IACTEC - Instituto de Astrofísica de Canarias

IACSAT DUNE

CALL for EXPRESSION of INTEREST

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1 Related Documents

1.1 Applicable Documents

N/A

1.2 Reference Documents

N/A

2 Acronyms

AEE	Agencia Espacial Española
AOCS	Attitude and Orbit Control System
AIV	Assembly, Integration and Verification
ALISIO	Advanced Land-Imaging Satellite for Infrared Observations
APE	Absolute Pointing Error
ARS	Angular Rate Sensor (MHD type, e.g. ARS-14)
BEE	Back-End Electronics
CAT	Time Allocation Committee (Comité de Asignación de Tiempos)
CCD	Charge-Coupled Device
CDPU	Control and Data Processing Unit
CFRP	Carbon Fibre Reinforced Polymer
CHEOPS	ESA's mission CHaracterising ExOPlanet Satellite
CRR	Commissioning Result Review
CTE	Coefficient of Thermal Expansion
CVCM	Collected Volatile Condensable Materials (outgassing metric)
EBB	Engineering Bread-Board
ECSS	European Cooperation for Space Standardisation
EEE	Electrical, Electronic and Electro-mechanical (components)
EELV	USA program Evolved Expendable Launch Vehicle
EFL	Effective Focal Length
E-ELT	European Extremely Large Telescope
EM	Engineering Model (non space-grade components)
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOM	End of Mission
EQM	Engineering Qualification Model (space-grade components, not space-tested)
ESA	European Space Agency

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EUT	Equipment Under Test
FDIR	Fault Detection, Isolation and Recovery
FITS	Flexible Image Transport System
FM	Flight Model
FoV	Field of View
FPA	Focal Plane Assembly
FPGA	Field-Programmable Gate Array
FRR	Flight Readiness Review
FSM	Fast-Steering Mirror
FSW	Flight Software
GS	Ground Segment
GSE	Ground Support Equipment
HgCdTe	Mercury Cadmium Telluride (detector material)
HK	Housekeeping
HZ	Habitable Zone
IAC	Instituto de Astrofísica de Canarias
IACTEC	IAC Technology division
ICD	Interface Control Document
IDEF0	Integration DEFinition language 0, based on SADT, (pronounced I-def zero)
IRD	Interface Requirements Document
ISO	International Organisation for Standardisation (cleanliness class)
ITAR	International Traffic in Arms Regulations
ITR	Integrate Then Read
IWR	Integrate While Read
JPEG	Joint Photographic Experts Group (compression standard)
JUICE	ESA's mission Jupiter Icy Moons Explorer
JWST	NASA-ESA's mission James Webb Space Telescope
LCL	Latching Current Limiter
LEO	Low Earth Orbit
LEOP	Launch and Early Orbit Phase
LEON	Processor architecture (Cobham/Gaisler)
LETth	Linear Energy Transfer threshold
LLI	Long Lead Item
LTAN	Local Time of the Ascending Node
LVDS	Low-Voltage Differential Signalling
M1, M2	Primary, Secondary Mirror

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MHD	Magneto-HydroDynamic (angular rate sensor type)
MLI	Multi-Layer Insulation
MOC	Mission Operations Center
MRAM	Magnetoresistive Random-Access Memory
OBC	On-Board Computer
OS	Operating System
OTA	Optical Tube Assembly
PCDU	Power Conditioning and Distribution Unit
PDR	Preliminary Design Review (end of phase B, ref. ECSS-M-ST-10C)
PFCS	Pointing and Focus Correction System
PID	Proportional-Integral-Derivative (control algorithm)
PIL	Payload-in-the-Loop
PLATO	ESA's mission PLAnetary Transits and Oscillations of stars
POL	Point of Load (power converter)
PRNU	Pixel Response Non-Uniformity
PSF	Point Spread Function
PST	Point Source Transmittance
PUS	Packet Utilisation Standard
PWM	Pulse Width Modulation
QE	Quantum Efficiency
ROIC	Read-Out Integrated Circuit
ROM	Rough Order of Magnitude (cost estimate)
ROI	Region of Interest
RPE	Relative Pointing Error
RTEMS	Real-Time Executive for Multiprocessor Systems
RV	Radial Velocity
SAA	South Atlantic Anomaly
SDRAM	Synchronous Dynamic Random-Access Memory
SED	Spectral Energy Distribution
SEL	Single-Event Latch-up
SNR	Signal-to-Noise Ratio
SOC	Science Operations Centre
SPARC	Scalable Processor Architecture
SSO	Sun-Synchronous Orbit
STM	Structural and Thermal Model
SVF	Software Validation Facility

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SWIR	Short-Wave InfraRed
TBC, TBD	To Be Confirmed, To Be Defined
TC	Telecommand
TCS	Thermal Control System
TESS	NASA's mission Transiting Exoplanet Survey Satellite
TID	Total Ionising Dose
TIS	Total Integrated Scatter
TM	Telemetry
TMT	Thirty Meter Telescope (TMT International Observatory LLC)
TNID	Total Non-Ionising Dose
TRP	Thermal Radiative Properties
TVAC	Thermal Vacuum (test chamber)
UHF	Ultra High Frequency
UTC	Universal Time Coordinated
VNIR	Visible and Near InfraRed

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3 Context

3.1 IAC identity

The satellite IACSAT DUNE (evolution of IACSAT-1) will be under the responsibility of the Instituto de Astrofísica de Canarias (IAC) / IACTEC-Space, Spain.

3.2 Letter of Interest

IAC provides the following information for any industrial vendor to express their interest in a public ITT, not under IAC's responsibility, to cover both the platform and the ground segment. The interested vendors should present their proposed solution for IACSAT DUNE, in technical terms and in expected costs. IAC will support the vendor's bid if their solution fits the needs.

IAC kindly requests any interested vendor to send **by e-mail** a Letter of Interest that includes the herein requested information, no later than 14 August 2026 at 23:59 CEST. This will allow to start conversations as early as possible about possible solutions for the next phases of the development.

3.3 Contact people

If you have any question or you need clarifications, please contact IACTEC staff by email. Your email shall be directed to both the following contacts:

- José Alonso Burgal (joalbur@iac.es), project manager
- Alfonso Ynigo Rivera (alfynigo@iac.es), systems engineer

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4 Mission Concepts

IACSAT DUNE will be the first space observatory under the full responsibility of IAC, Instituto de Astrofísica de Canarias, under the management of its department IACTEC-Space. It is expected to be jointly operated by IAC for the SOC and by an external partner for the MOC, herein named “the Operator” (pending the formal agreement to this aim), with a technical support of the industry.

The phase B is ongoing. The IAC is looking for industrial partners to cover both the platform and the ground segment, to be operated by the customer. The partnership shall cover a phase B2, to allow the selected vendors for the flight segment and the ground segment to take part in IACSAT DUNE PDR, the phase C and the phase D, as well as a technical support during phases E and F. A proposal for the launch is also expected from the industrial partner.

The launch targets 2030 and the mission duration shall be a minimum of three years, with an expected lifetime of 5 years. An indicative overall budget is 18M€, including IAC’s engineering, payload, platform, launch, ground segment (CAPEX + OPEX) and ground support (maintenance, technical support).

4.1 Science: VNIR-SWIR Photometry at 100-ppm

4.1.1 Scientific objectives

IACSAT DUNE is the first IAC space observatory for astronomy. It follows the ALISIO-1 Earth-observation microsatellite, operating in orbit since 2023 with the payload DRAGO-2.

The primary goal is photometric confirmation and characterization of Earth-like exoplanet candidates in the habitable zones (HZ) of nearby M-dwarf stars (M0-M7, extending to early L-dwarfs up to L3) within ~30 parsecs. These are the most accessible targets for future atmospheric characterization via JWST, E-ELT or TMT. The mission addresses both ESA Voyage 2050 priorities and the USA Astro2020 Decadal Survey recommendations.

It intends to fill a scientific gap:

- ground photometry is limited to ~1 mmag precision by atmospheric scintillation;
- TESS has a small aperture and insufficient sensitivity on faint M-dwarfs;
- CHEOPS targets bright Solar-type stars;
- PLATO covers fixed sky regions.

IACSAT DUNE specifically validates marginal TESS candidates requiring space-based confirmation.

As secondary science goals, requests from the broader scientific community can be covered in the following additional fields:

- astero-seismology of main-sequence/sub-giant stars, in chromatic transit analyses;
- detection of transiting planets around ultra-cool dwarfs and brown dwarfs up to L3;
- young moving group transit searches;
- transient follow-up.

