ESRIN Contract No. 4000109587/13/I-NB

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SWARM ESL

ORIGINAL N° 1

ESA Contract No.4000109587/13/I-NB

with

Technical University of Denmark – National Space Institute

SWARM ESL

BET

esa

CONTRACT

Between:

The EUROPEAN SPACE AGENCY,

(hereinafter called "the Agency" or "ESA"),

located at: 8-10 rue Mario Nikis,
75015 Paris,
France,

represented by Mr Jean-Jacques Dordain, its Director General,

through its establishment

The European Space Research Institute (ESRIN),

located at: Via Galileo Galilei,
Casella Postale 64,
0034 Frascati (Roma),
Italy,

of the one part,

and:

Technical University of Denmark – National Space Institute,

(hereinafter called "the Contractor" or "DTU"),

whose Registered Office is at:

`` Elektrovej
Building 327
2800 Kgs. Lyngby
Denmark

represented by Mr. Kristian Pedersen, its Director,

of the other part,

the following has been agreed:

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ARTICLE 1 - SUBJECT OF THE CONTRACT – APPLICABLE DOCUMENTS

1.1. Subject of the Contract

The Contractor undertakes to provide and coordinate support for the operations, performance analysis, maintenance, and evolution of the Swarm Level 1 and Level 2 algorithms, processors and calibration data, and to deliver the software and documentation as described herein, and to make an oral presentation of the results.

The Contractor and its subcontractors agree to collaborate fully with any other contractor working in relation to the SWARM mission. Such collaboration shall include, inter alia, participating in potential co-location meetings and to assure free availability of project outputs.

The Contractor shall give the Agency full visibility over the Contractor's performance of the Contract and in the management of its subcontractors. The Contractor shall give the Agency the right to participate, at the Agency's request, in the Contractor's meetings with its subcontractors. The Contractor shall also give the Agency full access to all documentation associated with the execution of the project.

1.2. Applicable Documents

The work shall be performed in accordance with the following documents, listed in order of precedence, in case of conflict:

a) The Articles of this Contract and its Appendix 1 (Payment Plan and Advance Payment(s) and other Financial Conditions), Appendix 4 (Contract Change Notice), and Appendix 5 (Work order procedure) at the same level;

b) The General Clauses and Conditions for ESA Contracts (herein referred to as GCC), reference ESA/REG/002 not attached hereto but known to both Parties and available on http://emits.sso.esa.int – "reference documentation" – "administrative documents", as amended by this Contract;

c) The Minutes of the negotiation meeting held on 11 and 12 September 2013, reference SW-MN-DTU-GS-00067, rev. 1 not attached hereto but known to both Parties;

d) Appendix 2 hereto: The Statement of Work, reference SWAM-GSEG-EOPG-SW-12-0059, issue 1.0, dated 18 December 2012;

e) Appendix 3 hereto: The Standard Requirements for Management, Reporting, Meetings and Deliverables and its Annex A: Layout for Contract Closure Documentation;

f) The Contractor's Proposal reference ~~SE-OF-DTU-GS-01, Rev: 2A~~ SE-DTU-OS/2013 24, dated ~~23~~ October 2013, and Financial Proposal reference SE-OF-DTU-GS-03, Rev. 2C dated 22 October 2013, both documents not attached hereto but known to both Parties.

All of these documents together constitute "**the Contractual Baseline**". The Contractor is required to be flexible in its performance of the Contract and to accept changes which ESA may make to the requirements of the Contractual Baseline. This includes potential changes to the applicable documentation specified in either the SoW or the Technical Requirements. The Contractor shall do its upmost to minimize the impacts on the Contract of such changes.

ARTICLE 2 - DURATION OF CONTRACT AND DELIVERY

2.1. Duration of contract

The Contract shall cover an initial period to cover Swarm nominal mission duration but may be later extended by one or two years, at the Agency's sole discretion.
Activities pertaining to L1b shall start on 1 November 2013
Activities pertaining to L2 shall start on 14 February 2014

The agency's decision to go ahead with the extension and the contractual implications shall be put in place by means of a CCN to the present contract and on the basis of the proposal put forward by the Contractor.

2.2. Place and Dates of Delivery

2.2.1 Documents

The Contractor shall, during the performance of this Contract, deliver all documentation and reports specified in Appendix 2, in the required number of paper copies and in an electronic file. These shall be sent to the Agency's Technical Officer mentioned in Article 5, Clause 5, Sub-Clause 5.1 a) of the Contract, unless otherwise specified, in accordance with the following specific provisions:

The draft version of the final report as defined in Appendix 2 shall be submitted for approval, in electronic format, to the Agency's Technical Officer specified in Article 5, Clause 5, Sub-Clause 5.1 a) of the Contract, not later than **14 June 2018 for L1b and L2 cat-2 activities and 17 May 2018 for L2 Cat-1 activities.**

The finalised versions thereof shall be issued not later than four (4) weeks after the approval of the draft versions, as follows:

in two (2) paper copies and in two (2) copies on CD-ROM to the Agency's Technical Officer specified in Article 5, Clause 5, Sub-Clause 5.1 a) of the Contract and one (1) paper copy and one (1) copy on CD-ROM shall be sent to the ESA Information and Documentation Centre – ESTEC Library, Postbus 299, 2200 AG Noordwijk, The Netherlands.

2.2.2 Software

The source, executable, and object code relevant to the software, mathematical models, data files, design files and computer programmes, specified in Appendix 2 shall be delivered to the Agency's Technical Officer specified in Article 5, Clause 5, Sub-Clause 5.1 a) of the Contract, not later than 28 February 2018.

2.2.3 Contract Closure Documentation

The Contract Closure Documentation (Appendix 3, Annex A) shall be delivered in one (1) set of documentation each, to the Agency's authorised representatives not later than the time of submitting the invoice(s) for the Final Settlement (see also Article 3.2.1).

ARTICLE 3 - PRICE & PAYMENT

3.1. Price

3.1.1 For the purpose of clause 27.2 of the "General Clauses and Conditions for ESA Contracts", the operations, routine maintenance, on-demand work and monitoring service are to be performed at a Firm Fixed Price, as [redacted]

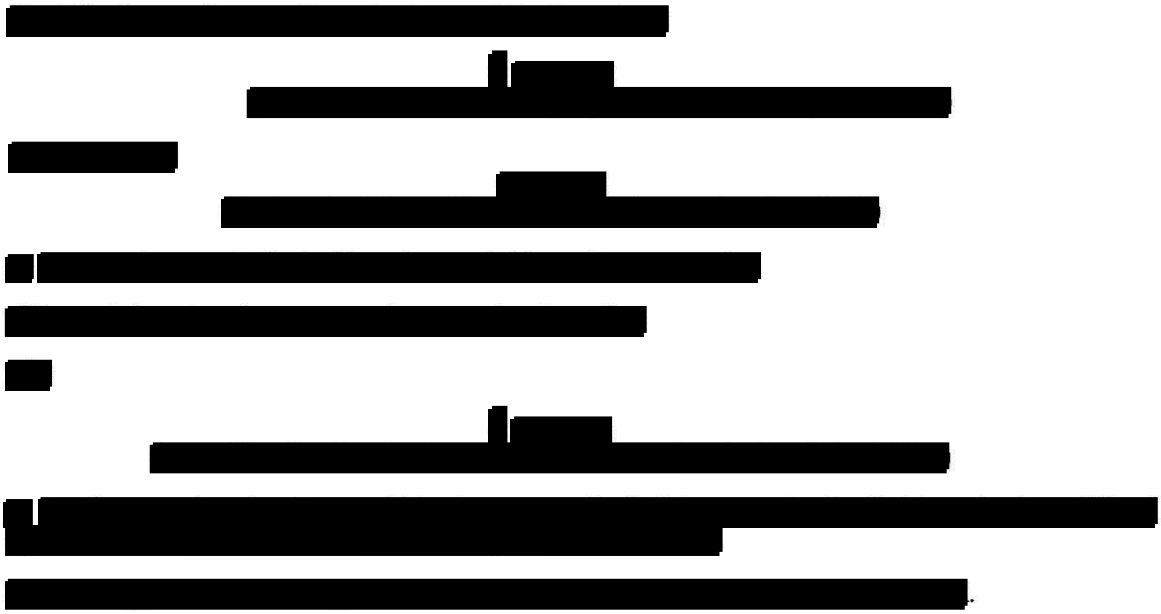
[redacted]

The above sums are further broken down per L1B and L2 work as specified in Appendix 1 hereto.

3.1.2 In addition to the above FFP, options have been agreed with the contractor to cover both incidents (such as additional changes to the processors) and potential extension of the various activities for additional periods as specified in Article 2.1 above.

These activities shall be called for by the Agency solely and to be authorised by the same, progressively, via the Work-Order procedure.

[redacted]



3.1.3 The above amounts do not include any taxes or duties in the Member States of the Agency.

The price is deemed to include all applicable fees for licences to be purchased and delivered in the frame of the Contract, indicating the Agency as the end user. The price is further deemed to include any and all licence fees payable according to Clause 43.7 of the GCC.

3.1.4 The price is Delivered Duty Paid for all deliverables, exclusive of import duties and VAT in accordance with the INCOTERMS 2010, to the addressee(s) specified in Article 5, Clause 5, Sub-Clause 5.1 a) of the Contract. Reference to INCOTERMS in this provision is exclusively for the purpose of price definition.

3.2. Payment

General

The Payment Plan and other financial conditions applicable to this Contract are specified in Appendix 1 hereto.

Payments shall be made according to the provisions hereunder.

The advance payment constitutes a debt of the Contractor to the Agency until it has been set-off against subsequent milestones as shown in Appendix 1 hereto. The advance payment shall nominally be set-off against the 1st progress payment and the remaining amount, if any, against the next following milestone(s).

Payments shall be made within thirty (30) calendar days of receipt at ESA-ESRIN Finance Payment Office of the documents listed and fulfilment of the requirements as specified in Articles 3.2.1 – 3.2.4 below. Only upon fulfilment of the latter requirements shall the invoice be regarded as due by the Agency.

Firm Fixed Price

3.2.1 Advance Payment:

- Advance Payment Requests: to be submitted after signature of this Contract by both Parties.

or

- Advance Payment Requests: to be submitted after receipt of the Agency's written Authorisation to Proceed with a Phase.

3.2.2 Progress Payment:

- Milestone Achievement Confirmation (MAC) with supporting documentation as necessary, submitted by the Contractor;
- Invoice(s);
- Actual achievement of the milestones as defined in the Payment Plan specified in Appendix 1 hereto.

3.2.3 Final Settlement:

- MAC, submitted by the Contractor;
- Invoice(s);
- Receipt and/or acceptance, by the Agency, of all deliverable items, of the services to be rendered and other obligations to be fulfilled, in accordance with the terms of this Contract;
- The Contract Closure Documentation using the template provided in Appendix 3, Annex A.

In case of non-authorisation by ESA at the end of a Phase, of the subsequent Phase, the last payment milestone of the last authorised Phase shall be deemed to constitute the Final Settlement of the Contract and all conditions associated to the Final Settlement shall be fulfilled for payment of such milestone

Fixed Unit Price

The costs incurred for these tasks shall be paid as per provisions of the related work-order.

3.2.4 The Contractor, furthermore, undertakes to provide further supporting documentation as required by the Contract, e.g. Summary Cost Reports etc., with the electronic invoices and MACs in support of the claims.

The Agency shall credit the account of the Contractor to the Contractor's benefit and to the benefit of the Contractor's Subcontractor(s). The Contractor shall be responsible for paying the accounts of its Subcontractor(s), for this Contract, within ten (10) working days. The Contractor shall indemnify the Agency against any claims arising from such Subcontractor(s), caused by the Contractor's failure to pay the Subcontractor(s). The Contractor shall supply to the Agency, upon request, evidence of payments made to its Subcontractor(s).

The Agency reserves the right to visit the Contractor's and/or Subcontractor('s)(s') premises and ascertain the progress of the work being performed under the Contract, prior to making the progress payment concerned.

The Contractor shall approve the Subcontractor('s)(s') invoices within ten (10) calendar days from their receipt/submission to esa-p and achievement of the relevant milestone - whichever the latter.

The Contractor shall, upon request at any time by the Agency, submit the payment conditions / provisions of individual Sub-Contracts to the Agency for approval (if requested before the Sub-Contract is placed) or verification.

3.2.5 If applicable, invoices shall separately show all due taxes or duties.

3.2.6 In the event that the achievement of a Milestone is delayed but the milestone is partially met at the Milestone planning date foreseen, the Agency may as an exception, effect a payment against an approved MAC of the partially achieved milestone, not exceeding the value of the work performed at the date of payment.

3.2.7 a) The Contractor shall ensure that all invoices, MACs, and Advance Payment Requests including those of its Subcontractors if applicable, are submitted for payment exclusively through the Agency's esa-p system. If the Contractor has no access to the Agency's esa-p system at the time of signature of the present Contract, an immediate request for an esa-p user account shall be made by the Contractor to the ESA Helpdesk (mailto: fasp.helpdesk@esa.int), specifying a contact name, the company name, and the ESA Contract number).

b) (i) Should the Contractor find the Agency's esa-p system technically inoperative at the moment of submission of the invoices or of Advance Payment Requests, the Contractor may submit invoices in paper format in five (5) copies to the ESA Financial Operations Department of the responsible ESA establishment ESA-ESRIN Finance Payment Office, together with justifying documentation as required by the Contract.

(ii) In cases where the Agency's esa-p system is inoperative at the moment of submission of the MAC, the Contractor may submit the MAC in paper format in three (3) copies to the Agency's Technical Officer mentioned in Article 5, Clause 5, Sub-Clause 5.1 a) of the Contract. A template MAC form can be obtained upon request to IDHelp@esa.int.

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c) The Contractor undertakes to submit as well as require its Subcontractor(s) – in case of direct payments by ESA – to submit, complete invoices, MACs, and Advance Payment Requests and to strictly adhere to the instructions (including those for billing taxes and duties, where applicable) contained in esa-p.
In the case of invoices submitted by the Contractor which are free of VAT, reference shall be made to the serial number indicated on the VAT Exemption Form which the Agency provided to the Contractor when forwarding two (2) originals of the present Contract for signature. On invoices submitted via esa-p, the number shall be put in the respective field 'VAT Exemption Number'.

Invoices submitted by the Contractor free of VAT due to the applicable national law, which for Italy is: Law Nr. 358 of 9/6/1977 – Gazzetta Ufficiale Numero 184 of 7/7/1977.

3.2.8 Payments shall be made by the Agency in EURO to the account specified by the Contractor. Such account information shall clearly indicate the IBAN (International Bank Account Number) and BIC/SWIFT (Bank Identification Code). The Parties agree that payments shall be considered as effected by the Agency on time if the Agency's orders of payment reach the Agency's bank within the payment period stipulated in Articles 3.2.1 – 3.2.4 above.

3.2.9 Any special charges related to the execution of payments will be borne by the Contractor.

3.2.10 Any questions concerning the operation of esa-p shall be addressed to the ESA Helpdesk (mailto: IDHelp@esa.int).

Any questions concerning the latest status of due invoices can be addressed to the ESA Payment Officer (mailto: esa.payment.officer@esa.int).

ARTICLE 4 - ITEMS PRODUCED OR PURCHASED UNDER THE CONTRACT – FIXED ASSETS

4.1. The following provisions apply to any items other than those items which fall within the scope of Article 2 of the Contract.

4.2. The title to the property of any items produced under the Contract, including electronic components, data sets, special jigs, tools, test equipment, and which are paid for under the Contract, with an individual or batch value in the national currency equivalent to, or above 5,000 Euro, shall pass to the Agency unless otherwise decided by the Agency.

In view of the above, all such items are to be delivered to the Agency at the end of the Contract. They may also be delivered at an earlier stage if so requested by the Agency where this will not cause a problem to the Contractor in completing the work specified in the Contract.

4.3. The Contractor shall maintain an inventory of all such items (called "Contract Inventory") and shall mark those items as falling under this Article of the Contract.

The inventory shall be updated and made available to the Agency during the execution of the Contract. A final issue of that inventory shall be submitted with the final contractual deliverables as foreseen in Appendix 3, Annex A, Table 2.1.2.

If that inventory also includes any of those items which fall within the scope of Article 2 of the Contract, these items are to be clearly set apart.

4.4. Upon completion of the work specified in the Contract, the Agency shall take decisions regarding the final destination and the final owner of each of the items listed in the Contract Inventory, apart from those which are governed by the provisions of Article 2.

The Agency shall be free to choose amongst the following options with respect to final destination and final owner:

a) the right to claim delivery to the Agency and transfer of ownership – with issue of appropriate instructions concerning packing and shipment (at the Contractor's expenses),

b) the right to claim transfer of ownership and to negotiate with the Contractor a loan agreement if the Contractor is interested in keeping and using an item that the Agency wants to acquire without delay, with loan conditions making the Contractor responsible for the custody, the delayed delivery and the risks involved (at the Contractor's expenses),

c) the right to extend the custody of an item to the Contractor (for instance: as a protection measure for further work contracted by the Agency) and to postpone its delivery to the Agency and the associated transfer of ownership – on conditions to be negotiated,

d) the renunciation of any rights to claim delivery and to claim transfer of ownership, leaving definitively the item in the possession and in the ownership of the Contractor, with or without financial compensation for the Agency (e.g. repurchase by the Contractor) and with or without special instruction,

e) the right to request the Contractor to dispose of an item on conditions to be negotiated.

The decisions taken by the Agency shall lead to instructions or negotiations, as the case may be.

4.5. The Contractor shall comply with the Agency's instructions and with the agreements referred to in Article 4.4 above.

