Aircraft Detection System – Safety Case and development of ICAO Regulations

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Agenda

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- Safety Case ADSL Germany 2019
  - ADSL Radar active/passive
  - ADSL Transponder using signal strength
  - ADSL Transponder using multilateration
- Pros and Cons from aviation perspective
- ICAO Aerodrome Design Manual Part 4

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- Expert Flight Operations / Air Traffic Control
- Former Air Traffic Control Operator
- PhD Aeronautical Engineer
- Flight Test Instructor/Engineer Lufthansa Aviation Training
- Advisor Federal Ministry of Transport / Economics Germany
- ICAO Visual Aids Working Group

Safety Case

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- Safety Case on behalf of Federal Ministry of Transport and Economics
  - Scientific analysis using ADLS-Transponder/Radar
  - Impact on aviation safety
- Risk-analysis comparing:
  - ADSL-Radar
  - ADSL-Transponder
  - No ADSL
- Extensive traffic analysis:
  - Low amount of affected traffic during night – approx. 40 movements in the whole German airspace
  - Biggest percentage HEMS, military-/police-operations

Safety Case

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- General Aviation VFR Night adhere to defined obstacle clearance specified in EU 923/2012 SERA
- Mostly affected trajecories HEMS, military, police

=> Task of ADSL

  - Detecting aircraft in a specifed airspace volume around the windfarm
  - Shall be able to distinguish between aircraft and other objects (e.g. birds, cars)
  - good ground coverage, e.g. helicopter landing sites within the airspace volume even in mountanious area
  - Robust technology

Systems: ADSL-Radar

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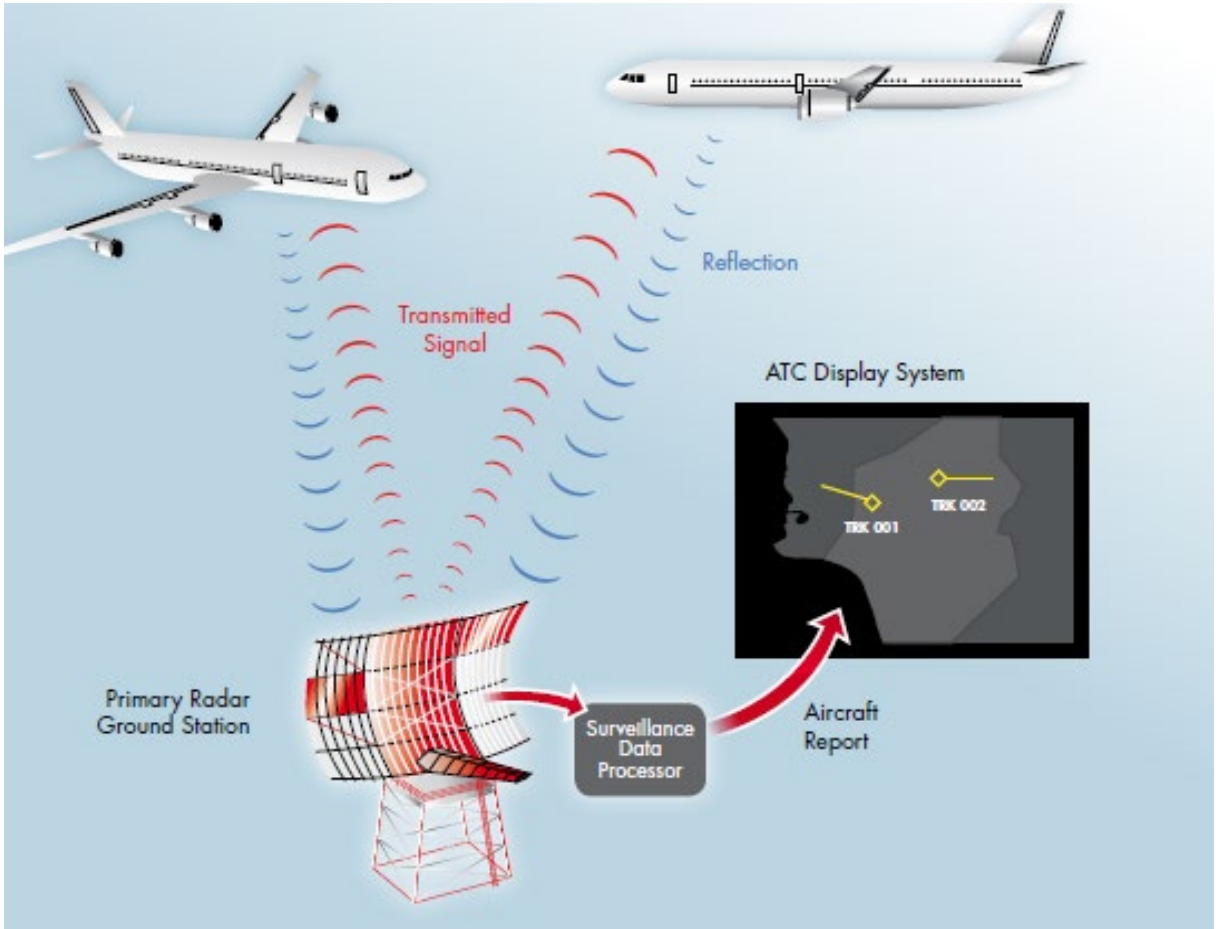

