

# **Service description**

**Satellite project: Procurement of solar cells  
and consulting services for mission concept  
and payload in the field of satellite technol-  
ogy  
- over 2 lots -**

**Award No.: OV-125-26**

Client:  
Technical University of Berlin, The President  
Straße des 17. Juni 135  
10623 Berlin

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## 1 BRIEF DESCRIPTION OF THE SERVICE – ACROSS ALL LOTS

As part of the in-orbit demonstration mission RACCOON IOD (**Robust And seCure post quantum COmmunication fOr critical iNfrastructure**), the Technical University of Berlin (TU Berlin, hereinafter referred to as the client – AG) intends to procure partial services and hardware components for the realization of the project.

During the project period, four small satellites (3U cubesats, 3 flight models (FMs), 1 flight spare (FS)) will be developed, built and launched into low Earth orbit within 24 months. This will be followed by a mission period of 12 months in orbit.

The mission builds on the predecessor mission RACCOON PoC, in which a demonstrator for a scientific payload was developed. This payload is used to test a **cognitive radio concept** for robust and secure satellite communication. In addition, **RACCOON OS** was developed as an open-source operating system for small satellites that meets current cybersecurity requirements and implements relevant CCSDS standards.

The aim of the RACCOON IOD mission and thus part of this tender is the triangulation of radio signals in orbit by means of a **formation of three cubesats**. The satellites must be able to record signals, the evaluation of which on the ground enables the **geolocation of the signal sources with the** help of suitable algorithms. The possibility of launching a fourth cubesat in the formation will be reviewed in phase 1 (May 2026 to April 2027) of the project and will be implemented if necessary. In addition, the RACCOON OS developed in the PoC mission will be used, tested and further developed in orbit. The **intelligent transceiver** developed in the PoC phase will also be operated on board the satellites to demonstrate robust and secure satellite communication.

To achieve the project goals, the procurement of solar cells will be put out to tender (Lot 1). In addition, a service is needed to provide advice on the mission concept and the RF payload and to provide frequency coordination in the project (Lot 2).

The exact contents and minimum technical requirements are defined in the following lot descriptions:

- Lot 1: Solar cells
- Lot 2: Consulting mission concept + payload

Each bidder can submit a bid **for one, several or all lots**, there is no lot limitation.

## 2 DESCRIPTION OF SERVICES – ACROSS ALL LOTS

In the following, the minimum criteria (MK) are described with the required components and parameters of the services to be procured per lot and the task description to be fulfilled with the offer is discussed in detail. Unfulfilled requirements will lead to the exclusion of the respective offer.

### 2.1 LOT 1 – SOLAR CELLS

Below are the minimum requirements for LOT 1.

#### 2.1.1 Background and objective

The subject of this lot is the procurement of solar cells for the power supply of the TUBiX-5 satellite bus as part of the RACCOON IOD mission.

The solar cells must be qualified for operation in Low-Earth Orbit (LEO), be mechanically and electrically fully compatible with the panels of the TUBiX-5 bus and have proven flight experience in orbit.

Solar cells with at least 30% BOL efficiency and a format of 40.15 × 80.15 mm must be procured.

The delivery includes the cells themselves, accompanying documentation, test reports and certificates that enable integration into existing solar panel structures at TU Berlin.

In addition, the cells must be fully characterized by the AN (Visual + AM0 IV Curve + EL + Bypass Diode Test)

Only new products are to be offered. Remanufactured products, returns, etc. or grey imports are excluded.

#### 2.1.2 Maximum price

The maximum price is **41,000.00 euros net or 48,000 euros gross**.

Bidders who submit a higher bid price will be excluded from the further procedure. Claims beyond the offer cannot be asserted against TU Berlin.