4.6. This process will be recorded as per the relevant part of the Contract Closure Documentation.

ARTICLE 5 - COMPLEMENTS AND AMENDMENTS TO THE GCC

The General Clauses and Conditions for ESA Contracts, ref. ESA/REG/002 (GCC) apply to this Contract with the following complements and amendments:

PART I: CONDITIONS APPLICABLE TO ESA CONTRACTS

CLAUSE 2: APPROVAL AND ENTRY INTO FORCE

For the purpose of this Contract the authorised representative of the Director General is

Mr. Volker Liebig, Director of Earth Observation Programmes (D/EOP)

CLAUSE 5: THE PARTIES' REPRESENTATIVES

Sub-Clause 5.1: The Agency's Representatives

The Agency's representatives are:

a) Mr. Giuseppe Ottavianelli for technical matters or a person duly authorised by him ("Technical Officer").

All correspondence for technical matters will be addressed as follows:

	To:	With copy to:
Name	Giuseppe Ottavianelli	Nathalie Boisard
Telephone No.	+39 06 94 18 04 84	
Fax No.	+39 06 94 18 03 02	
e-mail address	giuseppe.ottavianelli@esa.in	

b) Mrs Nathalie Boisard for contractual and administrative matters or a person duly authorised by her. ("Contract Officer").

All correspondence for contractual and administrative matters (with exception of invoices as mentioned in Article 3.3 will be addressed to:

	To:	With copy to:
Name	Nathalie Boisard	Giuseppe Ottavianelli
Phone	+39 06 94 18 08 13	
Fax	+39 06 94 18 03 82	
e-mail	Nathalie.boisard@esa.int	

Sub-Clause 5.2: The Contractor's Representatives

The Contractor's representatives are:

a) Mr. Nils Olsen for scientific and technical matters or a person duly authorised by him ("Technical Officer").

All correspondence for technical matters will be addressed as follows:

	To:	With copy to:
Name	Nils Olsen	Poul Erik Holmdahl Olsen
Telephone No.	+45 4525	
Fax No.	+45 4525	
e-mail address	NIO@space.dtu.dk	

b) Mr. Poul Erik Holmdahl Olsen for contractual and administrative matters or a person duly authorised by him ("Contracts Officer").

All correspondence for contractual and administrative matters will be addressed as follows:

	To:	With copy to:
Name	Poul Erik Holmdahl Olsen	Nils Olsen
Telephone No.	+45 45 25 97 12	
Fax No.	+45 45 88 71 33	
e-mail address	poeho@space.dtu.dk	

CLAUSE 9: KEY PERSONNEL

The Contractor's key personnel is listed in the Contractor's proposal referred to in Article 1.2 above.

CLAUSE 10: SUB-CONTRACTS

Part of the work is to be sub-contracted to the Subcontractors listed in Article 3 above.

CLAUSE 11: CUSTOMER FURNISHED ITEMS (CFI)

It is not foreseen that the Agency will provide any items in accordance with Clause 11 of the GCC to the Contractor.

CLAUSE 12: ITEMS MADE AVAILABLE BY THE AGENCY

It is not foreseen that the Agency will make any items available to the Contractor in accordance with Clause 12 of the GCC.

CLAUSE 13: CHANGES

The template of a Contract Change Notice (CCN) is attached hereto as Appendix 4.

CLAUSE 15: HANDLING, PACKING AND TRANSPORT, TRANSFER OF OWNERSHIP AND RISK

Article 15.3.6 shall now read:

Should in the execution of the contract a need arise to provide the Agency with information which is subject to export control laws and regulations, the Contractor shall secure that such information is only passed on to the Agency in accordance with the provisions of such export control and regulations.

CLAUSE 16: ACCEPTANCE AND REJECTION

General

Acceptance of the work shall be made by the Agency's technical Officer on the basis of the Progress Reports and the Progress Meetings and Reviews to be held as specified in the Appendix 2

Should the Agency's Technical Officer not accept the deliverables from the Contractor, he shall so inform the Contractor with the relevant justification and indication of the shortfalls to be remedied. If no decision has been notified within one month of receipt by the Agency of the deliverables, the deliverables shall be considered as having been accepted. Rejected deliverables must be rendered, at the Contractor's expenses, compliant with the Agency's requirements and represented for acceptance within the time scale fixed in writing by the Agency.

The scope of any acceptance under the Contract shall be limited to the technical aspects of the deliverables and services. Compliance with legal and contractual aspects, including in particular those described in the Contract, shall not be subject of any acceptance so that acceptance shall not affect the Contractor's obligations in this regard.

Deliverable Documentation

Deliverable documentation shall be submitted to the Agency for approval or review in accordance with the SoW. The Agency will ascertain whether the document is in conformity with the requirements of the Contract.

In the event that the Agency considers that a submitted document does not fulfil entirely the contractual requirements, the Contractor shall, at the request of the Agency, bring the document up to the appropriate standard within the time frame defined by the Agency.

The document shall not, however, be deemed to be rejected, unless it contains major errors or omissions, as determined by the Agency. For its part, the Contractor undertakes to rectify minor errors and omissions as soon as possible, and unless otherwise agreed by the Agency, not later than four weeks after being so requested.

Notwithstanding the aforesaid, the Contractor's obligation to bring the documents up to the required standard remains unaffected.

Software

For software/prototype(s), if any, acceptance shall be performed according to Space Engineering Software Standards, ECSS-E-40 Part 1B, 28 November 2003, Space Engineering Software Standards, ECSS-E-40 Part 2B, 31 March 2005, and Software Product Assurance Standards, ECSS-Q-80B, 10 October 2003, as tailored by the Agency for this project and the relevant Applicable Documents and Reference Documents, as described in Appendix 2.

Services

Acceptance and rejection of Services provided shall be governed by the relevant applicable Service Level Agreement (SLA) and documented as such in the relevant progress Reports. In case of unacceptability of the services, the Agency shall be entitled to retain associated payments until such time as services have been rendered acceptable by the Contractor.
If the Agency is repeatedly unable to accept the Services following evaluation against the applicable SLA, the Agency shall have the right to terminate the Contract in accordance with the application of Clause 32.1(a) of the GCCs.

The SLA(s) shall be in place before mission IOCR and shall be implemented by means of a CCN to the present contract.

Rejection of Deliverable Items

If any of the deliverables are rejected during the Acceptance Procedure, corrective action on the rejected items shall be undertaken by the Contractor, at its own risk, and within the time set by the Agency, after consultation with the Contractor.

Such corrective action shall be initiated immediately upon receipt of notice of rejection.

If the Contractor fails to remedy this situation within the specified time and to the satisfaction of the Agency, the Agency may elect, in exceptional circumstances, to have this situation remedied through any other means, e.g., by its own efforts or by means of replacement contract(s), the costs arising from which will be charged to the Contractor, and to assert any other rights accruing in relation to such failure. In any case, the Agency may return the rejected items at the Contractor's cost and risk. The requested remedy shall be carried out even if the Contractor expresses doubts. If such doubts are expressed in writing and are subsequently proven to be correct, any cost implications shall be dealt with at that point.

Unless the Contractor corrects or replaces the deliverables within the delivery schedule, the Agency may require the delivery of the deliverables at a reduced price which is equitable under the circumstances.

Disagreement

If a disagreement is recorded on matters related to this Clause, in particular with respect to rejection and if agreement cannot be reached at management level within 15 working days of an Agency decision or a longer period if agreed between the Agency and the Contractor, the matter may be referred to the Change Appeal Board, described in Appendix 4 'Contract Change Notice'.

CLAUSE 17: PENALTIES/INCENTIVES

Penalties shall not apply.

CLAUSE 27: PRICING

Sub-Clauses 27.3 and 27.4 do not apply, unless in case of termination as per Clause 30 of the GCC.

CLAUSE 32: TERMINATION WITH FAULT OF THE CONTRACTOR

In view of the fact that Clause 17 does not apply Clause 32 is replaced by the following:

32.1 The Agency reserves the right, after full consideration of all relevant circumstances, including the observations of the Contractor, and following a formal notification, to terminate the Contract in any of the following circumstances:

a) in the event of a material breach of contract or in case of the Contractor's failure to:

i) meet the technical requirements of the Contract, or
ii) meet the progress and / or delivery requirements;

to such an extent as to jeopardise seriously the performance of the Contract;

b) if the Contractor has not observed the provisions set out in clause 24 and clause 38/clause 52 of Part II, whichever is applicable, concerning the disclosure and use of information provided for by the Agency;

c) if the Contractor fails to comply with the provisions set out in clauses 11 and 12 concerning the CFIs and the items made available by the Agency;

d) if the Contractor transfers the Contract without the Agency's authorisation or concludes sub-contracts against the Agency's explicit wishes;

e) if the Contractor fails to obtain the export licences/authorisations and/or import licences/authorisations as required under clause 15.3.1.

32.2 In the event of such a termination,

- in the case of a fixed price Contract for the supply of equipment or material:

  The Contractor shall keep the amounts already paid for achieved milestones, if any, and shall be entitled to claim the cost, properly evidenced, of any items to be accepted under the special conditions of termination set by the Agency; In case Advance Payments effected exceed the cost incurred at the time of termination, the Agency may seek the refund of such excess portion of the Advance Payments.

- in other cases:

  The Agency shall pay a fair and reasonable price in respect of such work as has been carried out prior to receipt of notification of termination. In case Advance Payments affected exceed the cost incurred at the time of termination, the Agency may seek the refund of such excess portion of the Advance Payments.

32.3 clause 32.1 shall not apply if failure under a), b) and c) is due to circumstances outside of the Contractor's control.

32.4 In case of termination with fault of the Contractor, the Agency may, at its option and without prejudice to its right of claiming compensation for damage other than the damage already covered by the provisions of sub-paragraphs a), b) and c) below:

a) have the work performed under its direct responsibility in which case the Contractor shall be charged with all additional costs arising out of this solution and shall, in addition, pay compensation in accordance with the scale specified in Annex III to the GCC for each Day the work is not completed after the delivery date laid down in the Contract with a maximum ten (10) per cent of the contract price (excluding contributions from the consortium partners);
b) have the work performed by way of a replacement Contract with a Third Party, in which case the Contractor shall be charged with all additional costs arising out of this solution and shall, in addition, pay compensation in accordance with the scale specified in Annex III to the GCC, running from the delivery date laid down in the Contract up to the delivery date stipulated in the replacement Contract, with a maximum ten (10) per cent of the contract price (excluding contributions from the consortium partners);
c) have the work terminated, in which case the Agency shall be entitled to compensation for the damage caused by lack of Delivery.

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In the cases referred to in paragraphs a) and b) above, and in order to ensure completion of the supply of the goods and / or services, the defaulting Contractor shall, where the use of Intellectual Property Rights is required, do everything in its power to enable the new Contractor or the Agency to use the rights concerned. The defaulting Contractor shall make no claim in respect of such use, and shall bear the cost of the fees due to Third Parties for the use of their rights.
The Contractor's liability for all claims under the present sub-clause shall not exceed the Contract Price (including that of already placed Riders, CCNs and Work Orders but excluding contributions from the consortium partners), except in cases of gross negligence or wilful misconduct of the Contractor.

When calculating compensation, due attention shall be given to what has been already delivered by the Contractor at the time of termination and to the internal funding provided by the various consortium partners.

CLAUSE 33: TERMINATION IN SPECIAL CASES

The following provisions are added to Clause 33:

In the event of a launch failure of any of the SWARM satellites, or loss or damage of one of the SWARM satellites at any point during the Contract, the Agency shall be entitled to:

a) Terminate the entire Contract with immediate effect; or
b) Terminate with immediate effect the parts of the Contract which relate to the satellite which failed or is lost/damaged; and/or substantially modify the Contractual Baseline;
c) Freeze, until further notice, either the entire Contract or only the parts of the Contract which relate to the satellite which failed or is lost/damaged; and/or substantially modify the Contractual Baseline. At the end of the freeze, the Agency shall be entitled to exercise option a) or b), or to resume the Contract on the original or modified conditions, to be agreed with the Contractor.

In case of freezing period, the Contractor shall be entitled to compensation for idle periods, to be negotiated in good faith with the Agency.

The Agency shall notify the Contractor as soon as it is able to of launch failure or satellite loss or damage and shall state whether it wishes to terminate the Contract, or to take one of the alternative courses of action.

If the Agency decides to terminate the Contract, or to terminate only the parts which relate to the satellite for which the launch failed or is lost/damaged, the provisions of sub-Clause 33.2 of the GCCs shall not apply.

The Contractor shall assist the Agency in returning the CFIs to the Agency.

Further it is hereby recorded that, in case the contractor and/or one of the subcontractors have to step out of the contract for reasons outside of their control (such as but not limited to political reasons), this will be considered as a Force Majeure.

CLAUSE 34: APPLICABLE LAW

The substantive law referred to in Clause 34 of the GCC is the law of Denmark.

CLAUSE 35: DISPUTE RESOLUTION

The arbitration proceedings referred to in Clause 35 of the GCC shall take place in Copenhagen, Denmark.

PART II: CONDITIONS CONCERNING INTELLECTUAL PROPERTY RIGHTS FOR ESA STUDY, RESEARCH AND DEVELOPMENT CONTRACTS

For the purpose of this Contract:

- Part II, Option A of the GCCs shall apply, as modified by the special provisions below.
- The free licences provided for the benefit of ESA in the Part II provisions, shall be deemed granted through signature of the present Contract and without the need to implement a separate licence.

The following provisions are added:

CLAUSE 36: GENERAL

The following provision is added to Sub-Clause 36.2 of the GCC:

The term "documentation" as defined in Annex IV to the GCC shall be interpreted to also include data files, CAD files, EXCEL files and similar electronic files, which shall not be considered as "software" in the sense of Clause 42 of the GCC.

The electronic files containing these items shall be delivered to the Agency in the format agreed with the ESA Technical Officer.

CLAUSE 37: INFORMATION TO BE PROVIDED

The following provision is added to Sub-Clause 37.2 of the GCC:

The Contractor shall not mark any documents as "Proprietary Information" unless agreed in advance with the Agency. Any request from the Contractor shall be submitted accompanied by an appropriate justification.

ACCESS TO INFORMATION

The following provision is added to Sub-Clause 37.4 of the GCC:

a) The Agency shall have the right to disclose, at any time including throughout the duration of this Contract, any information generated in the frame of this Contract, to any Contractor/Subcontractor(s) performing work for the Agency in the context of the SWARM mission, , provided that the information concerned is exclusively used for the purpose of the said activities or programmes for the purpose of the SWARM mission.

b) If approved by the Member/Participating States, the Agency's right of dissemination for Level 1 and Level 2 CAT2 data is also extended to non Member States and to individuals, companies, bodies or organisations, residing in non Member States, collaborating or participating in official activities or programmes of the Agency, provided that the information concerned is exclusively used for the purpose of the said activities or programmes for the purpose of the SWARM mission.

CLAUSE 38: DISCLOSURE

The following provision is added to Sub-Clause 38.2 of the GCC:

The access rights granted to the Agency's employees under Sub-Clause 38.2 of the GCC are hereby extended to Contractor staff hired by ESA to provide technical, management, legal or administrative support to ESA as long as they have signed an engagement of confidentiality.

CLAUSE 43: BACKGROUND INTELLECTUAL PROPERTY RIGHTS

In pursuance of the requirements of Clause 43.1 of the GCC, the following is recorded:

a) It is not foreseen that the Contractor make use of any Background Intellectual Property.

b) Notwithstanding the second paragraph of Clause 43.1 of the GCC, the following is agreed: if the Contractor, after the signature of the Contract, invokes the existence of any additional Background Intellectual Property to be used for the purposes of the present Contract, the Contractor shall provide conclusive evidence to the Agency of the existence of this Background Intellectual Property and shall justify the reasons for which the existence of this Background Intellectual Property was not invoked before the Contract signature.

If conclusive evidence and appropriate justification are provided by the Contractor, the Parties shall formalise a Contract Change Notice to specify in detail which Information has been recognised as Background Intellectual Property.

Conversely, if such evidence and justification are not provided, all information delivered shall be deemed as having been generated in the frame of the Contract.

sub-Clauses 43.4 and 43.7**:**

For the purpose of Sub-Clauses 43.4 and 43.7 of the GCC, the term "Agency Project" shall refer to all present and future activities in the context of project SWARM.

CLAUSE 49 - TRANSFER OUTSIDE THE MEMBER STATES

The request for a transfer outside the Member States shall be addressed to the Agency's Technology and Product Transfer Board via the Secretary of the Board, Legal Department, ESA Headquarters, 8-10 rue Mario Nikis, 75015 Paris, with a copy to the technical and administrative representatives of the Agency identified in Article 5, Clause 5, Sub-Clause 5.1.

The terms of Clause 49 of the GCC shall not be construed as restricting the Agency's right to disseminate information and documents to non Member States as specified in Sub-Clause 37.4 b) above.

Done in two originals, one for each Party to this Contract,

In: Lyngby

On: 15/11 2013

For DTU Space

Mr. Kristian Pedersen
Director

In: Frascati

On: 4.11.13

For the European Space Agency (ESA)

Dr. Volker Liebig,
Director of Earth Observation Programmes (D/EOP)

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APPENDIX 1: PAYMENT PLANS AND ADVANCE PAYMENTS, AND OTHER FINANCIAL CONDITIONS

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[redacted]

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[redacted]

APPENDIX 2: STATEMENT OF WORK

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DOCUMENT

Statement of Work:

Swarm Expert Support Laboratories: Operations, Performance Analysis, Maintenance and Evolution of the Swarm Level 1 and L2 Algorithms, Processors and Calibration data.

