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SP/8

Update on ADS-B Thales Perspective

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Thales Air Systems & Electron Devices

Germany

Security and mobility in a networked world.

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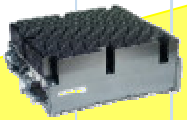
Thales has a long History in ADS-B

SBGS
FAA SBS

BX680



France
Germany

AX680

Helsinki, Finland
Taipei, Taiwan
Abu Dhabi, UAE
London, UK
Afghanistan
DFS PAM FRA, Germany
Chengdu-Lhasa, China
X'ian, China
Mexico

ACAS Monitor

US MIT LL
DFS, Germany

AS660 (VDL-4)
Sweden
Eurocontrol
France
Germany

AS680
Australia

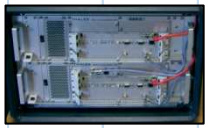
AS682
Lyon, Corsica, La Reunion, N. Caledonia, France
Madrid, Spain
Indonesia
Incheon, South Korea
Astana + Almaty, Kazakhstan

AS685
Eurocontrol

Milan,Italy

Frankfurt, Germany

Cologne, Germany



Germany (ACAS Monitor)

1996 1998 2000 2002 2004 2006 2008 2010 2012 2014

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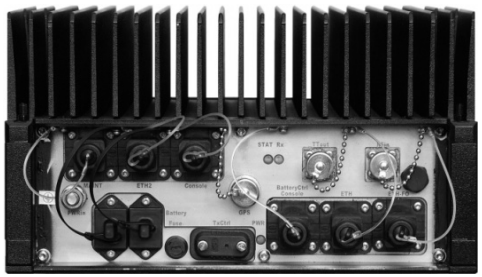
Typical ADS-B Equipment

AX680

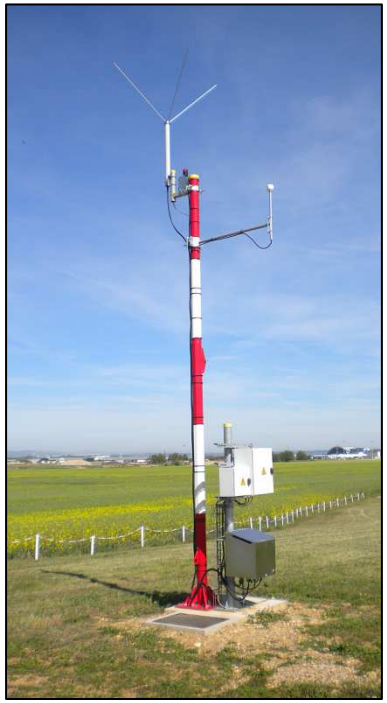
Single/dual channel/link ground station (indoor version)

- High Performance Receiver
- SWAL3 compliant Software
- Fully DO260B compliant
- Autonomous ADS- B Processing
- WAM Processing

BX680



Rugged single channel/link ground station (outdoor version)



FAA SBSS Radio

Dual redundant, quad channel, dual link SBS ground station

FAA SBS Site

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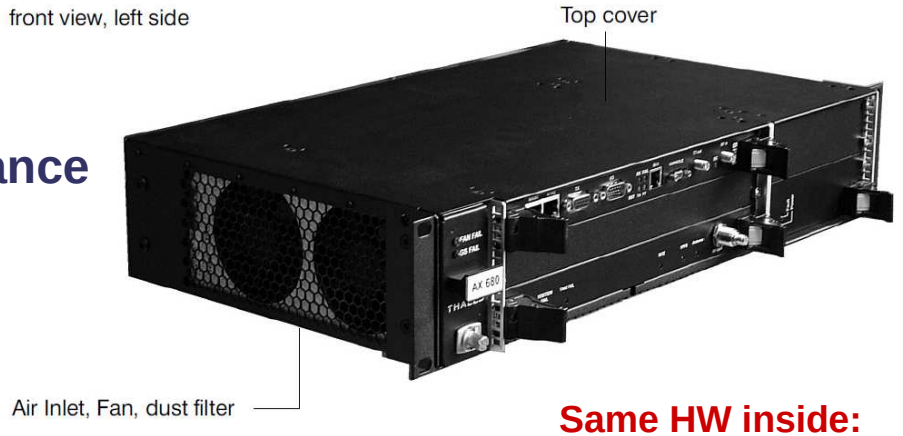
Ground Station Configurations

