RATIO-SIM Interactive Session during SESP 2017

The ESA activity "Rationalization of Simulators" (RATIO-SIM) aims at exploring the possibility to rationalize the European simulation tools, to allow for a smooth model-based process supporting the project life cycle and allow cross-tool building block exchange. The study should select those components or buildings blocks that are beneficial to jointly develop and/or maintain. Building blocks or tools could be made open source and with a license that allows adaptations or extensions.

The complete RATIO-SIM activity description can be found here.

Note: in Adobe Acrobat reader, use Alt + Left Arrow to move back to the main page.

Introduction

During the SESP workshop held at ESTEC from 28-30 March 2017, an Interactive session was organised, where the workshop participants could discuss their ideas on a number of related topics. This discussion was preceded by the major stakeholders presenting their positions on these topics.

The RATIO-SIM introduction presentation can be found here.

Stakeholder Positions

The major stakeholders were presented with the following questions, for which they were expected to provide a short elaboration:

- **Current status**: What are the major bottlenecks maintaining or replacing the Modelling and Simulation Infrastructures?
- **Opportunities**: What are main drivers to renew simulation infrastructure (technology push or application pull, obsolescence, etc.)?
- **Common interest**: Is the European Industry (Primes and SMEs) willing to work towards a harmonized Modelling and Simulation Infrastructure?
- **Approach**: What are the next steps that need to be taken to work towards a harmonized Modelling and Simulation infrastructure? Who needs to be in charge and who shall develop and maintain the tools?

The following major stakeholders have presented their position (listed in alphabetical order):

1. **Airbus Defence & Space (ADS TSOTC)**:

   SimTG is highly integrated in the overall design and development process, with a strong product line approach. New requirements are related to MBSE, early simulations, compatibility with the FMI standard, improved modelling using in-orbit data, automatic testing and automatic modelling based on system architecture and data. A global modelling and standardization approach is welcomed, however Simulation is considered a competitive advantage differentiator. The SMP2 standard could be improved, also considering an agreed standard reference architecture.

   The complete ADS TSOTC presentation can be found here.

2. **Centre National d'Études Spatiales (CNES)**:

   Basiles is used in all CNES projects for FES, SVF, AIVS and TOMS. Full SMP2 compliance and an MBSE approach are considered necessary. ESA UMF already under test by CNES, but licensing and support could be improved. Model design tools seems easier to start sharing than execution runtime products, transformation to new tools may be complex, lack of independence may be critical for maintenance and adaptation. An agreed standard reference architecture with functional building blocks and a normalized SMP2 is considered a priority. Open Source developments shall be considered.

   The complete CNES presentation can be found here.

3. **Deutsches Centrum für Luft- und Raumfahrt (DLR)**:

   No need for additional standards, complexity of existing standards such as SMP is too high, improvements needed on training and lowering the learning curve. No one simulator for all, allow full control over implementation to adjust to individual business needs. Simulator development has to start and be considered beginning from the system model. SSRA and SMP shall be updated considering other emerging standards such as OCDT and EGS-CC. Provision of accessible reference implementations e.g. for FES and SVF including the relevant models would be a great step forward.

   The complete DLR presentation can be found here.

4. **European Space Operations Centre (ESOC)**:

   Levels of rationalization and reuse will apply to processes and standards, tooling, the basic simulator architecture and generic models, reference spacecraft architecture and specific models. The balance between highly generic features and specific features shall be such that the optimum for economic reuse benefit is reached. Reuse of models can only be reached if an agreed reference architecture exists and if model suppliers have an incentive to develop reusable models. The SIMULUS package including the SIMSAT kernel is used for all ESOC supported missions. Governance of shared tools shall be agreed, e.g. using Open Source.

   The complete ESOC presentation can be found here.

5. **OHB System AG (OHB)**:

   Well defined rationalization with clear scope has very obvious advantages, with an incremental migration path for individual parts migration costs can be minimized. Standardization work must keep up with new (software) technologies. SMP2 runtime environment Rufos is used together with platform and common models to compose the OHB Software Base Simulator shared between projects. Future rationalization of Modelling and Simulation Infrastructure is supported when a modular approach is followed, with single well-defined improvement projects for specific parts of tools.

