



# 日欧GNSSミッション 海洋ロボット開発と運用化への課題 Development of USVs and agendas of their practical use in Japan



March 8, 2017

国立研究開発法人海洋研究開発機構

JAMSTEC

吉田 弘

Hiroshi Yoshida

第2回日欧GNSS官民ラウンドテーブル@駐日欧州連合代表部

# Technical Terms

- 無人航行船

UMV: Unmanned Maritime Vessel

- 洋上無人探查機

USV: Unmanned Surface Vehicle

- 洋上自律探查機

ASV: Autonomous Surface Vehicle

- 自律型無人探查機

AUV: Autonomous Underwater Vehicle

- 遠隔操縱型無人探查機

ROV: Remotely Operated Vehicle

Surface vehicles

Underwater  
vehicles

# Marine Robots





# UMVs

Large



? tons  
Drone ship/  
Rolls-Royce



40 m, 135 tons  
Sea Hunter/ DARPA



4.4 m, 1.5 tons  
Robotic Boat/  
JAMSTEC-Yanmar



350 kg  
C-Enduro / ASV

Small



90 kg  
Waveglider /  
Liquid Robotics

# Boat size UMV



3.5 tons  
C-Worker / ASV



1.7 tons  
Mariner/ Maritime Robotics



3 tons  
Kan-chan/  
Windy network



1.8 tons  
DELPHIS / MES

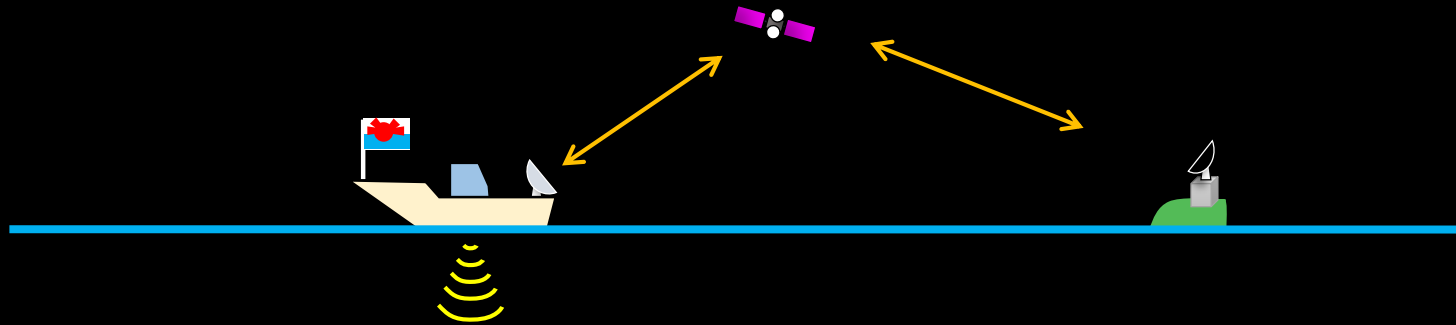


3 tons  
Mainami /  
JAMSTEC-MHI

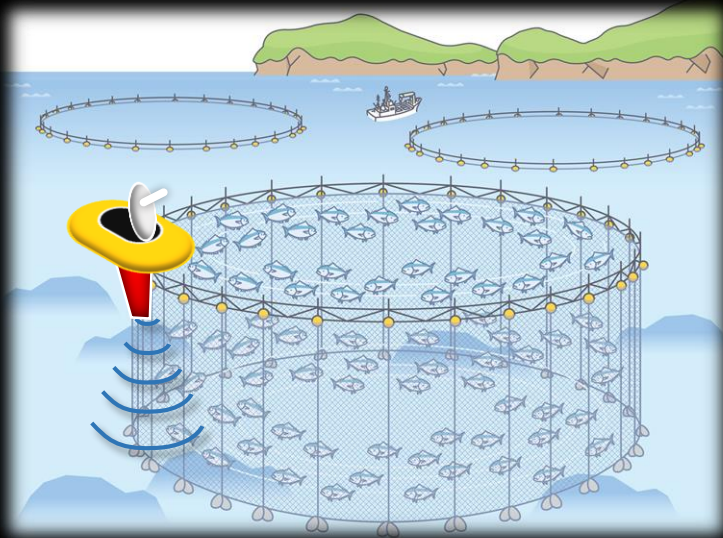


1.5 tons  
Robotic Boat/  
JAMSTEC-Yanmar 5

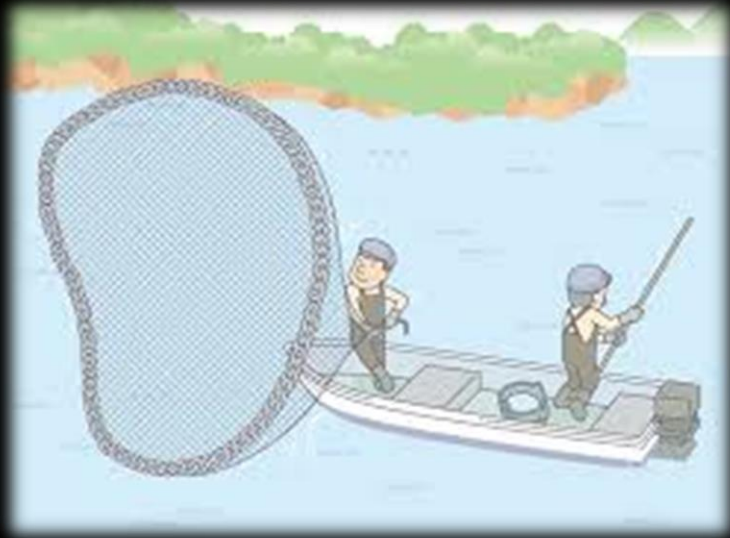
# Applications for the fisheries industry



