

The background image shows an offshore wind farm in a deep blue sea under a clear sky. Several white wind turbines are visible, with one in the foreground being particularly prominent. In the center-right, there is a yellow and white service platform or supply vessel. The overall scene is industrial and maritime.

# Investigating the dependability of SDN-enabled IoT-Edge Networks for next-generation offshore wind farms

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# AGRIPPINA MWANGI

Marie Curie early-stage researcher in smart grid communication whose work focuses on the adoption of IoT/Cloud technologies in the design of next-generation smart grid OT networks. Has a background in telecommunications and electronic engineering with extensive industrial experience in enterprise-wide networks and SDN. Seeks to contribute to research in reliability evaluation and performance assessment of emerging communication network trends for smart grids.



Trained  
Telecommunication  
Engineer



Design resilient OT  
networks for extreme  
environments





# Innovative Tools for Cyber-Physical Energy Systems (InnoCyPES)

Data Acquisition Systems  
(ESR1 → WP1)

## CUTTING EDGE RESEARCH AND TRAINING FOR DIGITAL TRANSFORMATION OF THE ENERGY

The increasing volume, velocity, and variety of data from a massive number of dispersed "Internet of things" sensors in the energy system offers opportunities for improved operational efficiency and reliability – but it also results in threats in the form of computational burden and cyber-attacks.

The transformation towards a fully digitalized energy system requires substantial improvements in coordinated design of cyber and physical systems, end-to-end data processing tools, and enabling changes in policy, incentive and regulatory mechanisms.

Their absence acts as a barrier for the energy industry in translating the fast-accumulating data into actionable knowledge. The 15 ESR projects will target key bottlenecks for this digital transformation.



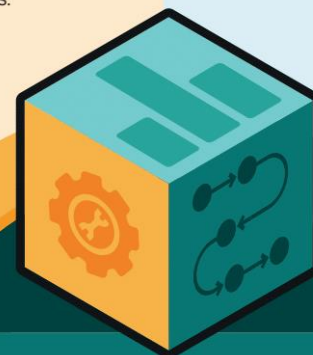
Power networks



Power plants



Offshore Oil & gas production



**InnoCyPES**

**CYBER PHYSICAL ENERGY SYSTEMS**

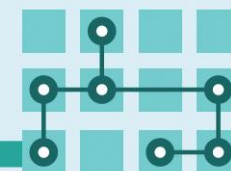
Design, modelling, assessment,  
operation, maintenance,  
planning.



Data Acquisitions Systems



Data Curation



Data Management

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 956433.