   The complete OHB presentation can be found here.

6. **Thales Alenia Space (TAS)**:

   The simulation platform K2 concerns a centralized architecture, models sharing using SMP2, and simulation kernel and services. Future customer needs shall be considered, such as improved performance and parallelization (multiple emulators). One-time model development at an organization central level, continuously increasing the maturity, successively for AOCS FES, SVF, AIVS and TOMS. Next generation Simulators to be based on a new architecture driven by tools sharing and models sharing (native SMP2 solution). The RATIO-SIM study shall in the short term clarify the technical perimeter, i.e. the chosen reference architecture, the identification of building blocks and the definition of the high-level requirements.

   The complete TAS presentation can be found here.

Interactive Discussion

The Interactive session was divided in six panel discussions. Each panel poses some questions as a starting point for discussion. Participants could provide short statements on Post-it sticky notes and attach it on one of the panels. For each panel, a summary is provided below, including a link to the detailed panel results:

- **Panel 1: Competition or Joining Forces?**
  Single or multiple implementations?
  Sharing development and maintenance costs?

  In general, the approach of Joining Forces is welcomed, however accompanied by a number of disclaimers. At the level of primes competition is envisaged, as simulation provides a differentiating business value. However, for SME not having the resources to develop entire solutions from scratch, reference implementations would be helpful. Competition at the lower levels should also be encouraged, as small companies can be more flexible and may lead innovation in specific areas.
  Joining Forces is identified as beneficial especially for innovative developments, not yet covered by the existing tools. Areas such as Model Development Tools, Open Tool Chains and Shared Models we identified having potential for Joining Forces. Before developments can take place, reference architectures shall be agreed and possible standards shall be defined. Also, interoperability of various tool chains shall be ensured.
  Open Source has been suggested, especially applicable to reference implementations. However, the governance of Open Source developments has to be considered. Furthermore, Open Source does not mean it will come at no cost, and the usage of COTS products may sometimes be more efficient than tailoring Open Source developments.

  The detailed results for Panel 1 can be found here.

- **Panel 2: Make or Buy?**
  Is the Space Domain special?
  COTS vs dedicated solutions, spin-in?

  To maintain a proper supplier base "buy" is important. Small players are better at innovation. Buy only COTS supporting open standards, promoting or creating these open standards. Strong product policy needed to allow the reuse across projects. Only buy what is specific, reuse OSS/COTS to increase commonalities with other applications, build only if it does not yet exist. Do not reinvent the wheel, look at other domains.

  The detailed results for Panel 2 can be found here.

- **Panel 3: What to Rationalize?**
  What should be the scope?
  Which facilities/components/building blocks?

  Standardizing the tooling should not be the first priority. First a consensus on workflows, the reference architecture, interfaces (e.g. spacecraft buses) will be needed. Further elaboration on REFA and SSRA is required. Only after that, some weak spots in the tooling support should be tackled: archiving, modelling, etc. The only exception to this is a comment from Mathworks, which claims that if the tooling is modular enough, than the reference architecture and standards becomes less important. If we start working on the tooling, than the EGSE/AIV shall be addressed first (drivers, reusable SCOEs).

  The detailed results for Panel 3 can be found here.

- **Panel 4: Rationalization or Standardization?**
  Are current standards (SMP/SSRA) all we need?
  Which interfaces could be agreed upon?

  First we need standardized use cases for all of the simulators. A reference architecture on top of SMP is needed. REFA/SSRA is not considered objective enough and may require updating. First standardization (effective exchange), then rationalization (effective use of resources). Standardization can be a driver for rationalization if a modular approach is used. Excess rationalization may kill competiveness; flexibility for customisation and differentiation is required. Standards must be simple to allow for easy adoption, especially by smaller players. To this extend, proper tooling, reference implementations, documentation, etc. shall be made available. Also processes to ensure compliance are necessary. SMP standardization shall go beyond level 2, e.g. architectures, conceptual data models, etc. At the model level, rationalization shall be considered across the life-cycle and across missions.
  New areas subject to standardization could be: simulator configuration, automation of writing test procedures and performing test execution, distributed simulation, simulation data archiving and data exchange.
  The use of Electronic Data Sheets (EDS) shall be considered. Draw upon lessons learned in other industries, such as automotive, aeronautics, etc. Prefer existing standards above inventing new ones.

