



EXECUTIVE SUMMARY REPORT

BIBLOS3

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1. INTRODUCTION

1.1. PURPOSE AND SCOPE

The purpose of this document is to specify the list of items in Technical Data Package.

1.2. ACRONYMS AND ABBREVIATIONS

Acronyms specifically used in this document are included in the following table:

Table 1-1 Acronyms

Acronym	Definition

2. REFERENCES

2.1. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the Contract or approved by the Approval Authority. They are referenced in this document in the form [AD.X]:

Table 2-1 Applicable Documents

Ref.	Title	Code	Version	Date
	Request for Proposal for "Model Library for Earth Observation (EO) End-to-End Simulators – EOLIB3" Appendix 1 – Statement of Work Appendix 2 – Draft Contract Appendix 3 – Tendering Conditions for Express Procurement Procedure (EXPRO/TC) Appendix 4 – Proposal Template (including Cover Letter and Detailed Proposal)	ESA RFP/3-16538/20/NL/AS	-	

2.2. REFERENCE DOCUMENTS

The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.X]:

Table 2-2 Reference Documents

Ref.	Title	Code	Version	Date

2.3. PROJECT DOCUMENTS

The following documents are produced in the frame of this activity. They are referenced in this document in the form [PD.X]:

Table 2-3: Project documents

Ref.	Title	Code	Version	Date
[PD.0]	BIBLOS Requirements Baseline	GMV-BIBLOS3-D0	1.7	08/05/2023
[PD.1]	Mission Concepts and Datasets Definition	GMV-BIBLOS3-D1	1.6	05/06/2023
[PD.2]	Website Design	GMV-BIBLOS3-D2	1.3	05/06/2023
[PD.3]	Platform and Systems Description	GMV-BIBLOS3-D3	1.3	05/06/2023
[PD.4]	Software Requirements Specifications	GMV-BIBLOS3-D4	1.4	08/05/2023
[PD.5]	Software Design Document Software ATBD Document	GMV-BIBLOS3-D5, GMV-BIBLOS3-D5_ATBD	1.3	05/06/2023
[PD.6]	Software Interface Control Document	GMV-BIBLOS3-D6	1.3	05/06/2023
[PD.7]	Software Unit and Integration Test Plan	GMV-BIBLOS3-D7	1.3	05/06/2023
[PD.8]	Software Verification and Validation Plan	GMV-BIBLOS3-D8	1.2	08/05/2023
[PD.9]	Software Product Assurance Plan	GMV-BIBLOS3-D9	1.1	15/06/2021
[PD.10]	Software Unit and Integration Test Report	GMV-BIBLOS3-D10	1.2	05/06/2023
[PD.11]	Software Verification and Validation Report	GMV-BIBLOS3-D11	1.1	05/06/2023
[PD.12]	Software Reuse File	GMV-BIBLOS3-D12	1.3	05/06/2023

Ref.	Title	Code	Version	Date
[PD.13]	Software User Manual	GMV-BIBLOS3-D13	1.1	05/06/2023
[PD.14]	Software Release Note	GMV-BIBLOS3-D14	1.1	05/06/2023
[PD.15]	Software Configuration File	GMV-BIBLOS3-D15	1.1	05/06/2023
[PD.16]	Software Maintenance Plan	GMV-BIBLOS3-D16	1.0	05/06/2023
[PD.17]	Software Acceptance Data Package	GMV-BIBLOS3-D17	1.0	05/06/2023
[PD.18]	Software Validation Specification	GMV-BIBLOS3-D18	1.2	05/06/2023
[PD.19]	Software Product Assurance Milestone Report	GMV-BIBLOS3-D19	3.0	05/06/2023
[PD.20]	Technical Data Package	GMV-BIBLOS3-TDP	1.0	05/06/2023
[PD.21]	Executive Summary Report	GMV-BIBLOS3-ESR	1.0	05/06/2023
[PD.22]	Abstract	GMV-BIBLOS3-ABS	1.0	05/06/2023
[PD.23]	Final Report	GMV-BIBLOS3-FR	1.0	05/06/2023
[PD.24]	Contract Closure Documentation	GMV-BIBLOS3-CDD	1.0	05/06/2023
[PD.25]	Lessons Learned and Roadmap	GMV-BIBLOS3-LLR	1.0	05/06/2023
[PD.26]	Brochure	GMV-BIBLOS3-BR	1.0	05/06/2023
[PD.27]	Technology Achievement Summary	GMV-BIBLOS3-TAS	1.0	05/06/2023
[PD.28]	Final Presentation	GMV-BIBLOS3-FP	1.0	05/06/2023
[PD.29]	BIBLOS-3 and GSOOS Synergy Assessment	GMV-BIBLOS3-GSOOS_SA	1.0	08/05/2023

3. BACKGROUND AND OBJECTIVES

This activity, i.e. BIBLOS-3, is a continuation of two previous BIBLOS activities, all of them inherit from ARCHEO-E2E.

Table 3-1 shows the coverage of various type of instruments by BIBLOS SW components released in the last official SW version, i.e. v2.2 released at the end of BIBLOS-2 Maintenance Period. As shown, there are a lot of missing SW components which makes impossible to create full E2E chain. Only for PMW instrument a chain composed from instrument simulation and ground processing can be build, however, without assessment of mission performances.

TRL for Kick-Off of BIBLOS-3 is #4.

