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RAISE-3 for Agile On-Orbit Demonstration of Innovative Satellite Technologies: Mission Definition and Conceptual Design

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ABSTRACT

The Japan Aerospace Exploration Agency (JAXA) has selected on-orbit demonstration missions for the Innovative Satellite Technology Demonstration-3 project in May 2020, as part of the Innovative Satellite Technology Demonstration Program. Seven on-orbit demonstration missions were selected in a category of "parts, components and subsystems" and those missions will be demonstrated onboard the RApid Innovative payload demonstration SatellitE-3 (RAISE-3). This 100kg-class satellite developed by JAXA is a flagship of the "Innovative Satellite Technology Demonstration-3" fleet. This paper describes an overview of the demonstration missions and system specifications of RAISE-3, as well as results of conceptual design of the satellite and a partial application of digital development process to an initial phase of the project. Further, project plan and technical challenges to be studied in a project implementation phase are also discussed.

INTRODUCTION

The Japan Aerospace Exploration Agency (JAXA) has been implementing the Innovative Satellite Technology Demonstration Program since 2015. It provides on-orbit demonstration opportunities for microsatellites and cubesats developed by commercial industries and universities, as well as for newly developed technologies and key-components for future space missions and programs. A total of seven microsatellites and cubesats were developed and successfully launched by an Epsilon launch vehicle in January 2019 as the first project, “Innovative Satellite Technology Demonstration-1”. The second project, “Innovative Satellite Technology Demonstration-2,” that includes a total of nine microsatellites and cubesats are currently being developed for a launch in FY2021 (Fiscal Year in Japan).

In May 2020, JAXA has selected on-orbit demonstration missions for the third project, “Innovative Satellite Technology Demonstration-3” for a launch in FY2022. Eight microsatellites and cubesats were selected from proposals by commercial industries and universities. In addition, seven on-orbit demonstration missions were selected in a category of “parts, components and subsystems” and those missions will be integrated and launched on the RApid Innovative payload demonstration SatellitE-3 (RAISE-3), a 100kg-class satellite developed by JAXA. In total, nine satellites including the flagship, RAISE-3, will be launched as the Innovative Satellite Technology Demonstration-3 fleet.

Following the selection of on-orbit demonstration missions onboard RAISE-3, JAXA has defined mission requirements and conducted conceptual design to develop RAISE-3's specifications. Those mission definition and system specifications were approved at the Mission Definition Review (MDR) & the System Requirement Review (SRR) in August 2020. A part of the conceptual design was conducted using Model-Based Systems Engineering (MBSE) approach based on previous studies of MBSE methodology in the System Technology Unit (STU) in JAXA[1][2][3] and a review process at MDR/SRR was also enhanced with MBSE tools and environment.

This paper describes the mission definition including selected on-orbit demonstration missions, system specifications and conceptual design results, as well as a partial application of our MBSE methodology to these processes.

MISSION DEFINITION

Selection of Demonstration Missions

JAXA has selected eight microsatellites and cubesats, and seven on-orbit demonstration missions in the category of parts, components and subsystems applied by commercial industries and universities for the Innovative Satellite Technology Demonstration-3 fleet. In the selection of on-orbit demonstration missions, significance and value of each mission including technical competitiveness, innovation, and industrial vitalization, as well as technical feasibility, system accommodation, safety compatibility, operability, and project feasibility were reviewed.

Seven missions summarized in Table 1 were selected in the category of parts, components and subsystems, and will be integrated on RAISE-3.

