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Nano and Picosatellites

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Small satellites

"Small" satellites, particularly nano and picosatellites are increasingly used for science (and other) purposes

Denomination	Mass (kg)
Large and medium	500 to several thousand
Minisatellite	100 -500
Microsatellite	10 - 100
Nanosatellite	1-10
Picosatellite	0.1-1

- **E.g. : http://en.wikipedia.org/wiki/Miniaturized_satellite**
- **For nano and picosatellite experiments the Cubesat standard has been adopted by developers and is used (almost) universally**

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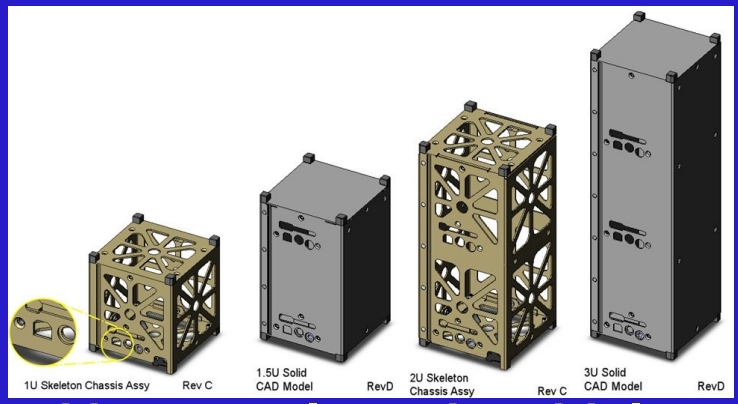
Cubesats (1/2)

- **Definition:** "miniaturized satellite for space research that has a volume of exactly one liter (10 cm cube), approximately one kilogram, and typically uses commercial off-the-shelf electronics components".
- **Units: 0.5U, 1U, 2U, 3U (in the future: 2U x 2U or 2U x 3U, etc.)**
- **Cost ~ $ 1 M (or less!)**
- **Launch: Piggyback on larger satellite launches; may launch several at the same time**



- **Standardized deployer developed (P-POD), easily integrated into any launch vehicle**
- **NSF program since 2008: Cubesat-based Science Missions for Geospace and Atmospheric Research**
  - One or two Cubesats expected to be launched per year
- **NASA: 3rd Cubesat Launch Initiative (CSLI), Feb. 2012**
  - 33 projects selected for 2013-14 period

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Cubesats (2/2)

Provide fast, cheap access to space for

- **Research: Space environment, Atmospheric Research, Astronomy, Planetary Science, Earth Environment monitoring, etc....**
- **Innovation and Technology Development: Communications, Space Debris Cleanup, Cluster Development, Repurposing of Geostationary Satellites, etc.....**
- **Education: Hands on space experience for students in a wide variety of fields and techniques**

Recently also proposed for solar system exploration, interplanetary and even outer solar system missions!

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Latin American Cubesat Projects*

(*Not a complete list)

Name	Country	Mission	Launch
Libertad-1	Univ. Sergio Arboleda / Colombia	Technology Demonstration	2007
NanoSatC-Br	U Fed Santa Maria/Brazil	Science	2012
PUCPSAT	Univ Catolica de Peru / Peru	Technology Demonstration	2012 (Planned)
NEE-01	Ecuadorian Space Agency / Ecuador	Technology Demonstration	2012 (late)
UAPSAT	Univ. Alas Peruanas/Peru	Technology Demonstration	2013
AntelSat	Univ de la Republica/Uruguay	Technology Demonstration	2013
LUSEX	AMSAT/ Argentina	Amateur Radio	2013
CHASQUI-I	Univ Nac. de Ingenieria (UNI) / Peru	Technology Demonstration	2014

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Issues: Spectrum

- Dedicated spectrum is desirable for Cubesat command, control and data transmission operations
  - Simplifies licensing, would allow intra "service" coordination
  - Would allow the use of standard, off-the-shelf components
- Requirements:
  - Omnidirectional antenna, relatively low data rates point to spectrum in the ~ 300 - 3 000 MHz range
  - Bandwidth to accommodate current and future users – worldwide (~10 MHz?)
- Under what radio service should Cubesats operate:
  - Many, but by no means all, Cubesats dedicated to space research–a non-trivial issue!

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Solutions?

- Spectrum Related Issues to Be Dealt with in ITU-R Study Group 7 (Working Party 7B) through Question XXX/7 (approved by SG 7, May 2012):

  -What are characteristic data rates, transmission times, bandwidth requirements of individual Cubesats

  -How much spectrum is needed? Worldwide estimate.

  -Under what service definition should Cubesats operate?

  - Preferred frequencies?

- Outcome: One or more Recommendations that should be completed by 2015, in time for the next Radiocommunication Assembly (in practice, by 2014)

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Cubesat Issues: Licensing/Regulatory

- **Cubesat timeline is much shorter than current national/international licensing process:**
  - **Many Cubesat projects take less than 2 years from approval to completion**
    - **No money to start licensing process prior to award**
    - **Design, construction, launch as short as ~ 1 year**
- **International registration of satellites (notification and recording) takes a minimum of 2 years, often much longer. Preceded by the national process that also may take 6 months to 2 years (in the USA)**
    - **Some info necessary for licensing is not known until near launch time (e.g. orbital parameters)**
- **Needed:**

  Fast approval process, preferably no longer than a couple of months

  - Minimum of international/national regulatory obligations and data requirements

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An Actual Cubesat Timeline

Milestone	Days elapsed
Preliminary Design Review	0
Critical Design Review	53
Launch	206
In Orbit Tests	277
In Orbit Mission	287
De-orbit	392

Total time from preliminary design to end of mission ~ 1 year and 1 month!

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Solutions?

Regulatory Issues have been placed on the Preliminary Agenda of WRC-18/19:

"to consider the appropriate regulatory procedures for notifying satellite networks needed to facilitate the deployment and operation of nano- and picosatellites, in accordance with Resolution 757 (WRC-12)"

resolves to invite WRC-18

- **to consider whether modifications to the regulatory procedures for notifying satellite networks are needed to facilitate the deployment and operation of nano- and picosatellites, and to take the appropriate actions,**

invites ITU-R

- **to examine the procedures for notifying space networks and consider possible modifications to enable the deployment and operation of nano- and picosatellites, taking into account the short development time, short mission time and unique orbital characteristics,**

Not clear at present where work is to be performed:

WP 4A (satellites), Special Committee(SC), WP 7B ?