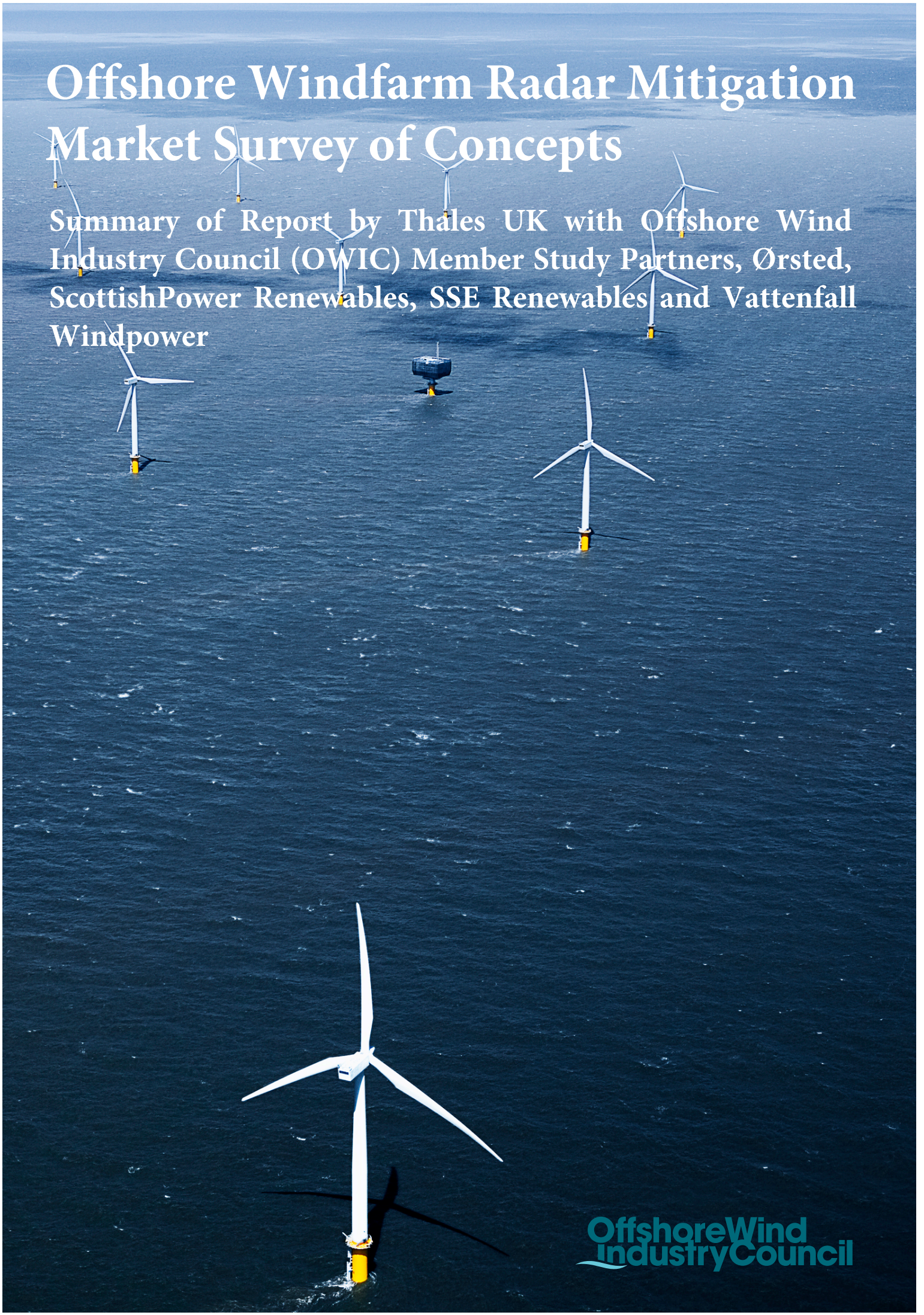
Offshore Windfarm Radar Mitigation Market Survey of Concepts

Summary of Report by Thales UK with Offshore Wind Industry Council (OWIC) Member Study Partners, Ørsted, ScottishPower Renewables, SSE Renewables and Vattenfall Windpower



Offshore Wind Industry Council

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Foreword

In the Strategy and Implementation Plan Issue 1, Annex A provides a Summary of Paper Based Studies. One of these studies is the "Windfarm Mitigation Request for Information Report, Air Defence Radar Market Survey", undertaken by Thales UK on behalf of Orsted, ScottishPower Renewables (SPR), SSE Renewables (SSE-R) and Vattenfall Wind Power (VWP), the four initial and voluntary members of the OWIC Aviation Task Force (ATF).