Table 1: On-Orbit Demonstration Missions Integrated on RAISE-3

Mission	Component Name	Organization	Mission Objective
On-Orbit Demonstration of 920MHz-band Satellite IoT Platform using Satellite MIMO Technology	LEOMI	Nippon Telegraph and Telephone Corporation (NTT)	On-orbit demonstration of the world's first application of satellite Multiple-Input and Multiple-Output (MIMO) telecommunication technology to a LEO satellite targeting large downlink capacity, and on-orbit demonstration of IoT protocol free transmission technology to demonstrate the feasibility of IoT platform realizing coverage extension.
Software Receiver using Flexible Development Method	SDRX	NEC Space Technologies, Ltd.	On-orbit demonstration of a high-speed flexible software receiver using a signal processing board with COTS parts, enabling on-orbit reconfiguration and extension of its function. Digital development with simulation is applied instead of breadboard testing to aim a short-term development.
On-Orbit Evaluation of Commercial GPU and its Model-based Development	GEMINI	Mitsubishi Electric Corporation (MELCO)	On-orbit evaluation of commercial GPU enabling ultra-highspeed computation. Model-based development is applied to the development of software to aim a short-term development.
On-Orbit Demonstration of Micro-propulsion System using Water Propellant	KIR	PaleBlue Inc.	On-orbit demonstration of micro-propulsion system using water as propellant. Two types of propulsion systems are integrated to enhance a potential adaptivity to various missions.
On-Orbit Demonstration and Performance Evaluation of Pulse-Plasma Thruster for Micro-satellite	TMU-PPT	Advanced Technology Institute, LLC.	On-orbit demonstration of Pulse-Plasma Thruster enabling low-power and low-cost small propulsion system using solid propellant, aiming to be applied to micro and small satellites.
On-Orbit Demonstration of Deployable Membrane Deorbit Mechanism for Micro-satellite	D-SAIL	Axelspace Corporation	On-orbit demonstration of deployable membrane structure aiming to increase atmospheric drag and orbital decay rate by deploying membrane structure at the end of operation.
On-Orbit Demonstration of Lightweight Deployable Membrane Structure with Power Generation and Antenna Function for Society 5.0	HELIOS	Sakase Adtech Co., Ltd.	On-orbit demonstration of lightweight deployable membrane structure with power generation and antenna function, aimed to enhance the capability of small satellite in terms of power generation, large capacity of communication, high resolution observation using interferometer for Society 5.0.

JAXA provided an Interface Condition Document to potential mission proposers, which describes technical interfaces between mission components and the satellite system as well as operational resources available to mission components. Providing the document not only made it easy for mission proposers to design and propose appropriate mission components, but also made it easy for reviewers in JAXA to examine compatibility and feasibility of the proposed mission components to the satellite. This approach enabled us to shorten the mission selection process by 1.5 months compared to the previous project, and overall selection process has been completed in 3.5 months.

Mission Definition of RAISE-3

Following the selection of the on-orbit demonstration missions, mission definition of RAISE-3 was formulated and approved at MDR in August 2020. The mission definition of RAISE-3 is summarized in a Mission Requirement Document as follows:

- ✓ To provide appropriate on-orbit demonstration opportunities to the seven selected demonstration missions, and
- ✓ To enhance global competitiveness of domestic space industries in Japan as a result of those missions.

SYSTEM SPECIFICATIONS

The System Specifications of RAISE-3 are derived and summarized in Table 2. Those specifications were reviewed and approved in SRR which was held together with MDR in August 2020.

The basic concept underlying these specifications is to achieve low-cost and short-period development by mostly following the standard specifications of 100kg-class satellite platform developed as RAISE-2[4]. Partial improvement of the satellite platform design and modification of the interface design for the RAISE-3 mission components are reflected on the specifications to provide various on-orbit demonstration opportunities to different types of mission components.

Table 2: System Specifications

Item	Specification
Operational period	1 month for Commissioning Phase 13 months for Nominal Operation Phase
Orbit	Sun-synchronous Orbit (initial) Altitude: 560km (nominal) Inclination: 97.6deg (nominal) Local Time Descending Node: 9:30 am
Launch	Planned in FY2022* Epsilon launch vehicle
Dimension	Approximately 1m x 0.75m x 1m (Launch configuration)
Mass	Less than 110kg
Power generation	More than 215W at BOL More than 180W at EOL (Average power generation during sunshine period)
Communication	S-band for telecommand: Uplink: 4kbps, Downlink: 64kbps X-band for mission data and stored telemetry Downlink: 16Mbps
Data recorder	8GB
Attitude control	3-axis stabilized Earth pointing for nominal attitude
Available resources to mission payload	Mass: more than 23kg Power: 105Wh (BOL) and 62Wh (EOL) over one orbit period Data volume: 926.7MB per day Payload mounting area: more than 2.5m^2

* Fiscal Year in Japan begins in April of the calendar year and ends in March of the succeeding year

In addition to the Mission Requirement Document, the Concept of Operations has been also documented, which includes basic concepts of operation plans, from operational planning to delivery of experimental data to mission users. All functions required to realize the Concept of Operations have been identified and allocated to either space segment or ground segment of RAISE-3, and thus traceability from the Concept of Operations to the System Specifications has been clarified.

