



CubeSat Communication Systems 2003-2013: A Historical Look

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Two Survey Papers

- “A Survey of CubeSat Communication Systems”
 - Paper presented at the CubeSat Developers’ Workshop 2008
 - By Bryan Klofas, Jason Anderson, and Kyle Leveque
 - Covers the CubeSats from start of program to 2008

- “A Survey of CubeSat Communication Systems: 2009-2012”
 - Paper presented at the CubeSat Developers’ Workshop 2013
 - By Bryan Klofas and Kyle Leveque
 - Covers the CubeSats from 2009 to ELaNa-6/NROL-36 launch in 2012

Summary of CubeSat Launches 2003 to 2013

- Eurockot (30 June 2003)
 - AAU1 CubeSat
 - DTUosat-1
 - CanX-1
 - Cute-1
 - QuakeSat-1
 - XI-IV
- SSETI Express (27 Oct 2005)
 - XI-V
 - NCube-2
 - UWE-1
- M-V-8 (22 Feb 2006)
 - Cute-1.7+APD
- Minotaur 1 (11 Dec 2006)
 - GeneSat-1
- Dnepr Launch 2 (17 Apr 2007)
 - CSTB1
 - AeroCube-2
 - CP4
 - Libertad-1
 - CAPE1
 - CP3
 - MAST
- NLS-4/PSLV-C9 (28 Apr 2008)
 - Delfi-C3
 - SEEDS-2
 - CanX-2
 - AAUSAT-II
 - Compass-1

Summary of CubeSat Launches 2003 to 2013

- Minotaur-1 (19 May 2009)
 - AeroCube-3
 - CP6
 - HawkSat-1
 - PharmaSat
- ISILaunch 01 (23 Sep 2009)
 - BEESAT-1
 - UWE-2
 - ITUpSAT-1
 - SwissCube
- H-IIA F17 (20 May 2010)
 - Hayato
 - Waseda-SAT2
 - Negai-Star
- NLS-6/PSLV-C15 (12 July 2010)
 - Tisat-1
 - StudSat
- STP-S26 (19 Nov 2010)
 - RAX-1
 - O/OREOS
 - NanoSail-D2
- Falcon 9-002 (8 Dec 2010)
 - Perseus (4)
 - QbX (2)
 - SMDC-ONE
 - Mayflower
- PSLV-C18 (12 Oct 2011)
 - Jugnu

Summary of CubeSat Launches 2003 to 2013

- ELaNa-3/NPP (28 Oct 2011)
 - AubieSat-1
 - DICE (2)
 - HRBE
 - M-Cubed
 - RAX-2
- Vega VV01 (13 Feb 2012)
 - Xatcobeo
 - ROBUSTA
 - e-st@r
 - Goliat
 - PW-Sat
 - Masat-1
 - UniCubeSat-GG
- ELaNa-6/NROL-36 (13 Sep 2012)
 - SMDC-ONE (2)
 - AeroCube-4 (3)
 - Aeneas
 - CSSWE
 - CP5
 - CXBN
 - CINEMA
 - Re
- ISS (4 Oct 2012)
 - FITSat-1
 - TechEdSat-1
 - F-1
 - WE-WISH
 - RAIKO

Summary of CubeSat Launches 2003 to 2013

- PSLV-C20 (25 Feb 2013)
 - STRaND-1
 - AAUSAT3
- Bion M1 (19 April 2013)
 - OSSI-1
 - SOMP
 - BEESAT-2
 - BEESAT-3
 - Dove-2
- Antares (21 April 2013)
 - PhoneSat (3)
 - Dove-1

Summary of CubeSat Launches 2003 to 2013

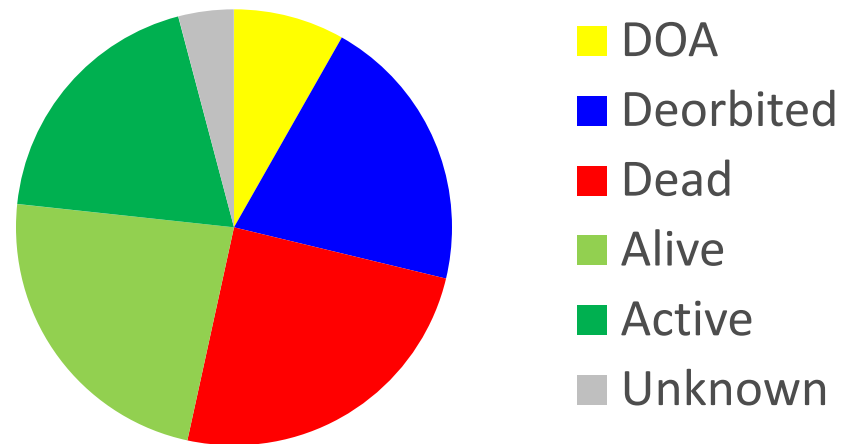
- 79 CubeSats Launched (+9 recently)