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European Space Agency
Agence spatiale européenne

APPROVAL

Title	
Issue 1	Revision 0
Author	Date
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CHANGE LOG

Reason for change	Issue	Revision	Date

CHANGE RECORD

Issue 1	Revision 0		
Reason for change	Date	Pages	Paragraph(s)

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1 INTRODUCTION

1.1 Purpose of this document

This Statement of Work (SoW) describes the activities and organisational requirements to the Contractor for the project "Expert Support Laboratories" (ESL) in the context of Swarm Level 1 (L1) and Level 2 (L2) data processing. This SoW defines the scope, context and objectives of the ESL Project and formulates the tasks to be performed.

1.2 Swarm background

The three Swarm satellites constellation will be launched in the first half of 2013 for a nominal mission lifetime of 4 years, following a 3-month initial commissioning phase.

The objective of the Swarm mission is to provide the best ever survey of the geomagnetic field and its temporal evolution, and gain new insights into improving our knowledge of the Earth's interior and climate.

The Swarm concept consists of a constellation of three satellites in polar orbits between 300 and 530 km altitude. High-precision and high-resolution measurements of the strength and direction of the electromagnetic field will be provided by each satellite. In combination, they will provide the necessary observations that are required to model various sources of the geomagnetic field.

1.2.1 Mission Objectives

The primary aim of the Swarm mission is to provide the best ever survey of the geomagnetic field and the best global representation of its variation on time scales from an hour to several years. The more challenging part, however, is to separate the contributions from the various sources. Swarm will simultaneously obtain a space-time characterisation of both the internal field sources in the Earth and the ionospheric-magnetospheric current systems.

The primary research objectives assigned to the mission are:

- studies of core dynamics, geodynamo processes, and core-mantle interaction,
- mapping of the lithospheric magnetisation and its geological interpretation,
- determination of the 3-D electrical conductivity of the mantle,
- investigation of electric currents flowing in the magnetosphere and ionosphere

In addition to the above sources, the ocean currents produce a contribution to the measured magnetic field. But the magnetic field is not only used as evidence of the evolution of the planet, it also exerts a very direct control on the dynamics of the ionised

and neutral particles in the upper atmosphere, and possibly even has some influence on the lower atmosphere. This leads to the identification of the secondary research objectives of:

- identifying the ocean circulation by its magnetic signature,
- quantifying the magnetic forcing of the upper atmosphere

Analysis of the Swarm data will greatly improve existing and provide new models of the near-Earth magnetic field of high resolution and authenticity compared to a single-satellite mission. This will provide the prospect of investigating hitherto undetected features of the Earth's interior.

A full description of the mission objectives is provided in the Swarm Mission Requirement Document [AD 1].

The expected internal field characteristics at 400 km altitude based upon current knowledge are shown in

Table 1. Also indicated are the types of measurements that are needed for the analysis. The aim is to recover the finest scales of this table with sufficient accuracy. In

Table 2 the expected signals of the external contributions are given. These values correspond to the same altitude.

Research Objectives	Time Range	Spatial Range	Signal Range	Signal at certain wavelength (wl)	Measurement (B= magnetic)
Core dynamics and geodynamo processes	Static	3000 km to global	±65000 nT	0.8 nT @ 3000 km wl	B-field vector, attitude and position
	3 months to decades	2500 km to global	±200 nT/year	0.025 nT/3 months @ 2800 km wl	
Lithospheric magnetisation	decades to static	300 km to 3000 km	±25 nT	1.8 nT @ 3000 km wl 1.9 nT @ 360 km wl	B-field vector, attitude and position
3-D mantle conductivity	1.5 hours to 11 years	300 km to global	±200 nT	n.a (modelled as conductivity)	B-field vector, attitude and position
Ocean circulation	12 hours to 2 years	600 km to 10000 km	±5 nT	0.5 nT @ 10000 km wl 0.01 nT @ 600 km wl	B-field vector, attitude and position

Table 1: Internal field characteristics at 400 km altitude.

Research Objectives	Time Range	Spatial Range	Signal Range	Measurement (B= magnetic)
Ionosphere-magnetosphere current systems	0.1 sec to 11 years 10 sec to 3 months	1 km to global 10 km to global	B-field: ±1000 nT E-field: ±0.2 V/m Ion drift velocity: ±4000 m/s	B-field, E-field, and ion drift velocity vectors, attitude and position
Magnetic forcing of the upper atmosphere	10 sec to 2 years 10 sec to 3 months	200 km to global	Plasma density $1*10^8$ m^{-3} to $5*10^{13}$ m^{-3} Air drag: $1*10^{-5}$ m s^{-2} Ion and electron temperature: 1000-100000 K	B-field and E-field vectors, ion and electron temperature and plasma density, attitude and position

Table 2: External field characteristics in 400 km altitude.

1.2.2 Payload configuration

In order to fulfil the mission objectives the Swarm space segment includes on each spacecraft the following payload configuration:

- Absolute Scalar Magnetometer (ASM)
- Vector Field Magnetometer (VFM)
- Electrical Field Instrument (EFI)
- Star Tracker System (STR)
- GPS Receiver (GPSR)
- Accelerometer (ACC)
- Laser Retro Reflector (LRR)

Absolute Scalar Magnetometer

The ASM measures the absolute high accuracy magnitude values of the magnetic field. The ASM provides the ability of performing an in-flight calibration of the vector magnetometer and of monitoring long term trends in a multi-year geomagnetic field mission.

Vector Field Magnetometer

The VFM accomplishes high precision, ultra-high linearity and low noise measurements of the Earth's magnetic field vector components.

Electrical Field Instrument

The EFI makes in-situ measurements of the ion distribution and its moments. Key parameters that can be determined by this instrument are ion arrival angle, drift velocity, ion density, temperature and spacecraft potential. These parameters are used to calculate the local electric field.

Star Tracker System

The STR delivers 3 axis highly accurate attitude data. The STR is mounted together with the VFM on a rigid mechanical interface to get the knowledge of the VFM axis orientation. This mechanical interface between STR and VFM is called optical bench.

GNSS Receiver

The GNSS receiver provides autonomous and real time satellite positioning and timing information. Precise orbit determination are computed during post processing in the ground segment. By using the precise timing information contained in each navigation solution in combination with a synchronisation pulse delivered every second by the receiver, a common time scale can be established for all the satellites and their instruments.

Accelerometer

The ACC takes measurements of the non-gravitational accelerations acting on the spacecraft caused by air density, solar wind, Earth albedo, attitude and orbit control actuators etc.

Laser Retro Reflector

The LRR allows precise range measurements from ground based satellite laser ranging stations.

1.2.3 Ground Segment

The architecture of the Swarm Ground Segment (GS) in more detail is provided in [AD 2][1].

Core Ground Segment Elements:

- The Swarm Flight Operations Segment (FOS)
- The Swarm Payload Data Ground Segment (PDGS)
- The Level 2 Processing System (L2PS)

Figure 1 highlights the key elements of the Swarm Ground Segment.

[1] Note: In the current version of this document the L2PS is not defined in detail.

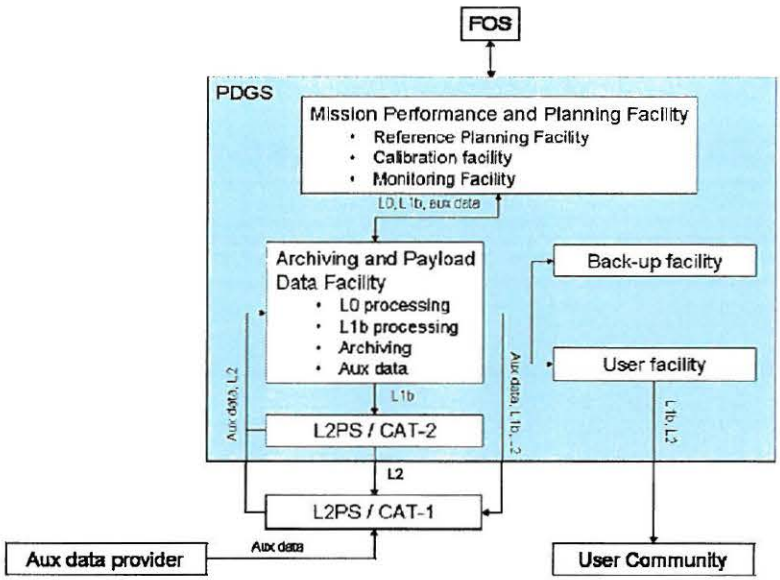

Figure 1: The Swarm Ground Segment

FOS is in charge of satellite operations and for the baseline acquisition.

The PDGS is in charge for science data processing, product archiving and dissemination to Swarm users as well as payload performance monitoring and calibration activities planning.

The PDGS system architecture is based on four building blocks:

- APDF – Archiving and Payload Data Facility, hosting the IPF0 (Instrument Processing Facility Level-0) and the IPF1 (Instrument Processing Facility Level-1b)
- ARC-BCK – Backup archiving facility
- MPPF – Mission Planning and Performance Facility
- USF- User Services Facility

The APDF is responsible for:

- Retrieving the VC4 Recorded Telemetry from the acquisition stations
- Retrieving auxiliary data from external sources (including FOS) and dissemination to MPPF
- L0 and L1 processing and dissemination of products to MPPF
- Archive all Swarm Telemetry product files received from FOS, all L0 and L1b products generated and all auxiliary products from FOS and ADPs on a rolling archive (storage time configurable according to operational needs).
- Quality control of L0, L1 and L2 products format (this is actually carried out by one of the MPPF elements as described below)

- Reporting for MPPF
- Dissemination of products to users
- Level 2 Category-2 (CAT-2) processing (refer to section 1.2.3.2)

The ARC-BCK will include a replica of the main APDF archive and shall provide the only functions of archive and retrieve of data.

The MPPF is responsible for the performance monitoring of the Swarm mission PDGS and for the provision of the operational plans of the Swarm constellation payload activities. The system will be composed by a set of independent elements having common interfaces and sharing database access provided by a front-end data server. The purpose of this function is to support the monitoring of the Swarm products quality (L0, L1b and L2 CAT-2), to monitor the processors and overall PDGS performances and L2PS overall performances. The MPPF shall verify the availability of all instrument data products and their circulation into the PDGS. The main MPPF tasks are provided by the following components:

- DMC (Data Management Component)
- RPF (Reference Planning Facility)
- ICM (Instrument Calibration Monitoring)
- GPM (Ground Segment Performance Monitoring)
- DVT (Data Validation Tool)
- DQC (Data Quality Control)

The Monitoring Baseline Document [AD 3] describes the data quality routines currently implemented in the ICM, DVT and DQC components together grouped as MPPF Calibration Validation and Quality control (MPPF-CVQ).

The USF is responsible for:

- Providing the user interface to the catalogue
- Providing user interface to registered user for product retrieval (on-line access)
- Providing a user interface for product ordering
- Providing mission general information and help-desk services

Level 1b Products for Swarm with a daily period are provided covering one day of observations, i.e. 0:00:00 through 24:00:00 (UTC). More detailed information is provided from [AD 4] to [AD 8].

The L2PS is responsible for:

- Level 2 Category-1 (CAT-1) (refer to section 1.2.3.2) processing by means of a distributed processing system
- Providing support for the evolution of the Level 2 CAT-1 and CAT-2 (refer to section 1.2.3.2) algorithms and processors

All Level 2 products will be collected by the PDGS and further distributed to the Swarm user community.

1.2.3.1 Nominal L1 Production sequence

The overall general requirement on the PDGS is that it shall be able to process and transfer to users, within 1 week after data reception on ground, routine scientific data products with the associated quality control results. The systematic L0 production is triggered by the arrival of Virtual Channel (VC) 4 file. The L0 product is then quality checked by the MPPF Data Quality Control - DQC) processor. After the quality report is generated by the DQC processor, a task is executed to pack the product and its quality report before disseminating it to final users. The L1 processing chain is documented in

in [AD 4], [AD 5] and [AD 9]. The chain consists of the following steps:

- ORBATT - Orbit related Data Processing
- ACCELE - Accelerometer Data Processing
- MAGNET - Magnetic Data Processing
- PLASMA - Plasma Data Processing

The production is driven by a regular (timer based) query for L0 products of 3 days in the past. Considering the processors times, the overall production latency of the PDGS is three days and a half.

There are also four calibration processors:

- MACGMP - VFM/ASM Calibration Manoeuvre Post-processing. References: [AD 9], [AD 12] and [AD 14].
- MAGREP - Magnetic Reprocessing of magnetic field data following an update in the **STR_q_VFM** alignment quaternion from CCDB. References: [AD 9] and [AD 12].
- EULCAL - Euler Angle Calibration Processing. References: [AD 9], [AD 12] and [AD 14].
- CEFITII - Determination of the TII detector center, the direction cosines and the Energy transfer function coefficient. References: [AD 13], [AD 14] and [AD 15].

The Swarm ESL shall focus on all of the above processors apart for the ORBATT processor. The contractor shall nonetheless assess any impact that a change in the ORBATT processor may have on the rest of the processing chain.

1.2.3.2 L2 Products

L2 products [AD 16] consist of two different product categories:

- **CAT-1:** Mature, complex algorithms contributing to the generation of a geomagnetic model of the various sources of the Earth's magnetic field, for which a 'scientist-in-the-loop' (SIL) is required. These models are based on the accumulation of satellite observations collected over a long period. The final product being the

result of the four year mission. These products will be generated off-line by a distributed processing system (L2PS)

- **CAT-2:** Mature algorithms leading to a Level 2 product with minimum delay with respect to the generation of the corresponding Level 1b data for various applications; e.g. space weather applications implemented in an automatic data driven way.

Whereas the CAT-1 processors are run in a distributed manner by a European consortium, the APDF will generate all CAT-2 products.

1.2.4 Overall Mission Quality Control Entities

During the Swarm Exploitation Phase (PhE2) various entities are involved in supporting the monitoring of the overall mission quality. These are illustrated in Figure 2 and further explained in this section with respect to the activities related to the ESL.

This figure also illustrates the key interfaces that the ESL team shall establish in order to optimally perform its mandate.

The ESA Swarm Mission Manager (MM) is responsible for the overall mission performance and achievements. The MM has therefore the overall responsibility over mission operations. According to the status of instruments and data quality and the achieved scientific objectives, the MM takes the ultimate decisions on calibration planning, on processors upgrades and processing baseline changes.

The ESA Sensor Performance, Products and Algorithms (SPPA) Manager will be the key interface for all technical and contractual aspects for this ESL contract. The SPPA Manager is also directly responsible for the ESA Data Quality team. This team is contractually set up via the Instrument Data quality Evaluation and Analysis Service (IDEAS) contract, which is in charge of the daily data quality monitoring and data long term analysis by using the various MPPF-CVQ facilities. The ESA Data Quality team is also maintaining the configuration control of these facilities and of the Operational Processors (OP). The SPPA Manager also manage the calibration operations at GS level.

The ESA PDGS Operations Manager coordinates all operational activities at the various GS facilities, with specific responsibility for the data flow and data production.

The ESA Post Launch Support Office provides support to all aspects related to the platform and on-boards instrumentation with the aim of keeping the satellite performance at the highest possible level, extending the mission life as long as possible, ensuring the safety of the spacecraft and its payload and supports the Flight Operation Team. The PLSO provides in-orbit performance reports and advices on technical decisions and mission improvements.

All the quality related information generated by the various entities including the ESL (e.g. calibration and instrument monitoring results, processors evolutions, platform anomalies, constellation modifications) must be shared and discussed. This will occur during the Quality Working Group meetings managed by the Agency. The QWG meeting meetings will be organised on a six months basis or with a higher frequency if required especially in the

first year of operations. The ESL teams, as part of the QWG, will report during the meetings and contribute to the scientific discussion.

The QWG composition will be defined and mananged by the Agency. The QWG attendees may vary depending on the specific needs of the mission.

The first QWG meeting will take place at launch plus 5 months. This date is before the Product Validation Review (PVR) as planned in [AD 11] that will be carried out with the Swarm Validation Teams (SVT). The SVT is composed by scientists who will focus their efforts on the scientific validation of the Swarm data during both the Commissioning Phase (PhE1) and the Exploitation Phase (PhE2).

Coordination between all these various entities will also be organised via web2.0 portal and functionalities. The portal will also facilitate discussion with the wider scientific community.

