2013-2022

NTNU Centre for Autonomous Marine Operations and Systems

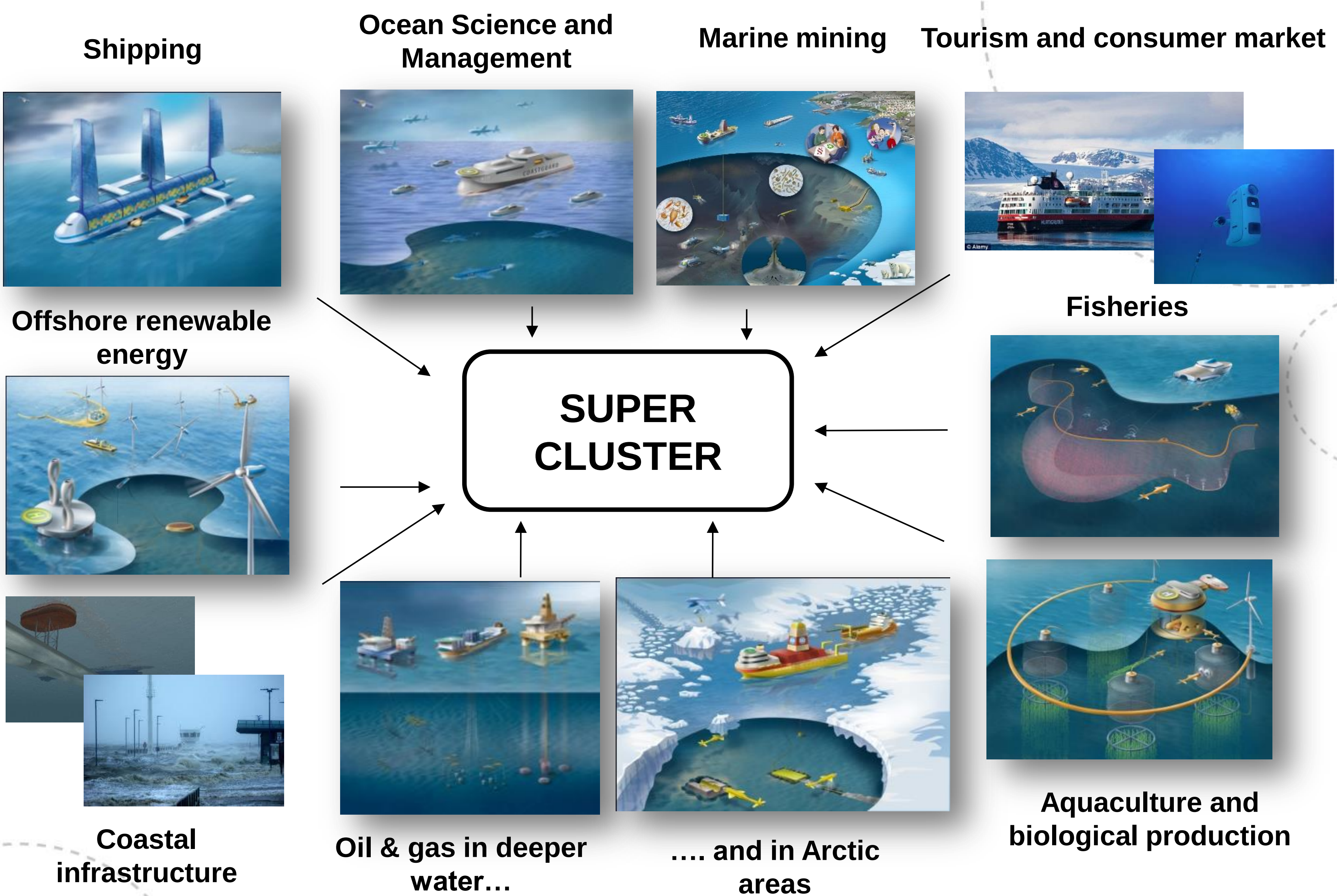
Norwegian Centre of Excellence

AMOS

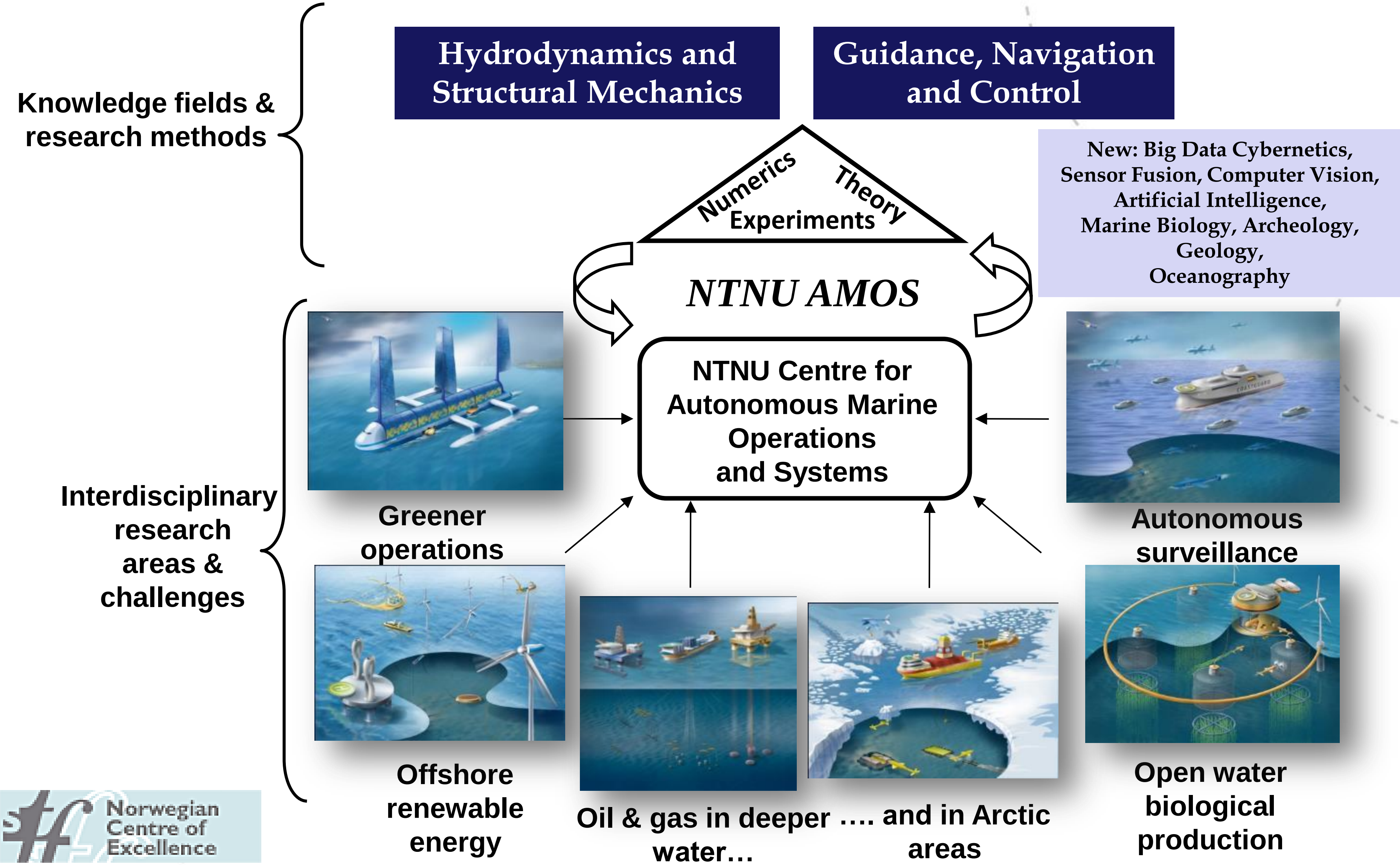
Outline

- AMOS Centre
- Autonomy
- AMOS in the Arctic

Ocean Space - The blue economy



Next step in research, education and innovation



Norwegian Centre of Excellence

NTNU AMOS Facts and Figures (Phase 1: 2013-2017)

Personnel by end of 2015:
6 Key scientists/professors
2 Scientific advisors/professors
10 Adjunct professors
13 Affiliated professors
4 Post Docs/researchers
5 visiting profs./researchers
81 PhD candidates
2 administrative staff
2 + lab engineers
