ARTES ScyLight Full Proposal

Requirements for the Content of the Technical Proposal

Part 3B
Product Development Plan

Statement of Applicability and Proposal Submission Requirements

Applicable Segment(s)	
Space	**Ground**
Yes[1]	Yes

Applicable Development Phase(s)			
Definition	**Technology**	**ScyLight Demonstration**	**Product**
Yes	Yes[1]	Yes[1]	Yes[1]

1. Requirements specific to Space Segment elements of the Technology, ScyLight Demonstration and Product Phases are stated in section 10.

Proposal Submission Requirements
1. A single Part 3B of the Technical Proposal shall be included covering all Development Phases for which support is being requested under the ARTES ScyLight Call for Proposals.
2. The whole development of the product from the current development status up to the completion of the product ready for commercialisation shall be included in this Full Proposal.
3. The Product Development Plan shall be at a level of detail commensurate with the development status of the product.

Notes on the Content of this Document

i *This style is used for explanatory notes and guidance to help you to develop the Full Proposal content.*

1 This numbered style in bold font identifies the main sections to be completed in this Part of the Proposal.

1.2 This numbered style identifies requirements for the Full Proposal content for each of the main sections of this Part of the Proposal.

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Requirements for the Content of the Technical Proposal: Product Development Plan	
1	**Reference Documents**
1.1	Standalone documents referenced as supporting information in the Product Development Plan element of the Proposal shall be delivered to the Agency as part of the Proposal documentation package.
i	*The use of standalone documents is encouraged. These documents should be referenced in the Development Plan and attached to the Proposal, not copied into the Proposal document.*
2	**Description of the Product**
i	*The purpose of this section is to clearly describe the proposed product and its baseline configuration, and to explain the rationale for selecting this baseline configuration for the development.*
2.1	The Tenderer shall provide a top-level description of the overall product and its main sub-systems.
2.2	The Tenderer shall describe the external interfaces of the product.
2.3	The Tenderer shall describe the role of the product in the context of overall system of its target users.
2.4	The Tenderer shall describe the preliminary architecture or design of the envisaged product starting from the high level architecture with external interfaces and shall show a first level decomposition into the functional building blocks.
i	*Please make use of block diagrams.*
2.5	The Tenderer shall provide the rationale for selecting the baseline architecture including relevant details of design trade-offs and implementation options.
i	*Reference may be made to design trade-offs carried out in previous Development Phase(s).*
2.6	The Tenderer shall provide, in the form of a product tree, a hierarchical breakdown of the product into the relevant hardware and software elements, as applicable.
3	**Third Party Products/Rights**
3.1	If the use of third party products/rights is proposed (e.g. existing sub-systems, open source software), the Tenderer shall explain the rationale for this choice in technical and commercial terms.
3.2	The Tenderer shall indicate the impact of this approach on the technical activities and resulting products, as well as their usage and commercialisation.
4	**Product Heritage and Current Development Status**
i	*The purpose of this section is to clearly identify the heritage and current state of development of the product, including its subsystems and key enabling technologies.*
i	*The description of the current development status may be a stand-alone document, in which case the Tenderer may simply provide a reference to the document and provide a copy, unless the document is already known to the Agency. For example, the Final Report of a previous Development Phase.*
4.1	The Tenderer shall clearly describe the heritage in design and development of the kind of product proposed. In particular, already developed products or parts thereof shall be described in terms of functionality, performance and applied technology, if applicable.
4.2	The Tenderer shall set out the current development status of the product including the current (starting) readiness level (RL) of the product, of its major subsystems and of its key enabling technologies.
i	*Readiness Levels for the Space and Ground Segments are defined in Appendix 1 to this document.*