In the Concept of Operation, the roles of mission users and RAISE-3 system has been also described. All functions required for either space segment or ground segment were allocated to the System Specifications and all roles which should be conducted on the mission users side were identified in the Interface Control Specifications (ICS) between the RAISE-3 and mission users.

Based on the basic principles of Systems Engineering process, visualization of all traceability to the System Specifications, helped reviewers at MDR/SRR to better understand the derivations and rationales of the System Specifications of RAISE-3.

CONCEPTUAL DESIGN RESULT

Based on the selected seven missions and System Specifications described above, JAXA has conducted conceptual design prior to MDR/SRR to evaluate the feasibility of the specifications.

Design and analysis items and their results are summarized as follow:

a) Configuration Design

The satellite configuration assumed as a baseline in the conceptual design is shown in Figure 1. As can be seen in the figure, two deployable structures and two micro-propulsion systems are the major technical issues for satellite configuration design. The following analyses such as FOV and attitude analysis verified that this configuration is feasible to achieve pre-defined mission success criteria.

The component list was also identified in the conceptual design. The information of mission components was provided by mission users, and satellite bus components were selected based on the 100kg-class satellite platform design.

b) Mass Budget

Based on the component list identified in the configuration design, mass budget for all components was evaluated. Mass margin of 5-15% was included in the mass budget depending on technological maturity and flight heritage of each component. It was confirmed that the total mass of the satellite is less than 110kg and more than 23kg mass can be allocated to the mission components.

c) Orbit Analysis

As the satellite platform has no propulsion system to maintain orbit, deviations from nominal orbit over the mission period need to be evaluated in the conceptual design. An orbit propagation considering orbit insertion error of launch vehicle was analyzed and the results revealed that β angle during mission operation phase ranges from 20.7 to 48.7 degrees as shown in Table 3. These results were used in power and thermal analysis shown in the later section.

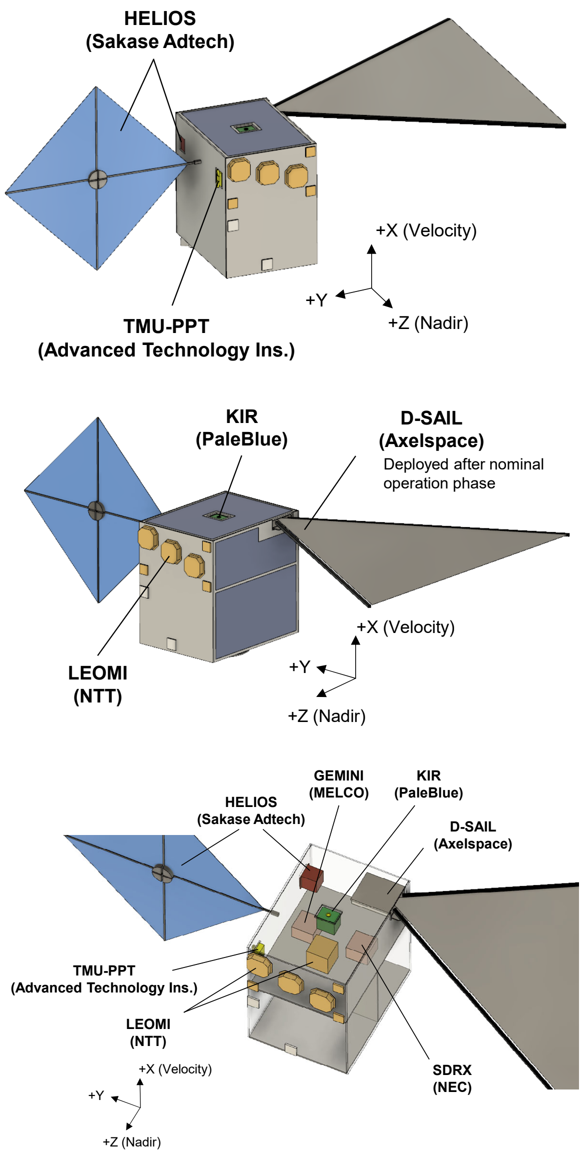

Figure 1: Satellite Configuration

Table 3: Result of Orbit Analysis

Item	Result	Note
Orbit period	94.6 min	Eclipse: 33.8 min
Nominal β angle after orbit insertion	31.0 deg	
Maximum β angle	48.7 deg	2023/6/12
Minimum β angle	20.7 deg	2023/2/23

