

RATIO-SIM Advisory Group

Terms of Reference

1. Introduction

The specification, design and verification of modern space systems rely heavily on the use of system modelling and simulation, in support of the space systems engineering process. The ECSS System Modelling and Simulation Technical Memorandum ECSS-E-TM-21A [RD.01] describes the use of modelling and simulation in the space systems engineering process, and defines the different simulators used in the project lifecycle.

The European Space Technology Harmonisation Technical Dossier on System Modelling and Simulation Tools [RD.02] [RD.03] describes the strategy to advance the technology at European level in the domain of system modelling and simulation by means of a Roadmap, which proposes a number of activities for the achievement of the aims as defined in the Dossier.

Two activities of the 2012 Dossier [RD.02], i.e. C11 on Rationalisation of Simulator tools and C12 on Qualification of Simulator tools, have been considered by the Agency for implementation. However, after a first assessment and consultation with the stakeholders [RD.04], it was concluded that these activities could have a major impact on all of the simulation facilities, infrastructures, methods, tools and processes currently in place at the European space systems integrators, suppliers and operators. As such, the two activities have been joined under the larger scope of the Rationalisation of Simulators (RATIO-SIM).

As RATIO-SIM is now considered more as a long-term collaboration with its stakeholders, rather than a single activity, the RATIO-SIM Initiative has been introduced. This initiative aims at the rationalisation of simulation infrastructures, including the methods, tools and processes being utilised by the European space systems integrators, suppliers and operators.

In advance of the RATIO-SIM Initiative, ESA has initiated the RATIO-SIM Pilot Study with the European Large Space Systems Integrators (ADS, TAS and OHB) and including European and National Space Agencies (CNES, DLR and ESA). The Pilot Study provides a first iteration on the RATIO-SIM Goals and Governance [RD.06], a Simulation Infrastructure Reference Architecture [RD.07] and the proposed Activities and Roadmap [RD.08], being the starting point for the RATIO-SIM Initiative.

This document contains the Terms of Reference of the RATIO-SIM Advisory Group, or in short *Advisory Group*, which will be the term used throughout this document.

2. The RATIO-SIM Initiative

The main goal of the RATIO-SIM Initiative is to achieve a reduction of cost related to the development, utilisation and maintenance of the modelling and simulation facilities and infrastructures. Existing facilities and infrastructures will require continuous maintenance and evolution, the latter to support future missions that are becoming ever more advanced in terms of technology (e.g. in the area of processors and data buses) and performance (e.g. in terms of data throughput rates and produced data volumes). By empowering the re-use of existing options, RATIO-SIM will counter the escalation of cost and allow higher quality, higher efficiency and higher effectiveness across the European Space Sector.

The RATIO-SIM Initiative covers in principle the entire system simulation domain as described in ECSS-E-TM-10-21A [RD.01]. This also includes the interfaces to any adjacent domains, with the understanding that the interface between domains can only be agreed with all responsible parties involved.

- **Simulation Infrastructure.** The simulation infrastructure is the main concern of RATIO-SIM; this includes simulator development, run-time and post-processing environments. RATIO-SIM includes the definition of a generic Simulation Infrastructure Reference Architecture, detailing the architectures of the above-mentioned environments from different perspectives. In addition, the specification of building blocks that make up the simulation infrastructure is also addressed.
- **Simulation Models.** The RATIO-SIM Initiative shall not be concerned with the actual development of mission specific or generic reusable models. The specification of the model internal architecture and implementation is out-of-scope. RATIO-SIM shall instead focus on the model interfaces, in particular:
 - System-level interfaces (e.g. hardware and bus interfaces, model-to-SCOE interfaces);
 - Physical model interfaces (e.g. with environment, thermal, power);
 - Model-to-infrastructure and model-to-model interfaces (e.g. SMP, FMI, model assembly);
 - Auxiliary data interfaces (import of configuration data, use of test and validation data).

The existence of standardised model interfaces will enable the efficient exchange of simulation models, including exchange between organisations (e.g. between primes, suppliers and agencies) and within organisations (between missions and mission phases). RATIO-SIM shall follow-up here on existing work already done in this area, e.g. with the ECSS SMP standard and the SSRA reference architecture.

A more complete description of the RATIO-SIM scope can be found in [RD.06] section 3. The long-term goals and detailed objectives are described in [RD.06] section 5.

The establishment of the RATIO-SIM Initiative as governed by the Advisory Group is expected to contribute to the synergy across activities performed within the scope defined above.

The objectives of the Advisory Group are to review the current roadmaps, to guide the R&D activity plans and to monitor their execution, to maximise the results towards a shared vision.