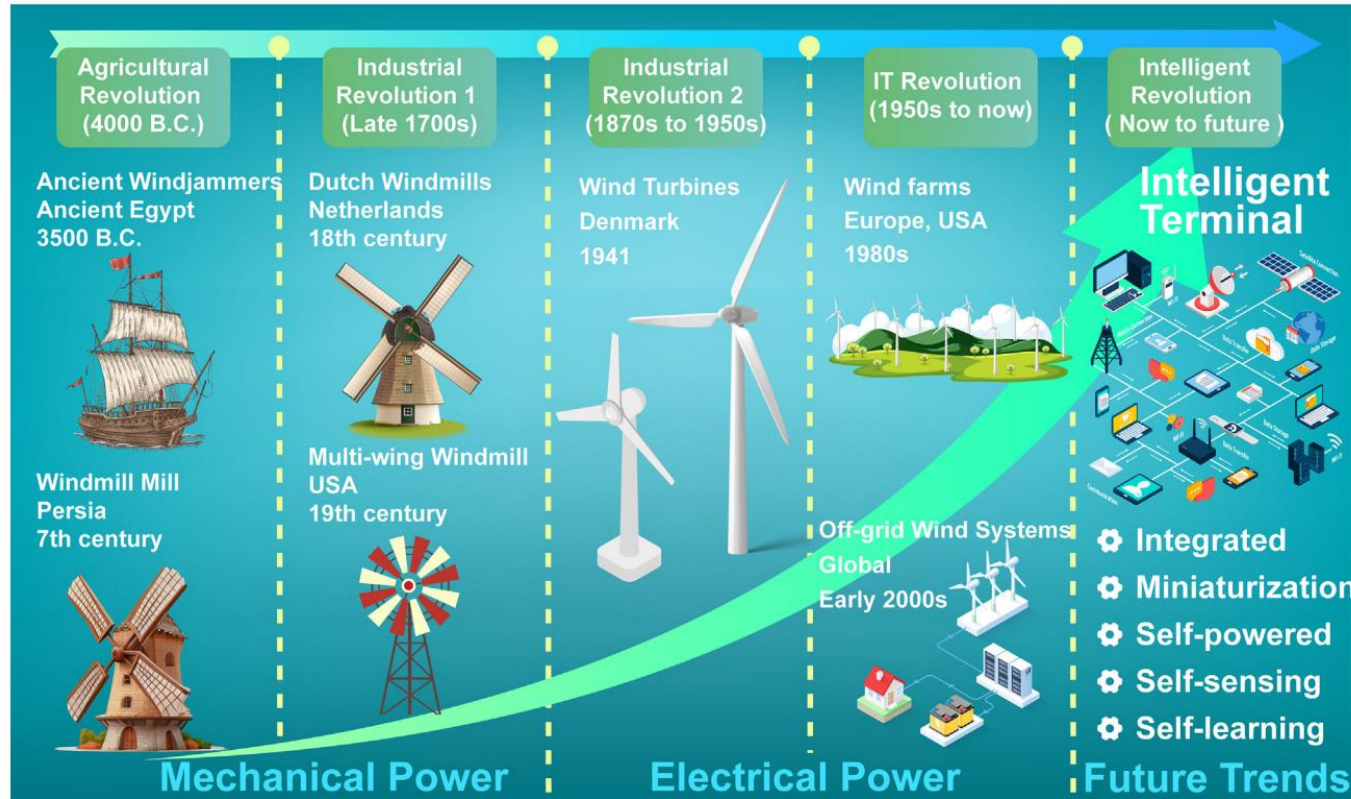


Orsted

edf

TU Delft

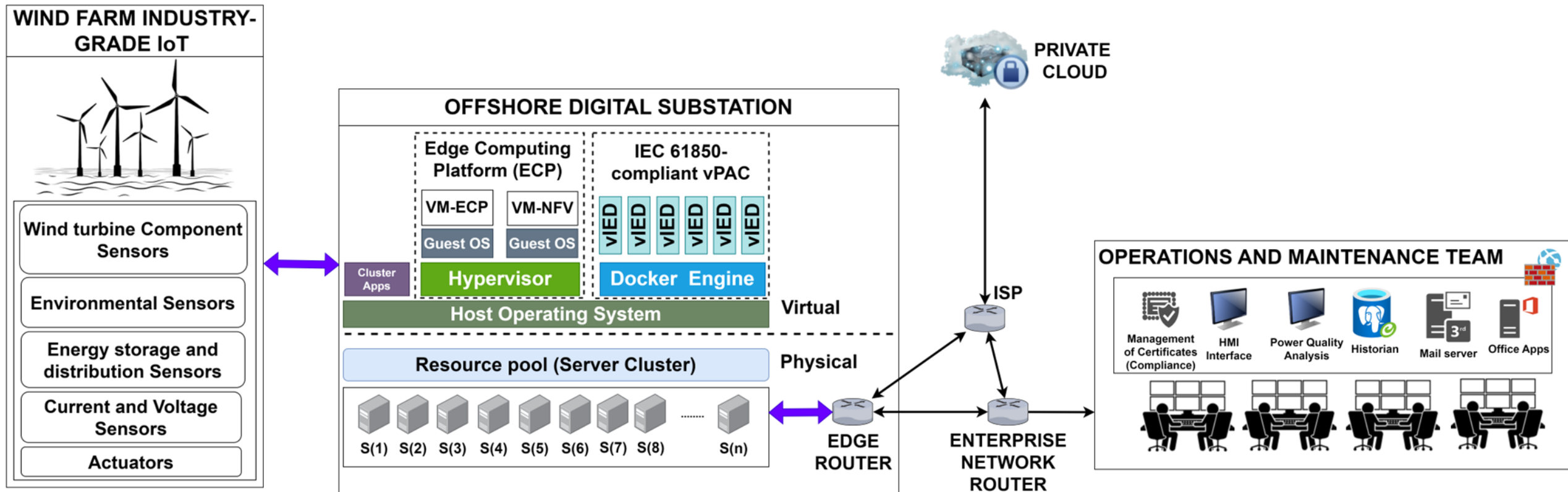
# IoT Network Design and Reliability Evaluation for the Renewable Energy Sector



