Aurora

Peer reviewed, conference and workshop publications

D7.3

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Signature Control

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1.1	2023-02-14	J.A. de la Puente	All	Initial issue
1.2	2023-06-05	J.A. de la Puente	Section 4	Response to comments from EC: Details are provided about the content of publications, and Peer-reviewed (published or submitted) are listed separately in section 4.

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1. Executive summary

This document is deliverable D7.3 – Peer-reviewed, conference and workshops publications of Task 7.2 – Dissemination activities, within Work Package 7 Lead beneficiary [AD1].

The main purpose of this document is to make a list of publications written by the AURORA partners to disseminate its results to the widest audience. This report relies on the AURORA communication plan [RD2], and the AURORA Plan for Exploitation and Dissemination of Results (PEDR) [RD3]. In addition, the AURORA Grant Agreement [AD1] describes the basis for the dissemination policy of the project,

The rest of the document is organized as follows:

- Section 2 describes the purpose of the document and its intended audience.
- Section 3 includes references of technical and management documents, and acronyms applied in this deliverable.
- Section 4 contains the list of AURORA publications.
- Section 5 summarises the main outcomes of this deliverable.

2. Introduction

2.1. Purpose

The purpose of this document is to present the publication written by the AURORA members in order to disseminate the project results to the general public.

This document is related to the following documents:

- D7.2 AURORA Communication Plan: describes the communication strategy for the AURORA project and the tools and activities to be used for its implementation.
- D7.5 Plan for Exploitation and Dissemination of Results (PEDR): describes the plan for disseminating the project results.

2.2. Scope and intended audience

This document is an output of the T7.2 activity included in WP7. The contents of this document will be updated as necessary.

This is a public report, which has been written for the research community at large, especially those interested in advanced software engineering methods and tools for embedded systems. The publications listed provided insight in the results obtained by the AURORA project members during the execution of the project

3. Related documents

3.1. Applicable documents

AD#	Title	Reference	Version/Date
[AD1]	Grant Agreement (GA)-101004291 - AURORA — H2020-SPACE-2018-2020 / H2020-SPACE-2020	GA number 101004291	October/20
[AD2]	AURORA Consortium Agreement (CA)	CA Nº 101004291 AURORA	September/20

Table 1. Applicable documents

3.2. Reference documents

AD#	Title	Reference
[RD1]	H2020 Work Programme 2018-2020 - Technologies for European Non-Dependence and Competitiveness	SPACE-10-TEC-2020
[RD2]	D7.2 AURORA Communication Plan	AUR-UPM-PL-0006
[RD3]	D7.5 Plan for Exploitation and Dissemination of Results (PEDR):	AUR-UPM-PL-0007

Table 2. Reference documents

3.3. Acronyms

Acronym	Description
AD	Applicable Document
ADCSS	Workshop on Avionics, Data, Control and Software (ESA)
AOCS	Attitude and Orbit Control Systems
CDC	Communication & Dissemination Coordinator
CEDI	Congreso Español de Informática, Spanish Informatics Conference
cFS	NASA core Flight System
CI/CD	Continuous Integration and Continuous Delivery
COTS	Commercial Off the Shelf
DASIA	Data Systems in Aerospace
EBd	Executive Board
EC	European Commission
ESA	European Space Agency

Acronym	Description
ESTEC	European Space Research and Technology Centre
FSW	Flight SW
GA	Grant Agreement
GNC	Guidance, Navigation and Control systems
IEM	Innovation and Exploitation Manager
IP	Intellectual Property
IPR	Intellectual Property Rights
JRC	Joint Research Center
KPI	Key Performance Indicator
MBSE	Model-Based Software Engineering
N/A	Non-Applicable or Non-Available
OA	Open Access
PEDR	Plan for the Exploitation, and Dissemination of Results
PM	Project Manager
PSA	Programme Support Activity
RD	Reference Document
REA	Research Executive Agency (European Commission)
SAVOIR	Space AVionics Open Interface aRchitecture
SW	Software
WP	Work Package

Table 3. Acronyms

4. AURORA publications

4.1. Articles published in peer-reviewed journals

Extension of the Modeling Tool Suite for Development of Embedded Systems for the Space Domain

Hugo Valente, Miguel Ángel de Miguel, Jesús Zurera, Ángel G. Pérez, Alejandro Alonso, Juan Zamorano, Juan A. de la Puente
IFAC-PapersOnLine. 55 (4): 286-291
DOI 10.1016/j.ifacol.2022.06.047 (open access)
Also available at https://oa.upm.es/72199/1/1-s2.0-S2405896322003627-main.pdf

In this paper, we propose a way to extend the elements supported by the TASTE toolset for real-time embedded systems for the space domain. This enables developers to have greater flexibility by allowing them to modify the TASTE tool suite to fit their needs. This article fits in the AURORA project since it focuses on how we can add new functionalities to the TASTE toolchain in order to extend the toolset support throughout the software development lifecycle or by increasing the modelling or code generation capabilities of the toolchain to support new graphical elements or new elements in the code generation.

4.2. Articles submitted to peer-reviewed journals

Integration of modelling languages for the development of space domain software applications.

Ángel G. Pérez, Miguel A. de Miguel, Hugo Valente, Jesús Zurera, Juan Zamorano, Alejandro Alonso, Juan A. de la Puente.
Accepted for publication in *Ada User Journal* (2022)
Preprint available at https://oa.upm.es/71908/

This paper describes the work performed in the AURORA project regarding the integration of the QGen code generator into the TASTE toolchain from the European Space Agency (ESA). The solutions provided in this paper required the study and analysis of the current integration of Simulink models into the TASTE component-model. In addition, several improvements were included to support features for the application of the toolchain in industry projects. The UPMSat-2 project was used as the technology validator that allowed us to test the changes in the tool as well as to verify the generated code.