Table 3-1: Instrument vs. SW v2.2 components

Instruments vs. Modules	Passive Optical (PO)	Passive Microwave (PMW)	Active Microwave (AMW)	Active Optical (AO)	Generic (GEN)
Geometry (GM)	BBs available in BIBLOS v2.2	BBs available in BIBLOS v2.2	BBs available in BIBLOS v2.2	Outside the scope of BIBLOS-1 & -2	BBs available in BIBLOS v2.2
Scene Generator (SGM)	BBs available in BIBLOS v2.2	BBs available in BIBLOS v2.2	BBs available in BIBLOS v2.2	Outside the scope of BIBLOS-1 & -2	Outside the scope of BIBLOS-1 & -2
Instrument (IM)	BBs available in BIBLOS v2.2	BBs available in BIBLOS v2.2	Outside the scope of BIBLOS-1 & -2	Outside the scope of BIBLOS-1 & -2	Outside the scope of BIBLOS-1 & -2
Level-1 Processing (L1PM)	Outside the scope of BIBLOS-1 & -2	BBs available in BIBLOS v2.2	Outside the scope of BIBLOS-1 & -2	Outside the scope of BIBLOS-1 & -2	Outside the scope of BIBLOS-1 & -2
Level-2 Retrieval (L2RM)	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project
Performance Assessment Tool (PAT)	Outside the scope of BIBLOS-1 & -2	Outside the scope of BIBLOS-1 & -2	BBs available in BIBLOS v2.2	Outside the scope of BIBLOS-1 & -2	Outside the scope of BIBLOS-1 & -2

The main objectives of this Activity are as follows:

[Objective #1] To **complete the definition and implementation** of the remaining and necessary **Building Blocks** for active microwave, passive microwave and passive optical instruments; and to **define and implement a first version** of building blocks supporting active optical instruments.

[Objective #2] To identify already **existing modules, blocks, libraries** (developed under ESA contracts and with a licence compliant to BIBLOS software) and verify if these components can be **integrated into BIBLOS framework**. Also, one of the modules is to be integrated within BIBLOS, and a smooth **process is to be defined** for new modules to be integrated.

[Objective #3] To **re-design BIBLOS website**, helping new users in an easier understanding of BIBLOS concept and more advance users in the definition of a mission scenario and software reference architecture. This includes the improvement of the user friendliness of the tool (i.e. hiding complexity from the user), the preparation of new tutorials (both written and videos) and new automated documentation of source code, requirements, algorithms, interfaces and tests.

[Objective #4] To **release upgraded software versions** for Earth Observation community as raw sources files, automated installers for various operating systems and virtualization packages/containers.

[Objective #5] To **publicize the already proven BIBLOS's concept** within the Earth Observation community for new users and more advanced users, by promoting the advantages and benefits of BIBLOS software in mission scenario definition, mission performance evaluation and data simulation & processing for early stages (phase 0, A, B1) of Earth Observation mission design; and **to apply**

BIBLOS concept to current or future Earth Observation missions (e.g. Copernicus HPCM missions).

[Objective #6] To **raise the TRL** of the tool to TRL #6.

[Objective #7] To **assess harmonisation** of Earth Observation E2E simulator activities **with activities on space science E2E simulator**

4. EXECUTIVE SUMAMRY

All work done in the frame of BIBLOS-3 activity is summarized in following sections. To facilitate reding, description is provided per each of the Task according to logic defined in the SoW.

4.1. PROMOTION OF BIBLOS CONCEPT

Dedicated workshop has been organized to promote already proved concept of BIBLOS within the Earth Observation community. The major aim of the workshop was to show the advantages and benefits of BIBLOS as a generic tool for E2E Mission Performance Simulator.

Table 4-1 shows summary of attendance statistic at BIBLOS Workshop.

Table 4-1: Statistics of Workshop attendance

Session	Clicked Registration Link	Registrants / Attendees	Questions, Problem, Feedback	Follow-up Survey
Main	268	69 (26%) / 56 (81%)	66 Questions, 7 Problems with Installation, 1 email with feedback	6
PMW	134	41 (30%) / 30 (73%)	43 Questions	0
PO	138	54 (39%) / 46 (85%)	60 Questions	2
AMW	110	38 (35%) / 28 (74%)	36 Questions	2
AO	118	26 (22%) / 19 (73%)	9 Questions	-

Most participants were interested in learning about BIBLOS and provide information we are asking in survey, but only a small number of them wanted to help with the specification of mission scenarios for SW validation and TRL assessment. Finally, none of the participants participated in the preparation of mission scenarios and datasets. Scenarios were defined by BIBLOS-3 Team to support validation of SW and assessment of TRL. There seem to be also applicable for further activity.

4.2. REDESIGN OF BIBLOS WEBSITE

This section include description of two fallowing activities made by subcontractor:

- Designing the BIBLOS logo.
- Redesigning the BIBLOS website to match the new internet content style.

The logo was decided to be created for BIBLOS to provide graphical identification of the project. Selected version of logo is shown in Figure 4-1.



Figure 4-1 Selected version of BIBLOS logo

The website redesign was conducted with the subcontractor specializing in both graphic design and website preparation. The redesign included merge of E2ES Tools website and old BIBLOS website into one site Figure 4-2 but with two subpages. The subpages are separated but contact and registration form are shared between both sites. BIBLOS website present on screenshot Figure 4-3.

