Current Status on ASI EO Missions and activities on Polar Regions

Fabrizio Battazza, ASI – EO Polar Space Task Group, SAR Coordination WG#1 Frascati, 12-13.11.12
Opportunity mission: ROSA*

- National program
- Fully funded by ASI
- on-board on OCEANSAT-2, Aquarius/SAC-D, Megha-Tropiques Missions
- Launches: Sept. 2009, June and October 2011

(*) ROSA = Radio Occultation for Sounding the Atmosphere

SAR mission: COSMO-SkyMed**

- A National Program funded by Italian Ministry of Research (MUR) and Italian Ministry of Defence (MOD)
- Managed by ASI in cooperation with It-MOD
- The largest Italian investment in Space Systems for Earth Observation
- Constellation fully deployed, the satellites will be gradually replaced by the second generation

(**) COSMO = COntellation of small Satellites for Mediterranean basin Observations
Hyperspectral mission: PRISMA*
- National program
- Fully funded and managed by ASI
- System B2/C/D/E1 contract running
- CDR is on-going
- Launch: by the end of 2015

SAR mission: COSMO-SkyMed-SG
- A National Program funded by Italian Ministry of Research (MUR) and Italian Ministry of Defence (MOD)
- Managed by ASI in cooperation with It-MOD
- CSK satellites will be gradually replaced by the second generation
- COSMO-SkyMed Seconda Generazione (CSG) currently is at the beginning of phase C
- Next Launch (CSG): by the end of 2016

VHR Optical mission: OPSIS**
- National program
- Fully funded and managed by ASI
- Phase A is on-going
- Launch: 2018

(*) PRISMA = PRecursore IperSpettrale della Missione Applicativa
(**) OPSIS = OPtical System for Imagery and Surveillance
DUAL USE SYSTEM

ALL WEATHER NIGHT / DAY ACQUISITIONS

WORLDWIDE GLOBAL COVERAGE

ORBITAL PERIOD       ~ 97 m

4 SAR SATELLITES CONSTELLATION

HEIGHT                        619.6 Km

ORBIT                           SSO

INCLINATION               97.8°

SENSOR      X-BAND SAR (9.6 GHz)

REVISIT TIME

4 SATELLITES

MAX < 12h (worst case)
Earth Observation

CONSTELLATION SATELLITES LAUNCH DATES

8 JUN. - 2007
COSMO-1

9 DEC. - 2007
COSMO-2

25 OCT. - 2008
COSMO-3

5 NOV. - 2010
COSMO-4
Earth Observation

COSMO-1
180°

COSMO-2

COSMO-1

180°

COSMO-2

COSMO-3
90°

COSMO-4
90°

TANDEM-LIKE OPERATIONAL CONFIGURATION

CONSTELLATION DEPLOYMENT STRATEGY
Unique Capabilities - the Constellation

FAST RESPONSE
LARGE COVERAGE

FAST LARGE/LONG
AREA MAPPING

MOTION
TRACKING
Earth Observation

SCANSAR WIDECANSAR WIDE
100 Km X 100 Km
30 m Resol.

SCANSAR HUGE
200 Km X 200 Km
100 m Resol.

STRIPMAP – PING PONG
30 Km X 30 Km
15 m Resol.

STRIPMAP – HIMAGE
40 Km X 40 Km
3 m Resol.

SPOTLIGHT
10 Km X 10 Km
1 m Resol.

WIDE FIELD
NARROW FIELD

75 Narrow Field
+ 375 Wide Field
Images per day per satellite
1800 images per day (end-to-end system)

MULTI-MODE ACQUISITION CAPABILITY
Earth Observation

KIRUNA (SWEDEN)
S/X BAND

ITALY
S/X BAND

GEOGRAPHICALLY DISTRIBUTED
GROUND SEGMENT

D-MAPSD-MAPS
C-MAPSC-MAPS

CORDOBA (ARG.)
S/X BAND

FUCINO SPACE CENTER
Telespazio

S-BAND

FUCINO SPACE CENTER
Telespazio

X-BAND

ASI SPACE GEODESY CENTER
(MATERA)

GEOGRAPHICALLY DISTRIBUTED
GROUND SEGMENT
The instrument uses the Radio Occultation technique to retrieve the vertical profile of atmospheric temperature, pressure and humidity from the ground up to 100 km as well as the profiles of the electron content in the ionosphere.

The first ROSA instrument is performing the operational phase on board of OCEANSAT-2, the Indian mission for the oceanography and meteorology study launched on September 2009, on June 2011 a second instrument was launched with the Aquarius/SAC-D a NASA-CONAE mission and on October 2011 the third one on CNES-ISRO Megha-Tropiques mission.