漁船のGNSS・自律認識ハイブリッドによる自動航行  
Autonomous cruising of fish boats

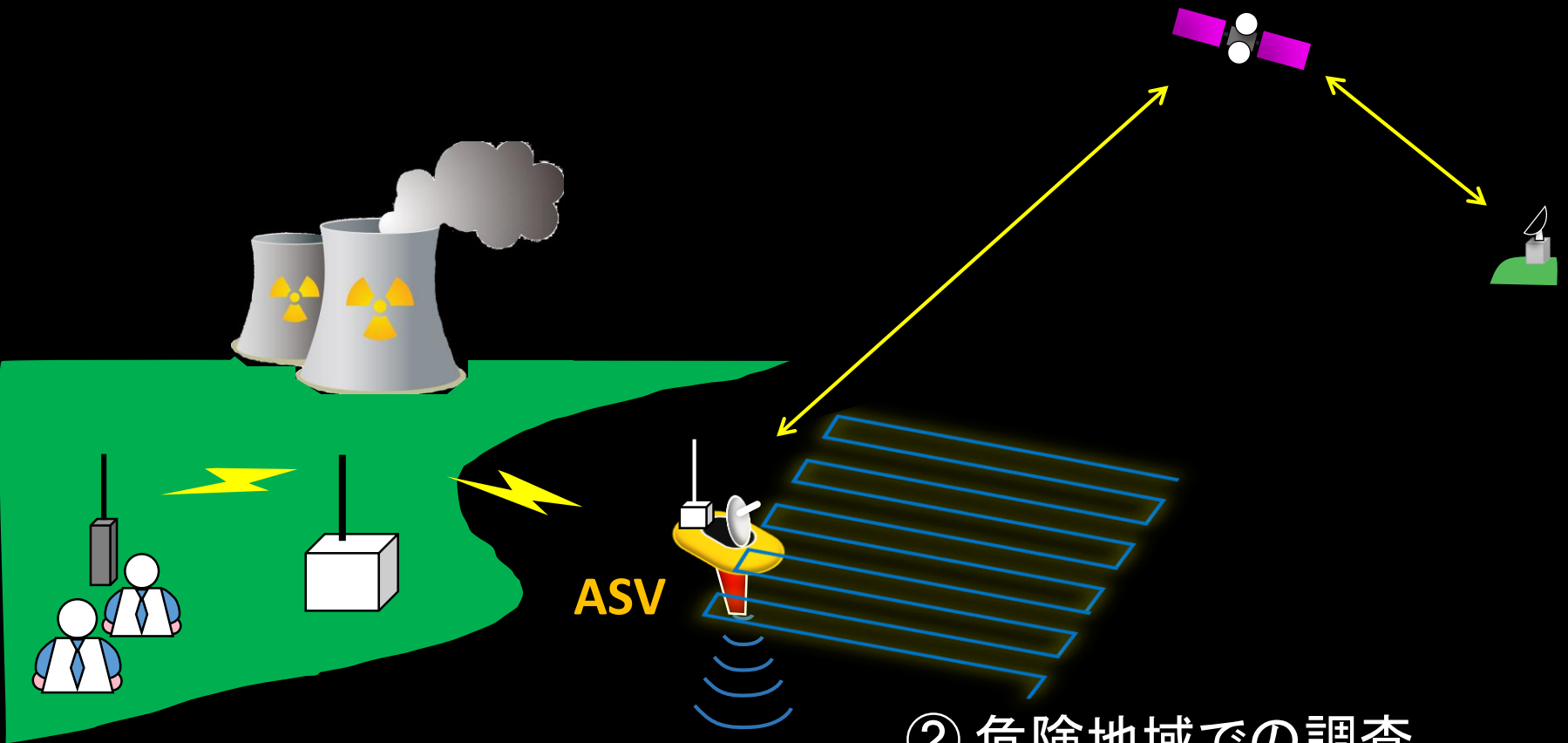


Monitoring of marine farms



Automatic fixed-point operation