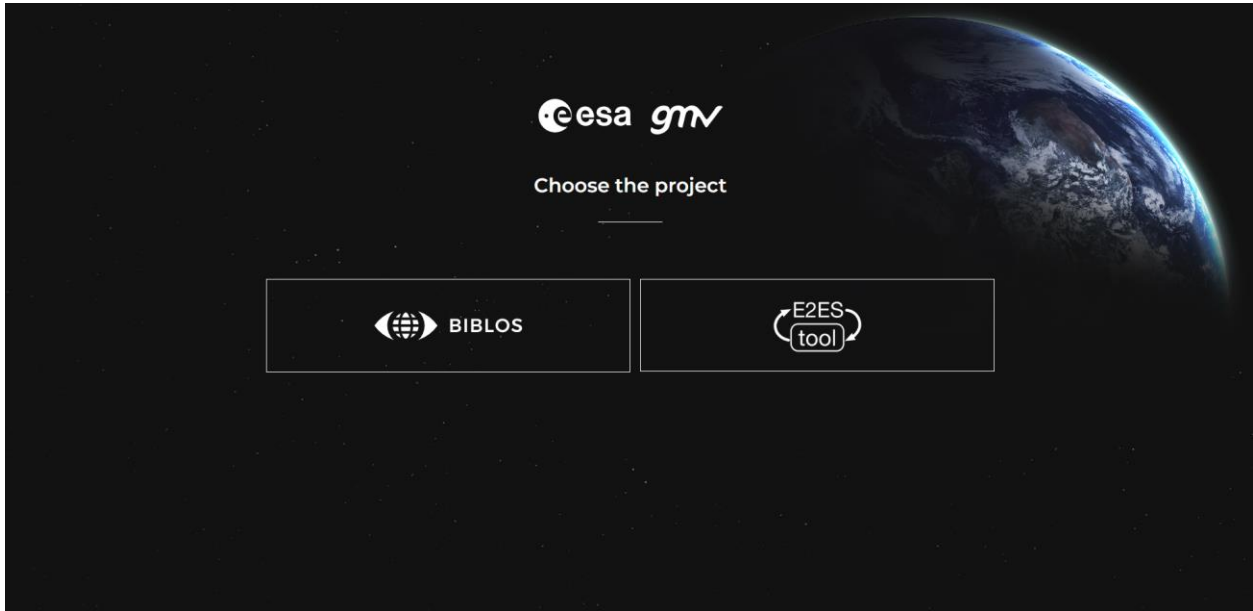


Figure 4-2 BIBLOS and E2ES Tools main page

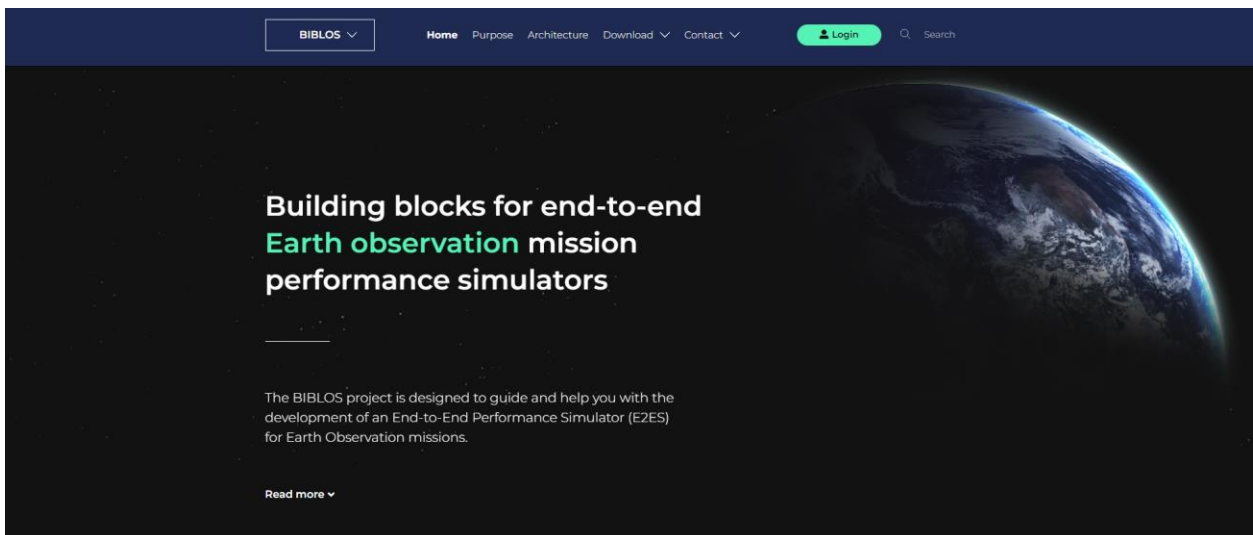


Figure 4-3 BIBLOS main page

4.3. ASSESS HARMONISATION WITH SS-E2E TOOLS SIMULATOR

Harmonisation includes the analysis of possible solution for integration and solving all of incompatibility problems. Output of this task is a draft of roadmap for integration presented in Figure 4-4, including proposition for integration of BIBLOS and SS-E2E-Tools.