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The expected coverage targets ~4 000 stars within 30 pc (~2 900 M-dwarfs). Between 19 and 62 systems may host transiting Earth-sized HZ planets. Up to 100 targets are expected over the nominal 3-year mission, assuming a 70% duty-cycle for scientific activities (i.e. 18 000 hours expected, resulting in 7 000 h for the primary goals and 3 000 h for the secondary goals). Data will be generated during an average of 55% of the total time.

The products of the mission are observations at various “levels” of processing:

- L0: Raw unpacked telemetry (MOC to SOC).
- L1: Raw 2D images + metadata.
- L2: Reduced images (pipeline-calibrated, error maps, metadata).
- L3: Light curves — primary science output (transit timing accuracy < 1 min for validated events, enabling JWST scheduling and radial-velocity follow-up).

4.1.2 Observation band: VNIR-SWIR (500-1700 nm)

Single panchromatic detector covering 500-1700 nm (VNIR-SWIR) with QE > 80% between 900-1600 nm. This window is optimal for M-dwarf stars: spectral peak at 1000-1300 nm and stellar activity reduced in the near-IR, while SWIR range (900-1700 nm) is blocked by atmospheric water vapor. A single broadband detector avoids dispersive elements. No spectroscopic mode is foreseen. The instrument is strictly photometric (panchromatic only, no spectral discrimination). Wavelength discrimination beyond the single channel is not required.

The following numbers constrain the entire system:

- photometric accuracy better than 100 ppm RMS during 30 min at J-mag 8 (required to confirm Earth-radius transits around M0-M2 stars, with transit depth ~500-1000 ppm and duration of 3-4 h).
- sensitivity better than 1 milli-magnitude (920 ppm) during 30 min at J-mag 12 (covers M3-M5 stars, with transit depths 1000-3000 ppm and duration 1-2 h).
- Noise budget 80 ppm at J-mag 8, or 900 ppm at J-mag 12. These include all noise sources: photon noise, dark current, readout noise, jitter+PRNU, stray light, zodiacal background.

For reference: IACSAT DUNE shall be more than twice better than CHEOPS and more than ten times better than TESS on comparable M-dwarf targets. These precision figures are the key-drivers for the design of the payload as well as for the platform and the operations.

4.1.3 Observation concept

The cadence of observations for the primary science is targeted at more than 1 image/minute throughout observations. Observations are conducted using a single-axis rotating pointing that can last up to 8 hours, called “continuous rotation”. A three-axis inertial pointing option is also considered, see below, called “static field”. With the “continous rotation”, exposure times may range from 2 s to 60 s, and reduced images of 200×200 pixels are generated every minute to download. With the three-axis inertial pointing option, “static field”, a full-frame image is added every 15 min (1280×1024 pixels), in addition of the reduced images of 200×200 pixels per minute. Goal for astero-seismology: 2-5 measures/min, up to 24 h of continuous pointing. The

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timestamp accuracy shall be better than 1 second per measurement, eventually expressed in UTC (needed for complementary observation requests with JWST scheduling).

The sky coverage is of course driven by the Sun direction, but also by the risk of stray light from the day-side limb of the Earth and by the direction and phase of the Moon. The orbit and platform design shall allow the observations of a region – to be identified – greater than 50% of the full sky (2π steradians) during more than 50 cumulative days per year for any target in that region. A dawn-dusk SSO was proven to be feasible, but more flexibility with launch opportunity shall also be assessed (e.g. 10H15-22H15 SSO, more or less inclined orbit, more or less eclipses). The following "all met" conditions shall apply for any observation to be acceptable:

- Sun exclusion angle from the bore-sight ≥ 120° (payload's radiator needs to be protected from light exposure)
- Earth day-side limb exclusion angle from the bore-sight ≥ 35°
- Earth occultation: bore-sight above 100 km altitude
- Moon exclusion angle 10° from bright Moon (TBC, baffle design in process)

Pointing requirements are expressed in the context of a control-loop involving the payload (PFCS) and 2 possible pointing modes, whose only one will be implemented after phase B:

- Pointing stability < 2 arcsec RMS over 8 hours
  - Platform ADCS: APE ≤ 8 arcsec RMS (required), 2 arcsec (goal);
  - Payload PFCS corrects residual from 8 arcsec to 2 arcsec RMS at ≤ 100 (TBC) Hz.

- Pointing modes:
  - "Continuous rotation", required: 1-axis inertial pointing with 3.6 °/min (current baseline) around this axis, with Cut-down images for laboratory calibration only. Then, average data volume during observation (full frame every 1 mn) = ~10kbps.
  - "Static field" (goal): 3-axis inertial pointing during 10 minutes, then 36-degree rotation around bore-sight axis. Then, average data volume during observations = ~33 kbps.

4.2 Payload: 24-cm Telescope in SWIR

Although the payload will not be part of the call, as it is a Customer Furnished Item (CFI), it interfaces with the platform mechanically as well as for pointing, power, data handling, stray-light control and thermal control. The payload covers: the Optical Tube Assembly with mirrors, the baffle system, the Focal Plane Assembly (FPA) with pointing and focus correction (PFCS), the electronics (BEE) and the Thermal Control System (TCS).

The requirements on the payload are expressed as follows, for reference:

- PSF 90%-encircled-energy radius < 9 arcsec (baseline ~8 arcsec), required for source isolation in crowded fields, as well as for background contamination control.
- Flat-field PRNU residual ≤ 0.1%, stable within 0.1% over 8 hours (desirable: 48 h), which demands very precise FPA thermal control.

Payload characteristics (from the SRR):

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- envelope of 750 mm x 500 mm x 440 mm, including baffle (without radiator), nevertheless there is still some flexibility at the interfaces with the platform (e.g. pods) and with the baffle extent, a CAD model will be provided on request.
- associated mass: 24 kg (incl. margins)
- moving parts: a 3-axis piezzo is considered (PFCS), a deployable baffle is still TBC
- 30 W (FPA, PFCS, BEE, TCS) average during observations / 50 W peak from regulated secondary bus (two redundant).
- Data storage (payload): 8 GiB rad-hard flash (3D-Plus)
- Total on-board data production by the payload: 196 MB or 59 MB (resp. with “Static field” pointing or “Continuous rotation” pointing) / day (average) or 210 GB or 64 GB (resp.) over the 3-yr mission
  NOTE: with the science case of “astero-seismology” (priority #3), a peak of data production is expected at 446 to 641 MB in one day, that would impact the on-board storage capacity but not the telemetry requests.

Optical Tube Assembly (OTA) characteristics:

- Ritchey-Chretien Cassegrain, all-reflective, F/5, Equivalent Focal Length (EFL) 1200 mm
- M1: 240 mm clear aperture, AlSi40 substrate (CTE ~10-13 E-6 K^{-1}), Nickel polishing interface, silver-coated with best reflectance accross 550-1700 nm.
- M2: convex hyperbolic, AlSi40, supported by 3-blade spider and an internal baffle.
- Structure:
  - AlSi40 (CTE-matched to mirrors)
  - mounts on platform via titanium bipods
  - interface flatness better than 0.05 mm.
  - M1 on 3 flexural interfaces
  - A fold mirror shortens the OTA and positions the FPA + radiators at OTA top. It can optionally serve as fast-steering mirror (PFCS alternative).
- Cleanliness: AIV in ISO-6; storage/transport in ISO-8. Baffle cover "remove before flight".

Baffle system (still under design, CFI):

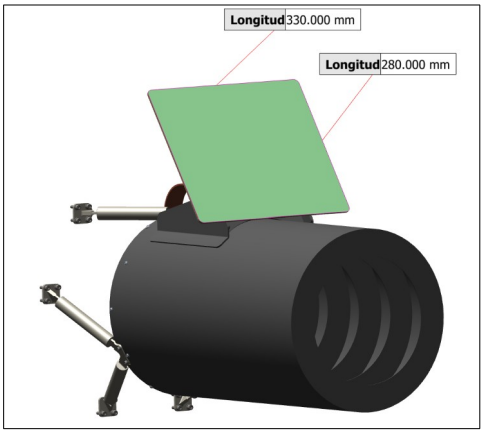
- allows Earth stray-light exclusion angle down to 35°
- external baffle length to reject 35° direct rays from M1:
  - minimal 315 mm
  - baseline: 507.29 mm
- Standard anodising is explicitly EXCLUDED (excessive SWIR reflectance) on the platform within the 35° exclusion angle for Earth stray-light.
- CRITICAL OPEN TRADE: deployable (telescopic) baffle under study within the ESPA Grande envelope (taken as a reference), as doubling the length would reduce exclusion angle to ~13.8°.