#### 2.1.3 Service description

##### 2.1.3.1 SCOPE OF SERVICES

The Contractor (Contractor) shall deliver to the Client (Client):

- 200pcs Triple Junction Solar Cells Assembled
- Qualification and integration documentation
- Test documentation of cell characterization (Visual + AM0 IV Curve + EL + Bypass Diode Test)

#### 2.1.3.2 TECHNICAL REQUIREMENTS

ID	Requirement	Veri- fication
<b>SOL-01</b>	Efficiency at the beginning of life (BOL) must be at least 30% under standard test conditions.	T
<b>SOL-02</b>	The dimensions of a solar cell must be 40.15 mm × 80.15 mm.	I
<b>SOL-03</b>	The total thickness of a solar cell, including substrate and metallization, may not exceed 330 $\mu\text{m} \pm 75 \mu\text{m}$ .	I
<b>SOL-04</b>	The mass per solar cell must not exceed 3.8 g.	I
<b>SOL-05</b>	The open-circuit voltage (Voc) of a solar cell must be about 2750 mV under standard conditions for BOL.	T
<b>SOL-06</b>	The short-circuit current (Isc) of BOL must be approximately 520 mA under standard conditions.	T
<b>SOL-07</b>	The operating voltage of a solar cell must be 2430 mV under standard conditions.	T
<b>SOL-08</b>	The operating current must be at least 503 mA under standard conditions.	T
<b>SOL-09</b>	The solar cells must be designed for an operating and storage temperature range of $-20\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$ and be suitable for use in Low Earth Orbit (LEO).	T
<b>SOL-10</b>	The solar cells must be space-qualified; the qualification status must be proven by existing qualification documents. Proof of flight heritage is also permitted.	R
<b>SOL-11</b>	200 solar cells are to be provided; these include the number of units required for development, integration and flight models.	I
<b>SOL-12</b>	Complete testing, operating and integration documents must be provided.	R
<b>SOL-13</b>	A complete characterization must be performed (Visual + AM0 IV Curve + EL + Bypass Diode Test) and the test documentation must be provided as a PDF.	R
<b>SOL-14</b>	If defective cells are detected during testing and characterization, they must be replaced by the Contractor for functional cells.	R

#### 2.1.3.3 QUALIFICATIONS AND CERTIFICATES

All solar cells supplied must:

- be subject to a space qualification, or:
- Prove in-orbit heritage (at least one successful mission),
- Have complete test trails at component and system level.

#### 2.1.3.4 ACCOMPANYING DOCUMENTATION

- Data Sheet with Electrical Interfaces (ICD)
- Inspection and test reports (environmental tests)
- Integration manual (connections, assembly, handling)
- Transport and storage instructions
- Proof of flight experience (reference mission or test report)

#### 2.1.4 Place of service and acceptance

Technical University of Berlin, Marchstraße 12-14, 10587 Berlin

The acceptance is carried out by the responsible employees of TU Berlin. Acceptance criteria are the complete fulfilment of the service description.

#### 2.1.5 Delivery and Dates

- **Appointment:** Q3 / 2026 (expected August 2026)
- **Delivery:** No later than 28.02.2027

The solar cells must be delivered by the Contractor to the place of service. The transport, including the assumption of all costs incurred with the transport, as well as the risks of delivery, shall be borne by the Contractor.

#### 2.1.6 Payment methods

Advance payments can only be made upon presentation of an **unlimited bank or group guarantee**, waiving the objections of enforceability, voidability and advance action (§§ 770, 771 BGB). **The costs for the bank or group guarantee are borne by the contractor.**

Without the presentation of the security deposit - in this case the unlimited bank or group guarantee - the advance payment of the order is not possible in accordance with the State Budget Code (LHO Berlin).

In compliance with the above provisions on advance payment, the remuneration shall be as follows:

- **35% of the total contract amount** as an advance payment after the order has been placed, upon presentation of a corresponding open-ended bank or group guarantee
- **65% of the total contract amount** after successful acceptance of the contractually owed services

The remuneration is in each case plus the statutory value added tax.

The final payment will be made by **February 28, 2027 at the latest**, provided that an auditable invoice has been submitted in time in accordance with the contractual provisions (cf. General Terms and Conditions of TU Berlin).

The agreed delivery periods are binding. Delays in delivery and service must be reported to TU Berlin immediately. This applies if, due to significant and unforeseeable circumstances of political and/or economic proportions, supply bottlenecks or disruptions occur in the supply chains that are not within the Contractor's area of responsibility. With the prompt notification of this to the TU Berlin, the expected delivery times at this time must be communicated.

