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INESCTEC
TECNOLOGIA E CIÊNCIA
| LABORATÓRIO ASSOCIADO

THE MARITIME INTERNET

Rui Campos | Area Coordinator
Centre for Telecommunications and Multimedia
Wireless Battle of the Mesh v9, May 2016

WiN Research Team

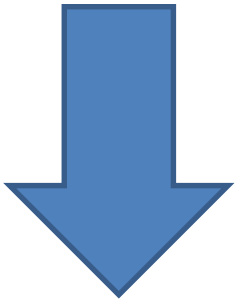
- 10 PhD holders
- 5 MSc researchers
- 8 PhD students
- 3 MSc students

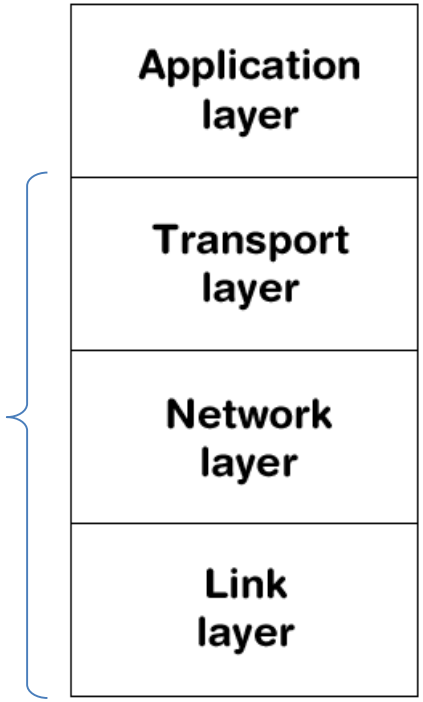
26 researchers

WiN Research Topics

Wireless (Mesh) Networks

- static and mobile
- homogeneous and heterogeneous

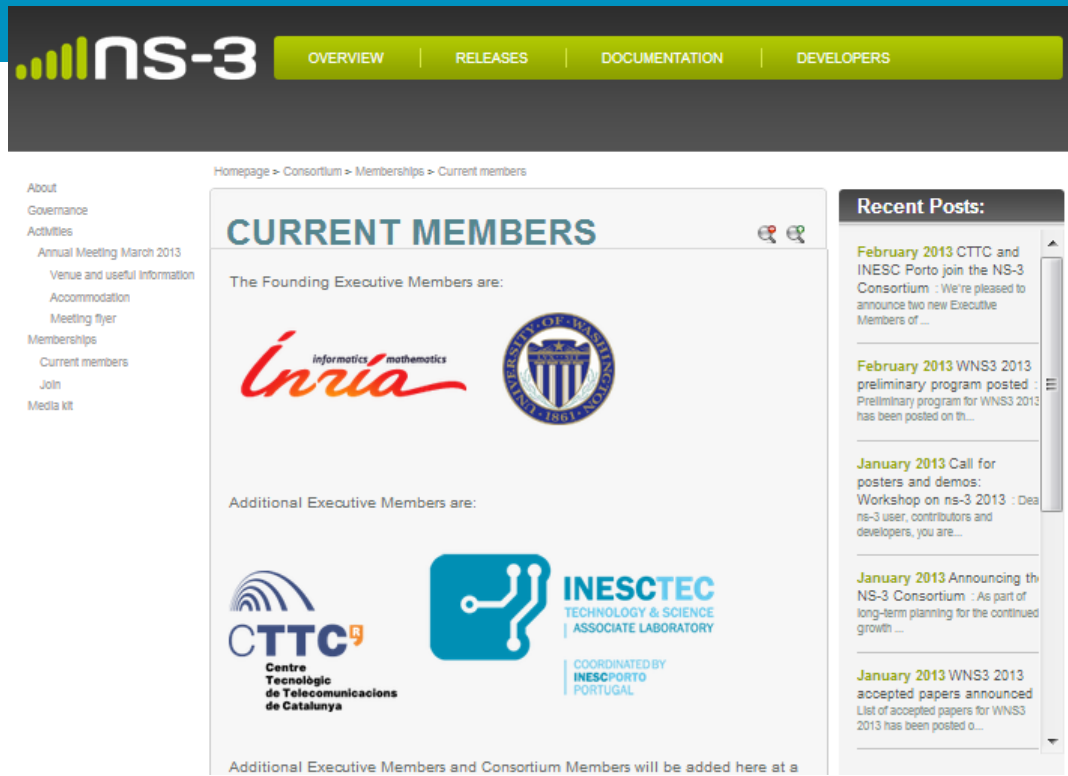




self-configuration
cross-layer optimization
security

medium access control
mobility
congestion control

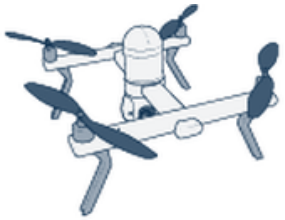
WiN research methodology



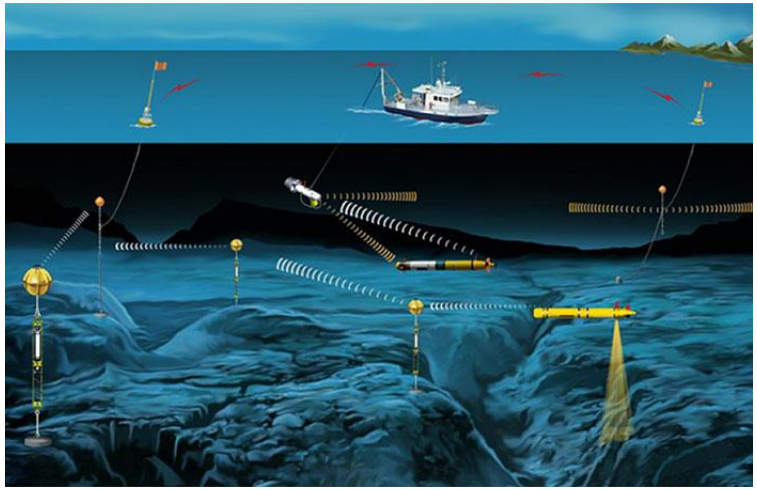
1. Design
2. ns-3 simulation
3. Lab experiments – Linux / OpenWRT
4. Real-world experiments