# Securing communication and observation in a disaster-stricken region



① 被災時の通信確保

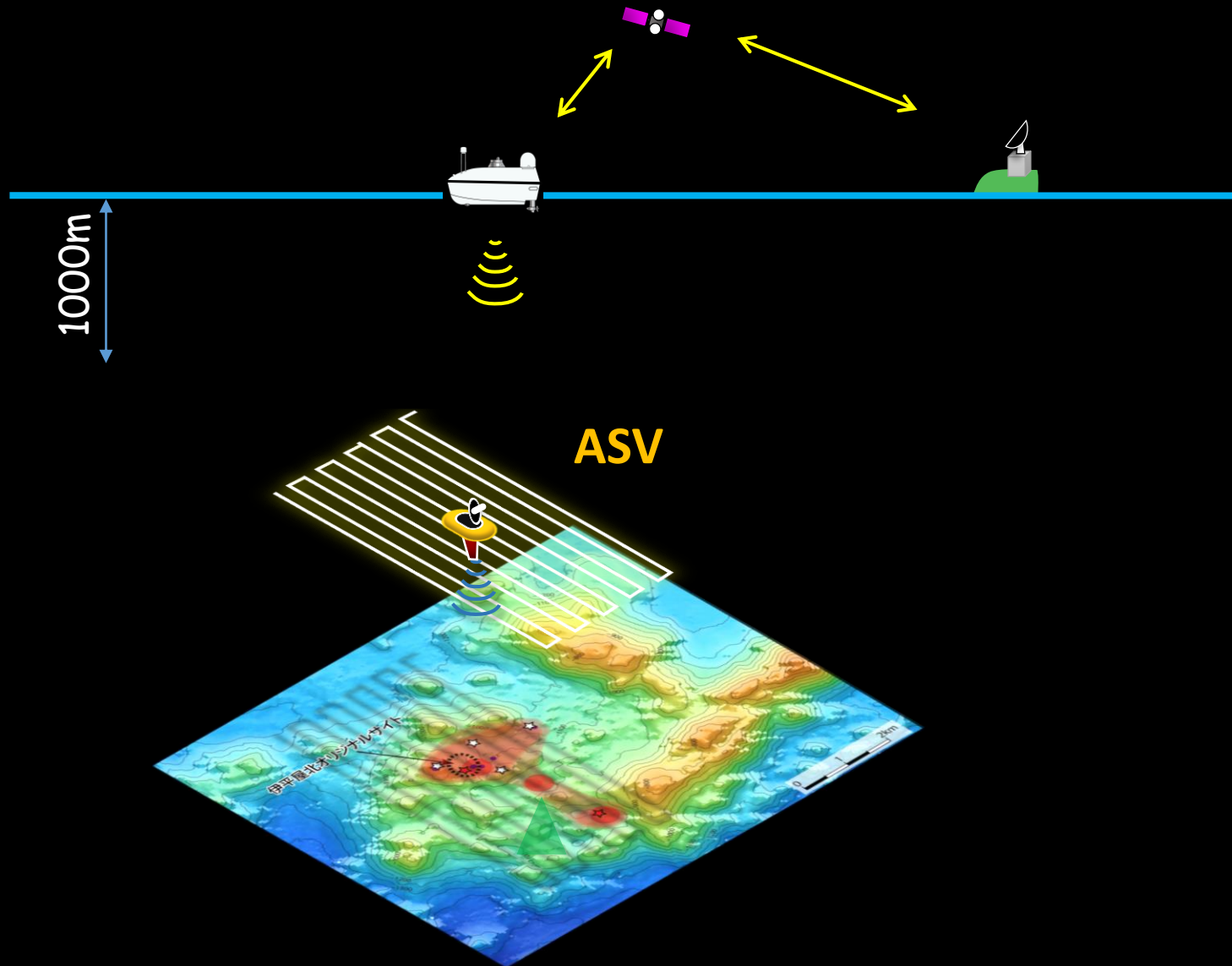
securing communication in emergency situations

