Space Activities: Educational aspects
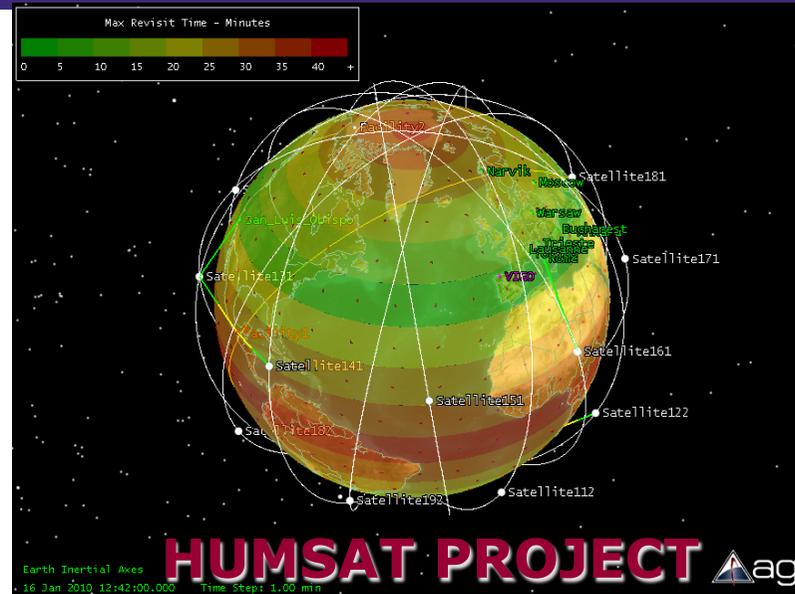
Humsat: *example for international cooperation in small satellite missions*

Graz– July 2011

UniversidadeVigo

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HUMSAT

Example for international cooperation in small satellite missions

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Jordi Puig-Suari – **CALPOLY**

A. Castro – **ESA Education Office**
Werner Balogh – **UNOOSA**
Sergio Camacho/Esau Vicente Vivas –
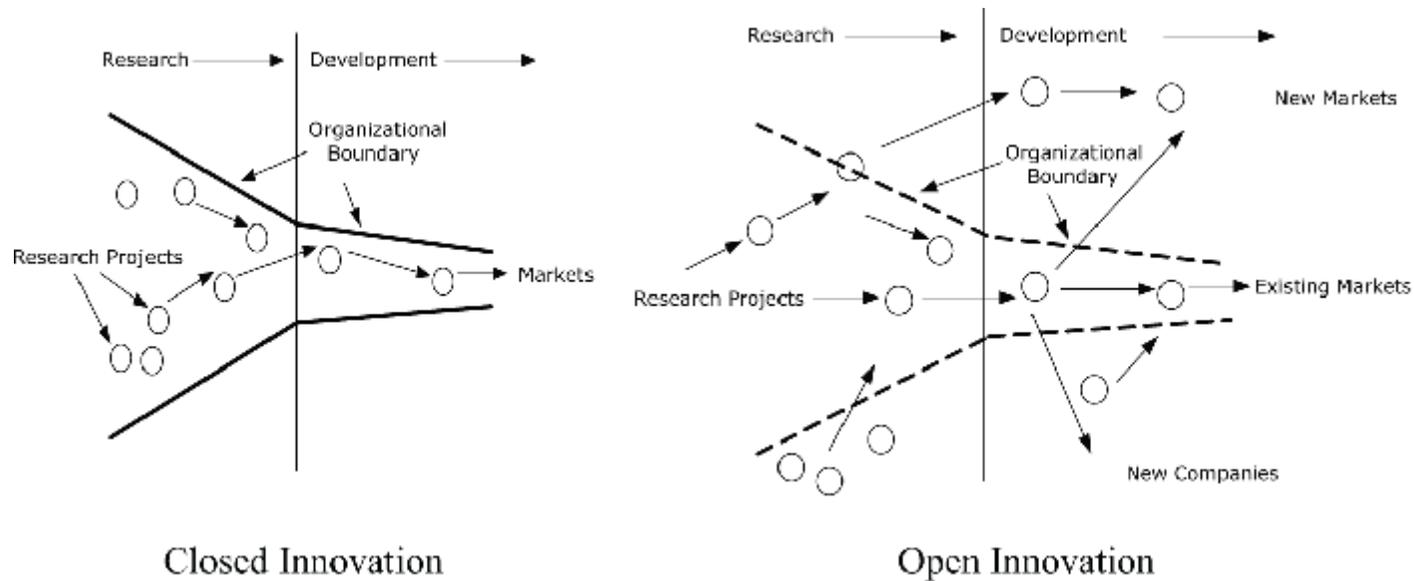**(UNAM – CRECTEALC)**