Systems: ADSL-Radar

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- No requirement for onboard equipment
  - As well using passive radar
  - However, requirement for available radar-frequencies
- No hazard by transponder failure
  - All aircraft should be detected
  - No dependence on onboard-equippment
- Possible disturbances by ground clutter or other objects (e.g. wind turbines)
  - Especially in mountainous area
- Proper identification of aircraft requires in depth knowledge of radar data processing and filtering
- Simulation and flight-test required to provide sufficient coverage

Systems: ADSL-Transponder

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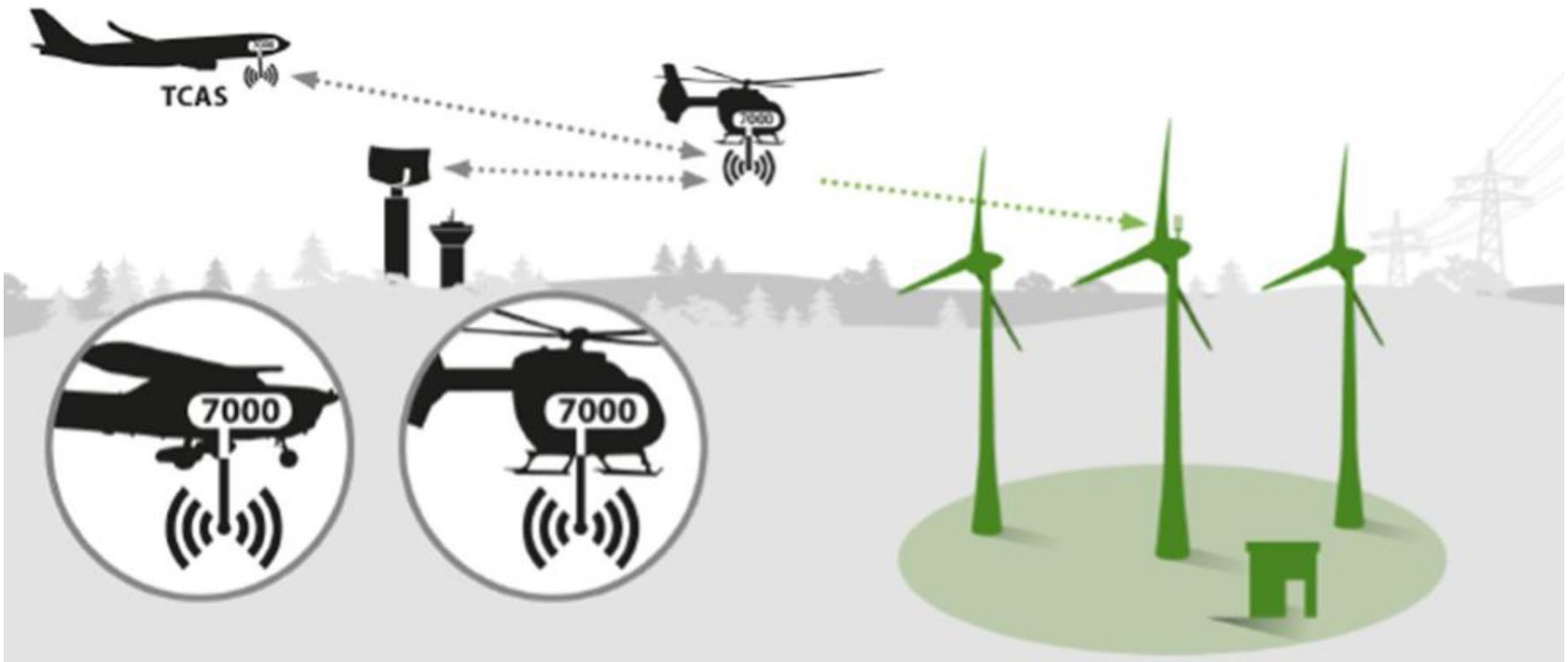
- Using signal-strength, aircraft ID, altitude information. ADS-B information, FLARM for filtering



