GMES SENTINEL-1 INDUSTRY DAY

ALCATEL ALENIA SPACE
An Alcatel/Finmeccanica company

Morning Agenda

PRESENTED ITEM	PRESENTATION RESPONSIBLE	DAY TIME
ESA PRESENTATION		
1. Introduction	ESA	
2. Mission & Program Objectives	ESA	9:30 – 9:50
3. Procurement Rules	ESA	
INDUSTRY PRESENTATION - PLENARY SECTION		
4. Mission and Operation Concept	AAS-I	9:50 – 10:00
5. Spacecraft (S/C) Concept	AAS-I	10:00 – 11:55
6. S/C Development Models, AIV/AIT, EGSE, MGSE	AASI	11:55 – 12:05
7. Program Phases	AASI	12:05 – 12:10
8. Industry Core Team and Procurement Items/ Responsibilities/Planning	AASI	12:10 – 12:25
9. Procurement Organization	AASI	12:25 – 12:35
10. Conclusions; Afternoon Splinter Meetings Organization	AASI	12:35 – 12:40
11. Points of Contact at Industry	AASI	12:40 – 12:45

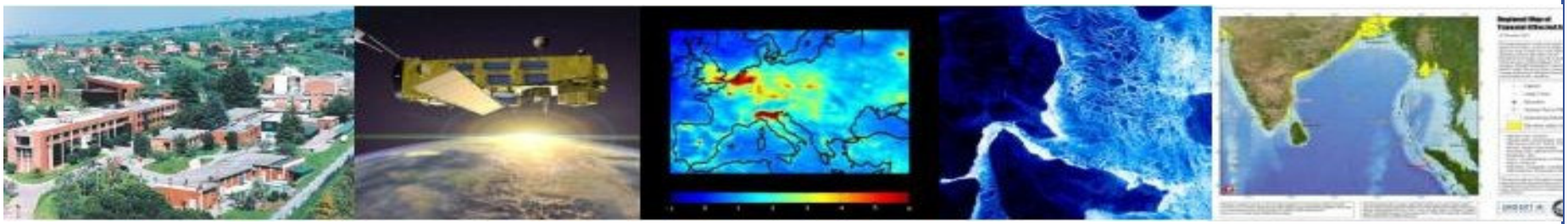
Afternoon Agenda

PRESENTED ITEM	PRESENTATION RESPONSIBLE	DAY TIME
INDUSTRY PRESENTATION – PARALLEL SPLINTER MEETINGS		
12. Open Competition Items Presentation (Main features/Requirements) for Group of Procurement		
A. Mechanical & Thermal; MGSE		13:45 – 14:45
❑ Bi-lateral meetings	AASI/ASD	14:45 – 16:45
B. Power; Electrical; Harness; EGSE		13:45 – 14:45
❑ Bi-lateral meetings	AASI/ASD/ASU	14:45 – 16:45
C. Avionics & Propulsion – Summary		13:45 – 14:45
❑ Bi-lateral meetings	AASI	14:45 – 16:45
D. Digital Electronics; RF Units; Antennas – Summary		13:45 – 14:45
❑ Bi-lateral meetings	AASI/ASD/ASU	14:45 – 16:45
E. Software Items – Summary		13:45 – 14:45
❑ Bi-lateral meetings	AASI/ASD	14:45 – 16:45

ESA PRESENTATION

GMES Sentinel-1 Industry Day

12 April 2007



ESA Presentation

1. Introduction — G. Levrini
2. Mission Objectives — *(ESA Sentinel-1 Project Manager)*
3. Procurement Rules — C. Bayle

(ESA Sentinel-1 Contract Officer)

European Space Agency
Agence spatiale européenne

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Introduction & Objectives

- Welcome to 99 participants from 66 companies

- Objective of the Sentinel-1 Industry Day are;
  - Presentation to the European Industry of:
    - The Sentinel-1 Project and its status
    - The procurement approach
    - The planning and subjects of ITTs to be issued
  - Consultations with Core Team via:
    - Questions in plenary session
    - Bilateral discussions