The study was presented as one of three paper-based studies to the Joint Task Force (JTF) in Spring 2020, co-chaired by Wing Commander Kevin Walton of the Royal Air Force and Dujon Goncalves-Collins, the OWIC Workstream Lead of VWP. The study explores novel and innovative ideas, not just focusing on technical performance or market readiness of radar systems, but uniquely operating concepts of such technologies. This includes varying onshore and offshore deployment concepts.

In the spirit of sharing knowledge from the UK experience and supporting learning across the offshore wind sector and stakeholders, this Summary is released as a supporting document to RenewableUK's Wind & Aviation event at the Royal Air Force Club, London on 24-25 May 2022.

It is hoped that attendees of the event, as well as wider readers that access this document from the OWIC website, find this a useful resource and reference for their future work, not only in the UK but further afield across Europe and across the globe.

The OWIC ATF wish to thank the study partners for their work in completing this study and sharing the Summary, and all those across the stakeholder group that engaged with the it.

If you have any comments and suggestions on next steps, please do get in touch with Head of Aviation at RenewableUK (info@RenewableUK.com).

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Windfarm Radar Mitigation

Market Survey of Concepts

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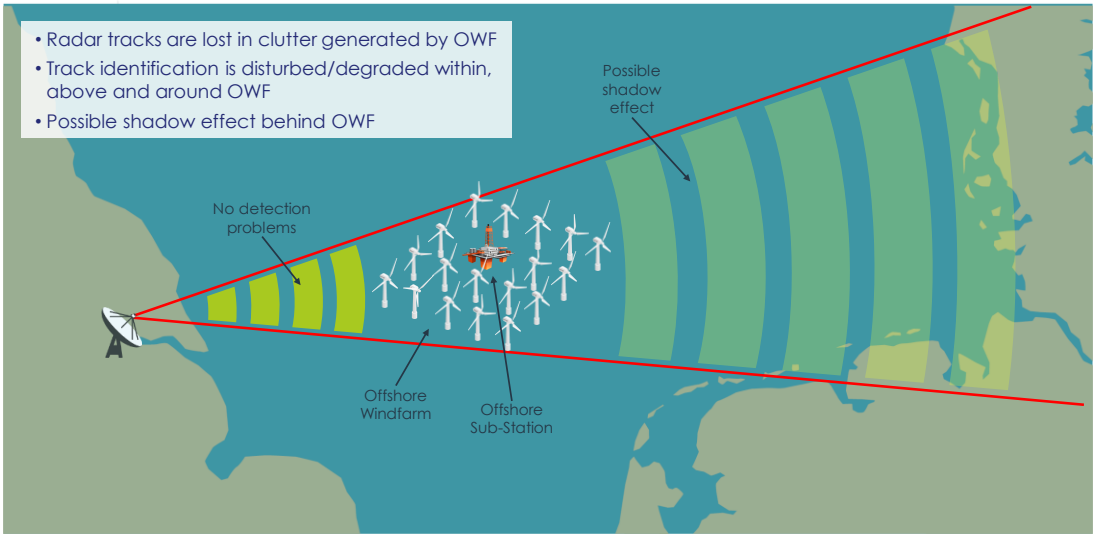
Concept Development: Understanding the issue…



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Market Survey Context and Evolution

Origin

- Purpose was to provide basis for dialogue by study partners with stakeholders on what air defence radar mitigation concepts and solutions exist.

Process

- Study used a combination of expert knowledge and evidence-based information to examine viable offshore windfarm mitigation solutions either currently available or that could be quickly adapted to become deployable solutions.
- A range of operating concepts were evaluated and matched to typical solutions.

Inputs

- A RFI was issued to elicit responses from a variety of solution providers: a few responded. Expert assessment of a range of products was conducted and combined with RFI responses.