Focal Plane Assembly (FPA), for information:

- 1280×1024 pixel sensor for extended-SWIR, with intentional defocus
- FoV: 0.94° circular (circumscribing 0.59° x 0.73° rectangular)
- Passive thermal control properties:

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- Thermal straps from the detector to the radiator (part of CFI).
- The baseline design is the radiator mounted on the baffle (see figure)
- FPA housing: Al, gold-coated exterior, black interior.



Current Radiator Envelope

PFCS (Pointing and Focus Correction System) is a CFI feature under development that can provide a centroiding of the target. The PFCS is 3-axis piezo stage assembly operating on the tertiary mirror:

- target's centroiding is performed by CDPU (CFI) at the same frequency like the scientific exposures (every 2 to 60 seconds),
- tip-tilt (jitter correction) controlled at 100 Hz, based on a MHD sensor.
- Z (focus/defocus) ±200 µm travel of the tertiary mirror (few-grams load).

Back-End Electronics (BEE):

- LEON3FT SPARC V8 architecture, with 16 Mbit MRAM boot, 3 Gbit SDRAM working
- board $\sim 100 \times 100 \times 25\,\mathrm{mm}^3$
- power ~ 6 W (included in the 30 W average power of the payload), input: 12 V or 28 V regulated from platform (two redundant lines)
- Mass memory 8 GiB 3D-Plus rad-hard flash (stores ≥ 3 FSW copies + ≥ 2 days science data + HK)
- SpaceWire TM/TC (PUS protocol)
- PFCS centroid loop and actuator commanding, with attitude error computation (PIL mode, after every exposure).
- FDIR
- PWM heater drivers with EMI filtering.

Thermal control: The OTA and the PFA require a thorough thermal control. The Thermal Control System (TCS) is a CFI. Platform's TRP will be required. For information about Payload's needs:

- detector temperature: -50°C ± 0.1°C (223 K ± 0.1 K) during observations, i.e. up to 8H
- thermal momentum: temperature must stabilize within ~50 min of power-on before observations
- thermal environment: the reference is a Dawn-dusk SSO (~100-min period), the flexibility is LTAN up to 10H00 (or 18H00 and 22H00), then a radiator on the platform would see periodic Earth albedo/IR and orbital eclipse transitions. Hence, active thermal control is expected.
- orbital-period temperature cycling must be absorbed by the TCS.
- passive radiator mounted on the baffle.
- a survival heater is expected, ~20W (included in the 30 W average power of the payload), to keep the detector above -60°C when not observing.
- temperature monitoring is included in the total data volume.

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- BEE thermal control is anticipated: CDPU + PCDU (~10 W total), conductively cooled, thermally isolated from FPA, to be absorbed by the platform.
- Radiative protection from the Sun (in operational angles) and from the Platform is anticipated for BEE / FPA / OTA / Baffle with MLI (which is a CFI)

4.3 Ground facilities

Section 4.4 presents how the tasks are expected to be broken down between IAC and the Operator, with the support of the Prime at some point. This functional analysis comes with the following organization and assets.

IAC provides:

- AIV Facilities for the payload, including:
  - clean rooms at ISO-6 for AIV, ISO-8 for storage,
  - TVAC chamber larger than the payload alone (600L, $710\,\mathrm{mm} \times 710\,\mathrm{mm} \times 710\,\mathrm{mm}$ EUT)
  - Vibration bench up to 50 kg EUT at typical launcher loads (payload level),
  - EMC chamber for parts testing ($50\,\mathrm{cm}\ (\mathrm{L}) \times 70\,\mathrm{cm}\ (\mathrm{W}) \times 40\,\mathrm{cm}\ (\mathrm{H})$ EUT),
  - access to external facilities for radiation tests;
- UHF antenna, La Laguna, Tenerife;
- GSE for the payload (at its facility or at Prime's facility, whose specification is part of the call), including:
  - High-precision optical/mechanical alignment tools and OTA alignment supports,
  - Radiometric equipment for payload calibration (flat-fields, linearity, QE, dark frames, PRNU characterization);
- a location for the SOC (IAC HQ, La Laguna, Tenerife), considering that the MOC-SOC ICD is part of the call;
- a location or agreement for data archiving and a server access for the entire mission;
- the staff to maintain and operate the SOC.

The preliminary analyses showed that 2 antennas in S-band cover the needs for IASCAT DUNE. The Operator shall provide the following:

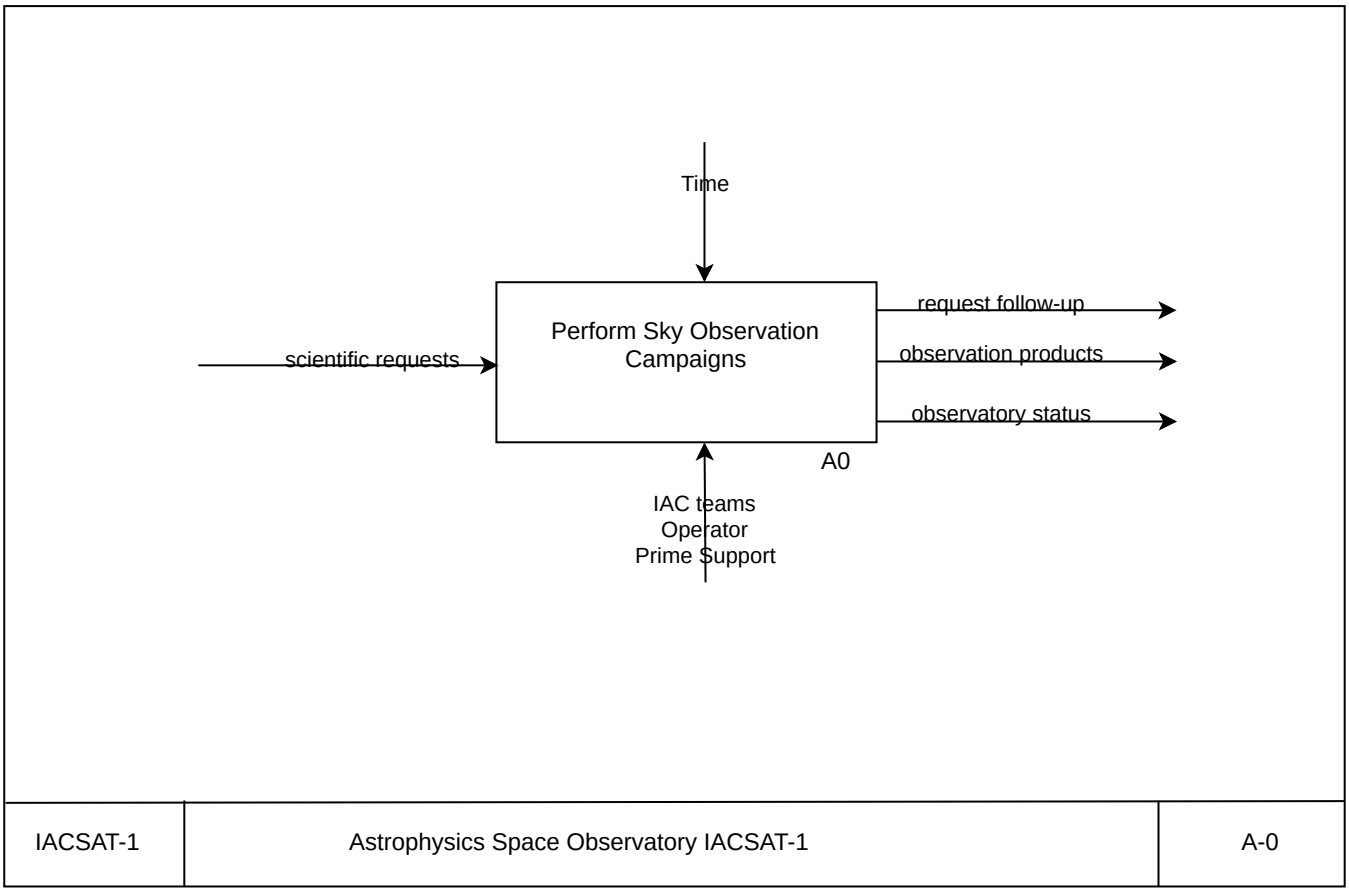
- a location for the MOC in Spain, whose equipment is part of the call;
- S-band antenna(s) in Europe;
- secured / dedicated link via Internet/Intranet between SOC and MOC;
- the staff to maintain and operate the MOC.