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Space Activities

CONTENTS

- Project Definition and Initiators

- Supporting Organizations

- Universities and Countries Participation

- Educational Objectives

- Mission Concept and Architecture

- System Design Details

- User Data Distribution

- Project Management and Schedule

The Innovation Strategy

Closed Innovation

Open Innovation

Closed Innovation refers to a situation in which all innovation is developed internally and kept inside the company.
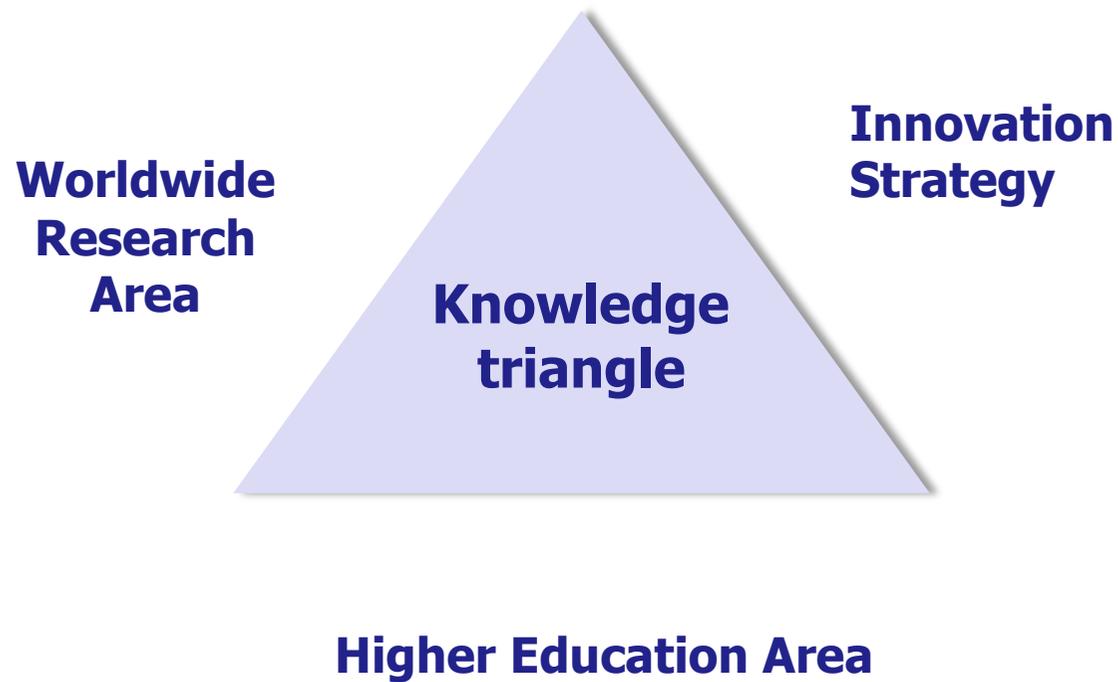
No knowledge flows into or out of the company.

"Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation respectively."

Source: Chesbrough (2003,2006)

Space Activities

Worldwide
Research
Area

Innovation
Strategy

**Knowledge
triangle**

Higher Education Area

Project Definition

- HUMSAT is an international educational initiative for building a constellation of nano-satellites providing communication capabilities to areas without infrastructure.

  - Based on the CubeSat standard and using GENSO as ground segment (open other standards).

- HUMSAT is meant to provide data-relay services (storage and forward concept) for transfer of data like for example:

  - In-situ Environmental information (uni-directional)

  - Humanitarian (Simple bi-directional data)

  - Possible additional specific payloads.

