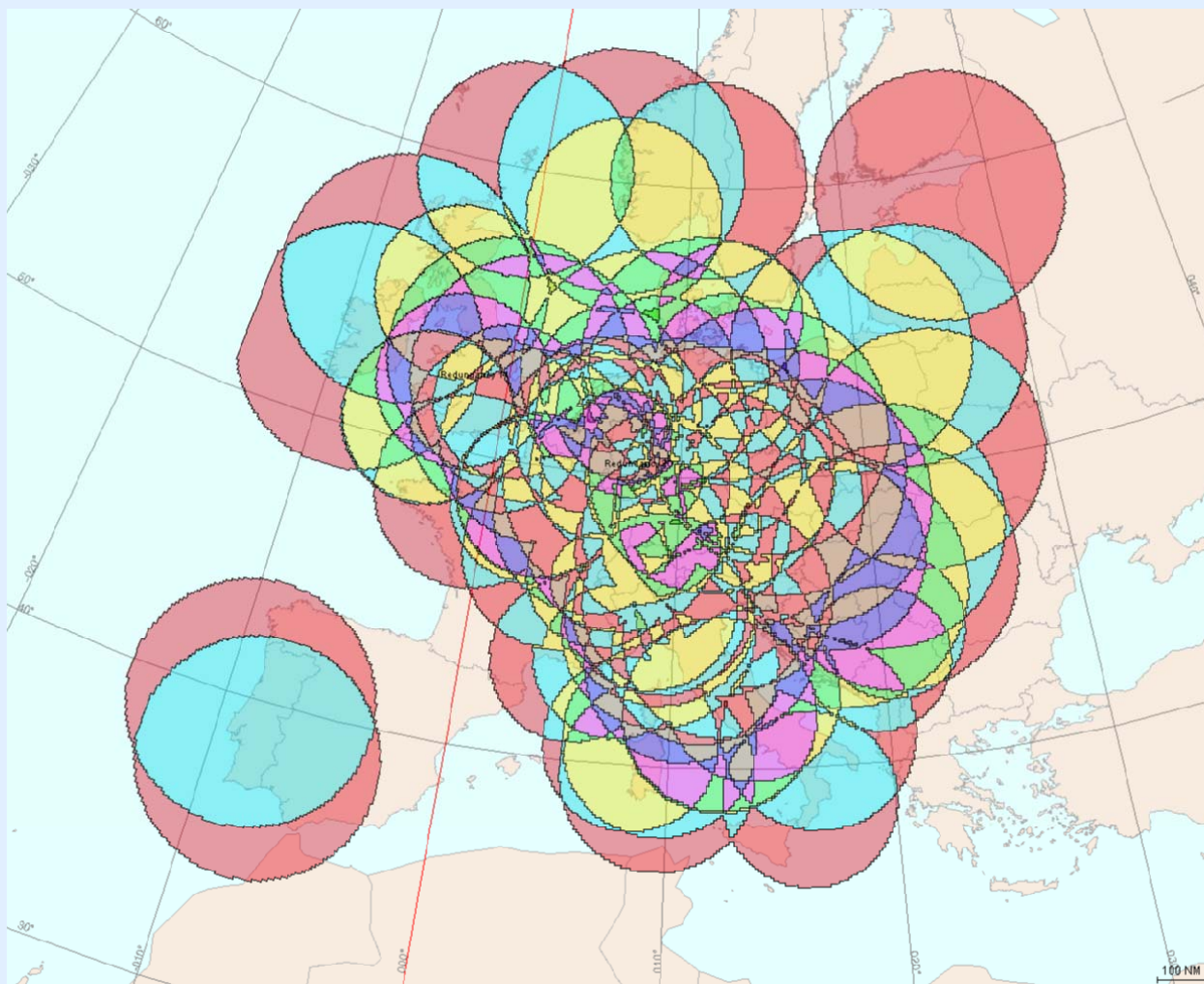
This procedure is defined in **ICAO EUR ANP, Volume IV, FASID, Appendix K,** and detailed within the Mode-S Interrogator Code Allocation Process document.



