

Stealth Technologies to Reduce the Impact of Wind Turbines on Radar Systems

Tu Delft, *Electromagnetic Waves and Wind Turbines 2018*
6-7 December 2018
QINETIQ/18/04489

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Contents

- Background
- The problem
- Mitigation options
- Stealth wind turbines
 - Technologies
 - Strengths and weaknesses
 - Proven performance
 - Case study



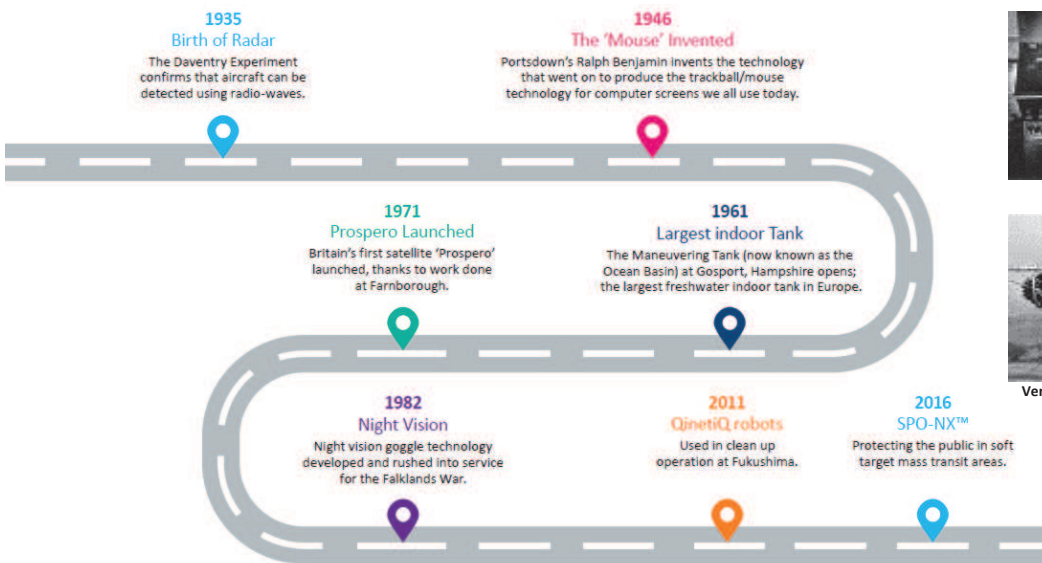
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Background

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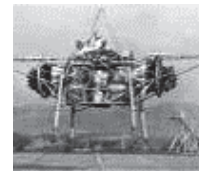
Background: QinetiQ



Radar



Thermal Imaging



Vertical Take Off and Landing flight



Carbon Fibre



Liquid Crystal Display

This slide relates to QinetiQ and predecessor companies.

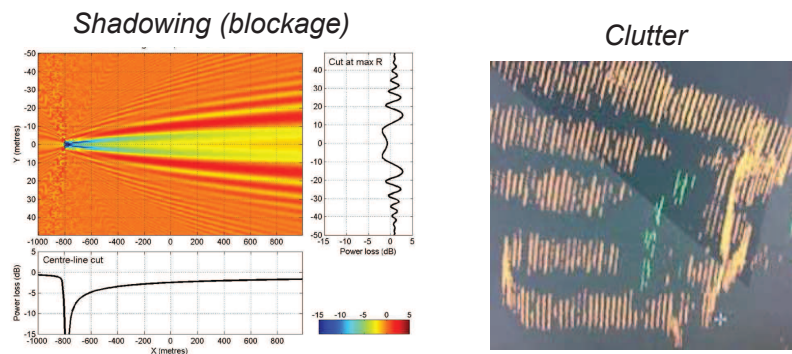
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The problem

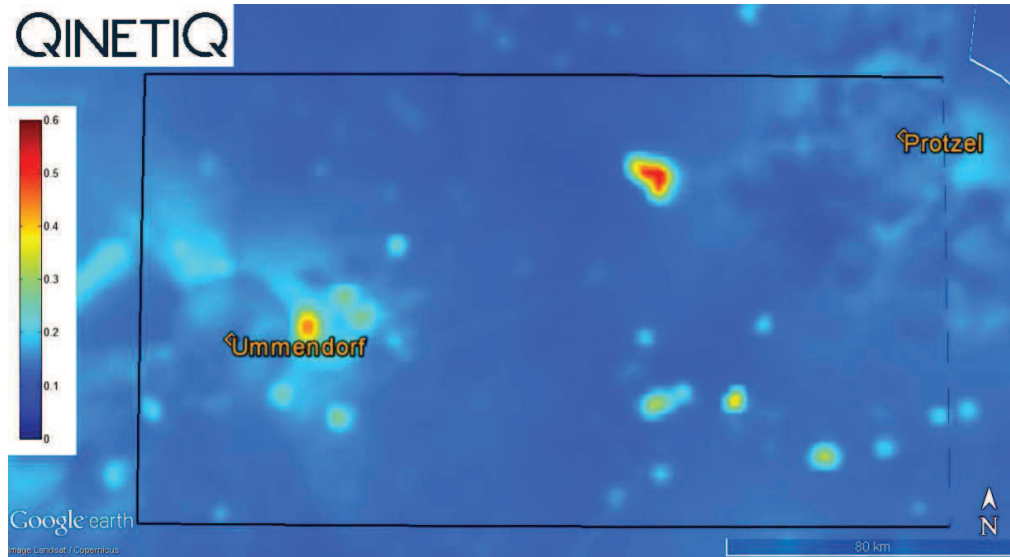
The problem

- Wind turbines can have an unwanted impact on radar systems (and other systems)
- Main impacts are clutter and shadowing