② 危険地域での調査

Observation in a hazard area

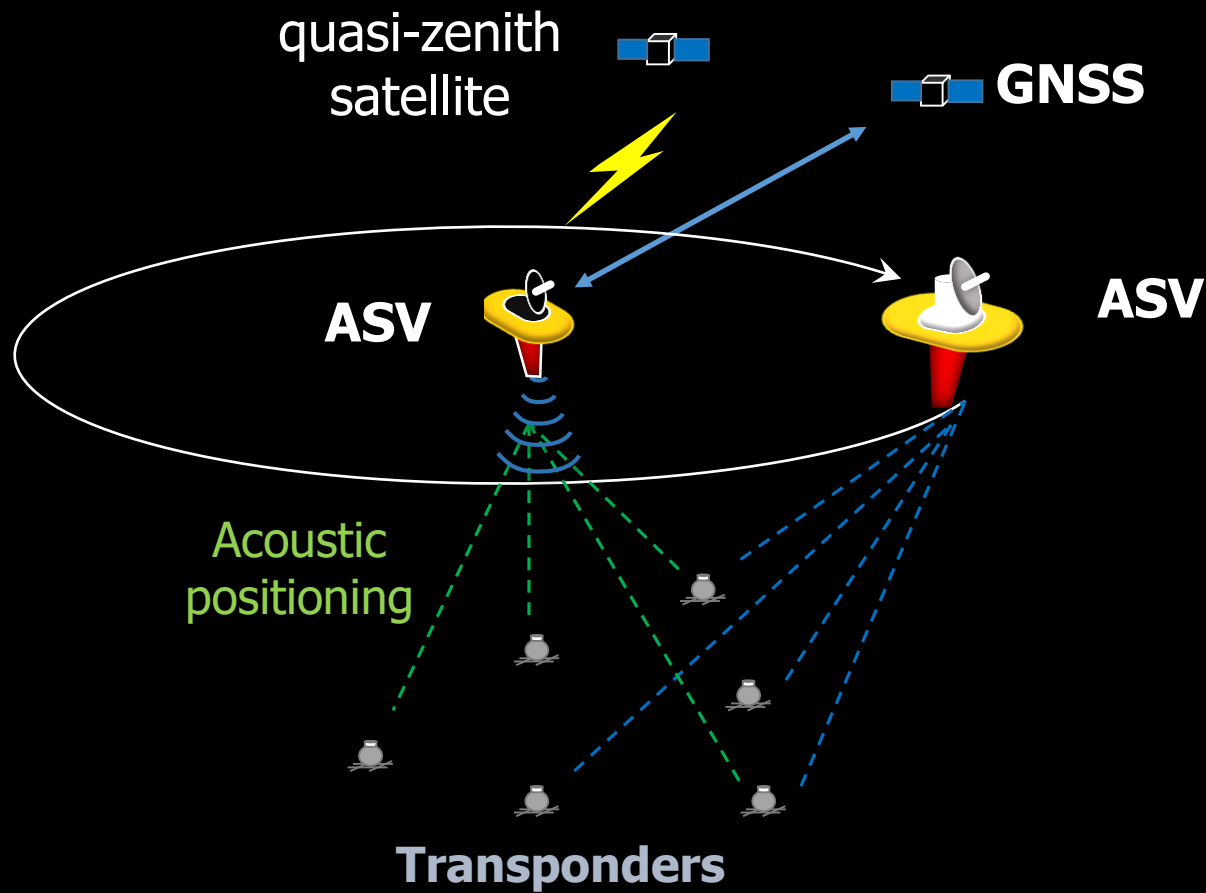


# Creating bathymetry map in shallow water





# Observation of crustal movement



# 無人船とAUVの同時利用

## ASV-AUV applications

# Why we need underwater vehicles

ITEMS	Surface	Shallow water	Deep sea
資源開発 Development of resources	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
気候変動 Climate change	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
環境調査 Environment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
港湾点検 Inspection in port and harbor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