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Mode-S Interrogator Code

- **Civil & Military Mode S radar installations in Europe**



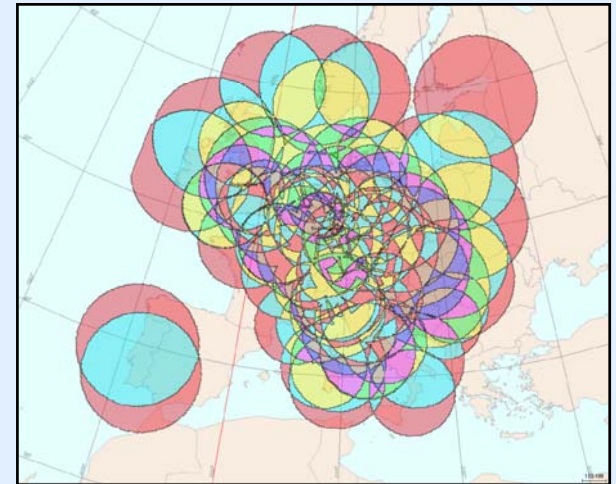
Also Military fixed
Mode-S
Interrogators
(radars) have to
request an IC code !

Mobile Mode-S
Interrogators
(including military
ships) in principle
have to use code
“0”

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Mode-S Interrogator Code

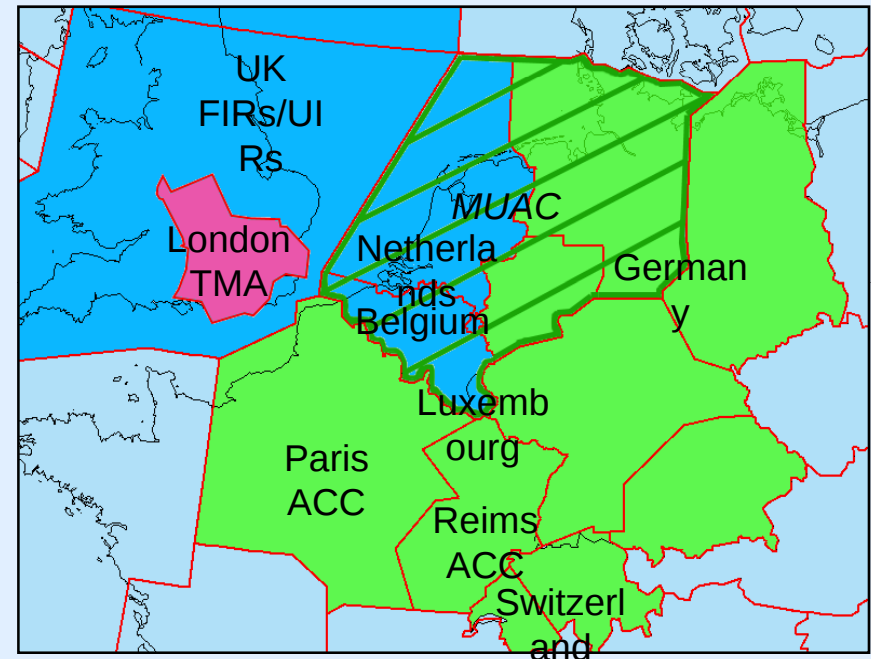
- **IC Allocation conflict issues**
 - inability to assign to new radar requests
 - Coverage restrictions have to be applied
- **Clustering:** potential alleviation
 - Already implemented by the Royal Netherlands Air Force
 - In other areas considered
- **SI code allocation**
 - high % capable aircraft required
 - Currently > 90 %
 - Allocation of SI codes will start now !!!