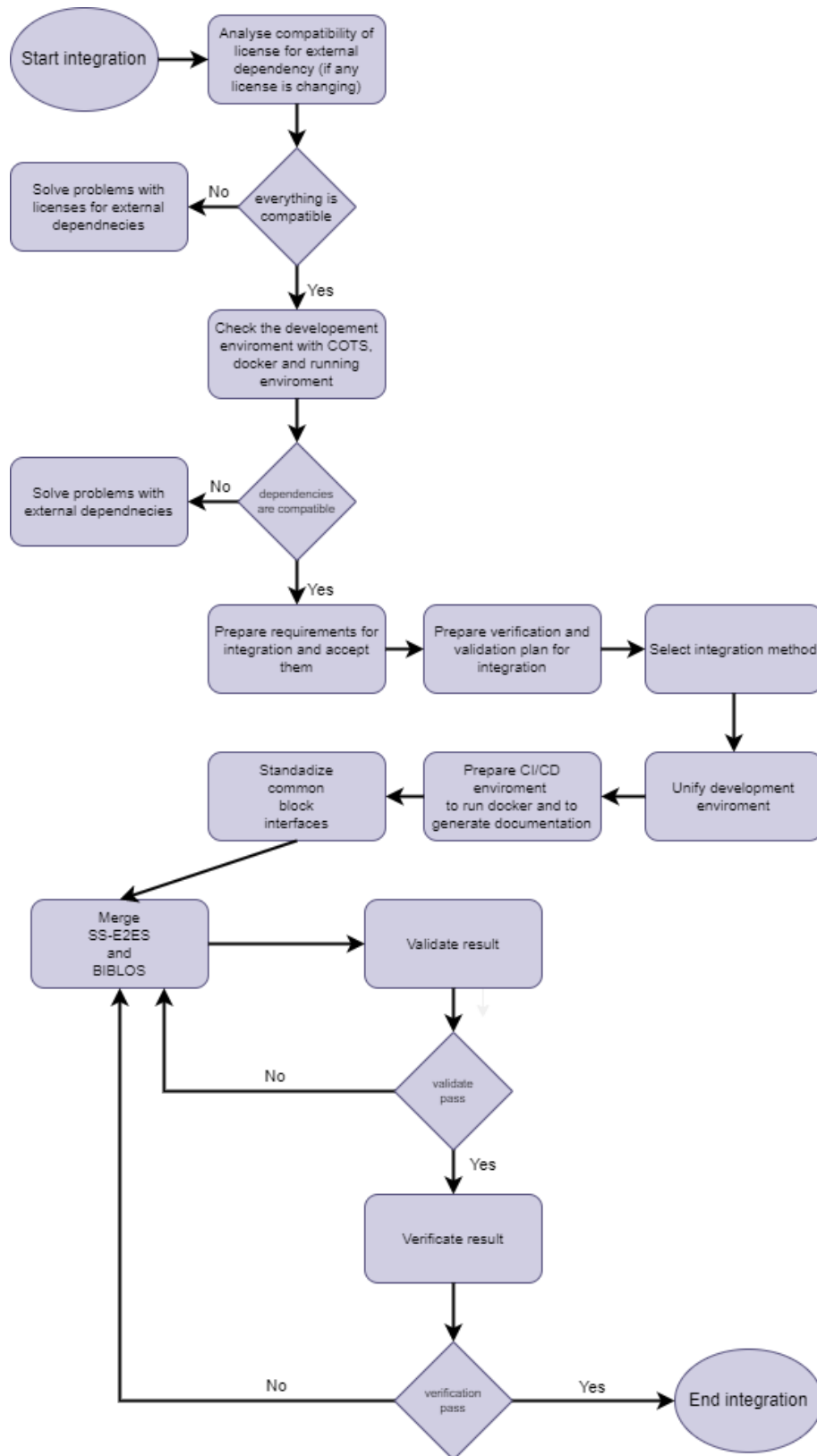


Figure 4-4 SS-E2ES Tools and BIBLOS projects integration roadmap

4.4. REQUIREMENTS SPECIFICATION AND ARCHITECTURE EVALUATION

As mentioned in Section 3. , all BIBLOS activities inherit the Reference Architecture (Figure 4-5) created in the frame of ARCHEO-E2ES activity. The Reference Architecture defines two concepts:

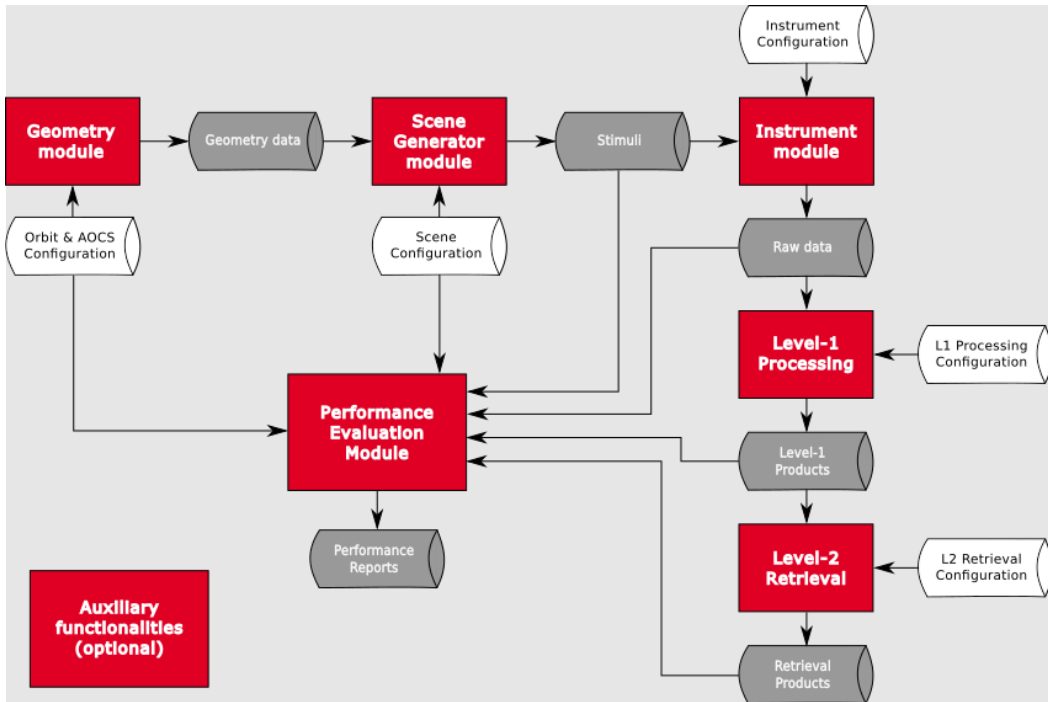


Figure 4-5 ARCHEO-E2E Reference Architecture

BIBLOS-3 follows this architecture and provide the SW components, both the Building Blocks and Modules, that result from this architecture.

Selected BBs have been agreed with and accepted by the Agency. In consequence, each of the new BBs have been designed, coded and unitary tested in the frame to Task #5 (See Section 4.5).

Complete set of BBs for each of Instruments is shown in Figure 4-6, Figure 4-7, Figure 4-8, Figure 4-9, and Figure 4-10, respectively, for Generic, AMW, AO, PMW, and PO Instrument.

