

Sentinel-2 Presentation GSC days

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- **S2 Mission, System & Satellite requirements**

- S2 Mission requirements
- S2 System requirements
- S2 Satellite requirements

- **S2 status at SRR**

- S2 Satellite design

- **S2 Procurement philosophy**

- S2 Development logic
- Main characteristics

- **S2 ITT status**

- Peculiarities & Risks

- **S2 compliance to Land User Services**

- A unique tool for Europe
- Fast Track Services
- GSE's

- **Towards S2 Phase B2 start**

- Way forward

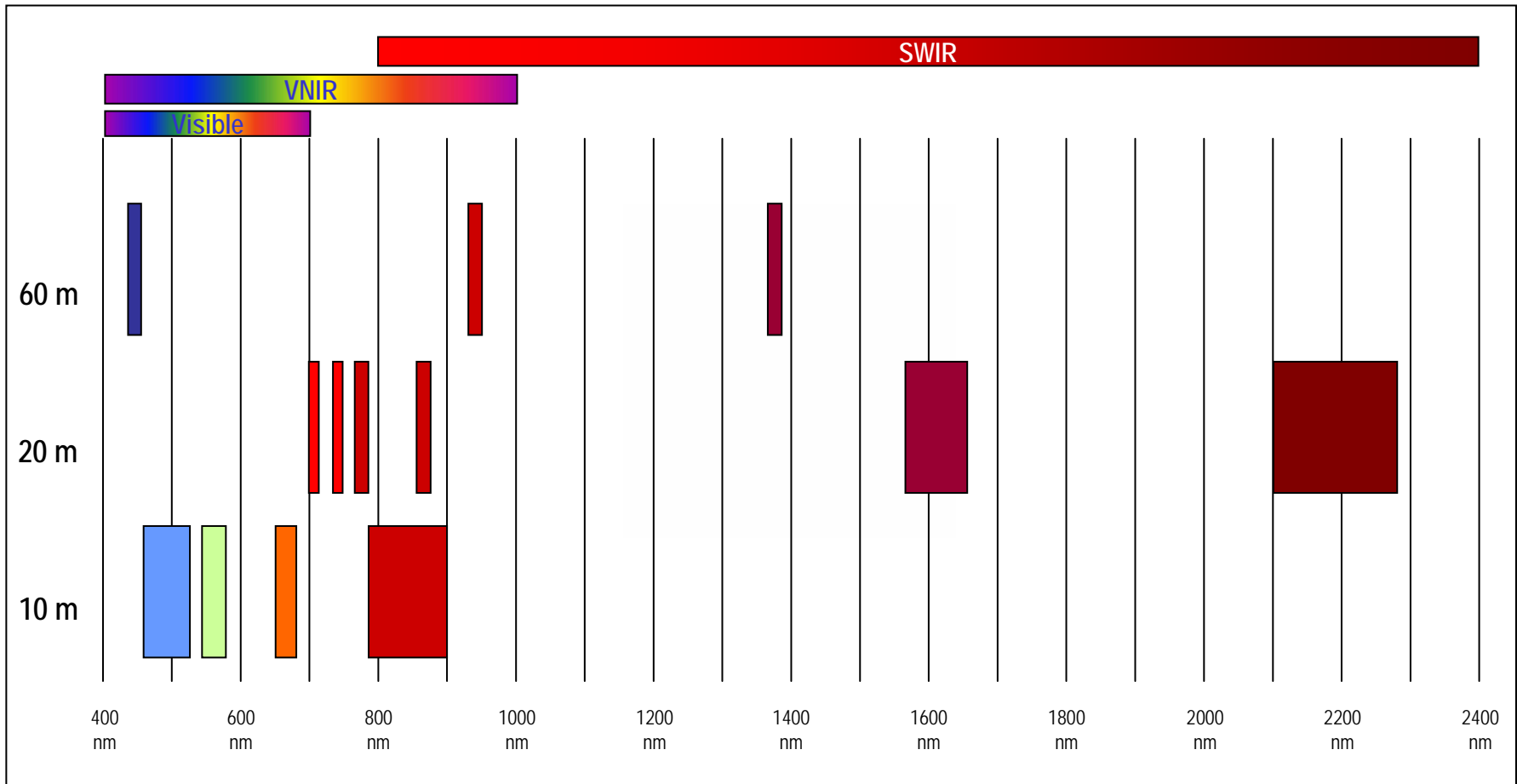
S2 Mission Requirements

- **Global land surface coverage (except Antarctica)**
- **Operational Land Cover maps and land variables analysis (leaf area index, leaf chlorophyll content, leaf water content, fraction of photo-synthetically active radiation - fAPAR)**
- **Products update mostly required every few days/month for every season, depending on product type**
- **Mission well consistent with ESA GSE & EC GMES Land Fast Track Services objectives (see later VG's)**

