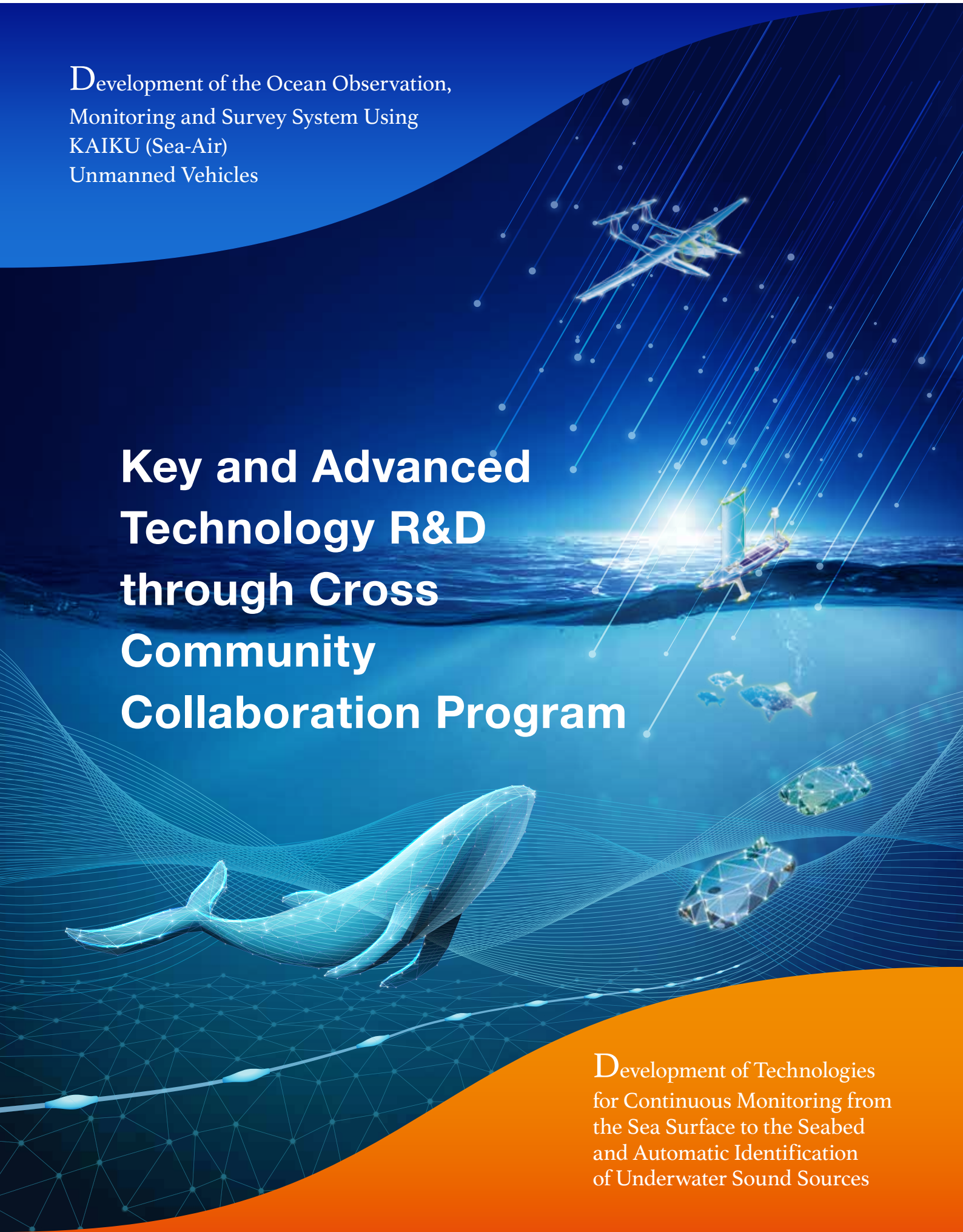
JAMSTEC 国立研究開発法人 海洋研究開発機構
Japan Agency for Marine-Earth Science and Technology

K Program
Key and advanced technology R&D through cross community collaboration Program

Development of the Ocean Observation, Monitoring and Survey System Using KAIKU (Sea-Air) Unmanned Vehicles

Key and Advanced Technology R&D through Cross Community Collaboration Program



Development of Technologies for Continuous Monitoring from the Sea Surface to the Seabed and Automatic Identification of Underwater Sound Sources