AX680 series

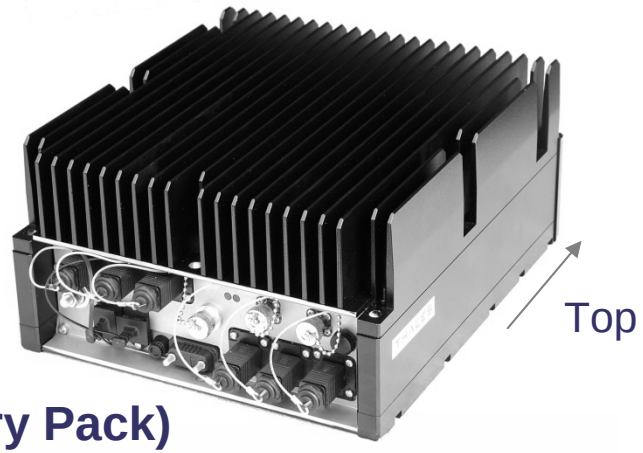
- 19” form factor indoor equipment
- Hot-swap elements, low prev. maintenance
  - Redundant fans
  - Dual power supply
  - Ethernet Asterix interface
  - Integrated GPS, Site Monitor



Same HW inside:
Integrated Receiver/Signal Processing Board
Digital, software-defined radio
Sensitivity -91 dBm
Mode A/C/S, 1090 ES ADS-B Decoding
Compliant to DO260/A/B, exceeding class A3

BX680 series

- Rugged outdoor equipment:
  - IP66: no dust/water ingress, salt spray tested
  - Passive cooling, no fans
  - -40° to +70°C (incl. 15°C solar load)
- Ethernet + PoE and Fibre Optic Interfaces
- Integrated GPS, Site Monitor, UPS (external Battery Pack)



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Some selection Criteria

Life Cycle Costs for a System.

- Site Rental Costs, incl. ground station footprint
- Communication System Costs (acquisition versus leased lines)
- Power Consumption
- Trips for Maintenance due to routine or failures

Requirements:

- As much as possible a ground station design should minimize the number of trips to the actual site.
- A ground station should have low power consumption and optimise communication bandwidth requirements
- Should be able to handle interference, overlapping..
  - Interference is a major threat to robust ADS-B performance and achieving performance at range, 250+ Nautical miles.

Entrance Barriers for ADS-B Introduction

- **Equipage levels**

  Mitigation:

  - provide benefits for equipped aircraft, or
  - issue mandates, e.g. as in AUS, EU, US

- **Integrity / security**

  Mitigation:

  - add integrity layers to ground system, as proposed and implemented in SESAR

Thales Activities to enhance ADS-B Data Integrity

SESAR WP 15.4.5

- **Implementing means**
  - on ground station level (decentralized), and
  - in a centralized ADS-B Validation Server
- **Defined new Asterix cat 21 edition 2.77 to include validation results (was Basis for ed. 2.1)**
- **Simple data consistency checks**
  - Velocity vs position change
  - ADS-B transponder also provides other Mode S signals and/or replies
- **Additional Measurements**
  - TOA validation, DTOA validation, WAM integration
  - Angle of Arrival Validation
  - Ranging