WiN main focus areas

AIRBORNE COMMUNICATIONS



MARITIME COMMUNICATIONS



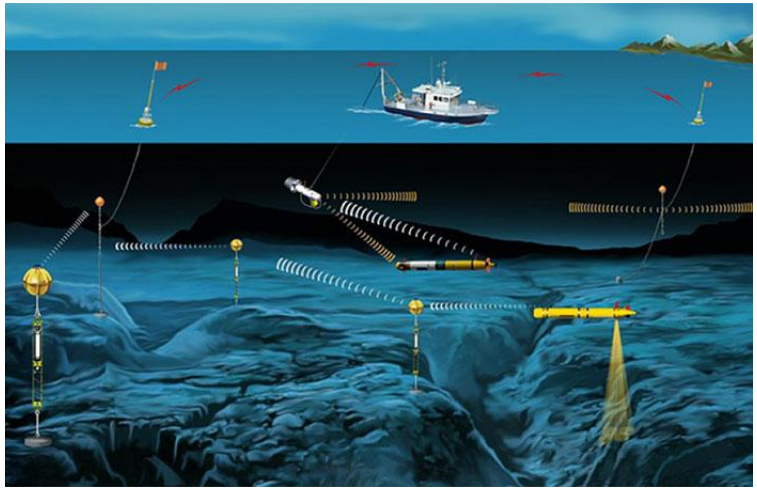
SMART GRID COMMUNICATIONS

WiN main focus areas

AIRBORNE COMMUNICATIONS

MARITIME COMMUNICATIONS

SMART GRID COMMUNICATIONS



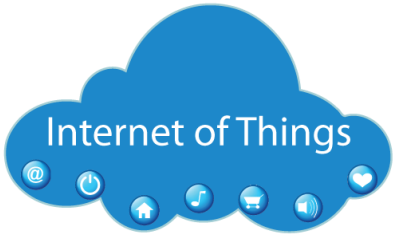
Motivation

Ocean covers **71%** of Earth's surface

Blue Economy
traditional and emerging activities

Remote monitoring
marine environment and ecosystems

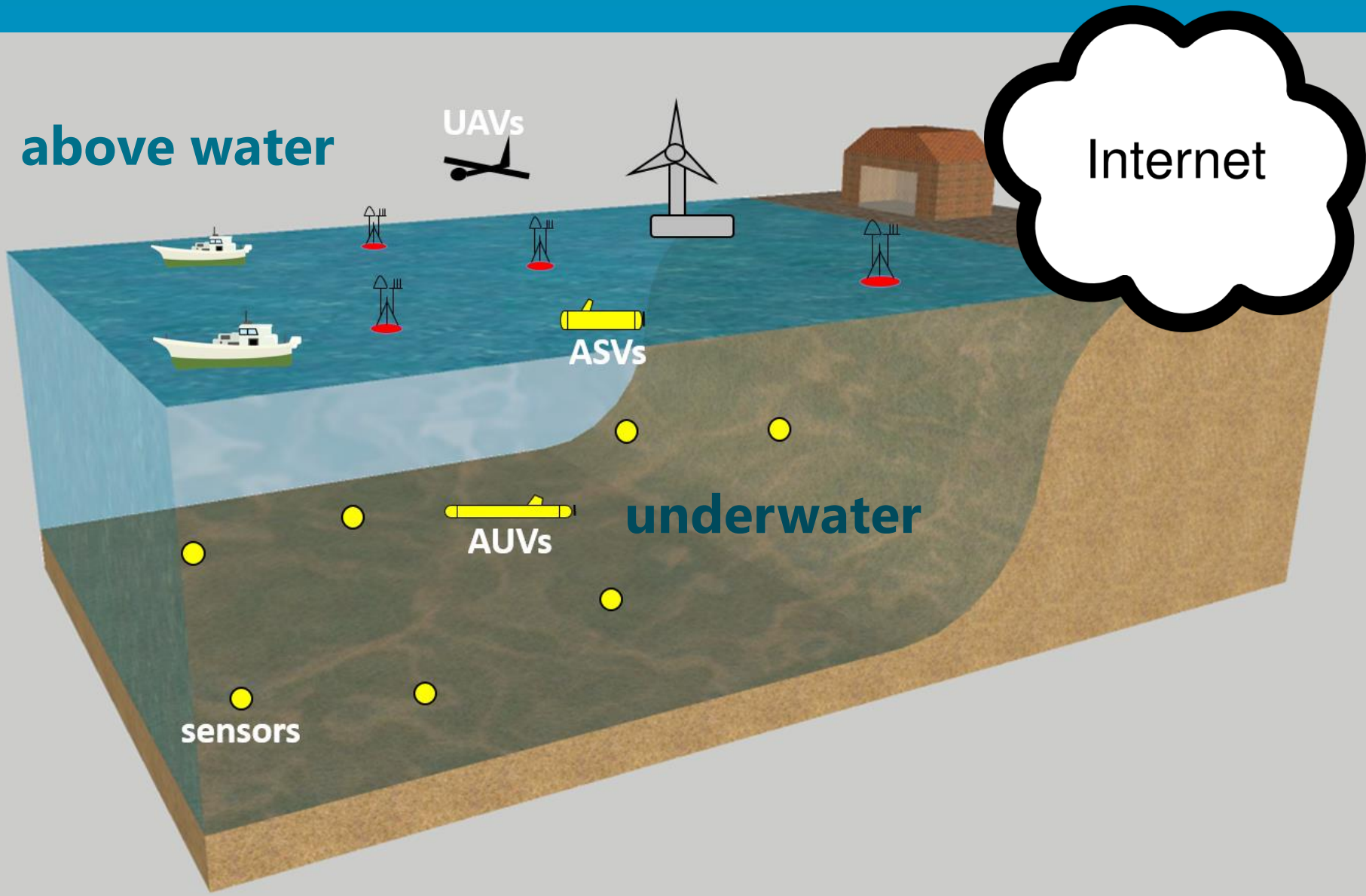
Motivation



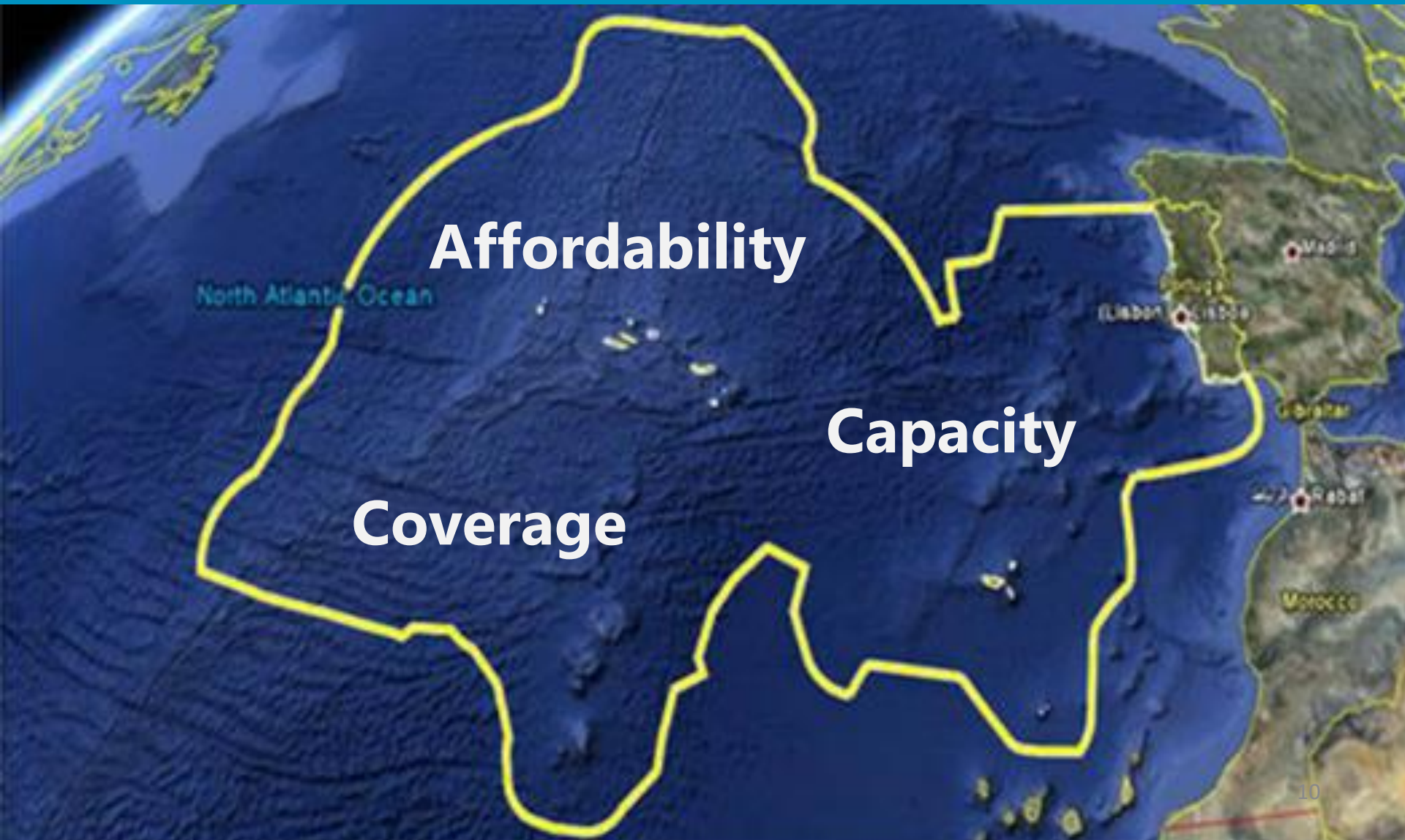
Apps and services
access to Internet-based apps/services in remote ocean areas

Marine data dissemination
collected by ocean intelligent platforms in remote ocean areas

The vision: Maritime Internet of Everything



Challenges



Current scenario – Above water

HF – narrowband

Satellite – high costs and narrowband

VHF Radio – narrowband and half-duplex

Mobile GPRS/3G/4G – broadband, only near shore

No solution enabling affordable broadband at remote ocean areas

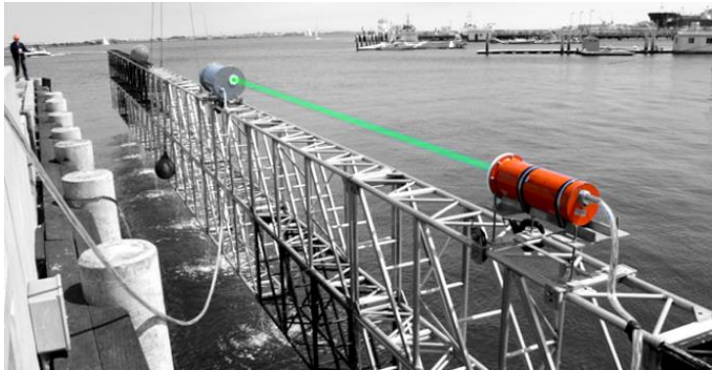
Current scenario – Underwater

Acoustic communications

- ✓ Long range
- ✕ Low bitrates (in the order of few kbit/s)
- ✕ High latency
- ✕ Affected by turbidity and shallow waters
- ✕ Impact on marine life

Wireless optical communications

- ✓ High bitrate
- ✕ Require line-of-sight
- ✕ Proper alignment



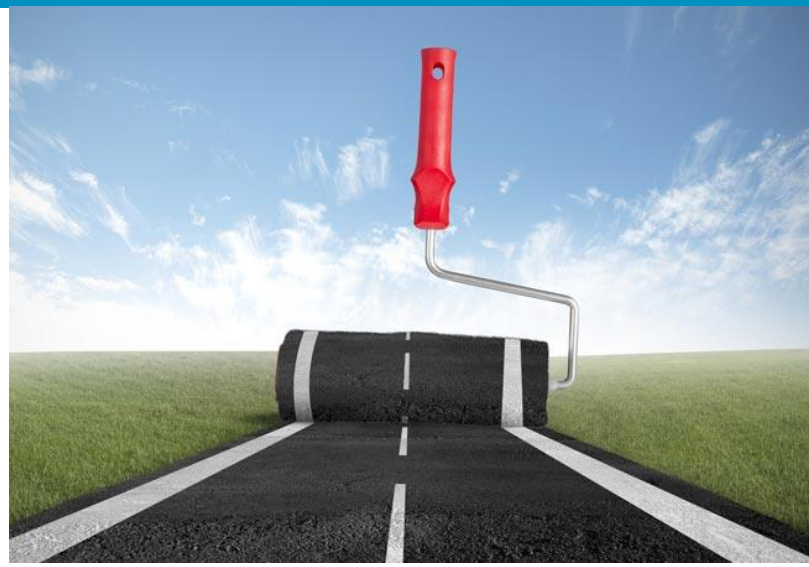
Current scenario – Underwater

Radio Frequency (RF) communications

- ✓ High bandwidths at short-range
- ✓ Low latency
- ✓ Works without line-of-sight
- ✓ Unaffected by turbidity or pressure
- ✓ Low cost, low power solution
- ✗ Higher attenuation

There is no affordable broadband, low latency solution

Our roadmap



Evaluation of existing comms solutions

Identification of novel problems and challenges

Redesign of communications stack

Development of multi-technology solutions

Application areas

Aquaculture

onshore and offshore

Fisheries

Security

e.g., video surveillance

Maritime transportation

Offshore facilities

e.g., wind farms

Search and Rescue

Waterborne events

e.g., surf, regattas

Deep sea mining

Offshore oil & gas drilling

Environmental monitoring

Mare-Fi

Wi-Fi Long Distance Land-Sea Communications

Objectives

Study Wi-Fi performance for **land-sea and sea-sea comms** using **license exempt bands**

Extend free **Wi-Fi on land to the sea** using **community networks** of fishing ships