Systems: ADSL-Transponder

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- Based on passive usage of 1090MHz signals
- Since Mode-S implementation(approx. 2008) Stringent technical requirements for transponder
  - Low risk of transponder failure
- Robust antenna-diagram provide good ground coverage
  - even for aircraft on runway/heliport
  - Does not require flight-test for coverage-assessment
- All aircraft flying during night-time must be equipped with transponder
- Identifying relevant aircraft using signal strength requires in-depth knowledge of 1090MHz wave propagation and the Mode A/C/S transmission protocol

Systems: ADSL-Transponder

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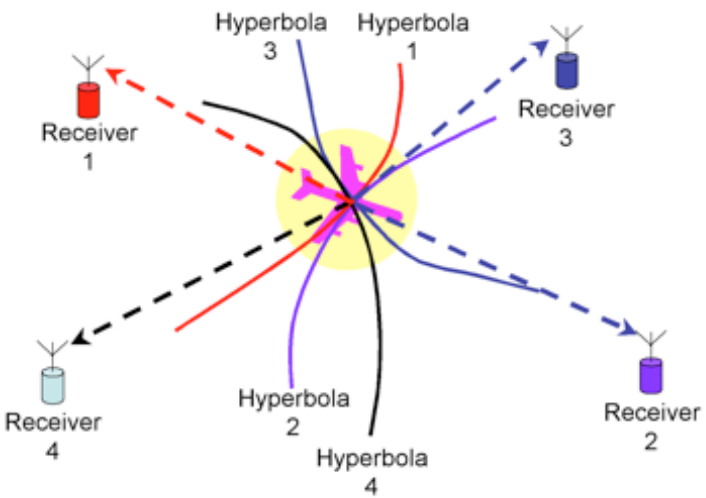
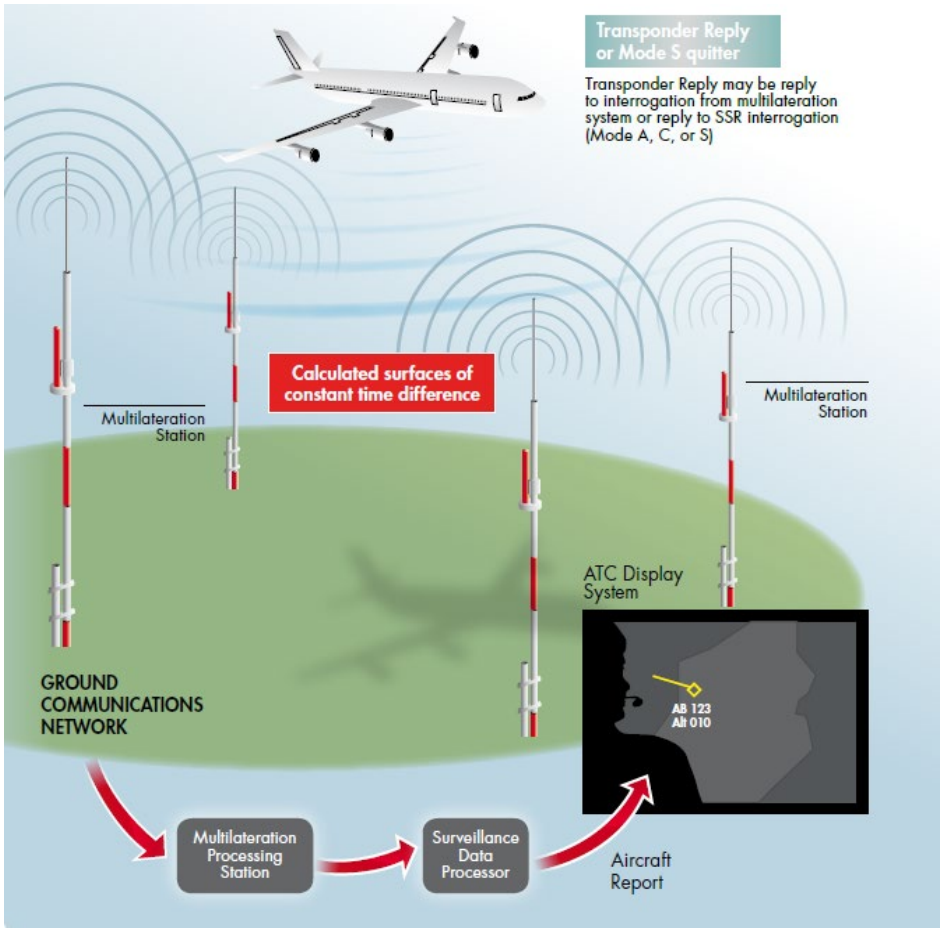
- Using Multilateration
- Based on principle of „Time Difference of Arrival“ TDOA