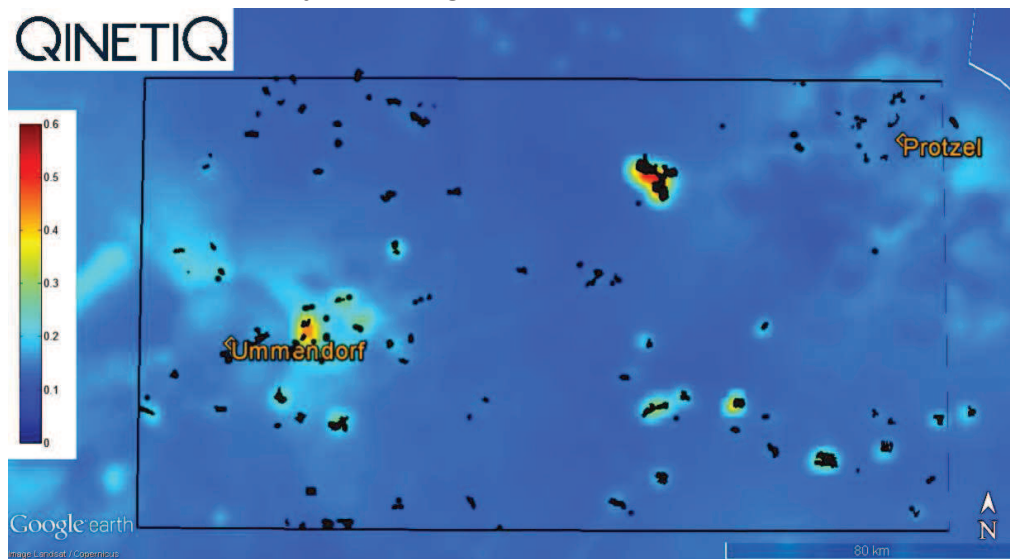
The problem

- Clutter example – Germany – average rain data



The problem

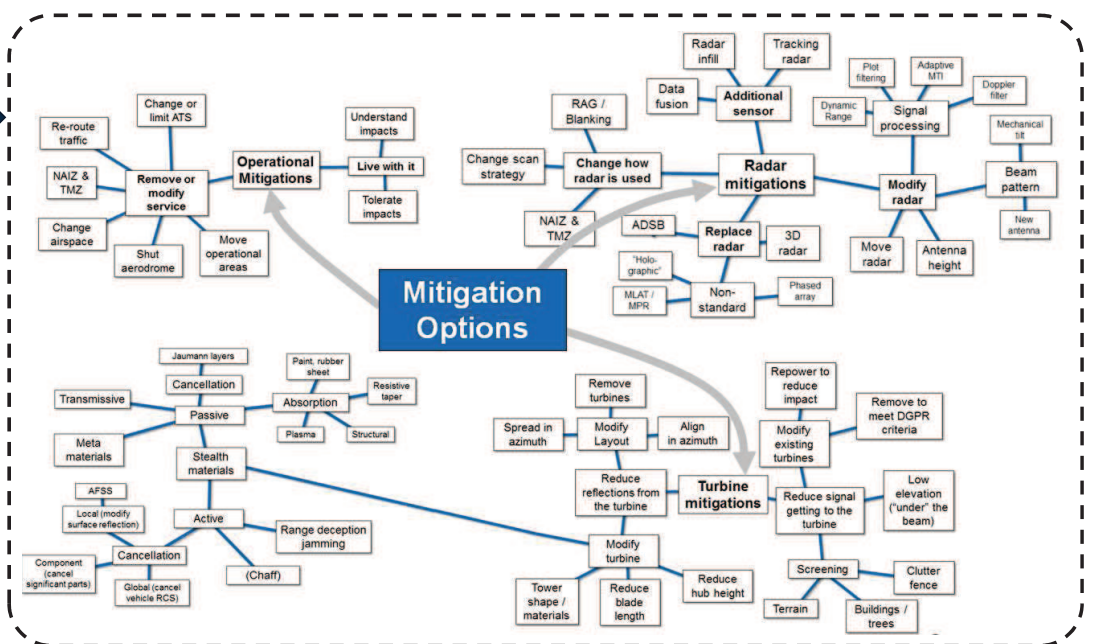
- Clutter example – Germany – average rain data + turbines



Mitigation options

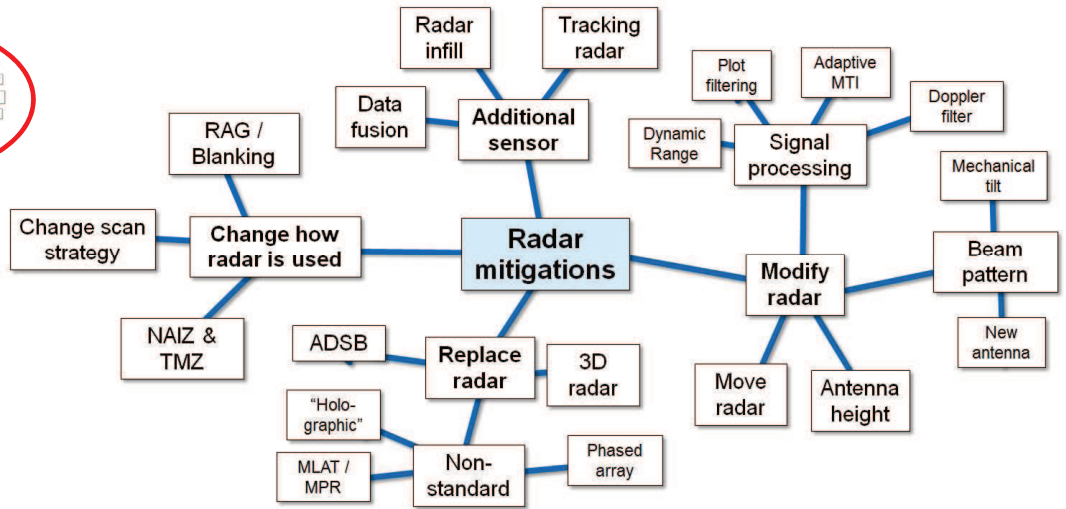
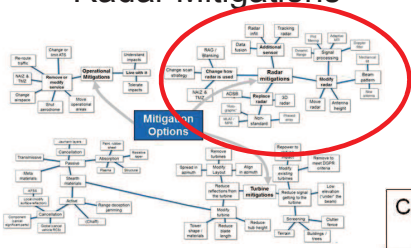
Mitigations

- There are many options →
- Why do we need to consider stealth?



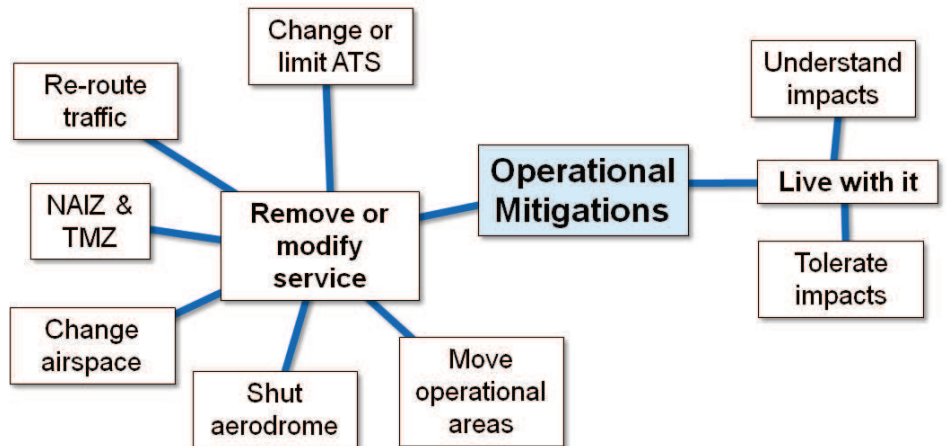
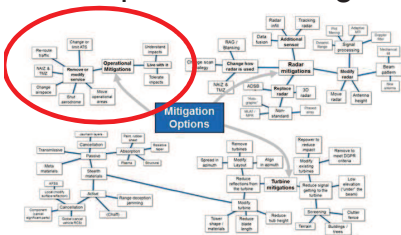
Mitigations

- Radar Mitigations



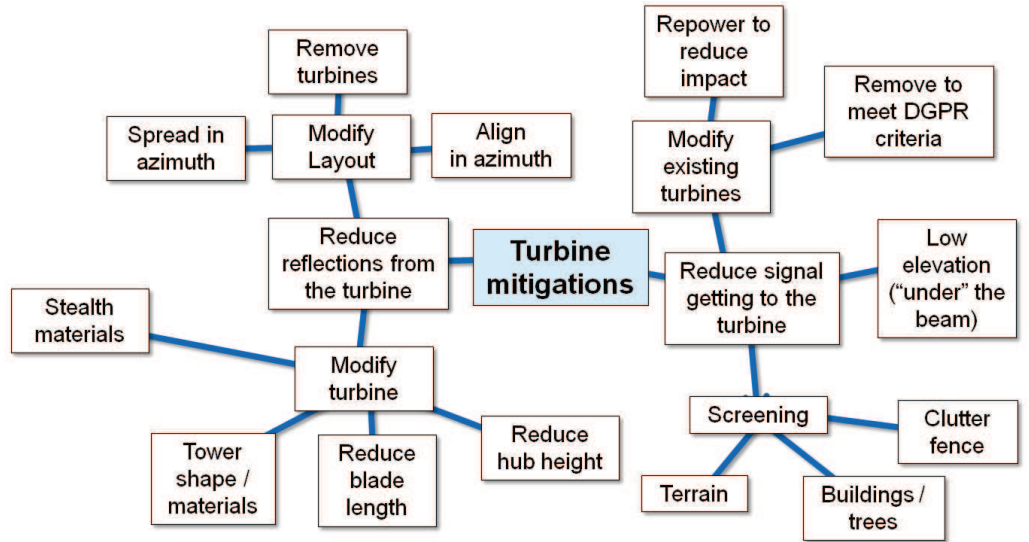
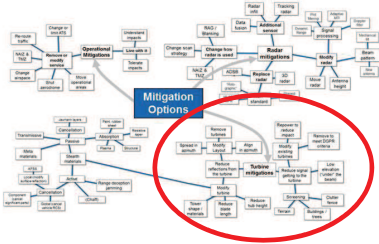
Mitigations

