Aurora

23/may/2023

AURORA - EU project 101004291

EC Final Review

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

2 Agenda

09:00 – 09:30 **Welcome & Registration**

1) 09:30 – 10:15 **Introduction, Status per WP (SENER AE)**
2) 10:15 – 11:30 **QGen TRL Demonstration (SENER AE& ESC) – videos/demo & Presentation**

11:30 – 11:45 Coffee Break

3) 11:45 – 12:30 **Component Based Interface Development (N7S) – videos/demo & Presentation**
4) 12:30 – 13:15 **QGen/TASTE/cFS Integration (UPM) – videos/demo & Presentation**

13:15 – 14:45 Lunch Break

5) 14:45 – 15:00 **Dissemination/Communication & Exploitation Activities (SENER AE)**
6) 15:00 – 15:30 **Development Roadmap (SENER AE)**
7) 15:30 – 16:00 **AURORA objectives, Milestones Achievement (SENER AE)**
8) 16:00 – 16:15 **Status of Financial & Technical Reporting (SENER AE)**
9) 16:15 – 17:15 **Q&As, Conclusions, Feedback from PO and Expert**

Aurora

1) Introduction, Status per WP (SENER AE)

Final Project Review

4 Introduction and Status per WP

1. Objectives of the activity
2. Work Breakdown Structure
3. Planning
4. WPs Achievements

Project Challenges

AURORA – Tool suite AUtomatic code generation and validation of model-based critical inteROpeRAble components

Goal of the activity:

- The AURORA project aims to provide a European tool suite for the process of development and validation of a critical Auto-coded Flight software product in the Space domain

Response to H2020 Work Programme 2018-2020 (SPACE-10-TEC-2020) “Technologies for European Non-Dependence and Competitiveness” topic JTF-2018/20-23 – SW tool: automatic generation of code [N64]”

Challenges:

1. European Technology:
   - European solution of Software Tool suite for "Automatic Generation of Code“
   - Technology demonstration of QGEN (from previous European projects), improving the concept of “model compilers", essential elements to a more and more expanding model-based engineering
2. Initial estimated TRL 4; Target TRL 6/7 for an operational certified tool
3. Product solution is applicable to Space Missions

Project Objectives

AURORA – Tool suite AUtomatic code generation and validation of model-based critical inteROpeRAble components

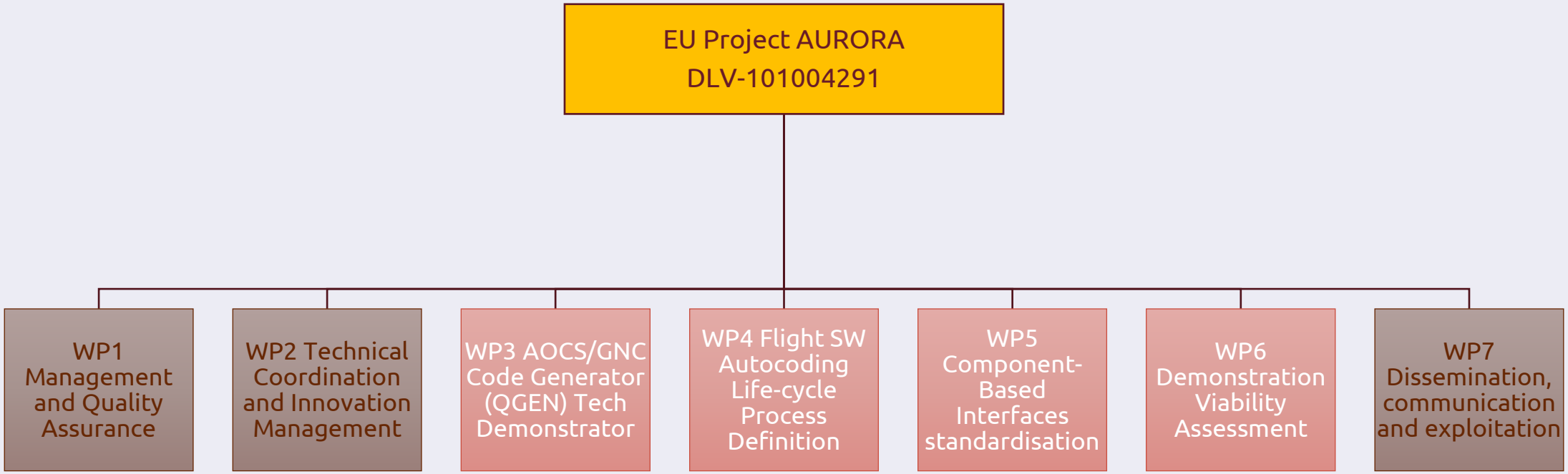
Technical Objectives

- European Technology:
  - Demonstration of European Autocoding technology based on QGEN in an industrially relevant environment
- TRL:
  - Development Plan for a target TRL-6
- Space Mission Product solution:
  - Autocoded Flight Software Life-cycle process and methodology
  - Interoperability capability of SW components
  - Tool-chain integration into ESA TASTE framework

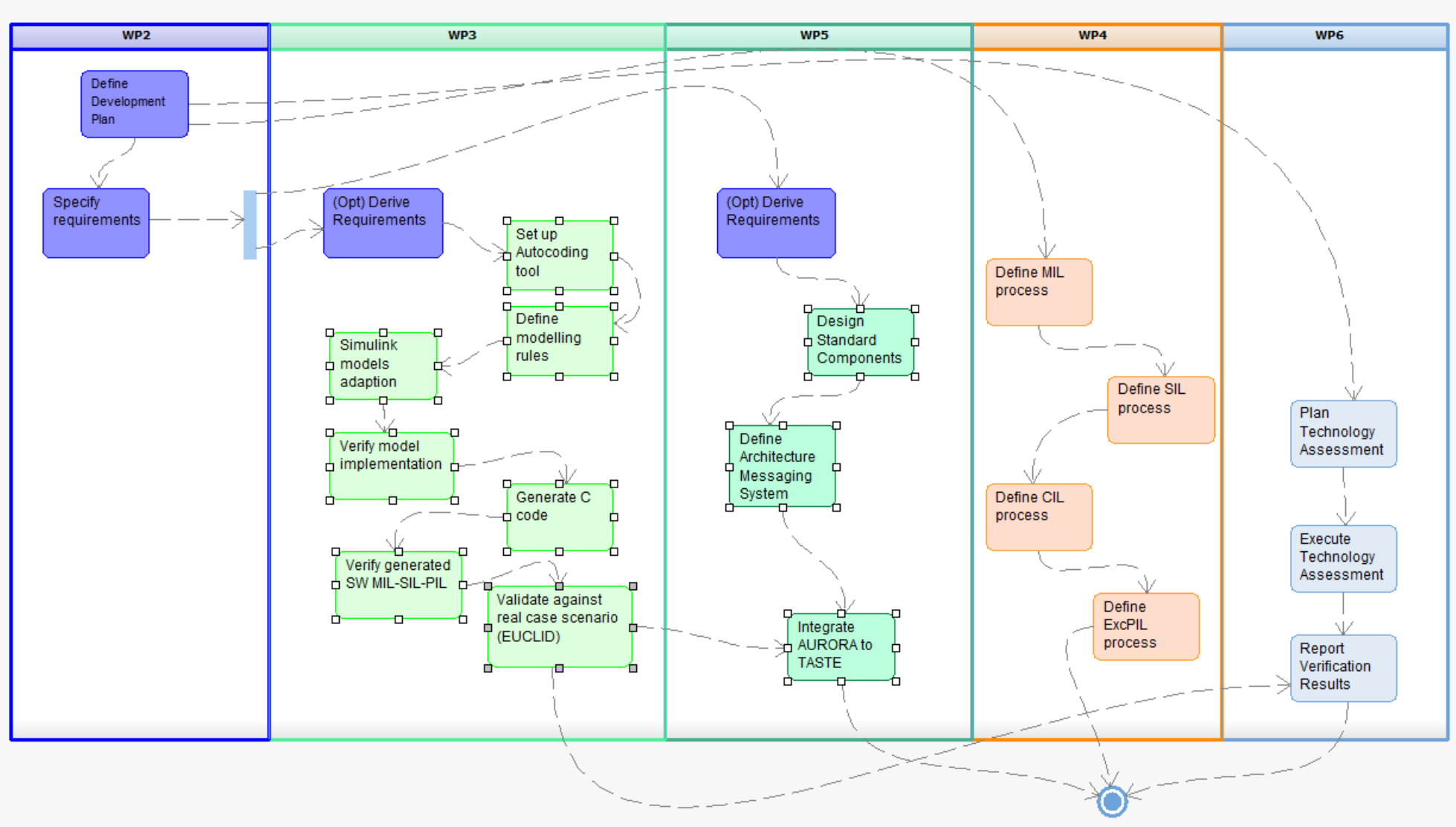
Ambition, Impact & Management Objectives