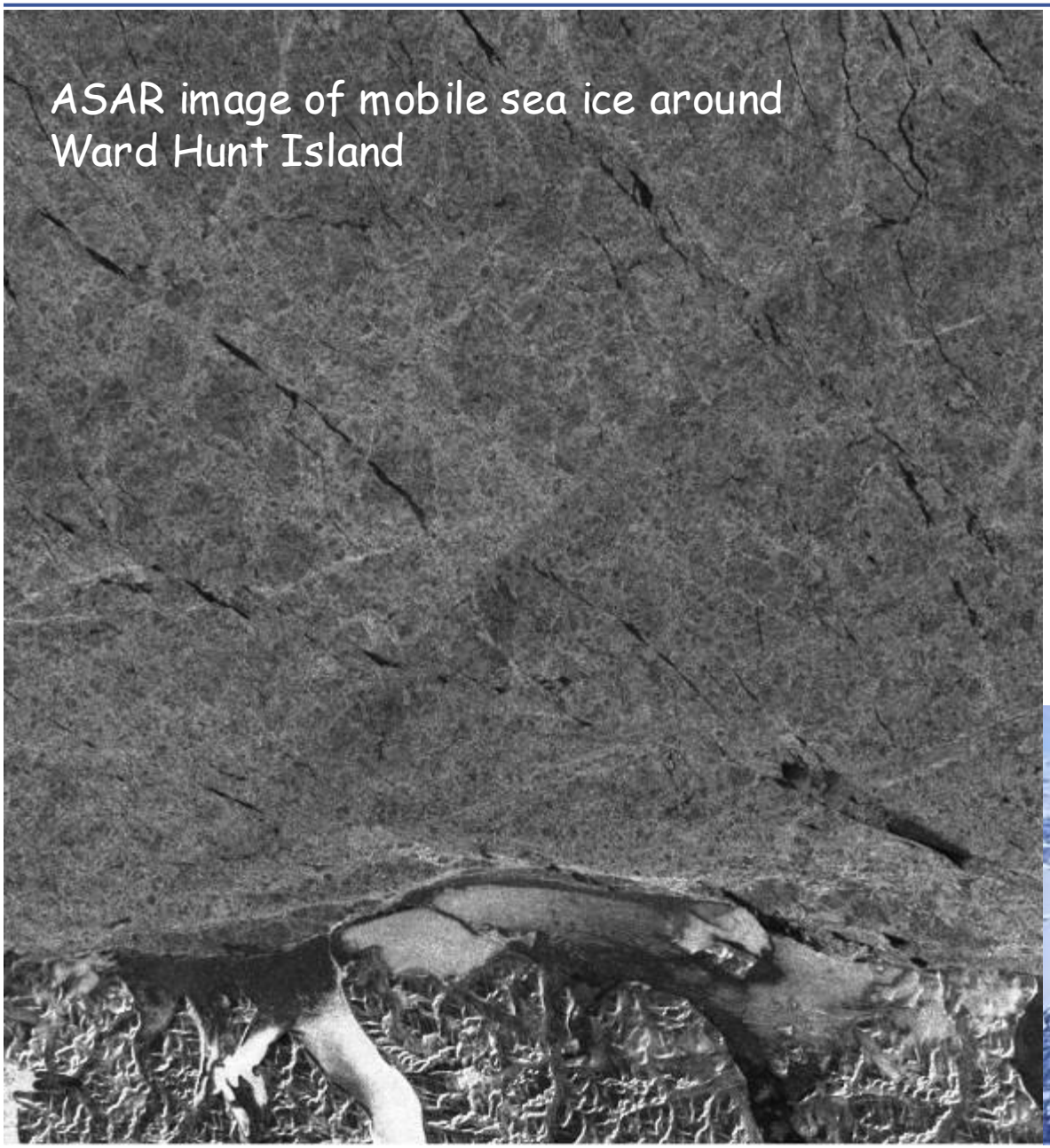
Sentinel-1 Mission Objectives

The Sentinel-1 mission provides continuity of C-band radar observations and satisfies the requirements of its operational users in terms of data availability, coverage & revisit, timeliness and the quality of its data products.

The Sentinel-1 provides radar data products in support of the GMES Services.

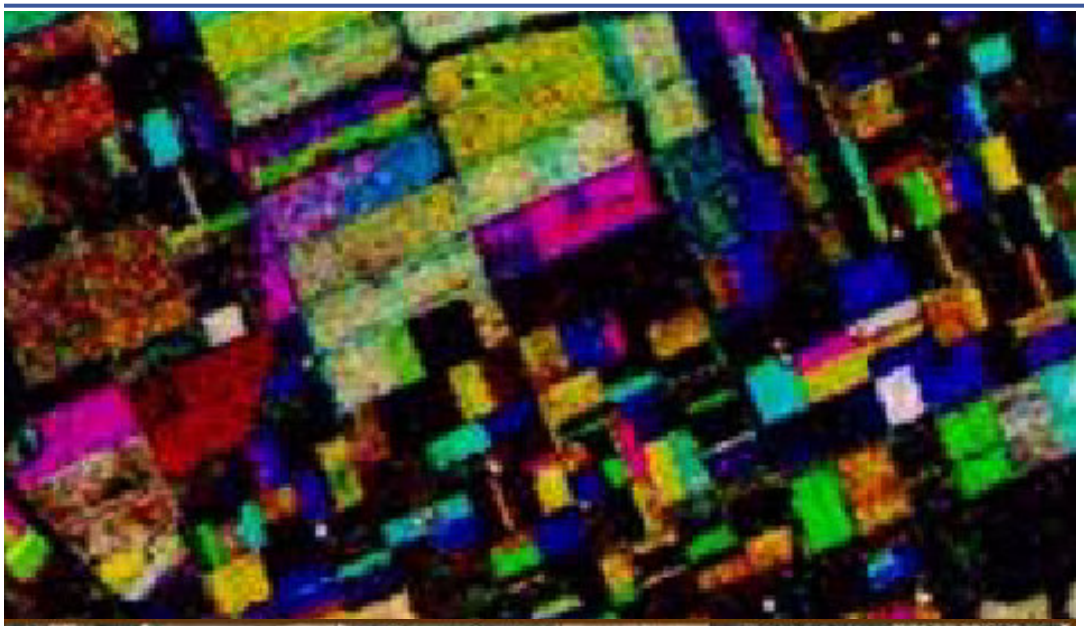
Launch of Sentinel-1A: second half 2011

Sentinel-1 Data Products for Marine Services



- Sea ice monitoring
- Iceberg detection
- Ship detection
- Fisheries monitoring
- Oil spill detection
- Ocean waves
- Sea surface winds
- Ocean front features
- Ocean currents