- GEOID is the ESA's HUMSAT testbed in support of the project and for educational purposes:

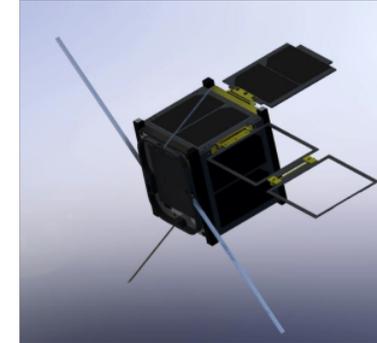 - Constellation of 13 CubeSats for testing purposes over the European region
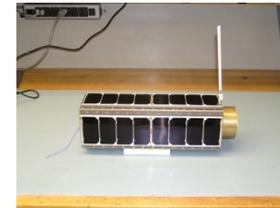
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Project Initiators

- ➲ Concept definition and initiators:

  - ➲ **University of Vigo (Spain)**
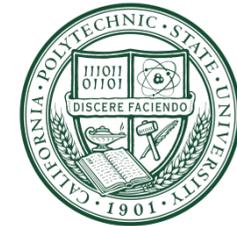   - ➲ Xatcobeo
    - ➲ European GENSO Operations Node

  - ➲ **California Polytechnic State University (USA)**
    - ➲ CubeSat standard definition
    - ➲ P-POD development
    - ➲ Candidate for US/American GENSO Operations Node

  - ➲ **Universidad Nacional Autonoma Mexico (Mexico)**
    - ➲ CubeSat development for HUMSAT
    - ➲ SATEX (50 Kg s/c)

  - ➲ **CRECTEALC: Regional Center for Education in Space Science and Technology in Latin America and Caribean Countries.**

Supporting Organizations

The system is supported by a number of international organizations and countries:

- ⮩ UNOOSA
    - ⮩ HUMSAT discussed at UN Symposium on Small Satellites organized in Graz in September 2009 an
    - ⮩ HUMSAT under the United Nations Basic Space Technology Initiative (UNBSTI, http://www.unoosa en/SAP/bsti/index.html).

- ⮩ ESA
    - ⮩ Optional Educational Program for State and Cooperating Members
    - ⮩ GENSO development and operations node selected.
   - ⮩ Leading the implementation of the test-bed via GEOID: 13 satellites.

- ⮩ IAF
    - ⮩ Special discussion on HUMSAT during the International Astronautical Congress organized in Prague September 2010
    - ⮩ HUMSAT presented at IAF Workshop on Space Sensors for Climate Monitoring organized in Paris in 2010

- ⮩ CALPOLY
    - ⮩ Educational program to launch US/CubeSats.
    - ⮩ Use of GENSO for their CubeSat projects.
    - ⮩ Selection of the US/American GENSO node.
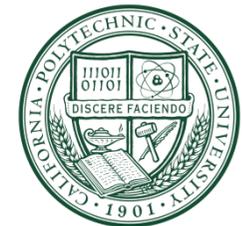
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- **ESA**: Educational Program of the European Space Agency to launch 13 nanosatellite.
  - Universidad de Vigo – Spain: ESA Prime.
  - Constellation of 13 Satellites in 3 SSO orbital planes (TBC)

- **California Polytechnic University**
  - Coordinates the US participation.

- **UNOOSA** (Trough Regional Centers: i.e. CRECTEALC) :
  - Central and South America:
    - Mexico (2 satellites)
    - Colombia
    - ......
    - ......
    - ....
  - Russia
  - India
  - Nigeria
  - Malaysia
  - Vietnam

- Many other countries have expressed interest (e.g. Japan, South Africa, Pakistan, Turkey, Gabon, Indonesia, …).

- **Open for all interested participants.**

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Space Activities

Educational Objectives

- ➲ Provide hands-on-project experience on a space project for engineering/science students.

    - ➲ Covering all design, implementation and operations phases.

    - ➲ Covering all technical aspects of a space development

- ➲ Get students familiarized with ESA project management, standards and procedures for space projects.

- ➲ Hands-on experience with universities, institutions and space agencies at worldwide scale.

- ➲ Promote international cooperation between universities, space agencies and countries in space.

- ➲ Sharing experience with universities/institutions of emerging countries.