Requirements for the Content of the Technical Proposal: Product Development Plan	
5	**Overall Product Development Constraints**
i	*The purpose of this section is to establish the constraints that drive the development plan.*
5.1	The Tenderer shall provide a description of the key requirements that drive the development.
i	*Key requirements are those considered essential to the success of the proposed development, or those that are likely to significantly affect the course of the development (e.g. design drivers).*
i	*Note: The Tenderer should consider which of these key requirements should be included in the risk register.*
5.2	The Tenderer shall identify any constraints imposed on the development plan by the model/prototype requirements and philosophy.
i	*For example, an EQM of an equipment assembly may not be fully populated with active units.*
5.3	The Tenderer shall identify any constraints imposed on the development plan by qualification, certification or type approval requirements.
i	*For example, type approval requires six months to carry out prior to product launch.*
5.4	The Tenderer shall identify any constraints imposed on the development plan by verification requirements.
i	*For example, the product requires life testing prior to product launch.*
5.5	The Tenderer shall identify any time to market constraints from the business plan which are driving the development plan.
i	*The answer to this requirement should take into account the information provided in Part 2 of the Proposal.*
5.6	The Tenderer shall identify any product cost constraints from the business plan which affect the development plan.
i	*For example, the number of parts and the complexity of manufacturing may impact the target product cost as identified in Part 2 of the Proposal.*
6	**Dependencies on Other Activities**
6.1	Previous activities to be followed up by the proposed activities shall be identified in the Proposal.
i	*This includes previous activities from an ARTES contract, any other ESA contract, or activities performed without ESA support.*
i	*This is not required for activities performed within the current contract.*
6.2	The following information shall be provided for each followed-up activity: - The programme (for example, a national, EU or ESA programme, or an internal company project). - The activity name. - Completion date. - A brief description of the activity. - The main outcomes.
6.3	Any dependencies between the proposed activity and other external activities outside of the scope of the proposed activity shall be identified.
i	*In this context a dependency means that the success and timeliness of the outcome of one activity may be affected by the other.*

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6.4	If dependencies between the proposed activity and other external activities are identified the following information shall be provided for each of the other activities: - The programme (for example, a national, EU or ESA programme, or an internal company project). - The activity name. - The status (on-going/to be started) and the start and completion dates (expected or actual, as appropriate). - A brief description of the activity. - The nature of the dependency (for example, schedule dependencies, input/output dependencies, external influences on key decision points). - A plan setting out how the dependencies between activities will be managed to minimise the risk of adverse impacts on either activity.
6.5	The Tenderer shall confirm that the work proposed does not overlap with any previous or currently running ESA contract(s) awarded to any entity in the proposed project team.
7	**Overall Product Development Plan**
i	*This section should build and elaborate upon the brief overview of the proposed activity provided in Part 1 of the Full Proposal ("Cover Letter").*
7.1	The Tenderer shall provide the overall Product Development Plan covering the whole development of the product from the current development status up to the completion of the product ready for commercialisation.
i	*The Product Development Plan presents the development logic for a product for commercial exploitation using the Development Phases as required (Definition, Technology, ScyLight Demonstration and Product), but including as a minimum a Product Phase.*
i	*The overall development approach defines at a top (high) level the plan to develop the product from its current readiness level (RL) to the point at which the product is ready for commercial exploitation.*
i	*The development logic/approach shall be provided at a level of detail appropriate for the development maturity of the product.*
7.2	The Tenderer shall provide a list of all the Development Phases necessary to develop the product up to the point when it is ready for commercial exploitation.
i	*The term "Development Phase(s)" is used hereafter to refer to ARTES ScyLight Development Phases, i.e. Definition, Technology, ScyLight Demonstration, Product.*
7.3	The Tenderer shall indicate the status of each of the Development Phases (intended, running, completed).
7.4	The Tenderer shall indicate the support requested/provided for each of the Development Phases (e.g. internal project, ARTES ScyLight Element, other ARTES Element, national funding programme).
7.5	The Tenderer shall indicate which Development Phases are included in the Full Proposal.
7.6	The Tenderer shall provide an explanation of the logical execution of the development activities from the current product development status through to the readiness of the product(s) for commercial exploitation.
7.7	With reference to the architecture/interface definition and for each of the functional building blocks, the Tenderer shall identify: - Any required adaptation or modification of existing building blocks, and under which Development Phase this work will be performed. - For each item/functional building block, in which Development Phase the development of the item/function will be developed.
7.8	The overall development logic shall define and include decision points upon which the course of the development will depend.