漁業・養殖 Fisheries	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
海洋エネルギー Ocean energy	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
輸送 Carrier	<input checked="" type="checkbox"/>		



# AUV....., What?

Manned

Remotely

Autonomous

Famous Robots



Underwater  
Vehicles



HOV



ROV



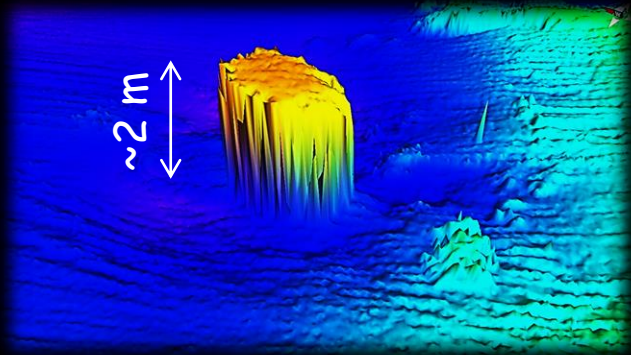
AUV

AUV = Autonomous underwater vehicle

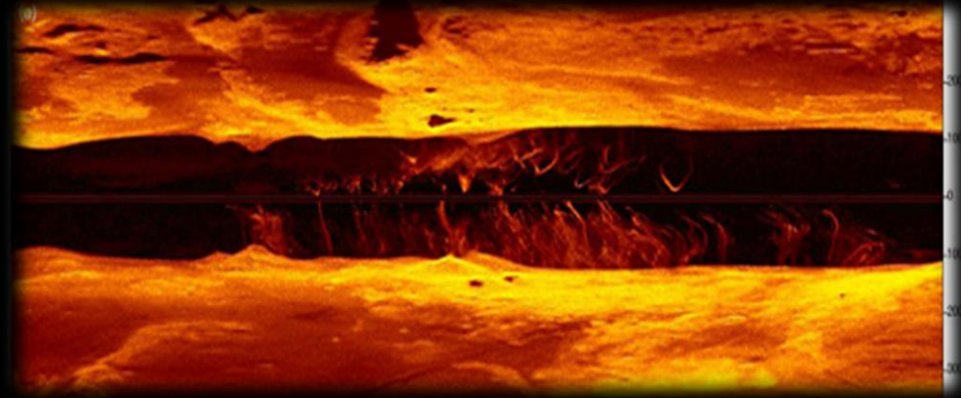
# AUV enables underwater imaging and...



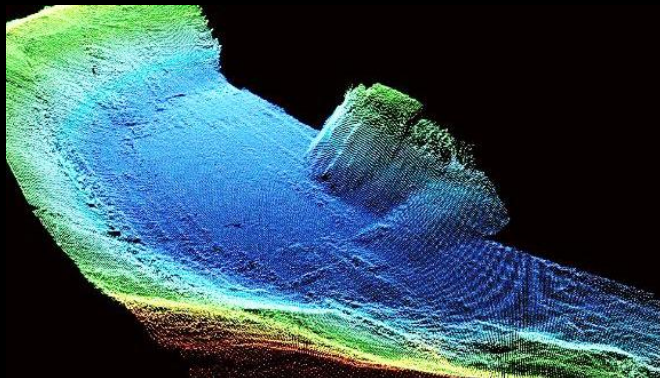
CTD measurement, pH, Co<sub>2</sub>, ATP, DO, etc.