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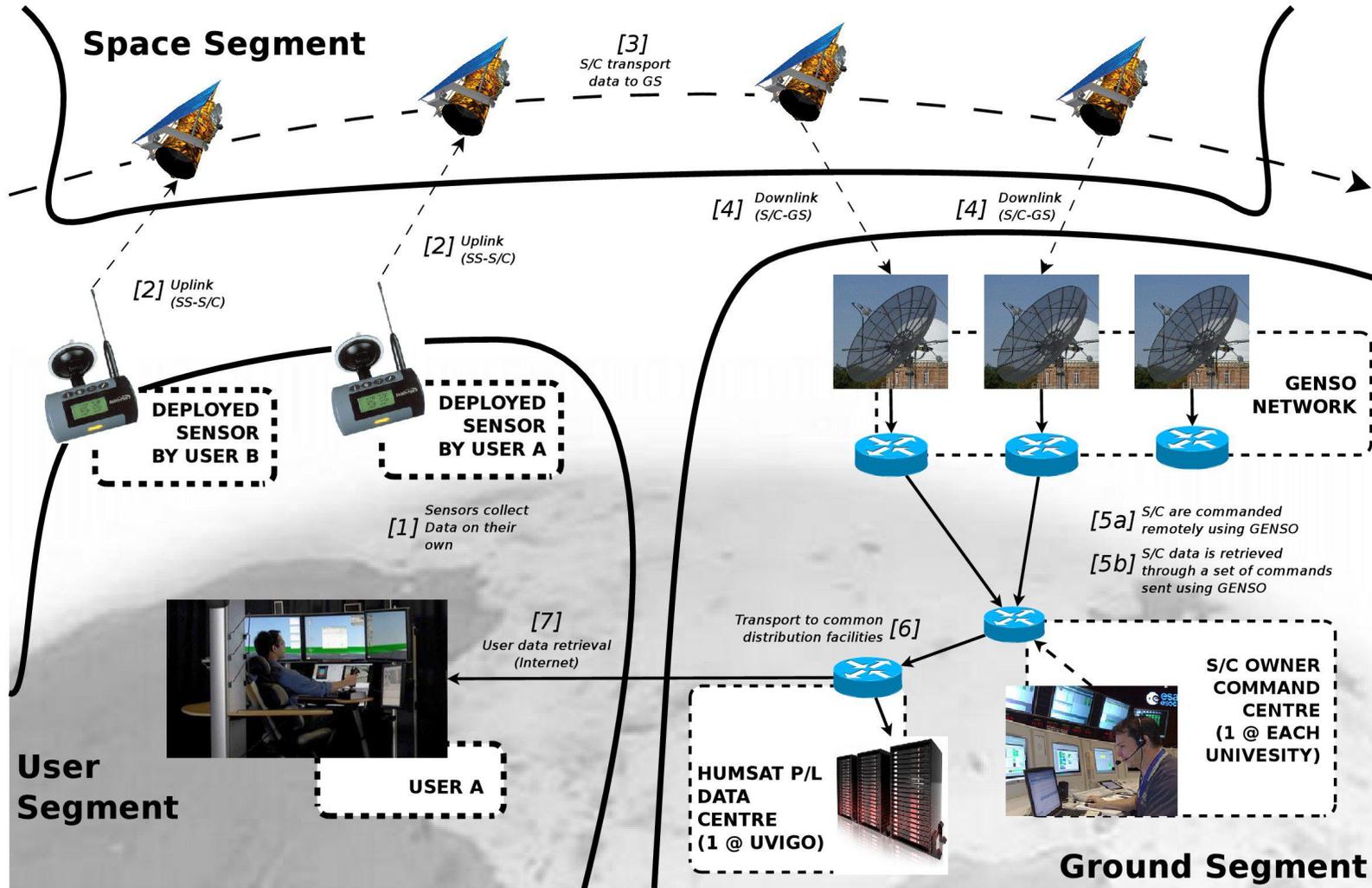
⮕ **Space segment** is based on nano-satellites, according to the **CubeSat** standards as baseline.

⮕ **Ground Segment** is based on the GENSO network (near worldwide coverage).