- Launch Failures:

- Dnepr-1 launch (14)
- Falcon-1 (2)
- ELaNa-1/Taurus XL (3)

- Status of CubeSats as of April 2013:

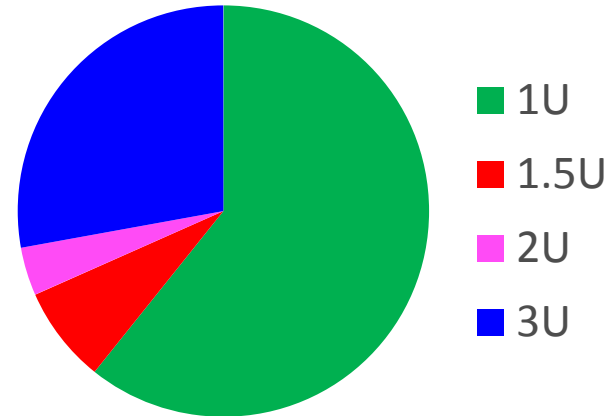
- DOA: 6
- Deorbited: 15
- Dead: 18
- Alive: 17
- Active: 14
- Unknown: 3



CubeSat Details: Size and Transmitters

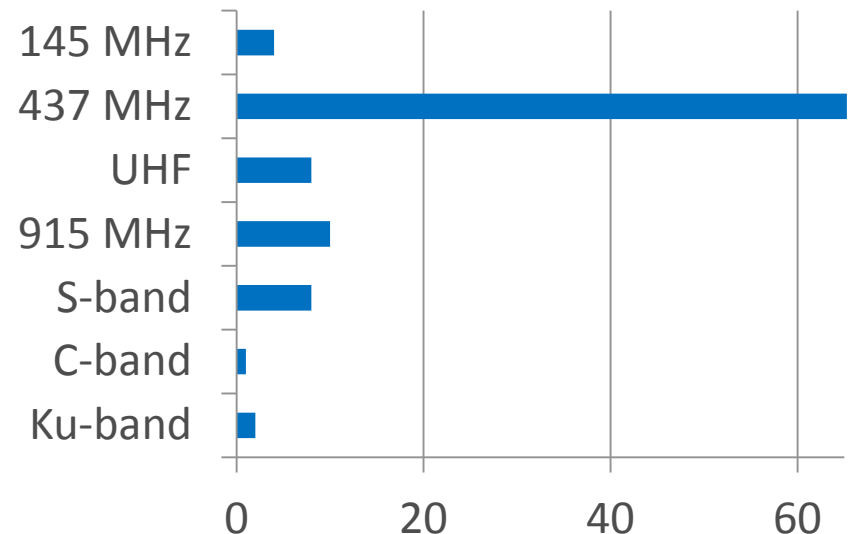
- Size of CubeSat (Total 79 CubeSats):

- 1U: 48
- 1.5U: 6
- 2U: 3
- 3U: 22



- Transmitters (Total 108 transmitters):

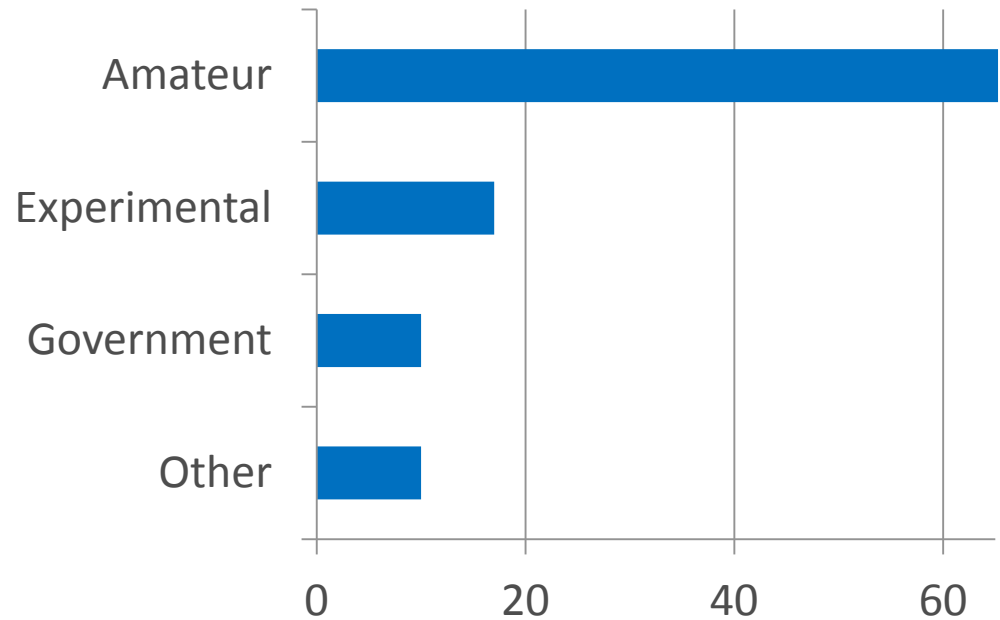
- 145 MHz amateur radio: 4
- 437 MHz amateur radio: 71
- Other UHF spectrum: 9
- 915 MHz experimental: 13
- S-band: 8
- C-band: 1
- Ku-band: 2



