

# SPACE AND SENSORS: DEVELOPMENT AND PERSPECTIVES

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Sensors play a key-role in a number of present and perspected space activities. The paper highlights some of those activities, particularly in the area of Earth observation. Furthermore, the key-elements for building effective sensor-based space networks are pointed out and framed in the future plans of the Italian Space Agency.

## 1. Introduction

Sensors play a key-role in several space systems and related applications. Examples are provided by photonic sensors for robots in the area of universe observation, inertial optoelectronic sensors for Earth observation, photonic nanosensors for scientific payloads, optoelectronic sensors for stress and vibration detection in space transport systems, inertial nanoelectronic sensors for satellite navigation, etc.

Sensors can be related to space also from a different standpoint. In fact, space systems could be exploited to transport partially or fully the data gathered through terrestrial (e.g. Wireless Sensor Networks, WSN) or space-based sensor networks. This approach is compliant with the perspected development of next generation networks through an effective integration of the terrestrial and the satellite components in terms of both architectures and applications [1,2,3].

Moving from the above frame, the paper highlights some of the activities that the Italian Space Agency (ASI) is undertaking, where sensors are used (Section2). In Section 3 the key-elements that can be envisaged to develop future sensor-based space networks are highlighted.

## 2. ASI and Sensors

An area of ASI activities where sensors are widely used is related to Earth observation.

COSMO-SkyMed (CONstellation of Small satellites for the Mediterranean basin Observation) is the first satellite constellation devoted to Earth observation (Figures 1 and 2).

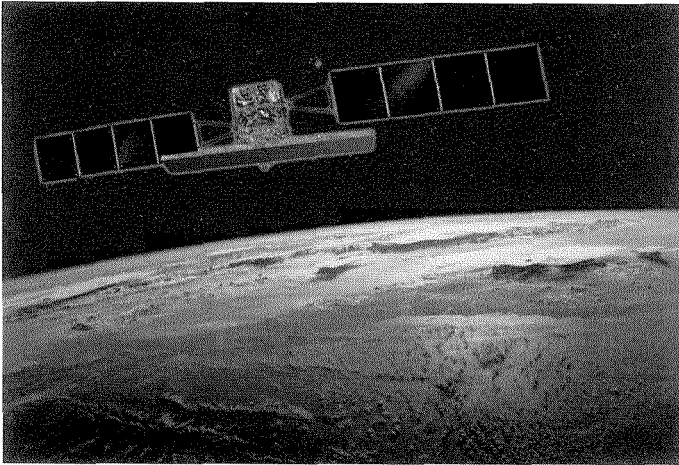


Figure 1. COSMO-SkyMed pictorial view

Four satellites are envisaged, all devoted to remote sensing through X-band SAR (Synthetic Aperture Radar) payloads. The data will be exploited, according to a properly developed policy, for dual applications, providing support to both civil (institutions, commercial) and military users [1].

COSMO-SkyMed, one of the most important Italian space programs, is hence based on the use of SAR, i.e. an active, scanning, imaging sensor.

COSMO-SkyMed is designed to allow the development and exploitation at international level of large operations capability: global coverage; revisit time and response time in the order of a few hours and a few tens of hours, respectively; metric and sub-metric space resolution with field of view ranging from km to hundreds of km; operational capability in every meteorological and enlightenment condition; high quality images in order to allow a suitable measurement and interpretation of the observed data; interferometric and

polarimetric measurements; interoperability and expandability; security and integrity of infrastructures as well as confidentiality of the observed data. The SABRINA mission for interferometric applications, based on the use of passive radar, will fly in formation with COSMO-SkyMed.