Develop Wi-Fi-based comms solutions **addressing** the **challenges in sea** environment

Mare-Fi

Wi-Fi Long Distance Land-Sea Communications

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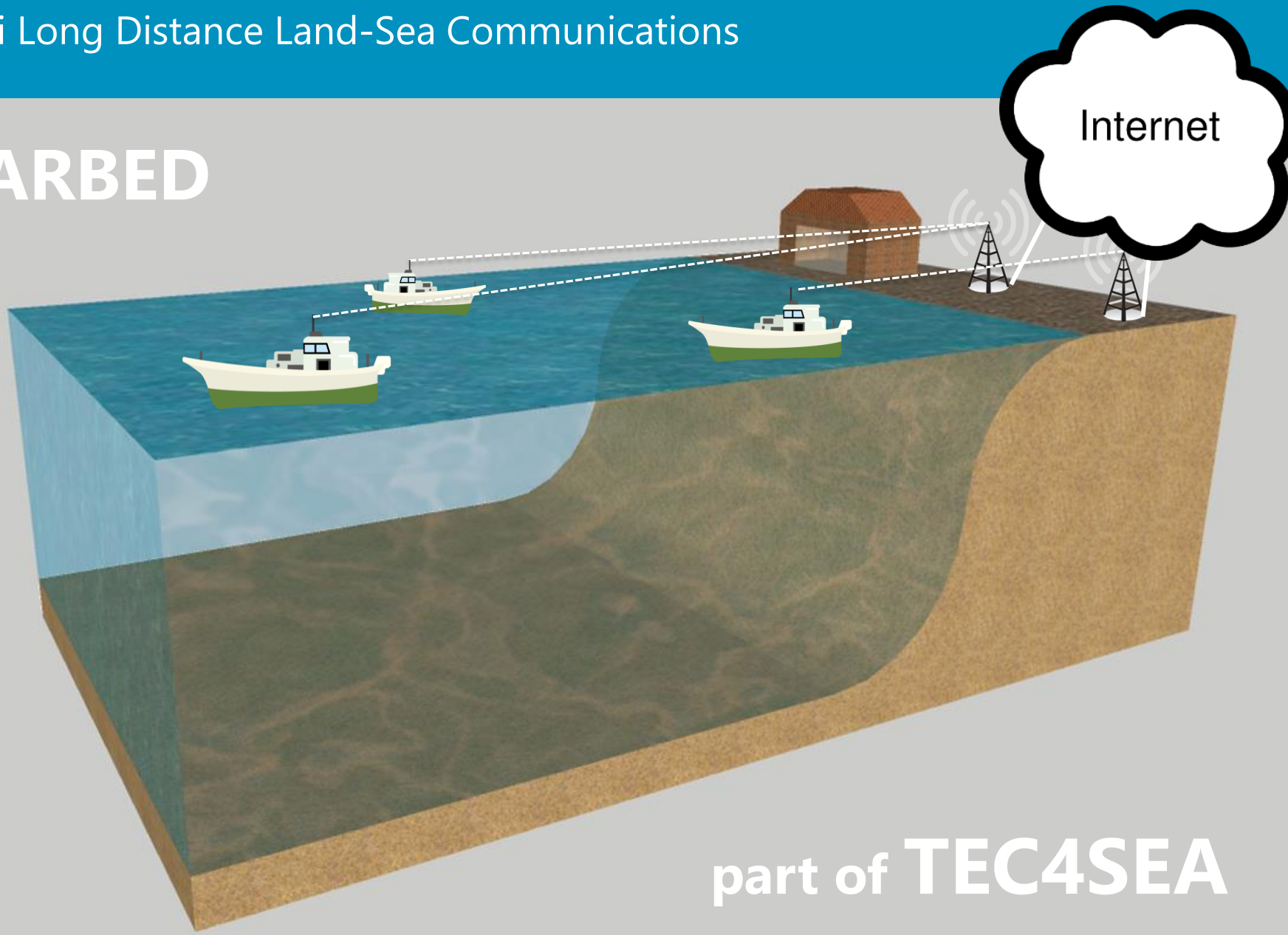
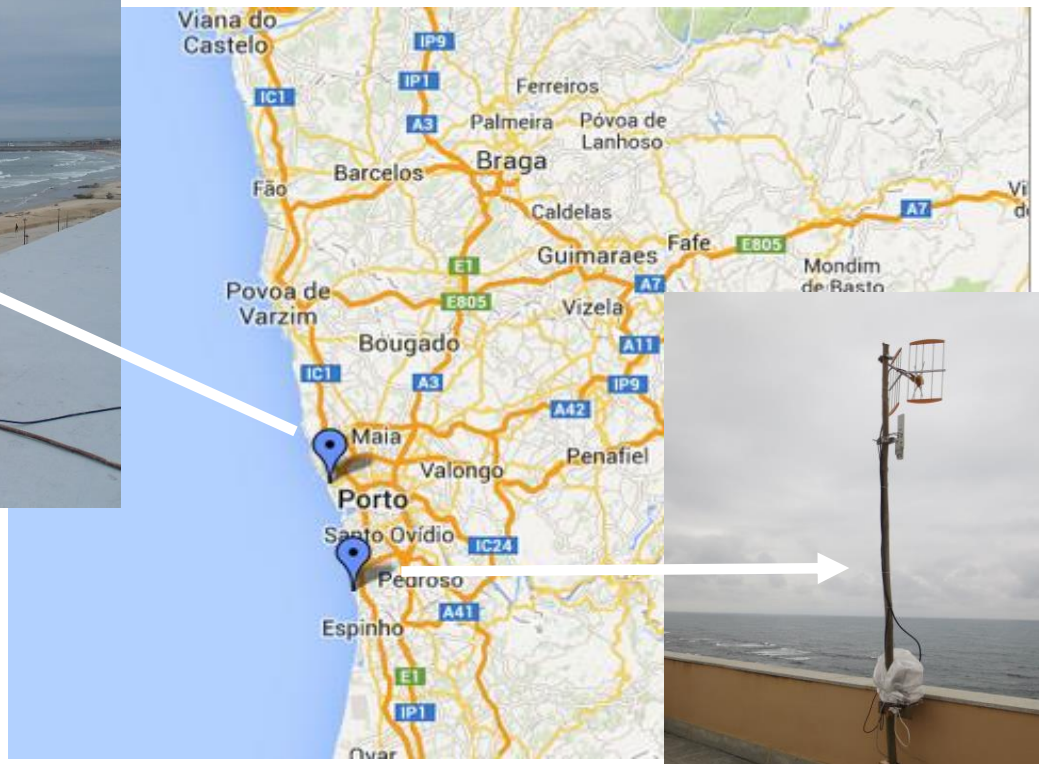
MARBED



part of TEC4SEA

MARBED: land stations



Mare-Fi

Wi-Fi Long Distance Land-Sea Communications

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MARBED: northern land station

Mare-Fi

Wi-Fi Long Distance Land-Sea Communications

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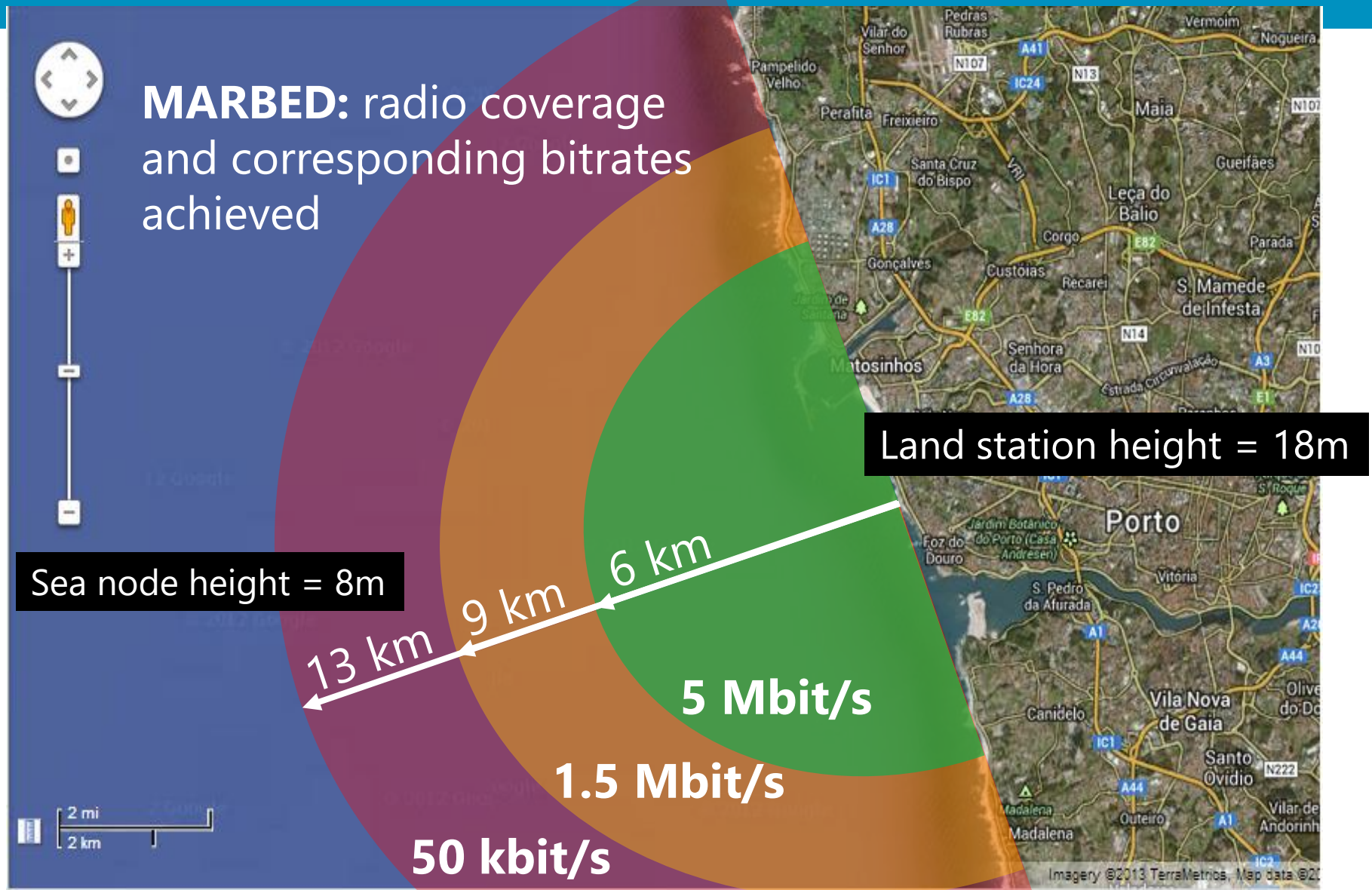
MARBED: sea nodes