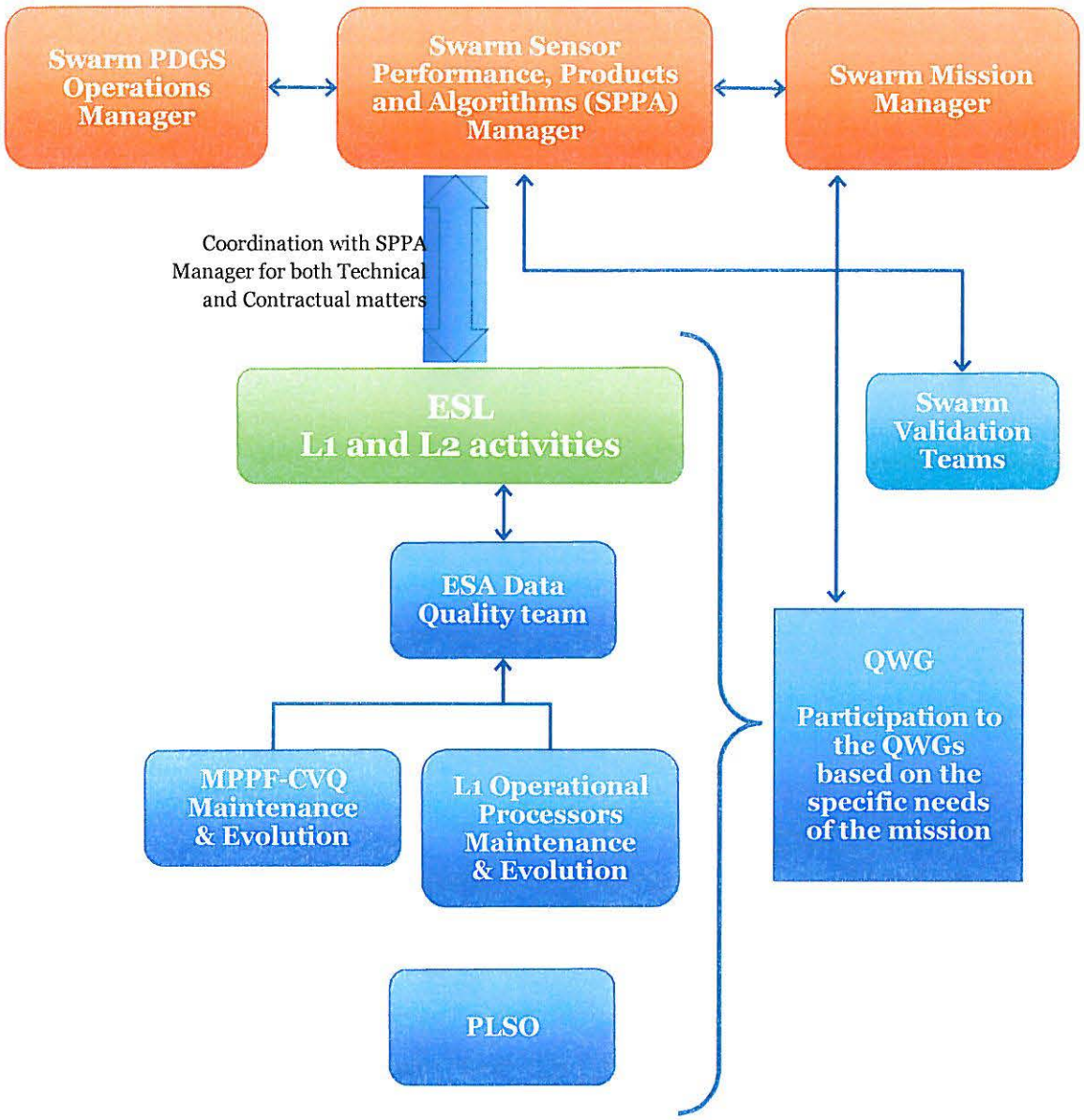

Figure 2: Entities linked to the mission and data quality assessment. The green colour identifies the ESL element. The orange colour identifies ESA entities. The blue colour identifies other relevant entities related to mission/product quality assessment.

1.3 Algorithm and processor prototype evolution cycle

The algorithm and prototype processors evolution can be considered as a continuous evolving cycle, as depicted in the graph below Figure 3.

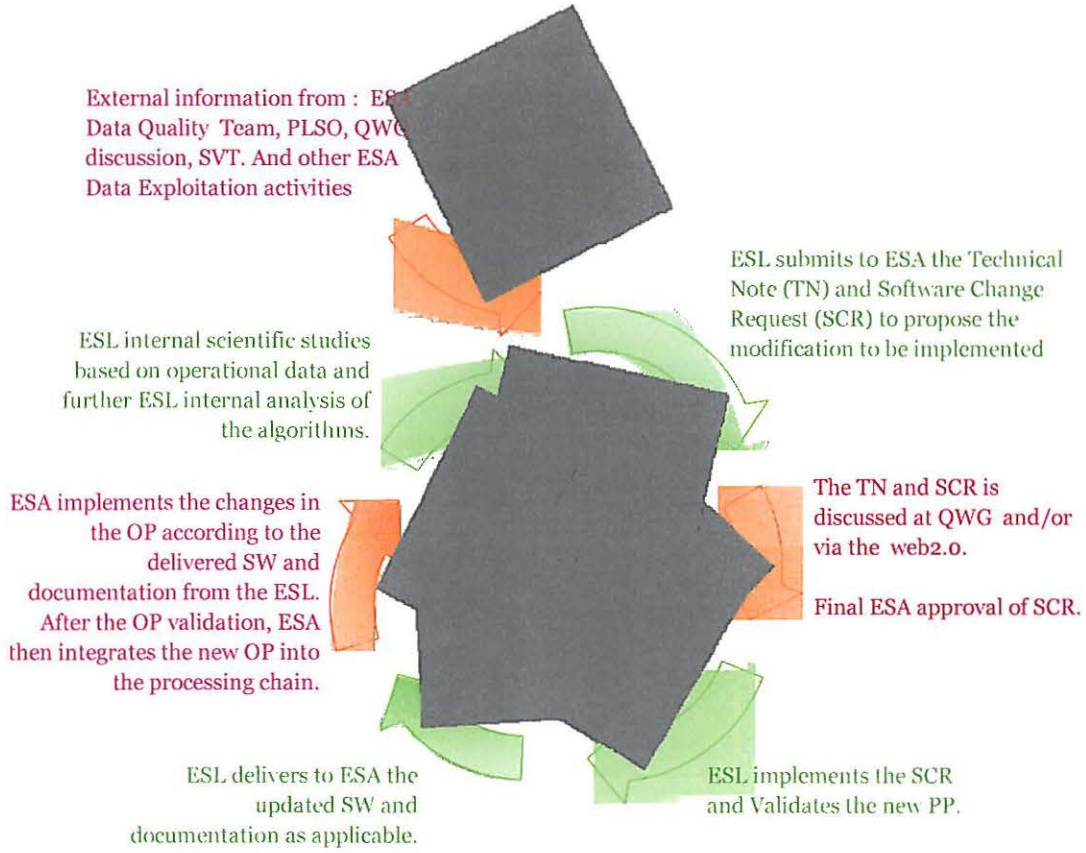

Figure 3: Algorithm and processor prototype evolution cycle. The green colour identifies the ESL related activities. The orange colour identifies ESA or external related activities.

The figure above provides an overview of the activities involved in the update of the PP or potentially a CCDB parameter or external ADF. The graph also shows the TN and SCR submission process that is necessary to coordinate the PP and OP during the mission. Any upgrades are first implemented in the prototype after the approval of the SCR by the Agency. Subsequently the Agency updates operational processor based on the detailed algorithm definition. Acceptance of the operational processor is based on the comparison

with the prototype results. This has the advantage of checking twice the correct implementation of the algorithm.

1.4 Scope of the procurement

ESA has the responsibility of assuring the overall success of its missions. Fully accomplishing this goal means establishing that the data products meet required performance throughout the mission lifetime, taking into consideration possible variation of the instruments' characteristics and new acquired knowledge on the measured phenomena. Therefore, the scope of this ESL Project is to manage such evolutions and apply the necessary modifications in the processing algorithms for both L1 and L2 during the Swarm Exploitation Phase (PhE2). The procurement also covers the operation of the L2 processing chains.

1.5 Document structure and content

This Statement of Work is structured as follows:

Chapter 1: Introduction, purpose and scope, acronyms, references and document structure;

Chapter 2: Work description, high level work logic and task description with requirements ;

Chapter 3: Project organisation;

1.6 Acronyms and abbreviations

ACC	Accelerometer
ACCELE	Accelerometer Data Processing
AD	Applicable Documents
ADF	Auxiliary Data File
APDF	Archiving and Payload Data Facility
ATBD	Algorithm Theoretical Baseline Document
ASM	Absolute Scalar Magnetometer
CAT	Category
CCDB	Characterisation and Calibration DataBase
CEOS	Committee on Earth Observation Satellites
DMC	Data Management Component
DPM	Detailed Processing Model
DQC	Data Quality Control
DVT	Data Validation Tool
EFI	Electrical Field Instrument
ESA	European Space Agency
ESL	Expert Support Laboratories

Products, and Algorithm Management Section.

ESL	Expert Support Laboratories
FOS	Flight Operations Segment
GPM	Ground Segment Performance Monitoring
GPSR	GNSS Receiver
GS	Ground Segment
ICM	Instrument Calibration Monitoring
IDEAS	Instrument Data quality Evaluation and Analysis Service
IODD	Input/Output Definition Document
LRR	Laser Retro Reflector
L0	Level 0
L1	Level 1
L2	Level 2
L2PS	Level 2 Processing System
m	months
MAGNET	Magnetic Data Processing
MM	Mission Manager
MPPF	Mission Planning and Performance Facility
OM	Orchestration Model
OP	Operational Processor
ORBATT	Orbit related Data Processing
ORR	Operational Readiness Review
PDGS	Payload Data Ground Segment
PhE2	Exploitation Phase
PLASMA	Plasma Data Processing
PLSO	Post-Launch Support Office
PP	Prototype Processor
PPR	Preparatory Phase Review
PRV	Product Validation Review
QWG	Quality Working Group
Req	Requirement
RP	Reference Platform
RPF	Reference Planning Facility
TDS	Test Data Set
SIL	Scientist in the loop
SLA	Service Level Agreement
SoW	Statement of Work
SPPA	Sensor Performance, Products and Algorithms
STR	Star Tracker System
SUM	Software User Manual
SVT	Swarm Validation Team
TDS	Test Data Set
TN	Technical Note
VC4	Virtual Channel 4
VFM	Vector Field Magnetometer
WGCV	Working Group on Calibration and Validation
y	years

1.7 Definitions

In this document, 'shall', 'should' and 'desirable' or 'optional' are used to define the priority of the requirements / activities, with the meaning that requirements / activities described by:

'shall'	are mandatory
'should'	are strongly recommended, but may be replaced by a different solution with equivalent or better functionality or deleted for well justified reasons
'desirable' or 'optional'	are not mandatory and improve the quality of the Technical proposal and of the final system

'Should' and 'desirable' / 'optional' requirements or activities remaining in the Technical proposal shall be, in agreement with the ESA Technical Officer, converted to 'shall' requirements or activities or deleted during the negotiation phase or after the necessary investigations have been performed.

Baseline, Software, Prototype and IPF are defined as follows:

Baseline:	The complete specification, maintained under configuration control, of all elements (e.g. documents, software, hardware, auxiliary data files, CCDB) that compose the processing chain and that defines the production of inter-usable data products. Such products can be used for the generation of higher level products. This means that after a change of the Baseline (e.g. due to a major processor update or CCDB change) the ground segment will generate products that cannot be any longer used for scientific purposes with the data previously generated. An update of the Baseline subsequently triggers the reprocessing of the mission data in order to generate a consolidated mission data set. This operational mechanism is described in [AD 10].
Software:	A consistent (i.e. applicable to the same version) set of source code, binaries, and full specification including configuration documentation and user manual information.
Prototype Processor:	Software that demonstrates the validity of the algorithm, based on a well-defined set of documents (i.e. Algorithm Theoretical Baseline Document (ATBD), Detailed Processing Model (DPM), Orchestration Model (OM), Auxiliary Data Files (ADF), Test Data Set (TDS), Input/Output Definition Document (IODD)).

Operational Processor:	Operational implementation of the prototype to be run in the Ground Segment (GS). The OP takes one or more input data products and generates one or more output products. The OP functionality is implemented in a collection of tasks (at least one) that are called in a specific order by a processor management layer.

Calibration and Validation are defined by:

Calibration	The Committee on Earth Observation Satellites (CEOS)'s Working Group on Calibration and Validation (WGCV), and ISO 9000, defines Calibration as the process of quantitatively defining the system responses to known, controlled signal inputs. Correspondingly a calibrated product is the output from the complete calibrated data generation chain. Indirect, or vicarious, calibration simulates the signal at the satellite sensor input based on independently measured geophysical parameters and then compares it to the actual signal measured by the sensor. The outcome of the comparison can be used to calibrate the sensor output.
Validation	The WGCV and ISO 9000's definition of Validation is the process of assessing, by independent means, the quality of the data products as derived from the system outputs. Geophysical validation ensures that the quality of geophysical products derived from the system is properly assessed by independent means and via quantification of the uncertainties at any stage of the product processing chain. A validated product is thus the output from the complete validated data generation chain.
L0	Level 0 products are ordered raw measurements as downlinked by the spacecraft. No corrections are applied to them.
L1	Level 1 products are calibrated scientific data collected by the instruments and converted to geophysical units. L1 data are per satellite without making use of the mission constellation set-up.
L2	Level 2 data present advanced science products related to geomagnetic models and upper atmosphere conditions. Most L2 products take the constellation into account.

1.8 Applicable Documents

The following list provides the applicable document for the activities to be performed. Newer and updated versions of these document may be delivered to the Contractor at kick-off (KO).

[AD 1] Swarm Mission Requirements Document, SW-MD-ESA-SY-001. Issue 1 revision 0. September 2004.
[AD 2] Swarm Payload Data Ground Segment System Architecture Document, SWAM-GSEG-EOPG-DD-07-0002, issue 1.8.
[AD 3] MPPF-CVQ Monitoring Baseline Document. ST-ESA-SWARM-MBD-0001. v1.6
[AD 4] Level 1b Product Definition, SW-RS-DSC-SY-0007, issue 5.11
[AD 5] Swarm L1b Processor Algorithms, SW-RS-DSC-SY-0002 issue 6.6
[AD 6] Swarm L1b Processor CCDB, SW-TN-DSC-SY-0005 issue 4.11
[AD 7] Swarm Tailoring Document, SW-TN-ESA-GS-0074, issue 1.5
[AD 8] CDF Converter Data Format Document, SW-ID-GMV-GS-0006, issue 3.5
[AD 9] Swarm L1b Orchestration Model. SW-ID-GMV-GS-0004, issue 3.4
[AD 10] Swarm PDGS Operational Concept, SWAM-GSEG-EOPG-PR-11-0046 issue 1
[AD 11] Swarm scientific validation plan for phases E1 and E2, SWAM-GSEG-EOPG-PL-12-0093, v0.5.
[AD 12] Swarm L1B Processor Detailed Processor Model - SW-DS-GMV-GS-0001, issue 3.1
[AD 13] SWARM MPPF-CVQ CEFI-TII Calibration Data Processor ICD - ST-ESA-SWARM-ICD-0003, issue 1.3
[AD 14] Swarm Calibration Algorithms for the ICM - SW-RS-ESA-GS-0209, issue 1.4
[AD 15] SWARM MPPF-CVQ CEFI- TII Calibration Data Processor Software User Manual, ST-ESA-SWARM-SUM-0003, Issue 1.1
[AD 16] Product specification for L2 Products and Auxiliary Products, SW-DS-DTU-GS-0001. Rev 2E.
[AD 17] L2PS Architectural Design, SW-DD-DTU-GS-0002. Rev 2.
[AD 18] Auxiliary Data Providers to Swarm L2PS Interface Control Document for CAT-1 Processors, SW-IC-DTU-GS-0002. Rev 2A
[AD 19] Swarm PDGS to L2PS Interface Control Document, SWAM-GSEG-EOPG-IC-010-0009. Version 1.7.
[AD 20] Development of the Swarm Level 2 Algorithms and Associated Level 2 Processing Facility. Tailoring of ECSS Standards. SW-RS-ESA-GS-0175. Issue/Revision: 1/0.

2 WORK DESCRIPTION

This chapter describes the objectives and tasks that the Contractor shall perform.

2.1 Objectives and work logic

The objective of this contract is to :

- to assure the highest achievable quality of the data products during the whole mission exploitation phase (PhE2).
- to advance, maintain and evolve the know-how of the overall Swarm satellites systems, understood as a physical system composed of the phenomena to be measured, the space platform and payloads, and the processing algorithms from raw data (Level 0) to higher level products (Level 2).

To successfully carry out these activities, it is necessary to have an in-depth scientific and engineering knowledge on the different science fields of the Swarm mission and covering all the on-board instruments. This specific knowledge is provided by the Expert Support Laboratories (ESL).

This Project also involves the analysis of the calibration and validation results and the assessment of new scientific knowledge acquired throughout the mission and the support to instrument degradation or anomaly investigations.

The work logic of this ESL project is structured with three key activities:

- the L1 algorithms evolution and maintenance
- the L2 processing chains operations, and L2 algorithms evolution and maintenance
- Support, coordination and communication, through the EO Mission Management Division and its Sensor Performances, Products, and Algorithm Management Section, with the other entities involved in the operational phase of the mission

This work logic is reflected in the list of tasks on the next sections.

2.2 Assumptions

Swarm will be launched in the first half of 2013.

The Contractor and its consortium already has the availability of the L1 Prototype Processors of the processors listed in 1.2.3.1 (excluding the ORBATT processor), the End-to-End Simulator, the L2 CAT-1 processors, the L2 CAT-2 Prototype Processors and all related documentation and supportive material described in section 2.7. The Contractor shall guarantee in written form that the PPs and the End-to-End Simulator that are initially used in this Project are the ones delivered for the validation of the OP during the commissioning phase and that no modification has been applied before the start of this project to them.

The contractor shall not communicate and disclose any critical problem on algorithms and respective data products to any other party outside the ESL contract without the written authorisation of the Agency.

2.3 Task 1 : L1 algorithms evolution and maintenance

The following requirements are applicable to all L1 processors and calibration processors listed in 1.2.3.1 excluding the ORBATT processor. All deliverables are listed in section 3.2.8.

2.3.1 Data and Algorithm Performance Analysis

[Req-1] The contractor shall perform on-demand data analysis. Such need may be raised by the Agency, by the ESA Data Quality team or by the members of the ESL Team. Indeed, the ESA Data Quality team may contact the ESL teams if the nature of the anomaly requires this (e.g. level of complexity, relation to algorithms). Analysis, results and conclusive remarks shall be reported via email or ad-hoc documentation if necessary.

[Req-2] The contractor shall support the investigation of instrument and product anomalies. Anomalies can be detected by users, the Agency and the ESA Data Quality team, and the contractor itself. . For major anomalies impacting the overall project activity, the contractor shall devise an investigation plan together with the Agency and parties designated by them, including a schedule estimate, and contribute to the investigation and reporting. Analysis, results and conclusive remarks shall be reported via ad-hoc documentation.