- IoT for machine-to-machine communication in offshore wind farm management<sup>1</sup> (Inter-turbine communication)
- Operations and maintenance of offshore wind farms<sup>2</sup> (10-20% wind farm's LCOE)

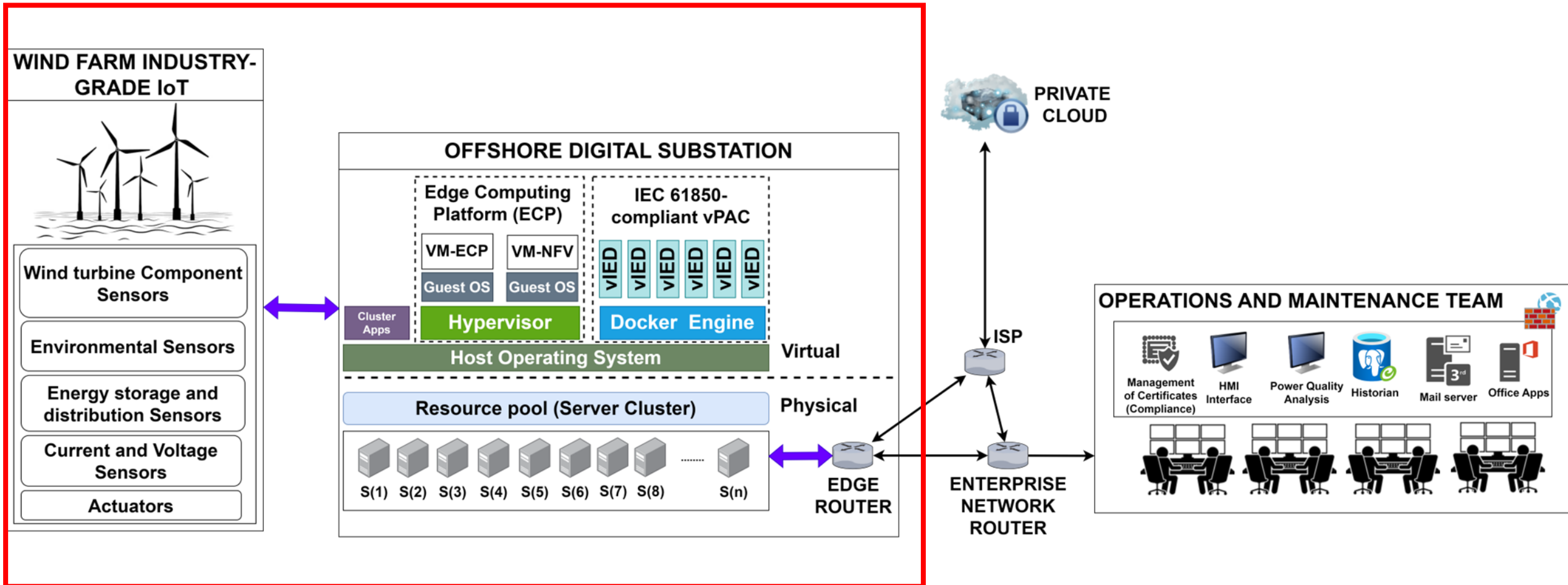
1. H. Wang, B. Xiong, Z. Zhang, H. Zhang, and A. Azam, "Small wind turbines and their potential for Internet of Things applications," *Iscience*, vol. 26, no. 9, 2023  
2. C. A. Walford, "Wind turbine reliability: understanding and minimizing wind turbine operation and maintenance costs.," tech. rep., Sandia National Laboratories (SNL), Albuquerque, NM, and Livermore, CA . . . , 2006