MOC is in charge of the orbit maintenance. For this particular task, we highlight that there is not any constraints in terms of Earth observation (nadir, revisits). It essentially consists in:

- establishing and circulating the LTAN of the orbit, during LEOP and later;
- computing the uplink/downlink windows;
- keeping the spacecraft safe;
- keeping the spacecraft within legal constraints (collision alert/avoidance, end-of-mission).

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4.4 Concept of Operations



We define here the features and interfaces that are expected for the whole IACSAT DUNE mission, using the IDEF0 standard*. The purpose of the following Process Booklet (also called “maps”) is to draw the technical perimeters for each player in the future contractual relationship with IAC. We remind that the booklet does not expect to be exhaustive, but it intends to express the needs and the context in a structured way, while keeping consistency from one process to another.

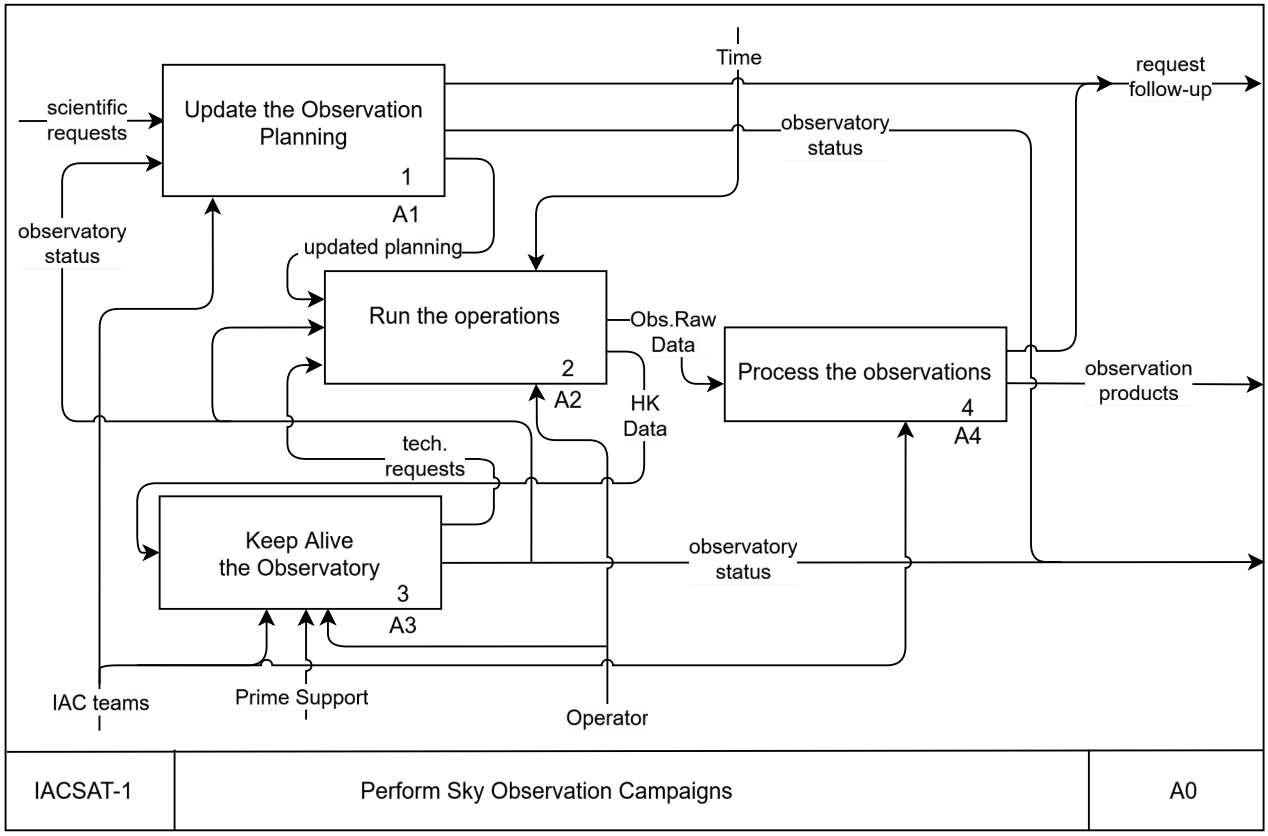
The mission, as a whole, will provide astrophysics space observations according to requests coming from the scientific community. The requests are translated into observation campaigns, making the “time” the only external trigger of the mission. The resources involved in the operations are teams from IAC, the Operator and platform’s Prime (technical support). In addition of performing observations, the mission includes a follow-up of the requests and some communication about the space observatory towards the broader community.

As “definitions”, the interfaces and their names are requested to be adopted within the dialog between all players. Nevertheless, such definitions can be modified, upon request and traceability.

* “Integration Definition for Function Modeling”, National Institute of Standards and Technology (NIST, 1993)

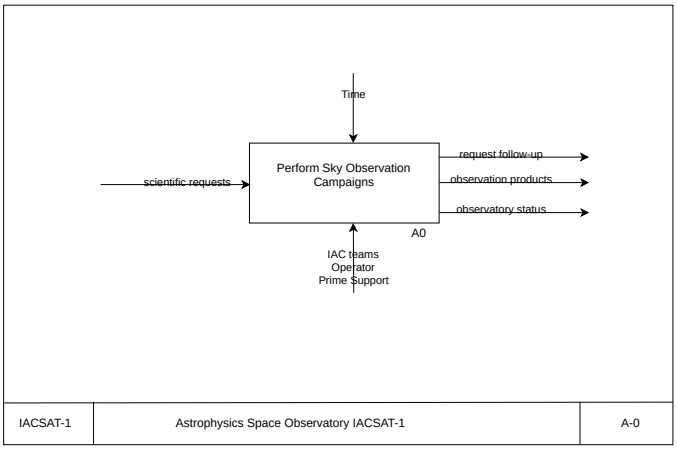
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4.4.1 A0: Perform Sky Observation Campaigns



IACSAT DUNE is meant to perform campaigns of multiple observations of the same inertial targets in the sky. Its primary users belong to a scientific consortium led by IAC scientists. Nevertheless, the observatory is offered to the broad community via calls for scientific requests, submitted to IAC for a possible implementation (1), generating a follow-up of the requests. When a request is approved, a planning for observations is issued, to be inserted in the flow of the operations (2) under Operator's management. As a permanent activity, IAC and the Operator coordinate to respectively monitor the payload and the platform (3), issuing a status of the observatory, that could also be adapted for programmatic reasons within the activity (1). After the observations, the raw data are processed, along with the HK data (on a permanent basis) from the platform and the payload: various data products, from L0 to L3 data, are issued and the initial requests are updated to their authors.

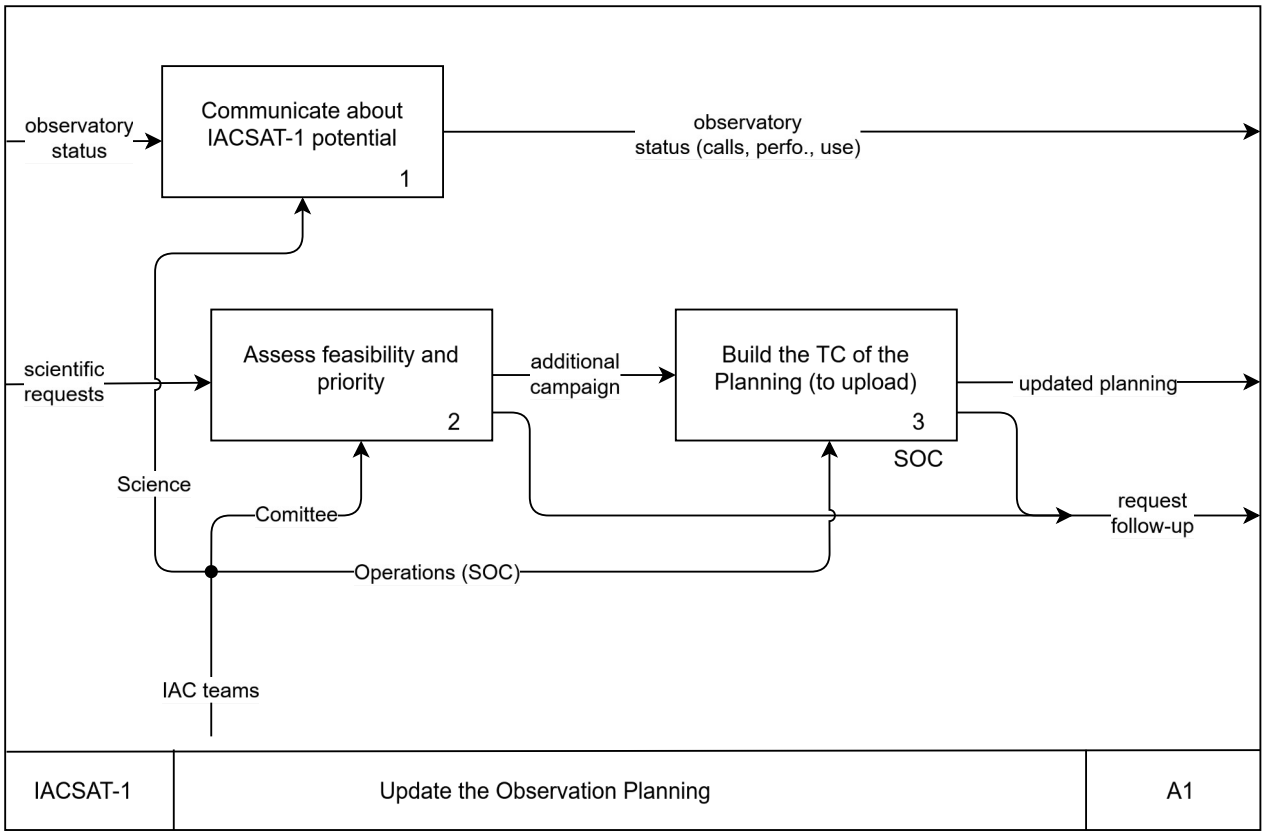
Processes (1), (2), (3), (4) of this map A0 are detailed in maps A1, A2, A3, A4.