Requirements for the Content of the Technical Proposal: Product Development Plan	
7.9	The product development plan shall include a mapping of the planned major reviews to all the Development Phases necessary to develop the product up to the point of readiness for commercial exploitation.
i	*The Tenderer should take into account the mandatory reviews identified for each Development Phase identified in Part 5C of the Requirements for the Content of the Management Proposal.*
i	*This requirement is not mandatory for the Definition Phase.*
7.10	The Tenderer shall define the model philosophy for the product between its current state and completion of the development.
i	*Model Philosophy is defined as: the number and characteristics of models to achieve a high confidence in the product verification with the shortest planning and a suitable weighting of costs and risks (e.g. breadboard, EQM, prototype, software).*
i	*Space Segment models are defined in Appendix 2.*
i	*Ground Segment models are introduced in Appendix 1.*
7.11	The Tenderer shall identify the development models, ground support equipment, integration tools, test equipment and external items necessary to verify the product, as applicable.
7.12	The Tenderer shall identify the characteristics of product to be verified by the each of the models.
7.13	The Tenderer shall identify the Development Phase in which each model shall be developed.
7.14	The Tenderer shall define a verification approach to ensure and demonstrate that the product is fully compliant with the established requirements and is capable of fulfilling the mission objectives.
i	*The level of detail provided should be commensurate with the development maturity of the product.*
i	*The overall verification approach should take into account the verification requirements identified in Part 3A of the Requirements for the Content of the Technical Proposal.*
i	*Verification methods include test, analysis, similarity, review of design, inspection, or some combination of these. Test is the preferred method.*
i	*The verification approach may be defined in a separate document (or set of documents), a copy of which should be attached to the Proposal.*
i	*For Space Segment activities the verification approach should be presented in the form of a Verification Plan. ECSS-E-ST-10-02C, Annex A, provides a description of the contents of a Verification Plan for Space Segment products. For the Space Segment verification includes qualification.*
7.15	The Tenderer shall identify the major verification activities to be undertaken during the development of the product, the Development Phase during which these verification activities will be carried out and on which model they will be performed.
i	*Major verification activates may include life testing, end user testing, in-orbit verification and tests for which specific/unique test facilities are required.*
7.16	The Tenderer shall identify the verification approach and plans for each product requirement in terms of methods/levels.
i	*The verification approach should be presented in the form of a Verification Plan.*

	Requirements for the Content of the Technical Proposal: Product Development Plan
7.17	The Tenderer shall identify the approach to qualification, certification or type approval (as applicable) for the product, or parts thereof, required prior to release of the product. *The Definition Phase may include activities to fully define the approach to qualification, certification or type approval. However, an initial approach should be outlined within the Proposal for a Definition Phase.* *For Space Segment related activities qualification includes the qualification of Parts, Materials, and Processes (PMP). Qualification refers to demonstrating that the product is capable of operating in the specified space environment.* *For Ground Segment, the term validation is often used in place of qualification.* *Certification refers to meeting the safety or regulatory requirements (e.g. CE marking).* *Type approval refers to a demonstration, by test to the extent practicable, that a product meets the technical requirements for its use within a given satellite system, with a certification that all units of the same product type will meet the requirements in a similar manner.*
7.18	The Tenderer shall identify the models to be used for qualification, certification or type approval tests.
8	**Overall Product Development Schedule**
8.1	The Tenderer shall provide an overall product development schedule for the product from the current development status up to the point where the product is ready for commercial exploitation. *Where provided, Table 1 of the Financial Forecast Workbook attached to Part 2 of the Proposal can be used for this purpose.*
8.2	The overall product development schedule shall identify the start and end of each of the Development Phases.
9	**Risk Analysis and Management**
9.1	Technical risks associated with the development of the product shall be: - Identified. - Analysed in terms of their severity (potential impact) and probability of occurrence. - Associated with a mitigation plan, indicating in which Development Phase the risk will be retired. *The risk analysis may be a stand-alone document, which is referenced in the Product Development Plan and is attached to the Proposal.* *The technical risks identified here should include, and be consistent with, the main technical risks identified in Part 2 of the Proposal.*
9.2	The Risk Management Plan shall be referenced in the Development Plan (See Part 5A of the Management Proposal). *Reference may be made to a standard company management plan, a copy of which should be attached as an annex to this part of the Proposal.*