[Req-3] The contractor should contribute to the data quality monitoring. This monitoring should also include assessment against L2 product results and with regards to the performance/adequacy of the characterisation and calibration database (CCDB) parameters, auxiliary data files and the MPPF-CVQ thresholds. Analysis, results and conclusive remarks shall be reported via ad-hoc documentation every two months and with a higher frequency in case of urgent communication needs. The reports should address all products types and also assess multi-satellite aspects.

[Req-4] The contractor shall contribute to the review of the results from calibration processors that are run in the PDGS as described in 1.2.3.1 ([AD 5], [AD 9], [AD 12] and [AD 14]). Analysis and conclusive remarks shall be reported.

[Req-5] The contractor should support the assessment of the results of the Swarm Validation Teams [AD 11]. Analysis and conclusive remarks shall be reported.

The contractor shall not communicate and disclose any critical problem on algorithms and respective data products to any other party outside the ESL contract without the written authorisation of the Agency.

2.3 Task 1 : L1 algorithms evolution and maintenance

The following requirements are applicable to all L1 processors and calibration processors listed in 1.2.3.1 excluding the ORBATT processor. All deliverables are listed in section 3.2.8.

2.3.1 Data and Algorithm Performance Analysis

[Req-1] The contractor shall perform on-demand data analysis. Such need may be raised by the Agency, by the ESA Data Quality team or by the members of the ESL Team. Indeed, the ESA Data Quality team may contact the ESL teams if the nature of the anomaly requires this (e.g. level of complexity, relation to algorithms). Analysis, results and conclusive remarks shall be reported via email or ad-hoc documentation if necessary.

[Req-2] The contractor shall support the investigation of instrument and product anomalies. Anomalies can be detected by users, the Agency and the ESA Data Quality team, and the contractor itself. . For major anomalies impacting the overall project activity, the contractor shall devise an investigation plan together with the Agency and parties designated by them, including a schedule estimate, and contribute to the investigation and reporting. Analysis, results and conclusive remarks shall be reported via ad-hoc documentation.

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[Req-4] The contractor shall contribute to the review of the results from calibration processors that are run in the PDGS as described in 1.2.3.1 ([AD 5], [AD 9], [AD 12] and [AD 14]). Analysis and conclusive remarks shall be reported.

[Req-5] The contractor should support the assessment of the results of the Swarm Validation Teams [AD 11]. Analysis and conclusive remarks shall be reported.

[Req-6] The contractor should contribute to the assessment of the results of the ESA Data Quality team analysis results [AD 3]. Analysis and conclusive remarks shall be reported every two months together with reports of [Req-3].

[Req-7] The contractor shall contribute to the review of the results from the Post Launch Support Office (PLSO) reporting. Any relevant information shall be taken into consideration as input for further analysis. For example a change in one of the CCDB instrument related parameter shall be assessed in relation to the potential impact to the L1 processing chain. Analysis and conclusive remarks shall be reported.

[Req-8] The contractor should contribute to the review of the relevant results achieved by the wider scientific community that are reported in the web2.0 portal.

2.3.2 Algorithm Configuration Control, Maintenance and Evolution

2.3.2.1 Prototype Processor Configuration Control, Maintenance and Evolution

[Req-9] The contractor shall set-up and maintain a reference platform for all prototype processors (PP) (ref. to section 1.2.3.1) excluding the ORBATT processor.

[Req-10] The contractor shall maintain configuration control of all elements under its responsibility and of all deliverables. This includes hardware, software and respective documentation.

[Req-11] A dedicated configuration control software tool shall be used.

[Req-12] For all components the contractor shall ensure strict correspondence between software and associated documents and data. For example algorithm DPM, SUM, TDS, IODD.

[Req-13] The contractor shall acknowledge and respond to Software Problem Reports (SPR) identified by the Agency or the ESA Data Quality team. The contractor can also generate SPRs related to problems that are identified during the activities performed.

[Req-14] The contractor shall study solutions for the quality-improvement actions following the results related to the requirements from [Req-1] to [Req-8] included and [Req-13]. The results of these studies shall be presented in Technical Notes (TN) containing the scientific description of the matter and the change justification. The TN shall be accompanied by the Software Change Request (SCR) describing the description of the exact L1 algorithm proposed change, including an estimate of the impact. The TN and SCR

forms are subsequently discussed via the web2.0 portal and/or at the QWG for final approval by the Agency.

[Req-15] The contractor shall implement the approved Software Change Requests into updates of the algorithms documentation. This includes updating the relevant supportive documents (eg. DPM, TDS etc) and implementing the modifications in the Prototype Processor. For modifications that affect the Baseline (as defined in 1.7), the full list of items listed in 2.7 shall be delivered.

[Req-16] The contractor shall demonstrate to the Agency the proper Software Change Requests implementation through thorough verification. The results of this verification are documented in the Verification Report, to be delivered to the Agency for approval.

[Req-17] The contractor shall not distribute the algorithms or PP (both the latest and older versions) to any other party outside of the ESL contract without the authorisation of the Agency.

[Req-18] The contractor shall not distribute L1 and L2 data products (both the latest and older versions) to any other party outside of the ESL contract without the authorisation of the Agency.

[Req-19] The contractor should update and maintain the end-to-end simulator. This is also necessary in order to be able to assess modifications of the ORBATT processors on the rest of the processing chains.

2.3.2.2 Characterisation and Calibration Configuration, Maintenance and Evolution

[Req-20] The contractor shall be aligned with the PDGS with regards to all databases (e.g. auxiliary data files, CCDB, parameters in the MPPF-CVQ monitoring checks etc.) used for the operational calibration processing and data product generation. The configuration control, maintenance and change management of such items in the PDGS Operational framework will be carried out by the ESA Data Quality team. It is a responsibility of the contractor to remain aligned within its infrastructure towards the PDGS Operational framework.

[Req-21] The contractor shall study solutions for the quality-improvement actions following the results related to the requirement [Req-3]. In case any CCDB, ADF or MPPF-CVQ parameters need to be adapted to respond to the evolution of the mission/instruments, the contractor shall provide support to the formulation of modifications of the parameters or of the calibration planning (e.g new methods, manoeuvres, algorithms). The results of these studies shall be presented in Technical Notes (TN), containing the scientific description of the matter and the change justification. The TN shall be

accompanied by the Software Change Request (SCR) describing the description of the exact proposed change, including an estimate of the impact on the data quality. The TN and SCR forms are subsequently discussed via the web2.0 portal and/or at the QWG for final approval by the Agency.

[Req-22] The contractor shall implement updates of the proposed parameters (e.g. CCDB, ADF, MPPF-CVQ) identified in the approved Software Change Requests. This includes updating the relevant documentation when applicable. For modifications that affect the Baseline (as defined in 1.7), the full list of items listed in 2.7 shall be delivered.

[Req-23] The contractor shall demonstrate to the Agency the proper Software Change Requests implementation through thorough verification. The results of this verification are documented in the Verification Report, to be delivered to the Agency for approval.

2.4 Task 2 : L2 processing, maintenance and evolution

This task can be split in the following two sub-tasks:

1. CAT-1 processing, maintenance and evolution
2. CAT-2 support and maintenance

The Contractor shall include a Service Level Agreement (SLA) where the execution and provision of those services is presented in detail. Special emphasis shall be given to:

- Provisions to guarantee the delivery of all CAT-1 products according to the requirements (both with respect to scientific quality and turnaround time) as defined in the [AD 16]
- Configuration control of the distributed processing system
- Algorithm maintenance and evolution for CAT-1 and CAT-2 processors (one key element for CAT-2 is also the maintenance of the embedded libraries and auxiliary data and indices)
- Proper Work package structure to reflect the distributed system including the local (per facility) management
- Detailed schedule for the processing of the different entities during the lifetime of the project
- Proper project management approach
- Availability of key persons for CAT-1 and CAT-2 (remark: the Agency does not ask for certain percentages of availability, but for a general approach to reach key persons in urgent matters)
- Proper risk management

2.4.1 CAT-1

For CAT-1 the Contractor shall provide the following services:

[Req-24] Timely delivery of all CAT-1 Level 2 products as defined in [AD 16]:
The provision of all CAT-1 L2 products according to the required scientific quality specifications as well as the specified turnaround time is a key service within this task 2. In the provided SLA the Contractor shall describe in detail all planned measures (e.g. procedures etc.) to ensure the proper execution of this service.

[Req-25] Maintenance and evolution of all CAT-1 algorithms:
During the lifetime of Swarm the different scientific algorithms forming the base of the CAT-1 processors will have to be modified. It is expected that such an evolution is not only necessary during the beginning of the activity when, for the first time, real Swarm data are available, but it will also take place during later stages. This activity has to be performed in parallel to the routine operations. In his SLA the Contractor shall describe the planned procedures to ensure a proper evolution of the algorithm. One key element is an estimation of the gain (with respect to scientific quality, speedup of the processor etc.) before any update of an algorithm takes actual place. No update shall be made without the written permission of the Agency.

[Req-26] Maintenance and evolution of all CAT-1 processors:
After the thorough assessment of any update of a CAT-1 processor as described above, the actual implementation is another key element of this task 2. Appropriate measures shall be taken by the Contractor to minimize the risk for the actual nominal operations. Such measures should include performing and testing the upgrade not on the operational hardware, but on backup systems. On top the Contractor shall ensure that any update of the processors is reversible (i.e. it shall be possible to switch back to the previous version of the processor). These measures shall be explained in detail in the SLA.

[Req-27] Maintenance and evolution of all related documents:
All documentation produced during the development of the L2PS shall be maintained and (in case necessary) updated by the Contractor. This documentation includes (list not exhaustive):

- Architectural Design Documents
- User Manuals
- Product Definition Document including CAT-2
- System Requirement Documents

The number of newly produced documents shall be kept to a minimum.

2.4.1.1 Related development requirements

Development requirements applicable to the ESL contract are reported in this section. They address:

- functional requirements,
- interface requirements,
- performance requirements,
- product performance requirements, as well as
- other L2PS requirements concerning reliability, availability, security and maintenance.

It is the responsibility of the Contractor to allocate these requirements to his Sub-Contractors and suppliers, if any, and to ensure their implementation. All requirements in this document are indicated by a number in the left margin, of the form "TR PP-n" where "TR" is the identifier for a particular type of Technical Requirement, "PP" is the type of requirement and "nn" is a consecutive counter (identifier) for individual requirements.

2.4.1.1.1 Functional requirements

Mission Planning and Operations

TR-PO-01	The L2PS shall work autonomously for routine operations, i.e. in the absence of any processing or distribution instruction, the nominal chain of processing and distribution shall be executed.
TR-PO-02	A manual override capability shall be available in order to take manual control over all L2PS processing. Manual processing control shall also be available in the event that ▪ processing must be interrupted in case that required input is missing, ▪ re-processing of specific time intervals of data is required (e.g. due to an update of the Level 1b product), ▪ a systematic re-processing of data is required.
TR-PO-03	The products generated by the L2PS shall be distributed as follows: ▪ quick-look and fast track Level 2 products at a regular rate to the PDGS ▪ Level 2 products at a regular rate to the PDGS ▪ auxiliary data used in the processing at a regular rate to the PDGS ▪ specified products and auxiliary data at a regular rate to the PDGS ▪ product reports at a regular rate to the PDGS

TR-PO-04	The L2PS processors shall accept and execute re-processing and re-distribution instructions.
TR-PO-05	The L2PS shall be able to handle several versions of input data and products (e.g. as a result of re-processing).
TR-PO-06	A product generation report shall be produced for each product generated by the L2PS. Such reports shall be written in a clear, consistent and self-explanatory way, and shall contain at least: ▪ the full name of file generated ▪ the software name and version number used to generate the product ▪ the list of names (including version number) of all files used to generate the product ▪ the data and time of generation ▪ generation result (processing log) ▪ a list of errors and warnings encountered during product generation ▪
TR-PO-07	This product generation report and the associated product shall be clearly linked by using the same filename.
TR-PO-08	The L2PS shall report all input parameters and decisions made by the "scientist-in-the-loop" activities.

Data Ingestion

TR-DI-01	The L2PS shall make use of the operational archive specified by the Agency (APDF). All essential files needed to generate any L2PS product shall be made available (through polling) for storage in the operational archive.
TR-DI-02	The L2PS shall retrieve the following files automatically (by polling) from Auxiliary Data Providers (ADPs) and deliver them to the PDGS for archiving and further dissemination: ▪ all auxiliary data products required for the L2PS processing and not already delivered by the PDGS Remark: all data products are identified in the corresponding ICD ([AD 18]).
TR-DI-03	The L2PS shall retrieve the following files automatically (by polling) from the PDGS/APDF (through a dedicated server): ▪ all applicable Level 1b data products ▪ all applicable auxiliary data products which are assembled by

	the PDGS or the L2PS and required for the L2PS processing Remark: all data products are identified in the corresponding ICD ([AD 18]).
TR-DI-04	The L2PS shall enable the operator of the interfaces to the PDGS and the ADPs to manually ingest all required input data products in the case the automatic transfer fails.

Data Distribution

TR-DD-01	Data distribution of L2PS products shall nominally take place over the network (LAN/WAN).
TR-DD-02	The L2PS shall maintain a list of L2PS products.
TR-DD-03	The L2PS shall analyse and document the quality of its products before they are distributed to the PDGS.
TR-DD-04	The L2PS shall deliver data only to the PDGS via the defined interfaces. No data products shall be delivered to other recipients without the written approval of the Agency.
TR-DD-05	The L2PS shall not share any information concerning the quality of any Swarm product with entities outside the Agency, without written approval of the Agency.

Local Archiving

TR-LA-01	All processors/sites of the L2PS shall implement their own archiving system to store Level 1b, Level 2 and auxiliary data needed for a possible regeneration of Level 2 data during the operations.
TR-LA-02	All processors/sites of the L2PS shall implement their own temporary archiving system for storing intermediate files generated during the operations.
TR-LA-03	The L2PS shall maintain its own inventory functions for all L2PS products generated during the processing. Likewise, the L2PS shall maintain an inventory of all ingested Level 1b and auxiliary data products.
TR-LA-04	It shall be possible to query the inventory using any possible combination of fields as filtering criteria. It shall be possible to export the inventory information in the form of a text document, written in a clear and self-explanatory way. It shall be possible to easily send such a document to:

	▪ file ▪ printer ▪ e-mail address ▪ ftp
TR-LA-05	The L2PS shall implement a set of pre-defined queries to support the most common query actions, such as: ▪ display all new files generated or received over the last 24 hours / week ▪ display all new L2PS data products generated over the last 24 hours / week ▪ show all invalid files over the last 24 hours / week Other pre-defined queries may be agreed upon during operations. Note: by "file" is intended the file name, not the actual file content.
TR-LA-06	Only files marked as "valid" shall be made available for subsequent data processing.
TR-LA-07	The L2PS shall establish its own file configuration control for input and output data files.

Reporting

TR-RE-01	The L2PS shall generate regular reports on the progress of the processing activity containing at least: ▪ success rate of L2PS production vs. Level 1b products made available. Note: this applies primarily to time series products. ▪ statistics on products routinely generated since last report ▪ statistics on products routinely distributed since last report ▪ statistics on specific processing and distribution requests ▪ statistics on overall cumulative archive content.

Processing Requirements

TR-PR-01	All routine processing shall be performed off-line.
TR-PR-02	It shall be possible to re-process existing data. Typically, such re-processing will be performed after improvement of the L2PS software or when a new version of Level 1b products becomes available. Note: new versions of Level 1b product files are the logical result of re-processing at PDGS-level.

TR-PR-03	The L2PS shall be able to handle data gaps, i.e. the processing shall not be interrupted in case there are gaps in the Level 1b data.
TR-PR-04	No files (L1b and auxiliary data) shall be lost during L2PS processing.
TR-PR-05	The L2PS shall specify which data sets are used to generate each L2PS product.
TR-PR-06	All L2PS products shall be delivered according to the standard as defined in [AD 16].
TR-PR-07	Quality information as part of Level 1b data shall be used in the Level 2 data processing.
TR-PR-08	The quality report associated to Level 1b data shall be used in the Level 2 data processing.
TR-PR-09	The L2PS shall generate all products defined in [AD 16].
TR-PR-10	The L2PS shall use clear, transparent and documented procedures for evaluating all candidate Level 2 products.
TR-PR-11	The L2PS shall produce a final report on the evaluation of all candidate Level 2 products generated. This report shall contain a recommendation for official products to be released to the science community for higher-level applications.

Quick-Look and Fast track Level 2 Product Generation

TR-QF-01	The L2PS shall generate quick-look and fast track products.
TR-QF-02	Quick-look and fast track products shall also be provided in case auxiliary data are not available in time. Note: Such "reduced" operations may not be very meaningful for the full range of products to be delivered by the L2PS. However, as a minimum, essential products that are required for the monitoring of the system shall be delivered.
TR-QF-03	Quick-Look and Fast track products shall be generated as defined in [AD 16].
TR-QF-04	Quick-look and fast track products shall include an assessment of the product quality.
TR-QF-05	Quick-look and fast track products shall include clear, concise and unambiguous written reports about the conclusions which can be drawn from the quick-look assessment.
TR-QF-06	Validation of the quick-look and fast track products and algorithms shall be performed on a routine basis.