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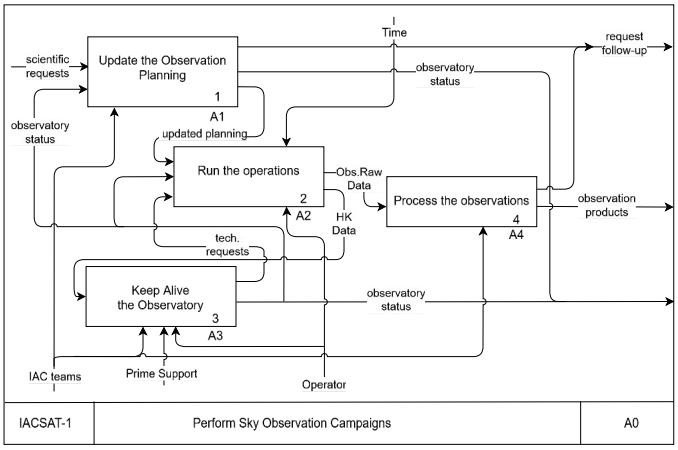
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4.4.2 A1: Update the Observation Planning



The observation planning is updated whenever a scientific request is accepted by IAC. This process assumes that IAC communicates about IACSAT DUNE's potential (1) via calls for observations and via technical documentation on the performance and the use of the telescope. Then, on a regular basis, requests are evaluated based on their scientific interest and their technical feasibility (2), by a committee supported by an implementation team. The result of an acceptance is a new planned campaign with some rules for priorities and contingencies. It comes in addition to the already planned operations (3). It is SOC's responsibility to build the TCs that contain both the planning and the parameters for observation, then to combine them with the previously planned TC. At each stage of the process, a follow-up shall be sent to the author of the request.

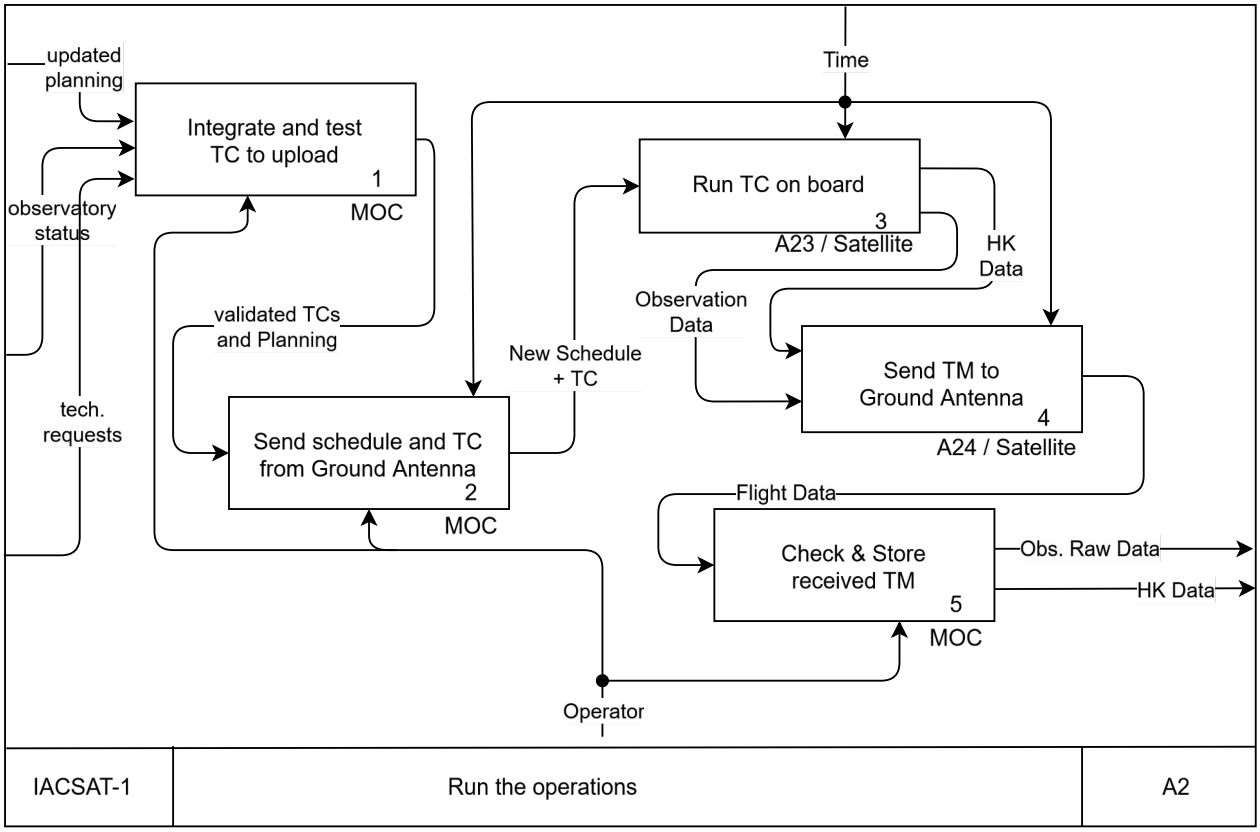
(A1 will not be detailed further in this document)



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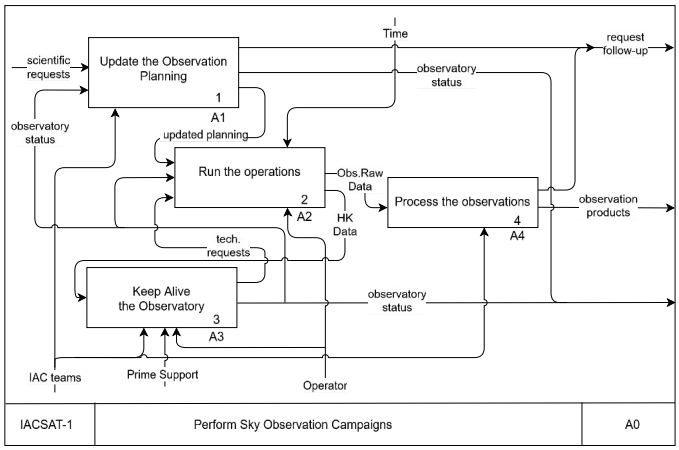
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4.4.3 A2: Run the Operations



The “updated planning” includes the previous planning and the observation campaigns, as requested by the SOC (see A1). They are combined with new technical requests and possible constraints (see A3) for their integration and test before sending (1), under Operator’s management, which yields a planning of TCs, along with the code of any new TCs. All this is uploaded to the satellite when it passes over an antenna (2). Once retrieved on board, the TC are run at the expected time (3), which produces observation data as well as HK. At the planned time corresponding to a pass over a ground station, an on-board TX command sends these data to the ground (4). On ground, the signal is retrieved, decoded into TM for observation and HK TM, stored and distributed as needed.