Mare-Fi

Wi-Fi Long Distance Land-Sea Communications



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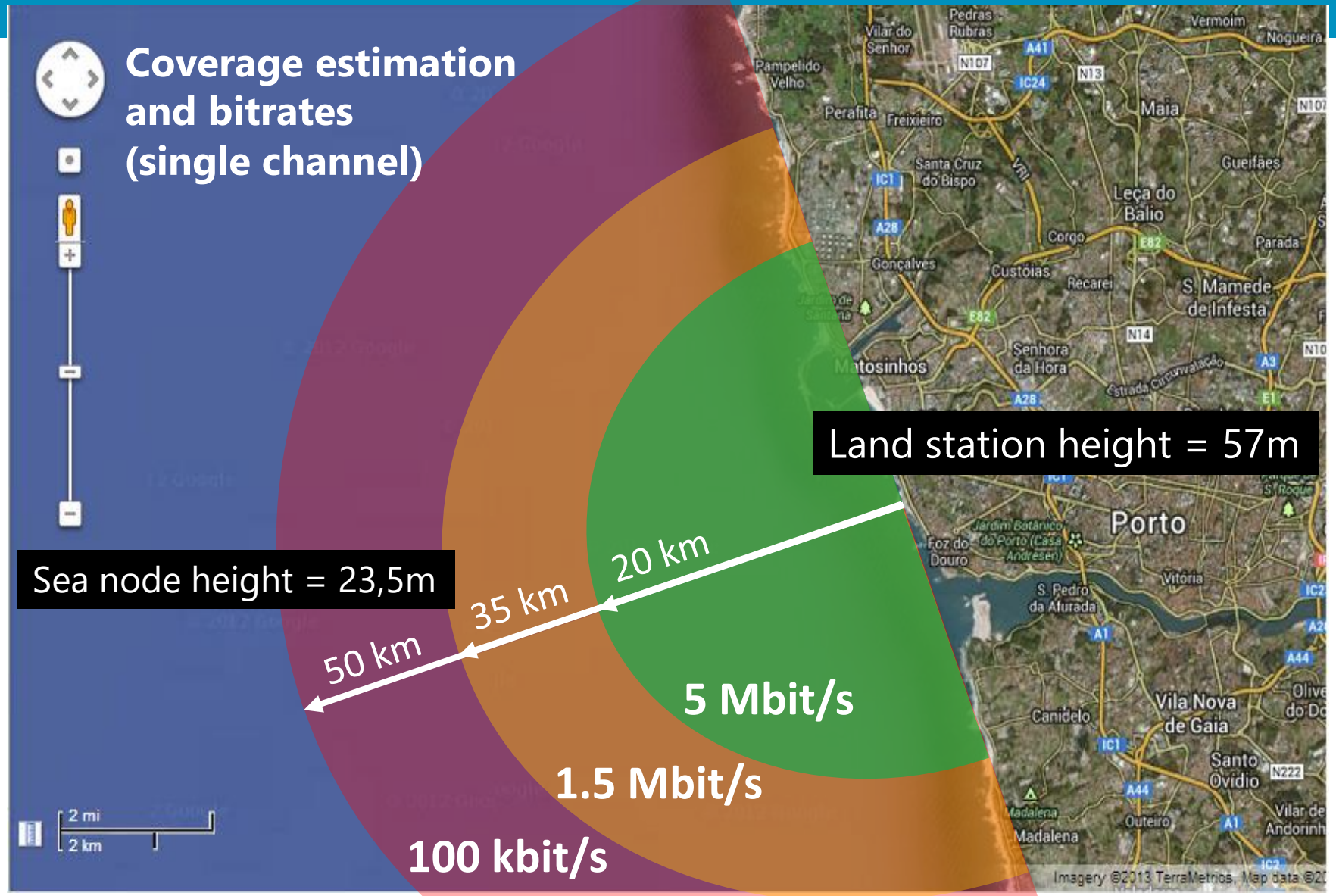
Wi-Fi Long Distance Land-Sea Communications



Mare-Fi

Wi-Fi Long Distance Land-Sea Communications

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MARBED

maritime video surveillance at 9km from coast

MareCom

Maritime Community Networks and Services

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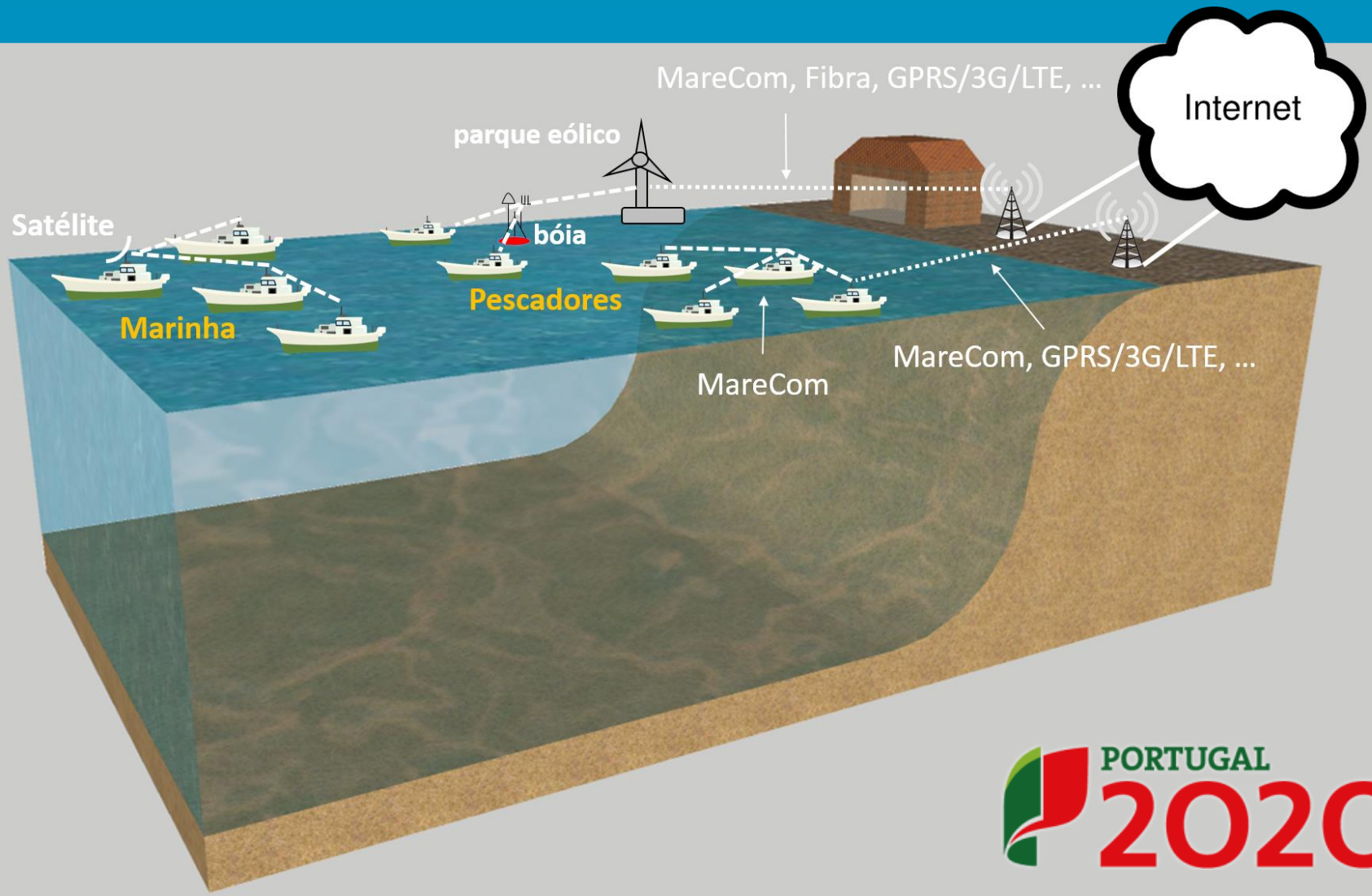