Further Roadmap

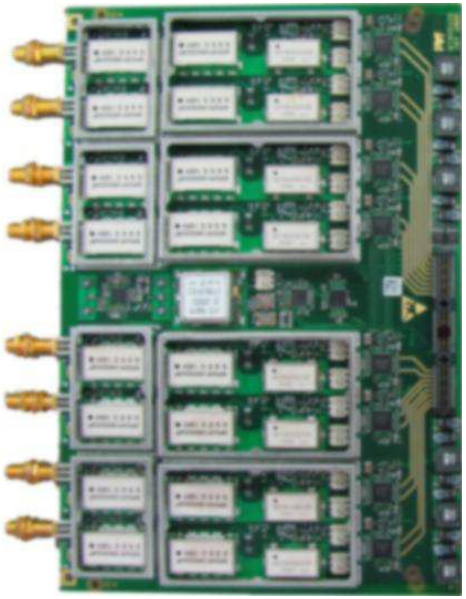
- **Integrity Overlay based on 1090 MHz D8PSK Phase Overlay (long term)**

Passive Angle of Arrival for ADS-B Ground Station

Prototype

- 8 RX channels, integrated into BX680 outdoor case
- Synchronous multichannel signal processing
- Accuracy ~0.9° within 120° azimuth sector, plan to increase sector
- Integrated into AX680 (19“ indoor) and BX680 (outdoor) configurations

Receiver Frontend



Antenna and Ground Station

Trials at Frankfurt Airport

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Another approach for transition to ADS-B…

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Precision Approach Monitor Frankfurt – PAMFRA

Customer

- DFS
- Main Drivers:
  - High update rate in final approach
  - High accuracy
  - Transition technology to ASDS-B

Locations of DFS

Public-sector sites

Locations the of Federal Armed Forces (Bundeswehr)

Privately-owned sites

Main Task

- Provide Multilateration Surveillance within 128x80 NM coverage region around Frankfurt International Airport
- Focus on closely parallel approaches
- Primary means of Surveillance in approach sectors

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PAM FRA required Performance

Main Parameters

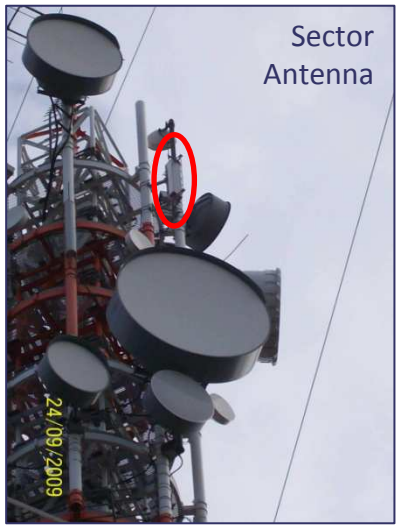
- Output Probability of Detection: PD ≥ 97%
- Up to 500 targets Mode A/C & S in coverage at any one time
  (plus up to 500 targets outside coverage to be detected to discard)
- Reporting interval: 1 second (Radar: 4.8s, 10s…)
- Direct plot output (no coasting, extrapolation or smoothing)
- Horizontal Position Accuracy: HPA ≤ 50m RMS (150 m for TMA in ED-142)
- Probability of Code Detection: PCD ≥ 97% (Mode A), ≥ 96% (Mode C)
- Altitude Timeout 1s
- Dual synchronisation required (GPS and RF Time Beacon)
- N-1 redundancy