### 2.1.7 Warranties

A warranty period of 12 months from acceptance applies to the delivered hardware.

During this period, the hardware will be integrated into the satellite as part of the integration and testing campaign at system level, where it will be subjected to an acceptance test. This includes, in particular, environmental tests (vibration, shock) carried out or commissioned by the client.

If defects are found in the course of these system acceptance tests that can be attributed to the delivered hardware, these are considered warranty cases, even if they occur after formal acceptance.

The Contractor is obliged to remedy the identified defects within 30 calendar days of the written notification of the defect or to provide equivalent replacements so that the integration and testing campaign can continue without undue delay.

The Contractor shall ensure that suitable spare parts and/or repair facilities are available and ready for use within the specified period.

If an immediate repair or replacement delivery is not possible for objectively comprehensible reasons, the Contractor shall immediately inform the Client of the expected schedule and take measures to keep the delay as low as possible.

### 2.1.8 Documents to be submitted

The following evidence must be submitted by the bidder:

- **TUB - Offer letter from the bidder:** Please submit this document completed with the offer.
- **TUB - Price sheet (ZK<sup>1</sup>):** Please submit this completed document with the offer.
- **TUB - Declarations to be submitted by the company EU (EC):<sup>2</sup>** Please submit this document completed with the offer.
- **TUB - References (EK):** The bidder submits at least one reference. These must be services performed in the last 5 years. Evidence of an orbital mission with comparable solar cells is valid. Solar cells of the same size and the same power class are comparable.

The reference must contain the following information: company/authority, type and scope of the service, service period, service data.

- **TUB - Specification Documents (EK):** The bidder submits the following documents:
  - a technical data sheet of the offered solar cells (dimensions, dimensions, electrical interfaces, performance data),
  - an integration and assembly manual (interface specifications),
  - a production and delivery plan with an availability period of 2026
  - Proof of space qualification (test reports and certificates) showing compliance with the required specifications or evidence of in-orbit verification.

### 2.1.9 Award criterion and weighting

Taking into account all the circumstances, the contract will be awarded to the most economical tender. The evaluation is based on the submitted offer. Therefore, it is in the interest of the bidder to provide all requested information in as much detail and accuracy as possible.

**The award criterion is 100.00% of the total net bid price.**

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<sup>1</sup> CC = Award criterion

<sup>2</sup> EK = Suitability Criterion



## **2.2 LOT 2 - MISSION CONCEPT + PAYLOAD CONSULTING**

Below are the minimum requirements for LOT 2.

### **2.2.1 Background and objective**

The subject of this lot is the technical support of the client in the development and validation of the mission concept of the RACCOON IOD mission with a special focus on regulatory framework conditions as well as on radio technology (RF) consistency and feasibility.

The lot includes support in the mission design, the independent processing of the regulatory requirements in the area of frequency use as well as the continuous independent expert analysis and evaluation of the RF concept of the mission.

The aim is to ensure the technical, regulatory and radio feasibility of the mission, to identify risks at an early stage and to iteratively improve the quality of the mission design.

For this purpose, the Contractor (Contractor) shall provide in particular:

- Contributions to the mission concept,
- a complete regulatory analysis
- full frequency coordination,
- a continuous technical evaluation of the RF design,
- as well as recommendations for the optimization of antenna concept, frequency use and communication architecture.

### **2.2.2 Service description**

The project is divided into two phases. This lot includes services in both phases.

The lot is purely a service. All technical systems, simulations and system models are provided by the AG. Business trips and coordination are to be taken into account in the offer price.

#### **Phase 1 "Mission Design" (expected 17.08.2026<sup>3</sup> – 28.02.2027)**

In this phase, the mission concept will be supported as well as the initial regulatory and RF technical assessment.

Service blocks:

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<sup>3</sup> The start of the service is based on the date of the award. If necessary, the contract can be awarded earlier, in which case the start of the service must be implemented promptly by the contractor in consultation with the client.