- Effective and coordinated Management of the project
  - Project Management and Quality Assurance
  - Specific Technical Management
- Overall Return On Inversion:
  - Divulgate and disseminate generated knowledge and innovation
  - Communication of results
  - Market exploitation of results

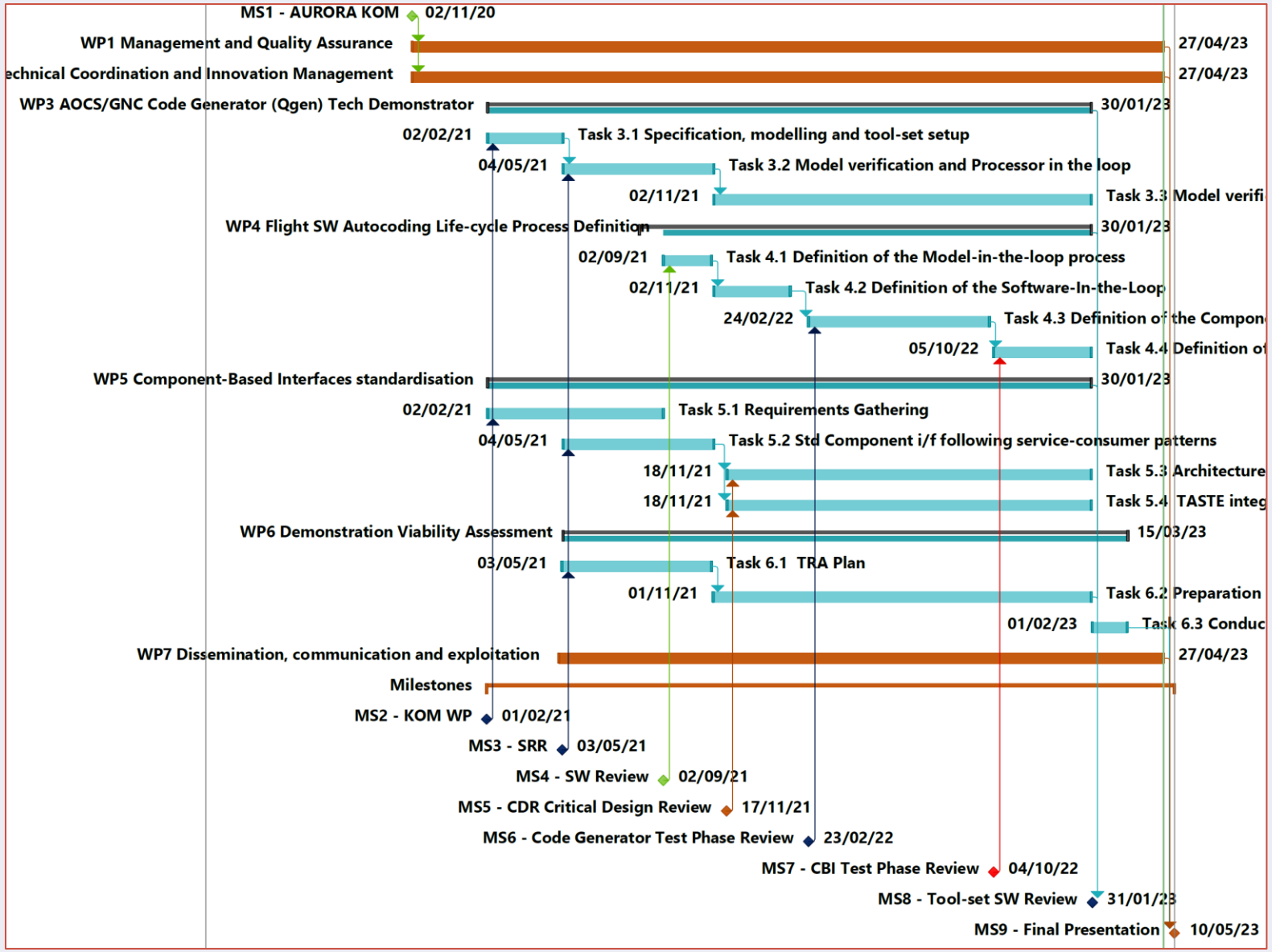
Work-Breakdown Structure



8 Development cycle



9 Planning



23/24 May EC Final Review Meeting

WP1 Management and Quality Assurance

- Project coordination
  - Planning Monitoring
  - EEAB Coordination
  - Contractual (GA, CA)
  - Milestones Management
  - Evaluation of KPIs for AURORA progress monitoring and assessment
  - Preparation, compilation, and issue of the Management Reports
  - Management of the Project in the unforeseen COVID-19 situation
- Administrative management
  - Financial issues
  - Periodic Reporting
  - Amendment request
  - Payments

WP1 Management and Quality Assurance

- Quality Assurance
  - Quality Assurance Management Plan
  - Quality metrics
  - Review project deliverables for quality assurance.
  - Quality Assurance reporting
- Risk assessment and contingency management, Ethics and gender aspects