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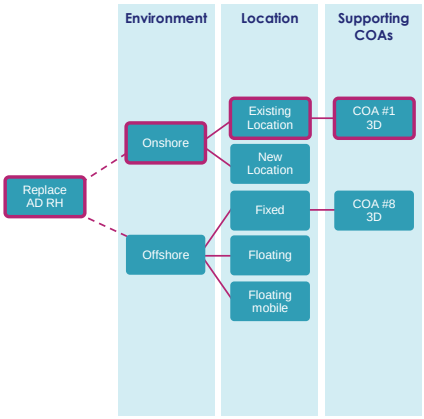
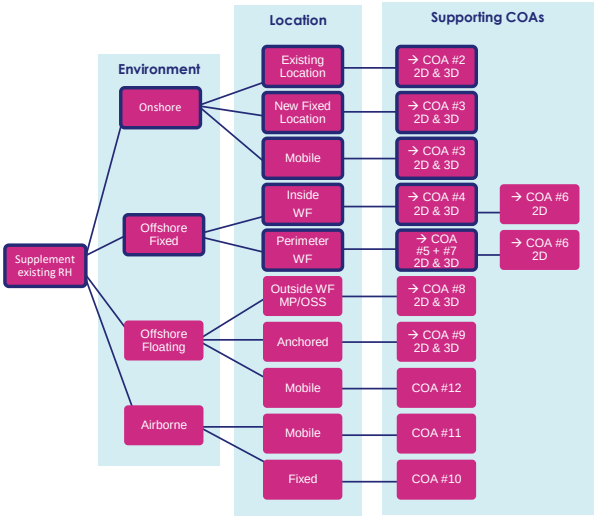
Operating Concept Evolution

A broad selection of application concepts were envisaged

The set that were evaluated are outlined below





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RADAR CLASSES

Radars were grouped into Classes by generic system characteristics

- To avoid specific product bias or product-specific features

Classes and typical products:

- **Long Range Air Defence (LR AD)**
- **Active Electronically Scanned Array LR AD**
- **Medium Range Air Defence (MR AD)**
- **Active Electronically Scanned Array MR AD**
- **2D Short Range Primary Surveillance Radar (2D SR PSR)**
- **Dual-beam Medium Range Primary Surveillance Radar MR PSR**
- **Dual-beam Short Range Primary Surveillance Radar SR PSR**
- **Staring 3D**

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Solution Down-Selection Diagram

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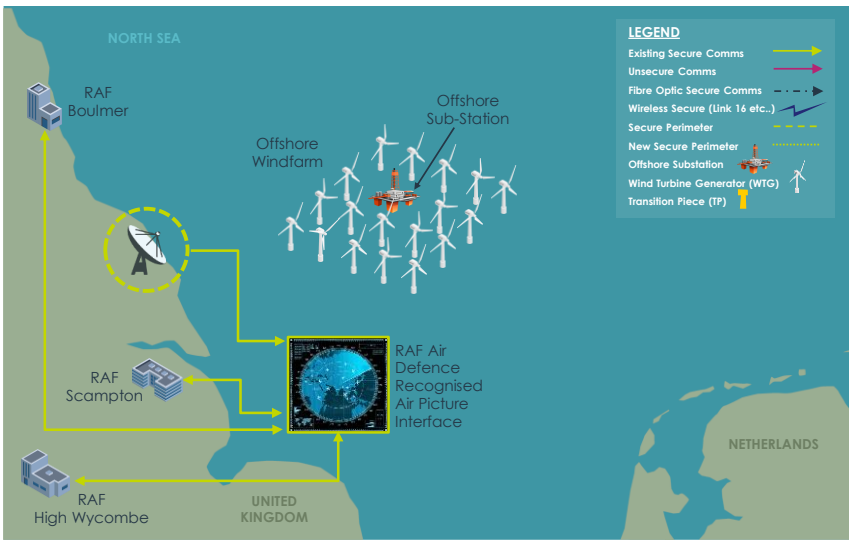
Concept Onshore: Replacement of Radar Head