3 Spin off companies

Partners and collaborators:

Partners: The Research Council of Norway, NTNU, Statoil, DNV·GL, MARINTEK SINTEF, SINTEF

International collaborators: Denmark, Sweden, Portugal, Italy, Croatia, USA, Australia, Ukraine

National collaborators: University of Tromsø, UNIS, UNIK, Kongsberg Maritime, Rolls-Royce Marine, FMC, Ecotone, Maritime Robotics, FFI, NGU, Ulstein Group, Eelume, NORUT, Marine Technologies, Akvaplan Niva, …

Budget (10 years): 800+ MNOK (~95 MEUR)

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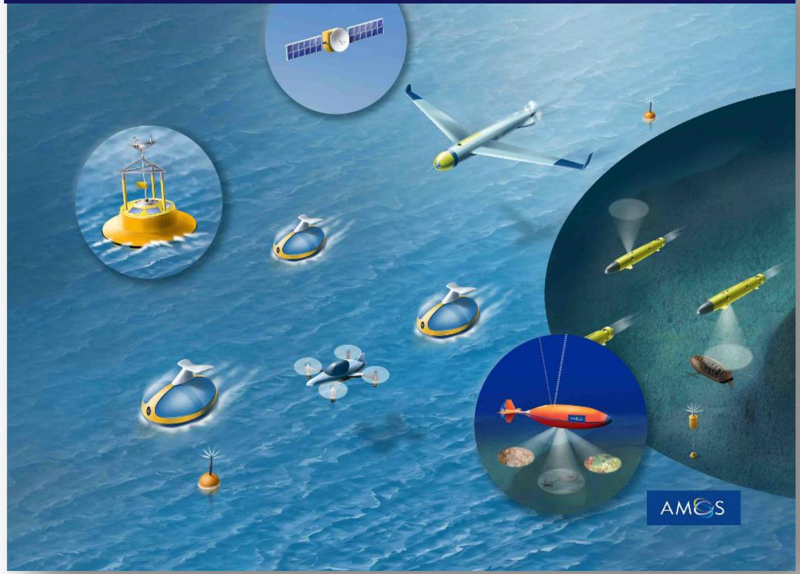
NTNU AMOS
Centre for Autonomous Marine Operations and Systems