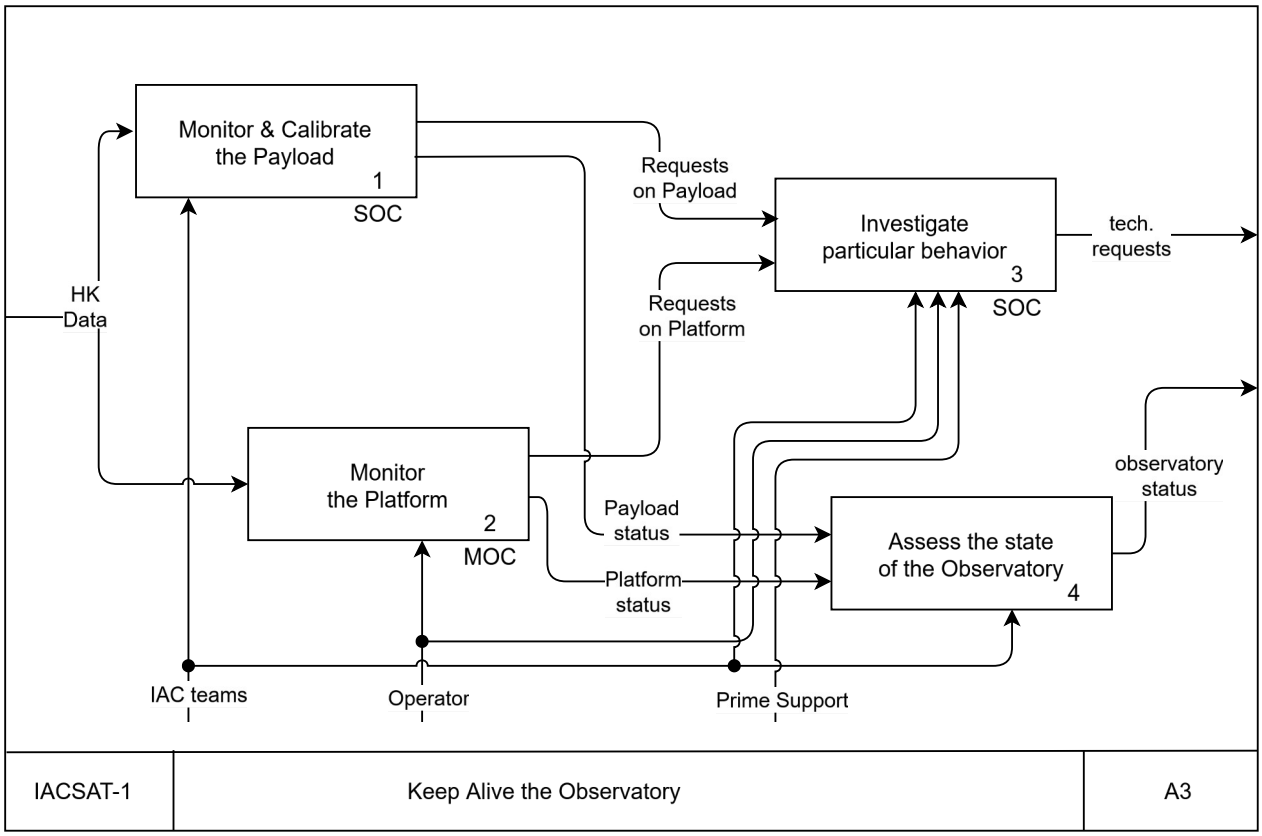
Processes (3) and (4) of this map are detailed further into maps A23 and A24.



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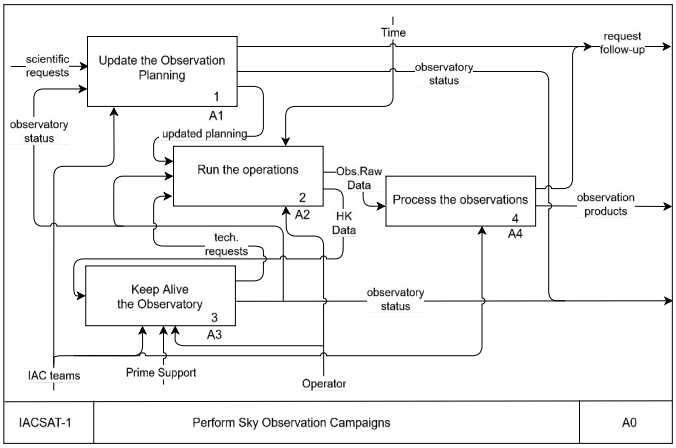
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4.4.4 A3: Keep Alive the Observatory



In order to watch for the safety of the space observatory, HK data are processed at the SOC for the payload by IAC (1) and at the MOC for the platform by the Operator (2). Calibration needs or alerts based on on-board data, on missing data or ground alerts (collision risk) may trigger additional actions: if an urgent action is required, it goes under MOC's responsibility. In any case, non routine operations are considered as "requests" on payload or platform and are further investigated by SOC (3), with the Operator and Prime's support, as they may result in additional technical requests to upload to the spacecraft. Routine and non-routine status of the payload and the platform is further processed by IAC as an "official status" of the space observatory (4).

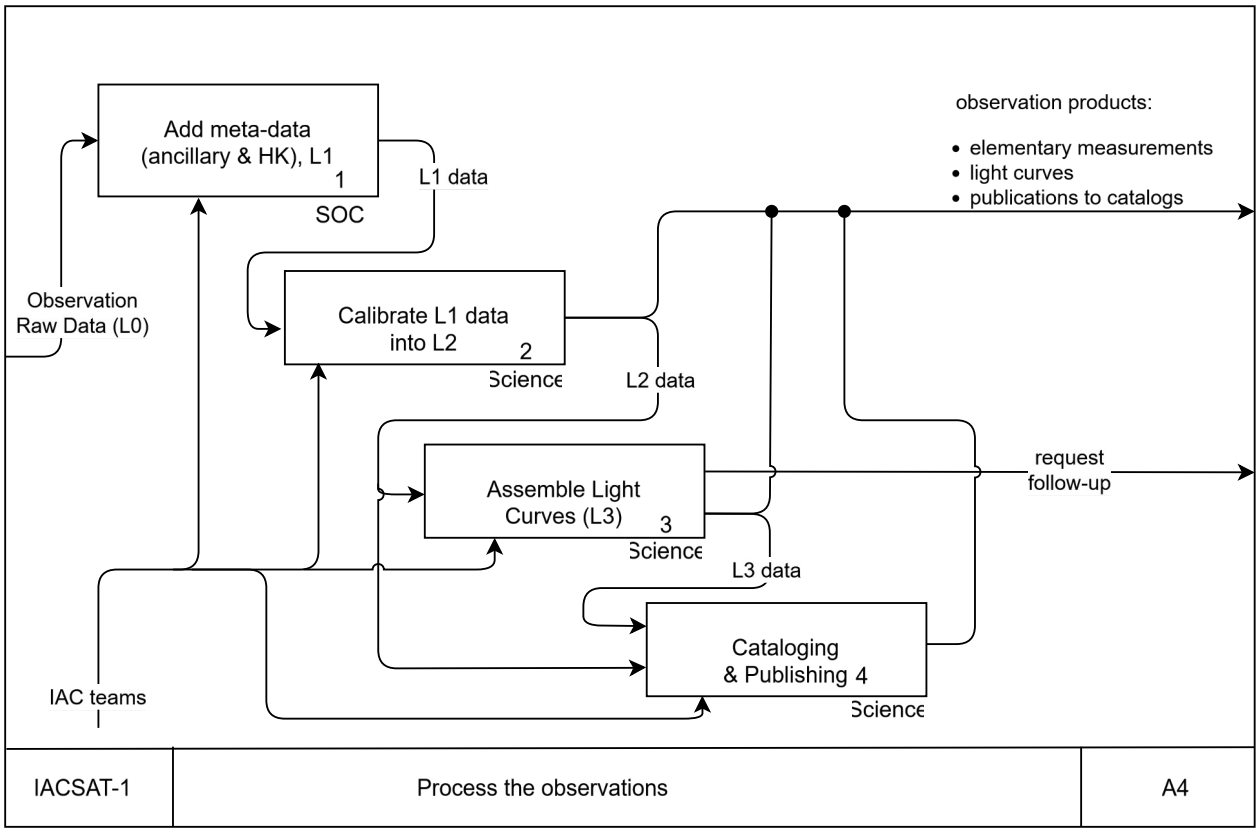
Processes in map A3 are not further detailed in this document.