3. Organisation and Management

3.1 General Principles

- (a) The RATIO-SIM Initiative relies on the voluntary participation of the organisations represented in the Advisory Group and its Working Groups. The costs associated with the participation in the Advisory Group and related Working Groups shall be borne by the participating organisation. No exchange of funds is foreseen.
- (b) Activity contracts to Industry, which are related to topics falling within the technical scope covered by the RATIO-SIM Initiative, shall be implemented by the contract-awarding organisation following its own contractual rules and managerial procedures. The contract-awarding organisation shall endeavour to keep the Advisory Group informed on the technical status and achievements of the contract.

- (c) All Participating Organisations of the RATIO-SIM Initiative agree to coordinate with the Advisory Group any public relations activities that refer to the RATIO-SIM Initiative.

3.2 Participation

- (a) The RATIO-SIM Initiative is open for participation by organisations residing in any of the ESA Member States and that are stakeholders in the domain of system modelling and simulation.

- (b) Participants

Participants belong to the following categories:

- a. European and National Space Agencies
- b. Large System Integrators (LSI)
- c. Small and Medium Enterprises (SME)
- d. Institutes and Academia

The RATIO-SIM stakeholder entities and the possible roles in the development and utilisation of space system simulators are described in [RD.06] section 4.

Participants shall support the functioning of the Advisory Group and of its Working Groups, as defined in this document and take part in the corresponding consensus and voting processes.

- (c) Participants as identified above but not having an active role in the Advisory Group or in its Working Groups are considered Observers. They will have access to any artefacts produced by the RATIO-SIM Initiative and will be informed about the overall status and the progress of the ongoing activities.

4. Advisory Group Objectives

The Advisory Group shall define the overall RATIO-SIM goals and ensure that any activities performed in the RATIO-SIM Initiative are in line with these goals.

The Advisory Group shall regularly reiterate these goals, considering the evolving needs of the RATIO-SIM stakeholders and the feedback from the Working Groups.

The Advisory Group objectives are:

- (a) Establishing and maintaining the work plan in line with these RATIO-SIM goals and agreeing a corresponding implementation roadmap.
- (b) Regularly surveying among the RATIO-SIM stakeholders the current progress, status and performance in the domain of Simulation within scope of the RATIO-SIM Initiative and identifying any problem areas.
- (c) Agreeing on the priorities and need dates for the definition of any standardised architectures and interfaces, and the implementation of simulation infrastructure building blocks, with due regard to user and application requirements.

- (d) Considering the long-term maintenance of the Simulation infrastructures and facilities at the RATIO-SIM stakeholders, in the trade-off between leveraging advanced technology and fostering the stability of existing infrastructures.
- (e) Establishing Working Groups for the execution of specific tasks with limited duration, approving their specific Terms-of-Reference, membership and any reports as an output of the Working Group.
- (f) Providing full visibility and access to the results of the RATIO-SIM activities to the European Space community.
- (g) Disseminating the RATIO-SIM vision in the stakeholder organisations, promoting adoption of the resulting outputs, with the emphasis on the application of the RATIO-SIM results in Space programmes.

A Working Group is a work force mandated by the Advisory Group to work on a specific activity. Its members are designated by the Advisory Group from any of the RATIO-SIM stakeholders (i.e. Space Agencies, Space System Integrators, Simulator developers, Tool Vendors), depending on their field of expertise.

The outcome of a Working Group could be, but is not limited to:

- The definition of a standardisation specification in the scope of RATIO-SIM;
- The specification of a Simulator Infrastructure Building Block;
- The development of a Simulator Infrastructure Building Block;
- The maintenance of Simulator Infrastructure Building Block;

The Advisory Group shall define the Terms of Reference (ToR) of a Working Group before its initiation. The ToR shall include the definition of the ownership, governance and licensing of any artefacts created by a Working Group, including documents and software. In case a Working Group relies on any industrial work or support tasks, then the Advisory Group shall ensure that the ownership, governance and licensing resulting from these is in line with the policy of a Working Group as laid out in its ToR.

5. Governance of Artefacts

The European Space Agency, on behalf of the participating Members, will hold the Intellectual Property Rights of any documents and software produced by the Advisory Group and its Working Groups.

Artefacts provided by Members or 3rd-parties in the context of RATIO-SIM can only be accepted, in case the license conditions of these artefacts are compliant with the general constraints as defined in this document and any specific constraints as identified by the Advisory Group.

The RATIO-SIM Advisory Group shall perform the governance of all RATIO-SIM artefacts and shall verify that the dissemination of these artefacts in the frame of RATIO-SIM is compliant with any licenses applicable to these artefacts.

All outputs of RATIO-SIM shall be available to organisations residing in ESA Member States. As it is acknowledged that some stakeholders do business on a worldwide basis, the Advisory Group shall distinguish between RATIO-SIM artefacts containing the core knowledge (e.g. specifications, design information, source code) and the artefacts supporting the end-user (e.g. user manuals, executable code).

In case a stakeholder requires access to RATIO-SIM artefacts outside of the agreed policy of a Working Group as laid out in its ToR, then it shall submit a written request to the Advisory Group for such an exception. The topic of Information Dissemination is described in more detail in [RD.06] section 6.3.