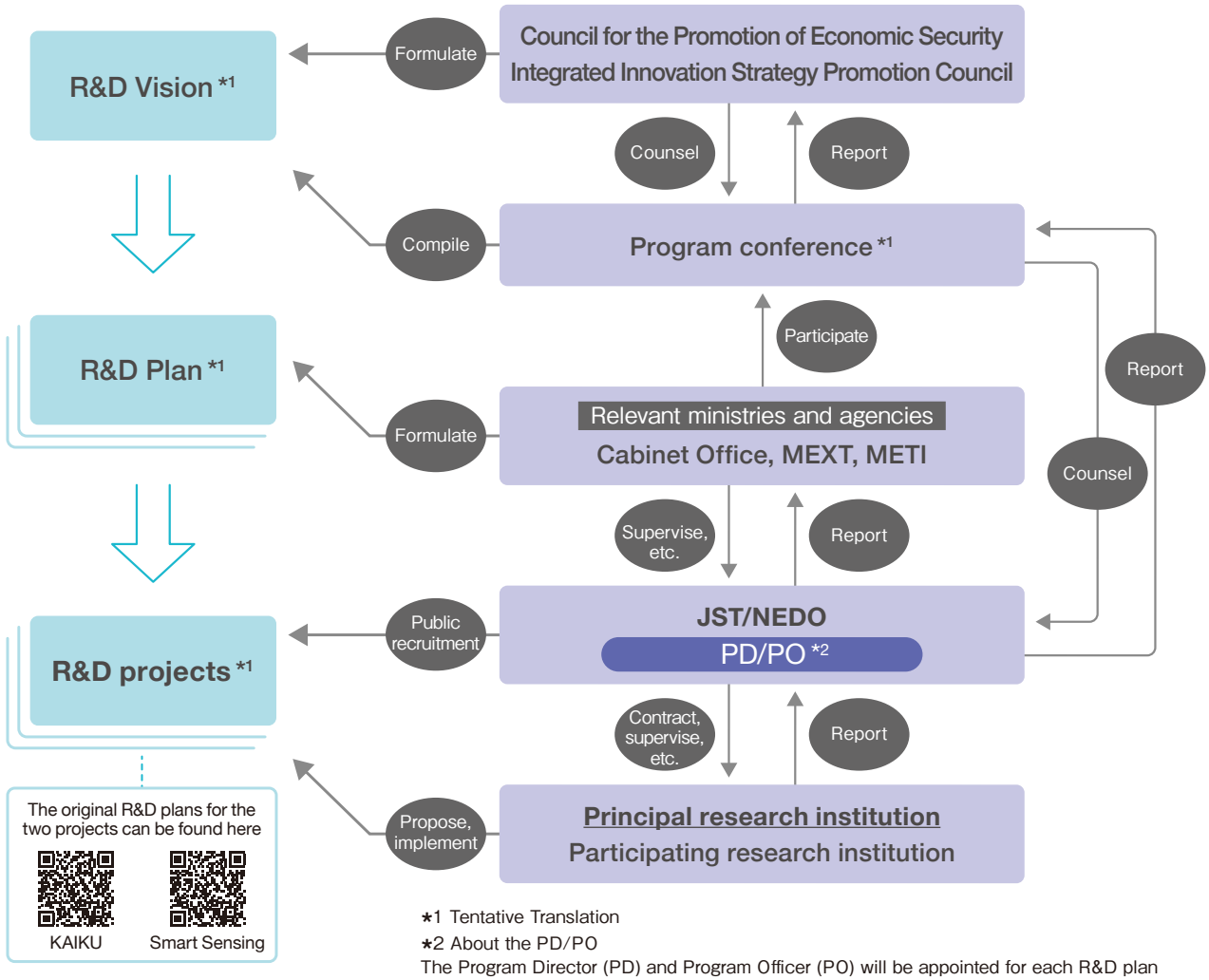
What is the Key and Advanced Technology R&D through Cross Community Collaboration Program (K Program) ?

K Program

Japan Science and Technology Agency

This program was established under the leadership of the Cabinet Office to promote the research, development, and utilization of technologies that are vital for Japan's economic security.
Under this program, JAMSTEC has been contracted by the Japan Science and Technology Agency (JST) as the principal research institution conducting research and development for two projects: "Development of the Ocean Observation, Monitoring and Survey System Using KAIKU (Sea-Air) Unmanned Vehicles" and "Development of Technologies for Continuous Monitoring from the Sea Surface to the Seabed and Automatic Identification of Underwater Sound Sources."