WP1 Management and Quality Assurance

Deliverables

WP	Del №	Title	Lead Beneficiary	Nature	Dissemination Level	Del. Date	Status
WP1	D1	D1.1 Kick-off Minutes of Meeting,	SENER AE	Report	Public	30 Nov 2020	Approved
WP1	D2	D1.2 Management Reports	SENER AE	Report	Confidential	30 Apr 2021	Approved
WP1	D3	D1.3 General Assembly Minutes of Meeting	SENER AE	Report	Confidential	30 Apr 2021	Approved
WP1	D4	D1.4 Quality Assurance Management Plan	SENER AE	Report	Public	31 Jan 2021	Approved
WP1	D5	D1.5 AURORA Interim Period Report	SENER AE	Report	Public	31 Oct 2021	Approved
WP1	D6	D1.6 AURORA Period Report	SENER AE	Report	Public	05 May 2023	Delivered

WP2 Technical Coordination and Innovation Management

- Project technical management
  - Executive Progress Meeting
  - Technical Workshops
  - Milestones Management
  - Actions monitoring
- Systems Engineering
  - Coordination of all the AURORA Systems Engineering related actions and supporting development and verification actions
  - SW Development Plan

WP2 Technical Coordination and Innovation Management

- Innovation management
  - Continuous monitoring of the state-of-the-art
  - Analysis of technology roadmaps on critical space technologies:
    - Ro-cKETs - Roadmap for cross-cutting KETs activities in Horizon 2020
    - ESA Technology Roadmaps
    - Technologies Application in AURORA companies
  - Most of innovation activities has been centered into:
    - Design and improvement of some new technologies:
      - Modelling Component Based Software Architectures
      - Application of QGen for auto coded software development
    - Application of new technologies into Software development

WP2 Technical Coordination and Innovation Management

- Development roadmap
  - Definition the following steps in the AURORA technological development based on the obtained results
  - Technological development strategy
  - Business Plan for the exploitation of AURORA results, assessing key exploitable results of the project and their economic potential:
    - Which are the Key Exploitation Results of the project that are selected and prioritized due to its high potential to be exploited.
    - Management of IPR
    - The market potential areas
    - Business Model

WP2 Technical Coordination and Innovation Management

Deliverables

WP	Del Nº	Title	Lead Beneficiary	Nature	Dissemination Level	Del. Date	Status
WP2	D7	D2.1 Executive Board Minutes of Meeting	SENER AE	Report	Confidential	30 Nov 2020	Approved
WP2	D8	D2.2 Innovation Management report	UPM	Report	Confidential	30 Apr 2023	Delivered
WP2	D9	D2.3 AURORA SW Development Plan	SENER AE	Report	Confidential	30 Apr 2021	Approved
WP2	D10	D2.4 Development roadmap, competitiveness and costs assessment	SENER AE	Report	Confidential	30 Apr 2023	Delivered
WP2	D11	D2.5 Business Plan	SENER AE	Report	Confidential	30 Apr 2023	Delivered

WP3 AOCS-GNC Code Generator (QGen) Technology Demonstrator

To demonstrate and validate the code generated by QGEN on Euclid models. This code will be tested against the previously and validated code obtained inside the Euclid project

- ✓ Task 3.1 Specification, modelling and tool-set setup
- ✓ Task 3.2 Model verification and Processor in the loop
  - Code Generation/Model-in-the-loop
  - SW in the Loop (SIL)
- ✓ Task 3.3 Model verification and Hardware in the loop
  - Processor in the Loop (SIL)
  - Hardware in the Loop (HIL)

WP3 AOCS/GNC Code Generator (QGEN) Tech Demonstrator

WP	Del Nº	Title	Lead Beneficiary	Nature	Dissemination Level	Del. Date	Status
WP3	D12	D3.1 Requirements specification	SENER AE	Report	Confidential	30 Apr 2021	Approved
WP3	D13	D3.2 Modelling guidelines	SENER AE	Report	Confidential	30 Apr 2021	Approved
WP3	D14	D3.3 V&V Plan	SENER AE	Report	Confidential	30 Apr 2021	Approved
WP3	D15	D3.4 QGen toolset and SW Development Environment	esc Aerospace	Other	Confidential	30 Apr 2021	Approved
WP3	D16	D3.5 Demonstration Simulink models	SENER AE	Report	Confidential	05 Jul 2022	Submitted
WP3	D17	D3.6 QGen evaluation report	esc Aerospace	Report	Public	01 Feb 2023	Submitted
WP3	D18	D3.7 Test cases specification	SENER AE	Report	Confidential	25 Jan 2023	Submitted
WP3	D19	D3.8 MISRA C Source code	esc Aerospace	Report	Confidential	27 Jan 2023	Submitted
WP3	D20	D3.9 Test cases reporting (PIL & HIL)	esc Aerospace	Report	Confidential	23 Jan 2023	Submitted
WP3	D21	D3.10 SW Verification Report (PIL & HIL)	esc Aerospace	Report	Confidential	01 Feb 2023	Submitted
WP3	D22	D3.11 AURORA QGen toolset	SENER AE	Other	Public	30 Jan 2023	Submitted

WP4 Flight SW Autocoding Life-cycle Process Definition

WP3 & WP5 execution sprints provide inputs to WP4 (and WP6) that are running in parallel. This allows iterating to the definition of the life cycle processes (WP4) and providing preliminary conclusions in the assessment of this technology (WP6)

- Task 4.1 Definition of the Model-in-the-loop process
- Task 4.2 Definition of the Software-In-the-Loop
- Task 4.3 Definition of the Component-In-the-Loop
- Task 4.4 Definition of the Execution Platform-In-the-Loop

WP4 Flight SW Autocoding Life-cycle Process Definition

Flight SW Autocoding Life-cycle Process (Model-in-the-loop)

- Define the workflow and standards involved in the process.
  - The model must comply with the **modelling standards and guidelines** (QGen Model Verifier)
  - Model simulations demonstrate the **feasibility of the preliminary design** and the robustness of the selected solutions using Monte Carlo test campaigns.
  - **Unit test** validation and verification environment definition (QGen Model Debugger).
- Being able to perform such tests during the preliminary stages of the development allows for efficient iterations at system level, giving valuable contributions for trade-offs that involve other subsystems enabling an **early verification of the GNC models**.

