Landing Integrated Simulation for Reusable Launch Vehicle and Probe

● **Responsible Representative**

Taro Shimizu, Research and Development Directorate, Research Unit III

● **Contact Information**

Hiroaki Amakawa , Research Unit III, Research and Development Directorate. Japan Aerospace Exploration Agency(amakawa.hiroaki@jaxa.jp)

● **Members**

Hiroaki Amakawa, Masaru Kusano, Kaname Kawatsu, Kugo Okada

● **Abstract**

In reusable rockets and probe landers, landing is a crucial part of the mission, and the success of the landing determines whether the mission is achieved. While responding to disturbances and environmental changes such as wind and terrain at the landing site during the mission, autonomous and safe landing is required. Focusing on reusable rockets and probe landers, we aim to acquire composite physical modeling and simulation technologies to evaluate the feasibility of landing (precision landing/landing stability) during the early design stages, contributing to the realization of landing systems and ensuring mission success.

● **Reasons and benefits of using JAXA Supercomputer System**

All JAXA employee can use JSS quickly and easily without any complicated procedures.

The system can be connected within the JAXA intranet, so there is little risk of information leakage.

Quick access to extensive support on how to use the system.

The ability to perform numerous Monte Carlo simulations in a short time by utilizing large computational resources.

● **Achievements of the Year**

To enable the evaluation of landing feasibility in the upstream design phase, a system for efficiently conducting parameter studies on design, disturbances, and environmental factors was developed, achieving the expectation of executing a large number of runs. Specifically, code exported as C-code from the Modelica language solver SimulationX was built on the JSS3 TOKI-RURI, and a system for parallel execution of landing integration simulations through batch jobs was established, enabling up to 400 parallel computations. When a parameter study on landing feasibility for reusable rocket thrust patterns was trialed, it was found that 441 simulation cases could be executed in 47 seconds on the JSS3 TOKI-RURI, leading to the expectation that Monte Carlo simulations

(hundreds of thousands of cases) could be executed in the future.

● **Publications**

- Oral Presentations

1)Amakawa et. al., Validation of Reduced-Order Landing Stability Evaluation Model for Reusable Launch Vehicle by Multi-Physics System-Level Integrated Simulator, 68th Space Sciences and Technology Conference, 2M10 (2024)

2)Okada et. al., Preliminary Study on Thrust Control Model Development for Reusable Rocket Landing Stability Evaluation, The Annual Meeting of JSASS Northern Branch in 2025 and 6th Reusable Space Transportation System Symposium, JSASS2025-H18 (2025)

● **Usage of JSS**

● **Computational Information**

Process Parallelization Methods	N/A
Thread Parallelization Methods	N/A
Number of Processes	1
Elapsed Time per Case	10 Second(s)

● **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.01

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	4,319.30	0.00
TOKI-ST	512.38	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	30,290.41	0.54
TOKI-TGP	0.00	0.00
TOKI-TLM	21,823.85	57.92

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[2] (%)
/home	233.33	0.16
/data and /data2	14,580.95	0.07
/ssd	2,390.48	0.13

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[2] (%)
J-SPACE	8.58	0.03

[1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[2]: Fraction of Usage ：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[2] (%)
ISV Software Licenses (Total)	5.39	0.00

[2]: Fraction of Usage ：Percentage of usage relative to each resource used in one year.