

# Technical Demonstration Enhancement for “Robotics in Space” utilizing KIBO



**NASA-JAXA Joint Workshop  
2019/02/14**

**Shinobu DOI/JAXA  
JEM External Systems and Robotics  
JEM Mission Operation and Integration Center**

# JAXA's Vision in Robotics View Point

## Expansion of Economic Activities on LEO (2020s~)

Technical  
Demonstration

International Space Station

Cutting Edge  
Robotics Technology  
on the ground

*Applying Robotics, Automation  
and Autonomization Technology,  
Make Manned Space Activities*

- *Efficiently and Effectively*
- *Safely*

Feedback to the ground

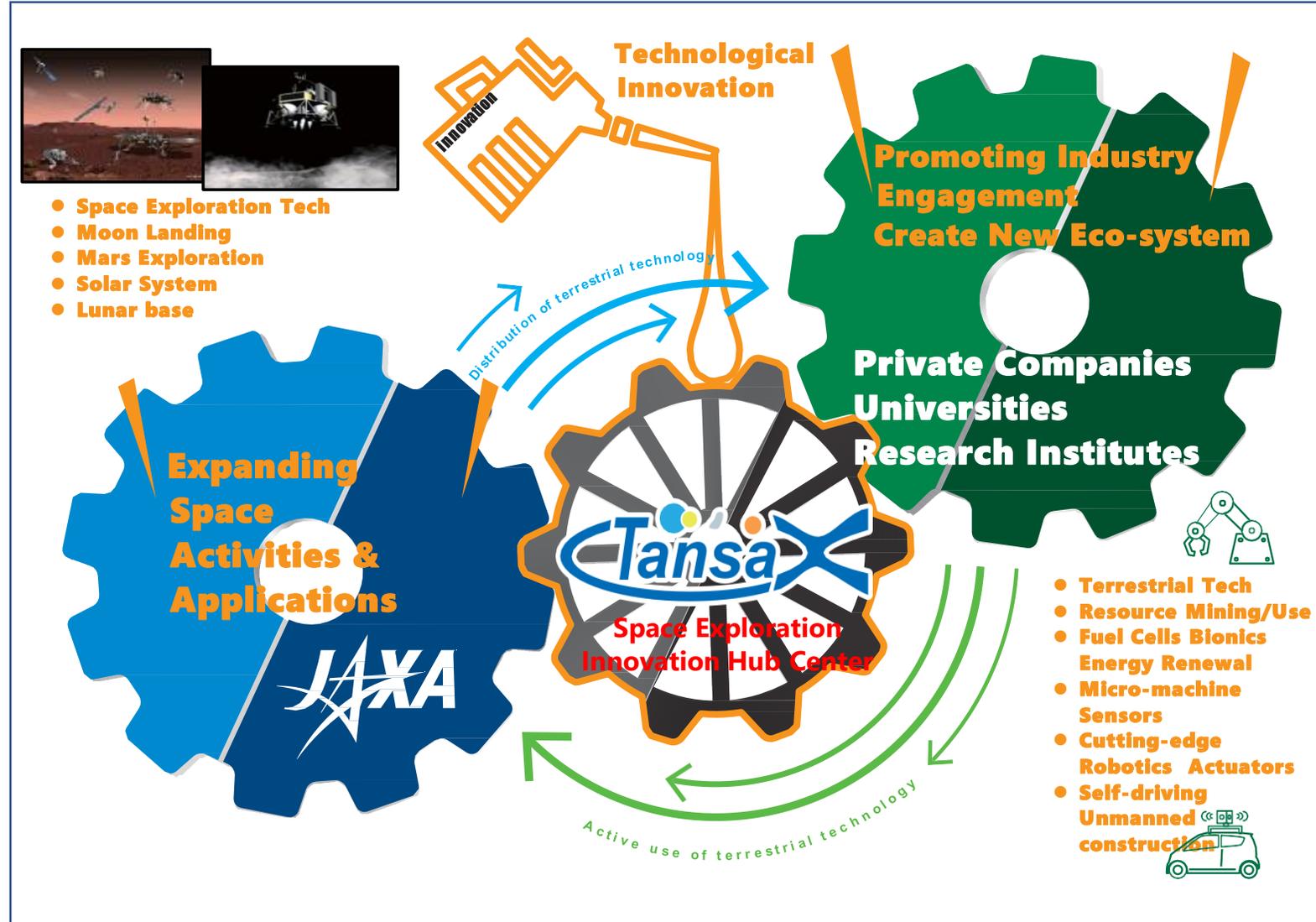
**Expansion of Human Activities**  
Lunar Orbit (Gateway) (2020s~)  
Lunar Surface (2030s~)



# Joint Work with Space Exploration Innovation Hub Center



- Based on the Japanese government strategy issued in 2014, the public research institutions and agencies are expected to work as a bridge between the technological “seeds” and “needs” to create innovation.
- Per this strategy, JAXA was re-organized in April 2015 and the Space Exploration Innovation Hub Center was established in Sagami-hara Campus.
- Since then, 86 companies and 40 universities or research institutes have joined in the collaborative researches with JAXA.
- Recently one new theme, “Robotics for future manned space activities” was added for this hub research project.