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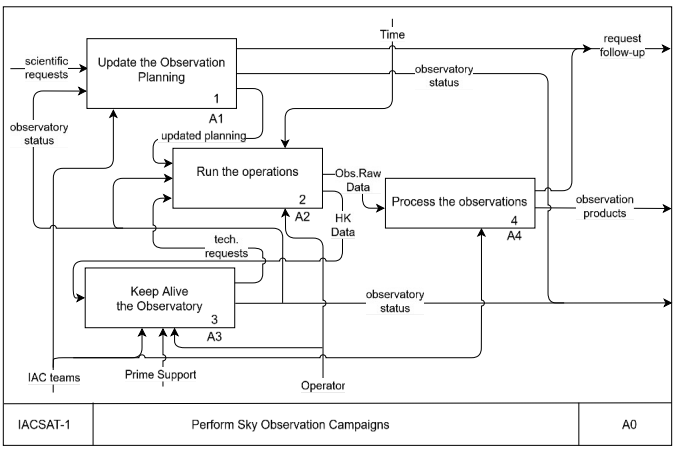
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4.4.5 A4: Process the Observations



This activity produces, stores and distributes the expected scientific products in addition to raw data: Level 1 for ancillary and operational data at the time of observation, such as pointing data or temperatures (1); Level 2 for data following instrumental calibration and conversion to photometric data (2); Level L3 for high-level data like light curves, fitting to a photometric transit model, spectral analysis of intensity... (3). Finally, a data dissemination activity (4) involves publishing and indexing these data in various astrophysical resources (e.g., the Strasbourg Astronomical Data Center).

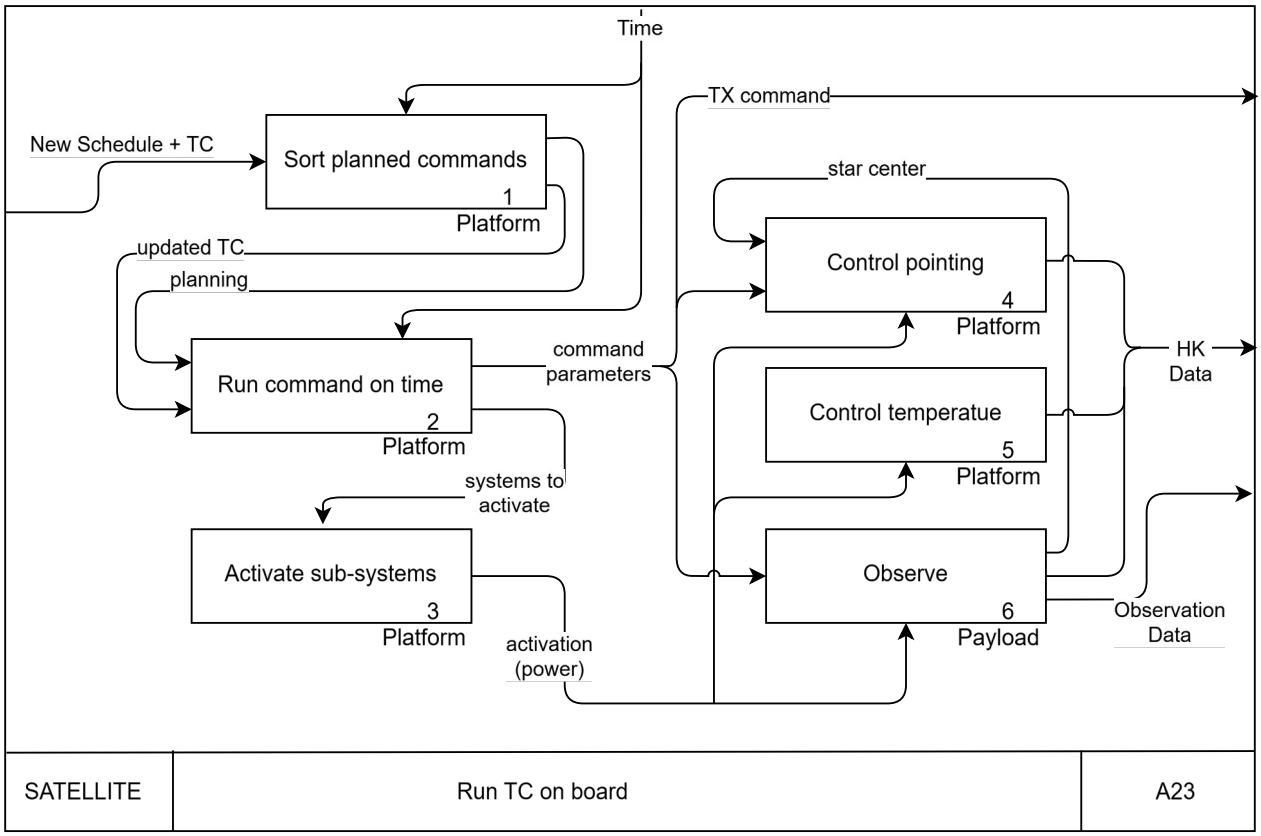
Processes in map A4 are not further detailed in this document.



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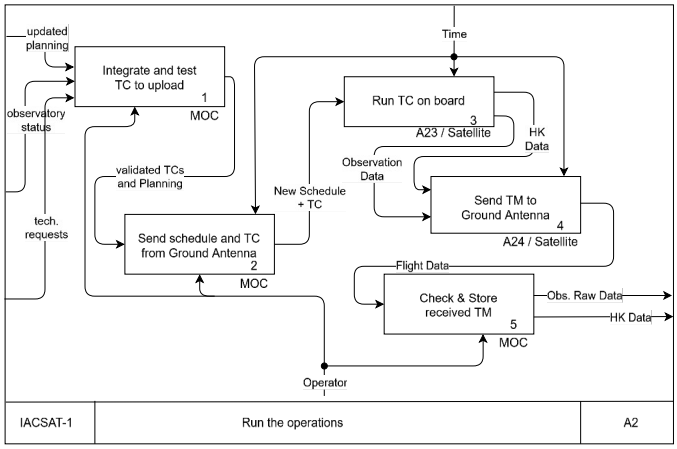
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4.4.6 A23: Run TC on board



This process is entirely on board the satellite. It is detailed to show the payload-platform interfaces. When TCs are received, they are sorted in ascending time (1). A TC is triggered at the commanded time (2). Then, the platform is in charge of powering on the systems associated with the TC or a "mode" (3), including the payload whenever involved. The platform also computes and sends the needed commands to control the pointing (at platform level, 4) and the temperatures (at platform level, 5). It also passes the payload TC (i.e. digital parameters) to the payload itself (6). All systems send HK as long as they are on. In addition the payload can compute on-the-fly a direct measure of the pointed star photocenter as projected on its CMOS, and offer it as an additional sensor to the platform's ADCS. Depending on the target, this information is computed every 2 to 60 s.

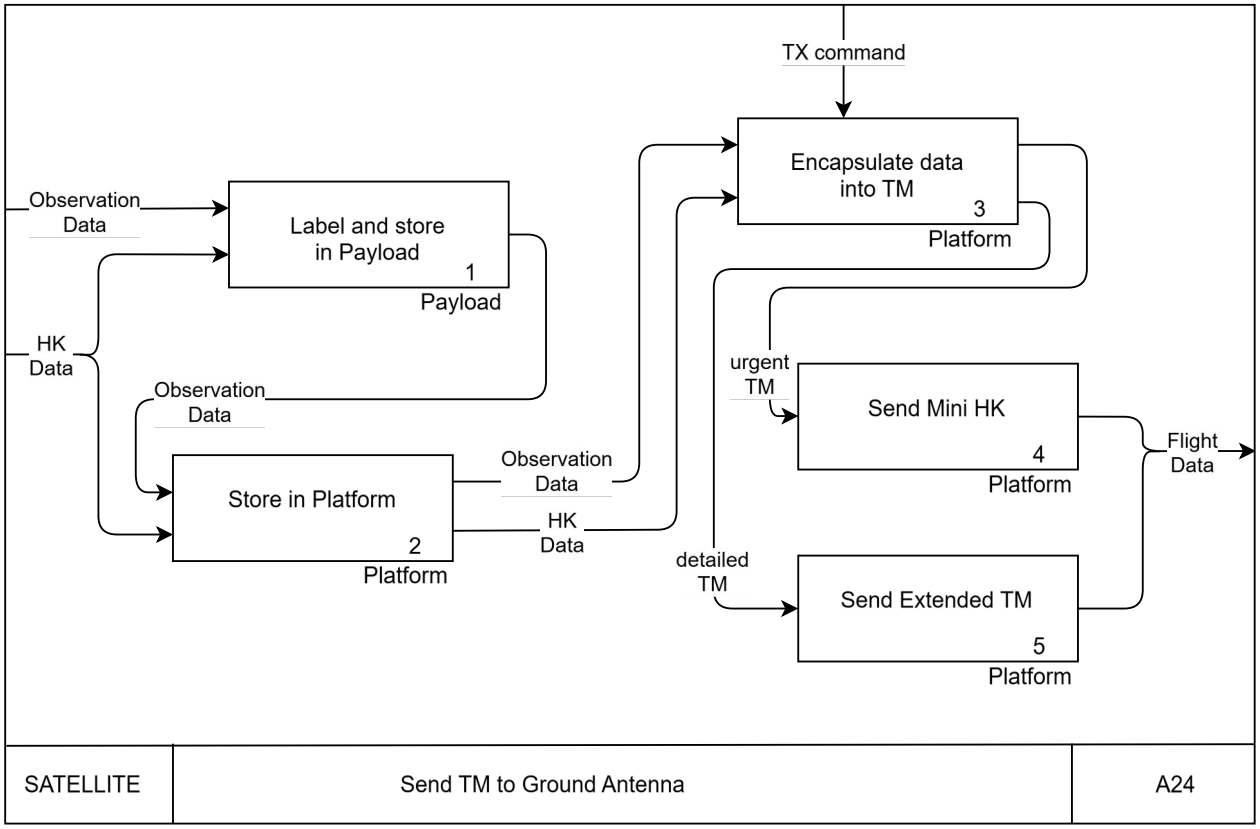
Processes in map A23 are not further detailed in this document.