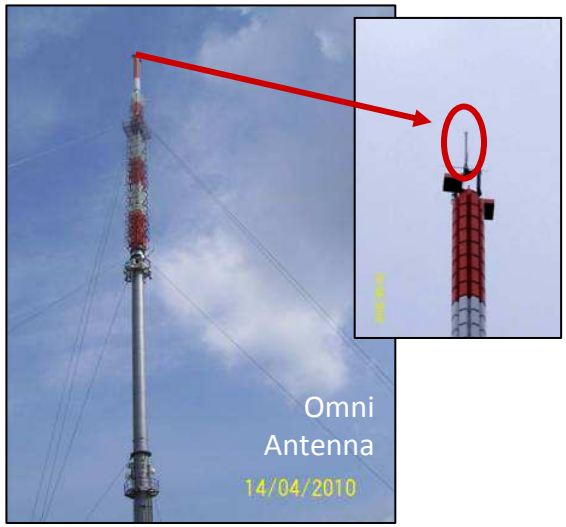
Main constraints

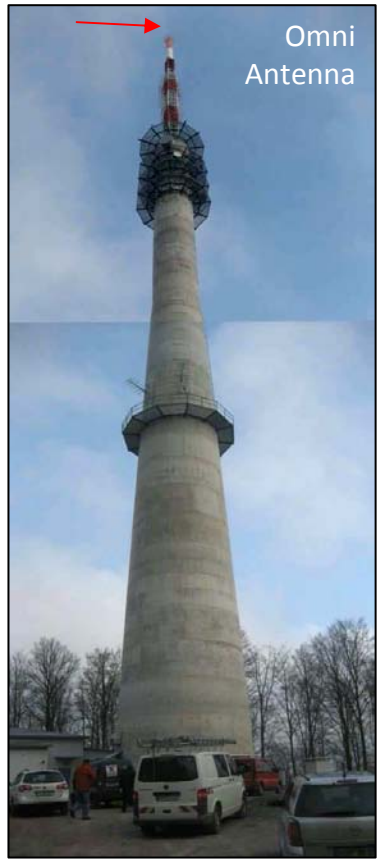
- High Radio Frequency environment (most loaded 1090 MHz environment)
- High traffic load (>500 WAM targets seen in physical coverage)
- Difficult traffic mix (gliders, ultralights, helicopters, military, air transport,…)

Siting Concept

- **DFS concluded a comprehensive initial site survey presenting a selection of more than 80 sites for tenderers to choose from**
- **Thales identified 34 sites (12 of these for airport GND alone) and their respective role**
  - Main driver: low level WAM visibility, rather than power budget
  - Re-use existing sites as far as practial
  - Requires system adaptability: antenna types, EMC, communication, packaging, lightning protection, etc.
  - Confirmed findings in final site survey







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Typical PAM FRA Ground Station Sites

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WAM Sensor Equipment

Small Indoor Cabinet

AX680 Receiver

- Digital, software-defined radio
- 1090 ES ADS-B Decoding
- Hot-swap elements
- High Performance