# IT/OT architecture for the next generation IEC 61850-compliant offshore wind farms





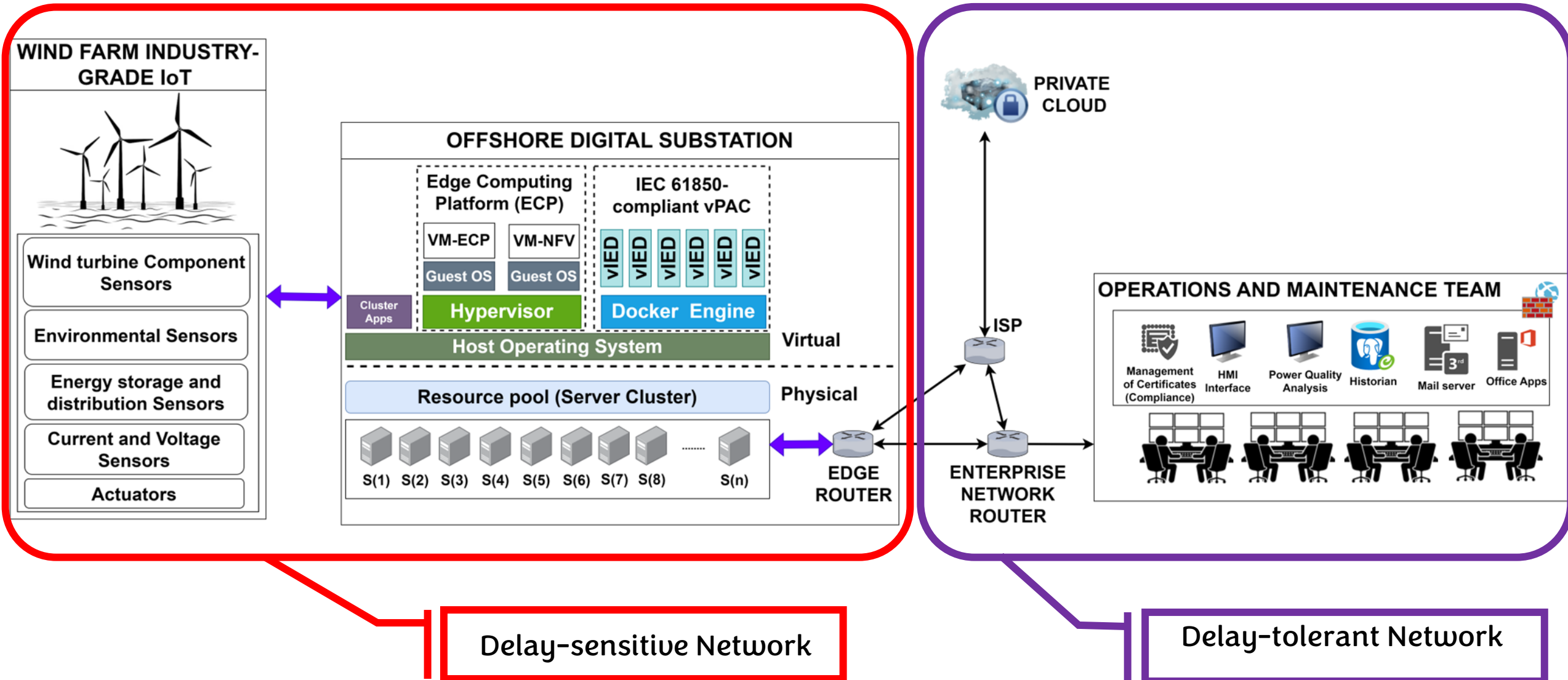
# IT/OT architecture for the next generation IEC 61850-compliant offshore wind farms