NTNU AMOS Research Areas

Ocean space: The blue economy

Autonomous unmanned vehicles and operations



Smarter, safer and greener marine operations and systems

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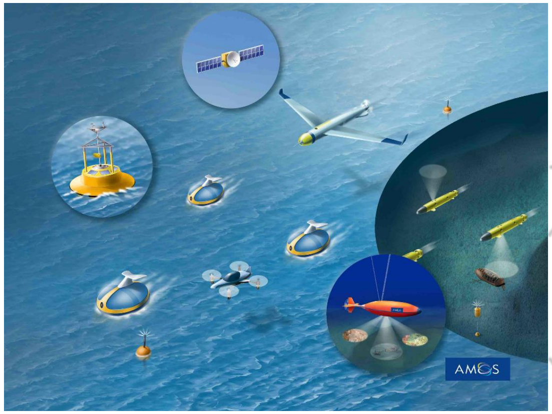
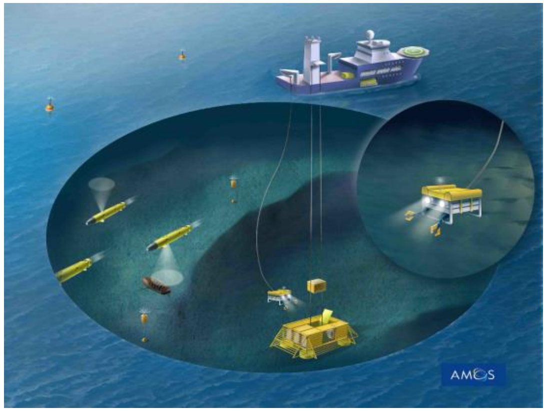
Autonomous unmanned vehicles and operations – 4 projects

- Autonomous unmanned vehicle systems
- Autonomous underwater robotics for mapping, monitoring and intervention
- Autonomous aerial systems for marine and arctic monitoring and data collection
- Safety, risk and autonomy in subsea operations





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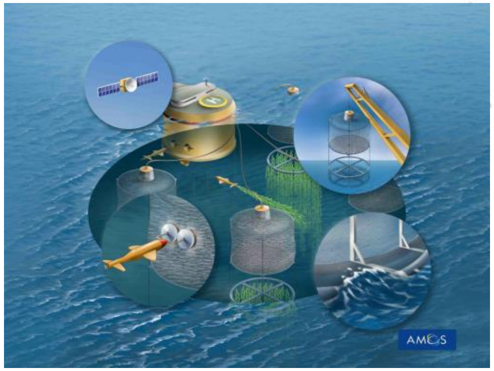
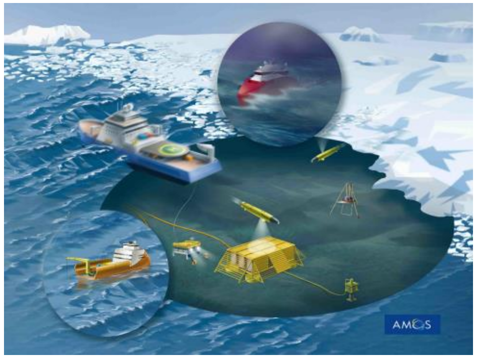
Smarter, safer and greener marine operations and systems – 5 projects

- Optimization and fault-tolerant control of offshore renewable energy systems
- Intelligent offshore aquaculture structures
- Energy management and propulsion for greener operations of ships and offshore structures
- Autonomous marine operations in extreme seas, violent water-structure interactions, deep waters and Arctic
- Consequences of accidental and abnormal events on ships and offshore structures





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Why autonomy?

More intelligent systems that depend less on human operators

Unique (or cheaper) solution when no (or limited) communication is available (bandwidth, remoteness)

Unmanned systems may be smaller, lighter, cheaper and safer to deploy and operate

Qualified operators may be a shortage

Mandatory for new functions

Enables complex functionality; provides fault tolerance and robustness

Enables operations in complex, harsh and remote environment (Dull/Dirty/Dangerous Operations)

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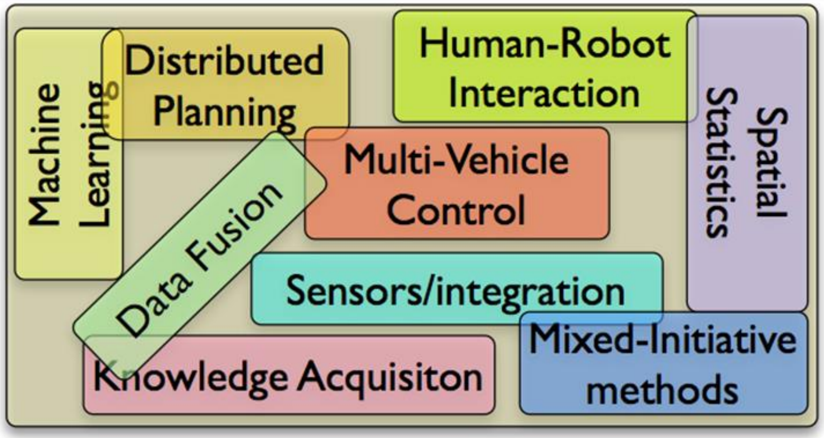
Bottom-up vs. top-down approach to autonomy

- In order to develop autonomous robots, the focus of engineering cybernetics must be widened to include methods for cognitive planning, typically through methods within artificial intelligence (AI)
- Considerations by autonomy expert Kanna Rajan:
  - "While AI has often been in the public imagination and associated with robotic platforms, the field's impact on real world problems especially in robotics has, till recently, been relegated to interesting laboratory methods that do not scale to real world environments. This is changing, with top-down abstractions in AI meeting bottom-up methods coming from Robotics."
  - "While AI is a conglomeration of techniques, the most relevant towards the key goal of ocean exploration, observation and monitoring are, we believe, Automated Planning and Execution, Machine Learning, Autonomous Agents and Diagnosis."