WP4 Flight SW Autocoding Life-cycle Process Definition

Flight SW Autocoding Life-cycle Process (SW-in-the-loop)

- Software in the loop specified the analysis process of the autogenerated code from Simulink models
- The assessment of the criticality of the software is used to define the required V&V activities
- The analysis to perform enclose Static analysis and dynamic analysis
- Static Analysis:
  - Analysis of structure and syntaxis of the code: Cyclomatic complexity, nesting levels, number of statements, …
  - Adherence to coding rules: MISRA C rules has become a standard
- Dynamic Analysis:
  - Runs the code to ensure correctness in generation
  - The process requires to perform a MIL-SIL comparison
    - Numerically compare outputs
    - Tolerance is model dependent and agreed by experts. Typical range 1E-12 - 1E-15. The key element is that the AOCS performance is not affected by numerical differences
  - Coverage analysis: an Iterative process until reaching 100%. If not possible, justification is required

WP4 Flight SW Autocoding Life-cycle Process Definition

Flight SW Autocoding Life-cycle Process (Component-in-the-loop)

- Introduction to the TASTE toolchain, which is used to define and integrate SW components:
  - Runtimes, extended within the scope of the project, hosting the user components
  - Automatically generated GUIs, which can be used to manually exercise the developed SW
  - Function Tester, developed within the scope of the project, supporting the testing of QGenC components
- The built-in Simulator and Model Checker are also introduced as additional utilities for testing SDL components, which can be used in the system in addition to the C, GUI and QGenC ones
- Implementation of the component model over TASTE functions is described, followed by the integration of the UPM-Sat2 TASTE model into a cFS architecture
- Guidelines for Component-in-the-Loop testing using TASTE were provided, including approaches to testing using static test vectors and testing using dynamic environment

WP4 Flight SW Autocoding Life-cycle Process Definition

Flight SW Autocoding Life-cycle Process (Platform-in-the-loop)

- An integrated version of the OBSW is deployed in a simulation environment with some sort of hardware component on the loop
- Software verification facility: Software environment capable of replicating the real satellite
  - Simulators of sensors, actuators, hardware interfaces, power lines, etc.
  - Capable of performing and support integration tests, parameter settings validation, open loop functional validation, SW maintenance evolution, validation of the database.
  - The loop can be close with a DKE simulator
- Hardware verification facility
  - Unitary testing
  - Real sensors and actuators are placed in a test bench for isolated testing
  - Performance test or mapping and sign tests are the most common
- Flight software testing
  - This environment incorporates the complete OBSW on the loop, which is deployed in a representative model of the OBC
  - Simulated or real hardware components are used
- End-to-end test campaign is performed in situ with the real and complete spacecraft
  - Qualification and acceptance test campaign are performed

WP4 Flight SW Autocoding Life-cycle Process Definition

Deliverables

WP	Del Nº	Title	Lead Beneficiary	Nature	Dissemination Level	Del. Date	Status
WP4	D23	D4.1 Flight SW Autocoding Life-cycle Process (Model-in-the-loop)	SENER AE	Other	Public	31 Oct 2021	Approved
WP4	D24	D4.2 Flight SW Autocoding Life-cycle Process (Software-in-the-loop)	N7 Space	Report	Public	18 Feb 2022	Submitted
WP4	D25	D4.3 Flight SW Autocoding Life-cycle Process (Component-the-loop)	N7 Space	Report	Public	09 Oct 2022	Submitted
WP4	D26	D4.4 Flight SW Autocoding Life-cycle Process (Execution-Platform-the-loop)	SENER AE	Other	Public	01 Feb 2023	Submitted

WP5 Component-Based Interfaces standardisation

- Requirements for a component model and relevant architecture, provide a design, implement and validate it as a part of the TASTE toolchain
- Integration of Simulink models and QGen generations into TASTE toolchain and modelling languages
  - ✓Task 5.1 Requirements Gathering
  - ✓Task 5.2 Standardized Component Interfaces
  - ✓Task 5.3 Architecture Messaging System
  - ✓Task 5.4 TASTE integration

WP5 Component-Based Interfaces standardisation

Deliverables

WP	Del Nº	Title	Lead Beneficiary	Nature	Dissemination Level	Del. Date	Status
WP5	D27	D5.1 CBI Requirements Specification	UPM	Report	Confidential	30 Apr 2021	Approved
WP5	D28	D5.2 Technical Architecture	N7 Space	Report	Confidential	10 Oct 2022	Submitted
WP5	D29	D5.3 AURORA Component Model Report	UPM	Report	Confidential	03 Feb 2023	Submitted
WP5	D30	D5.4 AURORA Interface Specification	N7 Space	Report	Confidential	03 Feb 2023	Submitted
WP5	D31	D5.5 MVP CB API	N7 Space	Other	Confidential	07 Feb 2023	Submitted
WP5	D32	D5.6 MVP CB Message Broker	N7 Space	Other	Confidential	07 Feb 2023	Submitted
WP5	D33	D5.7 CBI Demonstration Report	UPM	Report	Confidential	06 Feb 2023	Submitted
WP5	D34	D5.8 Tool-chain framework release	N7 Space	Other	Public	07 Feb 2023	Submitted
WP5	D35	D5.9 Tool-Chain Demonstration report	N7 Space	Other	Public	06 Feb 2023	Submitted

WP6 Demonstration Viability Assessment

- TRL Assessment (TRA) of the project technology:
  - The Relevant TRL is understood accordingly with the H2020 “WP General Annexes - Extract from Part 19 -Commission Decision C (2014)4995 G.”
  - Demonstration use cases:
    - a GNC Demonstrator that make use of current EUCLID AOCS validation facilities at SENER Aeroespacial, what is an industrially relevant environment for this key enabling technology)
    - UPMSat-2 is a micro-satellite that can be used as an in-orbit technology demonstration platform

✓Task 6.1 TRA Plan

✓Task 6.2 Preparation of the key data TRA for Qgen

✓Task 6.3Conducting and reporting the TRA for QGen

WP6 Demonstration Viability Assessment

Deliverables

WP	Del Nº	Title	Lead Beneficiary	Nature	Dissemination Level	Del. Date	Status
WP6	D36	D6.1 TRA Plan	UPM	Report	Public	31 Mar 2022	Submitted
WP6	D37	D6.2 Evidence for the assessment Report	esc Aerospace	Report	Public	06 Feb 2023	Submitted
WP6	D38	D6.3 TRA Report	UPM	Report	Public	06 Mar 2023	Submitted

WP7 Dissemination, communication and exploitation

- Promotion of AURORA contribution to the embedded SW scenario and Navigation technologies
- Divulge and disseminate the generated knowledge and innovations, guarantee impact and the Safeguard the process of exploitation of results and investigating the market exploitation potential
  - ✓Task 7.1 Communication activities
  - ✓Task 7.2 Dissemination activities
  - ✓Task 7.3 Exploitation activities

WP7 Dissemination, communication and exploitation

Deliverables

WP	Del Nº	Title	Lead Beneficiary	Nature	Dissemination Level	Del. Date	Status
WP7	D39	D7.1 AURORA website and social media profiles	UPM	Other	Public	18 Mar 2022	Approved
WP7	D40	D7.2 AURORA Communication Plan	UPM	Report	Confidential	01 Apr 2022	Approved
WP7	D41	D7.3 Peer-reviewed, conference and workshops publications	SENER AE	Report	Public	16 Feb 2023	Submitted
WP7	D42	D7.4 Communication material Videos, leaflets, etc	SENER AE	Other	Public	30 Apr 2023	Submitted
WP7	D43	D7.5 Plan for the Exploitation, and Dissemination of Results	SENER AE	Report	Public	30 Apr 2023	Submitted

Aurora

2) QQen TRL Demonstration (SENER AE& ESC) – videos/demo & Presentation

Final Project Review

Aurora

3) Component Based Interface Development (N7S) – videos/demo & Presentation

Final Project Review

Aurora

4) QGen/TASTE/cFS Integration (UPM) – videos/demo & Presentation

Final Project Review

Aurora

5) Dissemination/ Communication & Exploitation Activities (SENER AE)