d) Power Analysis

Power budget for all operational modes was evaluated based on the 100kg-class satellite platform design. Mission experiment modes were categorized into either continuous experiment or event-type experiment, and power budget was allocated accordingly. According to the power analysis result, average power generation of 180W during daylight period is achieved at EOL, which is sufficient for all operational modes including event-type experiments.

e) Ground Station Visibility Analysis

Based on the orbit analysis, ground station visibility analysis was conducted assuming one ground station in Japan as shown in Figure 2. The analysis results of average numbers of operational pass and average pass duration are shown in Table 4.

Table 4: Result of GS Visibility Analysis

Item	Result	Note
Average number of operational pass per day	2.95	
Average duration of an operational pass	393.8 sec	Minimum Elevation: 10 deg
Average pass duration per day	1161.7 sec	

Figure 2: Assumed Ground Station

As two passes per day is assumed as nominal operation in the Concept of Operation, average duration per day was calculated to be 787.6 sec according to the analysis result. By considering 5% margin, 748.2 sec per day was assumed to be available for data downlink in data budget analysis below.

f) Data Budget Analysis

Data budget was evaluated based on all data generated in both mission and bus components during operational time for one week. 10% margin for bus components and 15% margin for mission components were included in the analysis, and total data volume generated in one week was estimated to be 2036.3MB/week as shown in Table 5. As effective data rate of X-band downlink is assumed to be 12.8Mbps, 1272.7sec is required to downlink all data in one week. Therefore, it was confirmed that 748.2 sec/day (5237.4/week) pass duration available is sufficient to downlink all data to the ground station.

Table 5: Data Generation from All Components

Item	Result	Note
Mission components	331.3 MB	Including 15% margin
Bus components	1705.0 MB	Including 10% margin
Total	2036.3 MB	

Data recorder capacity is 8GB as shown in Table 2, so all the data generated on the satellite can be stored in the data recorder for at least 28 days.

g) Communication Link Analysis

Communication link analysis was conducted to confirm that more than 0dB margin to required C/N0 is achieved for both S-band telecommand link and X-band downlink, based on an assumption of worst operational condition such as altitude and elevation. It was also confirmed that transmitting power from the satellite satisfies PFD limitation to the ground as regulated by ITU.

h) Attitude Analysis

A series of attitude analysis was conducted based on the configuration of the 100kg-class satellite platform design, including maneuver analysis, disturbance analysis, evaluation of flexible mode, and evaluation of attitude determination/control accuracy.

As mentioned in the configuration design, one of major technical issues in the conceptual design was an evaluation of deployable membrane structures in terms of attitude control. Especially the accommodation of D-SAIL was the main issue, since there was a requirement from the mission users that the membrane surface of D-SAIL is pointing as close to perpendicular to the velocity vector of the satellite as possible. This is because the D-SAIL mission is aimed to evaluate the deorbit performance due to the increased atmospheric drag caused by deployable membrane structure.

However, it was predicted that large deployable structures attached on one side of the satellite would cause a large aerodynamic torque applied to the satellite, increasing the accumulated angular momentum of the satellite over time and eventually the satellite would lose attitude control if accumulated angular momentum exceeds the maximum momentum capacity of the reaction wheels. Therefore, the attitude controllability with respect to various cant angles of D-SAIL membrane structure was analyzed. Also, a pitch bias angle of the satellite was also evaluated as one of measures to mitigate aerodynamic torque applied to the satellite as shown in Figure 3.

Figure 4 shows an analysis result of the maximum accumulated angular momentum of the satellite with respect to various cant angles of D-SAIL and satellite pitch bias angles. As the maximum angular momentum of the reaction wheels is assumed to be 0.3Nm, approximately half of this angular momentum (0.15Nm) was assumed to be acceptable. Therefore, it was confirmed that attitude control will be maintained if D-SAIL is mounted with 50-80 degrees cant angles, depending on the pitch bias angle of the satellite during D-SAIL mission operation.