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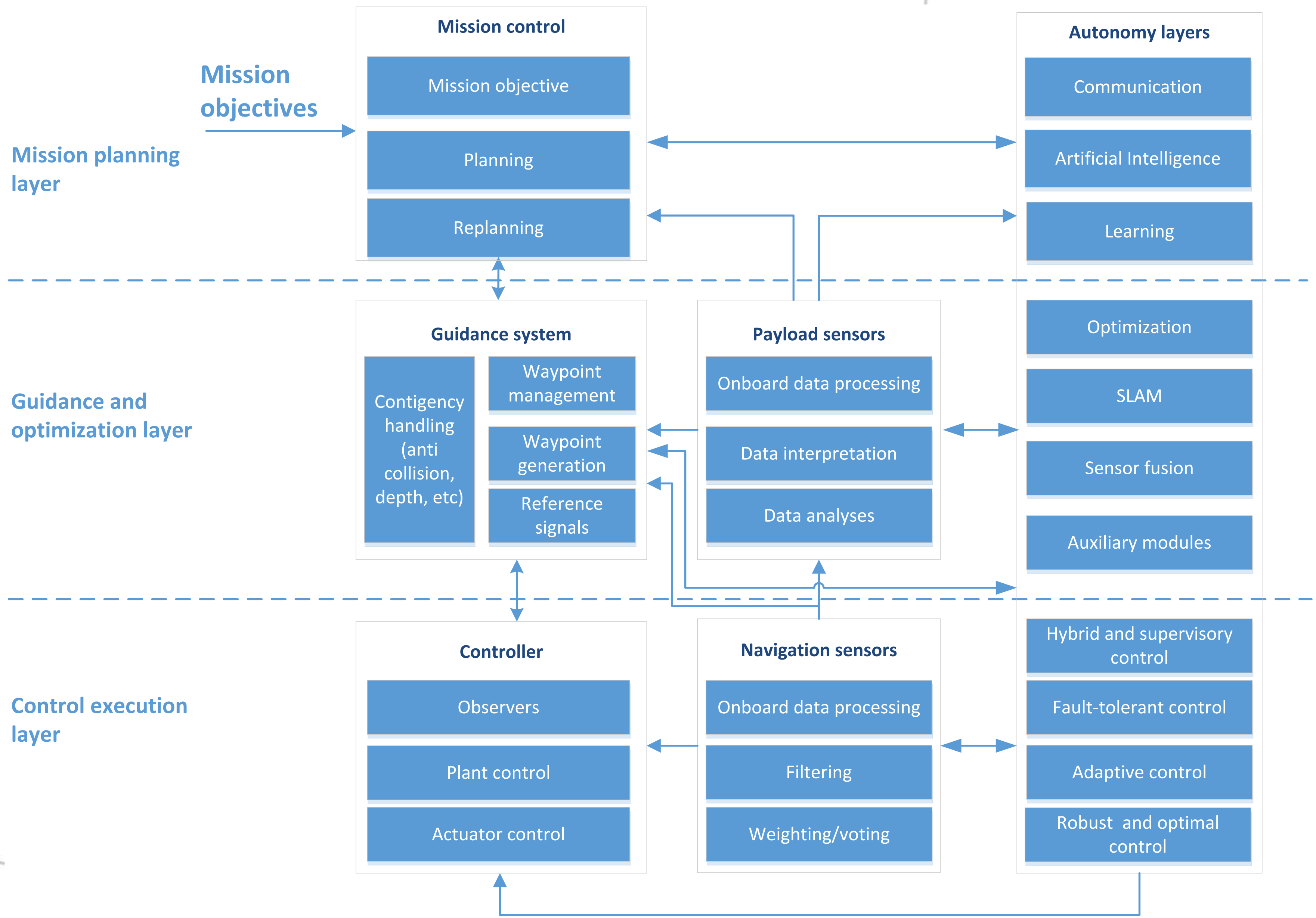
Control architecture for underwater vehicles



NTNU AUR-Lab og UAV-Lab: Integrerte teknologi plattformer for forskning i havrommet

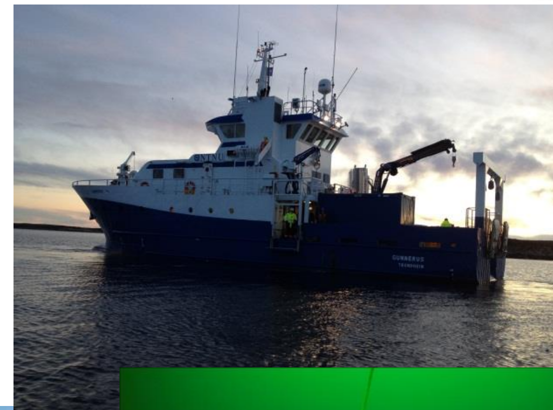
Air:

Penguin B fixed-wing UAV
X8 fixed-wing UAV
Hexa-copters



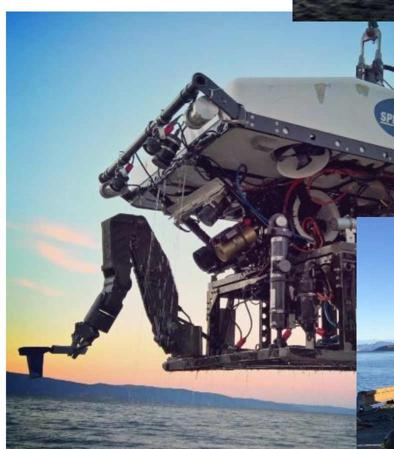
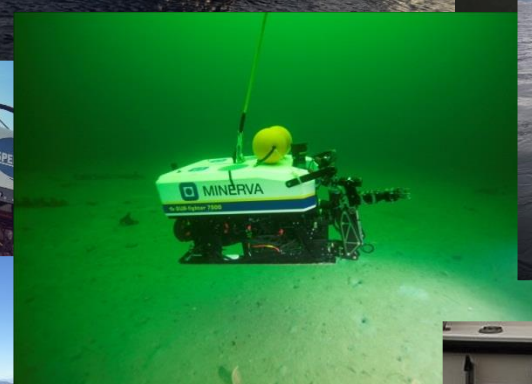
Surface:

Manned vessel – Gunnerus
Unmanned vessel – Jetyak




Underwater:

ROV Minerva
ROV 30k
AUV Remus 100
HUGIN HUS
2 LAUVs



Arctic operations

- Ny Ålesund 79°N
- Polar Night - January
- AUV
- Zooplankton migration

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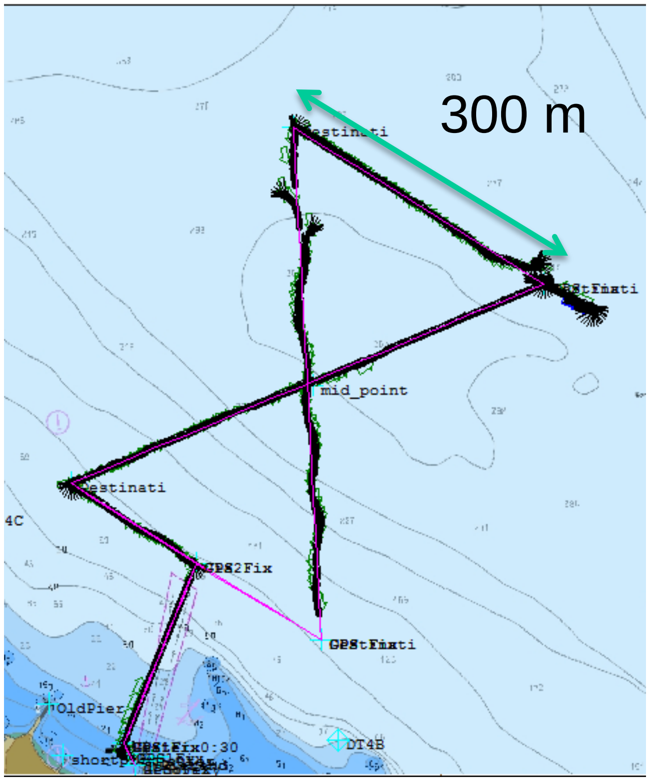
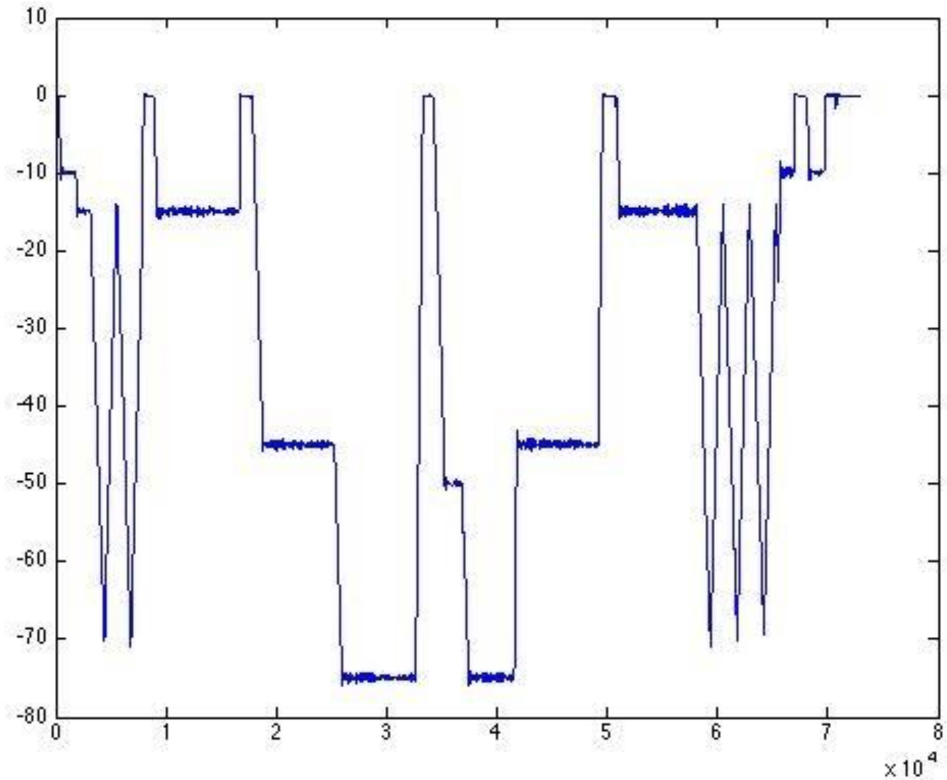
AUV track out of Ny-Ålesund 79°