PORTUGAL 2020

BLUECOM+

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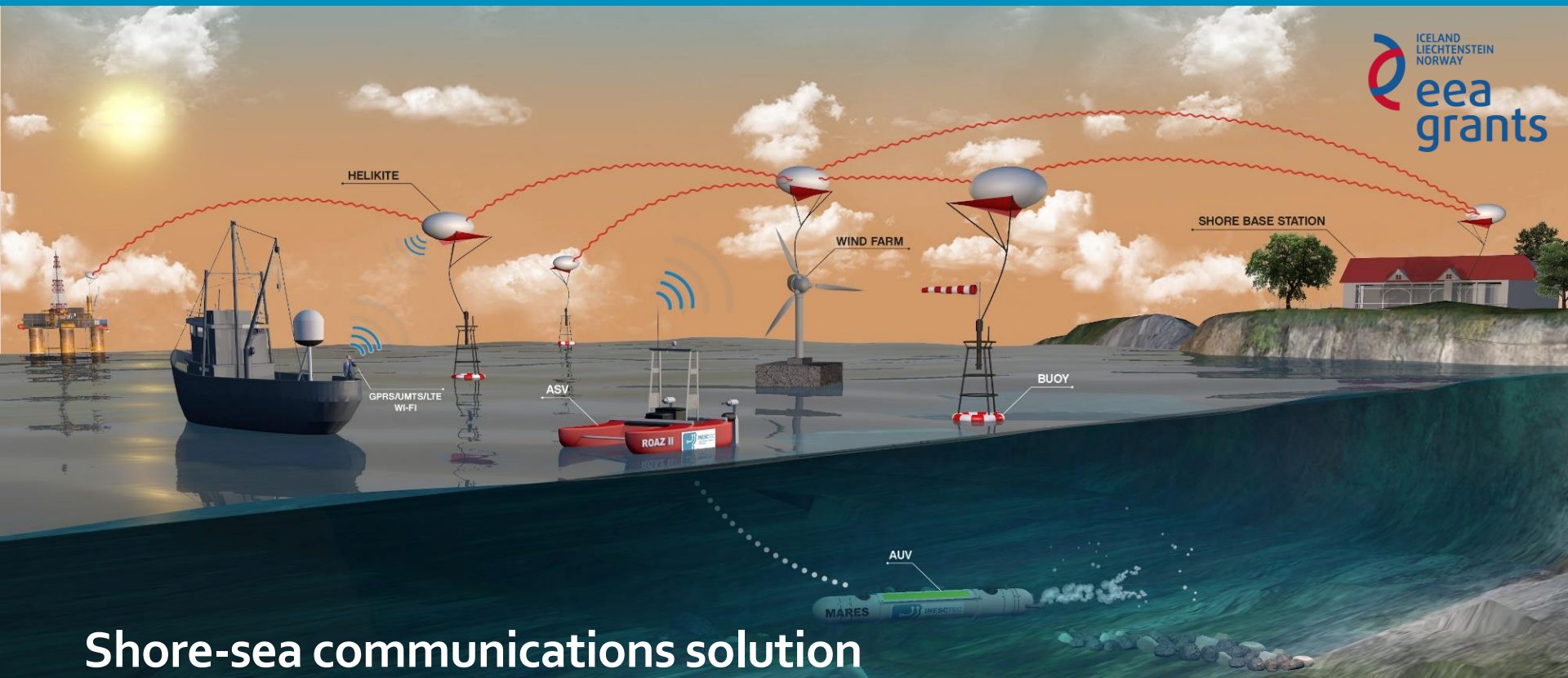
Connecting Humans and Systems at Remote Ocean Areas using Cost-effective Broadband Communications



Shore-sea communications solution

Tethered aerostats as flying Wireless Routers (TWR) communicating through TV White Spaces

Broadband Internet access at remote ocean areas through standard access technologies

WI-FI / GPRS / UMTS / LTE

LONG RANGE RADIO LINK

ACOUSTIC LINK

BLUECOM+

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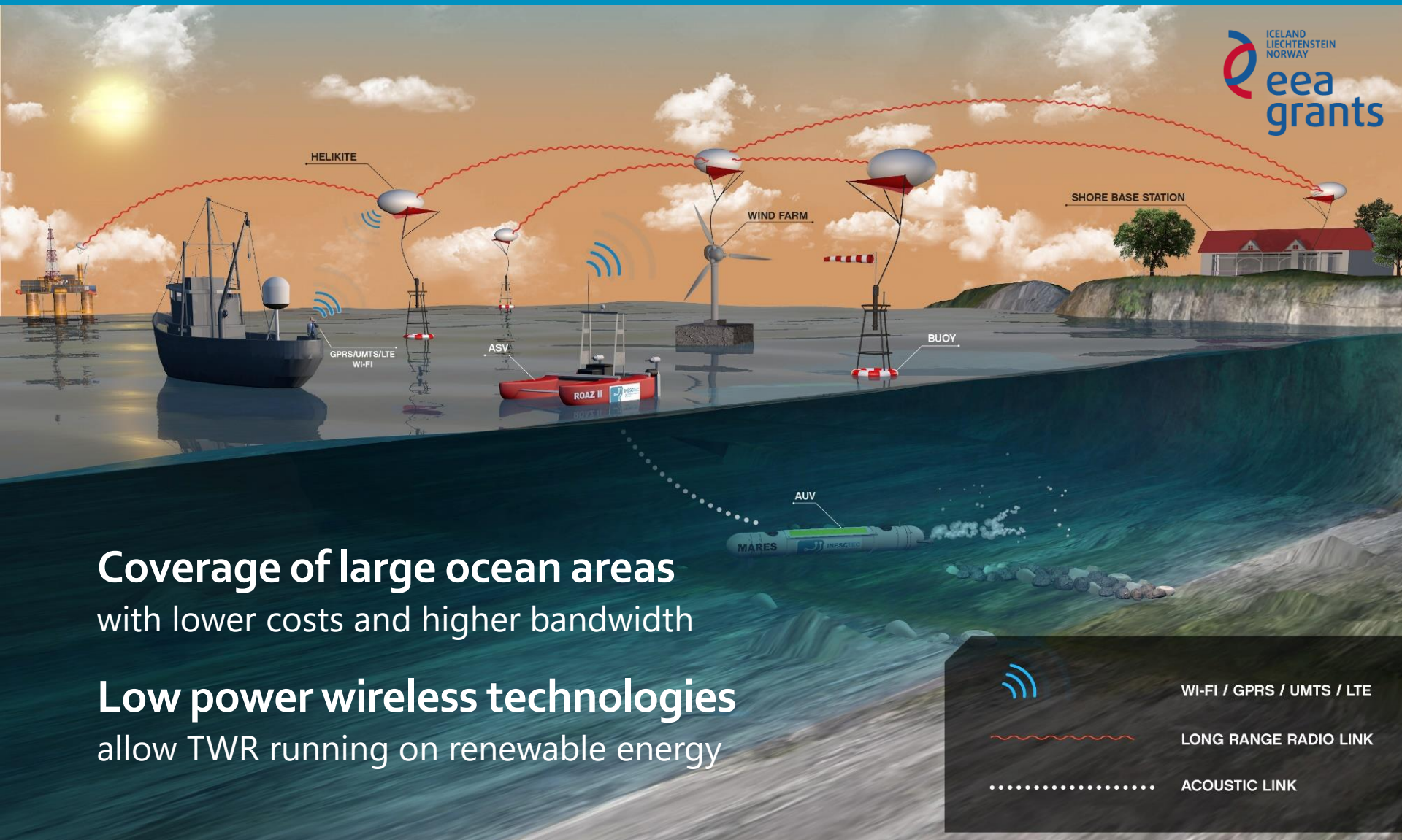

Coverage of large ocean areas
with lower costs and higher bandwidth

Low power wireless technologies
allow TWR running on renewable energy

BLUECOM+

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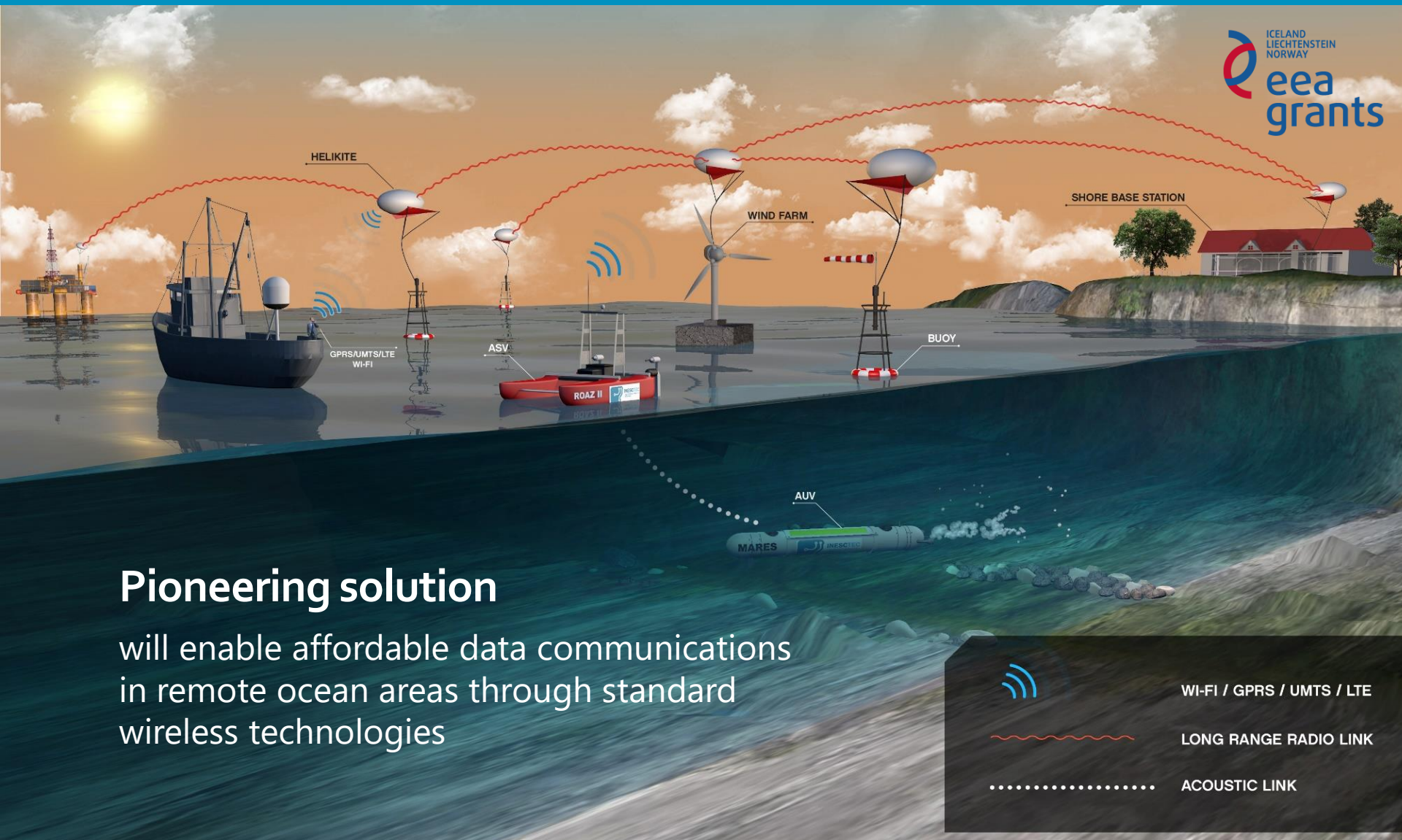
Connecting Humans and Systems at Remote Ocean Areas using Cost-effective Broadband Communications