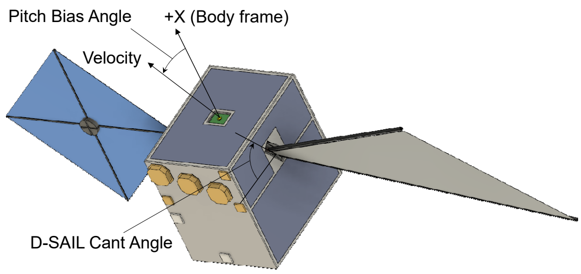

Figure 3: D-SAIL Attachment Angle and Pitch-biased attitude

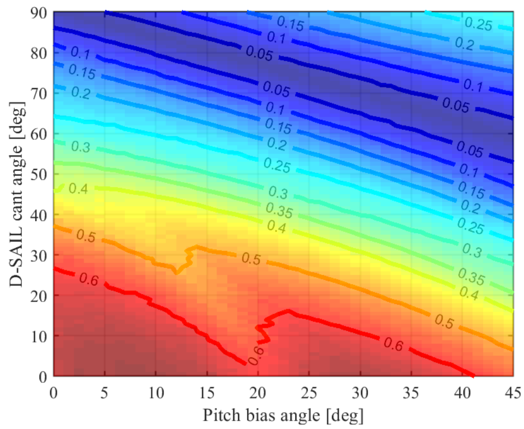

Figure 4: Accumulated Angular Momentum with respect to D-SAIL Cant Angle and Pitch Bias Angle

Another technical issue in the conceptual design was feasibility of on-orbit performance evaluation of micro-thrusters, i.e. KIR and TMU-PPT, since these thrusters generate very small thrust forces ranging from µN to mN. The trade-off study was required to determine the appropriate on-orbit demonstration concepts to evaluate the performance of those micro-thrusters on orbit, such as measuring orbital change by using GPS data or estimating torque applied to the satellite by the thrusters with either using accumulated angular momentum data of reaction wheels or using gyroscope data.

As a result of trade-off analysis, it was concluded that orbital change arising from thrust force of μN is within the range of GPS measurement errors, and performance evaluation by estimating torque to the satellite achieves better measurement accuracy.

In order to estimate torque generated by the thruster, it has to be large enough compared to disturbance torque such as aerodynamic torque or residual magnetic torque. Figure 5 shows analysis result of aerodynamic torque and residual magnetic torque exerted to the satellite with respect to orbital position. As shown in the figure, it is preferable to plan the thruster experiment during eclipse as aerodynamic torque will be minimized. The analysis result of residual magnetic torque is based on the measurement result of residual magnetism of the previous project and it is difficult to predict exact residual magnetic torque of RAISE-3 at the moment, but it could reach 10^{-4}Nm and likely to exceed the aerodynamic torque. Therefore, it was concluded that it is essential to measure the residual magnetism of the satellite and estimate the residual magnetic torque on orbit to improve the measurement accuracy of micro-thrusters.

The detailed layout of two thrusters needs to be adjusted in the next phase to maximize the measurement accuracy during on-orbit demonstration, based on the above trade-off studies.

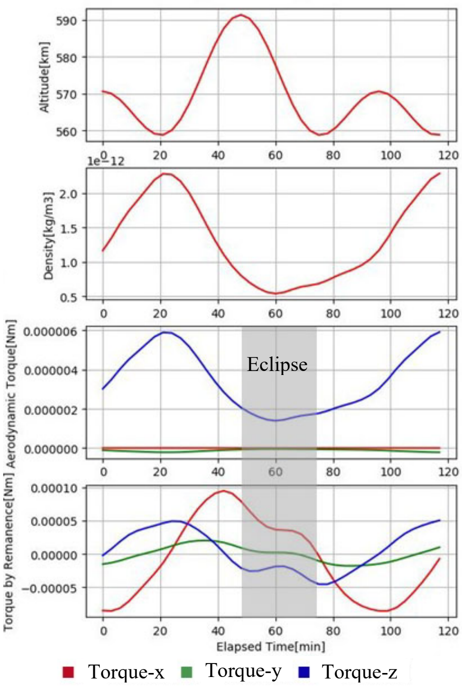

Figure 5: Analysis of Disturbance Torque

i) FOV Analysis

Field of View (FOV) analysis was conducted based on the configuration design. Required FOV of all components were confirmed and examined if there are no obstacles within the FOV of those components. Since there are two relatively large deployable structures but S-band antenna (SANT) requires a large FOV, a partial obstruction of SANT is inevitable. Therefore, an impact of this obstruction needs to be further examined in the next phase.