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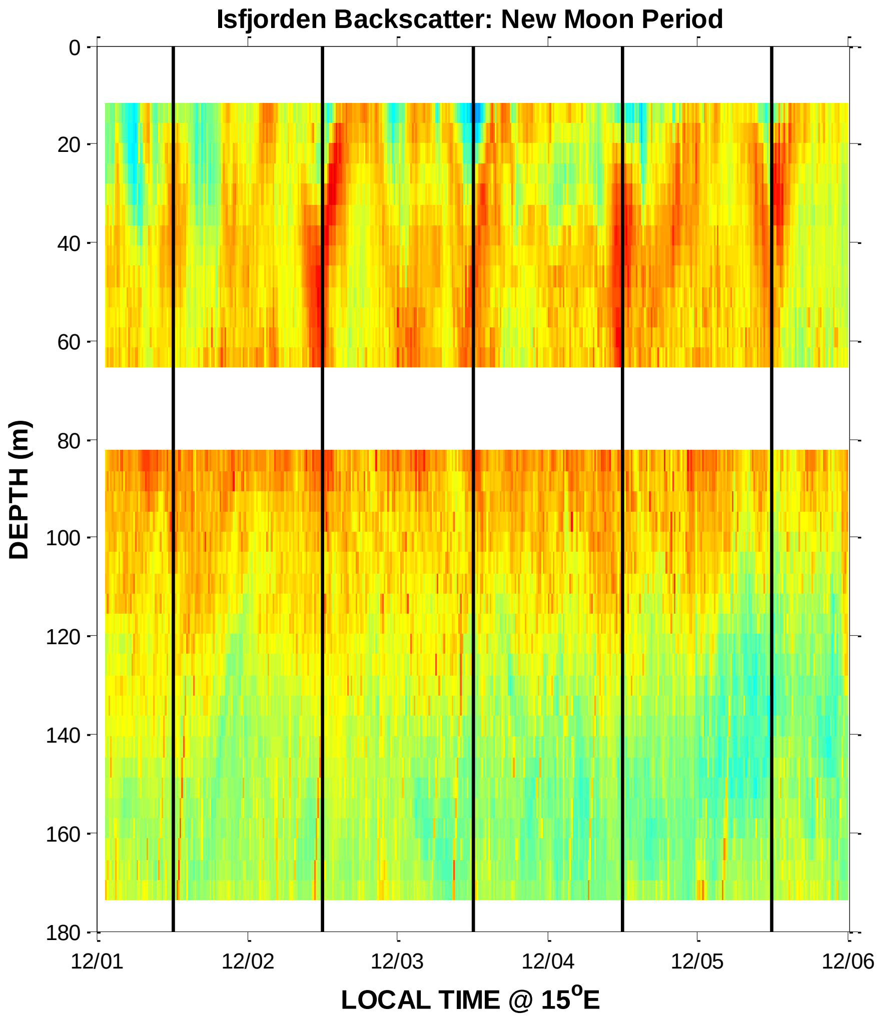