Laser scanning image



Sonar image



Bathymetry



Mosaicing by stereo camera

# AUV is higher performance platform but...

Now

A mother vessel positions and monitors AUV(s)



Operation cost of the vessel is about  
¥ 5,000,000/day



An ASV is a great substitute for a mother vessel

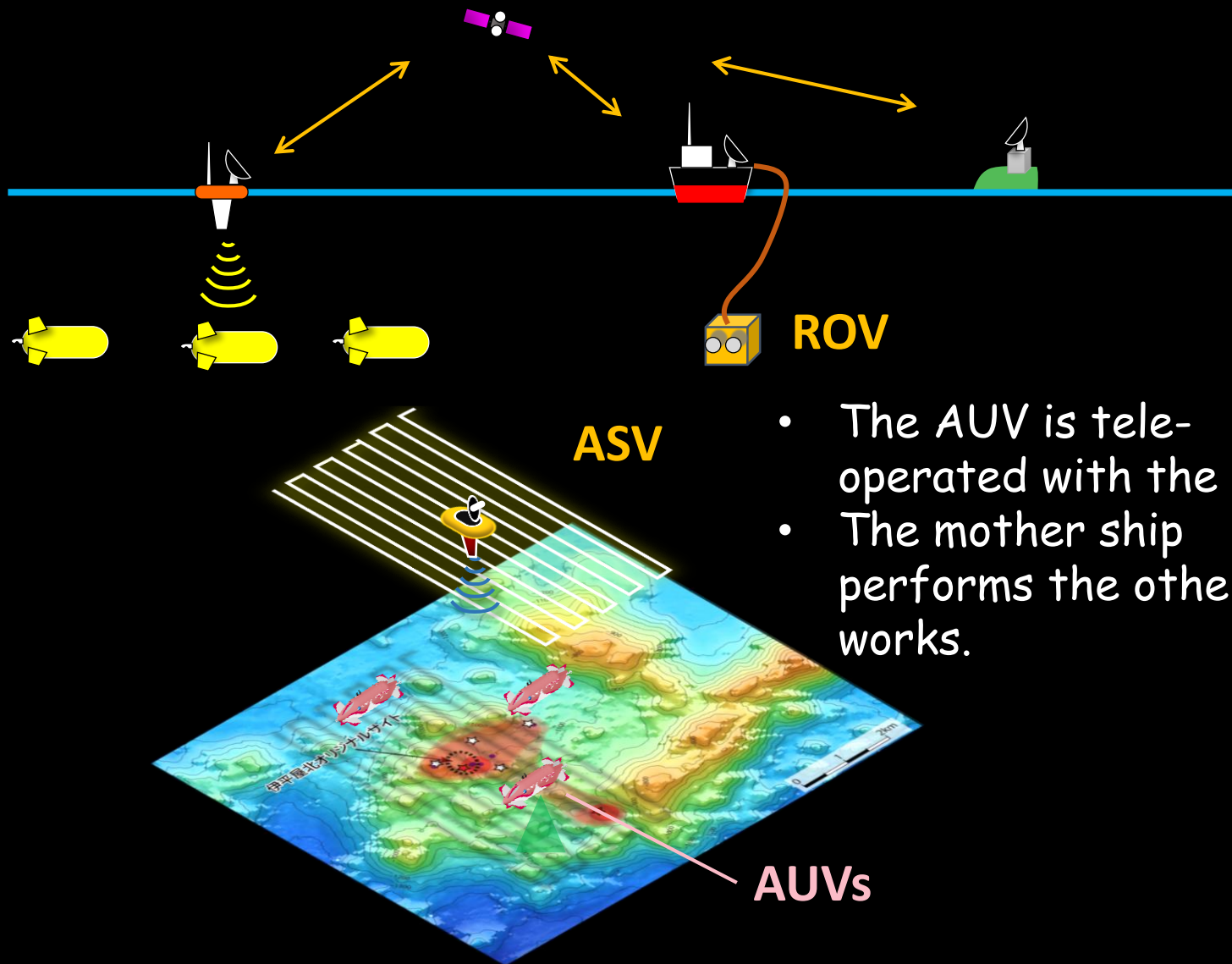


# 基本的なASV-AUVの使い方

## ASV-AUV operation



# Marine resource exploration with multiple AUVs



# Pipeline inspection



Sonar  
Laser Scanner  
Camera

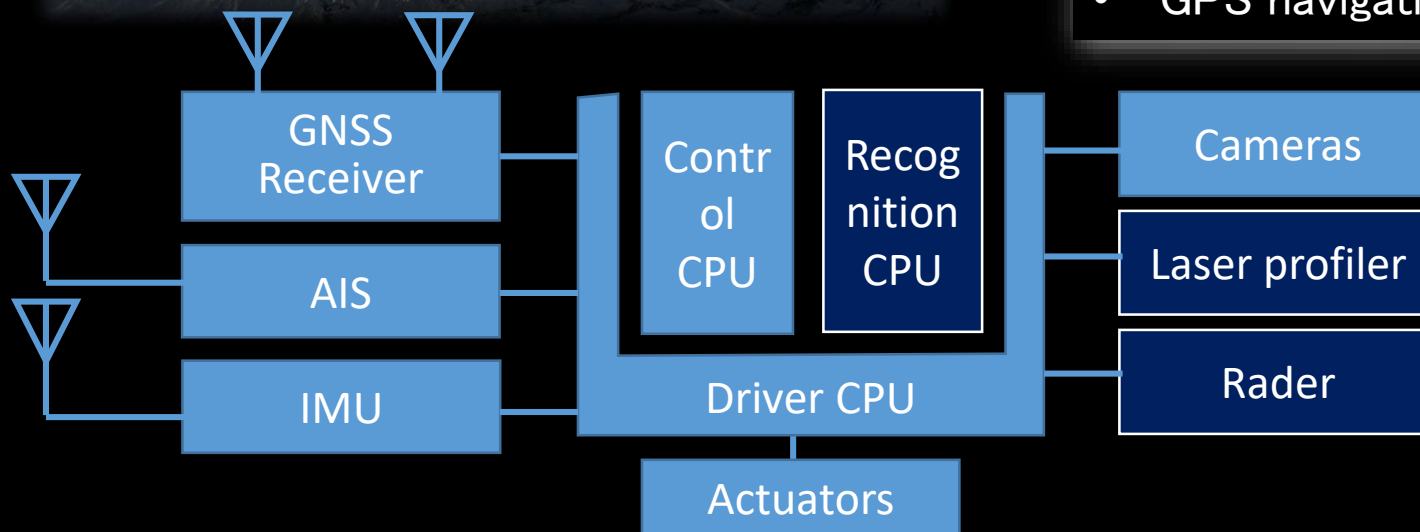


# JAMSTE's Robotic Boat



## Specifications of the ASV

- Length: 4.4 m
- Weight: 1.8 tons
- Speed: 5 knots
- Endurance: 48 hours
- 格納型キール搭載
- Ka & L satellite communication
- Iridium communication
- WiFi
- GPS navigation



# 運用化への課題

## Technologies improvement needed

### 1. 測位 (Positioning)

特に海中が難しい

GNSS-INS-Doppler velocity meter hybrid navigation

### 2. 他船舶や海洋構造物との衝突回避方法

(How do you avoid collisions?)

i. 自動認識 (Automatic recognition) → Probability of misjudgment?

ii. 遠隔監視 (Tele-monitoring) → Mandatory twenty-four-hour supervision?

### 3. 信頼性 (Reliability)

多数のロボットを同時に利用していくために、どのような信頼性基準が必要か？

# 運用化への課題 Regulations

- 海上衝突予防法

The Act for Preventing Collisions at Sea is the most important.

- 海上・海中ロボットのルール作りでは漁協の意見が重要

It is important to reflect views of fisheries cooperative association on the rules.