- Operational Mitigations



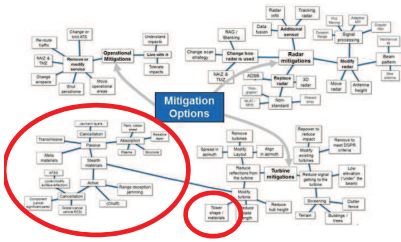
Mitigations

- Turbine Mitigations

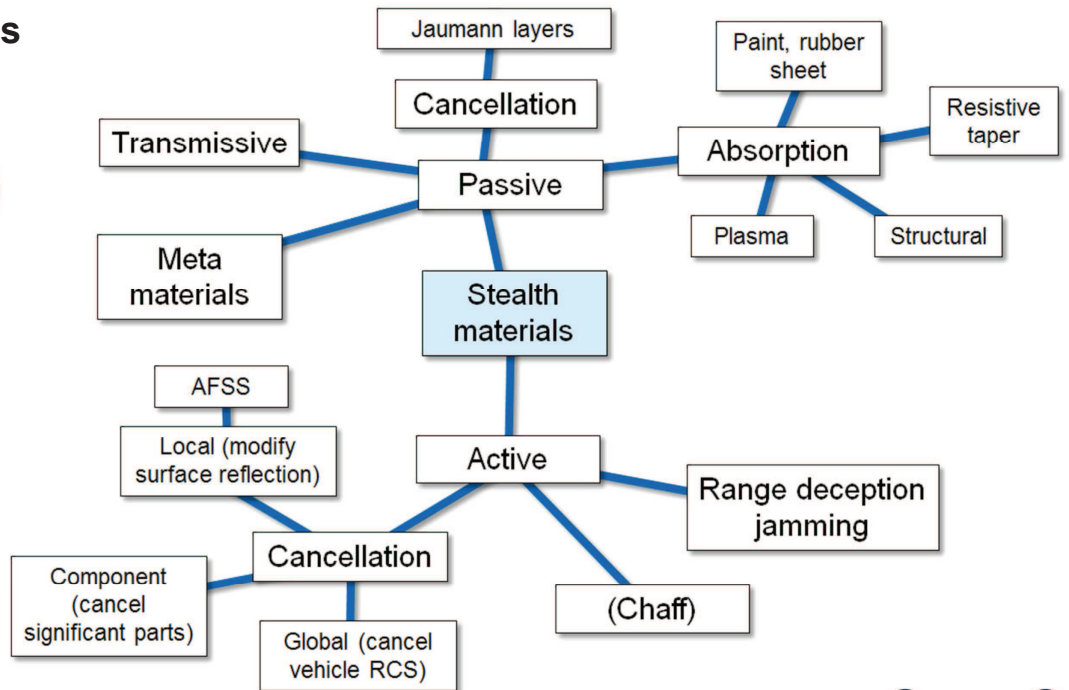


Stealth: technologies

Stealth

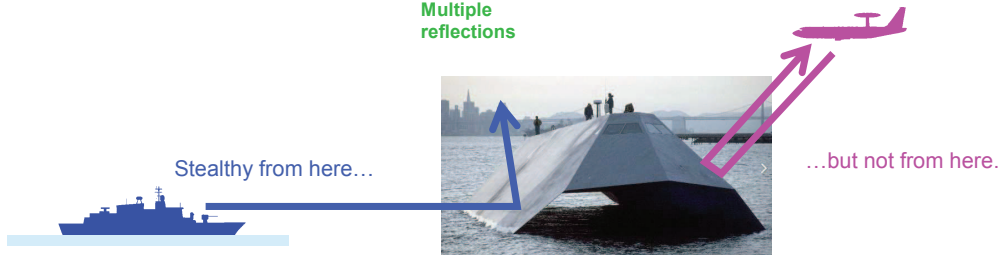
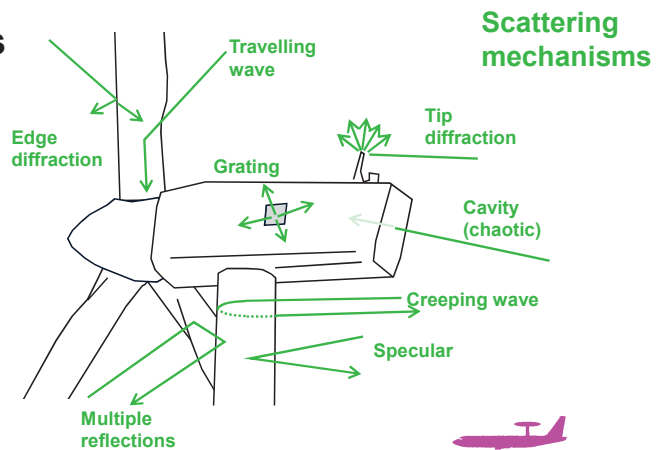


Includes tower & nacelle shaping. Not practical to change shape of blades



Stealth: Strengths and Weaknesses

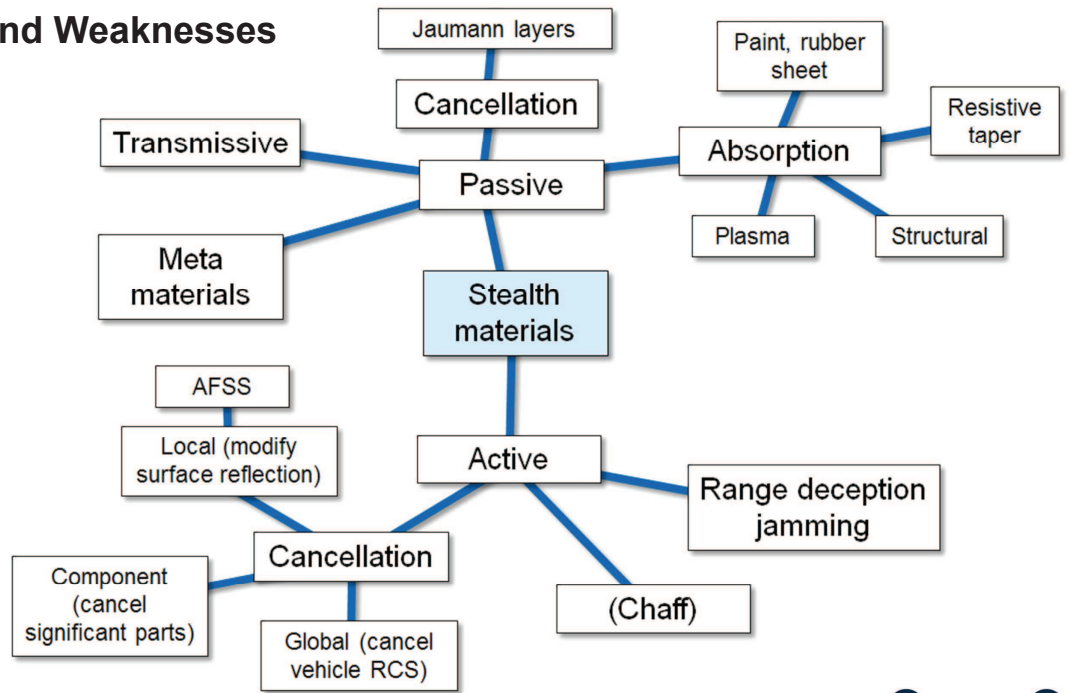
- There are many scattering mechanisms
- Difficult to reduce RCS of them all
- Shaping
 - Good for towers & nacelles
 - Not good for blades (cannot change aerofoil; viewed from all angles)
- Materials...



