UPCSat: A CubeSat Project

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Outline of the presentation:

1. **Introduction: Contour Conditions**
2. **Launch Opportunities**
3. **Space Segment**
4. **Ground Segment**
5. **Potential UPC Interests**
6. **Current Status of the Initiative**
7. **Next Steps**
8. **Conclusions**
9. **Open Discussion**

➢ **CRAE: Aerospace Research Center**

    Centre Específic de Recerca: ~90 researchers from 28 research groups

    Articulates UPC participation in IEEC

➢ **CRAE's second epoch:**

    ▪ UPC has extensive knowledge in aerospace projects

    ▪ Participation is limited due to lack of interconnections between groups

    ▪ Look for tractor projects both in aeronautics and **space**

➢ **Contour conditions:**

    ▪ ESA is now offering 6 launch opportunities for University 1 U CubeSats !

➢ **VEGA Maiden Flight Launches of Opportunity:**

    ▪ Vega Maiden Flight CubeSat Workshop (22-24/1/2008)

    ▪ **Educational payloads will be entirely developed by educational institutions**, with advice from ESTEC experts if requested and deemed appropriate by the Education Office.

    ▪ Orbit: perigee = 350 km, apogee = 1200 km, inclination = 71°.

▪ **Selection criteria:**

- **educational content, technical maturity and project objectives,**
- letters of commitment by funding bodies (institutions and/or industry)
- development compliance with Vega Maiden Flight schedule,
- signing of relevant agreements between the educational institutions (universities) and ESA's Education Office.

▪ **Schedule:**

-	Call for Proposals:	15/2/2008
-	Proposal submission deadline:	17/3/2008
-	Final selection:	15/4/2008
-	CubeSat Flight Acceptance Reviews:	launch – 12 weeks
-	CubeSat flight hardware shipment to Kourou:	launch – 10 weeks
-	Target launch date December 2008 (TBC)	

➤ **CubeSat 1 U Standard platform:**
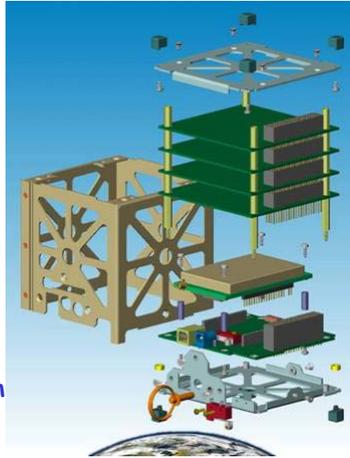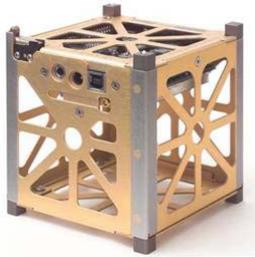
10 cm x 10 cm x 10 cm
< 1 kg
~2-3 W

➤ **CubeSat: development kit**

1 U Cubesat admits 5 std. boards
(2 U and 3 U CubeSats admit more, but are not considered by ESA for this opportunity launch)

Development Kit includes:
- 1 U skeletonized structure
- On Board Computer (FM430)
- MHX Transceiver
(f: 920, 2400 or 2400 MHz)
- Linear EPS

It does not include:
- Solar panels (expensive ~25 Keur!)
- Antennas
- Payload **(1 board)**

| Configuration	Mass	Notes
1U skeletonized chassis, complete[5]	165g	With Launch Switch. Add 85g for solid-wall chassis.
+ FM430 Flight Module and MHX-series transceiver	300g	No antenna. Using M/F standoffs.
+ Solar Panel Kit	479g	0.062" (1.5mm) bare PCBs on all six faces
+ Linear EPS w/Li-Ion iPod batteries	602g	In Slot 2
+ Experiment Board A	672g	In Slot 3, no antenna

➢ **CubeSat: development kit**

Linear EPS

On Board Computer

Also available in the market:

- Solar Panels (Clyde Space) - Magnetometers - ADACS (~55 Keur) - GPS (~18 Keur) etc.
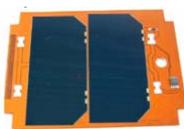
(e.g. MK-II SSTL) (e.g. IMI 100 Pumpkin)

But everything does not fit in 1 U structure!! => go to 2 U or 3 U structures

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➢ **Current situation -Limitations**

▪ From ~15 orbits there are around six passes a day, averaging ~ 5 min each,

▪ **Satellite in communications range < 3%, for 97% of the time the groundstation is idle,**

▪ Groundstation not configured to communicate with other educational spacecraft, and spacecraft only configured to communicate with the specific groundstation.

➢ **Solution: Global Educational Network for Satellite Operations - GENSO**

▪ Develop flexible global software standard to allow existing educational and

radio amateur ground stations worldwide to link together, communicate with each others' satellites, and stream mission data to operators via the Internet.

▪ GENSO currently envisaged to be fully operational as of 10/2008

▪ "Once the network is operational any educational, or amateur radio, spacecraft and ground stations will be most welcome to participate. There will be some simple user agreements."

[Extracted from ESA presentation on GENSO project]

• ETSETB & TSC Dept. will buy a ground station from ISIS company

• VHF/UHF/S-band remote controlled (internet) GENSO Compatible Ground Stations are already in the market for less than 30 Keur

• An educational value for many subjects in Telecommunications Engineering Carrers, final projects etc

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➢ **Potential Payloads and Subsystems that can be developed by UPC and "UPC Corona" research groups:**

- ▪ **Technology demonstrators:**
  - • Specific applications of telecom IC's (miniature radiometer receiver)
  - • Sun sensors
  - • Solar panels & photovoltaic cells
  - • Miniature & Active antennas
  - • MEMs: switches…
  - • Filters
  - • Efficient electrical power supply system
  - • Gyros
  - • Design of GPS receivers
  - • Design of AOCS
  - • Optical downlink
- ▪ **Small scientific missions:**
  - • Miniature radiometer (low power)
  - • Small VIS/IR camera (low resolution, wide FOV)
  - • Atmospheric limb sounding (GPS)
  - • Ionospheric TEC measurement (GPS)
  - • High atmosphere monitoring (pollutants)
  - • Radiation measurement (photodiodes)
  - • Microgravity experiments

Potential UPC Interests (ii)

➢ **Present conditions:** UPC is behind other Universities in this field, but not only from more developed countries (!)

➢ **Strategy:**
  ▪ 1st CubeSats:
  - start with simple missions: no attitude control, or passive control at most
  - buy as many required subsystems as needed: quick start-up !!
  - focus only in designing the ones with added value

  ▪ 2nd CubeSats:
  - replace previously bought subsystems (e.g. EPS, TC …) with in-house developments to be tested
  - include new developments (e.g. GPS, AOCS…) that could be used simultaneously for other scientific experiments.

➢ **Integration and tests:** Clean room at EEL Dept.
(Some tests may have to be carried out at LGAI or INTA)

Potential UPC Interests (iii)

➢ **Possible UPCSat program (TBD according to groups interests):**
  ▪ UPCSat-1: passive stabilization using Earth's magnetic field + spin miniature radiometer for future SMOS + giroscope (?)
  ▪ UPCSat-2: passive stabilization using Earth's magnetic field & boom VIS camera
  ▪ UPCSat-3: passive stabilization using Earth's magnetic field test GPS
  ▪ UPCSat-4: passive stabilization using Earth's magnetic field atmospheric sounding (GPS occultations)
  ▪ UPCSat-5: without stabilization
   GPS + atmospheric spectrometer + radiation sensor
  ▪ UPCSat-6: active stabilization
   test AOCS + VIS camera
       …