⮕ **User segment** based in low-cost ground sensors:

  ⮕ **Up-linking** key information for further release to users,

  ⮕ Providing **bi-directional** communication capabilities between users in remote locations.
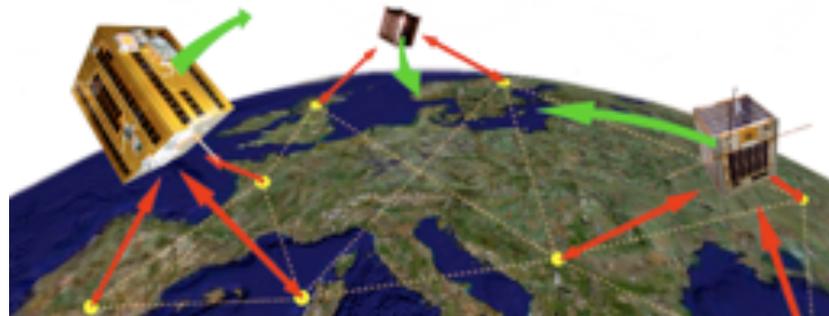
- Constellation of CubeSats, approx. 1.3 to 4.5 Kg. (Open for non-Cube Standards)

- Low Earth orbits, ~600 km.

- User time gap in visibility for any s/c in the constellation < 2 hours.

- GENSO ground station worldwide network used for data downloading and TTC, providing almost continuous visibility on the CubeSats.

- Possible user ground sensors (applications):

  - Public health: providing communication means from remote locations.

  - Monitoring and prevention of natural disasters through a worldwide sensor network.

  - Sensor networks for climate monitoring.

  - Monitoring of environmental pollution: wells, lakes, areas with difficult access, seas…

  - Space pollution: space debris.
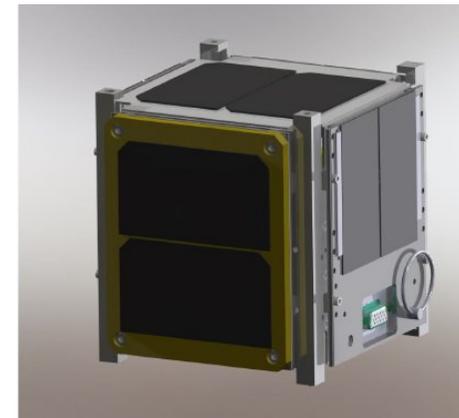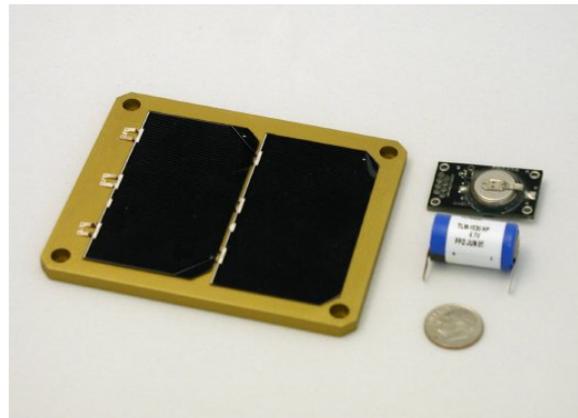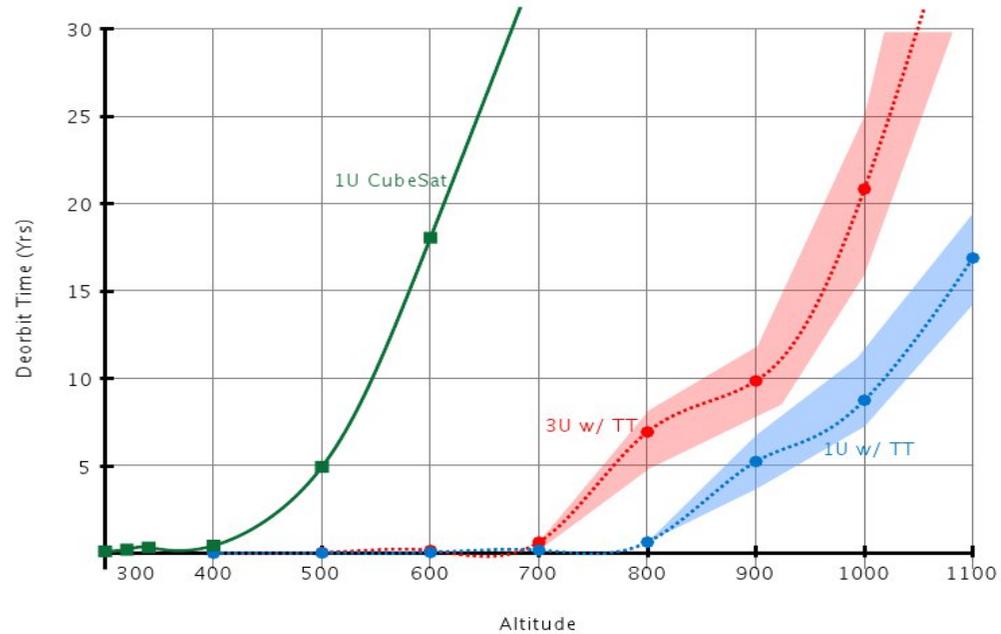
  - Use of nano- and micro-technology for the sensors.