ATM Surveillance Services Issues

ADS-B “out” (Ground based surveillance)

- The Globally agreed ADS-B link is the 1090 MHz ES (Mode-S transponder) link
- Mode-S (transponder) carriage has been mandated in Mode-S airspace in the Core Area of Europe
 - For IFR and VFR flights
- However, that does not automatically include the operation of the Mode-S Extended Squitter (ADS-B “out”) of these Mode-S transponders



ATM Surveillance Services Issues

ADS-B “out” (Ground based surveillance)

- **ADS-B Ground based surveillance** has the potential to become an important ATM ground surveillance system in the future
 - However, currently there are some issues that require attention
 - **There is no mandate yet for the carriage of 1090 ES**
 - **Certification of the 1090 ES just started**
 - **The aircraft avionic position needs to be verified by an independent means of surveillance (SSR/Mode-S or Multilateration)**
 - **Potential jamming of GPS satellite signals**
 - **Do we need another data link in the future ??**
- **In the next decade, confidence in ADS-B will grow**
 - **With the implementation of Galileo, the satellite signals will become more robust and harder to jam**

ATM Surveillance Services Issues

ADS-B “in” (Airborne surveillance)

ADS-B “in” is required for Airborne Separation Assistance System (ASAS) applications that become more and more important

- However, some issues still have to be solved in particular for Self-Separation applications, like:
 - Do we need “**TIS-B**” to supplement the air-to-air surveillance ?
 - What are the **procedures** (between ATCO’s & Pilots, and between Pilots & Pilots)
 - Which **additional avionics infrastructure** is required
 - Which **additional tools for the controller and aircrew** are required
 - Possibly **Legal issues, like licensing, liability**

“Each **State** is responsible for ensuring the safety, regularity and efficiency of aircraft operations under its jurisdiction.”

ATM Surveillance Services Issues

Wide Area Multilateration

Wide Area Multilateration (WAM) issues:

- Although some WAM systems are already operationally used in Europe by ATC, agreed Specifications are not yet available
- Certification has been done compared with Surveillance Standard (equal or better than SSR)

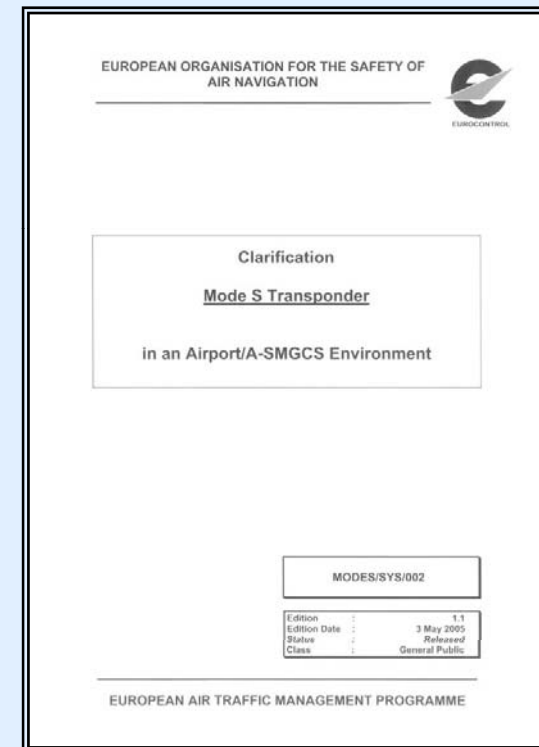
- Work is on-going:
- **Specifications: EUROCAE Working Group 70 (expected in 2008)**
- **Generic Safety Assessment (EUROCONTROL 2007 - available)**
- **Guidelines for Operational Approval/Certification (expected end 2007/2008)**

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Airport Multilateration

When implementing **Airport Multilateration**, some issues require attention, like:

- Transponder behaviour on the ground
- Instructions to Pilots how to operate and change the Transponder modes (e.g. switches on transponder box).
- To support the Advanced Surface Movement Guidance & Control System Programme (A-SMGCS), the Surveillance Domain has drafted a clarification document on the **Transponder behaviour on the ground**



ATM Surveillance Services Issues

Questions

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