## An illustration featuring five stylized wind turbines with three blades each, arranged in a cluster. To the right of the turbines are three interlocking gears of different sizes. Above the gears is a line drawing of a generator or motor unit with a lightning bolt symbol on its side. At the top right, there is a small icon of a power plant or refinery with smokestacks. The entire illustration is set against a light blue background with a subtle grid pattern.



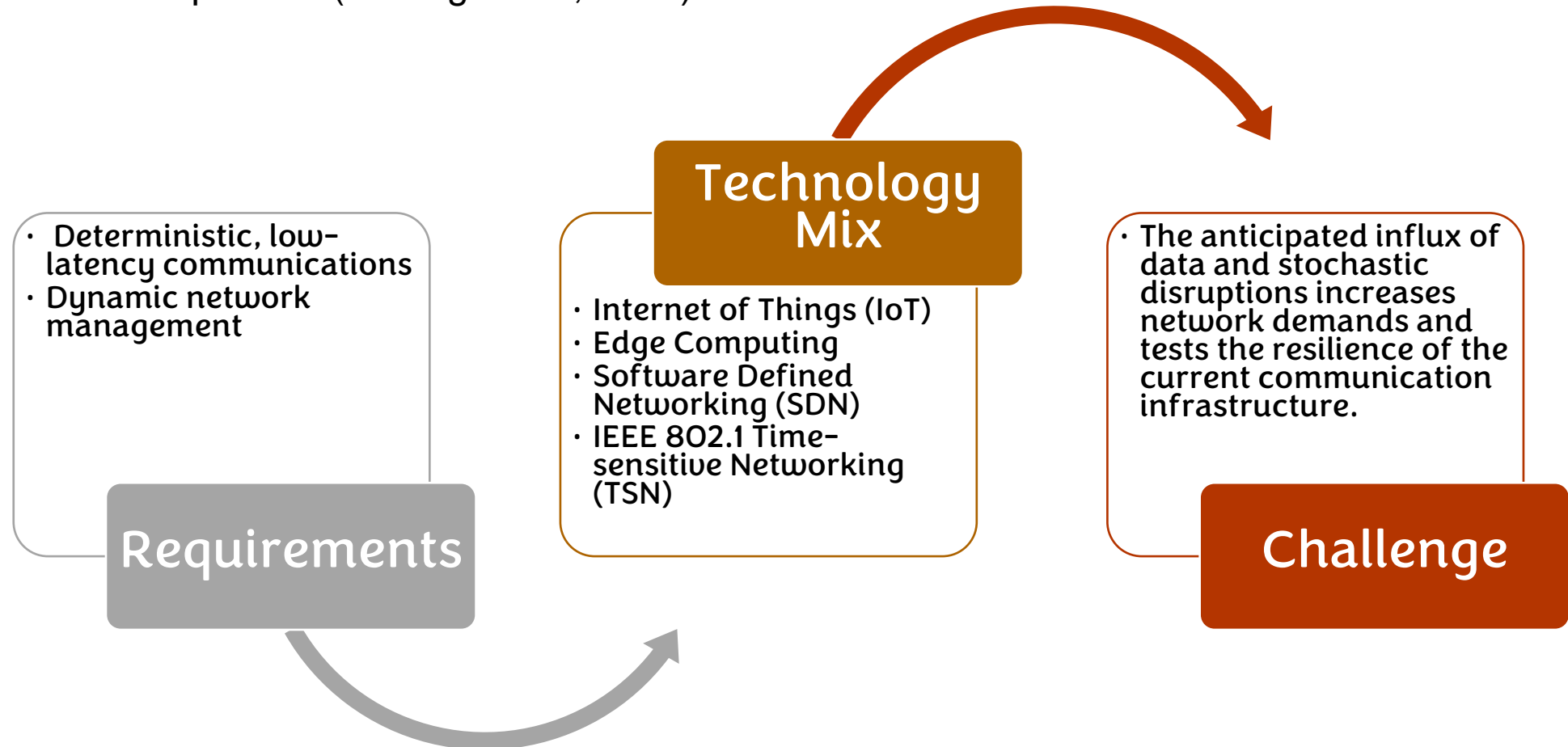
# Network Design





# IoT Network Design

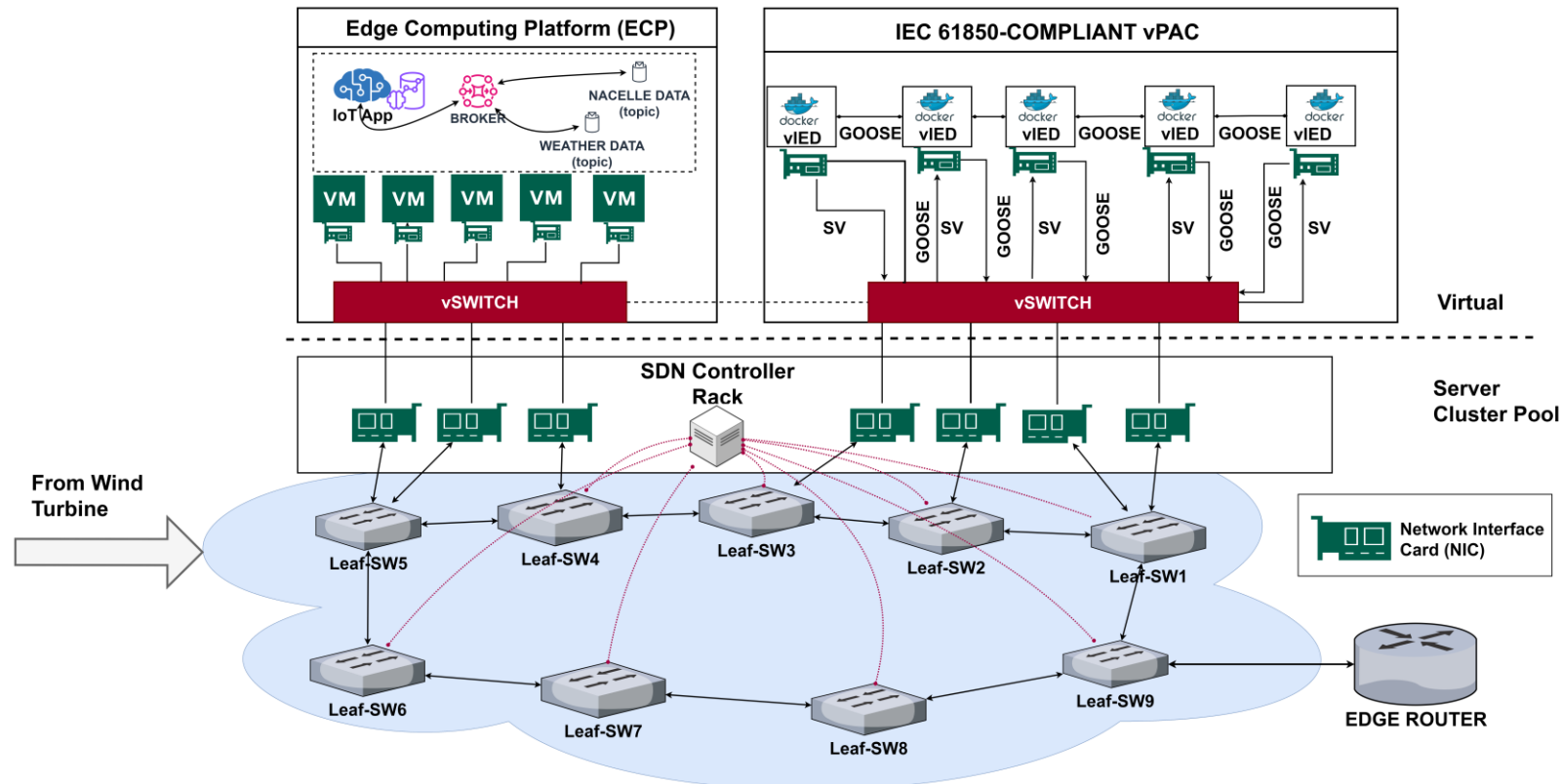
“The sensor data of different types are sampled at very high rates, change often, and require a real-time response.” (Mwangi et. al, 2023)