CONCEPT

Replacement of radar head with wind farm tolerant radar

- On existing RAF property
- Existing secure communication infrastructure
- Radar sensor give input to RAF Air Defence
- Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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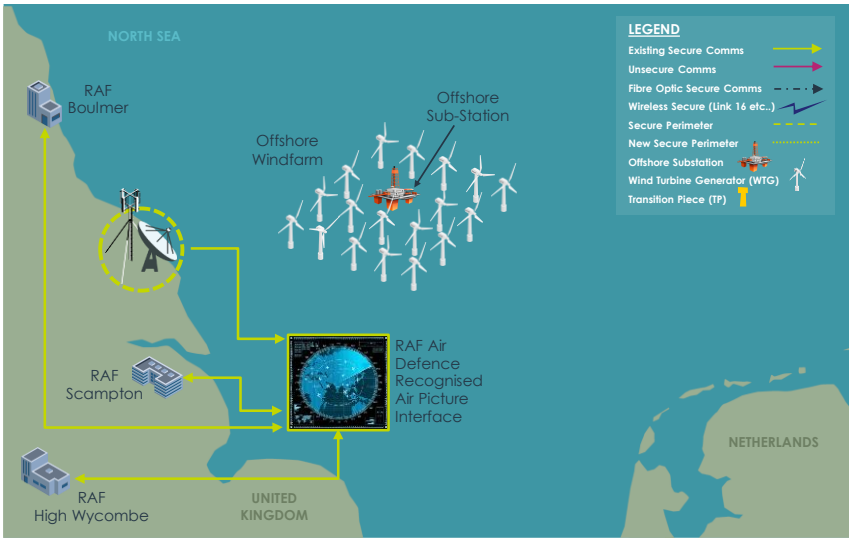
Overview: Onshore - Additional Radar System adjacent to existing system



CONCEPT

Place additional radar next to existing radar mitigating OWF degradation

- On existing RAF property
- Existing secure communication infrastructure
- Radar sensor give input to RAF Air Defence Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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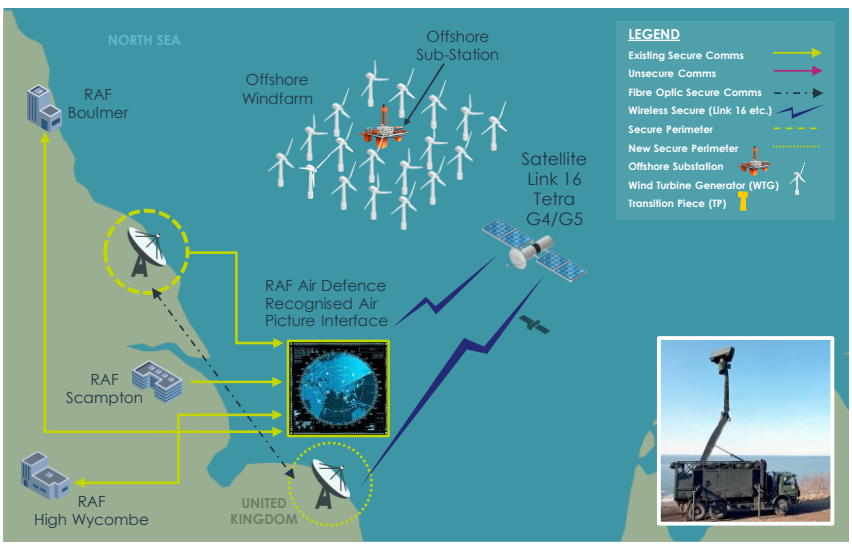
Overview: Onshore - Additional Radar System outside RAF Perimeter



