S2C (System & Safety Continuity) Project: The two RTOs IRT Saint Exupery and IRT SystemX offer methodologies to establish and maintain the consistency of safety architectures in the field of aeronautics

Toulouse, 23 March 2023 – **Today, at the Aeroscopia museum in Blagnac, the teams of the S2C project presented their work on methodologies and processes used to establish and maintain the consistency of data exchanged between system engineers and safety analysts (RAMS – reliability, availability, maintainability and safety). The teams hope these processes, which are the result of 48 months of research, will serve as a model in the industry. The ambitious project, launched in 2019, was led by a joint collaboration between two RTOs: IRT Saint Exupery in Toulouse and IRT SystemX in the Paris area.**

The aeronautics industry is faced with a growing number of developments that involve ever more rigorous certification constraints and operational safety standards (RAMS). During the design phase, engineers increasingly base their work on architectural models (Model Based System Engineering - MBSE) and safety models (Model Based Safety Assessment - MBSA). Faced with increasingly complex systems as the evolutions of the market accelerate, this work, which can be asynchronous, increases the risk of seeing problems appear at a late stage, which involve re-work with a high financial impact.

The aim of the S2C project was to define a tool-based methodological framework to guarantee and maintain the consistency of engineering data between system architectures and safety analyses, all the while meeting the certification requirements of civil aviation. Led by the two RTOs, the S2C project took place over 48 months, from 2019 to 2023, bringing together 17 partners[1] – industrials, academics, tool makers and engineering specialists – mainly from the aeronautics industry. A 3.8 million-euro project, it relies on a history of assets in system engineering and operational safety developed by IRT Saint Exupery (MOISE project) and IRT SystemX (OAR, I(SC)² projects).

3 lines of approach to foster the consistency of engineering data

In order to guarantee the consistency of engineering data exchanged between system engineers and safety analysts, the RTOs explored three complementary and interdependent lines of approach:

- **Consistency of SE/SA engineering data:** this work, which was carried out within the framework of the aeronautics industry, completes the existing normative framework of the ARP – Aerospace Recommended Practice. It provides a set of models (process, data-model, traceability plan, other models…) and recommendations that guarantee the consistency of engineering data shared between SE and SA teams, thus strengthening the developments/analyses carried out on either side. This work was implemented for the different systemic levels of the aeronautics industry: aircraft manufacturers, system

[1] Industrial partners: Airbus Defence and Space, Dassault Aviation, DGA-TA, Liebherr, MBDA, Thales AVS, Thalès Corp, Airbus Protect, LGM, Samares Engineering, SATODEV.
Academic and scientific partners: IRIT/INPT, ISAE-Supméca, IRT Saint Exupery, IRT SystemX, LAAS-CNRS, ONERA.

manufacturers and, to a lesser extent, part manufacturers. As a result, the following were produced: SE/SA consistency processes, associated data model and traceability plan, optimization recommendations for the traceability plan, checklist in support of consistency reviews, compatibility model for engineering solutions, POC for consistency management over time enabling to visualize the impact of an SE evolution on SA analyses and the management mechanism of the impact, as well as its severity**.**

- **MBSA practical guide:** this methodology guide is destined both for beginner engineers and experimented engineers in RAMS modelling. As such, it provides the keys to initiate a modelling project in MBSA (based on AltaRica) and studies sensitive issues and snares to be avoided. The guide also explores the heart of mathematical rules and principles governing calculations behind modelling software for more advanced readers. The different reading levels are clearly identified and explained in the document. The guide also comes with practical examples implemented with 3 available solutions on the market for industrials: SimfiaNeo®; Cecilia-Workshop®; Open AltaRica.

- **Consistency between MBSE and MBSA models**: the work on this line of research led to the distinction between several key dimensions in the search for consistency between separate models: structural or behavioural, localised or partial. Three different methods were then developed and tested on the use case of the project. These lead to an increased level of trust in consistency between models. These methods require the joint expertise of system architects and RAMS engineers. They result in the collaboration of these two specialisations further upstream and can rely on tools to identify possible inconsistencies. Potential efficiency gains were identified in the development of these methods.

In order to successfully complete the research, the teams of the S2C project applied the lines of approach in practice on the AIDA use case. This is a drone system destined for the inspection of aircrafts before take-off, which was developed within a previous project led by IRT Saint Exupery (MOISE). All processes and methodologies developed by S2C are thus illustrated in this use case which is available to the community[2].

"The very nature of collaborative projects led by RTOs makes it possible to bring together a team of industrials and academics with a variety of extraordinary skills and expertise" underlines Jérémy Perrin, S2C project manager.

A tool-based methodological framework for the industry at large

The pooling of multiple skills from both RTOs has led today to processes, methods, guides and tools that will support the increase in maturity of industrials on MBSA approaches, and the integration of MBSA in their development. As a key strategic component of the industry on the question of digitization, all S2C partners decided, ahead of launch, to publicly share the results of the project[3]. These deliverables are thus freely available to the community. The industrial partners of the project

[2] https://sahara.irt-saintexupery.com/AIDA/
[3] https://www.irt-saintexupery.com/fr/s2c/

were able to benefit from and analyse the deliverables of the IRT teams on their scope throughout the research. They offered a critical eye and direct feedback that guarantees a good level of maturity.

"The S2C project paves the way for new perspectives in the consistency management of engineering data" adds Anouk Dubois, coordinator of the S2C project for SystemX.

Architectural consistency remains a broad topic of which the S2C project has drawn the outlines. Many perspectives for study remain, whether to broaden the work carried out (namely in terms of behavioural consistency) or to extend the work to other engineering specialties, for which the consistency of definition with system engineering is just as necessary.

About IRT Saint Exupéry - www.irt-saintexupery.com

The French institute for Technological Research Saint Exupéry accelerate science, technological research and transfer to the aeronautics and space industries for the development of reliable, robust, certifiable and sustainable innovative solutions.

At our sites in Toulouse, Bordeaux, Sophia Antipolis and Montreal, we offer an integrated collaborative environment composed of engineers, researchers, experts and PhD students from academia and industry for research projects and R&T services supported by technological platforms around 4 axes: advanced manufacturing technologies, greener technologies, smart technologies and methods & tools for the development of complex systems.

Our developed technologies meet the needs of industry, integrating the results of academic research.

About IRT SystemX - www.irt-systemx.fr

SystemX, a French Institute for Technological Research (IRT), specialises in digital systems engineering. It provides expertise in analysis, modelling processes, and decision-making simulations of complex systems. SystemX coordinates partnered research projects, and promotes work relations between academia and industry, and across disciplines and fields. This means jointly tackling technological and scientific challenges in five top IT industries: autonomous transport and mobility, industries of the future, defence and security, environment and sustainable development, and health and digital. Through use-case projects, SystemX research engineers address major societal and technological challenges in order to accelerate the digital transformation of industries, services and territories. Since its creation in 2012, SystemX has launched 62 research projects (38 of which are ongoing), as part of the Paris-Saclay research and university cluster, which is driving the revival of French and European industries. These projects involve over 100 industrial partners and 55 academic laboratories, 181 full-time employees (ETP schemes) and 134 individuals who rely on their own resources. SystemX also has project teams in Lyon and Singapore.

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