Pioneering solution

will enable affordable data communications in remote ocean areas through standard wireless technologies

BLUECOM+

Connecting Humans and Systems at Remote Ocean Areas using Cost-effective Broadband Communications

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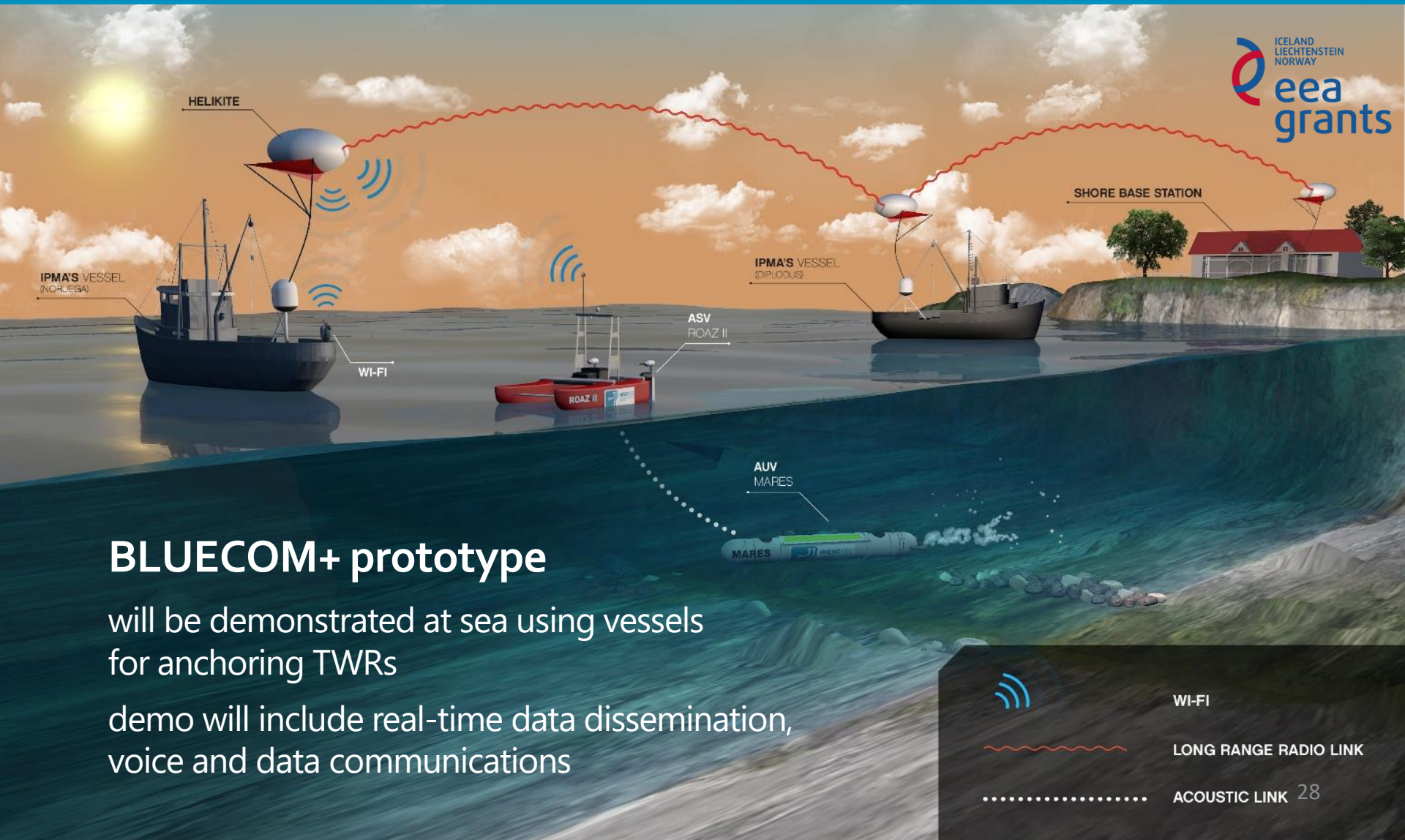

BLUECOM+ prototype

will be demonstrated at sea using vessels for anchoring TWRs

demo will include real-time data dissemination, voice and data communications

SUNNY

Smart UNattended airborne sensor Network for detection of vessels used for cross border crime and irregular entrY

WISE

Traffic-aware Flying Backhaul Mesh Networks

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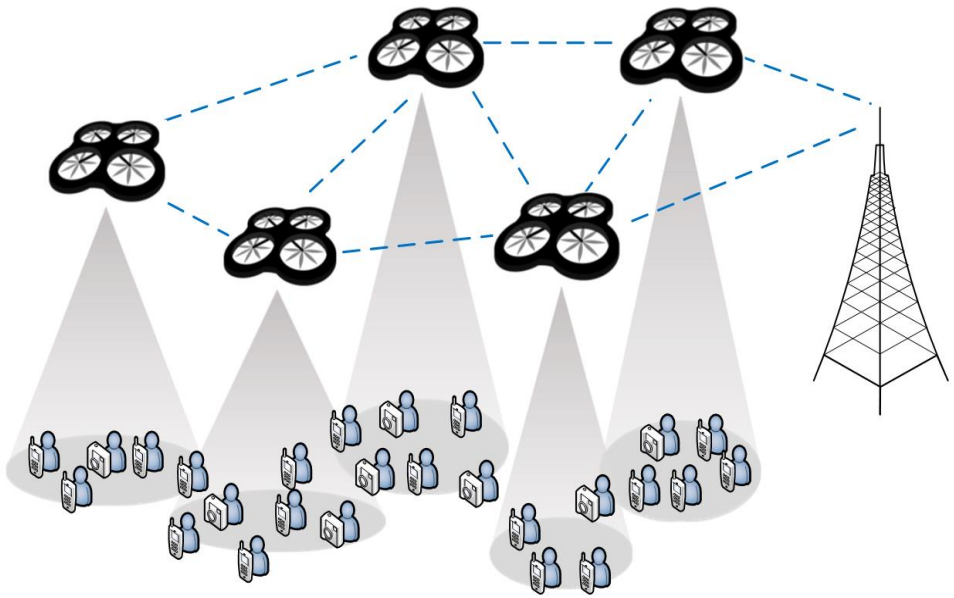
FCT
Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR



Under-Fi

Wi-Fi Tailored to Underwater Networks

Objectives

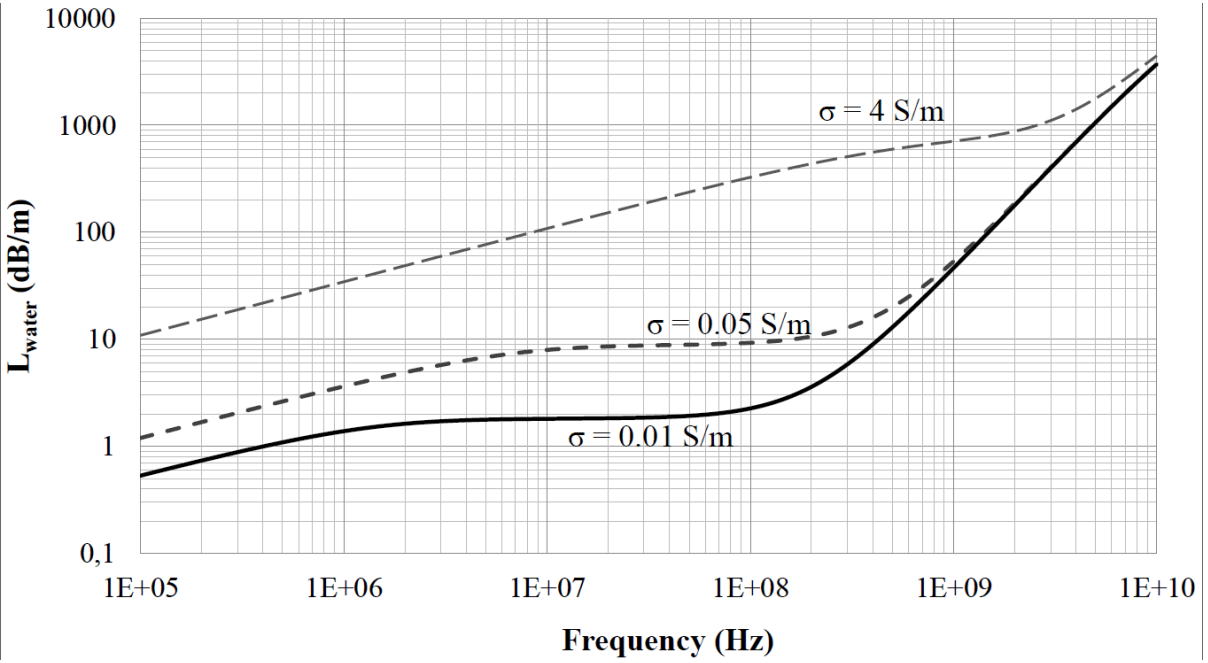
Develop **new simulation models** and **testbeds** for **underwater radio networks**

Study Wi-Fi **performance** for **multiple frequency bands** in **underwater environment**