CONCEPT

Infill radar on new location or multiple mobile locations

- On new site either permanent or deployable
- Using secure wireless comms or new communication infrastructure
- Radar sensor give input to RAF Air Defence
- Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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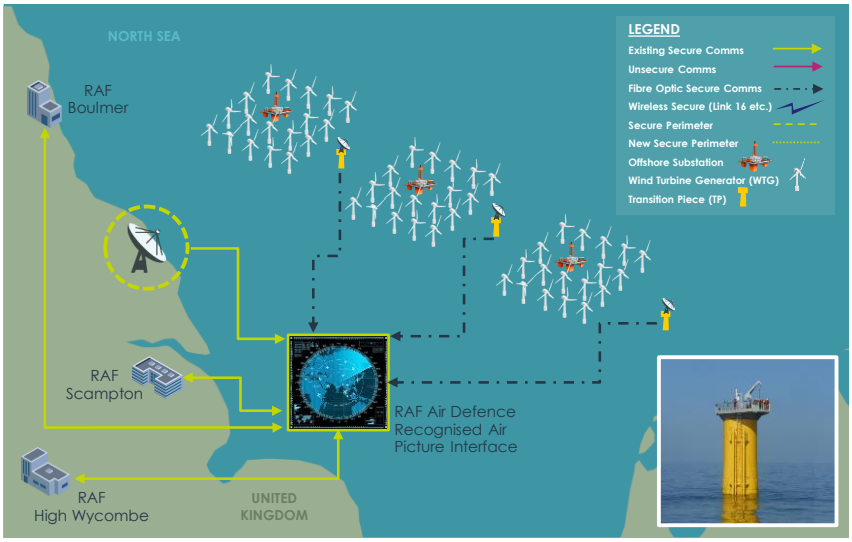
Overview: Offshore - Radar System located distant from OWF



CONCEPT

- Dedicated sensor/radar MP/TP placed outside OWF with no interference from OWF
- Radar sensor give input to RAF Air Defence Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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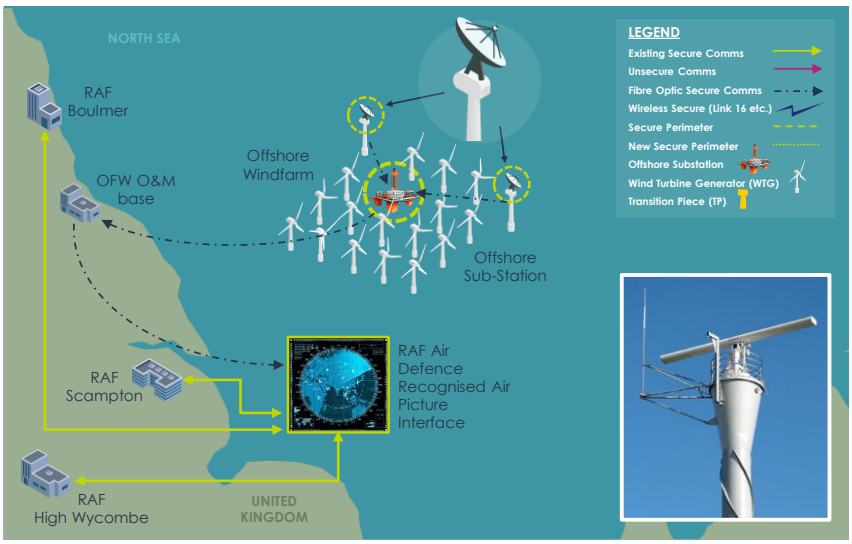
Overview: Deploy radar on stand-alone tower within windfarm environs



CONCEPT

Location of radar system on WTG

- Radar installed on tower
- Red secure server room allocated radar feed on OSS
- Allocated secure fibre allocated radar feed in export cable
- Radar sensor give input to RAF Air Defence
- Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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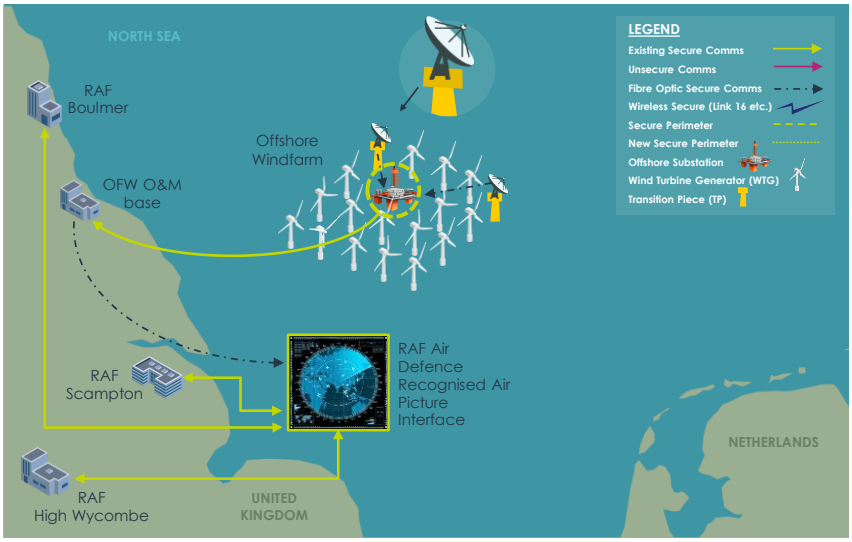
Overview: Deploy radar on stand-alone foundation/TP within windfarm