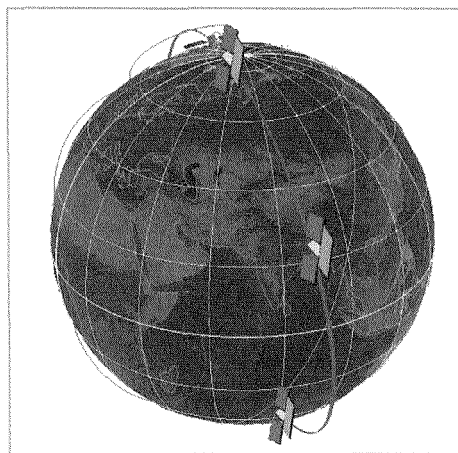


Figure 2. The COSMO-SkyMed constellation

ASI has recently started additional Earth Observation activities. An example is provided by MIOSAT, a small optical mission based on the use of a microsatellite (Figure 3).

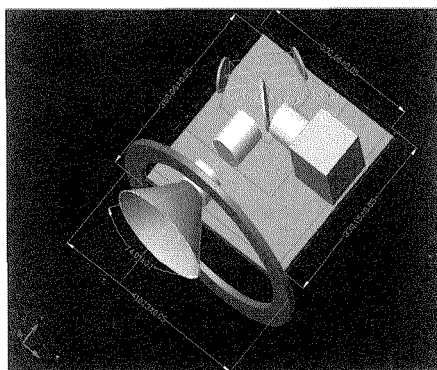


Figure 3. The microsatellite pictorial view.

PRISMA, an iperspectral precursor of the application mission, aims the deployment of an Earth observation system through the exploitation of advanced opto-electronic equipment. In particular an innovative iperspectral sensor is envisaged on-board.

The above activities are expected to stimulate effectively the devopnment of sensor technology for space, including light active and passive solid state sensors as well as inertial micro-sensors.

### 3. Integrated Architectures and Sensors

A vision on future space networks include the deployment of the so called "distributed space networks". The latter will largely exploit sensors belonging to either one of the following classes:

- passive
- reactive
- sensor web.

Reactive sensors are automatically reconfigurable, according to the collected information. When a set of "intelligent" sensors", connected through a communications tissue, behaves as a single, adaptive and flexible observation system, it is named "sensor web". In Figure 4 a space co-observation network is displayed as an example.

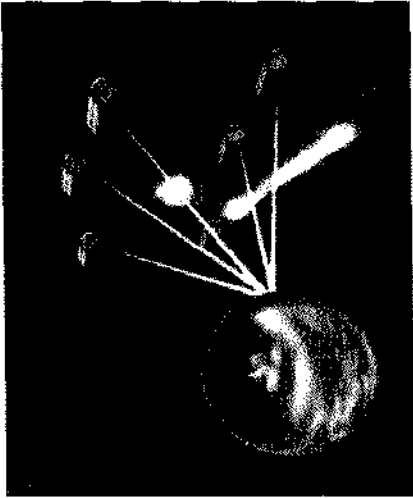


Figure 4. Co-observation through a sensor-based space network.

The development of space-based sensor networks implies the capability of deploying very flexible satellite nodes, including some of the following on-board capabilities:

- regeneration
- software-driven subsystems
- IP (Internet Protocol) routing
- satellite-to-satellite direct connection (Figure 5)
- formation flying.

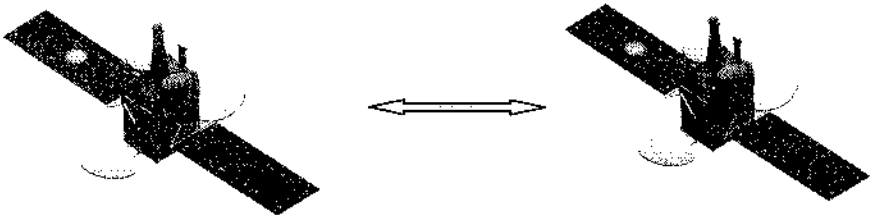


Figure 5. Satellite nodes connected through a direct link.

Some of those features are among the perspected developments of ASI future programs. The aim is to shape the satellite as an intelligent node for the deployment of global, integrated systems and, thus, to render space a means to improve the citizen's Quality of Life.

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