[1] https://en.wikipedia.org/wiki/Stealth_ship

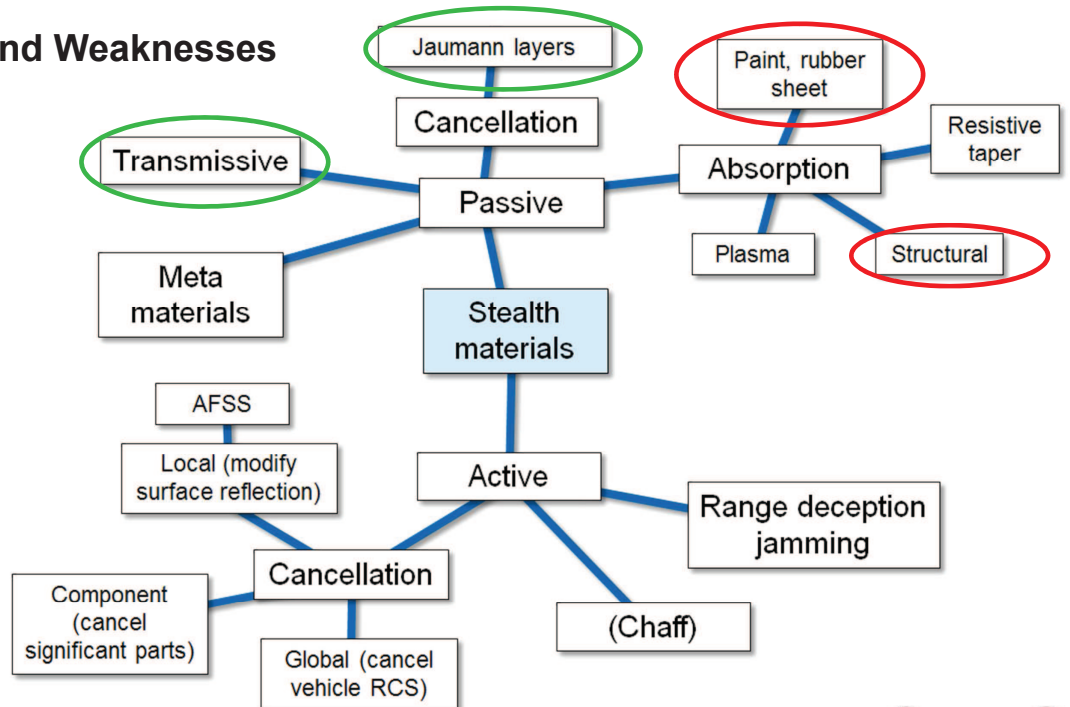
Stealth: Strengths and Weaknesses

- What are the strengths and weakness of each option?
- Examples follow – not exhaustive, just for illustration



Stealth: Strengths and Weaknesses

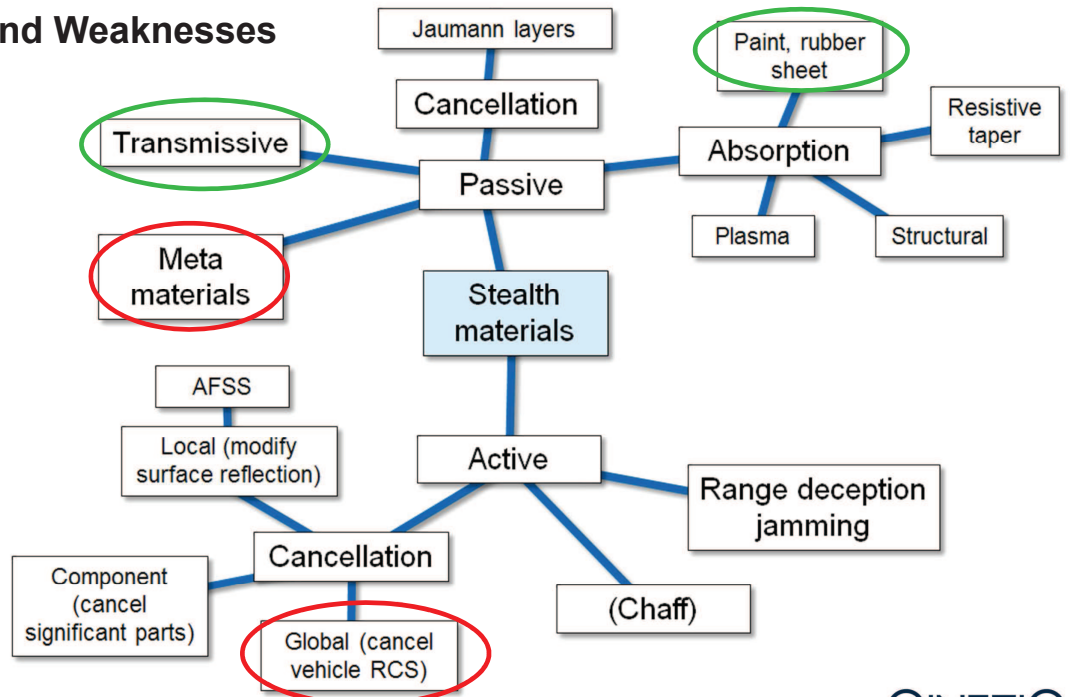
- Weight...