S2 Mission Requirements

- **Frequent revisit & high mission availability:** 2 Satellites with 290 Km swath using a single instrument (120 Km for SPOT5, with 2 adjacent instruments) operating simultaneously (180° phasing in orbital plane) for **5 day revisit** – 1 Satellite will provide 10 day revisit (26 days for SPOT5)
- **Continuous Land + Islands carpet mapping** imaging within the latitude range -56 deg / +83 deg
- **10m-20m-60m spatial resolution (VNIR-SWIR)** to identify spatial details consistent with 1 ha Minimum Mapping Unit
- **Accurate geo-location < 20 m** without use of GCP's (50 m for SPOT5)
- **Very good radiometric image quality** (combination of onboard absolute and on ground vicarious calibration)

S2 Mission requirements



13 spectral bands versus spatial sampling distance

S2 Mission requirements

(Wavelength nm/Width nm/SSD m)

MSI spectral bands	Mission objective	Measurement or Calibration
B1(443/20/60), B2(490/65/10) & B12(2190/180/20)	Aerosols correction	Calibration bands
B8(842/115/10)/B8a(865/20/20), B9(940/20/60)	Water vapour correction	
B10(1375/20/60)	Cirrus detection	
B2(490/65/10), B3(560/35/10), B4(665/30/10), B5 (705/15/20), B6(740/15/20), B7(775/20/20), B8(842/115/10)/B8a(865/20/20), B11(1610/90/20), B12(2190/180/20)	Land cover classification, Leaf chlorophyll content, leaf water content, LAI, fAPAR, snow/ice/cloud, mineral detection.	Land measurement bands

SPOT5 bands: 4 multi-spectral channels + panchromatic channel between 0.49 um and 0.69 um.

S2 System requirements

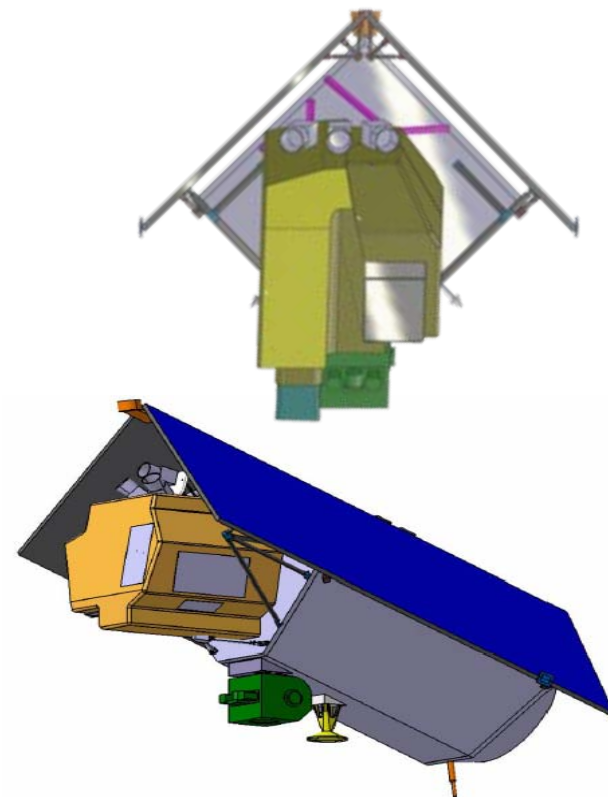
- **4 Core X band Ground Stations necessary for full Mission data recovery by the GMES PDS. 450 Mb/sec Mission data rate, and 2 Tbits Solid State Mass Memory**
- **2 weeks Satellite autonomy** and maximum decoupling between Flight Operations and Mission Exploitation → **robust Satellite FDIR**
- **Five key system analysis** to be conducted during Phase B2:
 - S2 Mission Data compression ratios optimisation
 - PLDHS & X band communications subsystems consolidation
 - Analysis & specification of Satellite crypto functions, shared with S1 and S3 (under ESA lead)
 - Mission Data recovery scenario analysis, given the simultaneous operations of S1, S2 and S3 (under ESA lead)
 - Thermal analysis for Instrument/Equipment accommodation, for consolidation of an adequate SA concept (not necessarily the roof type)
- Complete set of deliverables and service support requirements for **support to Mission Operations and Mission Exploitation until EOC**