K Program



*1 Tentative Translation
*2 About the PD/PO
The Program Director (PD) and Program Officer (PO) will be appointed for each R&D plan

Ken Takagi

Professor Emeritus, The University of Tokyo

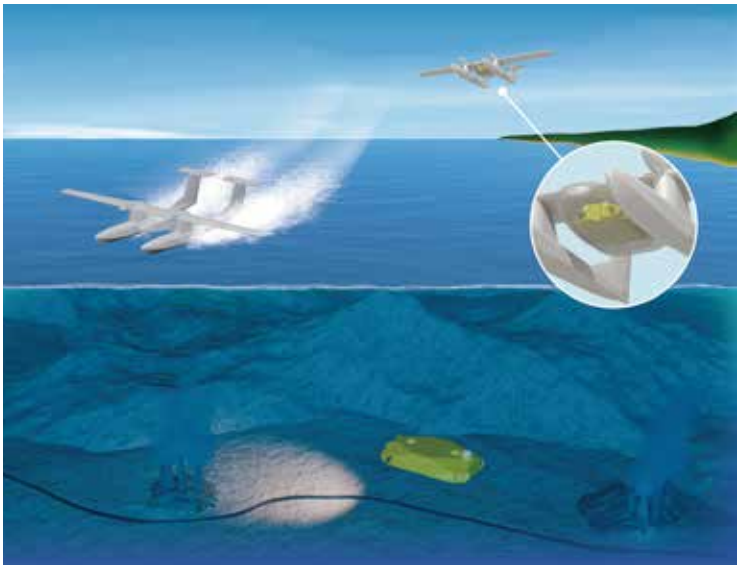
Program Director

Solving oceanic mysteries, protecting marine interests, and responding to marine disasters, etc. are common issues not only for Japan but for the entire world. The two research and development projects that JAMSTEC is in charge of as the principal research institution both aim to construct innovative marine survey systems. We are advancing research and development so that Japan can lead the world in marine survey technologies, and contribute the outputs to society.

Project name

Development of the Ocean Observation, Monitoring and Survey System Using KAIKU (Sea-Air) Unmanned Vehicles

Alias **KAIKU Project**



Japan is surrounded by vast oceans. Therefore, conducting surveys to efficiently and safely acquire information and understand the situation in its Exclusive Economic Zones is important from the perspective of its economic security and industry.
Traditional marine surveys were primarily conducted using manned vessels.
However, the use of aircraft enables access to remote ocean areas in a short time. Besides an unmanned system can survey dangerous parts of ocean where manned vehicle cannot reach. This project originated from such a concept.
One of the focuses of this project is developing technologies for KAIKU (sea-air) unmanned system: an Integrated system consisting of AUV (Autonomous Underwater Vehicle) that is automatically launched and recovered from unmanned seaplane. The other is the development of deep-sea AUV (hybrid type, capable of both cruising and hovering) that can conduct surveys in deep ocean areas up to 6,000 meters deep.

R&D item

Mission control system (MCS)

MCS is a system that coordinates multiple subsystems and provides integrated control for KAIKU in place of humans. A key function of MCS is mission transition decisions.

Unmanned seaplane

An unmanned amphibian that transports the AUV. It is capable of automatically landing on and taking off from the ocean. It has a twin fuselage to mount the LARS and transport the AUV.

KAIKU system

Automatic launch and recovery system (LARS)

Automatic launch and recovery system is mounted between the seaplane's twin fuselage. The LARS automatically launches the AUV into the ocean after the seaplane lands on the water and recovers it after the survey.

Automatic launch and recovery AUV

The AUV is designed to be lightweight for mounting on the seaplane. It conducts surveys such as creating topographical maps of the seafloor and is equipped with functions for automatic launch and recovery.

Deep-sea AUV

An AUV that is capable of diving to a depth of 6,000 meters. It is to quickly dive to the seafloor at great depths using its large attitude control.