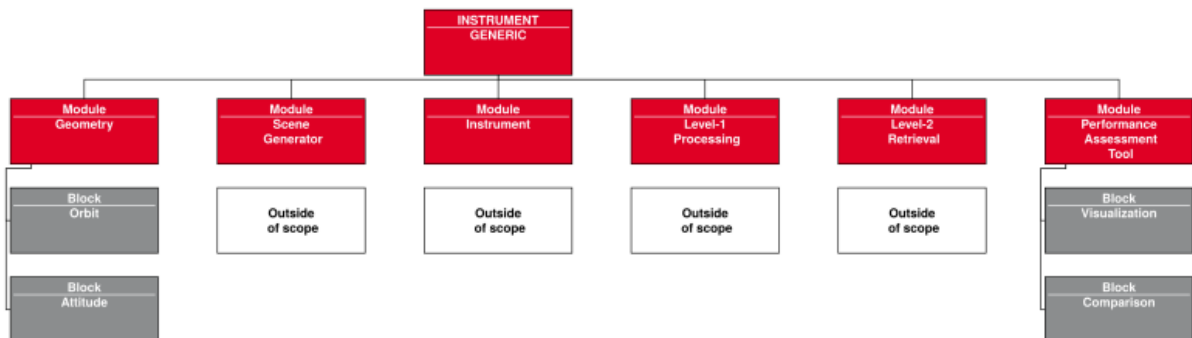


Figure 4-6 BBs for Generic Instrument

In Generic Instrument, the Orbit and Attitude Blocks were slightly refactored and two new BBs were added: Visualization and Comparison. Currently, Orbit and Attitude Blocks provide functionality to generated PVT data (position, velocity, time) and attitude data for any of EO mission. Comparison and

Visualisation Blocks can be used to compare and visualize inputs/outputs for any of BBs provided in BIBLOS SW.

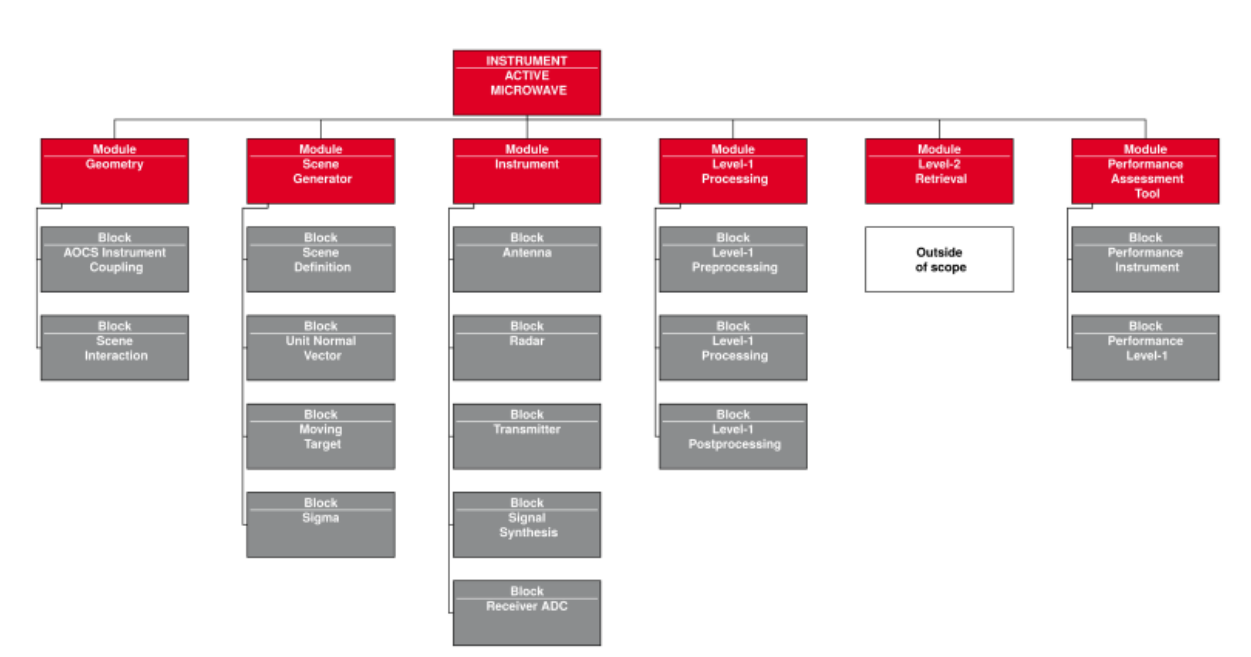


Figure 4-7 BBs for Active Microwaves Instrument

In Active Microwave, 10 BBs were added, i.e. 5 in Instrument, 3 in Level-1 Processing and 2 in Performance Assessment Modul. Currently, E2E chain is completed for the Synthetic Aperture Radar. For Scatterometer and Altimeter missions only simulation of instrument is supported.

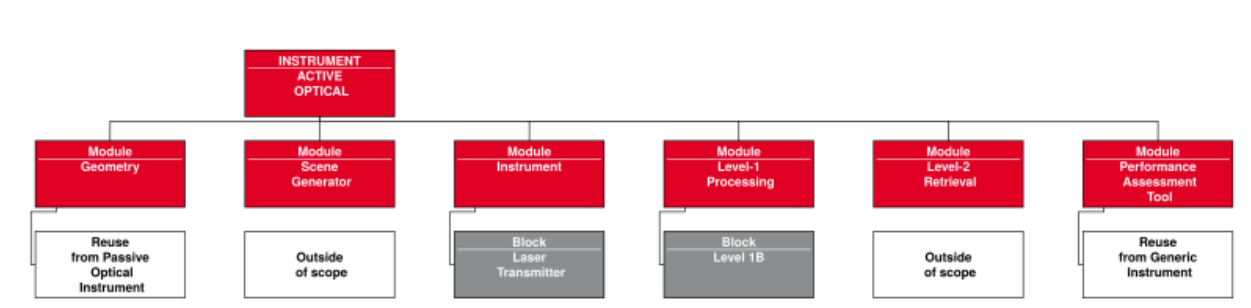


Figure 4-8 BBs for Active Optical Instrument

Active Optical Instruments, according to the agreed rescope, are to be finalized during the maintenance period. Currently underlying algorithms were implemented, and unit tests prepared. For AO the only dedicated Blocks are Laser Transmitter and Level 1B Blocks.