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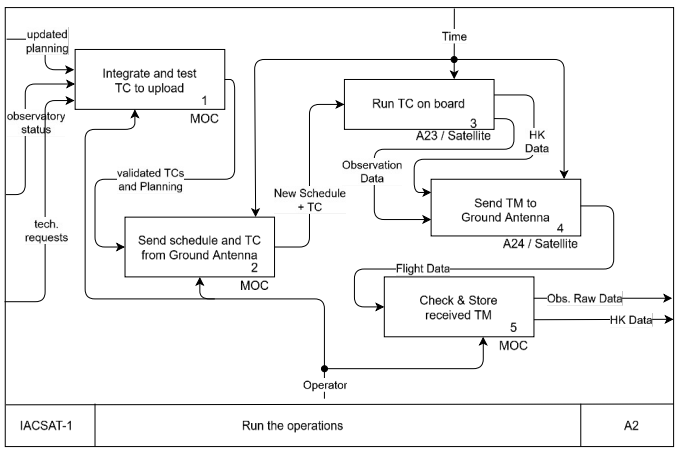
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4.4.7 A24: Send TM to Ground Antenna



Observation data are initially labeled with locally available data (target ID, exposure, detector temperature) and HK (timestamp, platform temperatures, pointing determination) and stored in a buffer of the payload (1). Eventually, the labeled observations are sent to the Platform. The platform stores its own HK data, as well as the labeled observations as quick as possible to free the payload memory (2). For the next planned communication pass, the platform encapsulates all data (3) and prepares the packet stack to be sent according to the default procedure or any special TC for retrieving specific data (TX command), resulting in two possible fluxes: urgent TM and detailed TM that are sent by the platform, (4) and (5), once the telecommunication protocol is established.

Processes in map A24 are not further detailed in this document.



(reminder of the upper map)

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4.5 Model Policy

The model policy shall cover the development needs, which are not defined yet. We anticipate the following models that can still be discussed with the Prime:

- Phase B: ADCS functional simulator (software) to inject stimulations and interface with the payload, and with the PFCS in particular.
- During phase C, as input to freeze the design before production:
  - STM of platform's mechanical and thermal interfaces with payload, for assessment of integration and thermal tests;
  - EQM of the Long Lead Items as a Spare Kit;
  - MOC's SOC/MOC software interface (API structure with remote and local protocols).
- Phase D:
  - OBSW simulator (SVF), for TC/TM validation by the ground segment.
  - PFM (i.e. the final delivery).

If needed, IAC can provide the following models for early tests, to be returned before LEOP:

- Payload STM, representative for housing, vibration, shocks and thermal control;
- Payload EM or EFM, as a ground twin.

5 Requests

5.1 Requirements on the Platform

We summarize here the requirements for the platform that will have to be addressed in an application to potential future funding and/or procurement opportunities, subject to confirmation by the competent authorities, to support IACSAT DUNE project, in accordance with the presentations in Section II.

The platform's Prime shall deliver the platform with the integrated payload to the launch provider. A ROM Cost specific to the platform must be provided. It shall cover the following aspects:

- phases B2 (a B1 phase has already started) to D, E for LEOP and technical support, and F;
- management, hardware and software interfaces with the payload in phases B2, C, D;
- documentation shall always distinguish between product's base-line and customization ("off-the-shelf adapted") for PDR (B2), CDR, AR, FRR, CRR, according to ref. ECSS-M-ST10C;
- models: ADCS functional simulator, limited STM, EQM for LLIs only, limited OBSW, PFM;
- the orbit and platform shall allow the observations of 50% of the full sky (2π steradians) during more than 50 cumulative days per year for any target in that region with the most tolerant LTAN, also considering the possibility of an extended baffle;
- the APE is 2 arcsec (goal), 8 arcsec (required) during up to 8 hours, considering the possibility to include the payload's PFCS as an additional sensor for the ADCS;

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- both pointing modes “static fields” and “continuous rotation”, with arbitration at the end of phase B (i.e. after the ITT process);
- Thermal radiative and conductive properties of the platform at their interfaces;high degree of autonomy during routine operations (i.e. low degree of interaction with MOC).

The launch will be procured within a separate contract. Nevertheless, the platform’s Prime must include a ROM Cost for the launch in its offer, but only as an option.

5.2 Requirements on the Ground Segment

We summarize here the requirements for the platform that will have to be addressed in an application to potential future funding and/or procurement opportunities, subject to confirmation by the competent authorities, to support IACSAT DUNE project, in accordance with the presentations in Section II.

The ground segment can be based on an existing design but it must be adapted, i.e. simplified, for the use of a sky observatory: inertial pointing to the sky is the main operational mode (not ground tracking), with a limited orbit maintenance to keep LTAN within specifications and to allow End-of-mission operations (controlled de-orbit). As an indication, after full commissioning, we expect the MOC to be operated during routine operations by 1 staff with a maximum of 2 hours per day, 5 times a week, in addition of having 1 staff on call 24/7 for urgent operations like weather alerts or collision alerts.

The ground segment’s Prime shall deliver the MOC’s hardware to be hosted at Operator’s facility, to be connected to IAC’s SOC at IAC facility and to make use of Operator’s antennas as the operational base-line. A ROM Cost specific to the ground segment must be provided. It shall cover the following aspects:

- phases B2 (a B1 phase has already started) to D, technical support (including maintenance) in phases E and F;
- management, hardware and software interfaces with the Operator and with SVF model in phases B2, C, D;
- documentation shall always distinguish between product’s base-line and customization (“off-the-shelf adapted”) for PDR (B2), CDR, ORR, according to ref. ECSS-M-ST10C;
- model: MOC’s SOC/MOC software interface.

The launch will be procured within a separate contract. Nevertheless, the ground segment’s Prime can include the ROM Cost for the launch in its offer, but only as an option.

5.3 Expected Answers

Subject to the applicable rules of the future funding or procurement procedure, IAC may engage in further technical discussions with respondents whose proposed solutions are considered compatible with the mission needs.

5.3.1 Synthesis

Compliance matrix wrt. Questionnaire in §5.3.2:

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- base-line: compliant / Partially / Non-compliant
- after offered modifications
- additional requirements on CFI (Customer Furnished Item)

5.3.2 Detailed answers

Questionnaire?

- Maturity of the main systems (TRL assessment, for base-line and modifications)
- Pointing stability
- Thermal properties
- Contamination risk on optical parts
- Power performances
- On-board data handling ↔ TT&C
- Interfaces as defined in §4.4
- Reviews and interactions with CFI?
- Procurement strategy (LLI?)
- indicative schedule (with milestone for CFI interactions)
- target of the cost breakdown in terms of studies (incl. management), models (incl. PFM), integration, commissioning, customer support during routine operations

5.3.3 ROM Cost:

- base-line design
- anticipated modifications
- breakdown per phase (separate orders are likely for phases B2, C, D, launch, E, F)
- specific ROM Cost for LLIs as EQM
- uncertainty margin (+/-)

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