- 日本国内には未だ無人船のルールが無い

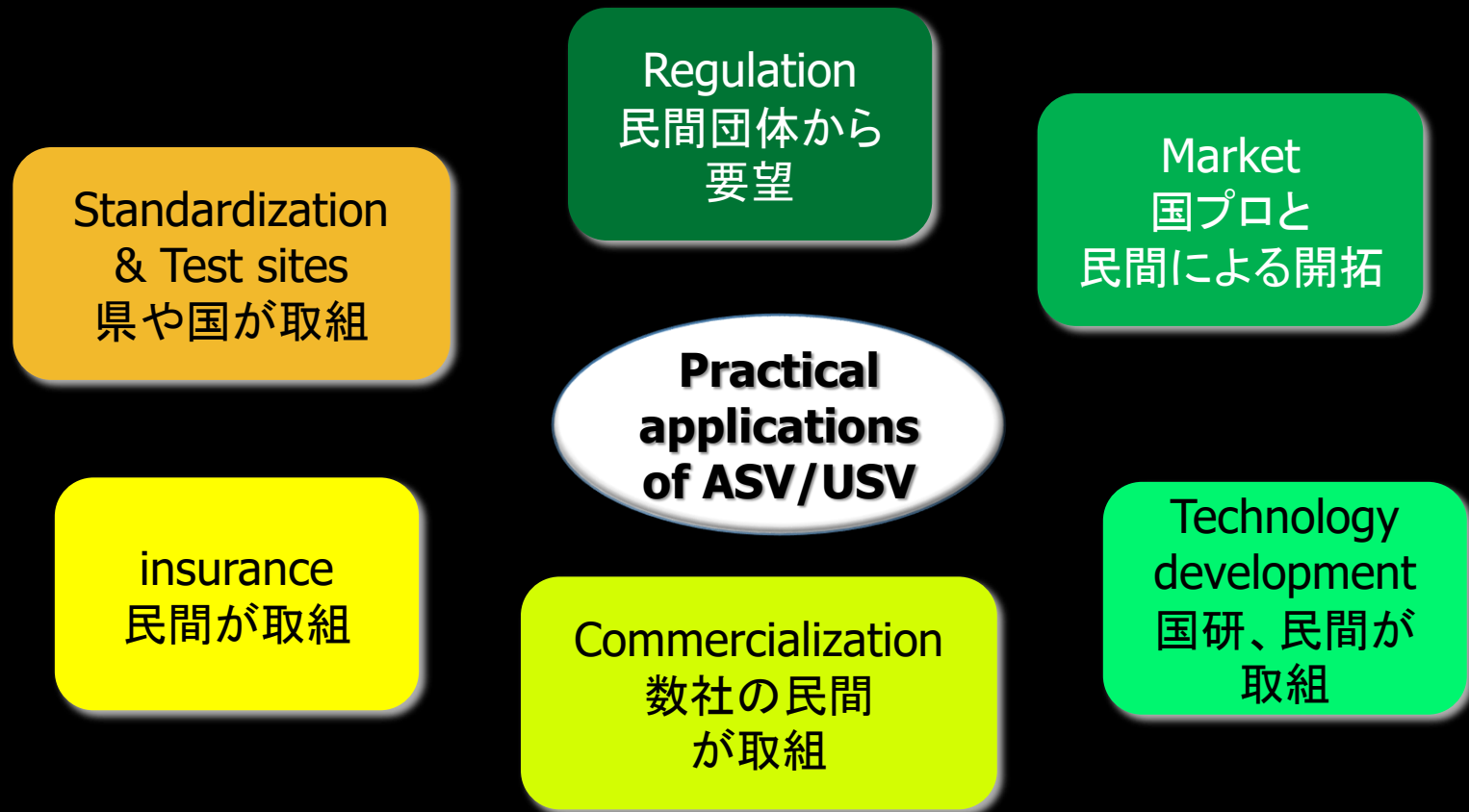
There has been no progress in making revisions to existing laws to deal with ASVs in Japan.

- 無人船のルール化に当たっては、無人船のメリットが出るようなレギュレーションが必要

The regulation to be revised must have the merit of ASVs compared to manned ships.



# ボートサイズ無人船(ASV)実用化において Toward the realization of ASVs in Japan



個別な取り組み  
individual actions



相互協力による統一的な取り組み  
Unified actions

END