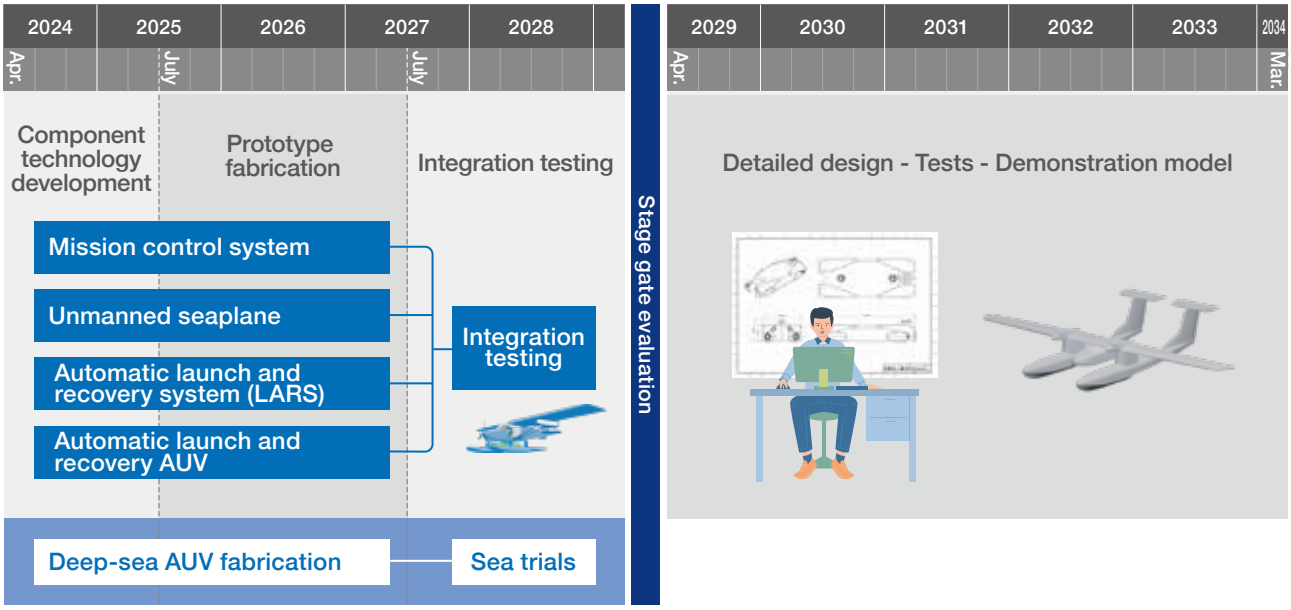
Tomoya Inoue

Director,
KAIKU Technology Development Center,
JAMSTEC

Principal Investigator

We are exploring new possibilities for marine surveys through the operation of autonomous underwater vehicles with unmanned seaplanes.
The development of unmanned and automation technologies will enable agile and efficient surveys and open up ways to conduct surveys in ocean areas that are difficult for manned vessels. Flying through the sky and diving into the sea – we will continue our research and development with the goal of building this grand and innovative KAIKU system.

KAIKU Research and Development Schedule



* May be subject to change

Project Team Organizational Chart

Program Director: Ken Takagi

Principal Investigator: Tomoya Inoue
(Director, KAIKU Technology Development Center, JAMSTEC)

K Program Management Group

KAIKU

R&D item 1	R&D item 2	R&D item 3	R&D item 4	R&D item 5
Mission control system	Unmanned seaplane	Automatic launch and recovery system	Automatic launch and recovery AUV	Deep-sea AUV
Participating research institution **JAMSTEC**	Participating research institution **ShinMaywa Industries**	Participating research institutions **JAMSTEC** ShinMaywa Industries/ IDEA Consultants/ National Institute of Maritime, Port and Aviation Technology	Participating research institutions **IDEA Consultants** National Institute of Maritime, Port and Aviation Technology	Participating research institutions **IDEA Consultants** National Institute of Maritime, Port and Aviation Technology/ JAMSTEC

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The information in this leaflet can be found at the link below.

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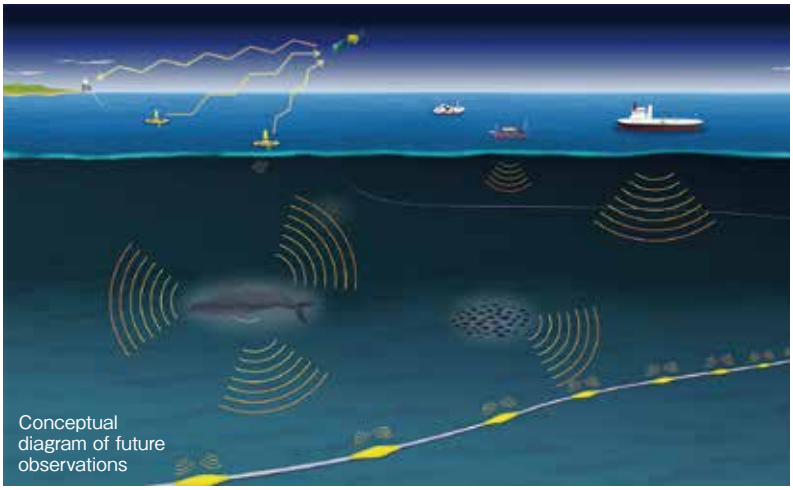
Research Institute for Marine Technology and Engineering