Fast Track Data Products: Land Monitoring



- Land cover classification of agricultural fields in Flevoland (NL) using ERS interferometry

- Land surface subsidence monitoring in Carbonile, Tuscany (It) using ASAR□ interferometry
- Refined risk-zone limits
  - Red: previous risk area
  - Pink: revised risk area

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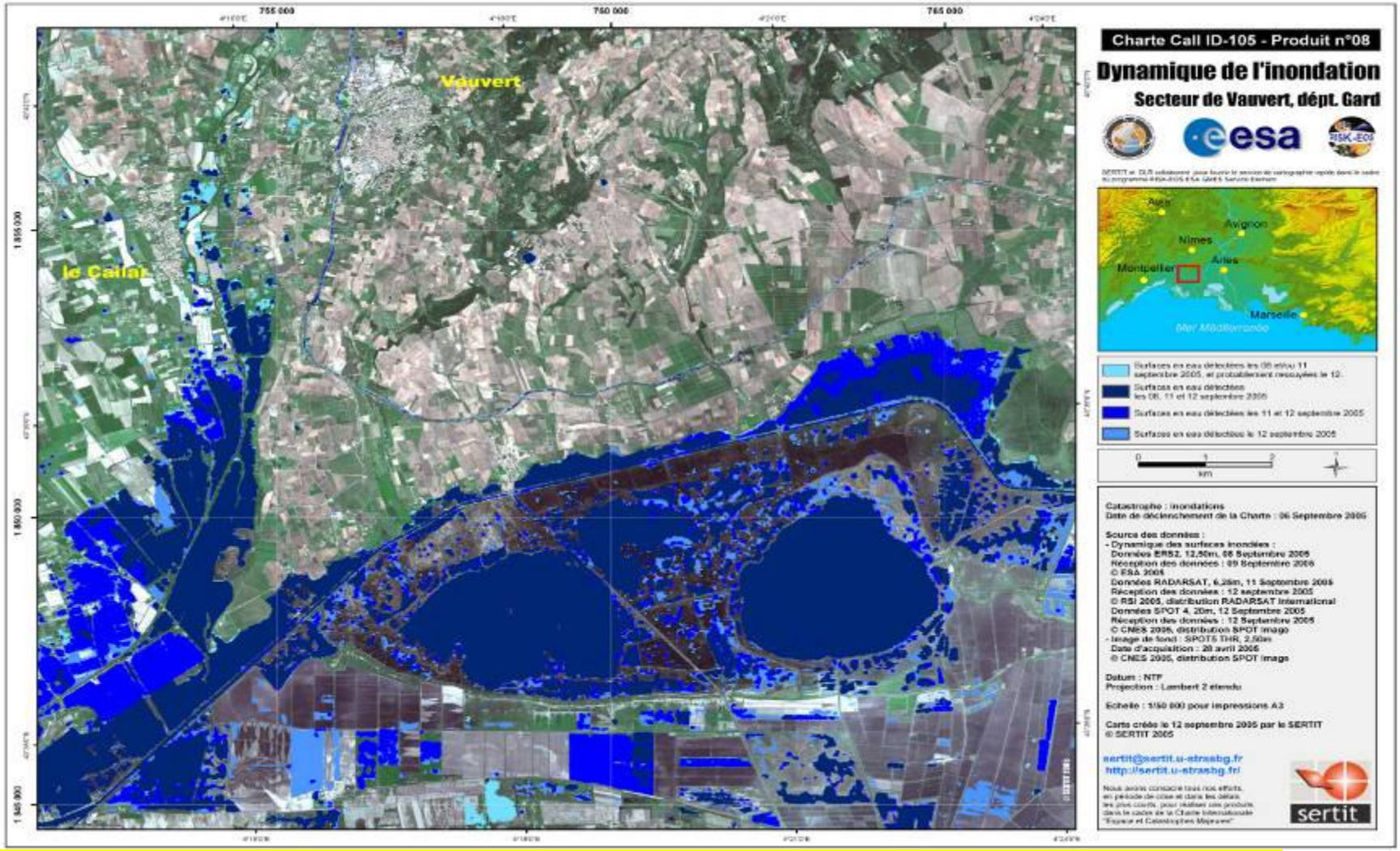
Fast Track Data Products: Emergency Response



Flood Dynamics Map: 06-12 September 2005 from ERS-2 and SPOT

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Sentinel-1 Industrial Roles

- Prime Contractor — Alcatel Alenia Space Italia (AAS-I)
  - Spacecraft — Alcatel Alenia Space Italia
- SAR Instrument — Astrium GmbH (ASD)
  - SAR Antenna — Astrium GmbH
  - SAR Electronics — Astrium Ltd (ASU)
- Additional Core Team partners

- All three major partners (AAS-I, ASD, ASU) will issue Invitation To Tenders for Spacecraft and Instrument equipments, respectively

Selection Procedure - Best Practices

- The Sentinel 1 Core Team will select its subcontractors largely through open competitive procurement under ESA control in accordance with "Best Practices". http://esamultimedia.esa.int/docs/industry/BestPractices/Best_Practices_August_2006.pdf

- It is to a large extent the same procedure as for previous ESA Major Projects (e.g Galileo, Swarm, Gaia, Bepi Colombo, etc).