Develop Wi-Fi-based **comms solutions adapted to underwater environment**

Under-Fi

Wi-Fi Tailored to Underwater Networks



ns-3 NETWORK SIMULATOR

New ns-3 underwater propagation model

Based on attenuation and propagation speed equations

Under-Fi

Wi-Fi Tailored to Underwater Networks

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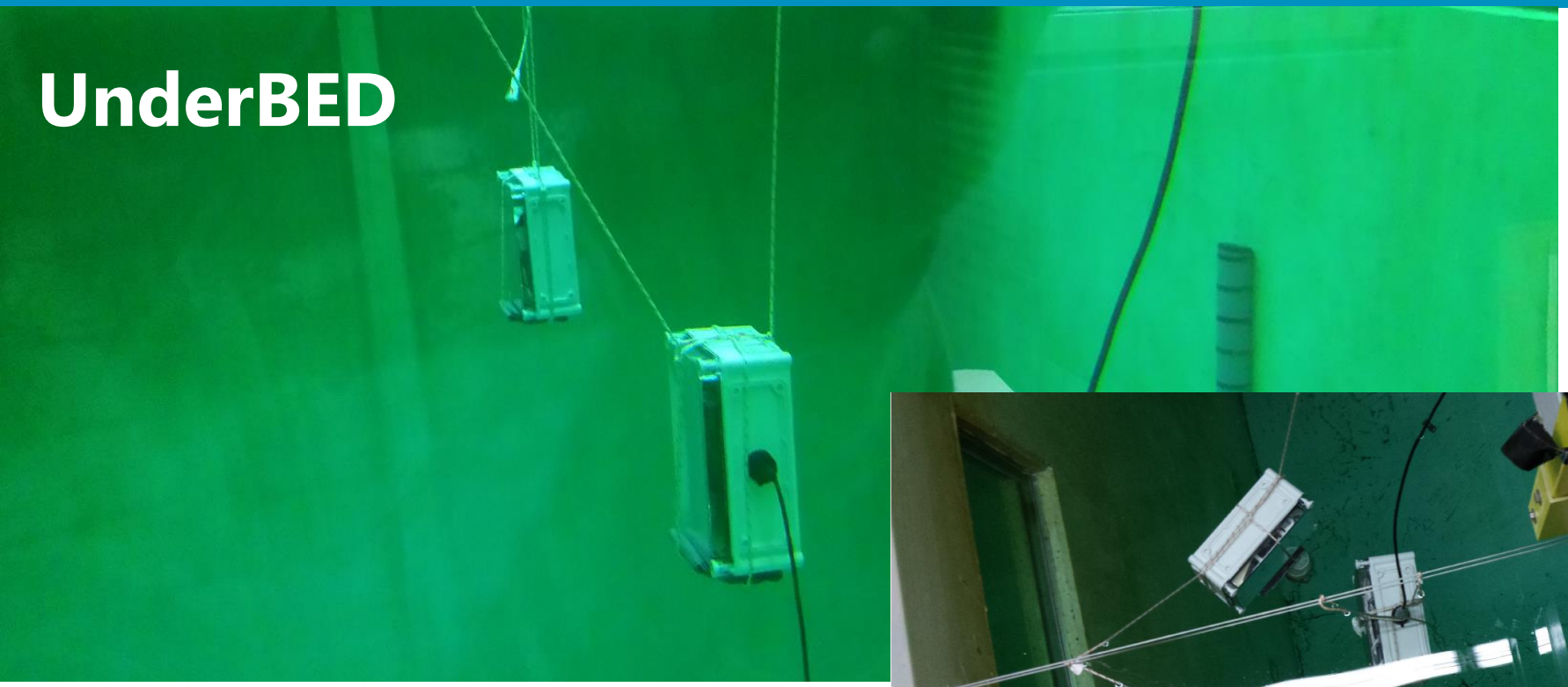
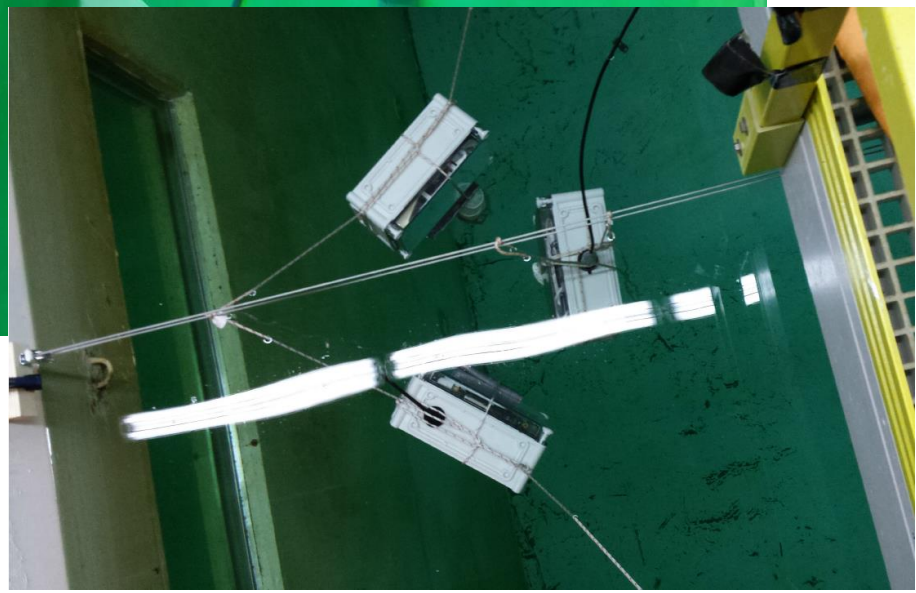
UnderBED

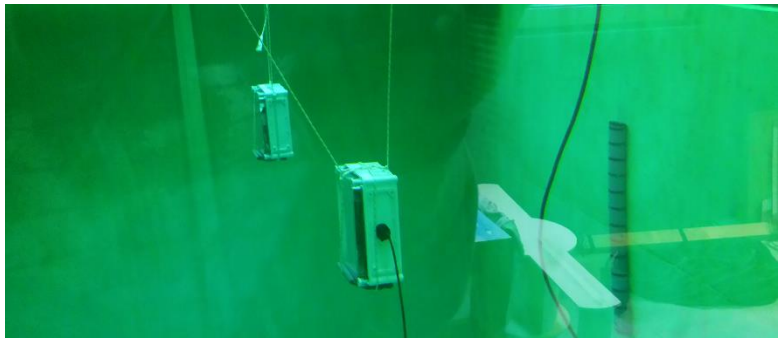




Under-Fi

Wi-Fi Tailored to Underwater Networks

ns-3 NETWORK SIMULATOR



ns-3 simulations and experimental tests performed

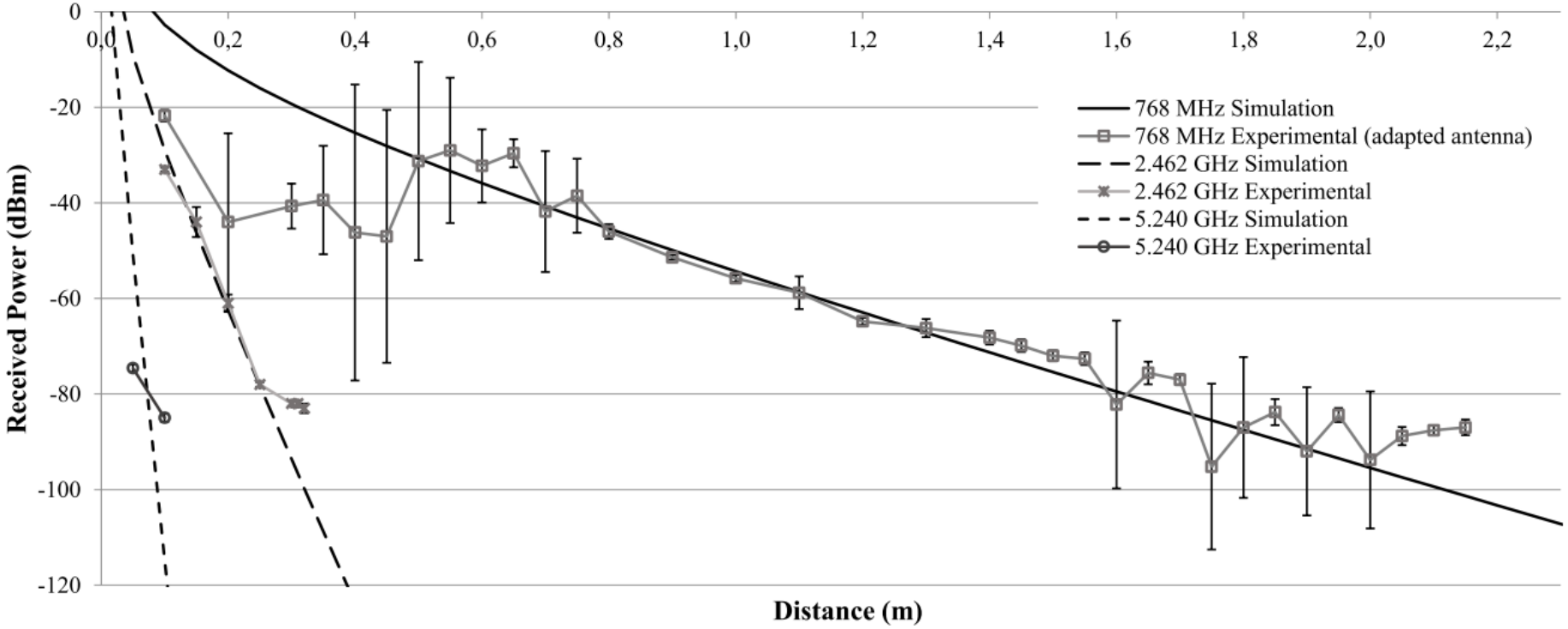
Frequencies: 100-700 MHz, 2.4 GHz and 5GHz

Freshwater and salt water

Under-Fi

Wi-Fi Tailored to Underwater Networks

Received power vs distance



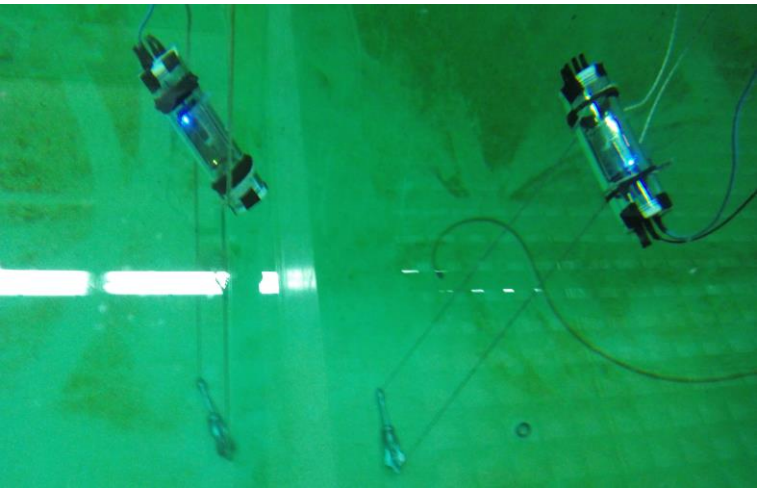
Simulation model matches experimental values for the 3 freq.