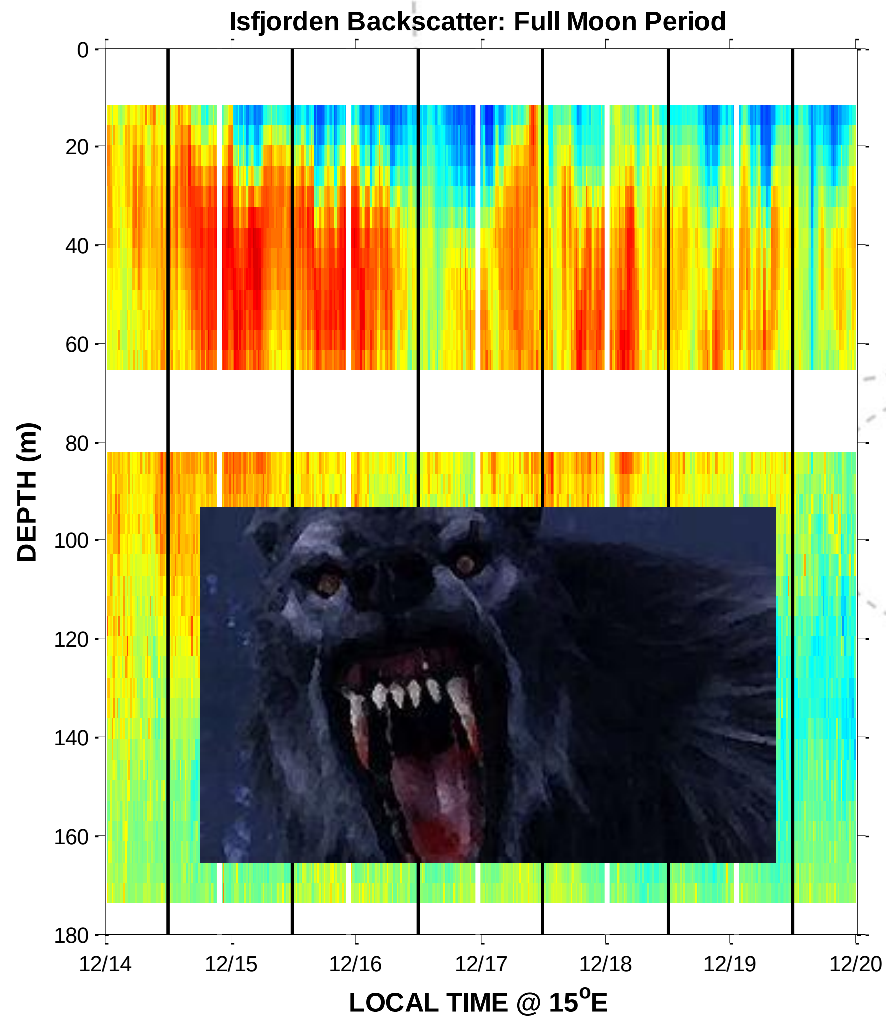

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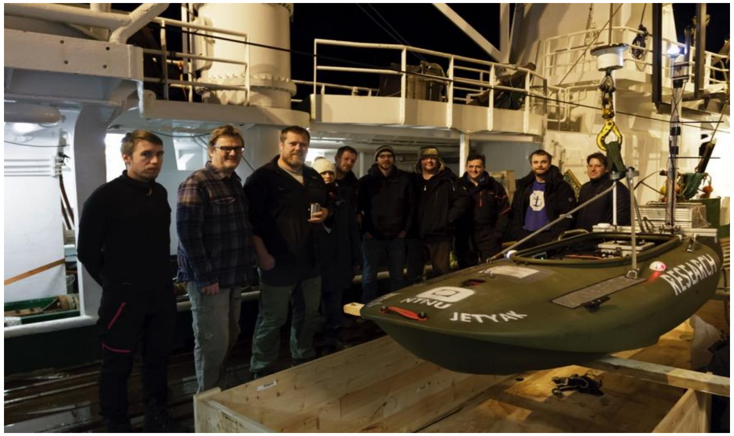
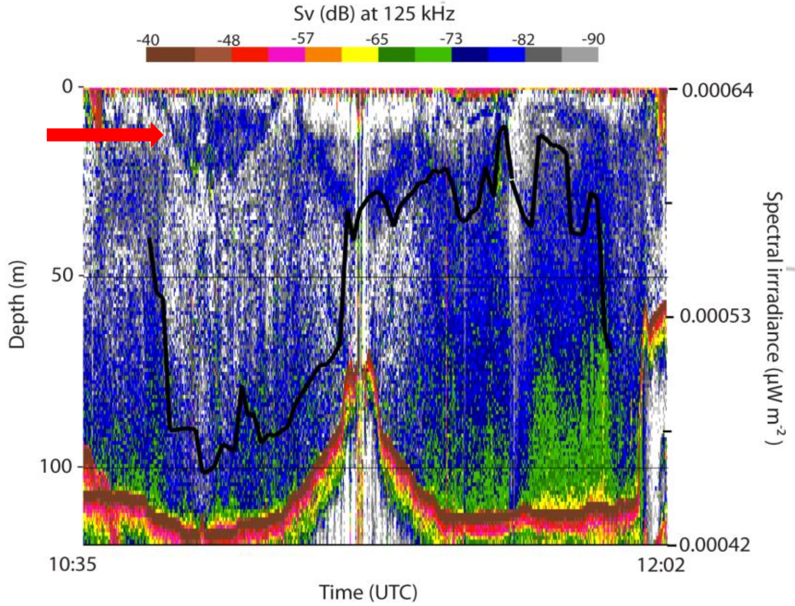
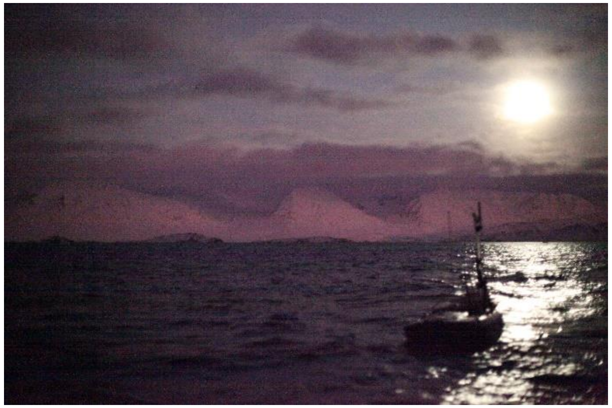
Diurnal migration of zooplankton in the polar night