Level 2 Product Generation

TR-L2-01	The L2PS shall generate Level 2 products as defined in [AD 16].
TR-L2-02	Level 2 products shall include statistical error information.
TR-L2-03	Level 2 products based on a spherical harmonic expansion shall include the model coefficients and at least their standard deviations.
TR-L2-04	The L2PS shall generate L2 products also in the case of instrument failures. Note: This may lead to a reduced product performance of the Level 2 products
TR-L2-05	Quality reports accompanying Level 2 products shall contain, at least the following information: ▪ statistical parameters, ▪ tables, ▪ figures, and ▪ summary/conclusion describing the product quality in a clear, consistent way.

Access Control

TR-AC-01	Access to the L2PS shall be controlled by username / password combinations.
TR-AC-02	The L2PS shall allow the operator to easily trigger re-processing of science data, e.g. after an upgrade of the science data processor software.
TR-AC-03	There shall be privileged users (e.g. L2PS (sub-)system administrator), which shall have exclusive authorisation to perform the following tasks: ▪ upgrade of software configuration ▪ upgrade of hardware configuration ▪ update of user access list ▪ stop/kill of running processes ▪ update of field limits for validity checking ▪ others tbd by the contractor

Process Control

TR-PC-01	It shall be possible to remotely control the L2PS, i.e. the L2PS shall not require the user to sit in front of the L2PS computer but shall allow him to operate from a remote computer (assuming there is no access security problem, e.g. firewall).
TR-PC-02	It shall be possible to enter command sequences by scripts.
TR-PC-03	It shall be possible to stop any sub-system at any time.
TR-PC-04	The L2PS shall have the capability to trap and log all major events. Major events are defined as (list not necessarily exhaustive): ▪ Start of a sub-system ▪ Unexpected termination of a sub-system ▪ IEEE events like *divide-by-zero* ▪ Successful termination of a sub-system
TR-PC-05	Access to all logged events shall be centralised (per processor/site).
TR-PC-06	Log events shall have a consistent structure, including at least: ▪ type of event, including: o information o warning o error o fatal error ▪ sub-system identification ▪ user name if manual operation ▪ date and time ▪ textual description of the event
TR-PC-07	The L2PS shall allow visualising the full log in a clear, structured, consistent way.
TR-PC-08	The L2PS shall warn the L2PS operators about all major processing events. Major processing events shall be reported to L2PS management.

2.4.1.1.2 Interface Requirements

All interfaces shall be as defined in [AD 18] and [AD 19].

2.4.1.1.3 *Performance Requirements*

General Processing and Re-Processing

PR-GP-01	The L2PS shall process Level 1b data until the product-specific performance requirements as defined in [AD 16] are met. In case the product specifications cannot be met, L2PS together with the Agency as well as external experts shall investigate the reasons.
PR-GP-02	The L2PS shall be able to download any file from the PDGS within 24 hours (TBD).
PR-GP-03	The L2PS shall be able to send any product within 2 hours (TBD) after creation to the PDGS.

Quick-Look and Fast Track Products

PR-QF-01	Quick-look and fast track processors shall be able to generate quick-look and fast track products within the time span defined in the PDD.
PR-QF-02	General re-processing efforts within the L2PS shall not affect the timely delivery of quick-look and fast track products.

Level 2 Products

PR-L2-01	L2PS shall take all necessary measures to meet the performance of the delivered Level 2 products as specified in [AD 16]. In case the product specifications cannot be met, L2PS together with the Agency as well as external experts shall investigate the reasons.

Solution Evaluation Products

PR-SE-01	Level 2 products shall be accompanied by quality reports as defined in [AD 16].

2.4.1.1.4 Other Requirements

Reliability and Availability Requirements

OR-RA-01	The L2PS shall ensure that all applicable the Level 1b data products are processed into Level 2 data files.
OR-RA-02	For all hardware facilities and software not procured in the frame of the Contract and needed in order to timely operate the L2PS in line with the Agency requirements, the Contractor shall maintain and make available the above-mentioned hardware facilities and software for the duration of the Contract.
OR-RA-03	Failure of one L2PS sub-system or component shall not affect the other sub-systems/components, other than (possibly) preventing start-up of a subsequent process.
OR-RA-04	In case of stoppage of any L2PS module / processor for whatever reason (crash, operator stop action) it is required that: ▪ the integrity of the inventory shall not be affected ▪ no file shall be lost or corrupted in the file transfer to any data storage
OR-RA-05	The L2PS operator(s) shall be warned automatically in case of stoppage of any L2PS module / processor.
OR-RA-06	The L2PS shall have the capability to warn the operator(s) when the FTP disk storage exceeds a configurable percentage of total space.
OR-RA-07	The L2PS shall allow "safe" clean-up of any storage or temporary archive at the beginning of the mission in order to remove all files generated for test purposes, which are not to be used during operations.
OR-RA-08	When polling for incoming files, the L2PS shall assume that a new file that appears is complete. For example, it is the task of the PDGS to verify that only complete Level 1b product files are made available to the L2PS.
OR-RA-09	The L2PS shall be designed such that no hardware or software resource is used beyond 80% capacity on average.
OR-RA-10	When generating quick-look or fast track products the L2PS shall not fail if auxiliary data files required as input are missing.

Security Requirements

OR-SR-01	The L2PS, including all sub-systems, shall be protected against unauthorized access using a firewall mechanism.
OR-SR-02	The L2PS firewall shall block all protocols by default, and allow only strictly necessary protocols between the internal LAN and the external access LAN or the external network (e.g. sft, ssh ...).
OR-SR-03	The L2PS firewall shall block access to all hosts by default, and allow access only to strictly necessary hosts between internal LANs and the external access LAN or the external network.
OR-SR-04	The L2PS shall restrict user access using a username/password mechanism.
OR-SR-05	Only a restricted number of dedicated usernames shall be given administrator privileges, providing access to critical parts of the L2PS.
OR-SR-06	The L2PS shall be able to use both a normal FTP client, and a secure FTP client.
OR-SR-07	It shall be possible to configure each external interface, such that the L2PS uses either a secure or a normal FTP client for that interface.

Maintenance Requirements

OR-MR-01	The L2PS shall allow integration of new versions of the processors. As far as possible, new processor versions shall be limited to re-compilation or re-linking of the L2PS process. If any, re-compilation or re-linking shall be limited to the processing functions of the L2PS, but excluding other functions, such as ingestion, distribution, monitoring and control, etc.
OR-MR-02	The L2PS shall allow updating the file formats definition. File reading/writing routines shall be grouped in software modules dedicated to file reading/writing, in order to minimize the impact of format modifications.
OR-MR-03	Maintenance of hardware and/or software shall be possible with the L2PS sub-system in question being shut down, but without any impact on other sub-systems. In particular, the scientific data processing chain shall be able to run, while any other part of the L2PS is being maintained. Operationally unrelated scientific processing chains shall also be able to run independently.
OR-MR-04	It shall be possible to verify proper operation after maintenance, before propagating the change to the operational systems.

OR-MR-05	It shall be possible to easily undo a maintenance action if the test described in OR-MR-04 is not successful.
OR-MR-06	Evolution and update of the L2 algorithms and processors shall follow ECSS standards as described in [AD 20].

2.4.2 CAT-2

For CAT-2 the Contractor shall provide the following services:

[Req-28] Quality checks of the CAT-2 products produced by the PDGS:
Especially in the early phase of this project, the Contractor shall scientifically validate the newly produced CAT-2 products. It is important, that any problems with the scientific quality of the products are quickly identified and countermeasures (e.g. update of the processors / algorithms) started. In the SLA the Contractor shall identify the necessary procedures to guarantee this service in detail.

[Req-29] Maintenance and evolution of all CAT-2 algorithms:
During the lifetime of Swarm the different scientific algorithms of the CAT-2 processors will have to be modified. It is expected that such an evolution is not only necessary during the beginning of the activity when, for the first time, real Swarm data are available, but it will maybe also take place during later stages. This activity has to be performed in parallel to the routine operations. In the SLA the Contractor shall describe the planned procedures to ensure a proper evolution of the algorithm. One key element is an estimation of the gain (with respect to scientific quality, speedup of the processor etc.) before any update of an algorithm takes actual place. No update shall be made without the written permission of the Agency. The process described in section 1.3 also applies to the CAT-2 algorithms evolution.

[Req-30] Maintenance and evolution of all CAT-2 prototype processors:
After the thorough assessment of any update of a CAT-2 processor as described above, the actual implementation of the prototype processors is another key element of this service. Any update of the prototype shall include also test data sets and proper documentation. On top the Contractor shall ensure that any update of the processors is reversible (i.e. it shall be possible to switch back to the previous version of the processor). These measures shall be explained in detail in the SLA and shall be aligned with the L1 requirements (i.e. Technical Notes, Software Change Request, Verification Report) (i.e. [Req-14], [Req-15] [Req-21] [Req-22]).

[Req-31] Maintenance and evolution of all related documents:
All documentation produced during the development of the L2PS shall be maintained and (in case necessary) updated by the Contractor. This documentation includes (list not exhaustive):

- Detailed Processing Models
- Orchestration Models
- User Manuals

The number of newly produced documents shall be kept to a minimum.

[Req-32] Support to any updates of the related operational processors:
In this service the Contractor shall support the Agency with the actual implementation of any changes in the operational CAT-2 processors. Please note, that the actual coding will be performed by a Software company, but the L2PS shall support this task, by evaluating any differences between the prototype and the operational processor prior to the integration in the PDGS.

[Req-33] Support for the integration of updated operational processors in the PDGS:
Similar to the service described in the previous bullet the Contractor shall support the actual integration of new versions of CAT-2 processors with the PDGS. Also here the support is mainly related to the scientific evaluation of differences between the prototype and operational processor.

Remark: It is supposed that activities related to CAT-2 will take place primarily during the initial phase of this activity. The Contractor is asked to take this assumption into consideration in the SLA.

2.5 Task 3 : Support Activities, Coordination and Reporting

[Req-34] The contractor shall produce and subsequently maintain the Swarm Product Handbook for L1 products ensuring that its content is aligned with the algorithm Baseline.

[Req-35] The contractor shall maintain the L1 processors documentation, ensuring that their contents are in line with the evolution of the processing and calibration baseline.

[Req-36] The contractor shall document and track all changes in a dedicated SPR/SCR database for both L1 and L2 chains.

[Req-37] After [Req-16] (i.e. for the processors) and [Req-23] (i.e. for the ADF and CCDB parameters), the updated and validated Algorithm Baseline will be transferred by ESA to the Operational Processors developers. During the implementation of the Operational Processor updates, the contractor shall be available to provide support to the Agency. The support shall consist of providing on-request clarifications, on-request generation of specific additional test data, and on-request investigation of specific discrepancies between products from prototype and the operational processor version under development.

[Req-38] The contractor shall support the Agency with the acceptance of operational processors. The support shall consist of assessment of remaining discrepancies between outputs from the prototype and the corresponding operational processor under acceptance.

[Req-39] Being part of the QWG, the contractor shall report and present the results obtained from the activities performed within the context of this contract. Technical presentations shall be given directly by the sub-contractors when applicable.

[Req-40] Being part of the QWG, the contractor shall contribute to the QWG discussion and final recommendation definition and agreement.

[Req-41] The contractor shall provide support to the Swarm web pages of the Agency with respect to information on the algorithms baselines and scientific results discussion.

[Req-42] The contractor shall report all technical results (also interim results are to be included) originating from [Req-1] to [Req-6] to the Agency and the ESA Data Quality Team. The report should be delivered on a bi-monthly basis and with a higher frequency in case of urgent communication needs.

[Req-43] The contractor shall provide a bi-monthly progress report as detailed in Section 3.2.6.

[Req-44] The contractor shall pro-actively interact with the SVT teams via the web2.0 interfaces.

[Req-45] The contractor shall pro-actively interact with the ESA Data Quality teamto share information and key know-how. The communication flow between the ESL teams and the ESA Data Quality team shall not only be via the ESL prime contractor but shall be established directly with all ESL technical teams.

[Req-46] The contractor shall provide annually input to a Web story to be published on the Agency Web Portal.

2.6 Task 4 : End of contract activities

[Req-47] The contractor shall deliver to the Agency the latest validated algorithm Baseline and all software of the Reference Platform (RP), cross verifying the status of the configuration control information.

[Req-48] The contractor shall deliver to the Agency the latest Swarm Product Handbook for both L1 and L2 products.

[Req-49] The contractor shall provide at the end of the project a final report summarising the technical and managerial achievements.

[Req-50] The contractor shall provide at the end of the project a document listing proposals for further evolution of the L1 and L2 algorithms and reprocessing needs.

[Req-51] The contractor shall provide at the end of the project a document summarising the lessons learned describing any critical issue encountered that lead to problems and/or failures.

[Req-52] The contractor shall implement a flexible management solution to respond to a possible mission termination before the expected life-time of 4 years.

[Req-53] Towards the end of the mission (i.e. after about 3.5 y), the contractor shall deliver a scientific proposal in order to assess the possible mission exploitation phase extension.

2.7 Baseline deliverables

2.7.1 Level 0–1b Processing

The following list provides the complete items to be delivered to the Agency when updating the Baseline due to a key change in the algorithms or a change of the ADF / CCDB:

- Change Proposal documentation (Technical Notes (TN) and accepted Software Change Request forms)
- Verification Plan
- TDS and TDD
- ATBD
- DPM
- IODD
- Prototype Processor
- ADF
- Any updated CCDB parameter
- L1 Product Handbook
- Verification Report
- Configuration Control report
- Disclaimer

3 PROJECT ORGANISATION AND OVERALL MANAGEMENT REQUIREMENTS

3.1 Indicative project schedule and management requirements

The ESL's contracts will cover a period of 4 years + 2 years to take into account the duration of the nominal lifetime of the Swarm mission.

As described in 2.1, the contract is built on two major activities:

- the L1 algorithms evolution and maintenance
- the L2 processing chains operations, and L2 algorithms and PPs evolution and maintenance

The L1 and the L2 activities may have different time schedules, therefore the management implemented by the contractor shall be flexible and allow independent progress and evolution of the two activities.

The Level 2 Task related activities will be kicked-off no earlier than the 1st September 2013.

The contractor shall plan for the following reviews and milestones as presented in Table 3:

Title	Date	Location
Kick-off [KO]	Satellite shipment to launch site.	All meetings will be organised in ESRIN apart the PPR (that will be carried out at the Contractor's promises) if not otherwise agreed during the project by the Agency and the contractor.
ESL L1 Preparatory Phase Review (PPR)	KO + 2m	
Mission event: Launch (L)	*KO+2m*	
ESL Operational Readiness Review (ORR)	Launch (L) + 3m	
Mission event: In Orbit Commissioning Review (IOCR)	*L + 3m*	
QWG Meeting 1	L + 5m	
Mission event: SVT Product Validation Review (PVR)	*L + 6m*	
QWG Meeting 2	L + 12m (1y)	
ESL Contract Review 1	L + 12m (1y)	
QWG Meeting 3	L + 18m	
QWG Meeting 4	L + 24m (2y)	
ESL Contract Review 2	L + 24m (2y)	
QWG Meeting 5	L + 30m	
QWG Meeting 6	L + 36m (3y)	
ESL Contract Review 3	L + 36m (3y)	

QWG Meeting 7	L + 42m	
QWG Meeting 8	L + 48m (4y)	
ESL Contract Review 4	L + 48m (4y)	
QWG Meeting 9	L + 54m	
QWG Meeting 10	L + 60m (5y)	
ESL Contract Review 5	L + 60m (5y)	
QWG Meeting 11	L + 66m	
QWG Meeting 12	L + 72m (6y)	
ESL contract Final Review Meeting	L + 72m (6y)	

Table 3: Project review and milestones. The table also illustrates (in italics and centred) relevant milestones in the overall schedule of the Swarm mission. The contractor shall not plan participation to these relevant milestones in the framework of this ESL contract.

The ESL L1 Preparatory Phase is intended to last 2 months in order to allow the Contractor to set up all the necessary infrastructure related to the L1 activities (i.e. both HW and SW). The ESL L1 Preparatory Phase Review (PPR) will assess the readiness of this infrastructure in terms of functionality and shall coincide with the launch of the mission.

The ESL Operational Readiness Review (ORR) will assess the overall ESL team readiness for the Operational Phase of the mission. This review shall coincide with the IOCR. During this ORR, the Contractor shall demonstrate that the PPs are fully aligned with the OPs and that the end-to-end simulator is capable of taking into account changes of the mission orbit parameters.

Additional meetings with selected participants will be scheduled if needed to resolve anomalies. The dates above might have to be adjusted at the Kick-Off meeting in response to the Swarm mission overall timeline.

The contractor shall provide all the necessary SW tools to perform the reviews (e.g. online management of SPRs, actions).

The reviews will be based on the assessment of documentation and infrastructure as applicable.

The contractor shall maintain a Document management system with all the updated and applicable documents and delivered items. This system shall be accessible remotely.

3.2 Project management

3.2.1 *Project management plan*

A Project Management Plan (PMP) shall define, organise, monitor and control all the activities within the project, including the identification and mitigation of possible risks.
The PMP shall be the controlling document for the project. It shall be prepared by the Contractor and submitted at the beginning of the project to the Technical Representatives of the Agency for approval. It shall be updated as necessary throughout the project. It shall be reissued at every major change with the Agency Technical Representatives' approval.
The PMP shall provide a feasible and effective breakdown of the activities and shall include the following items (described below):

- Staffing Plan
- Key Personnel
- Work Packages
- Deliverables
- Facilities and Resources
- Project schedule monitoring and progress reporting
- Quality Plan
- Risk management
- Project History Document

3.2.2 *Staffing plan*

The Staffing Plan shall provide updated visibility on foreseen and allocated manpower over time, providing also details on skill levels.

3.2.3 *Key personnel*

The list of the key personnel shall be provided, together with their curriculum vitae. Any key personnel shall be changed only in agreement with the Agency Technical Officer.