Note: 70% of transmitters using amateur-satellite frequencies!

CubeSat Details: Satellite Service Used

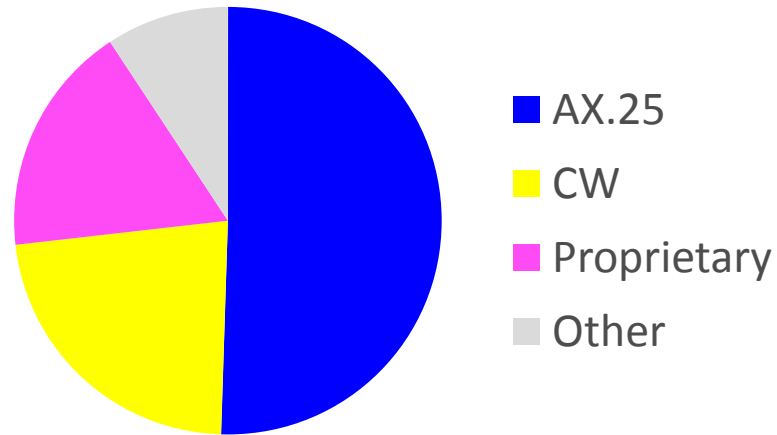
- Satellite Service (Total 108 transmitters):
 - Amateur: 71
 - Experimental: 17
 - Government: 10
 - Other:
 - Earth exploration: 1
 - Meteorological: 2
 - Space research: 2
 - Unlicensed/unknown: 5



CubeSat Details: Protocols and Data Rates

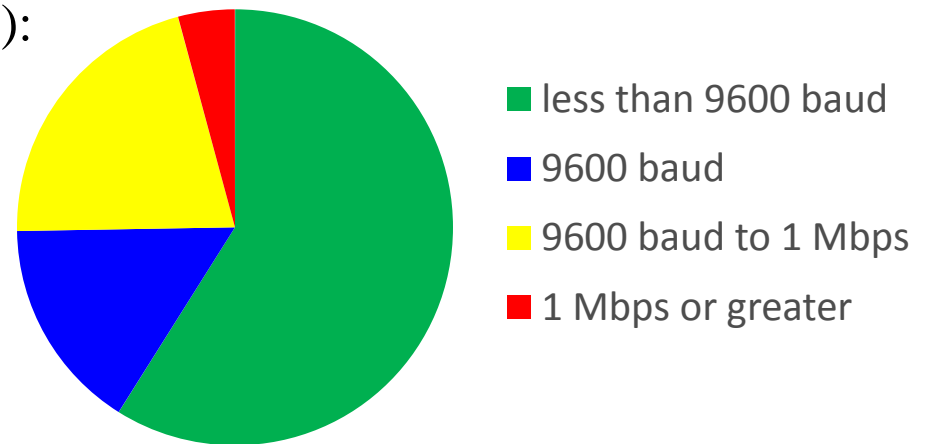
- Protocols (Total 97 transmitters):

- AX.25: 49
- CW: 22
- Proprietary: 17
- Other: 9



- Max data rates (Total 95 transmitters):

- < 9600 baud or CW: 56
- 9600 baud: 15
- 9600 baud to < 1 Mbps: 20
- 1 Mbps or greater: 4
 - Hayato, DICE, CINEMA



CubeSat Details: Countries

- Countries (Total 19 countries, 79 CubeSats):
 - USA: 41
 - Japan: 11
 - Denmark: 4
 - Germany: 4
 - Canada: 2
 - India: 2
 - Italy: 2
 - Switzerland: 2
 - Colombia: 1
 - England: 1
 - France: 1
 - Hungary: 1
 - Netherlands: 1
 - Norway: 1
 - Poland: 1
 - Romania: 1
 - Spain: 1
 - Turkey: 1
 - Vietnam: 1

Thank You



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