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➲ **Possibility to include additional payloads**:

    ➲ Scientific Sensors,

    ➲ Cameras,

    ➲ GPS,

    ➲ Space weather

    ➲ Debris sensors..

    ➲ …

➲ **Possibility to define inter-satellite links between certain HUMSAT satellites.**

- ➲ **Possibility to include deorbit mechanisms to minimize the orbit time after the mission?**

- ➲ **YES and compatible with typical LEO orbits used by Commercial Satellites**

➲ Typically, both commercial and agency-sponsored available launch opportunities for CubeSats allow developers to inject their spacecraft into orbits between 500 km and 800 km of altitude.

➲ CubeSats are not the primary payload of those launches and they cannot typically influence the orbit parameters of the main payload.

➲ BUT trough HUMSAT will be developed/demonstrated:

  ➲ Optimization/Selection of performance of the mission using as restriction the available launch opportunities → Flexibility.

  ➲ Swarm-like constellation can provide good performance → possible passive and active system to control the orbit position.

  ➲ No debris and large mission-lifes coherent with space companies requirements needed by in-orbit demonstrations.

Launch Opportunity

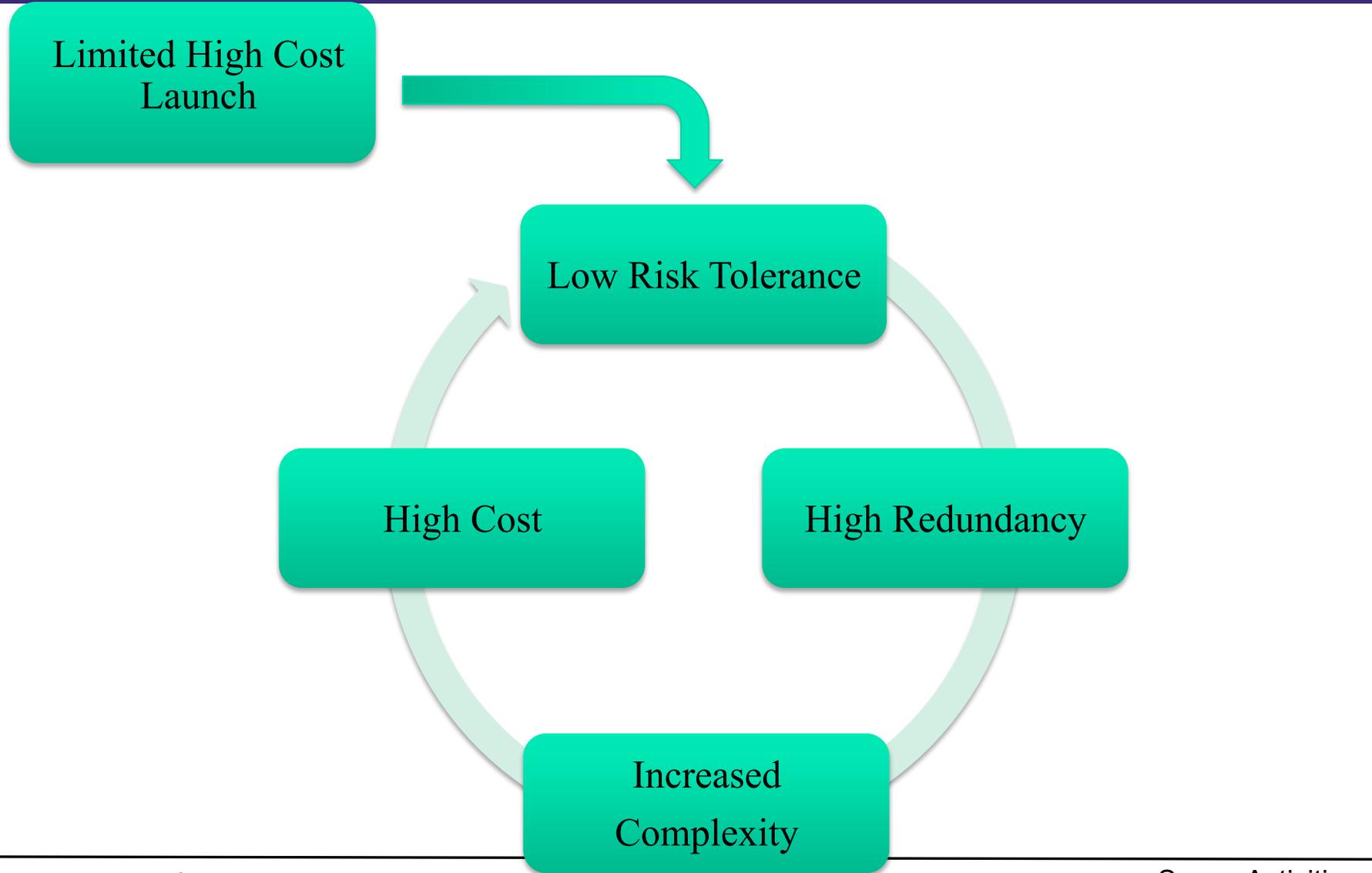Launch Opportunity

Launch Opportunity

Launch Opportunity

Standard Launch Interface / Services

Spacecraft Developer

Spacecraft Developer

Spacecraft Developer

Spacecraft Developer

Spacecraft Developer

Spacecraft Developer

Spacecraft Developer
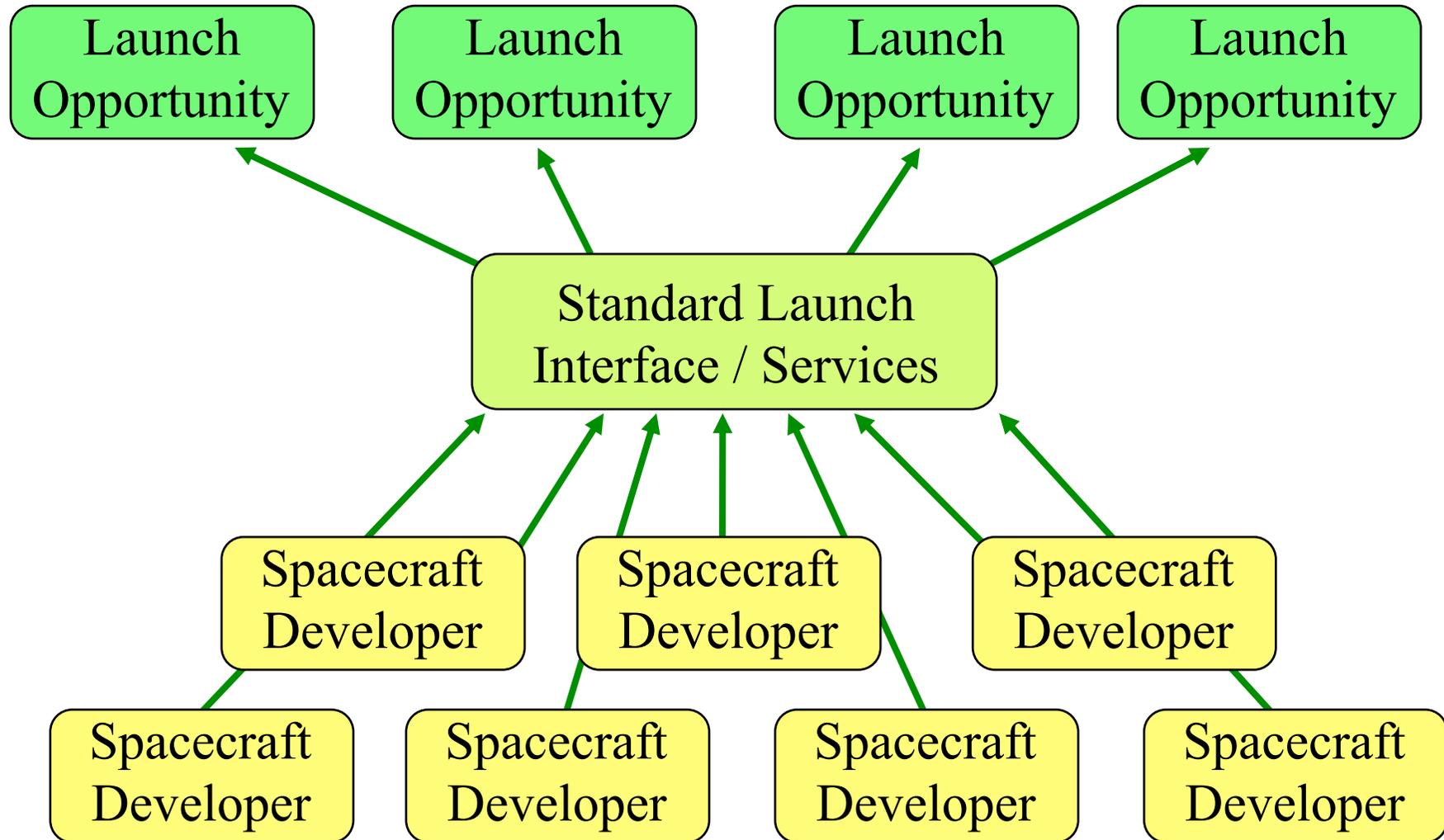
➲ Sensor interface to the constellation will be publicly available.