- As the GMES Space Component Programme is a joint programme with the European Commission, competition may be enlarged to the participating countries to the 7th Framework Programme

Best Practices main features

The main features of the Best Practices are:

- Involvement of the Agency at each stage of the selection of the subcontractors in order to ensure the fairness of the competition and impartiality of the evaluation
- In case the Issuing Company (or affiliate) bids, the evaluation will be performed by the next level up (Prime or ESA)
- Issue of ITTs with the Agency's procurement tool for External Entities (EMITS.EE)
- ESA Ombudsman has been formally established as a facilitator in case of disputes between companies linked to ESA procurement

Procurement process

- Intended ITT
- Pre-TEB
- ITT on EMITS EE (6-8 weeks)
- Closing date – TOB
- TEB
- Concurrence Prime/ESA on recommendation of the TEB or SPB
- Negotiation with winner
- Notification to other bidders

ESA Role in procurement process

- ESA will review the ITT package with the particular aim to secure its objectivity (not driven to a particular design or product)
- ESA will have full visibility during the tendering process (request for clarification) and authorise publication on EMITS *(=>* note that extensions are in principle excluded).
- Active role in evaluation, even when the TEB is lead by the Issuing Company and/or Prime
- Prime to make recommendation to ESA based on TEB recommendation and to justify any deviation from it, based on quality (marking), price and possibly on other considerations (programmatic risk, geo-return).
- In case of disagreement ESA/Prime wrt the recommendation, the Senior Procurement Board (SPB) will decide on selection of subcontractor.

Enhanced role when Issuing Company bids

- If Issuing Company or affiliated is bidding, then fairness imply that it is excluded from process and evaluation: however their comments are important as the Issuing company will take over responsibility

  => they may participate as OBSERVER in the TEB

- If Prime is not affiliate to Issuing company nor bidding, it will lead the TEB.

- Composition of TEB may be changed at Tender Opening if affiliate eventually does not bid or vice versa

Contractual Phasing

- The contract between ESA and AAS-I will be phased with a contractual breakpoint at the end of each phase of the contract (B2, C, D and E1) with a specific authorisation to proceed to be given by the Agency

- The contracts to be placed for items selected under Best Practices will consequently reflect such phasing

INDUSTRY PRESENTATION

PLENARY SECTION

Speakers:

Roberto BORDI (AAS-I)
Michelangelo L'ABBATE (AAS-I)
Aniceto PANETTI (AAS-I)

4. MISSION AND OPERATION CONCEPT

Space Segment

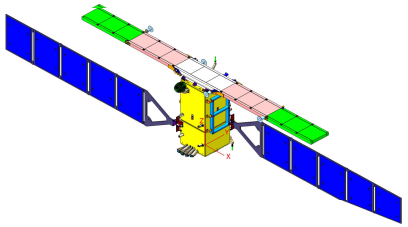
- LEO satellite with a nominal lifetime in orbit of 7 years (extendible to 12), ensuring global coverage by flying on a Near-Polar Sun-Synchronous dusk-dawn Low Earth Orbit.
- It is possible to form a constellation with the activation of an option for a second satellite, characterised by the same orbit but with a different Mean Anomaly.
- The satellites embark a C-Band Synthetic Aperture Radar (SAR) payload, providing the following SAR Measurement modes:
  - **Stripmap Mode (SM)**: dual polarisation, medium size swath, high radiometric performance, very high spatial resolution
  - **Interferometric Wideswath Mode (IW)**: ScanSAR-based (i.e. ScanSAR with progressive azimuth scanning) mode, dual polarisation, large size swath, high spatial resolution, burst synchronisation for ScanSAR interferometry
  - **Extra Wideswath Mode (EW)**: ScanSAR-based mode, dual polarisation, very large size swath, reduced spatial resolution
  - **Wave (WV) Mode**: Sampled Stripmap mode, single polarisation, low data rate

Ground Segment

- Mission operations for a system of satellites over a period of 20 years.
- Proposed S-Band station is Kiruna, with a back-up for S/C contingencies.
- The X-Band downlink currently assumes, for preliminary sizing, three X-Band receiving stations.