Goal: development of engineering and flight models of a new UPCSat (including tests) every 18 months involving **Final Project and Ph D Students**
≫ MUST SEE THEIR PROJECT FLY IN THEIR STUDENT LIFETIME
➢ Beware: only about 10-20 % end successfully (contacted in orbit)
The real success is to involve all the teams and students in such a project

➢ **Current Status:**

- Pumkin CubeSat Dev. Kit purchased (A. Camps): received

- Pumkin CubeSat Dev. Kit without structure purchased (EPSC): received

- ISIS CubeSat Structure purchased (A. Camps): received

- ISIS VHF/UHF/S-band remote controlled (internet) GENSO Compatible Ground Stations (ETSETB & TSC): on going

- Contacts with Barcelona Activa-Promoción Aeroespacial made: financial support for purchase of solar panels or launch costs

- UPC Social Council President (Mr. Folch):
  - Official support from UPC Social Council
  - Meeting arranged with Abertis Telecom, Applus, INDRA Espacio and Telefónica to "sponsor" the project: project support, consultancy, tests etc.
    » TESTS: Applus (LGAI)!! If not, INTA


UPC CubeSat Initiative

Goals:
- foster collaboration between groups within UPC and "UPC Corona" in space-related activities
- retain and attract students for final project & potentially for Ph D
- provide visibility of UPC space-related activities to the society
- continuity ⇒ launch a UPCSat every 2 years

Contour Conditions:
- Optimum conditions for opportunity launch (VEGA Maiden Flight)
- GENSO (Global Educational Network for Satellite Operations) must be operative by the end of the year: UPC could joint it readily
- Despite our current delay we can together make a big step forward in both space and ground segments by buying proven technology (not to reinvent the wheel) and focusing: in the short term » new, but simple payloads
  in the mid term » new subsystems and more complex payloads

Paves the path to larger spacecrafts and scientific missions:
e.g. INTA's OPTOS mission (launch date 2009) based on 3 U Cubesat standard
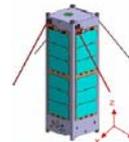
•Interested students can contact the faculty members listed for each different topic

•Coordination meetings will take place periodically

•ESA standards will be followed (not at 100 %: too much burden)

Francesc Moll	EEL	moll@eel.upc.edu	-Diseño y caracterización de circuitos integrados para comunicaciones -Diseño digital con FPGAs robusto a tolerante a radiación
Jordi Mateu	TSC	jmateu@tsc.upc.edu	- Diseño y caracterización de de filtros compactos de RF
Lluis Pradell	TSC	pradell@tsc.upc.edu	- Diseño y caracterización de conmutadores MEM
Manuel Domínguez	EEL	mpumar@eel.upc.edu	- Desarrollo de un giróscopo MEMS - On board software
Oleguer Nogués	IEEC	nogues@aliga.ieec.uab.es	- Desarrollo de un GPS para espacio
Juan Ramos Adriano Camps	EEL TSC	jramos@eel.upc.edu camps@tsc.upc.edu	- Desarrollo de un sistema de control de actitud
Josep Masdemont	MA-1	josep@barquins.upc.edu	- Análisis de misión, incluyendo radiación y control térmico.
Juan Antonio Ortega	EEL	Juan.antonio.ortega@mcia.upc.edu	- Diseño algoritmos de optimización de consumos del satélite, diseño y/o modificación de la electrónica relacionada.
Oscar Casas Gabriel Montoro Dagoberto Salazar	EEL TSC EPSC	jocp@eel.upc.edu montoro@tsc.upc.edu dagoberto.jose.salazar@upc.edu	- Integración de sistemas - Pruebas de test - Software del sistema - Transceiver de a bordo (incorporando diseño con FPGA)
Asensio Oliva	MMT	oliva@cttc.upc.edu	- Analisi y simulación numérica del comportamiento térmico del satélite
Xavier Alabart	A3E	Xavier.alabart@a3e.org	- Diseño de las pruebas de validación (test) a nivel sistema y aspectos de integración globales.