WAM / ADS-B Ground Stations

Central Processing Station

Regular Indoor Cabinet

Outdoor Cabinet

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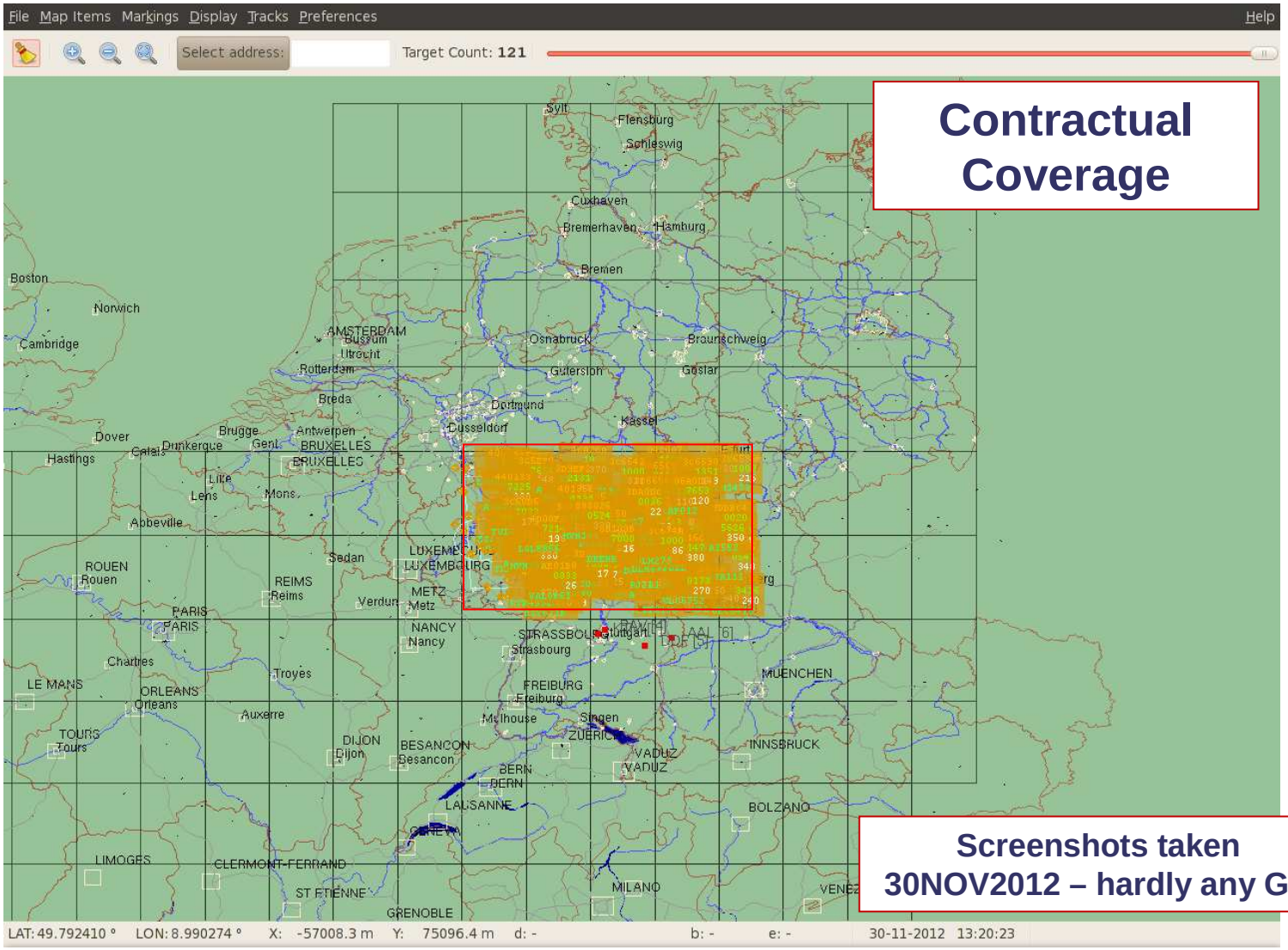
WAM Data used by DFS