# EDF Secondment

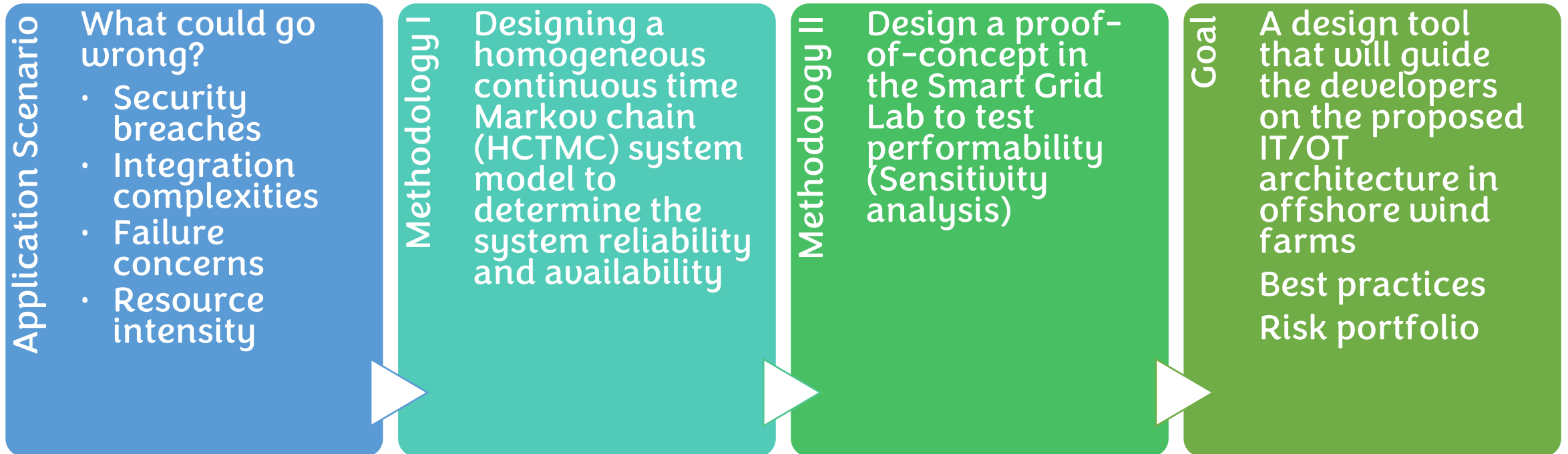
Investigating the dependability of SDN-enabled IoT-Edge Networks for next-generation wind farms

Why should wind farm developers adopt the proposed IT/OT architecture? Can they trust it to run efficiently? What will be the impact on O&M?



# EDF Secondment

Investigating the dependability of SDN-enabled IoT-Edge Networks for next-generation wind farms





# Acknowledgement



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