Project name

Development of Technologies for Continuous Monitoring from the Sea Surface to the Seabed and Automatic Identification of Underwater Sound Sources

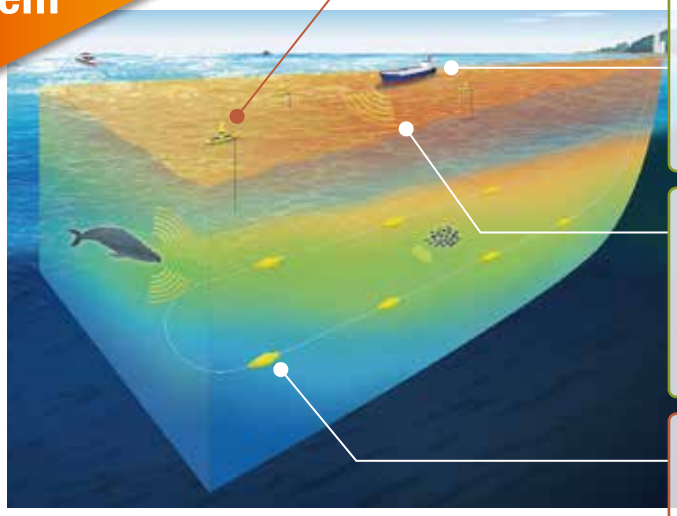
Alias **Smart Sensing Project**

We cannot directly observe underwater environments, and radio waves do not propagate effectively through water. However, the ocean is rich in acoustic signals.
This project aims to develop technologies that enable near real-time visualization of underwater conditions by autonomously monitoring underwater acoustics and oceanographic parameters –such as temperature, salinity, and current flow– and analyzing their collected data.
To monitor underwater acoustic data, a cable system equipped with numerous hydrophones will be laid on the seafloor from the land-based station. The detected acoustic signals will be transmitted via optical fiber cable to computers in the land station, and the data will be processed to estimate the type of sound and their movement patterns.
For oceanographic data, we will develop an unmanned surface vehicle powered by wind –similar to a sailboat– which will autonomously navigate and observe using onboard sensors. The collected data will be transmitted to land for analysis. We will develop an integrated system that combines these technologies: the Acoustic and Oceanographic Data Acquisition and analysis System (AODAS).



Conceptual diagram of future observations

R&D item



Integrated observation technologies using unmanned surface vehicles and oceanographic data analysis
Temperature and related oceanographic data are collected from the sea surface to subsurface layers using sailboat-type unmanned surface vehicles. These observations are integrated through data assimilation and multi-model ensemble approaches to visualize and interpret oceanic conditions.

Construction of an underwater sound source catalog using passive data from environmental, anthropogenic, and biological sounds
The catalog identifies and classifies various underwater sound sources—including environmental, anthropogenic, and biological sounds—and supports the analysis of acoustic data collected via seafloor sensing cables.