Final Project Review

Communication

Web-portal https://www.aurora-software.eu

- Description of the Project, Team Members with links to their websites and other sites of interest, news, events and a gallery of videos.
- Public Documents are available
- Published papers
- Videos
  - AURORA presentation video
  - Processor-in-the-loop (PIL) testing
    - PIL tests for the AURORA project
  - QGen-TASTE integration workshop
    - TASTE and QGen, a demo setup
    - CFS, RTEMS, and LEON3 platform
    - Simulink integration in the TASTE toolchain
  - CBI Implementation: Presentation of multiple features added to TASTE

    TASTE channel: https://www.youtube.com/watch?v=aQwdNFGek_8&ab_channel=taste

Dissemination and Communication Activities (I)

- Dedicated Workshop meetings for relevant Technical Issues (3):
  - TASTE, cFS, JTR (UPM)
- Press Release (6):
  - Sener Press Release: SENER Aeroespacial leads the AURORA project on advanced space software technologies: group.sener
  - Press Dossier: satelliteevolution.com, fly-news, avionrevue.com; defensa.com, industytalks.es
- Web Page (1):
  - www.aurora-software.eu
- Social Media (3):
  - www.twitter.com/SoftwareAurora
  - www.linkedin.com/groups/9024792/
  - info@aurora-software.eu

Dissemination and Communication Activities (II)

- Participation to a Conference (7):
  - ADCSS, MBDSE, DASIA 21, DASIA 22, Ada-Europe 22, Ada-Europe 23
- Participation to a Workshop (11)
  - TASTE, MBSE 22, Ada-Spain 22, Ada-Spain 23, JTR 23(6 px), ADEPT 23
- Video/Film (7)
  - Introduction (gallery); PIL tests; TAST & QGen; CFS, RTEMS; Simulink; CBI Implementation

Note: Most of the participation to Conferences/Workshop on-line (due to the covid situation)

Dissemination: Published papers

Papers

Integration of modelling languages for the development of space domain software applications.
A.G. Pérez, M.A. de Miguel, H. Valente, J. Zurera, J. Zamorano, A. Alonso, J.A. de la Puente
Accepted for publication in *Ada User Journal* (2022)
https://oa.upm.es/71908/

Requirements Gathering, Toolchain Creation and Platform Testing for a MBSE code generation.
J. Zurera, H. Valente, J. Zamorano, M.A. de Miguel.
Poster presented at the *MBSE 2022 Conference* — Toulouse, 22-24 November 2022.
https://oa.upm.es/72547/

Design, development, and implementation of a cFS, RTEMS, and LEON3 platform.
J. Zurera, M.A. de Miguel, H. Valente, A.G. Pérez, A. Alonso, J. Zamorano, J.A. de la Puente
DASIA 2022 — 17-19 May, 2022
https://oa.upm.es/70919/

Extension of the Modeling Tool Suite for Development of Embedded Systems for the Space Domain.
H. Valente, M.A. de MigueL, J. Zurera, A.G.Pérez, A. Alonso, J. Zamorano, J.A. de la Puente.
IFAC-PapersOnLine. 55 (4): 286-291
https://doi.org/10.1016/j.ifacol.2022.06.047

Requirements for a Component-Based Modelling Language for Space Missions.
J. Zurera, H. Valente, M.A. de Miguel, A.G. Pérez, J. Zamorano, J.A. de la Puente, A. Alonso
Congreso Español de Informática (CEDI 2021), VI Simposio de Sistemas de Tiempo Real —— 22-24 septiembre 2021, Málaga.
https://oa.upm.es/70963/

39 Dissemination: Published papers

- *"A Quantitative Analysis of an Automatic Code Generation Tool for Space Software Applications"*
- The analysis is limited to KPI data from UPMSat-2.

- Submitted on 5th April 2023 to the *Journal of Software: Evolution and Process.*
- Under review, preprint available in AUTHOREA ↗

Dissemination & Communication: Estimated Audience

- Supported by:
  - Conferences and Workshop Participation
  - Press Release
  - Published papers
  - Web activity
- Audience: 22.594

Scientific Community (Higher Education, Research)	1130
Industry	2259
Civil Society	2485
General Public	15567
Policy Makers	226
Media	452
Investors	226
Customers	249
Other	0

41 Exploitation of Results

D7.5 Plan of the Exploitation and Dissemination of Results (PEDR)

Innovation assets (D2.2 Innovation Management Report)

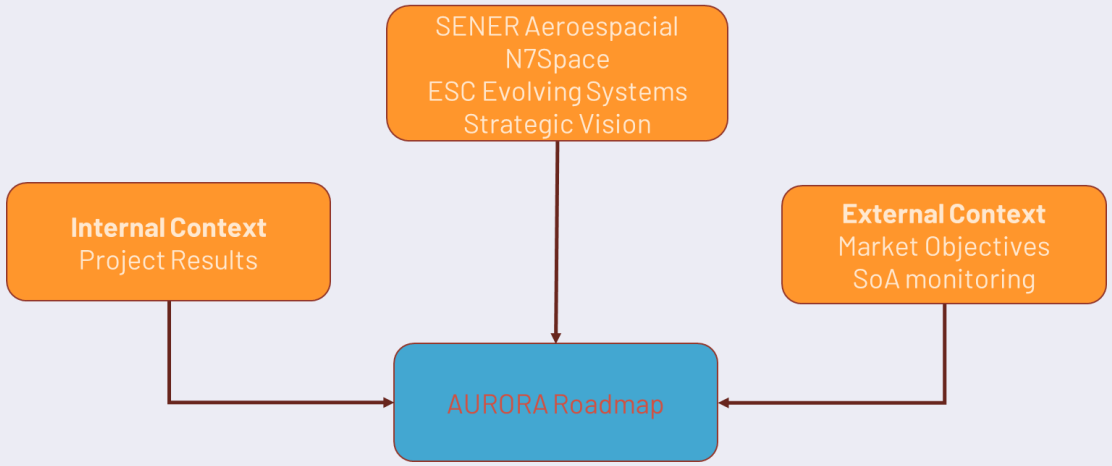
Res #	Result	Category	Partners	Actions
KER#1	Integrate in AADL automatically the code generated by QGEN from a Simulink model	Dissemination	UPM	Related published articles: • Integration of modelling languages for the development of space domain software applications. • Extension of the Modeling Tool Suite for Development of Embedded Systems for the Space Domain
KER#2	New version of SpaceCreator development tools with the new extension for modelling	Dissemination	UPM	Related published articles: • Requirements Gathering, Toolchain Creation and Platform Testing for a MBSE code generation • Design, development, and implementation of a cFS, RTEMS, and LEON3 platform • Requirements for a Component-Based Modelling Language for Space Missions
KER#3	Autocoding SW Development Lifecycle (processes, methodology and tools) for automatically generated code from MATLAB/Simulink models with the aim to optimise and automate, wherever possible, all stages of the process to enhance efficiency whilst ensuring the required quality level	Exploitation	All	Related articles: • A Quantitative Analysis of an Automatic Code Generation Tool for Space Software Applications • Toolchain for cFS embedded systems for microsatellites Related activities: • UPM: Seminars and Post Doctoral positions • Internal training at SENER AE about the Autocoding Lifecycle. • Autocoding Methodology in Commercial projects (SENER AE): AFTS autogenerated code from Simulink models.
KER#4	Software architecture and interfaces for functional components interoperability	Exploitation	All	Related activities in on-going Horizon Europe projects: • ORU-BOA (Orbital Replacement Unit) GA Project 101082078: supporting the Architecture solution. • SAFEST (Smart Avionics for Flight termination systems) Project Nº 101082662: supporting the Architecture solution and development methodology.
KER#5	Innovative MBSE techniques	Exploitation	All	