Sentinel-1 Satellite Mission Concept

- **Lifetime**
  - 7 years (consumables for 12 years)
- **Launch**
  - Launch with Soyuz from Kourou
  - Zenith back-up launch vehicle
- **Main Orbital Parameters**
  - Sun-Synchronous frozen orbit @ 693 km
  - Mean local solar time at ascending node: 18:00
  - Orbital period: 98.6 minutes
  - Eclipse duration: max.19 minutes along 3 months per year around Summer Solstice
  - Ground track repeat cycle: 12 days (175 orbits)



Products Typology and Acquisition Modes for SAR

- The following SAR products will be provided:
  - STRIPMAP: high resolution (5x5m), swath 80Km, dual polarization.
  - Interferometric WideSwath: based on SCANSAR (anti-SPOT mode), intermediate resolution (5m rg x 20 m az.), large swath (240Km), dual polarization.
  - Extra Wide Swath: based on SCANSAR, low resolution (rg. 25 x az. 80m), swath very large (>400 Km), dual polarization.
  - WAVE: based on sampled STRIPMAP, single polarization, low data rate, resolution (az. 5m x rg. 20m)
  - SAR access incidence angles range [20°-45°] with nominal image quality
- Product levels to be defined are:
  - Level 0
  - Level 1B (Single Look Complex Slant Range)

Sentinel-1: Access and Global Coverage

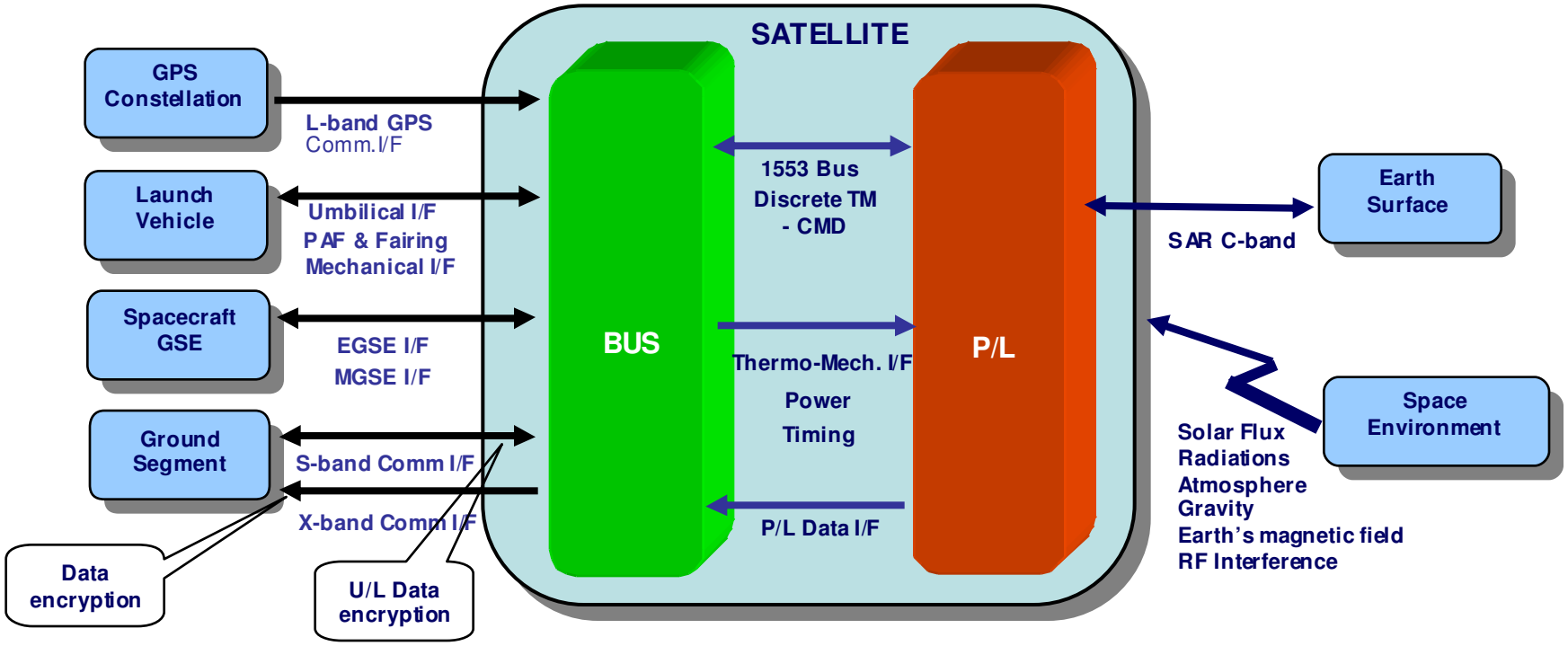
- Sun-Synchronous orbit with 18:00 as local time of ascending node, nominal altitude of 692 Km, repeat cycle of 12 days and 175 orbits in a cycle.
- Sub-interval (interval between contiguous orbital track) at the equator of about 229 Km.
- The access capability of [20°-45°] incidence angle with nominal image quality, in the main imaging modes (IWS and STRIP) ensures global coverage of the Earth, with exception of polar regions (exception allowed by requirements) because of the acquisitions condition of sensor in Right Looking.
- Solar eclipse conditions are present during the whole summer season on all orbits in the course of the pass over Antarctic region; the eclipses duration gets up to a max. of 18 min; this has a strong impact on the performances required to the platform power subsystem because of the satellite imaging operations have to be independent by lighting.