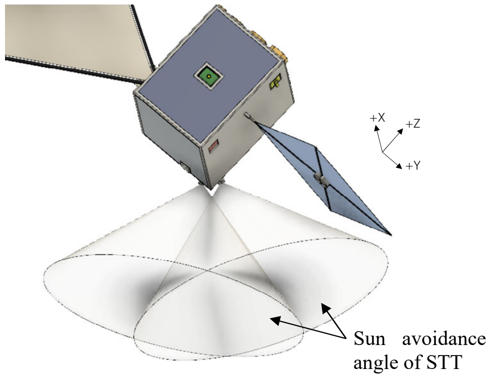

Figure 6: An Example of FOV Analysis (STT)

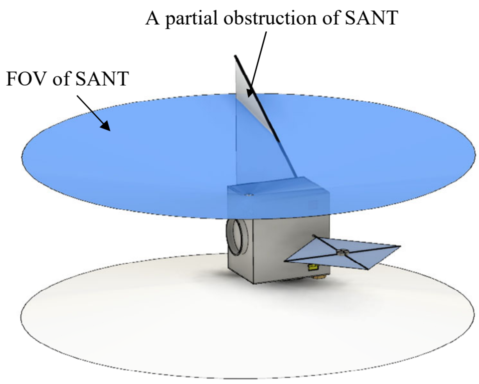

Figure 7: An Example of FOV Analysis (SANT)

j) Structural Analysis

Detailed structural analysis was omitted in the conceptual design, as mass budget allocated to the mission components was slightly increased by 2% from the 100kg-class satellite platform design, and it was not required to change the basic configuration of satellite platform at conceptual design phase. Therefore, the feasibility of structural design was confirmed based on the analogy to the 100kg-class satellite platform design and estimated that sufficient strength and stiffness can be achieved within mass budget allocated to the structure subsystem.

k) Thermal Analysis

In order to confirm the feasibility of thermal design, an equilibrium temperature of the satellite was evaluated by thermal analysis. Average solar flux input during one-orbit revolution was calculated with an assumption of optical surface characteristics (α/ε) of several materials such as MLI, solar arrays and radiators, and it was confirmed that equilibrium temperature of the satellite can be settled around 28°C by adjusting the size of radiating sufaces.

l) Summary

As a conclusion of those conceptual designs and analyses described above, it was confirmed that System Specifications described in Table 2 are feasible.

It is worth mentioning that all these designs and analyses has been completed in less than two months. A part of this accomplishment was due to the utilization of Model-Based Systems Engineering (MBSE) approach to the conceptual design phase as shown in the next section.

APPLICATION OF DIGITAL DEVELOPMENT METHOD

Application of Analysis Tool Chain to Conceptual Design

A part of the analyses shown in the previous section was conducted using digital development method, based on recent studies of MBSE methodology in JAXA.

The main purposes of applying the MBSE methodology to the conceptual design are summarized as follows:

- ✓ To ensure “Single Source of Truth” in design and analysis – avoiding inconsistency in design parameters applied to various system analysis
- ✓ To ensure accessibility to the latest design parameters and information to whoever and whenever needed
- ✓ To enable rapid re-analysis once design parameters are updated

Figure 8 illustrates analysis tool chain applied to the conceptual design of RAISE-3. All design parameters were input and updated on an Excel spreadsheet to ensure “Single Source of Truth” during the design process, which were then imported to a Systems Modeler. The Systems Modeler runs analysis tool such as MATLAB and STK with the design parameters and receives output from those tools. By utilizing these analysis tool chain, users can rapidly run a series of analysis without handling Systems Modelers or analysis tools such as MATLAB and STK, and results can be simply obtained in an Excel spreadsheet or OpenMBEE viewer with web browser.