S2 Satellite requirements

- **Sun-synchronous orbit** at 786 km altitude (14 + 3/10 rev/day)
- **Local Time Descending Node: 10:30** (compromise between cloud cover minimisation and sun illumination)
- **Mission Data recording and dump combined with Real Time transmission capability**
- **Quick access (1 to 3 days) to limited geographical areas in emergency mode with a Satellite tilted lateral look (+/- 20 deg – reaction wheel mode – available on SPOT5 with tilting mirror)**
- **Satellite Operations & Mission Data Exploitation: requirements commonality with S1 and S3 to the maximum extent. Reliability of the Satellite > 0.7 after 7 years**
- **Prototyping of the SWIR & VNIR detection chains during Phase B2 (filters, detectors, FPA) + dichroics separation. Engineering pre-development activities initiated by ESA handed over to the Prime Contractor.**


S2 Satellite design from Astrium-ED

- Body-mounted solar array configuration
- AOCS with star trackers, coarse gyro-meters and GNSS receiver
- Downlink data rate: 450 Mb/s (X-band, 8PSK)
- Mass: 1000 kg, incl. 200 kg for the MSI, 35 kg for the IR payload (optional) 80 kg propellant (hydrazine)
- Power: 1175 W max, incl. 170 W for the MSI and <100 W for the IR payload
- 7-year design lifetime, consumables for 12 years
- Push-broom instrument, 15 cm pupil Ø
- TMA telescope, 290 km swath width
- State-of-the-art lossy compression (wavelet-transform)
- On-board calibration + vicarious calibration
- VNIR Focal plane: CMOS (or CCD)
- SWIR Focal plane: cooled MCT detector hybridised on CMOS read-out circuit



S2 Development logic

Phase B2 - 12 m


**C/D/E1
conversion
to FP**

Phase C/D - 39 m

Phase E1 - 6 m



- Mission Analysis for concept consolidation
- Specs/plans/IF definition
- Consortium selection (best practices)
- Orders placed for LLI's
- Risky pre-developments
- First version of programme docts

- Instrument/Satellite EM/Virtual EM Programme
- Non-flight deliverables development
- Test & Verification phase (qualification of design/acceptance of model)
- SVT programme
- Support to PDGS for operational processor development

- Support to ESA for launch campaign
- Support for operational processor validation
- Preparation & support to execution of LEOP & IOC



PDR



CDR → QR → FAR



FRR → ORR → LRR → IOCR



EC → esa

2012

Main characteristics

- **Open competition**, with Prime to select **core team Partners** for risky developments, or when a unique expertise is available in Europe.
- **Prime responsible for all Satellite external Interfaces** (with GS for Satellite Operations & Mission Exploitation, for demonstration of Satellite compatibility with 2 launcher services until CDR).
- Prime Contractor to identify **commonality of requirements/design with other Satellite** projects (e.g. for X band, PLDHS, SA & Mechanisms): procurement under best practices procurement (ESA control).
- Requirements to ensure **fair distribution of activities between Prime / Non Prime** companies (target is > 45% of price under best practices)
- **ESA launcher policy: VEGA** as baseline launch service
- **Tight geo-return constraints** taking the S1 industrial set-up and the S3 ITT geo-return requirements into account

Peculiarities & Risks

- **MSI detection chains:** 13 spectral channels, 10m SSD and 290Km swath → Phase B2 to focus at technological pre-developments initiated by ESA → handover to Prime at Phase B2 K.O
- **Compression/PLDHS** (from 1.3Gb/s to 450 Mb/s) → further validation during Phase B2 by the Contractor (margin up to 460 Mb/s) → enable commonality of PLDHS and X band subsystems between Sentinels.
- **Commonality** to be proposed by the Contractor in core tasks, and/or to be achieved through best practices, based on S1 PDR status (S1 is 7 months ahead of S2).
- **Security** (common to S1/S2/S3): Phase B2 concurrent study for the 3 Sentinels led by ESA → enable common design of crypto functions for security → standardised GMES GS implementation.
- **S2 System Performance:** GPP (L1a/1b/1c) and SPS (GPP + simplified L2) used by the Contractor (baseline verification) and by ESA (concurrent validation) → track Instrument/Satellite performance vs MRD/SRD along the program development → **capability to reliably report to User Communities & EC.**
- **Specification of System Deliverables + Engineering Support Services:** Launch campaign (Project), Mission Operations (ESOC), and Mission Exploitation (ESRIN).

A unique tool for Europe

- Sentinel-2 system capability to address Land & Emergency Fast Track Services (draft FTS reports from EC) & Forest, Risks, GMFS, Land and Respond GSE's (GSE's from ESA/ESRIN): derived from **ideal operational or added value Service expectations expressed by Land User communities/added value industries & institutions.**
- **The S2 system can address fully 80% of the allocated FTS/GSE User services:** significant improvement wrt SPOT5 and Landsat services (e.g. 10 days/13 bands/290Km swath for 1 operational S2 satellite versus 26 days/5 bands/120Km for SPOT5).
- Coverage of the remaining 20% (i.e. for SSD < 10m) would require an unaffordable leap towards a <multi-satellites/wide swath/multi-channels system>: **these User services will be better addressed within GMES using nationally/ESA operated missions** (e.g. Pleiades, Rapid-Eye, SEOSAT, VEN μ S).
- The S2 system will permit the **development/validation of yet undefined operational User services over the next two decades**, like in the area of vegetation or terrain qualitative analysis, thanks to the S2 system radiometry performance & unique set of spectral bands.