- Service block 1: Support mission concept (RF & system reference)
- Service Block 2: Regulatory Framework and Frequency Management (Part 1)
- Service Block 3: Expert Review RF Concept (Part 1)

## **Phase 2 "AIV & Operations" (01.03.2027 – 28.02.2028, optional extension)**

In this phase, regulatory topics are deepened and finalized as well as the ongoing RF evaluation.

Service blocks:

- Service block 2 (continued): Regulatory framework and frequency management (Part 2)
- Service Block 3 (Continued): Expert Review RF Concept (Part 2)

Phase 2 will be applied for in the course of Phase 1. Approval is expected in Q1 2027. Therefore, Phase 2 is currently an **optional expansion. This optional service must be offered by the bidder in a binding manner. The Contractor will be informed of the decision as to whether this optional extension option will be additionally commissioned by 28.02.2027 at the latest.**

## **Service block 1: Support mission concept (RF & system reference)**

The contractor supports the working group in the development and iteration of the mission concept with a focus on radio technology and system-relevant aspects.

### **Scope of Tasks of the Contractor**

- Analysis and evaluation of the mission architecture with regard to RF-relevant aspects (frequencies, data rates, communication paths).
- Support for mission analyses and simulations with a focus on:
  - Orbit parameters, drift and coverage,
  - communication windows and ground station accesses,
  - Data processing and downlink strategies.
- Assess consistency between mission objectives, payload requirements, and communications architecture.
- Identification of critical dependencies (formation, contact times, frequency use).
- Advice on the design and selection of the antenna concept
- Support in the iteration of the mission architecture to ensure technical feasibility.

### **Minimum scope of services**

The Contractor must deliver at least the following content:

- Analysis of at least **3 mission scenarios** (different orbit/communication configurations)
- Rating of at least:
  - **3 Communication architectures** (focus on different downlink strategies)
  - **3 critical dependencies** (at least formation, coverage, contact times)

- Documented rating of at least:
  - **2 antenna concepts** including comparison
- Identification and description of at least:
  - **5 Technical Risks in Mission Design**

#### **Dependencies and boundary conditions**

- Responsibility for the mission concept remains with the working group.
- The Contractor provides only technical contributions and evaluations.

## **Service Block 2: Regulatory Framework and Frequency Management**

The Contractor is responsible for the complete analysis and implementation of the regulatory requirements in the area of frequency use.

### **Scope of Tasks of the Contractor**

#### **Phase/Part 1:**

- Identification of all relevant regulatory frameworks (national and international).
- Analysis of frequency use in the context of the mission.
- Identification of regulatory requirements regarding:
  - transmitting power,
  - frequency ranges,
  - Beacon concepts.
- Assessment of the regulatory feasibility of the mission.

#### **Phase/Part 2:**

- Implementation of frequency coordination and preparation of frequency allocation.
- Preparation and submission of the necessary applications and documents (Depending on the development of the framework conditions for the regulation.
- Processing of objections from other operators (when coordinating frequencies for satellites)
- Processing of objections and voting in case of potential risk of interference due to subsequent International Telecommunication Union (ITU) applications
- Derivation of mission-specific regulatory requirements.

#### **Results**

- Assessment of regulatory requirements.
- Frequency Utilization Strategy.
- Spectrum applications and ITU documentation.
- Logging of frequency coordination

### **Minimum scope of services**

The Contractor must deliver at least the following content:

- Identification and description of at least:
  - **3 relevant regulatory frameworks**
- Implementation and documentation of:
  - at least **1 complete frequency usage analysis**
- Creation of:
  - at least **1 frequency usage application (draft version)**
  - at least **1 complete ITU-related document set (draft)**
- Identification and evaluation of at least:
  - **3 Regulatory risks**
- Derivation of at least:
  - **3 Mission-specific regulatory requirements**

### **Dependencies and boundary conditions**

- Close coordination with the AG required.
- Requirements must be compatible with mission concept and system design.

## **Service block 3: Expert review RF concept**

The Contractor undertakes an independent, continuous expert assessment of the RF concept of the mission.