The coverage of these analysis tool chain applied to the conceptual design of RAISE-3 is summarized in Table 6. The analysis tool chain was applied to all analyses using Excel, MATLAB and STK, and more than a half of the analyses required for the conceptual design were accomplished using the tool chain.

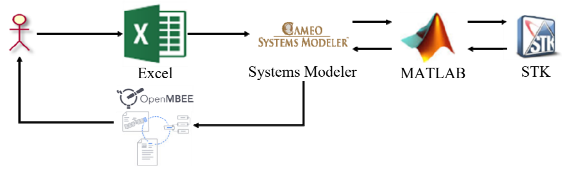

Figure 8: Analysis Tool Chain Applied to Conceptual Design

Table 6: Application of MBSE Tool to Analysis

Category	Analysis	Note
Fully Applied	c) Orbit Analysis d) Power Analysis e) Ground Station Visibility Analysis f) Data Budget Analysis k) Thermal Analysis	The result of orbit analysis is used in various analyses, and therefore it is crucial that relevant analyses are linked in tool chain. Impact of changing orbit parameters can be easily evaluated by re-analyzing d) – k) using the tool chain.
Partially Applied	i) FOV Analysis	A part of the FOV analysis was incorporated in the tool chain especially in case it is linked to orbit analysis e.g. sun avoidance analysis of STT.
Not Applied	a) Configuration Design b) Mass Budget g) Communication Link Analysis h) Attitude Analysis j) Structural Analysis	Those items were accomplished by using conventional analysis tool or by the analogy to the previous project. Extending the coverage of MBSE tool to those analyses are currently planned for future study.

By applying analysis tool chain, the efficiency of the conceptual design has been significantly improved in a sense that design parameters were handled as a “Single Source of Truth” in a System Model and rapid adaptation to design parameter modification was accomplished.

Further extension of the coverage of tool chain to various analyses as well as the link of analysis tools to a System Model created in the Systems Modeler are currently planned in future study.

Application of MBSE Methodology to SE Process

In addition to the integrated analyses shown in the previous section, a partial application of MBSE methodology to Systems Engineering process was also attempted during the project formulation phase, based on the recent studies of MBSE methodology in JAXA.

In a typical MBSE methodology, all information related to SE process are stored in a System Model, and all stakeholders are required to access the model with Systems Modeler to obtain information on the project. However, all the stakeholders in a project are not necessarily familiar with these tools and techniques as well as System Modelling languages to interpret the model. Especially during the reviews at major project milestones, various reviewers from outside the project need to access the information to review it.

In order to solve this issue, the System Technology Unit (STU) in JAXA has adopted OpenMBEE, which was developed by NASA/JPL, as a viewer of a System Model so that project reviewers are able to easily access the information in the System Model on a server through web browsers as shown in Figure 9. Creating document-style view from System Model using OpenMBEE has been also applied so that reviewers do not need any special tools and techniques during the review processes of the project. This is the first application in JAXA that MBSE is demonstrated in the actual project's systems engineering process.

The following documents were imported in the System Model of RAISE-3 during the conceptual design phase and were reviewed with OpenMBEE environment at MDR/SRR.

- Mission Requirement Document (MRD)
- Concept of Operations (ConOps)
- System Development Specifications (SDS)
- Interface Control Specifications (ICS) of Mission Components
- Traceability Document from high level requirements (MRD and ConOps) to detailed specifications (SDS and ICS)
- A part of Conceptual Design Report

Providing the above documents to the reviewers with OpenMBEE environment has yielded the following beneficial aspects:

✓ "Single Source of Truth" – one of the basic advantages of applying MBSE – has been realized, and inconsistencies between the documents were eliminated

✓ To enhance rigorous SE processes, Activity Diagrams were used in requirement analysis of the mission operations, and those information were also provided in OpenMBEE to supplement the traceability from high level requirements to detailed specifications

Since it was the first attempt of applying MBSE methodology to the actual project review in JAXA, the considerable amount of effort was required to establish these tools and the System Model before the review. However, it revealed that once the tools and model are established, updating the information in the model was far more efficient than a document-based approach especially in case the same information are used in various documents.

Further and broader application of MBSE methodology to the development process of RAISE-3 implementation phase is planned and foreseen to be utilized in the project life cycle.