➲ Every user can define its own monitoring sensors and locations.

➲ Once a sensor has sent their data to the s/c, this user data is downloaded through one of the GENSO ground stations and transported to the Data Distribution Center(s) using the Internet.

➲ Users will need to register and authenticate in order to access their data.

➲ Access is provided via the Internet to the data collected.

➲ No proprietary tools required for the access.

- **Europe: GEOID (ESA) Active !!**

- **USA**: Coordinated by CALPOLY

- **Central, South America and Caribbean Countries**: CRECTEALC (Regional Centre for Space Science an Technology Education, affiliated to the United Nations) and UNAM/AEXA coordination

- **Africa**: UNOOSA coordination with the support of the promoter group, IAF and the rest of the Space Agencies

- **Asia Pacific**: UNOOSA coordination with the support of the promoter group, IAF and the rest of the Space Agencies.

➲ Plan:

  ➲ System design activities are undergoing at present.

  ➲ Release of system documentation for participants last September 2010.

  ➲ Possibility to undertake efforts in three areas:

    ➲ Develop a CubeSat

    ➲ Develop the hand-set and sensors for communication with the constellation

    ➲ Join the GENSO network which will provide the ground infrastructure for data relay

➲ Open for cooperation in the Mission and System Requirement Phases.

➲ Mandatory use of a tailored version of the different SPACE QUALITY Standards (CCSDS).

➲ Debris mitigation.

- ➲ GEOID, the HUMSAT test-bed that ESA Education Office will develop is a 3 years project.

- ➲ Purpose: build the European component of the Global constellation

- ➲ Promote the concept of HUMSAT through international cooperation with other space Agencies

- ➲ Plan:

  - ➲ System design activities are undergoing at present.

  - ➲ Selection finished.

  - ➲ Possibility to undertake efforts in three areas:

    - ➲ Develop a CubeSat

    - ➲ Develop the hand-set and sensors for communication with the constellation

    - ➲ Join the GENSO network which will provide the ground infrastructure for data relay

- ➲ The System Engineering activities is led in Europe by University of Vigo which is one of the promoter of the HUMSAT concept under ESA management control.

◗ HUMSAT is currently actively participated and supported by Space Agencies and the most recognized International Organizations.

◗ Goals: Educational, Research, Humanitarian, Climate monitoring, Non Commercial.

◗ UNOOSA: United Nations Basic Space Technology Initiative (UNBSTI)

◗ Any country could join the project in different levels:

  ◗ Nanosatellite development

  ◗ GENSO Ground Segment.

  ◗ Specific User Segment (sensor)

◗ Capability to design Space Segment (secondary payloads) and Sensors specifically for the local/regional needs.

◗ Worldwide coverage.

◗ Open standard.

◗ Free access to the data through internet.

◗ WIN-WIN Approach: share satellites, GS, information, ….

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- Sergio Camacho (CRECTEALC)

- Esaú Vicente Vivas (UNAM)

- Antonio Castro (ESA)

- Werner Balogh (UNOOSA)

- Héctor Salvador (IAF)

- Victor Reglero (MICINN)