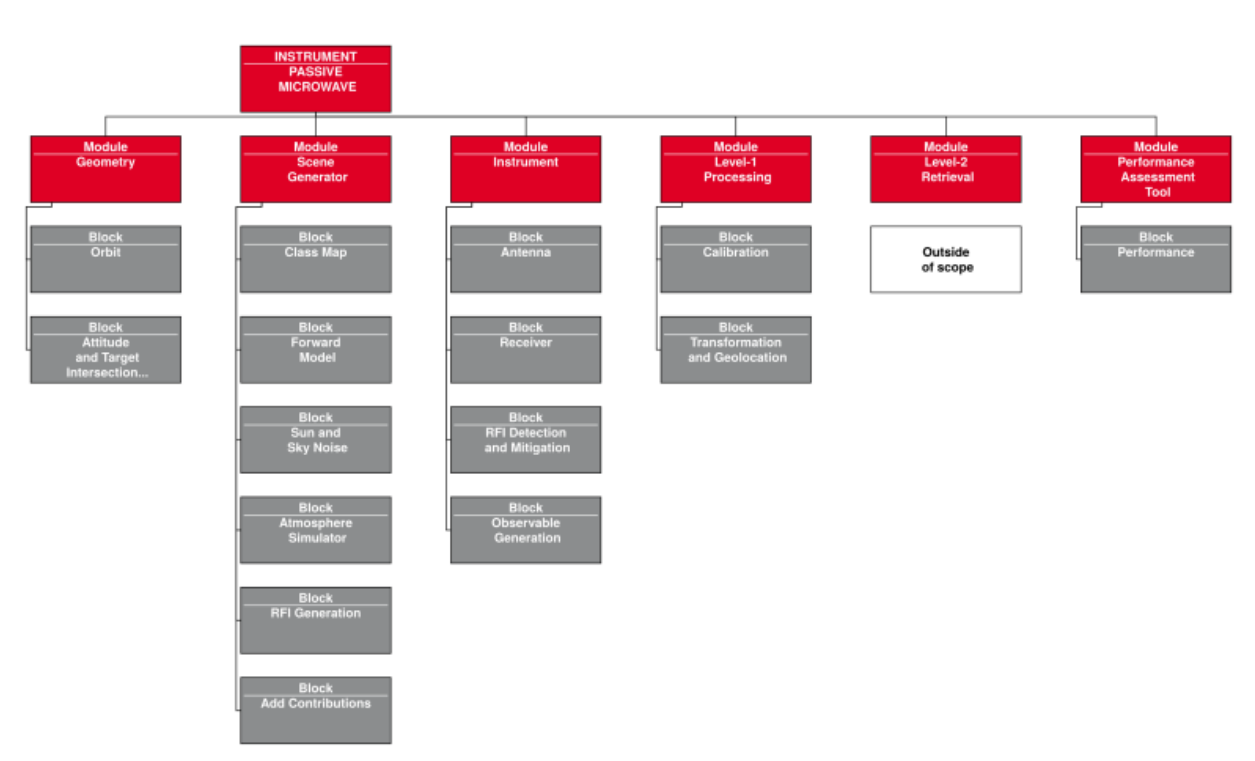


Figure 4-9 BBs for Passive Microwaves Instrument

In Passive Microwave Instruments the Antenna, Receiver, Observable Generation and Instrument Calibration Blocks were updated. Also, Performance Block was added.

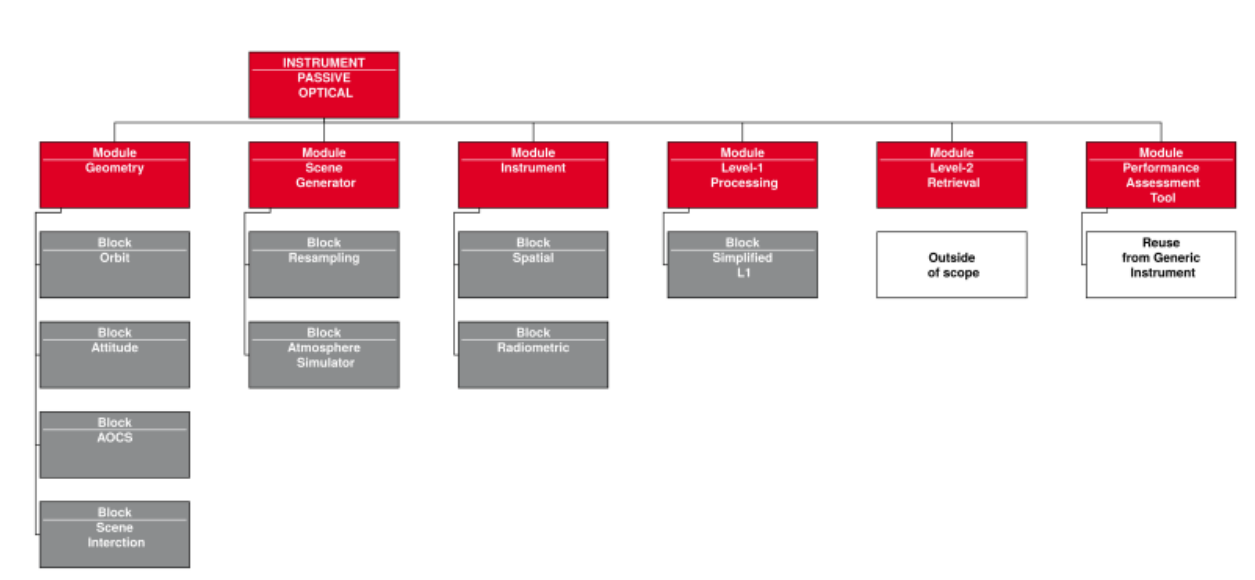


Figure 4-10 BBs for Passive Optical Instrument

The development of Passive Optical Instruments was postponed to the maintenance period, when code from the GSOOS project will be available to be reused. The graph is showing planned Blocks, the Simplified L1 Block is currently not supported but will be provided during the maintenance period.

