Analysis for Integration of G-HAB ECLSS

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Abstract

"Gateway" is the manned base to be constructed in lunar orbit as a relay base for sustained lunar surface exploration activities, in the international space exploration plan "Artemis Project". Space Agencies participating in the ISS project are mainly involved, and they share the development of each module and equipment. In the future, 4 astronauts are scheduled to stay Gateway for about 30 days a year, and it is expected that it will also be used as a base for manned exploration of Mars (Moon to Mars). Japan is mainly in charge of providing the Environmental Control and Life Support System (ECLSS) in the International Habitation Module (I-Hab). ECLSS includes equipment for controlling air circulation, air pressure, oxygen supply, temperature and humidity, and for removal of CO2 and toxic gases. In addition to ECLSS, Japan will also provide batteries to be used in the Gateway modules (I-Hab, Mini Habitat (HALO)), internal/external cameras of the I-Hab, and pumps to circulate the coolant of Thermal Control System (TCS) in I-Hab. In addition to the above, which will lead to future manned exploration and ground technology, the mission will also transport research equipment and tools (Extra-Vehicular Activity (EVA) suits, and research instruments) needed for lunar surface activities, as well as supplies to provide food, clothing and shelters for astronauts by the Gateway resupply vehicle.

Ref. URL: https://www.exploration.jaxa.jp/assets/img/program/Leaflet_Gateway_A4.pdf

Reasons and benefits of using JAXA Supercomputer System

The Gateway, which will be placed into lunar orbit, has strong resource constraints (Launch Mass etc.). So unlike ISS, it is considered to outfit the various equipment in an exposed state without cover panel, and it will bring a very complex internal shape. In addition, I-Hab module is integrated by ESA, and there is no available module including mockup in Japan. Thus, the verification of ECLSS functions and performance will largely depend on analysis, and the timing of demonstration will be limited in almost the final phase of development.

Air circulation analysis, oxygen mixing and diffusion analysis etc. will be required. However, due to the above situation, the analysis needs to be done with quite complex shape, and it requires a very large computational

resource. In addition, if a risk becomes apparent in the final phase, the impact will be difficult to accept. From those perspectives, it is considered that performing accurate analysis in early phase using the JAXA Supercomputer System (JSS3) will play an important role in completing the G-HAB project in success.

- **Achievements of the Year**

Trial analysis of oxygen mixing and diffusion (multiple gases, unsteady state) using JSS3 was carried out for the I-Hab module and ECLSS equipment, which are entering the detailed design phase. As a result, a major issue regarding oxygen mixing that could not be found by the single gas steady analysis using a simplified module was identified, and countermeasures are currently being considered and discussed in cooperation with ESA.

- **Publications**

N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	180
Elapsed Time per Case	500 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.00

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-ST	0.00	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	364.57	0.01
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	1,470.00	0.99
/data and /data2	91,860.00	0.44
/ssd	15,060.00	0.81

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	0.00	0.00

[*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)	0.00	0.00

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