Aurora

6) Development Roadmap (SENER AE)

Final Project Review

43 Development Roadmap



Potential Innovation

- Definition of deliverables with high innovation potential to define the following steps in the AURORA technological

Deliverables

- D2.4 Development roadmap, competitiveness and costs assessment
- D2.5 Business Plan

44 Development roadmap

Technology Development Plan: 2 lines of actions for the success of future deployment

1) Future prototypes
   - Funding exploration to CBI API deployment and TRL Assessment.
   - Promoting CBI/TASTE for Space Applications, through open-source licensing
   - Qgen future activities including extensions, customizations and integrations with other open-source software (Simulink alternatives Xcos, Scilab)

Additional investments will be needed in the future

Synergies with other funding Programmes should be identified in order to improve development cost-benefit and avoid duplications

2) Future Aeroespace applications
   - Development of opportunities in the AOCS/GNC market

Validate the AURORA tool-suite to serve a wider number of applications. This would maximise the penetration potential of the AURORA Project and allow specific applications to benefit from the developments resulting from it

45 Business Model

- D2.5 Business Plan for the exploitation of AURORA results
  - Identification Key exploitation results
  - Assessment of IPR issues
  - Description main clients and exploitation strategies
  - Business Models for exploitation
- Business models for the exploitation of the Project results:
  - Business model - Research use by Academic:
    - UPM research groups/UPMSAT-3
  - Business model - Research use by industrial partners
    - R&D actions for industrial partners
  - Business model - Direct exploitation by industrial partners
    - Company Strategic Plan
  - Business model - Open-source licensing

7) AURORA objectives, Milestones Achievement (SENER AE)

Final Project Review

Project Objectives

AURORA – Tool suite AUtomatic code generation and validation of model-based critical inteROpeRAble components

Technical Objectives

- European Technology:
  - Demonstration of European Autocoding technology based on QGEN in an industrially relevant environment
- TRL:
  - Development Plan for a target TRL-6
- Space Mission Product solution:
  - Autocoded Flight Software Life-cycle process and methodology
  - Interoperability capability of SW components
  - Tool-chain integration into ESA TASTE framework

Ambition, Impact & Management Objectives

- Effective and coordinated Management of the project
  - Project Management and Quality Assurance
  - Specific Technical Management
- Overall Return On Inversion:
  - Divulgate and disseminate generated knowledge and innovation
  - Communication of results
  - Market exploitation of results

48 Project Objectives

WP1 Management and Quality Assurance

Objective	Description	Consecution Status
01.1	Strategic and everyday management; effective Project monitoring, in administrative and financial terms.	Completed Project monitoring executed in line with administrative and financial needs.
01.2	Guarantee the coherence of the work to the overall Project plan, available resources and timing.	Completed Coherence of the work monitored during projects meetings according to foreseen resources and timing.
01.3	Offer the necessary interface to the EC services and external actors.	Completed
01.4	Coordinate the defined management structure, through the General Assembly	Completed GeA meetings.
01.5	Draft a Plan aiming to ensure the quality of the Project outcomes and the safety of its execution.	Completed Quality Assurance Plan (QAP) is approved
01.6	Identify and mitigate project risks by performing an effective risk management	Completed Risk report included in this document
01.7	Guarantee that all ethical, legal and gender issues related to the Project research are properly considered and any relevant conventions are being respected	Completed Issues continuously monitored.
01.8	Assure the quality of conducted work by implementing a functional and effective quality assurance plan	Completed Assuring the quality of work coherence is monitored during projects meetings according to QAP.

Project Objectives

WP2 Technical Coordination and Innovation Management

Objective	Description	Consecution Status
02.1	Strategic, everyday technical coordination; effective Project monitoring, in scientific and technical terms.	Completed. E-mail/Teams interactions. Specific meetings have been placed when needed.
02.2	Coordinate the defined technical management structure, through the Executive Board.	Completed. EBd meeting #15 held in April/23.
02.3	Interface among the members of the Executive Board and between this and the General Assembly.	Completed. Fluent communication within SENER AE and with the Consortium.
02.4	Monitor the state-of-the-art in Project related and transversal areas.	Completed. Special monitoring on Flight SW and MBSE evolution in the Innovation Report
02.5	Identify, manage and implement available and applicable innovations to respond to market evolution.	Completed. Innovation Report
02.6	Coordinate Systems Engineering tasks for AURORA tool set definition as well as integration.	Completed. Project Milestones
02.7	Analyse the Project results and the technologies maturity level reached in AURORA.	Completed. Innovation Report
02.8	Plan the next development phases, prepare technology roadmaps and outline the business plan.	Completed. Business Plan and Development roadmap, competitiveness and costs assessment Report

Project Objectives

WP3 AOCS-GNC Code Generator (QGen) Technology Demonstrator

Objective	Description	Consecution Status
03.1	Specify the requirements for the technology demonstrator	Completed Requirements baseline approved at MS#3
03.2	Definition of the Modelling standards and norms	Completed Guidelines documentation approved at MS#3
03.3	Plan the verification and validation activities	Completed V&V Plan at MS#3
03.4	Define the test cases of the Euclid Test environment facilities to validate the demonstrator	Completed Test cases have already been defined.
03.5	Install and set up QGen toolset in Matlab/Simulink and SW development environment	Completed SDE is defined and approved
03.6	Prepare the demonstration models in Matlab/Simulink based on Euclid AOCS/GNC SW. Evaluate compatibility with QGen support package and compatibility with modelling guidelines	Completed Baseline for Simulink models is defined.
03.7	Demonstrate the use of the QGen Model Verifier and Model Debugger	Completed SW Verification Report
03.8	Demonstrate the use of the QGen SW Generator	Completed QGEN Evaluation report phase by phase completed
03.9	Demonstrate Processor-in-the-Loop capabilities with QGen	Not achieved QGen capabilities QGenpil, is not supported in the latest versions of QGen. Instead, QGen Simulation Framework code was ported to run on TSIM/Leon2
03.10	Execution of test cases in the Euclid Operational Environment	Completed
03.11	Test Cases reporting and conclusion	Completed Working on SW Verification Report phase by phase
03.12	Code Metrics evaluation (SIL, PIL) and comparison against consolidated Flight SW results to assess SW quality	Completed SIL/PIL metrics available
03.13	Assessment of QGen for AOCS/GNC code generation	Completed TRL-7