3.2.4 *Work packages*

The organisation of the activities to be performed within this project shall be detailed by the Contractor into Work Packages. Each WP shall have a single responsible staff.

3.2.4.1 Technical documents

All documents shall be in English and shall be delivered in Portable Document Format, Microsoft Word or compatible systems.
The documents shall be provided as necessary in various versions during the course of the project.
Before the delivery of a version, documents can undergo revision loops. Revisions of documents shall be as much as possible planned between the Contractor and the ESA Technical Officer, and in any case at least 10 working days shall be available for each document's review by ESA. In reviewing documents, the Agency might produce Review Item Discrepancies (RIDs). For any RID the requested action shall either be performed or a different closing action agreed with the ESA Technical Representative.
Any version ready for delivery shall be approved with signatures by the Contractor's Project Manager.
Documents shall be considered delivered after ESA Technical Representative' signature.
Where the actual implementation of any delivered system does not correspond to the original specification document, the document shall be re-issued with the necessary modifications, even if it was prepared in a different project phase.

3.2.4.2 Software

Any software package shall be delivered on the electronic medium defined by the ESA Technical Representative. Software package delivery shall include executables, source code, object code, link libraries, automatic rebuild procedures and installation procedures.

3.2.5 Facility and resources

Unless stated otherwise, all work described in this project shall be carried out at the Contractor's premises. The Contractor shall:

- use the financial resources available in the contract in the most efficient way,
- define a homogeneous development environment, minimising the number of different tools used.

3.2.6 Project schedule monitoring and progress reporting

With a bi-monthly frequency, the Contractor shall report the progress of the activities performed with a Progress report.
Progress meeting frequency will be organised bi-monthly by teleconference and a contractual review will be organised each year.
The purpose of the Progress meetings is both to control the progress of the project and to verify the directions chosen. For each progress meeting the Contractor shall prepare a report highlighting the status of the project both from the management and technical perspective (i.e. [D-6] and [D-22]). A copy of the minutes of each meeting, signed by the Contractor's Project Manager and Technical Representatives from the Agency, shall be delivered at the end of the meeting.

The Progress Report shall be delivered bi-monthly to the Agency. It shall contain the following elements:

- Management status;
- Financial status;
- Technical status;
- Progress since last report;
- Delays identified / foreseen;
- Corrective action;
- Problem encounters;
- Evaluation / Planning;
- Action Items List;
- Delivery status;
- Meeting plan;
- Project presentations status.

The Contractor shall define the detailed schedule for the delivery of draft and final document versions and for software installation and test in relation to the reviews.
The Contractor shall inform the Technical Representatives from the Agency of any subsystem acceptance test or (evaluation milestone) two weeks in advance, in order to enable the Agency to witness the acceptance test.

3.2.7 Quality plan

The Contractor shall establish a Quality Plan (QP) and shall verify any deliverable against this plan. This includes specification and verification of quality criteria for:

- All documents;
- Methods and Tools;
- Coding Standards;
- Configuration Control (for documentation, software, procedures, data dictionary, tools, system configuration).

Deviations from the initial Quality Plan must be agreed with the ESA Technical Representative.

3.2.8 *Deliverables item list*

The Contractor shall produce a detailed list of deliverables per work package.
The deliverables shall include at least:

3.2.8.1 Deliverables related to Management, Task 3 and Task 4:

Code	Deliverables	Periodicity	Requirement
[D-1]	Project Management Plan (PMP) and Quality Plan	Proposal, KO and at ESL Contract Reviews	Section 3.2.1
[D-2]	Configuration and Documentation Management Plan	Proposal and KO	Section 3.1, TR-DD-02
[D-3]	PPR and ORR data package list	KO	Section 3.1
[D-4]	Baseline data package example/template/table of content documents.	KO	Section 2.7
[D-5]	PPR and ORR close out report	PPR, ORR	Section 3.1
[D-6]	Progress reports. Single document for L1 and L2 activities. This also includes : • Financial reporting • Action Items List • Meeting and Review Plan • Deliverable Items Status List • CCN status list • Project Directory for L2	Bi-monthly	Section 3.2.1, Section 3.2.6, [Req-43], TR-RE-01
[D-7]	Minutes of Meetings/Teleconferences/Reviews	as needed	Section 3.2.1, TR-RE-01
[D-8]	SW for managing Actions, Non-Conformance Requests, SPRs, and Waivers Status List	KO, as needed	[Req-36], Section 3.1 TR-RE-01
[D-9]	List of H/W and S/W Items (to be purchased / re-used)	Proposal, KO and PPR	Section 3.2 OR-RA-02
[D-10]	Documentation Tree, Status List, and updated Document Management System	ORR, as needed	Section 3.2
[D-11]	Contract Change Notices	as needed	Section 3.2

[D-12]	Copies of Class-B Contract Change Notices	as needed	Section 3.2
[D-13]	Copies of all signed Sub-contracts	KO, ORR as needed	Section 3.2
[D-14]	QWG reports and presentations	Every 6 months	[Req-39]
[D-15]	Input to Agency web story	Annual	[Req-46]
[D-16]	Close-out delivery: • Baseline (refer items listed in 2.7), • Final Report with Executive Summary of Final Results • Lessons Learnt	End of Project	[Req-47] [Req-49] [Req-50] [Req-51] TR-RE-01
[D-17]	Mission exploitation extension proposal	At 3.5 years into the mission operations	[Req-53]

Table 4: Deliverables related to Management, Task 3 and Task 4.

3.2.8.2 Deliverables related to Task1:

Code	Deliverables	Periodicity	Requirement
[D-18]	L1 Product Handbook	PPR, as needed, end of contract	[Req-34] [Req-48]
[D-19]	On-demand data analysis report	as needed	[Req-1]
[D-20]	Data anomaly investigation plan	as needed	[Req-2]
[D-21]	Data anomaly investigation report	as needed	[Req-2]
[D-22]	Technical progress report: • data products quality monitoring, • ESA Data Quality team results analysis, • PLSO results analysis, • Scientific community results analysis	Bi-monthly	[Req-3] [Req-6] [Req-7] [Req-8] [Req-42]
[D-23]	Calibration results analysis	After calibration processing run	[Req-4]
[D-24]	SVT results analysis	Following key reporting by SVT	[Req-5]
[D-25]	Technical notes and SCRs on proposed algorithms and	as needed	[Req-14] [Req-21]

	ADF/CCDB changes		
[D-26]	Processor and/or ADF/CCDB update : • Baseline documentation (refer items listed in 2.7), • Prototype Processors / ADF / CCDB parameter	as needed	[Req-15] [Req-16] [Req-22] [Req-23] [Req-35]

Table 5: Deliverables related to Task 1.

3.2.8.3 Deliverables related to Task 2:

The following tables list the DILs for Task 2 of this activity. Please note, that the same Doc ID as for the Development Phase of the L2PS is used, to indicate that most of the documentation already exists, and it is the responsibility of the Contractor to maintain those documents throughout operations.

3.2.8.3.1 Management Documents

Code	Deliverables	Periodicity	Requirement
[D-27]	System Design, Development and Operations Plan	as needed	TR-PO-01, TR-PO-02, TR-PO-03, TR-PO-04, TR-PO-05, TR-LA-01, PR-QF-01, PR-QF-02
[D-28]	Sub-System Design, Development and Operations Plan	as needed	TR-PO-01, TR-PO-02, TR-PO-03, TR-PO-04, TR-PO-05, TR-LA-01, PR-QF-01, PR-QF-02
[D-29]	System Product Assurance Plan	as needed	TR-PO-03
[D-30]	Sub-System Product Assurance Plan	as needed	TR-PO-03

Table 6: Management deliverables related to Task 2.

3.2.8.3.2 System Documents

Code	Deliverables	Periodicity	Requirement
[D-31]	L2PS System Requirements Document	as needed	TR-PO-01, TR-PO-02, TR-PO-03, TR-PO-05, TR-LA-01, TR-LA-02, TR-LA-03, TR-LA-04, TR-LA-05, TR-LA-06, TR-LA-07, TR-PC-01, TR-PC-02, TR-PC-03, TR-PC-04, TR-PC-05, TR-PC-06, TR-PC-07, TR-PC-08, PR-L2-01, PR-SE-01, OR-RA-01, OR-RA-08, OR-RA-09, OR-RA-10, OR-SR-01, OR-SR-02, OR-SR-03, OR-SR-04, OR-SR-05, OR-SR-06, OR-SR-07
[D-32]	L2PS Architectural Design Document	as needed	TR-RE-01
[D-33]	L2PS S/W Technical Specifications (per sub-system if	as needed	TR-PO-01, TR-PO-03,

	appropriate)		TR-PR-01, TR-PR-02, TR-PR-03, TR-PR-04, TR-PR-05, TR-PR-06, TR-PR-07, TR-PR-08, TR-PR-09, TR-PR-10, TR-PR-11
[D-34]	L2PS Acceptance Test Plan and Procedures	as needed	OR-MR-01, OR-MR-02, OR-MR-03, OR-MR-04, OR-MR-05
[D-35]	Sub-System Acceptance Test Plan and Procedures	as needed	OR-MR-01, OR-MR-02, OR-MR-03, OR-MR-04, OR-MR-05
[D-36]	L2PS Acceptance Test Report	as needed	TR-DD-03, OR-MR-01, OR-MR-02, OR-MR-03, OR-MR-04, OR-MR-05
[D-37]	Sub-System Acceptance Test Reports	as needed	TR-DD-03, OR-MR-01, OR-MR-02, OR-MR-03, OR-MR-04, OR-MR-05
[D-38]	Product specification for L2 Products and Auxiliary Products	as needed	TR-PO-03, PR-GP-01
[D-39]	Level 2 Algorithm Specification[2]	as needed	TR-RE-01
[D-40]	Level 2 Detailed Processing Model(s) (DPM)[1]	as needed	TR-RE-01

[2] For newly developed algorithms.

[D-41]	L2PS System User Manual and Operations Procedures	as needed	TR-PO-01, TR-PO-03, TR-PO-05, TR-QF-01, TR-QF-02, TR-QF-03, TR-QF-04, TR-QF-05, TR-QF-06, TR-AC-01, TR-AC-02, TR-AC-03, OR-RA-03, OR-RA-04, OR-RA-05, OR-RA-06, OR-RA-07
[D-42]	L2PS Technical progress report	Bi-monthly	TR-RE-01
[D-43]	Technical notes and SCRs on proposed algorithms and ADF/CCDB changes	as needed	[Req-30] TR-RE-01
[D-44]	Revision Release Notes	as needed	OR-MR-01, OR-MR-02, OR-MR-03,
[D-45]	L2PS Test Data Sets and Scenarios	as needed	TR-RE-01
[D-46]	L2PS Service Level Agreement	Proposal	TR-PO-01, TR-DD-05
[D-47]	CAT-2 Prototype Acceptance Test Plan	as needed	TR-RE-01
[D-48]	CAT-2 Orchestration Model	as needed	TR-RE-01
[D-49]	Level 2 Products Quality Reports	as needed	TR-PO-06, TR-PO-07, PR-GP-01
[D-50]	Level 2 Products Validation Reports	as needed	TR-DD-03, PR-GP-01

Table 7: System deliverables related to Task 2.

3.2.8.3.3 *Interface Documents*

Code	Deliverables	Periodicity	Requirement
[D-51]	Auxiliary Data Providers to Swarm L2PS Interface Control Document for CAT-1 Processors	as needed	TR-DI-01, TR-DI-02, TR-DI-03, TR-DI-04, TR-DD-01, TR-DD-04, PR-GP-02, PR-GP-03

Table 8: Interface deliverables related to Task 2.

APPENDIX 3: STANDARD REQUIREMENTS FOR MANAGEMENT, REPORTING, MEETINGS AND DELIVERABLES

This document contains standard requirements for Management, Reporting, Meetings and Deliverables for contracts to be placed by the Agency. The applicable Statement of Work (Appendix 2 to the Contract) has priority over the present document in case of conflict.

1. MANAGEMENT

1.1. General

The Contractor shall implement effective and economical management for the Project. His nominated Project Manager shall be responsible for the management and execution of the work to be performed and, in the case of an industrial team, for the coordination and control of the industrial team's work.

1.2. Access

a) During the course of the Contract the Agency shall be afforded free access to any plan, procedure, specification or other documentation relevant to the programme of work. Areas and equipment used during the development/testing activities associated with the Contract shall also be available for inspection and audit.

b) The Contractor shall notify the Agency at least three weeks before the start of any test programme, or as mutually agreed, in order to enable the Agency to select those tests that it wishes to witness. The Agency shall notify the Contractor of its visit at least one week in advance.

2. REPORTING

2.1. Minutes of Meeting

a) The Contractor is responsible for the preparation and distribution of minutes of meetings (see ECSS-M-20 section 5.3.1 for more details) held in connection with the Contract. Electronic and paper versions shall be issued and distributed to all participants, to the Agency's technical representative (4 copies) and to the ESA Contracts Officer (1 copy), not later than ten (10) days after the meeting concerned.

b) The minutes shall clearly identify all agreements made and actions accepted at the meeting together with an update of the Action Item List (AIL) and the Document List. The minutes shall be signed.

Note: This clause may be restricted to progress meetings if specifically expressed.

2.2. Documents List

The Contractor shall create and maintain a Document List, recording all the documents produced during the work, including reports, specifications, plans and minutes. The list shall indicate the document reference (with unique identifier), type of document, date of issue, status (draft or approved by the Agency), confidentiality level and distribution. This list shall be maintained under configuration control.

2.3. Action Item List (AIL)

The Contractor shall maintain an Action Item List (AIL, see ECSS-M-20 section 5.3.2 for more details), recording all actions agreed with the Agency. Each item shall be uniquely identified with reference to the minutes of the meeting at which the action was agreed and will record generation date, due date, originator and the person instructed to take action. The AIL shall be reviewed at each progress meeting.

2.4. Bar-Chart Schedule

a) The Contractor shall be responsible for maintaining the bar-chart for work carried out under the Contract, as agreed at the kick-off meeting.

b) The Contractor shall present an up-to-date chart for review at all consequent meetings, indicating the current status of the contract activity (WP's completed, documents delivered, etc.).

c) Modifications of the schedule shall be contractually binding only if approved in writing by the Agency's representative for contractual and administrative matters.

2.5. Risk Register

a) The Contractor shall be responsible for maintaining a risk register, agreed at the kick-off meeting. This register shall identify potential risks, their likelihood and severity, and propose meaningful mitigation measures (see ECSS-M-00-03B for more details).

b) The Contractor shall present an up-to-date risk register in his progress reports for review at monthly progress meetings.

2.6. Progress Reports

Every month, the Contractor shall provide a Progress Report to the Agency's representatives, covering the activities carried out under the Contract (see ECSS-M-20 section 5.3.3 for more details). This report shall refer to the current activities shown on the latest issued bar-chart and shall give:

a.1 action items completed during the reporting period
a.2 a status report on all long lead or critical delivery items
a.3 a description of progress: actual vs schedule, milestones and events accomplished
a.4 reasons for slippages and/or problem areas, if any, and corrective actions planned and/or taken, with revised completion date per activity
a.5 events anticipated during the next reporting period (e.g. milestones reached)
a.6 expected date for major schedule items
a.7 milestone payment status
a.8 status of risks

2.7. Problem Notification

The Contractor shall notify the Agency's representatives (Technical Officer and Contracts Officer) of any problem likely to have a major effect on the time schedule of the work or to significantly impact the scope of the work to be performed (due to e.g. procurement problems, unavailability of facilities or resources, etc.).

2.8. Technical Documentation

a) As they become available and not later than the dates in the delivery plan, the Contractor shall submit, for the Agency's approval, technical notes, engineering drawings, manufacturing plans, test plans, test procedures, specifications and Task/WP reports.

b) Technical documentation to be discussed at a meeting with the Agency shall be submitted two (2) weeks prior to the meeting.

c) Technical documents from Subcontractors shall be submitted to the Agency only after review and acceptance by the Contractor and shall be passed to the Agency via the Contractor's formal interface to the Agency.

d) Tests carried out under the Contract shall be performed according to test plans and test procedures approved by the Agency's Technical Officer (see ECSS-E-10 Part 2A and ECSS-Q-20A for more details).

3. MEETINGS

a) The kick-off meeting shall take place at the Agency's premises.

b) Progress meetings shall be held at approximately 2- to 3-monthly intervals, alternating between Agency premises and Contractor premises.

c) The final presentation shall take place at the Agency's premises.

d) Additional meetings may be requested either by the Agency or the Contractor.

e) The Contractor shall give to the Agency prior notice of any meetings with Third Parties to be held in connection with the Contract. The Agency reserves the right of participation in such meetings.

f) With due notice to the Contractor the Agency reserves the right to invite Third Parties to meetings to facilitate information exchange.

g) For all meetings with the Agency, the Contractor shall ensure that proper notice is given at least two (2) weeks in advance. For all other meetings, the Contractor shall inform the Agency, which reserves the right to participate. The Contractor is responsible for ensuring the participation of his personnel and those of the Subcontractor(s), as needed.

h) For each meeting the Contractor shall propose an agenda in electronic form and shall compile and distribute handouts of any presentation given at the meeting.

4. DELIVERABLES

This section specifies the generic deliverables that can be envisaged. The actual list of deliverables under the Contract is specified in the Statement of Work which may include, delete or add deliverables with respect to those specified in this Chapter.