The ROSA instrument is able to measure the atmospheric vertical profiles with high resolution (~200 m in the troposphere and ~1000 m in the stratosphere) and high thermal accuracy (<1K).
Earth Observation

PRI SMA Mission

Mission Objectives:
- Pre-operational and technology demonstrator nature
- Focus on
  - Space qualification of Hyperspectral (HYP) and panchromatic (PAN) payloads
  - Development and production of PAN/HYP products/applications

Applications:
- Vegetation monitoring, Geological mapping, Agricultural diagnostics, agricultural indicators, Land cover maps and crop inventories
- Urban and functional areas mapping and monitoring
- Coastal and inland productivity assessment of aquatic ecosystems
- Monitoring of carbon sources and sinks on land (Kyoto Protocol)
- Land surface hydrology and water management,
- Risk Management Support (fires, landslides, volcanic and seismic hazard).
- Atmosphere characterization
**PRI SMA: characteristics**

**Panchromatic**
- Swath: 30 km
- Spatial GSD: <5 m
- Spectral ranges: 400-700 nm

**Hyperspectral**
- Swath: 30 km
- Spatial GSD: <30 m
- Spectral ranges (contiguous spectrum):
  - VNIR: 400-1010 nm
  - SWIR: 920-2500 nm
- Spectral resolution: 10 nm

**Orbit and lifetime:**
- LEO SSO, 620km, 10.30 LTDN
- 5 years lifetime

**Coverage:**
- World-wide

**The Satellite**
- Mass: ≈700kg
- Power: ≈1000 W (generated)
OPSIS: OPtical System for Imagery and Surveillance

End Users: ASI and potential interest of IT DoD (to be formalized)

First step: contract for Space Segment only, phase A and B1 (till System Requirements Review)

Maximization of reuse of existing Italian assets: synergy with CSK (SAR) and PRISMA (hyperspectral)

About 60 months development time for the satellite
Satellite and Payload overview

- LEO SSO orbit (600÷700 km)
- GSD 50 cm PAN, 2 m MS
- $\geq 10 \times 10$ km$^2$
- 200 spot images per day
- 1 tons class satellite
- S-band T&TC
- X-band data download
- Lifetime 5 yrs + 2 yrs for consumables (7 as goal)
COSMO-SkyMed-SG:
CSG/ CSK THE SYSTEM CONCEPT

Earth Observation

Space Segment

CSK Sat

CSK Sat

CSK Sat

CSK Sat

Ground Segment

DEFENCE
DOMAIN

COMMON DOMIAN CSK + CSG

CIVILIAN DOMIAN
CSK CSG

USER

* User Ground Segment
** Satellite Control Centre
*** Planning Centre and Mission Control

CSG Ground Segment specific Update/Impovements
COSMO-SkyMed-SG: MAI N IMPROVEMENTS (1/3)

Spatial resolution

Full polarimetric capability
Improved operational profiles

- CSK* = 450 products/day/satellite
- CSG** = 520 ca. products/day/satellite ("equivalent" to 1000 ca. CSK products)

Landslide monitoring in Madesimo (Lombardia) obtained by scientific exploitation of a stack of COSMO-SkyMed images.
SYSTEM ACCESS AND USABILITY

- Capability to interface other systems
- Robust and innovative planning algorithm
- New processors developed on the basis of CSK experience
- Enhancement of Human Computer Interface
- SAR Antenna

- Data handling and transmission capabilities (PDHT)(*)

- Satellite Platform

- Ground Segment programming and processing capabilities(*)
ASI EO SATELLITES SCENARIO AND PERSPECTIVES

- COSMO-SkyMed constellation is FULLY DEPLOYED AND OPERATIONAL since mid 2011.
- CSG satellites will replace the CSK satellites that reached their end of life.
- With the launch of the first CSG satellite planned in mid 2015 and the second one year later, CSG will provide operational continuity at least until 2023.
- At least 5 years of both SAR and hyperspectral images. VHR optical images will follow.
Studies on Polar Regions (CSK AO)

Scientific & Research

Projects conducted in the framework of the ASI COSMO-SkyMed Announcement of Opportunity (CSK AO) conducted in 2010-2012.

Several projects with different objectives

1260 The use of SAR images for sea-ice studies in Antarctica. **Flavio Parmiggiani** - CNR-ISAC, Italy.

2145 Monitoring glacier activity by combined interferometry and Single Look Complex image processing. **Jean Marie Nicolas** - GET Télécom Paris, Dept TSI, France.

2183 Improved sea ice monitoring for the Baltic Sea. **Leif Eriksson** - Chalmers University of Technology, Sweden.

2215 Sea Ice Concentration and Kinematics from high-resolution SAR. **Hoonyol Lee** - Kangwon National University, Rep. Korea.

2222 Operational Snow and Land Cover Mapping on Boreal Forest Zone Using Polarimetric X-Band SAR Data. **Kari Luojus** - Finnish Meteorological Institute, Finland.

2283 Integration of classical and space geodetic techniques for the study of vertical ground motions. **Luca Vittuari** - Dip.Ingegneria delle Strutture,Trasporti,Acque,Rilevamento- Università di Bologna, Italy.
**CONCLUSIONS**

ASI activities on the polar regions are on-going and future calls (ITT) can be allow PIs to conduct further investigations on these regions.

The use of multi-sensors data is considered valuable

Synergy between remote sensing data and in-situ measurements

The development of ASI future EO missions such as PRISMA, COSMO-SkyMed-SG and OPSIS will provide the users with new datasets to be used for the investigations in the polar regions.