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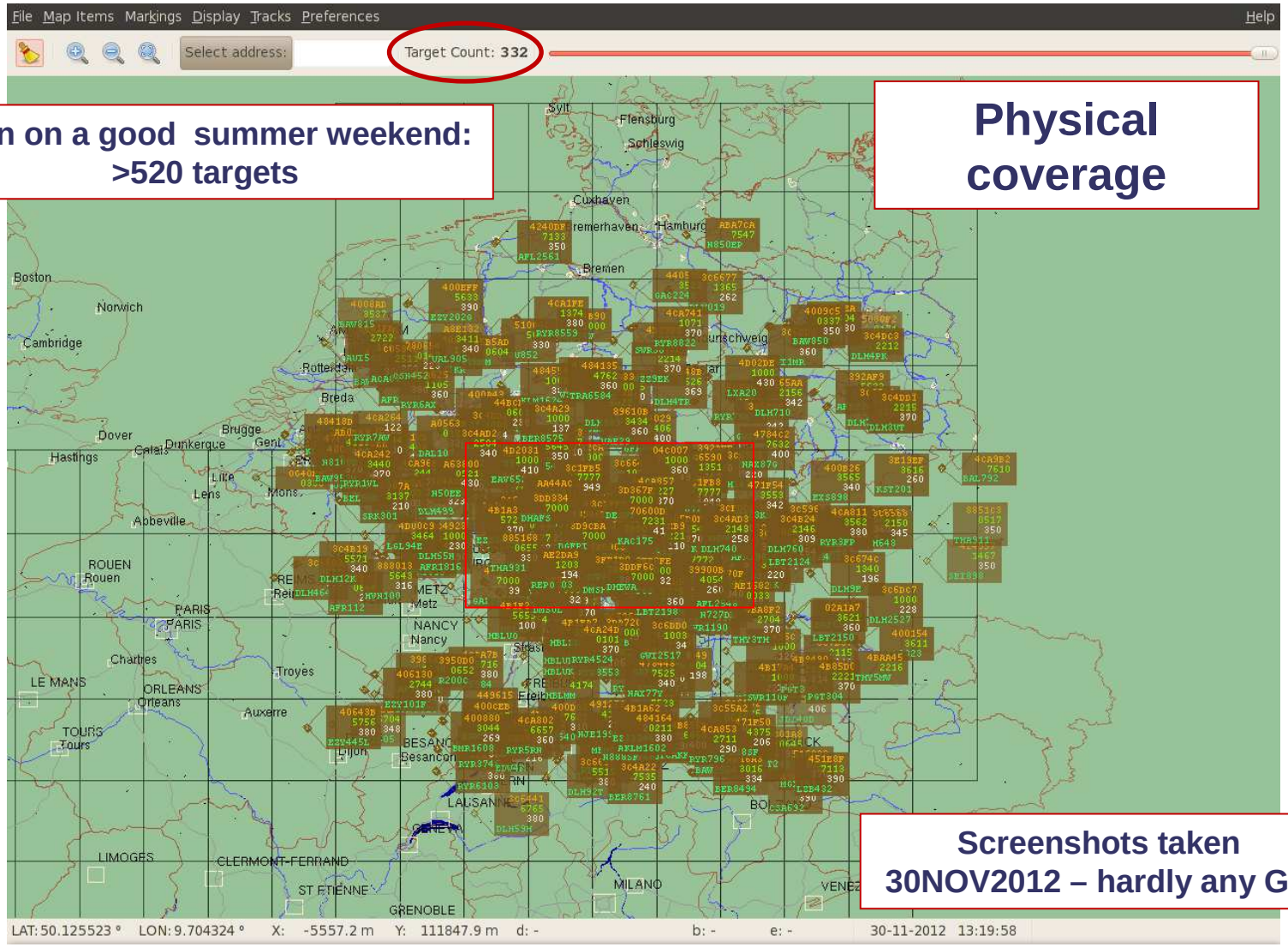
WAM Data seen by the System