- Example strength
- Example weaknesses

Stealth: Strengths and Weaknesses

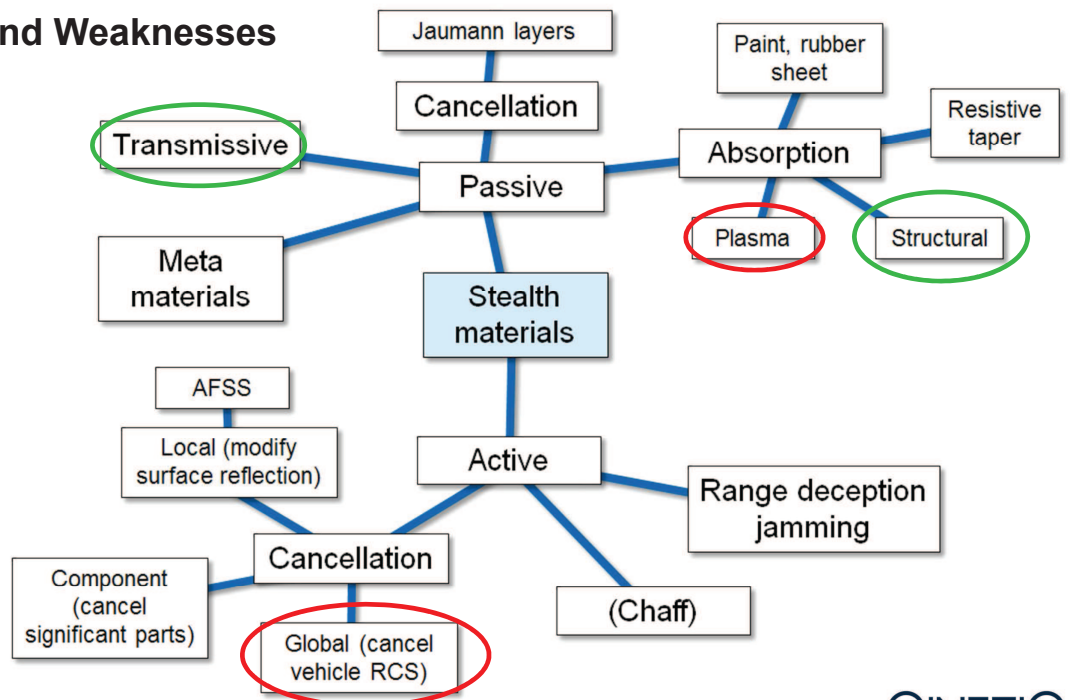
- Weight
- Complexity...



○ Example strength
 ○ Example weaknesses

Stealth: Strengths and Weaknesses

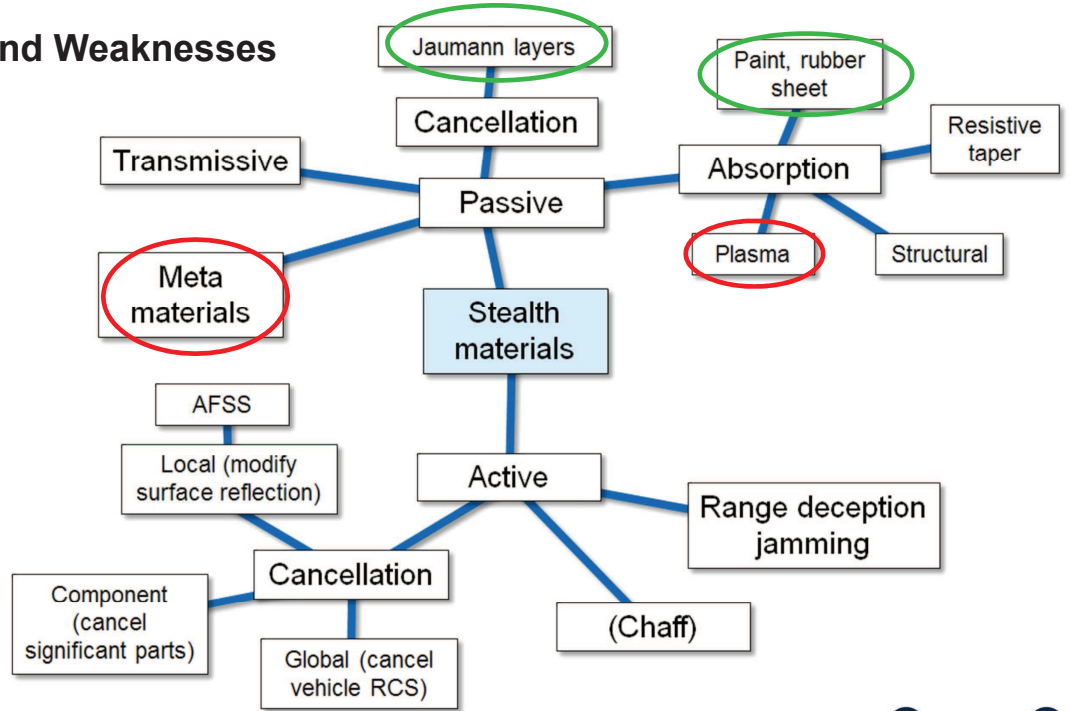
- Weight
- Complexity
- Maturity...



○ Example strength
 ○ Example weaknesses

Stealth: Strengths and Weaknesses

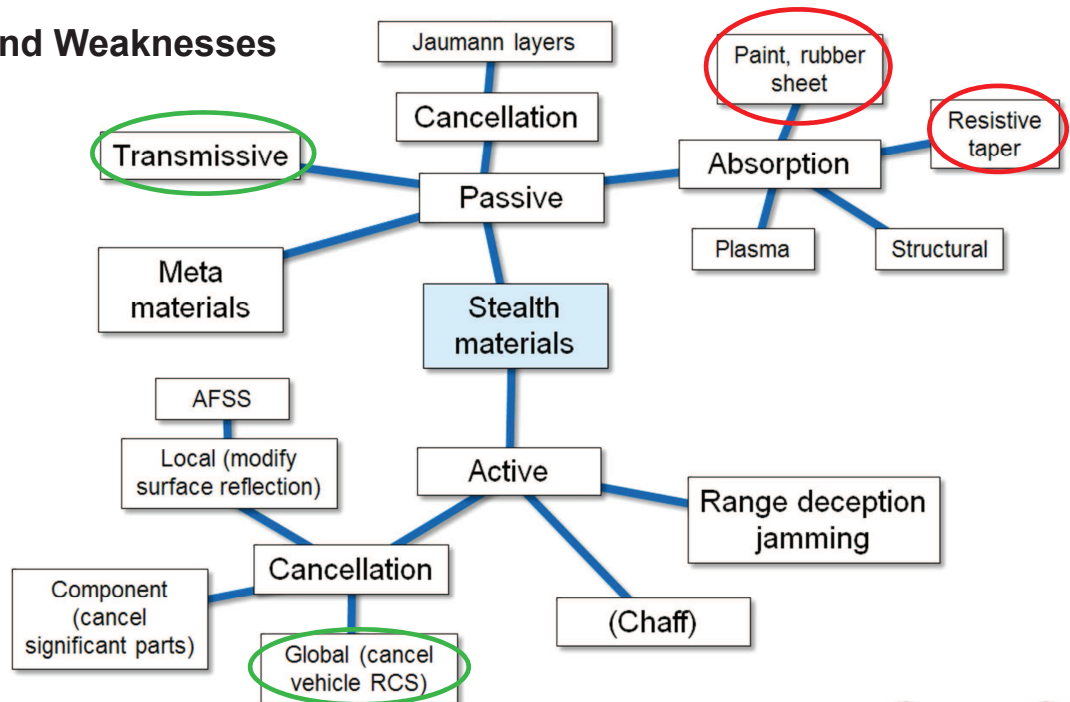
- Weight
- Complexity
- Maturity
- Cost...