Systems: ADSL-Transponder

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- Technology used mostly in mayor airports replacing ground-movement radar
- Based on passive usage of 1090MHz signals
  - However, interrogators used in ATM-applications
  - No interrogators allowed in Germany to protect 1090 MHz bandwidth
- Complex receiver constellation required to provide acceptable ground coverage (at least 4-5 receivers to detect one target)
  - At least complex line-of-sight simulation required to provide sufficient coverage
- All aircraft flying during night-time must be equipped with transponder
- Identifying relevant aircraft using multilateration requires in-depth knowledge of receiver constellation and data-processing

Overall Results

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- All systems with pros and cons
- From an aviation perspective:
  - robust safety level using transponder signal strength, especially for mostly affected stakeholder
    - Good ground coverage due to 1090MHz antenna diagram
    - Military concerns mitigated by using additional infrared lights
  - Radar system works without a transponder
    - No onboard equipment required, no dependencies
    - Disturbances for (ground-) coverage due to clutter
    - Each installation requires specific frequency
  - acceptable detection-results using Multilateration possible
    - Requires accurate planning and local verification process of receiver configuration to provide acceptable coverage

Development ADSL – ICAO

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- Aerodrome Design Manual Part 4 (ADM4)
  - Guidance Material for obstacle lighting
- Draft-regulation 2017 excluding ADSL-Transponder (never published)
  - Based on German „AVV“ from 2015
- Amended draft-regulation VAWG 18/19 including ADSL-Transponder
  - Based on German Safety-Case
  - Accepted by ADOP
- New ADM4 published in 2021
  - Regulatory framework for the implementation of ADLS-Transponder/Radar

Development ADSL – ICAO

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a) autonomous;

b) capable of detecting an aircraft prior to entering a volume of airspace, or coverage area, around the obstacle (or group of obstacles);

c) capable of detecting an aircraft prior to a specified time or distance which is sufficient for the pilot to recognize activation of the lighting and initiate a turn which enables avoidance of the object(s) by the required horizontal separation distance; and

d) capable of turning the lights on in the event of a failure of the detection system.

e) transponder-based systems can only be used when all affected aircraft within a three-dimensional volume of airspace, or coverage area, around the obstacle or group of obstacles are equipped with a transponder

Note: If an aircraft detection system is used to turn the obstacle lights on and off, affected pilots should be informed via appropriate means (e.g. Aeronautical Information Publication, VFR-charts)

Any questions?

Implementation Process Germany

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- Certification of Systems/Manufactures by notified body from Federal Ministry of Transport
- Intensive Assessment of:
  - Development process
  - Used technology
  - Quality assurance
  - Fail-Safe concept
  - Flight-test-Campaign

$\Rightarrow$ Certificate for generally accepted system

$\Rightarrow$ Local implementation process (site analysis) required

Implementation Process Germany

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- Site Analysis includes:
  - Analysis of affected Flight-Operations (e.g. flight procedures, aerodromes, heliports)
  - Coverage analysis of affected airspace volume (e.g. line-of-sight simulation, flight test campaign)
  - Technical analysis (e.g. obstacle-lights system architecture, interfaces
  - Verification of proper installation process