CONCEPT

Deploy radar head or radar system on standalone WTG foundation

- Red secure server room allocated radar feed on OSS
- Allocated secure fiber allocated radar feed in export cable
- Radar sensor give input to RAF Air Defence
- Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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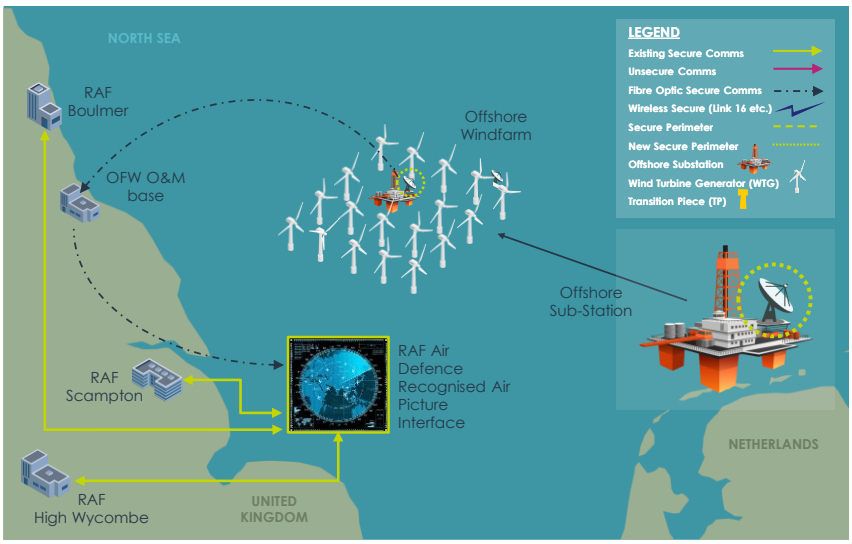
Overview: Radar System Located at Offshore Substation



CONCEPT

Location of radar system on OSS

- Radar installed on OSS
- Red secure server room allocated radar feed
- Allocated secure fiber allocated radar feed in export cable
- Radar sensor give input to RAF Air Defence
- Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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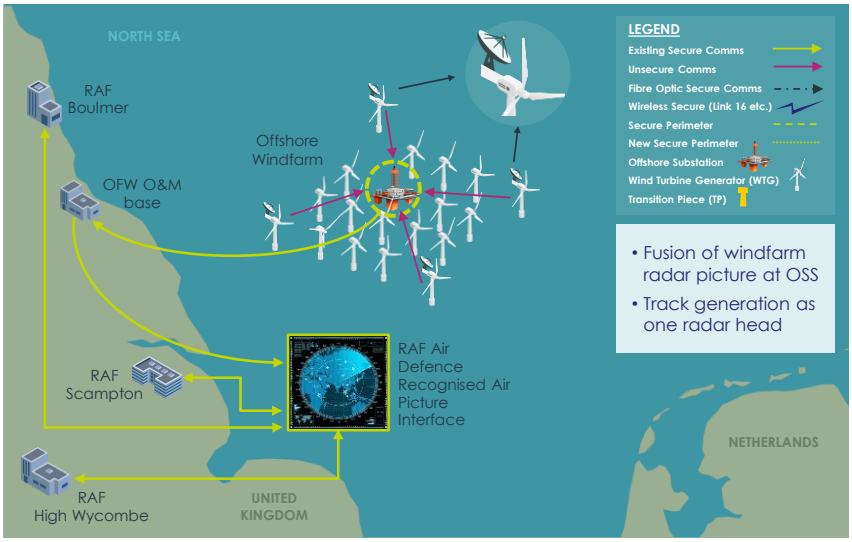
Overview: Deploy multiple civilian off-the-shelf radars to the WTG tower or Nacelle