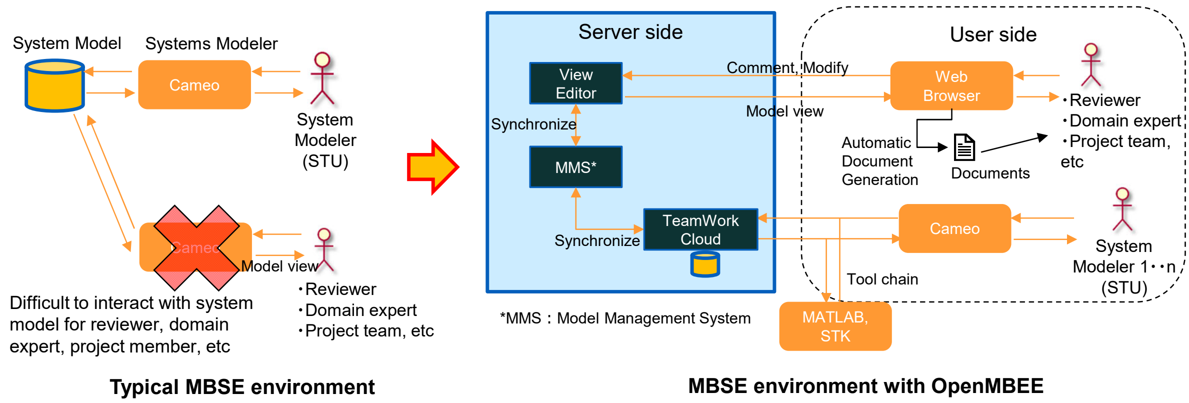

Figure 9: MBSE environment utilizing OpenMBEE tool

PROJECT PLAN AND TECHNICAL CHALLENGES

An implementation phase of RAISE-3 has been initiated after System Definition Review in February 2021, where updated System Specifications and the project plan were reviewed and approved.

Some of the major technical challenges of the projects are summarized as follows:

a) Development schedule

The satellite is scheduled to be launched in FY2022 and therefore the development of the satellite in one-year time frame is the biggest challenge of the project.

During the conceptual design phase, several efforts were made such as determining System Specifications from early phase based on 100kg-class satellite platform design and providing interface condition document to the mission proposers before the selection of mission components in order to shorten the schedule of project formulation phase.

Furthermore, during the implementation phase, more efforts to shorten the development schedule compared to the previous project as well as to keep on the schedule will be required.

b) The feasibility of system design taking into account large deployable structures

As shown in the previous section, the satellite accommodates two large deployable membrane structures. Therefore, the characteristics of the deployable structure needs to be further evaluated in the detailed design phase, such as aerodynamic torque, flexible mode, dynamic motion during deployment, interference with FOV of other components, and failure mode effect of deployment.

In addition to these issues, the layout and cant angle of the D-SAIL needs to be carefully determined, as the mission is aimed to evaluate the deorbit performance caused by the deployed membrane structure while the aerodynamic torque could affect attitude control of the satellite.

c) On-orbit performance evaluation of micro-thrusters

The basic concept of on-orbit performance evaluation of micro-thrusters, i.e. KIR and TMU-PPT, was studied in the conceptual design based on the preliminary analysis of disturbance torque. Although it was considered feasible to evaluate the thruster performance, more detailed studies will be required on an operational scenario to improve measurement accuracy and a possibility of thruster design modification to maximize thrust force.

d) Application of MBSE methodology

A partial application of MBSE methodology to the initial phase of the project was attempted as shown in the previous section.

Further application of MBSE methodology to the development process of implementation phase is currently being planned so that a part of the satellite development processes including design and verification will be enhanced by utilizing MBSE approach. However, since this is the first attempt of applying MBSE methodology to the actual project in JAXA, detailed methodology needs to be further studied and matured with the cooperation of satellite manufacturer.

By practical application of MBSE to the RAISE-3 project, benefits to realize efficient development will be clarified and the research efforts will be made to solve identified problems towards the full application of MBSE to the future project.

CONCLUSIONS

An overview of the mission definition, the on-orbit demonstration missions, the system specifications and the conceptual design results of RAISE-3 were described in this paper. The result of a partial application of digital development process to the initial phase of the project was also summarized. Based on the system specifications and the project plan which were approved at SDR, RAISE-3 is currently being developed for a launch in FY2022.

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