Project Objectives

WP4 Flight SW Autocoding Life-cycle Process Definition

Objective	Description	Consecution Status
04.1	Definition of auto-coding development stages and guidelines to be followed.	Completed. Life-cycle processes: MIL, SIL, PIL
04.2	Development of auto-generated GNC source code iterative process.	Completed. Life-cycle processes: MIL, SIL, PIL
04.3	Definition of verification scheme for auto-coded GNC.	Completed. Life-cycle processes: MIL, SIL, PIL
04.4	Definition of integration process through standard interfaces.	Completed. Life-cycle processes: CIL, PIL
04.5	Define the complete Flight SW Autocoding Life-Cycle from model to integration.	Completed. Life-cycle processes: CIL, PIL

Project Objectives

WP5 Component-Based Interfaces standardisation

Objective	Description	Current Status
05.1	Specification of requirements for standardisation of components.	Completed Requirements baseline approved at MS#4
05.2	Injecting current trends and products inspired by relevant projects (section 1.3).	Completed As part of the CBI requirements specification task
05.3	Define the Minimum Value Product (MVP) the minimum amount of functionality to test AURORA design.	Completed Requirements baseline approved at MS#4
05.4	Define a Component Model approach.	Completed AURORA Component Model Report was prepared
05.5	Obtain Standardized Component Interfaces following service-consumer patterns.	Completed AURORA Interface Specification was prepared
05.6	Design and implementation of a communications layer for components implementing the service provider interface.	Completed Runtime templates and libraries were implemented, SpaceCreator was updated to support the functionality
05.7	Messaging channel implementation supported by open-source frameworks.	Completed Runtime templates and libraries (including Broker) were implemented.
0.5.8	The code generation tool-chain integration into the TASTE framework	Completed The developed code (templates, libraries and SpaceCreator modifications) were supplied to the main TASTE repository.

Project Objectives

WP6 Demonstration Viability Assessment

Objective	Description	Consecution Status
O6.1	Plan for the TRL technology readiness assessment.	Completed. TRA Plan defines KPI and risks and Demonstrators for evaluation.
O6.2	Assessment of applicability of the tool suite to design, model, simulate and verify the AOCS/GNC software for several potential missions	Completed. TRA report: TRL-7 the QGen toolset and validity of the tool confirmed within intended application.
O6.3	Comparative analysis of costs in actual missions	Completed. TRA Report demonstrates the viability of a reduction in the efforts and planning of the software life cycle at incorporating Autocoding technologies in the process
O6.4	Risks analysis of the proposed solution	Completed. TRA Report: a higher TRL will enhance the insertion of the tool in future projects with lower technical risks.

Project Objectives

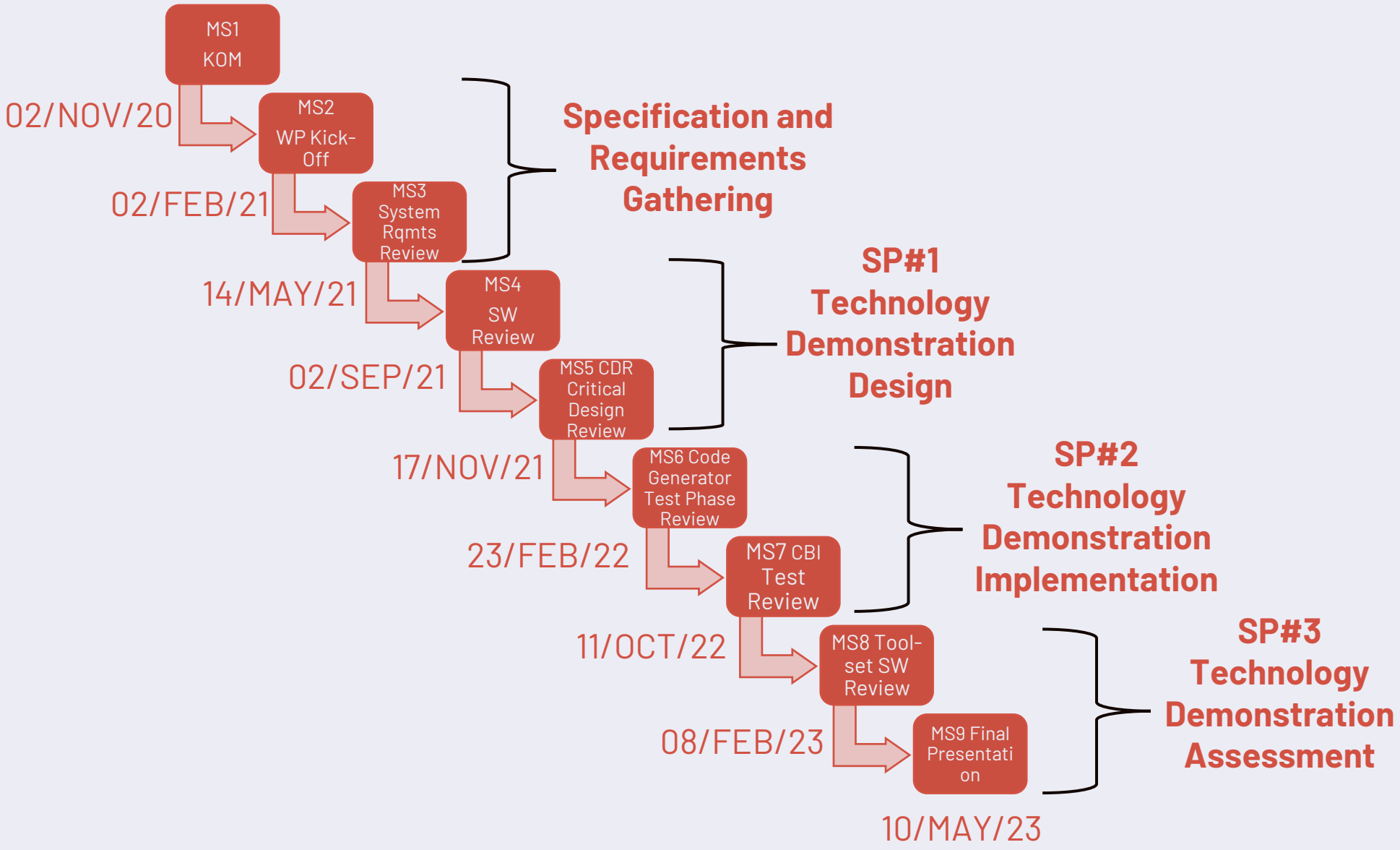
WP7 Dissemination, communication and exploitation