Modes	Access angle	Resolution (R x Az)	Swath Width	Polarisation
Stripmap (SM)	20°-45°	5 x 5 m	> 80 km	HH+HV, VH+ VV
Interf. Wideswath (IW)	> 25°	5 x 20 m	> 250 km	HH+HV, VH+ VV
Extra Widesw. (EW	> 20°	25 x 100 m	> 400 km	HH+ HV, VH,+ VV
Wave (WV)	23°	5 x 20 m	20 x 20 km vignettes at 100 km spacing	HH, VV

- **Radiometric accuracy (overall): 1 dB**
- **NESZ: -22 dB**
- **PTAR: -25 dB**
- **DTAR: -22 dB**

Due to long Operation times per orbit and high data volumes generated on board, the X-band downlink (PDHT) becomes a challenging subsystem.

5. Spacecraft (S/C) Concept

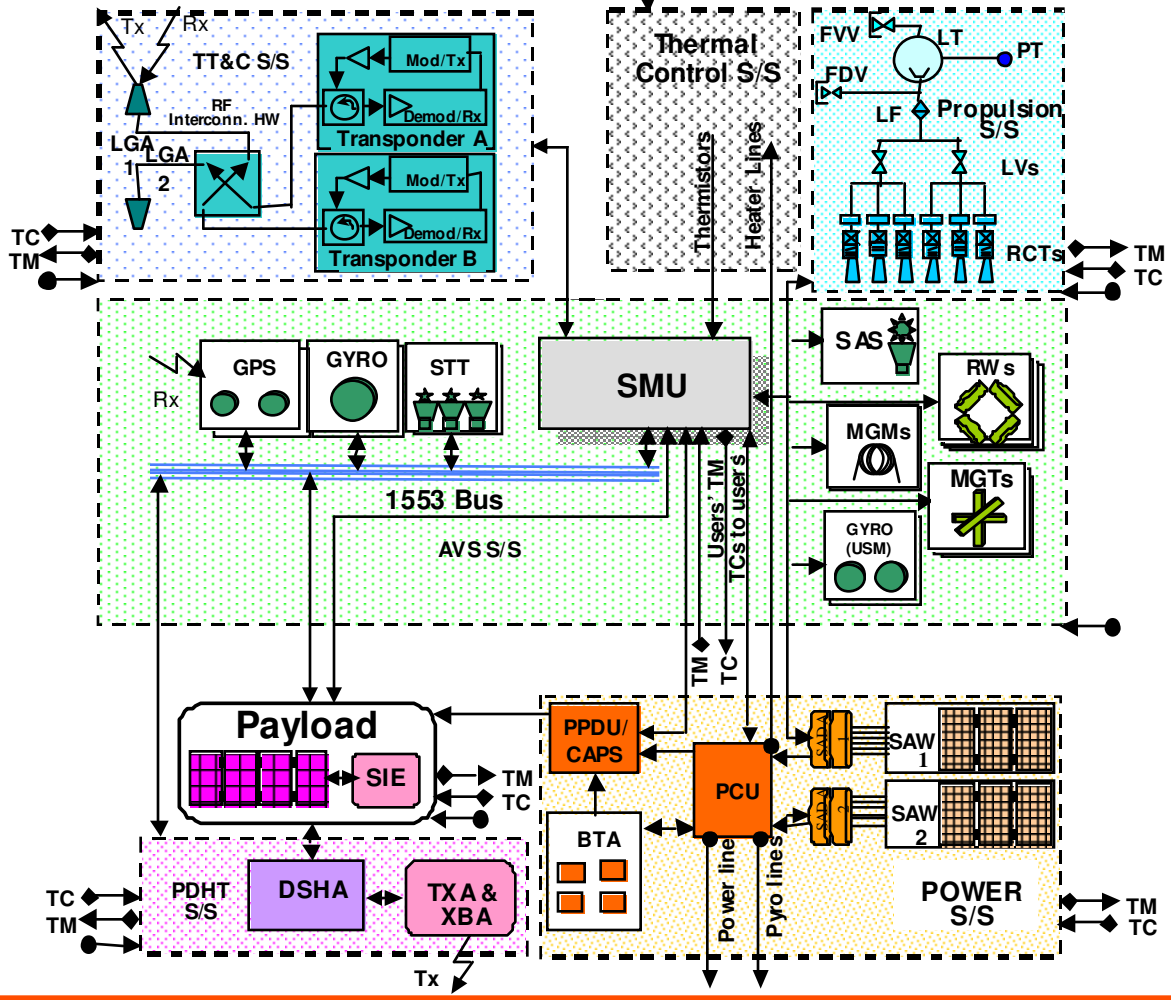


RF System	Band	TX Frequency	RX Frequency
SAR	C	5405 ± 50 MHz	5405 ± 50 MHz
PDHT	X	8025 ÷ 8400 MHz	N/A
TT&C	S	2200 ÷ 2290 MHz	2025 ÷ 2110 MHz
GPS	L	N/A	1575 MHz ±15 MHz 1227 MHz ±15 MHz