6. Composition of the Advisory Group and Working Groups

The Advisory Group and Working Groups shall be composed of representatives of the Participating Organisations as follows:

(a) Members of the Advisory Group:

In order to keep the size of the Advisory Group compatible with an efficient discussion and decision-making process, the following initial composition is proposed:

- European and National Space Agencies: ESA, CNES and DLR;
- European Large Space Systems Integrators: Airbus Defence and Space (ADS), Thales Alenia Space (TAS) and OHB.

(b) Members of the Working Groups:

Any organisations identified in *Participation* above.

The Advisory Group will review the composition of the Advisory Group Members every year, in order to ensure that it is in accordance with the fulfilment of the Advisory Group mandate, as per *Objectives and Scope* above with due regard to maintaining the level of expertise and balance among the various groups and categories represented.

Representatives of organisations that are member of the Advisory Group or member of a Working Group shall be deemed to have the authority to act in the name and on behalf of the organisation having nominated them. In case of absence of a Member's representative, such a Member may nominate a deputy who shall have similar authority. Each Member can replace its representative or deputy by giving written notice to the Advisory Group.

7. Proceedings of the Advisory Group and of Working Groups

- (a) The Advisory Group shall strive to reach its decisions by consensus. Formal votes may be taken with a two-thirds majority of the Members' representatives, preferably with all participant categories as per *Participants* defined above being represented.
- (b) The Advisory Group shall elect a Chairman by a simple majority of the representatives of its Members for a period of one year. The Chairman shall be eligible once for re-election for a term of one additional year.
- (c) The Advisory Group shall also elect a deputy Chairman by a simple majority for a period of one year, who shall assume the responsibilities and duties of the Chairman when necessary.

- (d) When constituting a Working Group, the Advisory Group shall issue the ToR for the Working Group, identifying the activities to be performed with their expected time frame, the output including the ownership, governance and licensing, and the reporting mechanisms. The Advisory Group will nominate a Working Group Convenor and a deputy Convenor as required.
- (e) Plenary Meetings of the Advisory Group shall be held at least twice a year, depending on the urgency of the matters to be discussed. More frequent meetings might be held as required. The use of video and teleconferencing facilities shall be maximised outside of the plenary meetings.
- (f) When a decision is required urgently, the Chairman of the Advisory Group may propose to proceed to a vote in writing.
- (g) The Working Group will meet with a frequency as required to accomplish the tasks in the allocated time as per Working Group ToR.
- (h) The proceedings of the Advisory Group or Working Group shall be recorded in minutes of its meetings, to be approved by the Advisory Group, no later than one month after the meeting date.

8. Resources

In agreement with the principles outlined above, the Members support the functioning of the Advisory Group and the performance of its activities on a no exchange of funds basis as follows:

- (a) Members shall support the activities of the Advisory Group and the ad-hoc Working Groups by assigning experts to the implementation of the defined tasks. These experts shall work in compliance with the provisions of this ToR and the applicable ToR of the Working Group in question;
- (b) Travel and mission expenditure of all representatives and experts shall be borne either by the employer organisations or by the authority responsible for the designation;
- (c) Required ad-hoc studies and contracts, supporting the tasks and activities of the Advisory Group and its Working Groups and not forming part of the harmonised and coordinated Technology R&D Roadmap, shall be jointly funded on a voluntary basis by ESA, National Agencies and Industry. This shall be based on the individual contractual and managerial procedures of a funding organisation, whilst providing full visibility concerning the status and technical achievements to all Members.

9. References

- [RD.01] Space engineering – System modelling and simulation, ECSS-E-TM-10-21A, issue 1, 16 April 2010,
<http://ecss.nl/hbstms/ecss-e-tm-10-21a-system-modelling-and-simulation>.
- [RD.02] European Space Technology Harmonisation Technical Dossier on System Modelling and Simulation Tools, issue 2.2A, 14 July 2012.
- [RD.03] European Space Technology Harmonisation Technical Dossier on System Modelling and Simulation Tools, issue 3.2, 5 March 2019.

- [RD.04] RATIO-SIM Summary of Interactive Session during SESP2017, ESA/ESTEC, 29 March 2017,
<https://indico.esa.int/indico/event/180/material/4>.
- [RD.05] RATIO-SIM Glossary, Acronyms and Abbreviations, RATIO-SIM-RP-001, issue 1.0, 11 March 2020.
- [RD.06] RATIO-SIM Goals and Governance, RATIO-SIM-RP-002, issue 1.0, 11 March 2020.
- [RD.07] RATIO-SIM Simulation Infrastructure Reference Architecture, RATIO-SIM-RP-003, issue 1.0, 11 March 2020.
- [RD.08] RATIO-SIM Activities and Roadmap, RATIO-SIM-RP-004, issue 1.0, 11 March 2020.