CONCEPT

Deploy COTS radar on WTG Tower or Nacelle

- Multiple civilian low-tech radars (Swarm concept) i.e. multiple COTS radars on multiple WTG/TP merging picture at OSS as one radar image sending it to RAF RAP Interface (Asterix/Guardian)
- Allocated unsecure fiber radar feed in array and secure fiber in export cable
- Radar sensor give input to RAF Air Defence
- Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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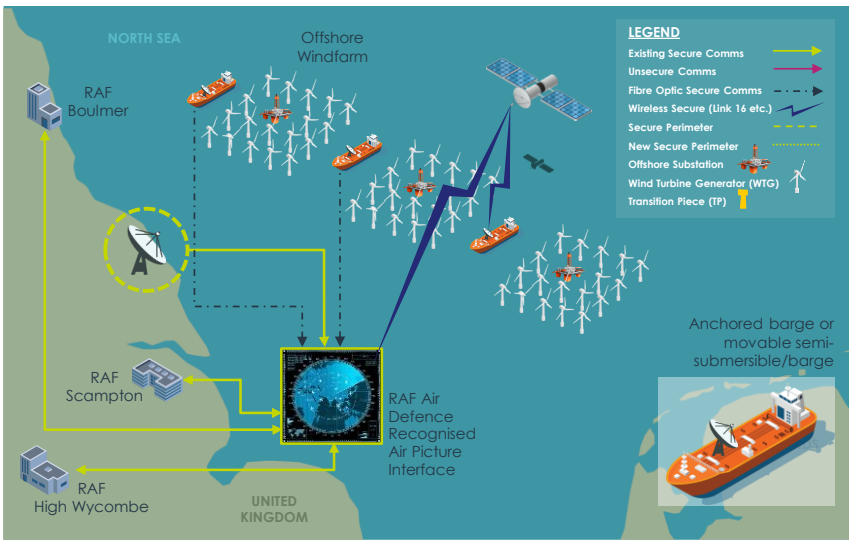
Overview: Floating



CONCEPT

Anchored barge or movable semi-submersible/barge

- Communication via secure fiber or wireless link
- Radar sensor give input to RAF Air Defence Recognised Air Picture (RAP)
- RAP distributed to RAF Boulmer, RAF Scampton and RAF High Wycombe

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Observations

Viable radar mitigation solutions exist

- They need to be formally tested and evaluated in environments that, crucially, include the concept of application of relevant technologies to increase confidence/reduce uncertainty. A range of solutions, including post-processing, may be required depending on local factors.
- Stakeholders should work together to agree relevance and priority weightings to facilitate consistent solution selection and to enable solution providers to target developments to best effect.

Apparent lack of formal technical and operational requirements

- An issue facing solution providers and broader industry is the apparent lack of formal technical and operational requirements. They should take into account not just the sensor performance but also the operating environment, threat assessments and the benefits that could arise from taking a holistic view of mitigation solution capabilities. They need to be agreed with stakeholders and industry, so that solution providers can be confident that development is relevant and beneficial.

Overall strategy

- A coherent national/regional strategy is needed to optimise the application of mitigation solutions and underpin the business case for their development. Without this, the case-by-case basis for specifying mitigation solutions will lead to an incoherent radar mitigation landscape.

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Thales conclusions and recommendations

The danger of the 'obvious solution'- 1:1 replacement with 'latest kit'

- Modern fully-digital software-defined radars should have the capability to mitigate the next generation of windfarms, **although no conclusive proof exists of this yet**. However the threat envelope and role requirements are changing rapidly **and such an approach may not be future-proof**.

Test and Evaluation phase – general recommendations

- Technology alone is not the only solution: **there is no 'silver bullet' to cover all cases and domains**. It is the *combination* of technology and application concepts which will produce the mutually beneficial outcomes that stakeholders seek. So test and evaluation should be conducted **in representative environments** that incorporate both candidate technologies and the most promising achievable application concepts.

Next Steps

- It is recommended to this continued evaluation it is recommended to **be aware of not only "legacy" concepts and solutions but also new ideas** in different environments i.e. offshore. Further it is recommended to consider willingness to evaluate degraded PD or 2D infill tracking for extended range or "over the horizon" detection using a "layered defence" approach.

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