A Quantitative Analysis of an Automatic Code Generation Tool for Space Software Applications.

Ángel G. Pérez, Miguel A. de Miguel, Javier Cubas, Hugo Valente, Juan Zamorano, Alejandro Alonso, Juan A. de la Puente.
Submitted to *Journal of Software: Evolution and Process*. Current status: major revision required.
Preprint available at https://oa.upm.es/74293/.

This paper describes the evaluation method followed to evaluate the QGen code generator for its applicability in industrial projects, integrability in other modelling or CASE tools, and the quality of its autogenerated code. To perform this evaluation, a set of key performance indicators (KPI), whose actual values were obtained from the Simulink models from the UPMSat-2 Attitude Control System, were used. This work is mainly related to activities performed during the Technology Readiness Assessment in WP6.

Design and Implementation of the Real-Time Onboard System for a Stratospheric Balloon Mission using COTS Components and a Model-Based Approach.

Ángel G. Pérez, José-Carlos Gamazo, David González, Juan Zamorano.
Submitted to *Computers and Electrical Engineering*. Current status: decision in process.
Preprint available at https://oa.upm.es/74304/

This paper presents the design and implementation of the on-board software system for the HERCCULES stratospheric balloon mission. The system is composed of several experiments equipped with COTS hardware

components such as radiometers, thermometers, barometers, and heaters, among others. The software system was developed with the TASTE modelling toolchain leveraging its automatic code generation capabilities. The architecture of this system was influenced by the work performed in the AURORA project, where several design patterns were discovered during the requirement phase such as data store, start and stop procedures, even-based communication, or data-pool.

Model-Based Toolchain for cFS embedded systems for microsatellites

Hugo Valente, Miguel A. de Miguel, Ángel G. Pérez, Alejandro Alonso, Juan Zamorano, Juan A. de la Puente
Submitted to *ACM Transactions on Embedded Computing Systems*
Preprint available at https://oa.upm.es/74294/.

In this article, we propose a solution to reduce the development time of embedded software systems, while ensuring reliability and maintaining consistency throughout the software development lifecycle. We integrated cFS, a message-oriented NASA framework based on a publish-subscribe architecture, inside TASTE, a European Space Agency toolset, to provide modelling capabilities and automatically generate code from models, thus avoiding error-prone repetitive tasks, ensuring consistency throughout the different stages, and allowing the end-user to focus on the implementation-specific details. In order to show the feasibility and the benefits of this model-based toolchain, a case study regarding a subsystem of the UPMSat-2 is presented, showing it can be used to successfully support the development of embedded software for microsatellites. This article fits in the AURORA project since it focuses on extending the TASTE toolset for the code generation of cFS components.

4.3. Other articles and posters

Requirements Gathering, Toolchain Creation and Platform Testing for a MBSE code generation.

Jesús Zurera, Hugo Valente, Juan Zamorano, Miguel Ángel de Miguel
Poster presented at the *MBSE 2022 Conference* — Toulouse, 22-24 November 2022
Full version available at https://oa.upm.es/72547/

This document includes an introduction to the set of requirements, based on cFS, for the development of a MBSE tool chain.

Design, development, and implementation of a cFS, RTEMS, and LEON3 platform

Jesús Zurera, Miguel A. de Miguel, Hugo Valente, Ángel G. Pérez, Alejandro Alonso, Juan Zamorano, Juan A. de la Puente
DASIA 2022 — 17-19 May, 2022
Full version available at https://oa.upm.es/70919/

This article describes the design and implementation of an execution platform based on Leon3, RTEM and cFS. The document introduces the modification that was done in cFS to use RTEMS as execution platforms, and the design of hardware platform based on Leon3 and FPGAs

Requirements for a Component-Based Modelling Language for Space Missions

Jesús Zurera, Hugo Valente, Miguel A. de Miguel, Angel G. Pérez, Juan Zamorano, Juan. A. de la Puente, Alejandro Alonso
Congreso Español de Informática (CEDI 2021), VI Simposio de Sistemas de Tiempo Real —— 22-24 septiembre 2021, Málaga
Full version available at https://oa.upm.es/70963/

This article includes an analysis of the main component-based software architectures in order to generate a list of requirements that describe their functionalities, abstracting from the specific platform. The requirements are intended to describe the modelling of components, the modelling of a communication system, and their integration in TASTE. As a result, cFS and AUTOSAR were selected due to their suitability and appropriate description of components.

Extension of the TASTE toolset to support publisher-subscriber communication

Hugo Valente, Miguel A de Miguel, Ángel G Pérez, Alejandro Alonso, Juan Zamorano, Juan A de la Puente
2nd ADEPT workshop: AADL by its practitioners. 16 June 2023, Lisbon, Portugal. Co-located with the 27th Ada-Europe International Conference on Reliable Software Technologies (AEiC 2023), 13-16 June 2023.

In this article, we propose a solution focused on integrating cFS, a Publisher Subscriber runtime made by NASA, inside TASTE, a model-based toolset developed by ESA, to build space systems focusing on a publisher-subscriber methodology, allowing the user to develop platform agnostic components, allowing for faster iterations, reducing the development time and increasing portability and reusability.

This article fits in the AURORA project since we extended the TASTE toolset by taking advantage of the modelling and code generation capabilities of the TASTE toolset to support a new communication paradigm, Publisher-Subscriber.

5. Conclusions

The articles written to disseminate the main results of the AURORA project have been presented in this document.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004291