Objective	Description	Consecution Status
07.1	Promote AURORA contribution to the Space MBSE scenario.	Completed Publications and communication actions
07.2	Divulge and disseminate the generated knowledge and innovations to the scientific and industrial community, as well as to potential stakeholders in Europe and internationally.	Completed Publications and communication actions
07.3	Communicate the Project and its results to General public, to strengthen its visibility.	Completed Publications and communication actions
07.4	Guarantee impact through the planning and management of joint and individual exploitation actions.	Completed Business Plan
07.5	Safeguard the process of exploitation of results.	Completed Commercialisation Roadmap
07.6	To investigate the market exploitation potential.	Completed Commercialisation Roadmap

Milestones: Phases of the project

1. Specification and Requirements Gathering — MS3 System Rqmts Review — COMPLETED
2. Phase SP#1 - Technology Demonstration Design — MS5 CDR Critical Design Review — COMPLETED
3. Phase SP#2 - Technology Demonstration Implementation — MS7 CBI Test Review — COMPLETED
4. Phase SP#3 - Technology Demonstration Assessment — MS9 Final Review — COMPLETED

Milestones Status



Aurora

8) Status of Financial & Technical Reporting (SENER AE)

Final Project Review

58 Periodic Reporting

- PMOC-10100429-2 RV3 Periodic Reporting launch on 02/May
- **Financial and Technical reporting** submitted in 60 days (Some late delivery might be accepted if justified)

  The technical reporting provides a general overview of the project, following the EC guidelines (H2020 AGA — **Annotated Model Grant Agreement: V5.2 – 26.06.2019**)
- The preparation of the **financial statements** also follows the Annotated Model GA rules.
  - The personal costs that are eligible are those use of resources done until 30/April/2023
  - However, **costs related to the preparation of the Review meeting (in May)** and the financial reporting are accepted
  - Also, those **costs resulting from changes to deliverables** (during the EC approval process)
  - Therefore, we can consider to include personal costs in our Financial Statements until **31/May/23**
- Guidelines: H2020 AGA — Annotated Model Grant Agreement: V5.2 – 26.06.2019

Technical Report

- **Technical Report (Part B): Explanation of the work - Overview of progress**
  - *Final technical report is a publishable summary of the entire project*
    - *overview of the results and their exploitation and dissemination*
    - *conclusions on the project*
    - *its socio-economic impact of the project*
    - *an up-to-date link to the project website*
    - *project logos, diagrams, photographs and videos illustrating its work (if available).*
  - *Final summary written in an **understandable style for a non-specialist audience**.*
- **Inputs from D1.6 AURORA Management Report - Period Report**
  - Technical achievements and work progress
  - Status of milestones and planning of the Project
  - Status of the deliverables of the Project
  - Reporting on Risks status, KPI and Quality metrics
  - Reporting on Communication activities

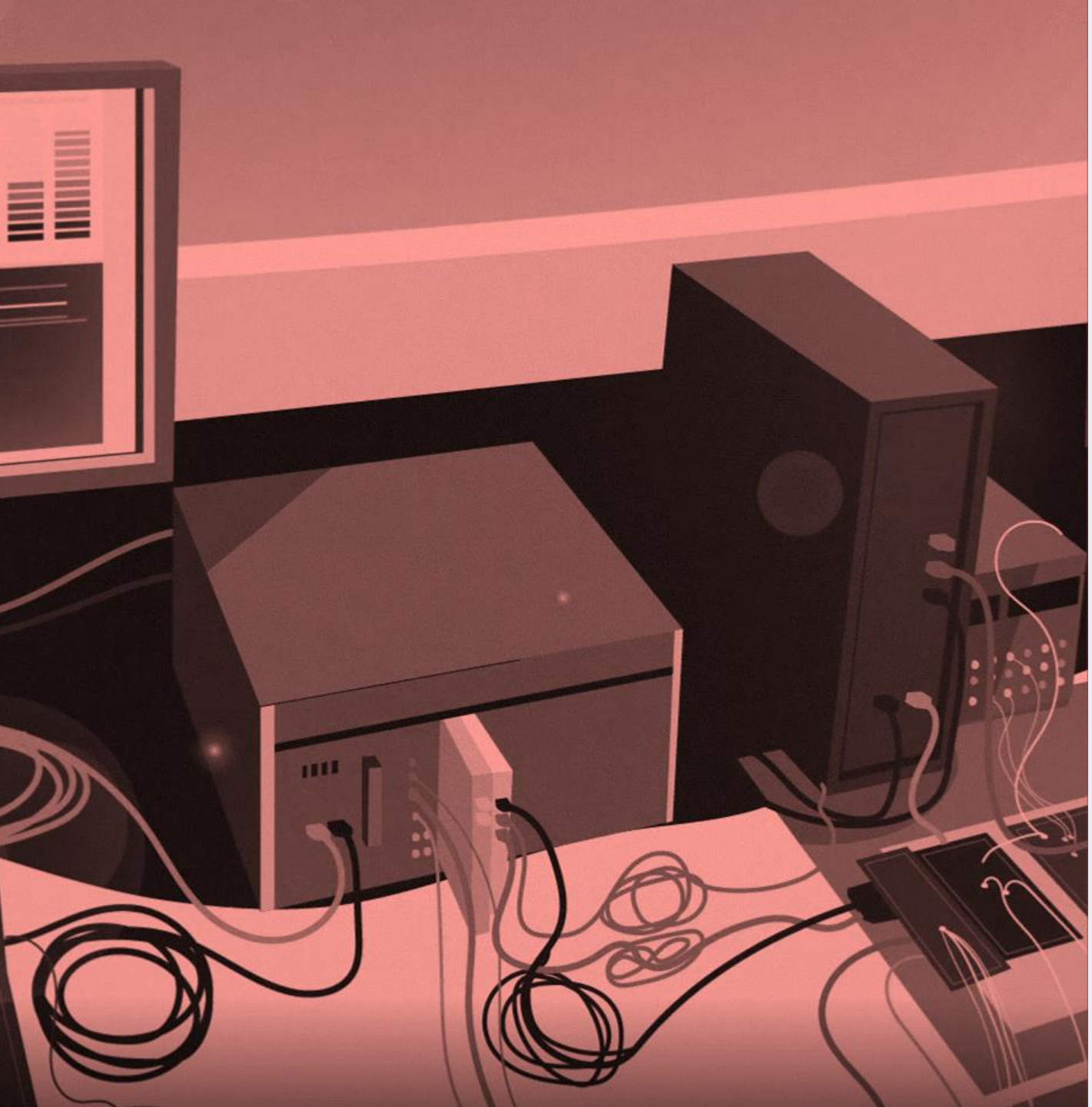
60 Financial Reporting

- SENER AE
  - Calculation of direct personal costs and other direct costs and preparation of the financial audit. PM aligned with the budget (pending costs in May)
- UPM
  - Direct Personal costs higher than the amount budgeted; PM increased in about 15%
- N7S
  - In preparation: financial evidence and financial audit
- ESC
  - In preparation: financial evidence and financial audit

Aurora

9) Q&As, Conclusions, Feedback from PO and Expert

Final Project Review



Thank you!!

www.aurora-software.eu

www.twitter.com/SoftwareAurora

www.linkedin.com/groups/9024792/

info@aurora-software.eu