4.1. Documentation

a) In addition to the documents to be delivered according to section 2 here above, the following documentation shall also be deliverable. In the case of alternative choices herein, the Statement of Work specifies which ones are applicable.

b) All documentation deliverables mentioned hereunder (including all their constituent parts) shall also be delivered in electronic form in a format agreed by the Agency (PDF format and the native format, and in other exchange formats where relevant (e.g. CAD, drawings, databases)).

c) All the documentation shall be delivered on computer readable media (e.g. CD-ROM, DVD-ROM) as agreed by the Agency with an additional two (2) paper copies.

d) The draft version of the documentation shall be sent to the Technical Officer in three (3) copies not later than two (2) weeks before the documentation is to be presented. The final version shall be provided in a number of copies specified in the Statement of Work.

4.1.1. Final Report

a) The Final Report shall provide a complete description of all the work done during the activity and shall be self-standing, not requiring to be read in conjunction with reports previously issued. It shall cover the whole scope of the activity, i.e. a comprehensive introduction of the context, a description of the programme of work and report on the activities performed and the main results achieved.

b) For phased contracts, a Final Report shall be produced at the end of each Phase in accordance with the above definition, describing the work and results of that Phase and previous Phases. It becomes the Final Report in case the Agency decides not to proceed with the subsequent Phase(s).

4.1.2. Technical Data Package

Each (design and development) contract shall be completed with a Technical Data Package. For a contract with Phases, the Technical Data Package shall be provided at the end of a Phase in the case that the Agency decides not to proceed with the next Phase. The Technical Data Package consists of the final versions of all approved technical documents.

4.1.3. Summary Report

For each (design and development) contract, one Summary Report shall be produced. It shall summarise the findings of the Contract concisely and, informatively. The Summary Report shall be approximately 20 pages or 6000 words.

NOTE:
The Agency may request the Contractor to produce the Summary Report in the form of a paper suitable for publishing in a technical journal.

4.1.4. Executive Summary Report

The Executive Summary Report shall concisely summarise the findings of the Contract. It shall be suitable for non-experts in the field and should also be appropriate for publication. For this reason, it shall not exceed five (5) pages of text and ten (10) pages in total (1500 to 3000 words).

4.1.5. Abstract

Each (study) contract shall also be completed with an Abstract, summarising the work performed. It shall be suitable for application at symposiums or technical journals, normally not exceeding three (3) to four (4) pages of text with coloured illustrations or photographs where appropriate.

4.1.6. Brochure

A Brochure is intended for marketing purposes. It shall be concise and it shall include a short description of the work performed and applications of the development, a photograph or functional drawing if applicable, technical fact sheet, estimate of availability (delivery time) and a contact point for marketing purposes.

It shall contain one (1) or two (2) pages of text (i.e. up to about 700 words).

4.1.7. Photographic Documentation

Photographic documentation comprises photographs of hardware under manufacture, showing major progress, as well as of tests and test set-ups. Videos presenting the functioning of hardware/test set-up and relating test activities may also be included in this category.

4.1.8. Contract Closure Documentation

The Contract Closure Documentation is a mandatory deliverable, due at the end of the Contract (or at the end of a Phase in case the Agency decides not to proceed with the following Phase). For the avoidance of doubt, "end of the Contract" shall mean the finalisation of a series of tasks as defined in the Statement of Work attached to this Contract. Therefore, work performed under Riders or Contract Change Notices adding new tasks with respect to the original contract shall require separate Contract Closure Documentation. The contents of the Contract Closure Documentation shall conform to the layout provided in Annex A hereto.

4.2. Hardware

Hardware (incl. test equipment and control electronics) built or purchased under the Contract, together with an Operation Manual, shall be a deliverable item after completion of the associated activities at the Contractor's premises, unless otherwise agreed in writing by the Agency.

4.3. Computer Programs and Models

Computer programmes, mathematical models of any type (e.g. closed-form, worksheets, XML, CAD/CAE) and HDL models developed or procured under the Contract shall be a deliverable, unless the Agency agrees otherwise in writing. Re-used or proprietary software embedded in the deliverable product and required for its correct functioning shall also be deliverable.

4.4. Project Web Page

The Contractor shall produce a Project Web Page which shall be suitable for public internet access.

5. COMMERCIAL EVALUATION (SPACE MARKET)

The Commercial Evaluation is a report containing an analysis and evaluation of the potential in the space market of the output (products) of the Contract.

The report shall identify the maturity of the output of the subject activity with respect to the market and, if applicable, describe the required additional work and the level of funding required for the product to reach a marketable level.

ANNEX A: LAYOUT FOR CONTRACT CLOSURE DOCUMENTATION
for
ESA Contract No. ..... [INSERT NUMBER]
"[INSERT ACTIVITY TITLE]",
hereinafter referred as the "Contract"

Section 1 – Parties, Contract Duration and Financial Information

<table>
<tr><td>Contractor</td><td colspan="3">[CONTRACTOR NAME]</td></tr>
<tr><td>Sub-Contractor(s)
(state if not applicable)</td><td colspan="3">[NAME AND COUNTRY]</td></tr>
<tr><td rowspan="2">Contract Duration</td><td rowspan="2">From:

To:</td><td>Phase 1 from:
to:</td><td></td></tr>
<tr><td>Phase n</td><td>from:
to:</td></tr>
<tr><td colspan="2">Total Contract Price
(including all CCNs, Work Orders, Call of Orders)

and Total Contract Value
(in case of co-funding; state if not applicable)</td><td colspan="2">EUR

EUR</td></tr>
<tr><td rowspan="2">Broken down as follows:</td><td>Original Contract Price

and original Contract Value
(in case of co-funding; state if not applicable)</td><td colspan="2">XXX EUR (XXX EUR)

EUR</td></tr>
<tr><td>CCN x to n

Work Order x to n

Call-Off Order x to n</td><td colspan="2">EUR in total

EUR in total

EUR in total</td></tr>
</table>

Section 2 – Recapitulation of Deliverable Items

2.1 Items deliverable under the Contract

If any of the columns do not apply to the item in questions, please indicate "n/a".

Table 2.1.1 – Items deliverable according to the Statement of Work

Type	Ref. No.	Name / Title	Description	Replacement Value (EUR)/ Other	Location[1])	Property of	Rights granted / Specific IPR Conditions[2])
Documen-tation							
Hardware							
Software			*(Delivery in Object code / Source code?)*				
Other							

[1] *In case the item is not delivered to ESA, please indicate the location of the deliverable and the reason for non-delivery (e.g. loan agreement, waiver, future delivery, etc.)*

[2] *e.g. IPR constraints, deliverable containing proprietary background information (see also 2.1.4 below)*

Table 2.1.2 – Other Deliverable Items: Inventory of Items produced or purchased under the Contract (*if applicable*)

[**OPTION 1**: No Fixed Assets]
No Fixed Asset has been acquired under the Contract by the Contractor and/or its Sub-Contractor(s).

[**OPTION 2**: Fixed Assets]
Any fixed assets, acquired under the Contract by the Contractor and/or its Sub-Contractors are listed in the List of Fixed Assets attached below. The Contractor certifies that all its obligations with regards to Fixed Assets have been fulfilled. The Agency will inform the Contractor of its decision with respect to the disposal of Fixed Assets items.

				ESA DECISION •		
Item Name	Part/ Serial Reference Number	Location	Value	Deliver to ESA	Sell or Dispose of	Leave in (Sub-) Contractor's Custody

Table 2.1.3 – Customer Furnished Items and Items made available by the Agency

Any Customer Furnished Items and/or Items made available by the Agency to the Contractor and/or its Sub-Contractor(s) under the Contract, are listed in the following List of Customer Furnished Items and Items made available by the Agency. The following tables certify which of the items have been returned to the Agency and which of the items remain in the custody of the Contractor, and/or a Sub-Contractor(s) and/or a Third Party for further ESA work or for other purposes.

Customer Furnished Items

				ESA DECISION		
Item Name	ESA Inventory Number	Location	Insurance Value	Confirmation of Receipt	Deliver	Leave at (Sub-) Contractor's Disposal

Items made available by the Agency

Item Name	ESA Inventory Number	Location	Replacement Value	Deliver	Leave at (Sub-) Contractor's Disposal

• To be completed by ESA

Table 2.1.4 – Background Information used and delivered under the Contract (see Clause 43 of the General Clauses and Conditions)

The following background information has been incorporated in the deliverable(s):

Proprietary Information (*title, description*)	**Owner** (*Contractor, Sub-Contractor(s), Third Party/ies*)	**Affected deliverable** (*which documents, hardware, software, etc.*)	**Description impact on ESA's rights to the deliverable**[3]	**Other/comments**

Section 3 – Output from / Achievements under the Contract

3.1 Technology Readiness Level (TRL)

Indicate the TRL of the technology developed under the Contract using the classification given below.

Initial TRL	Planned TRL as activity outcome	Actual TRL at end of activity

1	Basic principles observed and reported
2	Technology concept and/ or application formulated
3	Analytical and experimental critical function and/ or characteristic proof of concept
4	Component and /or breadboard validation in laboratory environment
5	Component and /or breadboard validation in relevant environment
6	System/ subsystem model or prototype demonstration in a relevant environment
7	System prototype demonstration in an operational environment
8	Actual system completed and 'flight qualified' through test and demonstration
9	Actual system 'flight proven' through successful mission operations

NOTE: The TRL shall be assessed by ESA. The Agency's responsible Technical Officer shall verify TRLs 1-4 while TRLs 5-9 shall be assessed through an ESA-internal formal procedure.

3.2 Achievements and Technology Domain

.....
Provide a concise description (max 200 words) of the achievements of the Contract and its explicit outcome (including main performances achieved): please refer to the final documentation (e.g. Final Report)

Please indicate the Technology Domain (TD 1 to 25) of the development (*please tick off*):

	1	On-Board Data Systems		14	Life & Physical Sciences
	2	Space System Software		15	Mechanisms & Tribology
	3	Spacecraft Electrical Power		16	Optics
	4	Spacecraft Environment & Effects		17	Optoelectronics
	5	Space System Control		18	Aerothermodynamics
	6	RF Payload and Systems		19	Propulsion
	7	Electromagnetic Technologies and Techniques		20	Structures & Pyrotechnics
	8	System Design & Verification		21	Thermal
	9	Mission Operations and Ground Data Systems		22	Environmental Control Life Support
	10	Flight Dynamics and GNSS		23	EEE Components and Quality
	11	Space Debris		24	Materials and Processes
	12	Ground Station System & Networking		25	Quality, Dependability and Safety
	13	Automation, Telepresence & Robotics			

[3] *if not explicitly stated otherwise, the contractual stipulations shall prevail in case of conflict with the description provided in this table*

3.3 Application of the Output/ Achievements

Please tick off as appropriate:

☐ Possible use in programme:

.....
Please indicate the service domain (see table) relevant to a possible application

	1	Earth Observation
	2	Science
	3	Human Spaceflight and Exploration
	4	Space Transportation
	5	Telecommunications
	6	Navigation
	7	Generic Technologies and Techniques
	8	Security
	9	Robotic Exploration

☐ Actual use in programme:

.....
Please describe the specific programme and application or mission for which the output of this Contract is or will be used.

3.4 Further Steps/Expected Duration

Please tick off as appropriate:

☐ No further development envisaged.

☐ Further development needed:

.....
Please describe further development activities needed, if any, to reach TRL 5/6 including an estimate of the expected duration and cost.

3.5 Potential Non-Space Applications

.....
Describe any potential non-space applications or products that may benefit from the technology that has been developed. Emphasize potential markets and costumers where known.

.....
Describe the principle features of technology that would be required in a technology demonstrator for any identified non-space application. Include an estimate of the resources in time and money that would be required.

Section 4 – Statement of Invention

[OPTION 1: NO INVENTION]
In accordance with the provisions of the above Contract, ...[Company] hereby certifies both on its own behalf and that of its consortium/Subcontractor(s), that no Intellectual Property Right(s) has(ve) been registered in the course of or resulting from work undertaken for the purpose of this Contract; and that no inventions have been made in the course of or resulting from work undertaken for the purpose of this Contract that generated knowledge that could be registered as Intellectual Property Rights.

[OPTION 2: INVENTION]
In accordance with the provisions of the above Contract, ...[Company] hereby certifies both on its own behalf and that of its consortium/Subcontractor(s) that the following Intellectual Property Right(s) has(ve) been registered in the course of or resulting from work undertaken for the purpose of this Contract.
.....

[OPTION]: In accordance with the provisions of the above Contract, ...[Company] hereby certifies both on its own behalf and that of its consortium/Subcontractor(s) that the following inventions have been made in the course of or resulting from work undertaken for the purpose of this Contract but have not been registered as Intellectual Property Rights:
.....

[OPTION]: In accordance with the provisions of the above Contract, ...[Company] hereby certifies both on its own behalf and that of its consortium/Subcontractor(s) that the following inventions have been made in the course of or resulting from work undertaken for the purpose of this Contract and are foreseen for and/or in the process of registration:

The Agency's rights on such registered and/or unregistered Intellectual Property Rights shall be in accordance with the ESA GCC Part II provisions as amended by the above Contract.

APPENDIX 4: CONTRACT CHANGE NOTICE

For submission of a change as per Clause 13 of the General Conditions, the Contractor shall submit his proposal in the format of a CCN using the cover page included below. The form shall be filled with the following information as a minimum:

- The Contractor's name and the Contract number
- The title of the area affected by the change (Work Package reference, new work, etc.)
- The name of the initiator of the change (Contractor or ESA)
- The description of the change (including Work Package Descriptions, WBS, etc.)
- The reason for the change
- The price breakdown in €, if any (breakdown by company, Phase, etc., including PSS-A2 and PSS-A8 forms)
- The Milestone Payment Plan for the CCN if any
- Effect on other Contract provisions
- Start of work - end of work (including contractual delivery dates and overall planning, milestones, etc.)
- A CCN Form, as per the format below, signed by the Contractor's representatives

The Contractor shall, on request of the Agency, provide additional documentary evidence. At the request of either Party, the proposed change may be discussed at a Change Review Board, consisting of both the Contracts Officer and the Technical Officer of each Party.

<table>
<tr><td rowspan="2"> </td><td rowspan="2">DIRECTORATE:</td><td>Contractor:</td></tr>
<tr><td>Contract No.:</td></tr>
<tr><td colspan="2">CONTRACT CHANGE NOTICE No.</td><td>DATE:</td></tr>
<tr><td colspan="2" rowspan="2">TITLE OF AREA AFFECTED (WORK PACKAGE ETC):</td><td>WP REF:</td></tr>
<tr><td>INITIATOR OF CHANGE:</td></tr>
<tr><td colspan="3">DESCRIPTION OF CHANGE</td></tr>
<tr><td colspan="3">REASON FOR CHANGE</td></tr>
<tr><td colspan="3">PRICE BREAKDOWN (Currency)/PRICE-LEVEL</td></tr>
<tr><td colspan="2" rowspan="2">EFFECT ON OTHER CONTRACT PROVISIONS</td><td>START OF WORK</td></tr>
<tr><td>END OF WORK</td></tr>
<tr><td>CONTRACTOR'S PROJECT MANAGER:

DATE:</td><td colspan="2">CONTRACTOR'S CONTRACTS OFFICER:

DATE:</td></tr>
<tr><td colspan="3">[DISPOSITION RECORD OR OTHER AGREED CONDITION RECORDED WITH THE CCN APPROVAL]</td></tr>
<tr><td>ESA TECHNICAL OFFICER:

DATE:</td><td colspan="2">ESA CONTRACTS OFFICER:

DATE:</td></tr>
</table>

APPENDIX 5: WORK ORDER PROCEDURE

The following procedure shall apply to all contracts specifically established to allow the issuing under them of Work Orders :

All Agency orders for developments, products or services shall be placed by means of a Work Order (WO), a sample of which is attached in Annex hereto, and in accordance with the procedure described below :

1. The Agency shall raise a WO and complete all sections

   either — on the basis of the information contained in the Contract and its Appendices,

   or — for orders worth more than 100 KEuro and all competitive offers, on the basis of the selected offer received in response to a request for proposal issued by the responsible Contracts Officer,

   or — for orders worth less than 100 KEuro and non-competitive offers, on the basis of an offer that the Technical Representative has requested the Contractor to submit in accordance with the terms and conditions of the Contract.

   If the WO involves one or more sub-contractors, this should be addressed in the "Price" and "Payments" sections of the WO form.

2. The completed WO form shall be signed by the Agency's Representatives mentioned in Clause 5 of Article 4 of the Contract and sent to the Contractor for signature.

3. In the event of any conflict between the WO itself and its annexes and/or documents referred to therein, the WO shall take precedence.

4 On receipt of the WO, the Contractor's Technical and Contractual Representatives, as mentioned in Clause 7.2 of Article 4 of the Contract, shall immediately sign the WO, return one Original to the Agency's responsible Contracts Officer, and implement the WO.

5. Any subsequent change to the terms and conditions of the WO, whether initiated by the Agency or the Contractor, shall be the subject of a CCN raised in accordance with Clause 26 of Article 4 of the contract and specifically referencing the WO. The CCN shall recall the value of the WO and that of any preceding CCNs and shall show the total value of the WO and all CCNs including itself.

e a	Contract No :	
	Contractor :	
WORK ORDER No. ⌊⌋⌊⌋⌊⌋⌊⌋⌊⌋	Date ⌊⌋⌊⌋⌊⌋⌊⌋⌊⌋⌊⌋	
SUBJECT :		
DESCRIPTION OF WORK :		
DELIVERABLES AND SCHEDULE :		
PRICE :		
PAYMENTS :	Start of work : End of work :	
SPECIAL CONTRACT CONDITIONS :		
APPROVED BY esa	TECHNICAL OFFICER : DATE :	CONTRACTS OFFICER : DATE :
APPROVED BY contractor	PROJECT MANAGER : DATE :	CONTRACTS OFFICER : DATE

ORIGINAL 1

NOTE: if space foreseen is insufficient, give additional details on separate page.