### **Scope of Tasks of the Contractor**

The scope of tasks is uniform over both phases of the project. In phase 1, the Preliminary Design Review (PDR) is carried out, in phase 2 the Critical Design Review (CDR) and the Flight Readiness Review (FRR). Counselling is necessary throughout until the FRR, which is expected to take place in February 2028.

- Systematic review of all mission-relevant steps with regard to:
  - consistency,
  - feasibility,
  - technical risks.
- Verification of:
  - Assumptions,
  - parameters,

- Interfaces.
- Analysis and evaluation of:
  - antenna concepts,
  - Frequency use,
  - Link budget and data rates,
  - I/Q data processing.
- Identification of technical vulnerabilities and risks.
- Derivation of concrete recommendations for improvement.
- Integration of results into system documents.

### Results

- Written technical assessments and reviews, in PDF format and English.
- Documented risks and optimization suggestions in PDF format and English.

### Minimum scope of services

The Contractor must deliver at least the following content:

- Implementation of at least:
  - **3 structured RF reviews** (before PDR, before CDR, before FRR)
- Analysis and evaluation of at least:
  - **5 central RF parameters** (at least link budget, frequency usage, data rate, antenna concept, interfaces)
- Identification and documentation of at least:
  - **5 Technical Vulnerabilities or Risks**
- Derivation of at least:
  - **5 concrete recommendations for improvement**

### Dependencies and boundary conditions

- Inputs from several work packages.
- Close coordination with the working group required through regular online meetings (at least once a month for one hour each).

#### 2.2.2.1 TECHNICAL REQUIREMENTS

Below are all the technical requirements that are relevant to the offer. These must be taken into account by the bidder in the bid. The described verifications (Analysis(A), Test(T), Review (R)) are relevant for meeting the requirements.

ID	Requirement	Verification
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<b>PM-01</b>	The Contractor must regularly (at least monthly) participate in coordination meetings with the AG. The working group initiates the meetings, which take place online.	R
<b>PM-02</b>	The Contractor ensures that all documents are versioned and maintained in a comprehensible manner.	R
<b>PM-03</b>	The Contractor is obliged to comply with the schedule specified by the Client.	R
<b>PM-04</b>	The deployed employee must remain available for the entire term.	R
<b>PM-05</b>	All documents must be prepared in English and made available in PDF format.	R
<b>SYS-01</b>	The Contractor must analyze and evaluate the mission concept with regard to RF aspects.	R
<b>SYS-02</b>	The Contractor must evaluate communication parameters (frequency, data rate, coverage).	R
<b>SYS-03</b>	The Contractor must analyze dependencies between orbit, formation and communication and prepare a report on them.	R
<b>SYS-04</b>	The contractor must evaluate the antenna concept and make recommendations for selection.	R
<b>SYS-05</b>	The Contractor must evaluate the consistency between mission requests and the RF system.	R
<b>REG-01</b>	The Contractor must carry out frequency coordination for all relevant frequency bands. These are at least: UHF (TT&C), S-Band Uplink, X-Band Downlink	R
<b>REG-02</b>	The Contractor must prepare and submit the frequency applications.	R
<b>REG-03</b>	The contractor must fully comply with regulatory requirements (ITU, national).	R
<b>REG-04</b>	The Contractor must identify and assess regulatory risks.	R
<b>RFV-01</b>	The Contractor must review and evaluate all mission steps for RF consistency	R
<b>RFV-02</b>	The Contractor must identify technical risks in the RF system.	R
<b>RFV-03</b>	The Contractor must analyze and evaluate link budget and data rates	R + A
<b>RFV-04</b>	The Contractor must derive concrete recommendations for improvement and make them available to the Client in the form of presentations or documents	R

### 2.2.3 Contractor's service team

All minimum criteria mentioned here must be met and proven by suitable documents (e.g. curriculum vitae, certificates, project references).

If the minimum criteria are not fully met, the bid will be excluded from the further procedure.