Requirements for the Content of the Technical Proposal: Product Development Plan	
10	**Specific Requirements for Space Segment elements of the Technology, ScyLight Demonstration and Product Phases**
i	*The requirements stated in this section only apply for an activity that includes a Space Segment element.*
10.1	The Tenderer shall define the product Margin Philosophy.
i	*The Margin Philosophy identifies the rules applied for:* - *Identification of budgets for each critical parameter;* - *Margins to be applied at each level of development (design maturity);* - *Margins to be applied at each level of integration (component, unit, sub-system, system).*
i	*For example the margin philosophy sets out how the Tenderer proposes to manage margins against critical parameters for the design. For example, at a preliminary design review:* - *10% mass margin shall be included for all new equipment and 2% for all heritage items, or* - *the required memory shall be less than 50% of the available memory, increasing to a maximum of 75% at the time of the critical design review.*

Appendix 1: Readiness Levels

Level	TRL Technology Readiness Level (Space and Ground)		
	Capabilities	**Space Segment model**	**Ground Segment model**
1	Basic principles observed and reported		Idea or concept
2	Technology concept formulated		Concept supported by paper
3	Analytical and experimental critical function or characteristic proof-of-concept	Mathematical models, supported e.g. by sample tests	Demonstrate feasibility
4	Functional verification of component / breadboard in laboratory environment	Breadboard	Partial prototype
5	Critical function of component / breadboard verified in a relevant environment	Scaled EM for the critical functions	Reduced scale prototype (for large pieces)
6	Demonstration of element critical functions in a relevant environment	Full scale EM representative for critical functions	Full prototype to demonstrate functionality
7	Demonstration of element performance in the operational environment	QM/EQM/PFM[a]	Verified Product with final BOM, layouts, released software, full GUI
8	Actual system completed and accepted for flight	PFM/FM	Validated Product in operation and commercial offer ready
9	"Flight proven" system through successful mission operations	PFM/FM	Product operationally deployed and used by paying customer

[a] A PFM may be used to achieve qualification provided that the commercial customer accepts the risk and it is demonstrated that the use of an alternative qualification model (e.g. EQM) is not viable. In this case the cost of the flight hardware is not supported by ESA.

See also "Guidelines for the use of TRLs in ESA programmes", ESSB-HB-E-002, Issue 1, Rev 0, 21 August 2013 (available on the ARTES web site at https://artes.esa.int/documents).

Appendix 2: Model Definitions for the Space Segment

Breadboard (BB):	An initial development model for a space product, electrically and functionally representative of the complete end item, or of one or more key elements of the end item. It is used to prototype the intended design and to mitigate technical risks. Verification is typically performed in a laboratory environment.
Engineering Model (EM):	Flight representative model in terms of form, fit and function used for functional and failure effect verification. The engineering model is usually not equipped with high reliability parts or full redundancy. The engineering model is also used for final validation of test facilities, ground support equipment and associated procedures. See ECSS-S-ST-00-01C.
Engineering Qualification Model (EQM):	Model which fully reflects the design of the flight model except for the parts standard, used for functional performance and EMC verification and possibly for qualification. Military grade or lower-level parts can be used instead of high reliability parts, provided they are procured from the same manufacturer with the same packaging. Functional performance qualification includes verification of procedures for failure detection, isolation and recovery and for redundancy management. The engineering qualification model may also be used for environmental testing if the customer accepts the risk, in which case the qualification model rules apply. See ECSS-S-ST-00-01C.
Flight Model (FM):	End product that is intended for flight. The flight model is subjected to formal functional and environmental acceptance testing. See ECSS-S-ST-00-01C.
Model:	Physical or abstract representation used for calculations, predictions or further assessment. Model can also be used to identify particular instances of the product e.g. flight model. See ECSS-S-ST-00-01C.
Proto Flight Model (PFM):	Flight model on which a partial or complete proto flight qualification test campaign is performed before flight. See ECSS-S-ST-00-01C.
Qualification Model (QM):	Model which fully reflects all aspects of the flight model design, used for complete functional and environmental qualification testing. A qualification model is only necessary for newly-designed hardware or when a delta qualification is performed for adaptation to the project. The qualification model is not intended to be used for flight, since it is over-tested. See ECSS-S-ST-00-01C.
Scaled Engineering Model (Scaled EM):	Engineering model that is not fully representative of the end product, but is sufficiently representative to permit the verification of critical functions of the product in a relevant environment. Critical functions are those functions of the product that deserve control and special attention in order to mitigate technical risks.