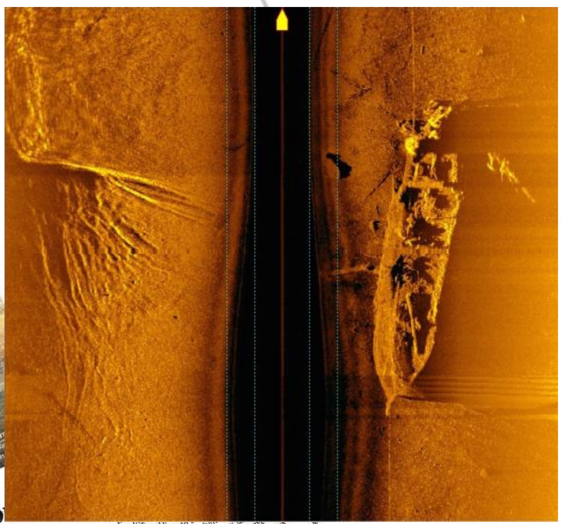




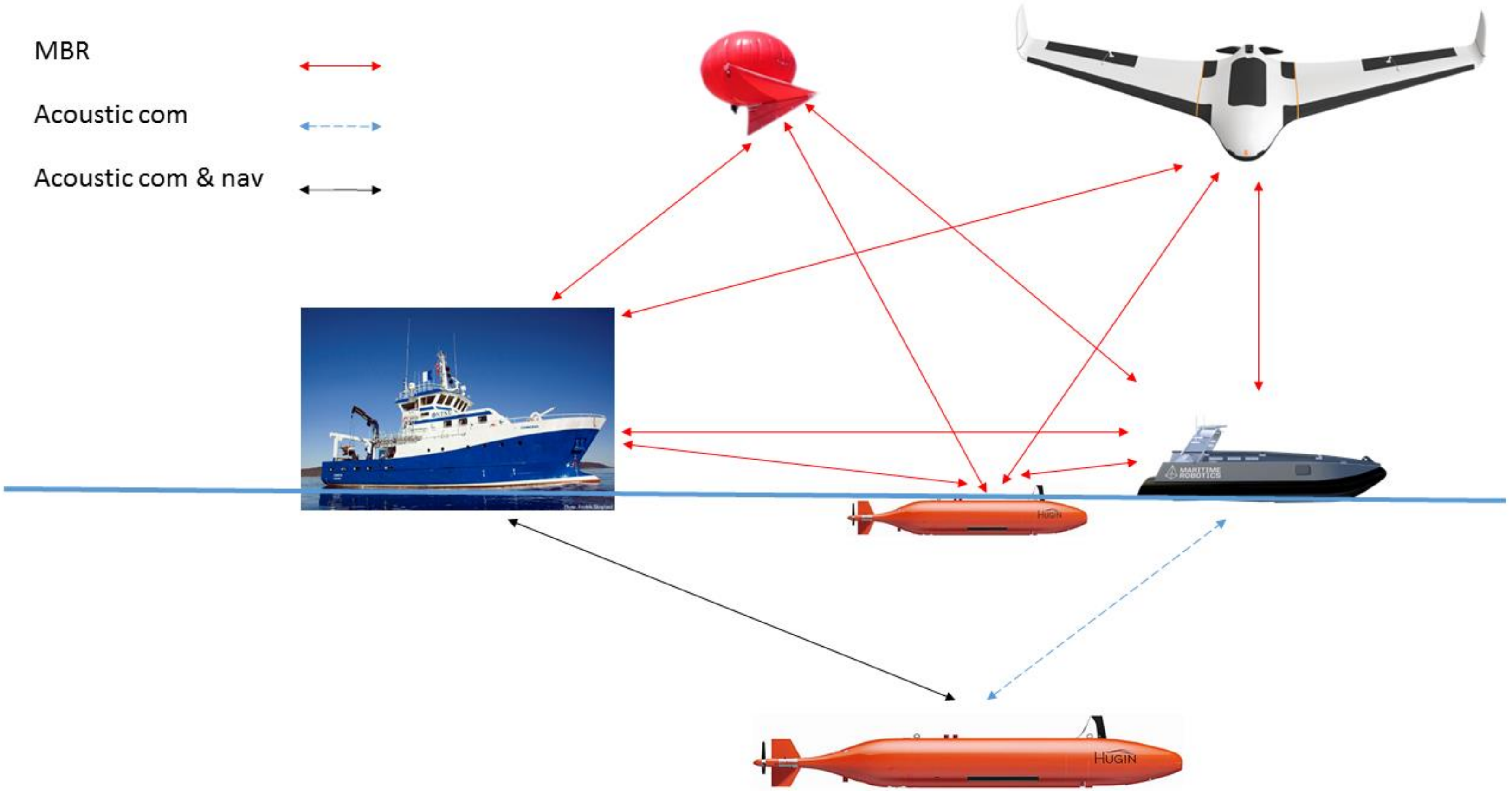


Archaeology in the Arctic

- Figaro
  - Northernmost identified wreck
- Shipworms
  - Newly discovered at higher latitudes



Network and communication



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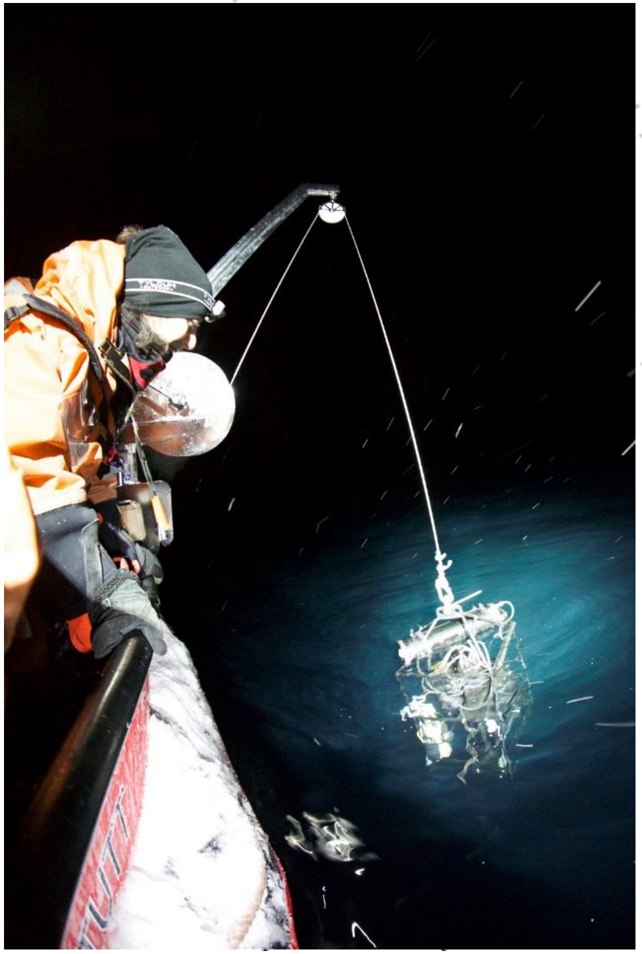
Glimpse from Arctic field campaigns



Glimpse from Arctic field campaigns

Glimpse from Arctic field campaigns

Summary

- AMOS Centre
  - Autonomy
- AUR-Lab
  - UAV
  - USV
  - AUV
  - ROV
- AMOS in the Arctic
  - Biology in the polar night
  - Archaeology
  - Education