# Key areas for “Robotics for Manned Space Activities”

## Localization and Mobility

- SLAM in closed and configurable environment
- Mobility in microgravity or low gravity
- Wireless Power Transmission

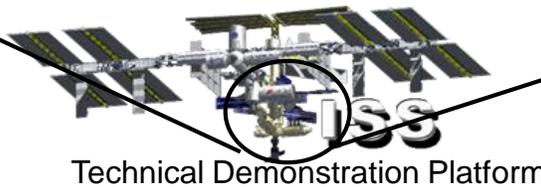
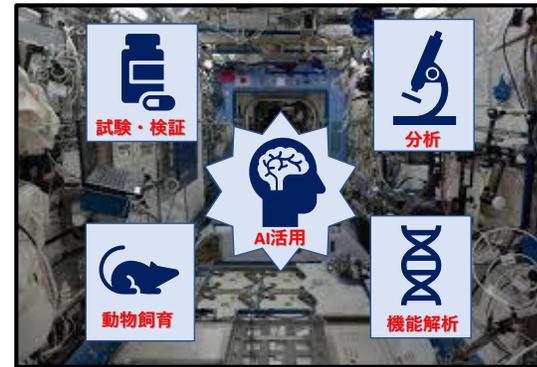


## Equipment Automation/Automization

- Automation/Automization of equipment
- Less or no interaction with astronaut and/or IVA robot

## Manipulation

- For combined task (Ex. Pull and turn)
- For soft item handling
- Dual arms
- Force feedback
- Haptics
- Multi-DOF, compact, and powerful hand

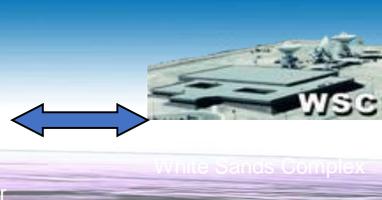
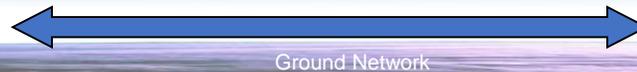


NASA's Relay Satellites

Significant Communication Delay

## Robot operation under latency

- Automization (Deep learning technology) in several seconds delay



# “KIBO” as Technical Demonstration Platform for Robotics



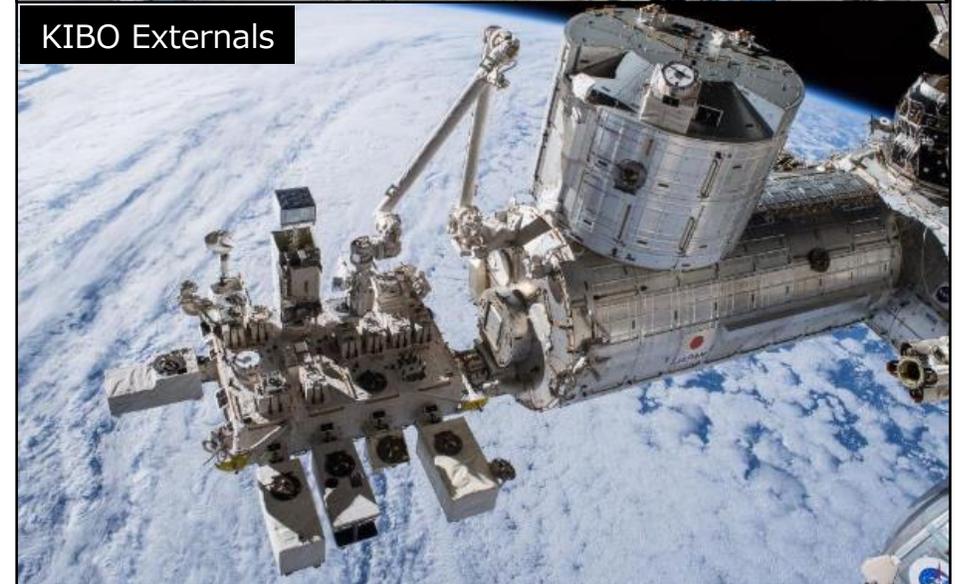
Intra-Vehicular Robot Test Field @ JAXA Tsukuba Space Center



Advanced Facility for Space Exploration @ JAXA Sagami-hara Campus



KIBO Internals



KIBO Externals

Technical Demonstration from “on the ground” to “onboard in ISS”

# Internal Robot Camera (Int-Ball)

- The main purpose of the Int-Ball is to reduce the crew time for video shooting onboard and finally to achieve crew time zero.
- The initial flight demonstration onboard in 2016 has been executed and acquired the flight performance data.
- Currently the next generation of the Int-Ball is under development to aim for the “crew time zero for video shooting”.
- Given the nature of this kind of “drone camera” in space, Int-Ball itself can be utilized as follows;
  - Technical demonstration platform
  - Tool for human resource development.



# Astrobee/Int-Ball Collaboration for the Asia-Pacific Region under JP-US OP3



## JP-US Open Platform Partnership Program (JP-US OP3)

- Increased cooperation with developing spacefaring countries in the Asia-Pacific region, possibly through the utilization of ISS resources.

## The First KIBO Robot Programming Challenge by Astrobee/Int-Ball Collaboration in 2020

- ◆ The competition is performed by programming to Astrobee to move around inside KIBO module. Int-Ball serve as a camera robot in the game.
- ◆ Target participant are undergraduate and graduate students from the Asia-Pacific region, the United States, and Japan.