Fast Track Services

Fast Track Service (Land Monitoring Core Services)	Compliance of the S2 system
Geographical coverage	All land areas/islands covered (except Antarctica)
Geometrical revisit	5 days revisit cloud free fully in line with vegetation changes
Spectral sampling	Unique set of measurement/calibration bands
Service continuity	S2 PFM launch in 2012: no continuity with SPOT5/Landsat after 2010?
Spatial resolution	< 1 ha MMU fully achievable with 10m SSD
Acquisition strategy	Systematic push-broom acquisitions, plus lateral mode capability for emergency events monitoring

Fast Track Service (Emergency Response Core Service)	Compliance of the S2 system
Spatial Resolution down to 5m	Reference/damage assessment maps limited to the 10m SSD
Accessibility/timeliness down to 6 hrs offline & 24hrs in NRT	Fully compliant (retrieval of already archived reference data in less than 6 hrs, and delivery of data after request in NRT in 3 hrs for L1c)

GMES Service Elements

GSE (Forest monitoring)	Compliance of the S2 system
Geographical coverage	All specified areas covered
Geometrical revisit	5 days revisit satisfy requirements on forest monitoring
Spectral sampling	13 spectral bands make S2 a very powerful tool for accurate vegetation monitoring
Spatial resolution between 5m and 30m	Limited to 10m

GSE RISK EOS (fire, floods)	Compliance of the S2 system
Geographical coverage	All specified areas covered
Geometrical revisit (daily to annual)	5 days revisit satisfies nearly all requirements on forest monitoring. Lateral view mode can be used
Spectral sampling	13 spectral bands make S2 a very powerful tool for accurate vegetation monitoring
Spatial resolution between 5m and 30m	Limited to 10m (below 10m, use Pleiades or SEOSAT)

GMES Service Elements

GSE GMFS	Compliance of the S2 system
Geographical coverage	All specified areas covered
Geometrical revisit (growth from planting date)	10 days already compliant
Spectral sampling (based on SPOT5 and Landsat bands)	10 bands in VNIR and 3 bands in SWIR make S2 a very powerful tool for accurate vegetation monitoring
Spatial resolution between 20/30m	Fully met with 10/20m SSD resolution

GSE Land	Compliance of the S2 system
Geographical coverage of Europe	All specified areas covered
Geometrical revisit	5 days fully compliant
Extended spectral sampling vs SPOT5 and Landsat bands: add 2 SWIR band for Mediterranean vegetation/fire scars monitoring, crop types/erosion/water	10 bands in VNIR and 3 bands in SWIR: very powerful tool for accurate Land monitoring
Spatial resolution allowing 1 ha MMU	Fully met with 10m to 20m SSD resolution for measurement channels
Acquisition strategy	Push-broom/290 Km swath/10m SSD mission with 2 satellites: very powerful/flexible tool for Land observations Users

GMES Service Elements

GSE Respond	Compliance of the S2 system
Global Geographical coverage	All specified areas covered, between 83deg N and -56deg S + islands > 100 KM ²
Geometrical revisit for mapping services with weekly update	5 days fully compliant
Spectral sampling	10 bands in VNIR and 3 bands in SWIR make S2 a very powerful tool for accurate Land monitoring
Spatial resolution (1m to 30m SSD for maps)	Partially met with 10m to 20m SSD resolution
Acquisition strategy	Push-broom/290 Km swath/10m SSD mission with 2 satellites make S2 a very powerful and flexible tool for Land observations Users

Way forward

S2 PHASE B2/C/D/E1 ITT PROCESS	DATE	PHASES
Pre-TEB and ITT released on EMITS	16 Feb 2007	End of the TEB preparatory Phase
S2 ITT bidding period	17 Feb → 7 May 2007	Bidding Phase
Tender Opening Board (Proposals received)	7 May 2007	Proposals Analysis Phase
Proposals Review	May/June 2007	
Panel Reports issued to TEB Chairman	End June 2007	
Tender Evaluation Board	27 June 2007	Contractor Selection Phase
Issuing of approved TEB report	Beginning of July 2007	

S2 Phase B2/C/D/E1 Contract Proposal to IPC with the goal to start B2 before end September 2007