  The detailed results for Panel 4 can be found here.

- **Panel 5: Where are we today?**
  Strong and Weak points, Opportunities and Threats
  Processes, Methods and Tools, Infrastructures

  A SWAT analysis has been performed here. SMP2 weaknesses identified: model exchange still challenging, standard limited to space industry only, difficult licensing process, no SMP compliance suite, validation not addressed, models are not fully Plug-and-Play. Opportunities in coupling the models development to MSBE and Digitization, also considering the FMI standard. A thread for rationalization may be the level of investment and legacy of companies.

  The detailed results for Panel 5 can be found here.

- **Panel 6: Any other suggestions?**
  Burning questions/remarks?
  Any bright or disruptive ideas?
  Way forward: Roadmap, Outlook, etc.

  Lessons learned: look at other industries (automotive, aeronautic, nuclear, banks), collaborate with other agencies and universities, start small – make it work – enhance it, different simulations have different users, e.g. for a TOMS it is the operator with focus on the MCS, for an SVF it is the OBSW software developer with focus on the CPU.
  Potential topics for harmonization are: failure injection, Artificial Intelligence (AI), reusing flight data to improve simulation models, multi-physics modelling, providing a “playground” for development, demonstration and training.
  Standardization: SMP2 compatibility with FMI shall be considered, configuration and parameterization shall be standardized, considering system design translated to model design, better documentation of standards to allow for easy adoption and “play around”, applying modern knowledge management tools (Web pages, Wiki, social networks).

  The detailed results for Panel 6 can be found here.

Conclusions

Considering the current level of investment and available legacy systems in industry, an evolutionary approach is preferred over a revolutionary approach. Starting from a commonly agreed architecture, building blocks could be identified and standardized interface could be defined.
Simulation is considered a competitive advantage discriminator for the primes. As such, the harmonisation of core simulation components may be difficult to achieve. Furthermore, it is expected that replacing these core components will imply major work, including the effort required to reach the needed maturity, e.g. with the revalidation of the Simulator.
It might be easier to start with those building blocks that are still in rather unexplored territory, or at the forefront of (software) technology, such as Artificial Intelligence (AI), the Digital Twin and use of flight data to update or check the simulation in real-time, Parallel, Distributed and Cloud computing, etc. Small companies may be involved here, as these may be more flexible and effective in adopting new emerging technologies. Open Source could be used here to support shared developments and the easy dissemination of the results amongst all of the stakeholders.

The SMP standard is currently widely used for space system simulators. With the current ECSS SMP effort, the level 1 and level 2 standards shall be stabilized. In general, standards shall be as simple as possible to allow for easy adoption. Proper documentation and training material shall be provided. For smaller players, a freely available reference implementation would be beneficial. Validation approaches and conformance suites shall be considered. Modern knowledge management tools, such as Web pages, Wiki, social networks, may be utilized. Online familiarization tools, model testing tools and conformance tools may be provided.
The future SMP standard could include support for standardized architectures and conceptual data models. SMP compatibility with the FMI standard, emerging from the automotive industry, shall be considered.
The currently existing reference architectures, such as REFA and SSRA, could possibly be converging into a single generic architecture. This architecture shall cover all possible use cases from any of the stakeholders. This architecture shall be linked to the system engineering models (MBSE). Also, Electronic Data Sheets (EDF) could be considered as a possible provider of system engineering data, mainly at equipment level. The evolution of this architecture, including the identification of the major building blocks and any related interface standards, must be considered with all stakeholders in the loop, potentially as part of a standardisation exercise.
Other potential topics for standardization are e.g. simulator configuration, automation of writing test procedures and performing test execution, distributed simulation, simulation data archiving and data exchange, visualisation, etc.

ESA/ESTEC
EGSE and Ground Systems section