○ Example strength
 ○ Example weaknesses

Stealth: Strengths and Weaknesses

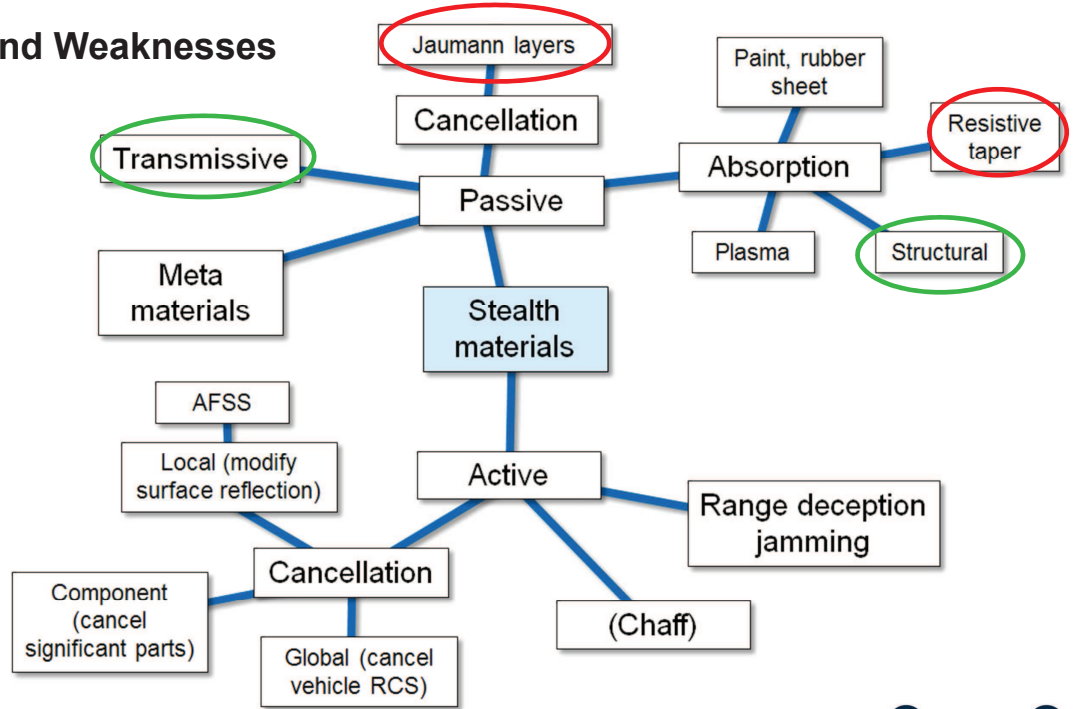
- Weight
- Complexity
- Maturity
- Cost
- Performance...



○ Example strength
 ○ Example weaknesses

Stealth: Strengths and Weaknesses

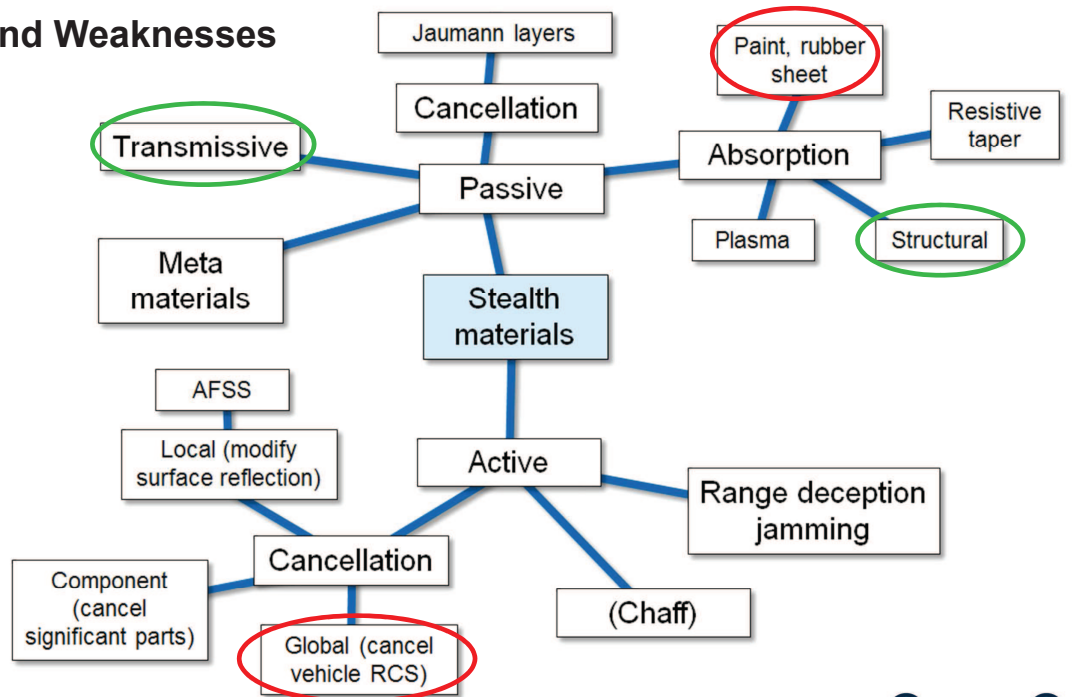
- Weight
- Complexity
- Maturity
- Cost
- Performance
- Bandwidth...



○ Example strength
 ○ Example weaknesses

Stealth: Strengths and Weaknesses

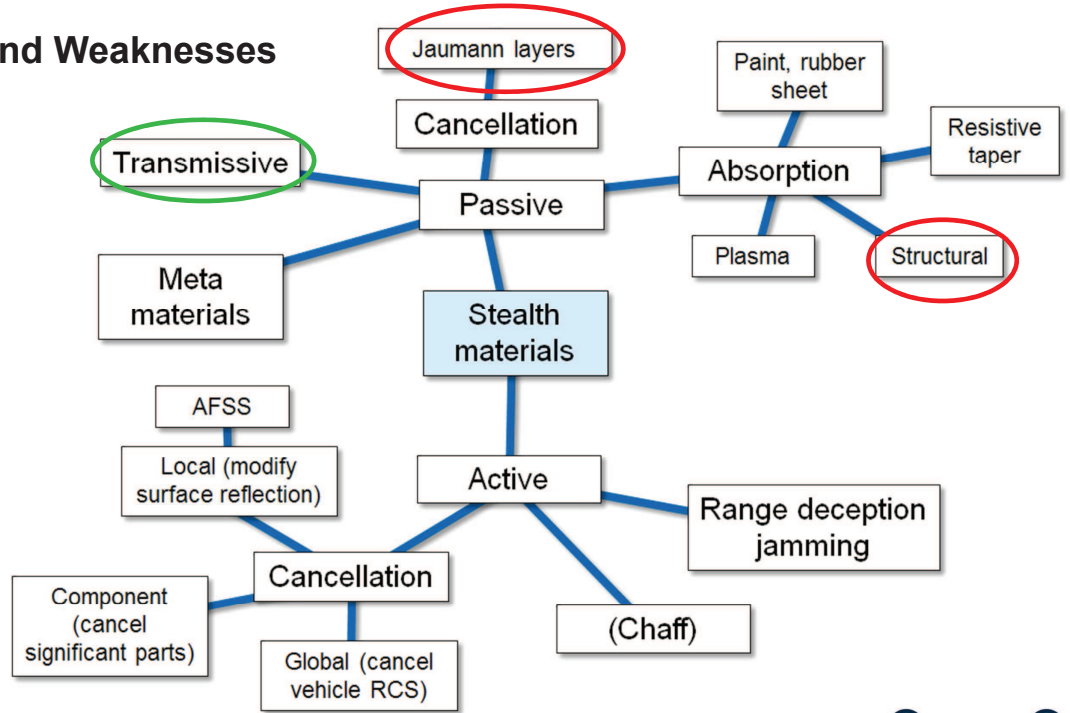
- Weight
- Complexity
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- Cost
- Performance
- Bandwidth
- Maintenance...