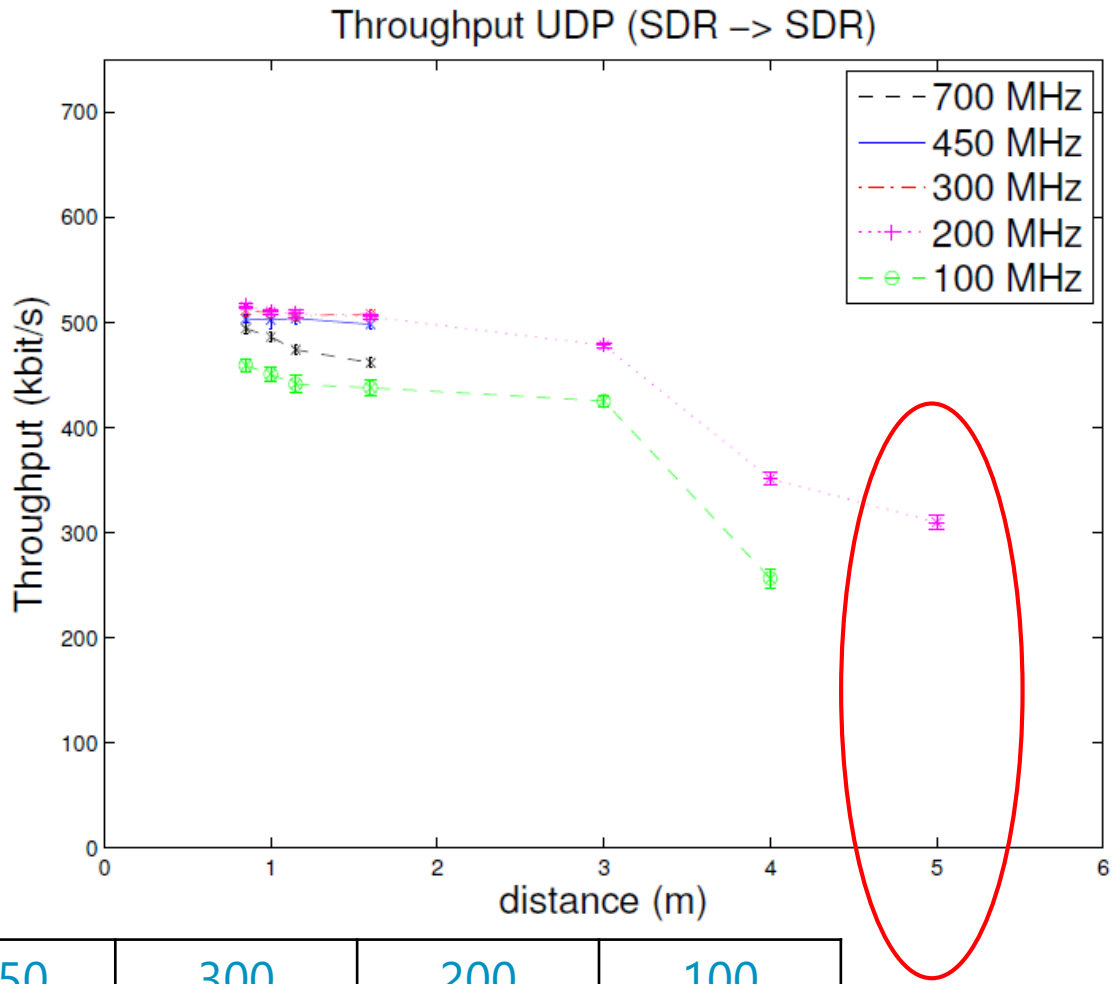
2.4 and 5.2 GHz → signal decays very fast

770 MHz signal received up to 2.15 m

Under-Fi

Wi-Fi Tailored to Underwater Networks





Freq. (MHz)	700	450	300	200	100
Range	1.77	2.94	4.16	5.12	6.37

ENDURE

Enabling Long-Term Deployments of Underwater Robotic Platforms in Remote Oceanic Locations

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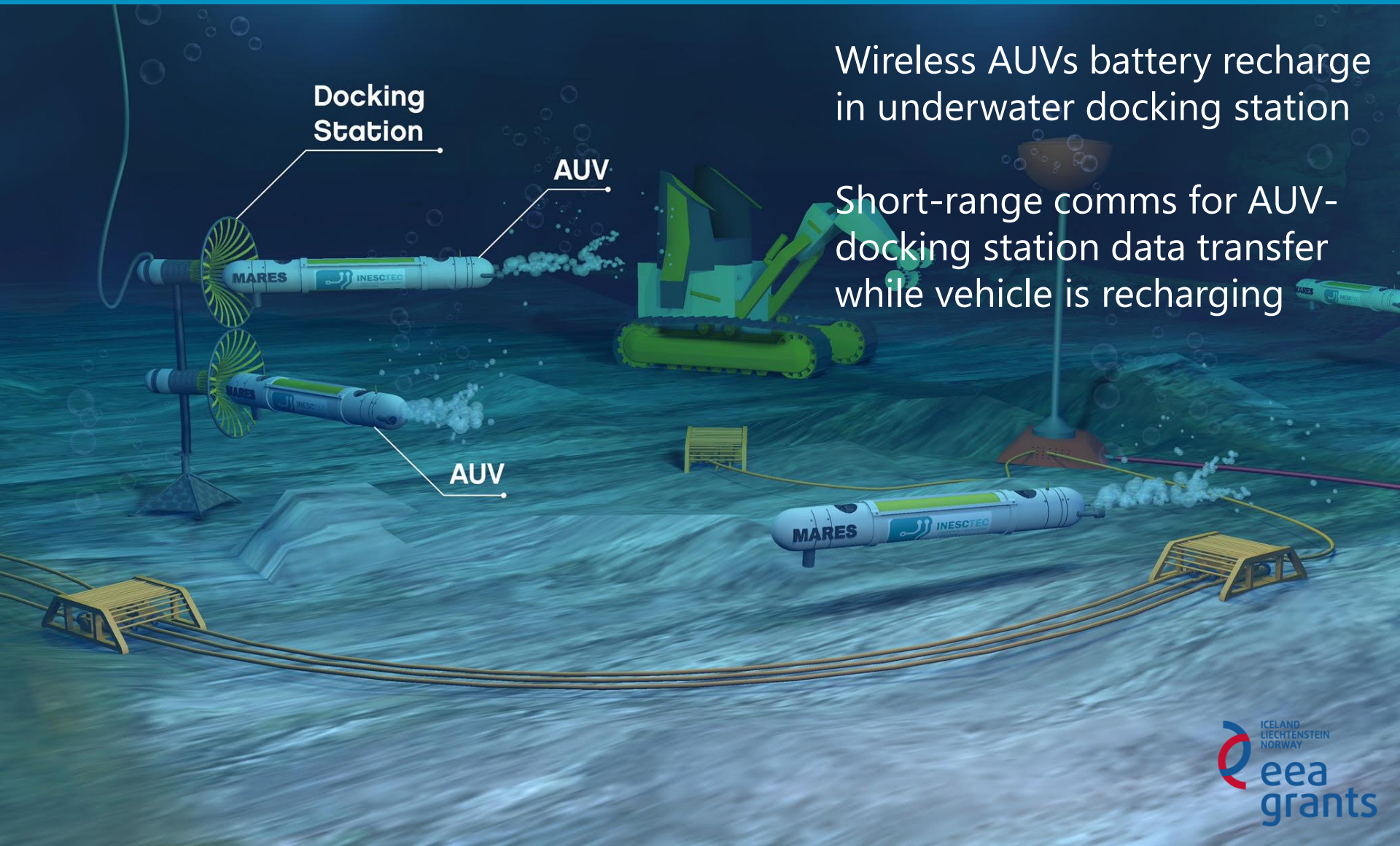
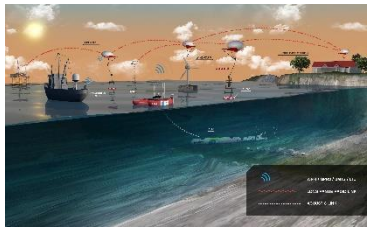


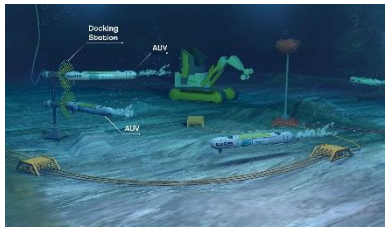
Wireless AUVs battery recharge in underwater docking station

Short-range comms for AUV-docking station data transfer while vehicle is recharging

ICELAND LIECHTENSTEIN NORWAY
eea grants

Opportunities





Airborne, floating, underwater network architectures

Network topology control algorithms

New protocols, mechanisms, algorithms at different layers

Novel cross-layering solutions

New simulation models

Innovative prototypes

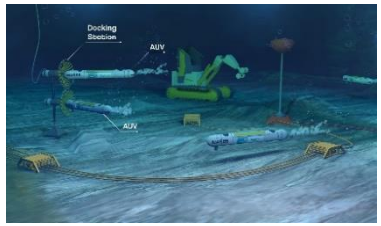
Conclusion

Wireless (Mesh) Networks have been focused on terrestrial environment

Maritime IoE opens up new R&D opportunities

INESC TEC has been exploring them

Plenty still open ...



THANK YOU!

http://win.inesctec.pt