Category	Minimum criterion (MK)	Description
Quantity	At least one person in a leading position	The Contractor's team must consist of at least one person who is in a management position and meets the following minimum criteria.
Experience	Satellite communication	The assigned employee must have at least 10 years of experience in the field of satellite communications or RF systems in their CV. In particular, the deployed employee must be able to demonstrate practical experience in the use of RF payloads for geolocation in the CV.
Experience	Frequency coordination	The deployed employee must have at least 10 years of verifiable experience in the field of frequency coordination and frequency allocation (ITU, national authorities) and must provide evidence of this in their CV. In this case, the employee must have demonstrably carried out both the regulatory steps (ITU registration, correspondence with national authorities) and the technical steps (link budget, impact analyses, coordination meetings) independently.
Language	Language skills	The employee employed must have business fluency in German and English.
Availability	Attending a meeting	The Contractor must ensure that he is available for a status meeting with the AG once a month.
Availability	Project duration	The assigned employee must be available for the entire duration of the project, including an optional extension.

#### 2.2.4 Milestone plan

The project milestones result from the completion of the respective work blocks 1 – 3. The specified deadlines of phases 1 and 2 must be adhered to in a binding manner. If a service block has been completed and it has been accepted by the Client, it is considered to have been fulfilled.

### 2.2.5 Payment plan

Payments are made after completion and acceptance by the AG of the individual service blocks.

Description	%- Payment of the offer price
<b>Phase 1</b>	<i>acc. to OV-125-26 Price sheet, rider lot 2, item 1</i>
Service block 1	30 %
Service block 2	40%
Service block 3	30%
<b>Phase 2 – if commissioned</b>	<i>acc. OV-125-26 Price sheet, Rider Lot 2, Pos. 2</i>
Service block 2	50%
Service block 3	50%

The remuneration is paid plus the applicable statutory value added tax.

### 2.2.6 Maximum price

The maximum price for Phase 1 is **€25,210.00 net or €30,000.00 gross**.

The maximum price for phase 2 is **€24,790.00 net or €29,500.00 gross**

Bidders who submit a higher bid price will be excluded from the further procedure.

Claims beyond the offer cannot be asserted against TU Berlin.

### 2.2.7 Place of service

All development work must take place on the Contractor's own premises. The AG does not provide any workplaces here. The monthly meetings take place online. The working group initiates the meetings and provides the digital meeting room.

Other place of service at the TUB: Technical University, Marchstraße 12-14, 10587 Berlin



## 2.2.8 Documents to be submitted

In addition to the required self-declarations (see award documents), the following points must be presented in writing in the tender. If the following points are not presented in writing, the offer will be excluded.

- **TUB - Offer letter from the bidder:** Please submit this document completed with the offer.
- **TUB - Price sheet (ZK<sup>4</sup>):** Please submit this completed document with the offer.
- **TUB - Declarations to be submitted by the company EU (EC):<sup>5</sup>** Please submit this document completed with the offer.
- **TUB - References (EK):** In order to prove the minimum requirements for the service team to be deployed in 2.2.3, the bidder must submit at least two references in the form of a suitable overview. These must be services performed in the last 10 years. Evidence is valid that proves that comparable services have been provided. This includes publications at conferences or journals, order receipts or similar documents.

Comparable services are in the field of consulting for satellite communications and frequency coordination.

The references must contain the following information: company/authority, type and scope of the service, service period, service data.

- **TUB - CV (EK):** The bidder presents his/her team to be deployed in accordance with point 2.2.3 with a CV that may be anonymised.
- **TUB - Presentation of services of the bidder (EK):**  
The tender must contain a structured presentation of the services offered. In doing so, it must be described in a comprehensible manner which services the bidder offers and how they meet the requirements of the service description (phases, service blocks, technical requirements and service team).  
This description must be described on a maximum of 10 pages.

## 2.2.9 Award criterion and weighting

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<sup>4</sup> CC = Award criterion

<sup>5</sup> EK = Suitability Criterion

Award No.: OV-125-26

Taking into account all the circumstances, the contract will be awarded to the most economical tender. The evaluation is based on the submitted offer. Therefore, it is in the interest of the bidder to provide all requested information in as much detail and accuracy as possible.

The award criterion is **100% of the total bid price net.**