Seen on a good summer weekend: >520 targets

Physical coverage



Screenshots taken 30NOV2012 – hardly any GA

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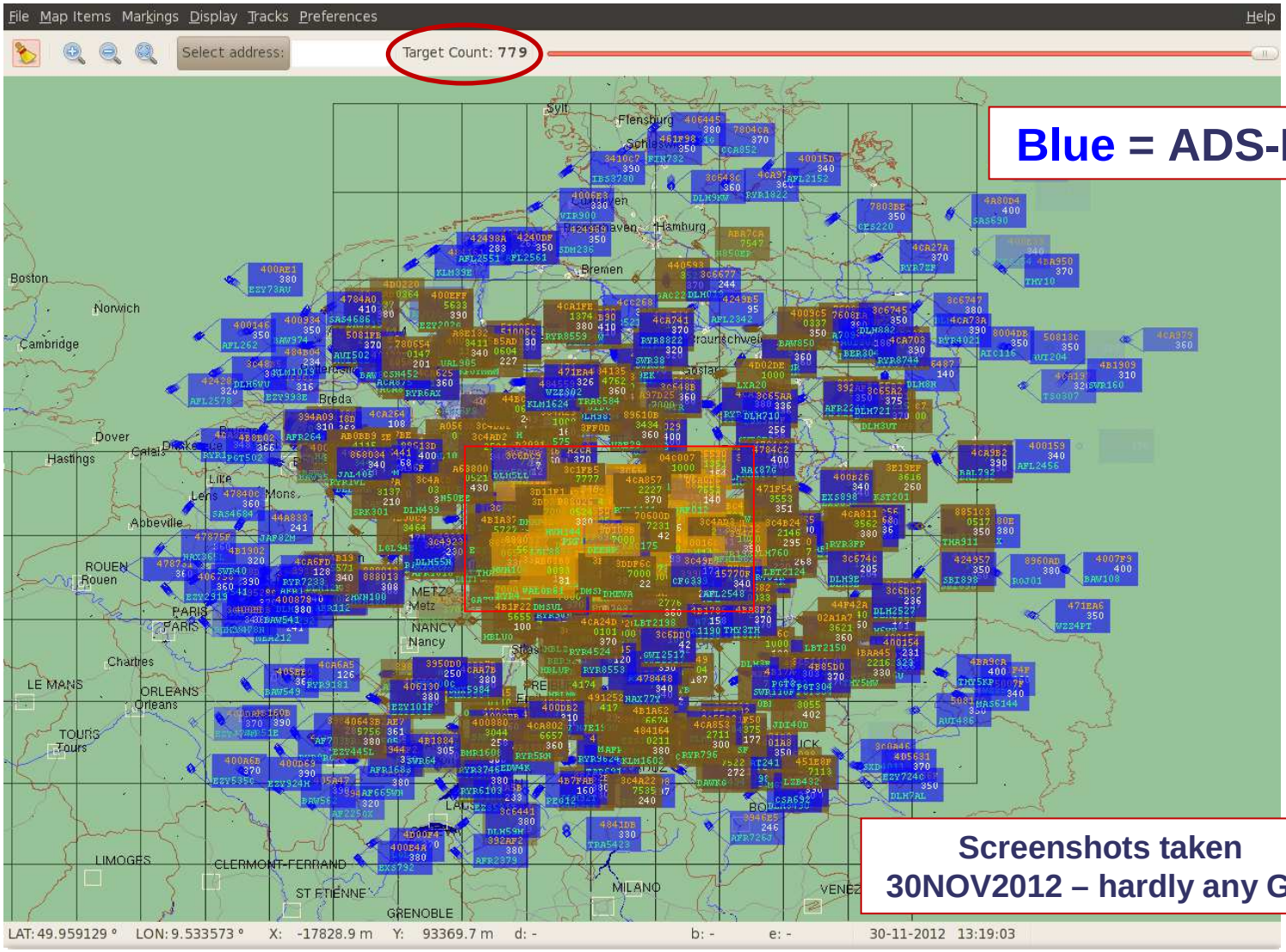
All Data seen by the System



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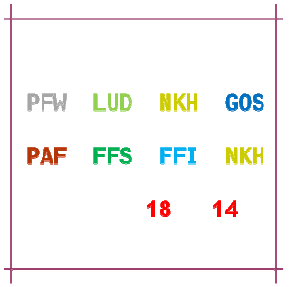
PAM FRA is operational



- **Operational Cutover on 09 April 2013**
- **PAM-FRA WAM sensor (PAF) is used as the leading surveillance system for Frankfurt APP**
- **Position accuracy equal or higher than ASR.**
- **Target update rate increased from 4.8 seconds to 1.0 second.**
- **Increased level of Safety – earlier detection of**
  - altitude, direction and speed changes,
  - potential conflicts and unauthorized entries into protected airspace
- **PAM-FRA Sensor treated like an ASR without primary component.**
  - Only cooperative targets presented with one second update rate.
  - Primary (non cooperative) targets and targets outside the PAM-FRA coverage need to be detected by conventional, rotating radars. Presented with lower update rate depending on the turn rate of the used radar.

Next steps:

- **Extend coverage and assess ADS-B Performance**

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ADS-B is the Target

- Best performance of all surveillance technologies
- Lowest cost of all surveillance technologies

Heard from DFS:

"ADS-B, when it works, is perfect"

– "So let's make it work"

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The End

Thank you very much!
Happy to answer Questions

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Security and mobility in a networked world.

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