4.5. DETAILED DESIGN, CODING AND UNITARY TESTING

As a continuation of Task #4 (Section 4.4), accepted BBs have been designed, coded and unitary tested. Detailed design and coding were based on the consolidated algorithms for each of Building Block.

Algorithms are defined only for the Building Block, providing algorithm definition, functional architecture and specification of inputs and outputs. While integration of GSOOS outputs is foreseen in the Passive Optical Instrument, there are not update in design and coding for this type of instrument. The design for the Active Optical Instruments was decided to be redone at the AR-BB milestone after review from the Agency, therefore Building Blocks for those instruments will be available during the maintenance period. It was agreed with the Agency, that the statement coverage shall be higher than 80% (the goal) including the unitary testing, integration tests and the system tests (performed in Task #6, see Section)

4.6. MODULE INTEGRATION AND END-TO-END SIMULATOR VALIDATION

In the frame to this Task, the E2E simulator use cases identified along the activity (Section 4.1) have been implemented as the Proof-of-Concept scenarios and agreed with the Agency.

4.6.1. ACTIVE MICROWAVES INSTRUMENT POC

Results generate for AMW POC SAR 01 show that BIBLOS SW can be used for simulation and processing of SAR data simulated in STRIPMAP mode. Figure 4-11 shows the SLC image (right) and result of RC (left). Result of multilooking is shown in Figure 4-12.

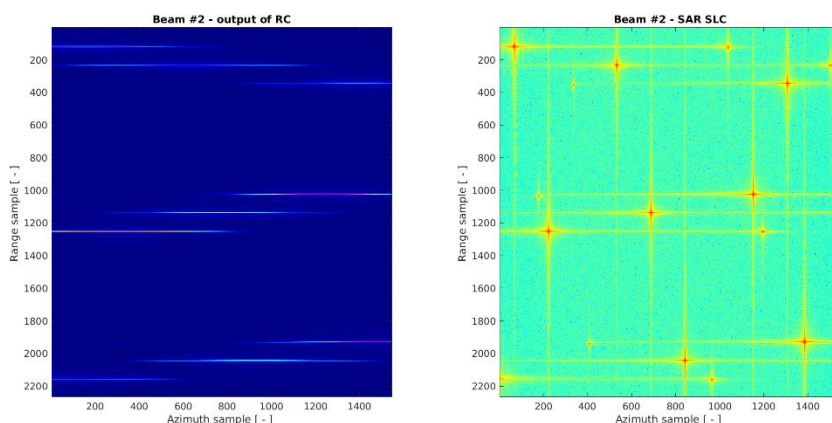


Figure 4-11 AMW POC – SAR SLC image simulated and focused for STRIMPAM mode.

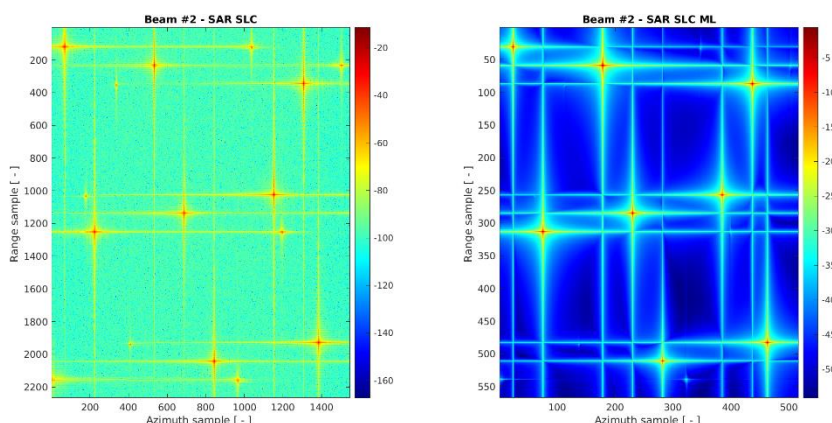


Figure 4-12 AMW POC – Result of range and azimuth multilooking for SAR SLC image

4.6.2.PASSIVE MICROWAVES INSTRUMENTS POC

POC for Passive Microwave Instruments was done for a conical scanning instrument flying above the Red Sea area, which was chosen to observe the effects of terrain type and altitude. Figure 4-13 shows a comparison of TOA brightness temperatures integrated by the antenna (left) and reconstructed values after Level 1 Processing (right).

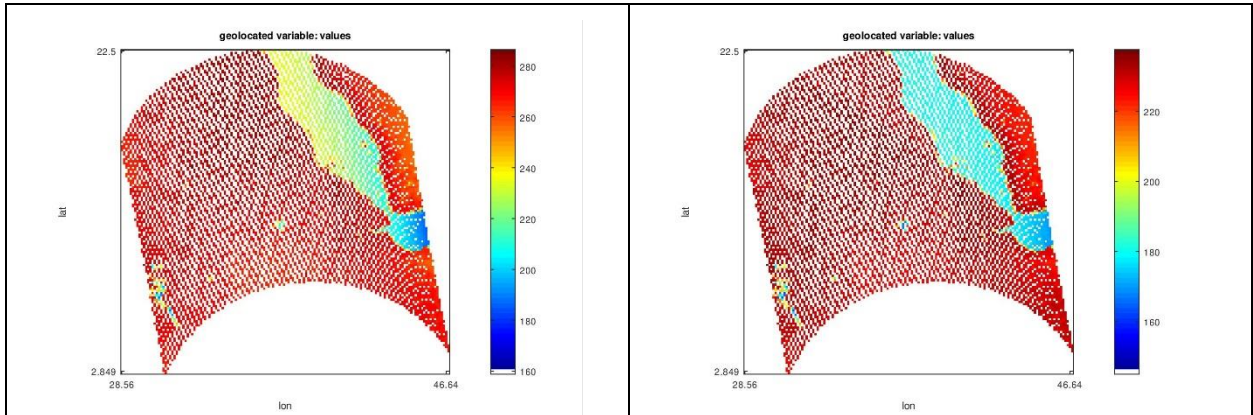


Figure 4-13 PMW POC – Comparison of integrated TOA brightness temperatures (left) and reconstructed values (right)

4.6.3.PASSIVE OPTICAL INSTRUMENTS POC

POC for Passive Optical Instruments was prepared for a single pushbroom instrument operating in two geometrical configurations and 5 bands: NIR, red, green, blue and panchromatic. Figure 4-14 shows two images: NIR image taken in one geometrical configuration with additional simulation of shot noise (left) and blue image taken in second geometrical configuration with additional simulation of pixel non-uniformities (right).