SENTINEL-1 Satellite Block Diagram

LEGENDA

AVS – Avionics S/S
BTA – Battery
CAPS – C-Sar Antenna Power Supply
FDV – Fill & Drain Valve
FVV – Fill & Vent Valve
GPS Lagrange Receiver
GYRO - Redundant Three axes sensor
LT – Propellant Tank
LV - Latching Valves
MGM - Magnetometer
MGT - Magneto Torquer
PCU – Power control unit
PDHT – Payload Data Handling & Transmission
PPDU – Power Protection & Distribution Unit
PT – Pressure Transducer
PT – Pressure Transducer
RCT – Thrusters
RWA - Reaction Wheels assembly
SADA - Solar Array Drive Assy
SAR – Synthetic Aperture Radar
SAS - Sun sensor
SAW – Solar Array Wing
SIE – SAR Internal Electronics
SMU - Spacecraft Management Unit
STT - Star Tracker
TT&C – Telemetry Tracking & Control



Satellite Performance Synthesis Table

5. Spacecraft (S/C) Concept

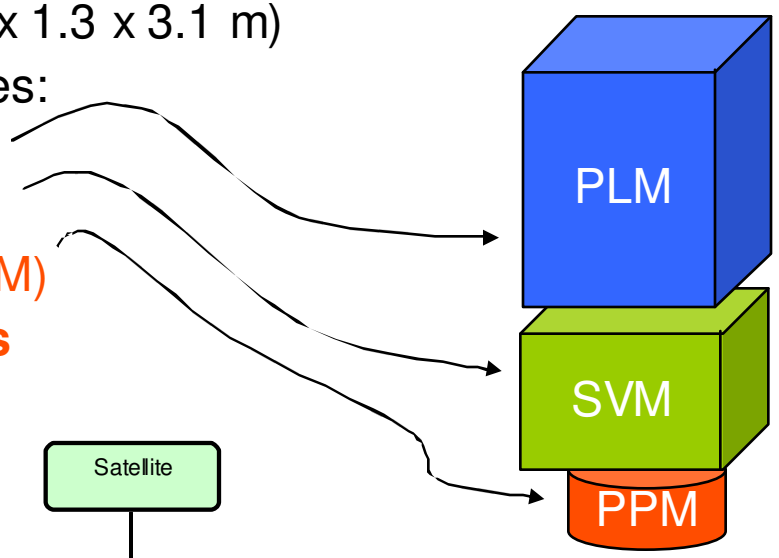
Satellite Overall Launch Mass	2282 kg (with 130 kg propellant)
Stowed Envelope Dimensions	~ 3900 x 2600 x 2500 mm (incl. stowed appendages)
Thermal Control type	Mainly passive, standard techniques
Structure Subsystem	Central structure in CFRP, external panel in Al
Operative autonomy	96 h
Attitude Profile	Geo-Centric and Geodetic
Nominal Flight Attitude	Right Looking
Control System	Integrated data handling, AOCS and FDIR system
Attitude Stabilization Type	3 axes
Attitude accuracy	0.01° each axis