○ Example strength
 ○ Example weaknesses

Stealth: Strengths and Weaknesses

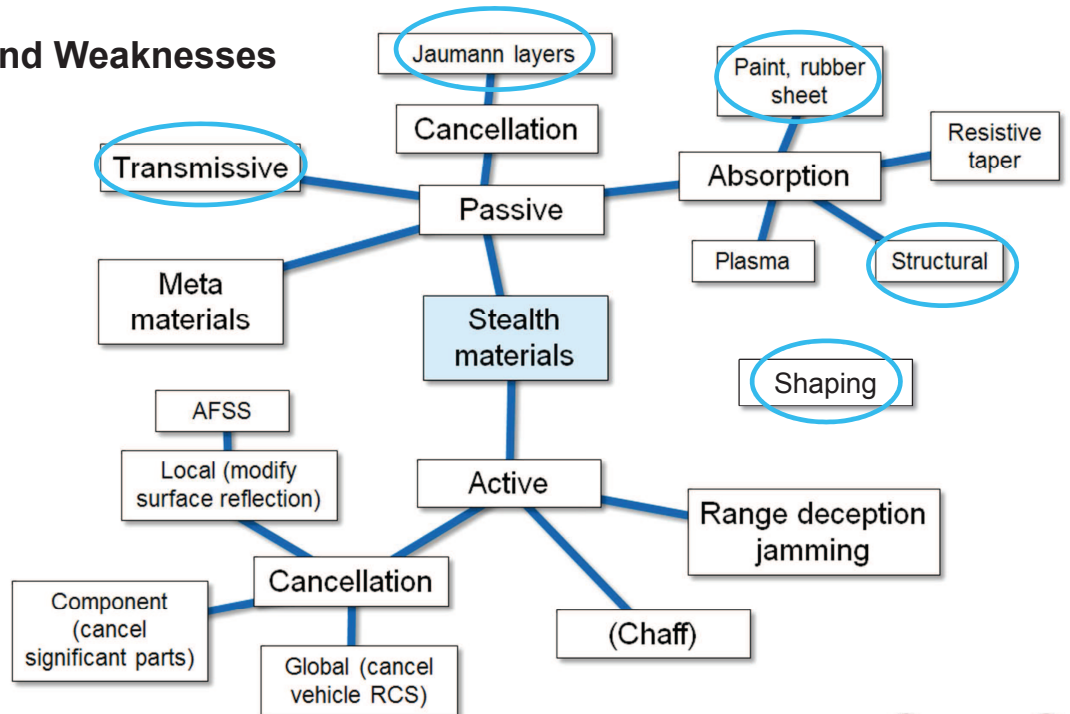
- Weight
- Complexity
- Maturity
- Cost
- Performance
- Bandwidth
- Maintenance
- Shadowing...



○ Example strength
 ○ Example weaknesses

Stealth: Strengths and Weaknesses

- What is practical?
- QinetiQ is aware of these: perhaps others?



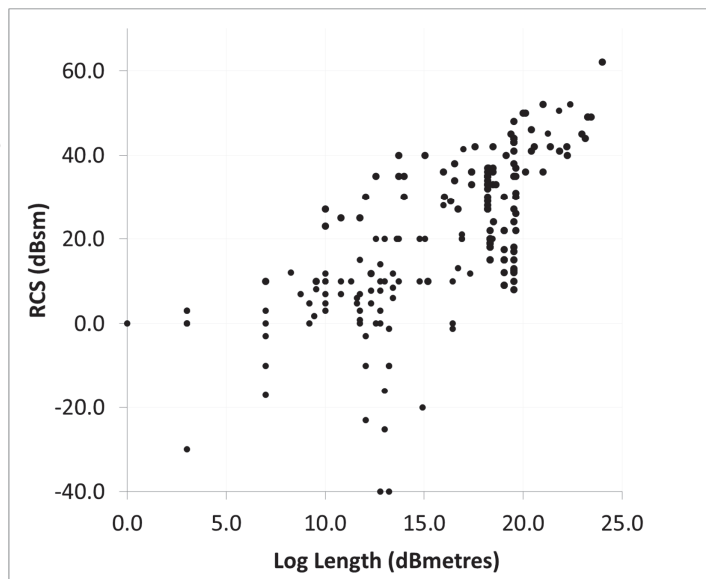
○ Practical / proven



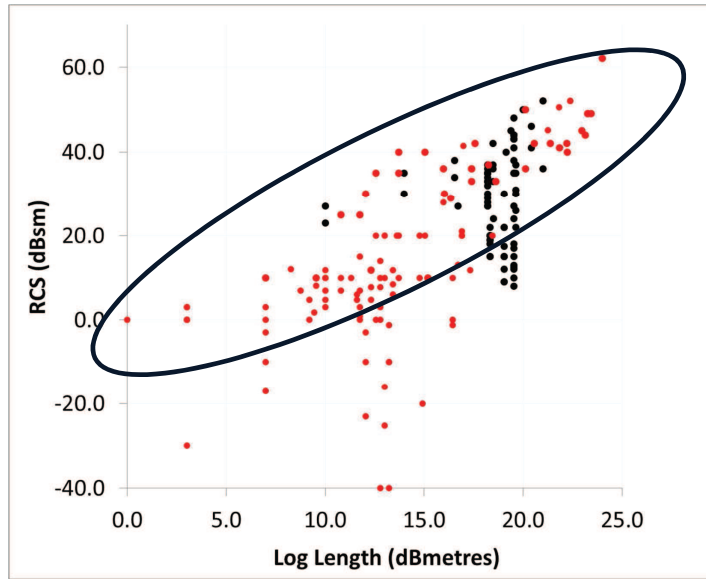
Stealth: RCS

Stealth: proven performance

- Data from QinetiQ database. Maximum and “average” values for aircraft, ships, wind turbines
- Caution: mix of frequencies, methods, polarisation, angles, elevations

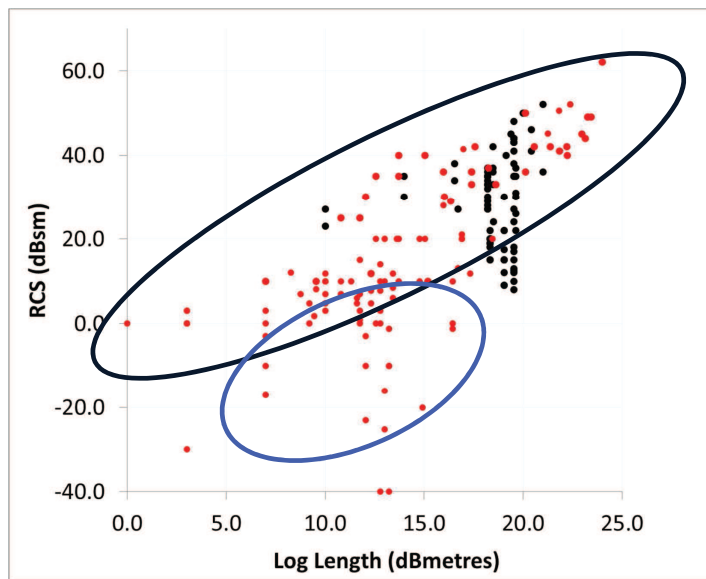


- Conventional aircraft and ships



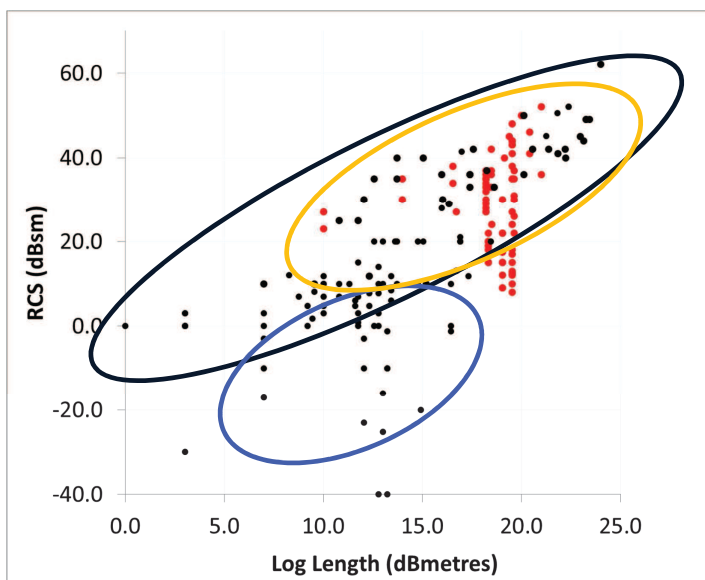
- Black dots = wind turbines
- Red dots = aircraft & ships