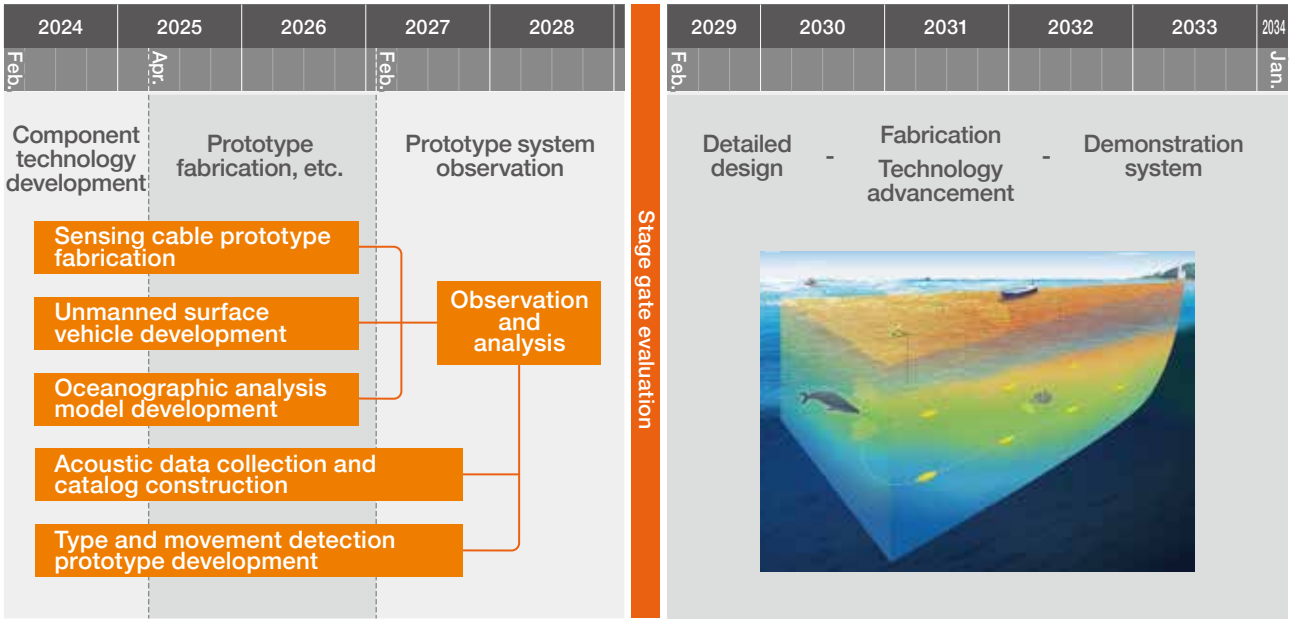
Development of classification techniques for environmental, anthropogenic, and biological sounds, and methods for detecting movement patterns of underwater/surface objects
A system is being developed to automatically identify sound sources and estimate their movement patten by analyzing acoustic data collected via seafloor sensing cables, utilizing a curated sound source catalog and AI-based technologies.

Development of advanced sensing cables
We are developing a seafloor cable system equipped with novel hydrophones that use optical fibers as sensors, enabling the acquisition of acoustic signals across the entire water column-from the sea surface to the seafloor.

Takafumi Kasaya
Director,
Smart Sensing Technology Development Center,
JAMSTEC
Principal Investigator

As a specialist in geophysical exploration, I have also contributed to the development of various marine observation instruments including leading the design of several key systems. Through the technology proposed in this project, we aim to visualize the ocean in such a way that people on land might one day say, “A whale just passed through that part of the sea!” By making the ocean feel more familiar and accessible, we hope to foster deeper deeper sense of coexistence between society and the sea – encouraging both its sustainable use and its protection.

Smart Sensing Research and Development Schedule



* May be subject to change

Project Team Organizational Chart

Program Director: Ken Takagi

Principal Investigator: Takafumi Kasaya

(Director, Smart Sensing Technology Development Center, JAMSTEC)

K Program Management Group

Smart Sensing

1 Technologies for observing the space from the sea surface to the seabed using cutting-edge sensing technologies

R&D item 1-1

Development of advanced sensing cables

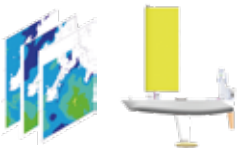
Participating research institutions

Oki Electric Industry

JAMSTEC

R&D item 1-2

Integrated observation technologies using unmanned surface vehicles and oceanographic data analysis



Participating research institutions

JAMSTEC

Kyushu University/
Japan Fisheries Research and Education Agency/
Japan Marine Science Foundation

2 Technologies that extract and analyze useful information from observation data for integrated processing

R&D item 2-1

Construction of an underwater sound source catalog using passive data of environmental, anthropogenic, and biological sounds

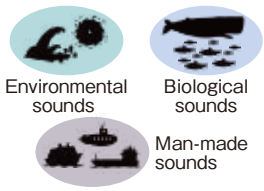
Participating research institutions

JAMSTEC

Waseda University/
Sasakawa Peace Foundation Ocean Policy Research Institute

R&D item 2-2

Development of classification techniques for environmental, anthropogenic, and biological sounds, and methods for detecting movement patterns of underwater/surface objects



Participating research institutions

JAMSTEC

Oki Electric Industry