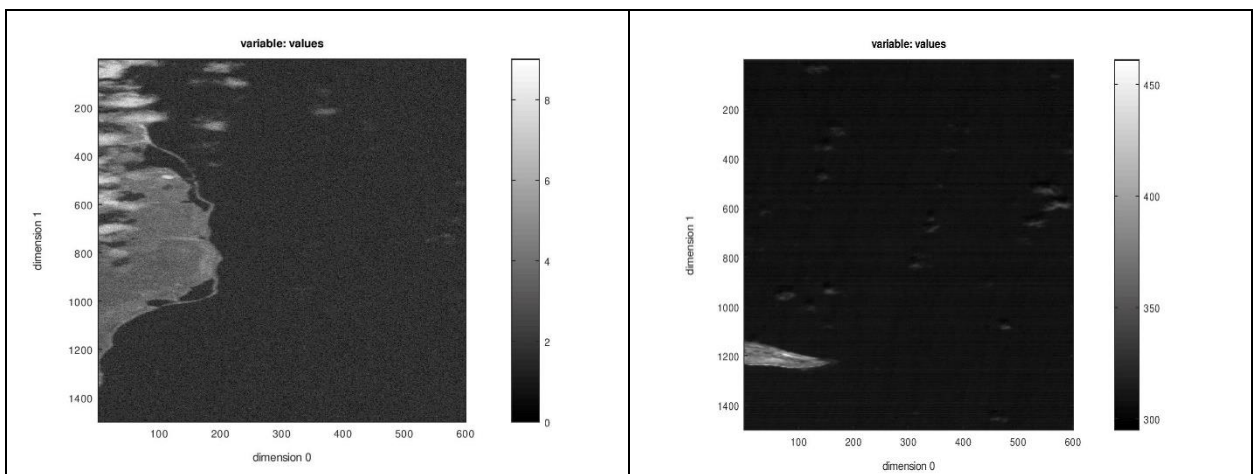


Figure 4-14 PO POC – images observed in NIR (left) and blue (right) bands for two different detector geometrical configurations on the same platform

4.7. SYNTHESIS STUDY AND EXTERNAL LIBRARIES EVALUATION

4.7.1. EXTERNAL LIBRARY EVALUATION

One of the tasks in scope of the project was to perform study of possible reuse of other existing software in scope of the BIBLOS software. Roadmap for integration of Space Science E2E Simulator was prepared, where identified problems that prevented products from being integrated were documented and best practices of developing reusable products were prepared based on the lessons learned from this activity.

4.7.2. SYNTHESIS STUDY

Looking at the overall of BIBLOS-3 activity, it can be firmly stated that the achieved results confirm the fulfilment of the vast of objectives imposed by the SoW. Table 4-2 shows the coverage of various type of instruments by BIBLOS SW components released in the last official SW version, i.e. v3.0 released at the Acceptance and Final Review of BIBLOS-3. It should be noted, that coverage can be improved by two releases planned in the Maintenance Period of current activity.

Table 4-2: Instrument vs. SW v3.0 components

Instruments vs. Modules	Passive Optical (PO)	Passive Microwave (PMW)	Active Microwave (AMW)	Active Optical (AO)	Generic (GEN)
Geometry (GM)	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0 (first version)	BBs available in BIBLOS v3.0
Scene Generator (SGM)	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0 (first version)	Outside the scope of BIBLOSs
Instrument (IM)	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0 (first version)	Outside the scope of BIBLOSs
Level-1 Processing (L1PM)	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0 (first version)	Outside the scope of BIBLOSs
Level-2 Retrieval (L2RM)	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project	Outside the scope of BIBLOS project
Performance Assessment Tool (PAT)	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	BBs available in BIBLOS v3.0	Outside the scope of BIBLOSs	BBs available in BIBLOS v3.0

Following table summarizes achieved results and presents the status of objectives.

Table 4-3: Results vs. Objective Status

Obj.	Results	Objective Status
#1	As presented in Table 4-2, SW components are significantly completed in this Activity, including first version of AO BBs.	Achieved.
#2	As summarized in Section 4.7.1, GRL was selected and reviewed for integration in BIBLOS. Nevertheless, as agreed with the Agency,	Achieved.
#3	As presented in Section 4.2, new layout of BIBLOS website has been developed. New website is ready to be published.	Achieved.
#4	SW v3.0 is ready to be released. Raised SPRs (TBC, during AFR) can be solved in Adaptive and EoC releases	Achieved.
#5	As presented in Section 4.1, workshop was organized. It was observed that number of registration at BIBLOS Website increased after the workshop. In addition, BIBLOS SW is reused as SW Mock-up for EE11 Candidate Missions, such as WIVERN, Nitrosat and CAIRT.	Achieved.
#6	SW was validated against mission scenarios and datasets representing the real missions.	Achieved.
#7	Harmonization with two others EO activities is provided, roadmap for integration is created.	Achieved.

It can be firmly stated that the BIBLOS SW reached the TRL #6 at the end of Activity.

4.8. MAINTENANCE

Upon a successful acceptance review, the BIBLOS software and website is to be maintained for a period of 12 months.



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