COSMO-SkyMed
Products and User Services

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Why COSMO-SkyMed?

To take appropriate decisions on strategic and operative context in a global environment

To build and maintain an accurate image archive with worldwide coverage and implementing many options in terms of:

- resolution
- size
- temporal sampling (revisit time)
Application areas vs. revisit time & spatial resolution

<table>
<thead>
<tr>
<th>Revisit Time</th>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spatial Resolution</strong></td>
<td>high</td>
<td>medium</td>
<td>low</td>
<td></td>
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- **Cartography for final user**
- **Agriculture, Forestry, Geology, Environment**
- **Marine/Coastal, Cartography (cadastral)**
- **Defense & Security, Risk Management, Land use monitoring**

- Cartography (telecom, utilities)
Dual Use Needs

Civilian
- Several Disciplines: Agriculture, Forest, Geology, Environment, Cartography
- Open and Accessible System

Defense
- Priorities Management
- Confidentiality and Integrity
- Protected System

Common
- Wide information collection (Database)
- Flexibility
  - Multi-mode operation (variety of sizes and resolutions)
  - Agility (reconfiguration and multiple acquisitions on a theater)
- High Reactivity
  - Response / Revisit Time
- Availability & Sustainability of Services
The COSMO-SkyMed mission

- Global Coverage
- SAR Night/Day, All Weather Observations;
- Revisit Time of few hours;
- Response Time very short (on daily basis);
- High volume of daily acquired Images with
  High Resolution, Image Quality and Geo-
  location accuracy on different sizes, polarizations and points of view;
- Management of different classes of Users
  and of Priority;
- High level of Satellite and payloads agility
  to acquire multiple images on the same
  theatre;
- Staggered deployment and “graceful
degradation”;
- Compatibility with Interferometric
  operations;
Performances

1800 Images/day
1500 Wide Field (Stripmap)
300 Narrow Field

Interferometric Campaigns
- Tandem – like
- Tandem

System Operative Modes
- Planning: Asynch.
- Very Urgent
- Crisis
- Routine
Acquisition modes

- **Stripmap**
- **Scansar**
- **Spotlight 2**

610 Km

Areas:
- 100 Km: 5 x 5 m²
- 90 Km: 3 x 3 m²
- 100: 30 x 30 m²
- 100 Km: 1 x 1 m²
- 200 Km: 100 x 100 m²

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COSMO-SkyMed

2005  2006  2007  2008  2009

LAUNCH SCHEDULE
The satellite during manufacturing
The overall architecture
- Ground Infrastructure geographically distributed and inter-connected (fixed / mobile stations and comm.network);
- Dual Use implementation: Security standards application, Integrity, Priority management, Plan Approval, Plan and data confidentiality;
- Reception/Elaboration/Distribution of the Observed data;
- GPS fiducial network;
- Calibration sites;
- Interoperability and Expandability with other Systems (optics, RADAR in other bands, on other platform, etc…);
- Multisensor capabilities (common operational environment for various sensors);
- Functional and Physical Redundancy;
- Integrated Logistics and Operative Support.
The primary objective of COSMO system is the provision of services to fulfill the Customer’s needs. The basic functions for the Civilian User are those related to a specific sequence.

1. The civilian user query the system for a Service Query

   - The user logs into the system and gets general info about the mission and the allowed services.

   - The user can then query the system for a Service Query.

   - The system provides a Products List and Services Info.

   - Services can be accessed through the COSMO SkyMed User Ground Segment interface.
2. The system reacts to the service request and asks the user for a choice.

- New acquisitions
- Catalogue products (already acquired)
The User Services

In case of a new acquisition, the user specifies the related parameters.

Definition of area of interest

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The User Services

4. The system ask for further sensor acquisition parameters.

Definition of time period of interest

Periodic acquisitions are allowed for time series applications.

Definition of delivery type

Definition of product format

The User Services

4. The system ask for further sensor acquisition parameters.

Status of order and expected delivery time.

The system asks for further sensor acquisition parameters and finalizes the status of the order and the expected delivery time.
The User Services

- **Additional User Services**
  - Access control
  - System documentation & information
  - Guide
  - Bulletin Board
  - Problem Solving
The Image Products

**SAR Standard Products**
- **RAW** (Received SAR Echo Signal)
- **SCS** (Single look, Complex, Slant range)
- **DGM** (Detected, Ground projected, Multilook)
- **GEC** (Geo-coded, Ellipsoid corrected)
- **GTC** (Geo-coded, Terrain corrected)

**Higher Level SAR Products**
- Quick look
- Speckle Filtered
- Co-registered
- Backscattering
- Mosaic
- DEM & Interferometric Products
  - Coherence map; Interferograms
In both images the grid is composed by lines at the same latitude and same longitude (iso-lat, iso-lon).

Etna as seen in ground range image (DGM product): note the reduction of the side looking distortions but the presence of a rotation with respect to North direction.

Etna as seen in a slant range image (SCS product modulus): note the magnitude of the geometric distortions.
GEC product
Vesuvio in a GEC image. Image is aligned with a cartographic map but distortions due to terrain height is still in place (see the compression of the right side of volcano)
Standard Products Typologies

**GTC product**

Vesuvio in a GTC image. Distortions due to terrain height are now compensated (see the right proportion of both sides of volcano)
Quicklook
- generated with low resolution focusing of SAR RAW data or by spatial averaging the full resolution products, even non SAR
- has a lat,lon grid overlaid for easy retrieval of geo location info, radiometry stretched to 8 bit

- ENIVISAT ASAR alternating polarization (100km x 100km) - Flevoland
- ENIVISAT ASAR ScanSAR (400km x 800km) - Netherland
Coregistered

Two or more images of the same earth zone are automatically distorted in order to make possible to geometrically superimpose them.

The corresponding product is a multilayer set of images useful for change detection, classification studies, false color representation.

Vesuvio as seen in a false color DGM coregistered product, composed by 3 images acquired in different seasons.
Higher Level Products Typologies

- **Speckle filtered**
  - Radar reflectance data but with a lower level of speckle noise
  - Many algorithms available, from Moving Window (improves the noise at expense of geometric resolution) up to sophisticated Gamma Map (image features contours and strong scatters are preserved by adaptive filtering)

Original  Moving Window filter  Gamma Map filter
DEM

Generated by interferometric techniques: an earth zone is imaged twice within a very short time delay, the phase information of the complex SCS product gives the target to satellites distance, using some geometry the extraction of the height information is then possible.

Processing chain includes the generation of two Interferometric products: wrapped flattened phase and terrain corrected coherence.

A Virtual Flight in a DEM generated with interferometry: color is associated with interferometric fringes, saturation with coherence.
Mosaikded
- generated joining a set of separate images acquired in the same geometry, in order to obtain a larger coverage
- automatic processing with compensation of the radiometric discontinuities at edges

Example of mosaikded product: note as even with a very small overlap, the processor correctly joins the components with a small discontinuity in radiometry
Antarctica Ice Evolution
The following COSMO characteristics are particularly suited for Marine Applications like Oil Spill and Sea Ship Detection:

- Short revisit time (few hours) allowing the gathering of the SAR images with an adequate time sampling. In Oil Slick applications this feature, in conjunction with suitable models, allows the forecasting of the slick position/velocity and hence the determination of the point and time of arrival of the oil in coasts or beaches.

- Short response time (daily in routine mode) allowing the acquisition of scenes containing slow moving targets with an high probability of success.

- Large swath (200km) with a medium spatial resolution (100m) allowing the monitoring of extended coverages, particularly suited for semi- or fully-automatic target detection algorithms (like ships).