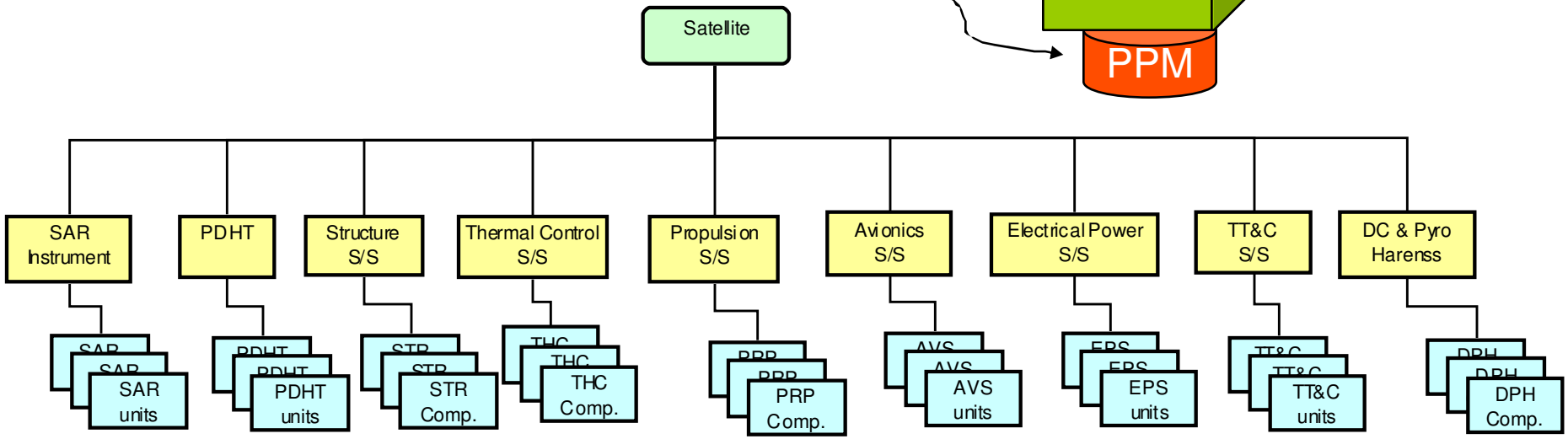
Satellite Performance Synthesis Table

Attitude Knowledge	Better than 0.003° each axis
Propulsion	Mono-propellant, 6 (orbit control)+8 (attitude) thrusters
SAW Average Power (EOL)	~4800 W
Battery Capacity	> 300 Ah
Power Bus Voltage	26 V to 37.8 V unregulated bus
Satellite BUS & P/L Reliability	0.75 & 0.93 @ 7.25years
Satellite Availability	0.998
TT&C band	S-Band,
TT&C antenna orientation	zenith/nadir
TT&C data rates	TC Uplink: 4 kbps; TM Downlink: 512,128,16 kbps (in flight selectable)
Satellite Orbit Knowledge	With GPS: better than 10 m (3 sigma) in each axis accuracy on real-time processed data vectors and 5 cm in post-processing

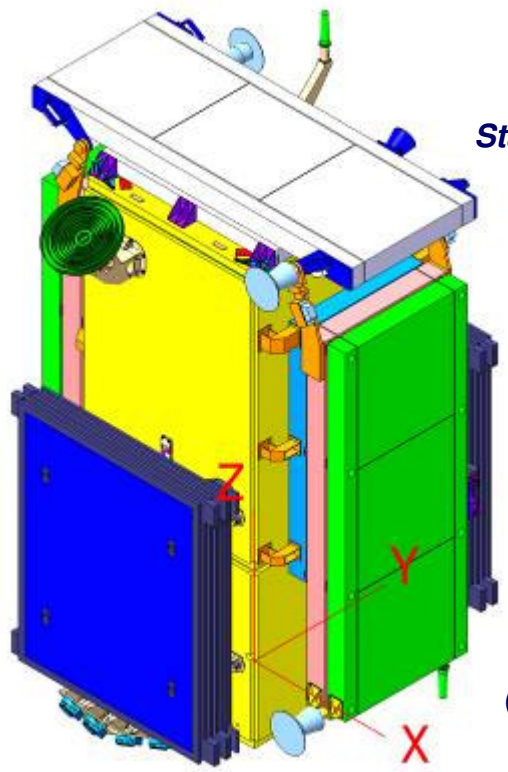
Satellite Architectural Concept

- **Satellite Body** (Main Dim.: 1.3 x 1.3 x 3.1 m)
  - Made up of 3 distinct modules:
    - Payload Module (PLM)
    - Service Module (SVM)
    - Propulsion Module (PPM)
- **Satellite Constituent Elements**

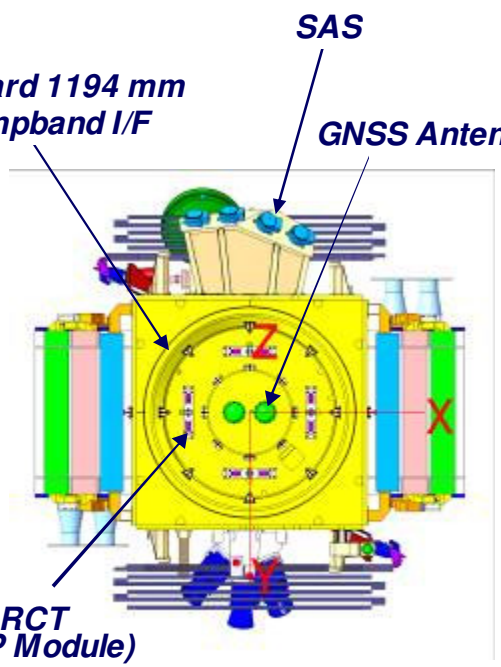




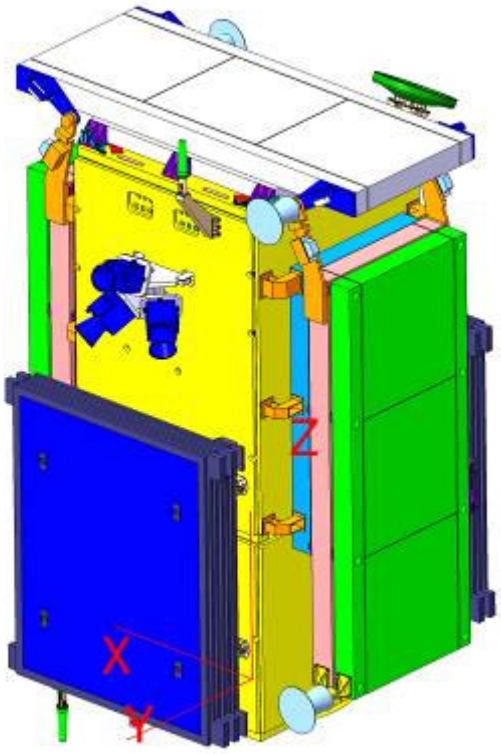
Stowed Satellite Views



Satellite -Y, +X sides



Satellite - Z side



Satellite +Y, -X sides