- Conventional aircraft and ships
- Stealth aircraft and ships



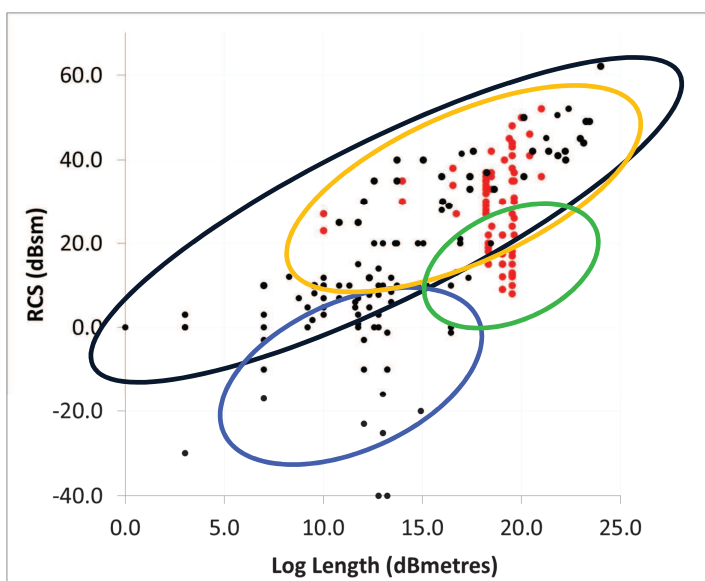
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- Conventional aircraft and ships
- Stealth aircraft and ships
- Conventional wind turbines



- Black dots = aircraft and ships
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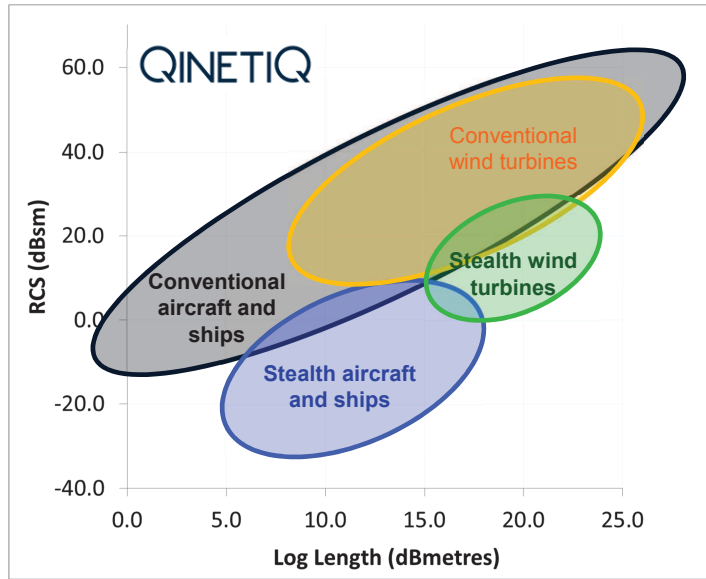
- Conventional aircraft and ships
- Stealth aircraft and ships
- Conventional wind turbines
- Stealth wind turbines



- Black dots = aircraft and ships
- Red dots = wind turbines

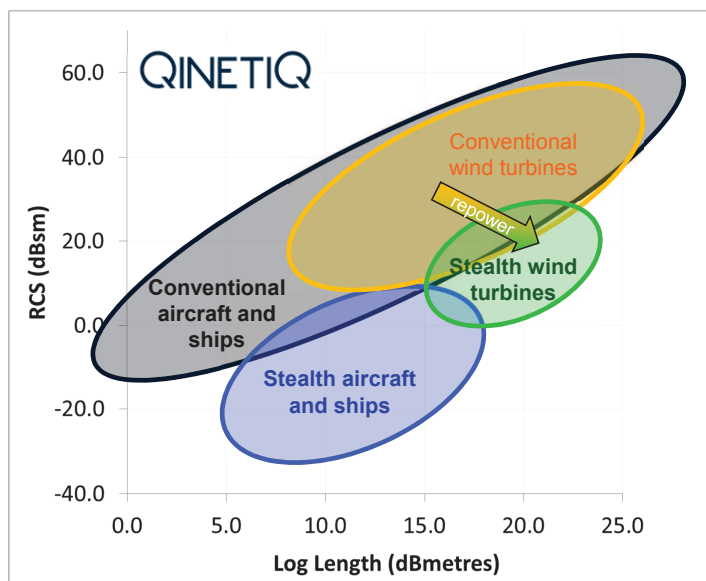
Summary

- Can apply same technology to turbines as used for aircraft and ships
- Similar performance achieved: reduction, not “invisible”
- RCS is a distribution, not a single value



Summary

- Can apply same technology to turbines as used for aircraft and ships
- Similar performance achieved: reduction, not “invisible”
- RCS is a distribution, not a single value
- Can repower with larger turbines with no increase in RCS

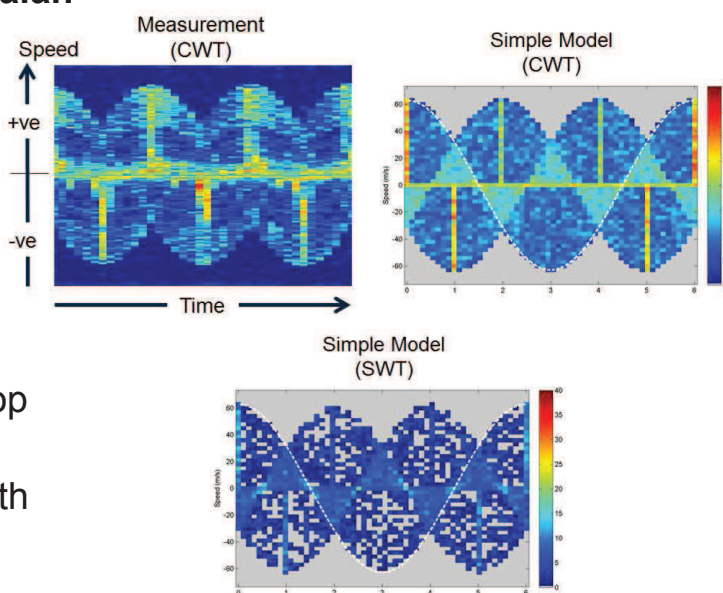




Case Study: Ensemble Eolien Catalan

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- Proposed EDF EN windfarm, Perpignan, south of France
- Meteo France prescribed acceptable level of interference
- Project not viable with conventional turbines
- QinetiQ Stealth Wind Trubine (SWT) technology used to develop turbines
- Operational turbines validated with measurement



Case study: Ensemble Eolien Catalan

- World-first stealth wind farm opened in 2016 (EDF EN Ensemble Eolien Catalan wind farm, France)
- 96MW – 35 stealth turbines
- All turbines use QinetiQ SWT technology to mitigate impact on nearby weather radar (S band – 2.8GHz)



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