CubeSat

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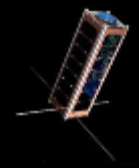

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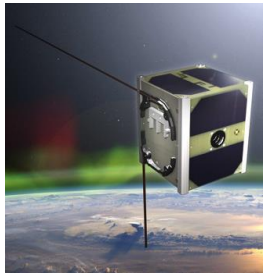
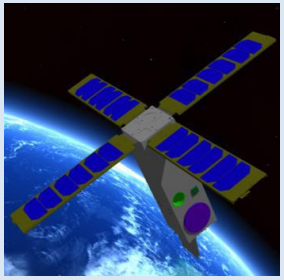
What is CubeSat?

PocketQube
0,5 Kg

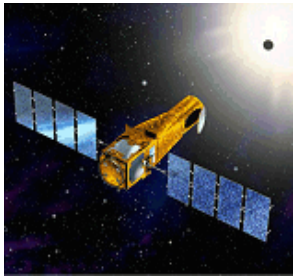


EyeSat
4 Kg

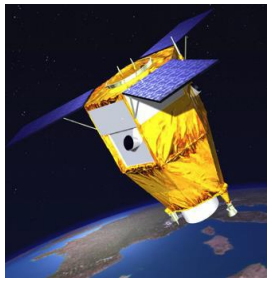


Demeter
130 Kg

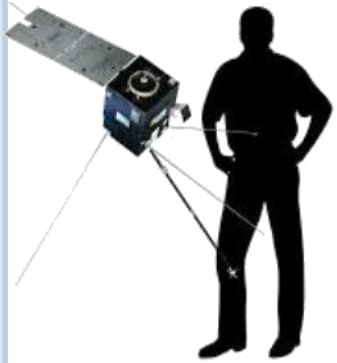
Corot
630 Kg



Pleiades
1 000 Kg



0kg Pico 1kg Nano 50kg Micro 200kg Mini 800kg



What is CubeSat?

- For space research
- Miniaturized
  - Simple 1U: 10 × 10 × 10 cm
  - Double 2U: 10 × 10 × 20 cm
  - Triple 3U: 10 × 10 × 30 cm
  - Etc 12U: 10 × 10 × 120 cm
- Lowcost
  - Rapid development
  - Modular design
  - COTS hardware

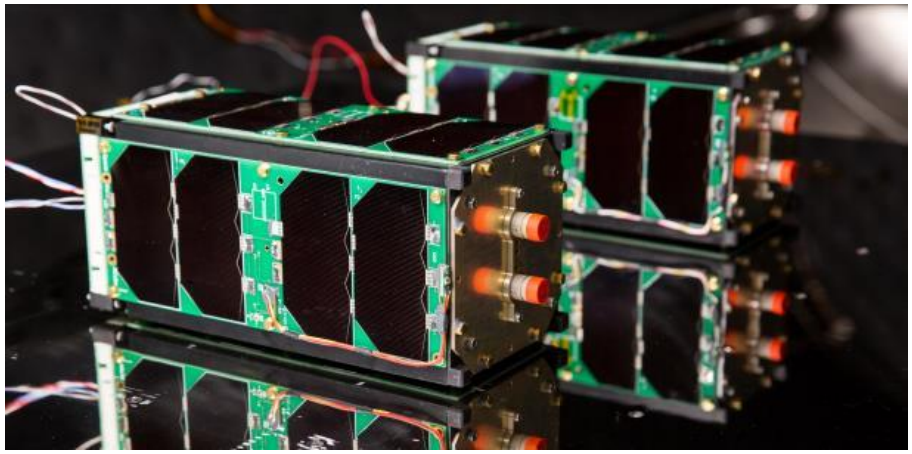


Figure 1: XcubeSat (Polytechnique)
SpaceCube (Mines)

What is CubeSat?

Composition:

- Attitude Determination and Control system (ADCS)
- On-Board Computer
- Communication system
- Power system
- Payload

Figure 2: Interior (QB50 precursor)

On-Board Computer

- Controls all subsystems
- Power efficient Microcontroller
  - STM32 family chips
  - ARM cortex M4/M7 processor
- Language: C/C++
- FreeRTOS
  - Taskscheduling
  - Semaphore
  - Queue operations
- Use Finite-state machine
  - Good for debug, test and validation

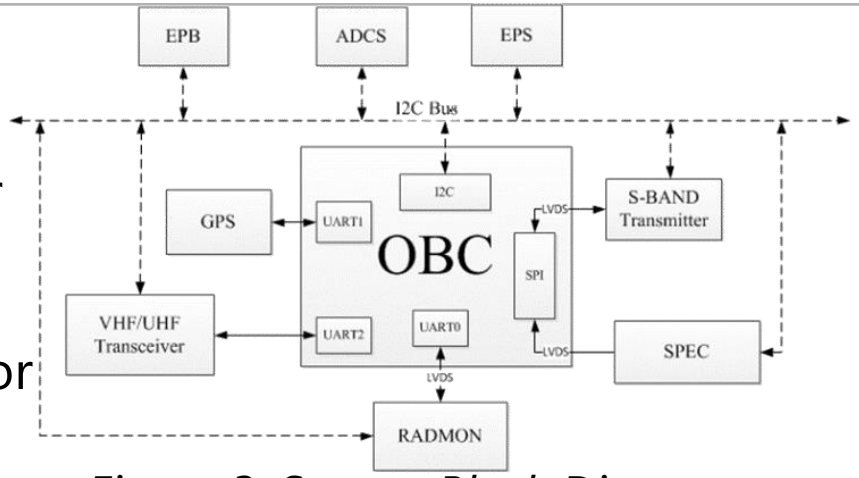


Figure 3: System Block Diagram

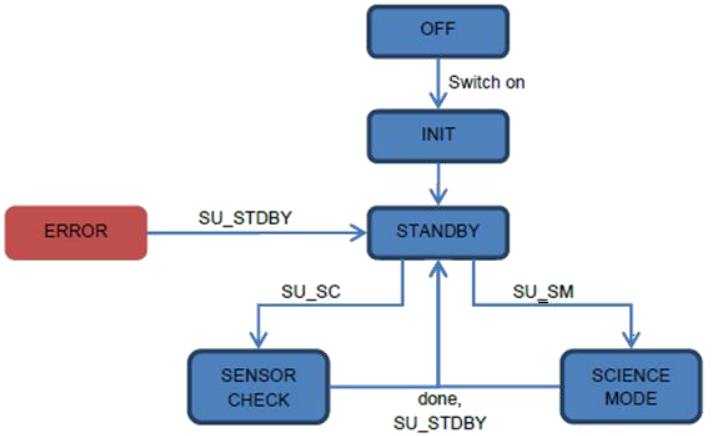


Figure 4: State Transition Diagram

On-Board Computer

- Autonomous system
- Power efficient software coding
  - No unnecessary action in background
  - Handling Sleep Transitions Seamlessly
  - Scale Behavior Based on Machine Power State
- Space contraints
  - Phantom Commands (PC)
  - Random Part Failures (RPF)
  - Single event upset (SEU)

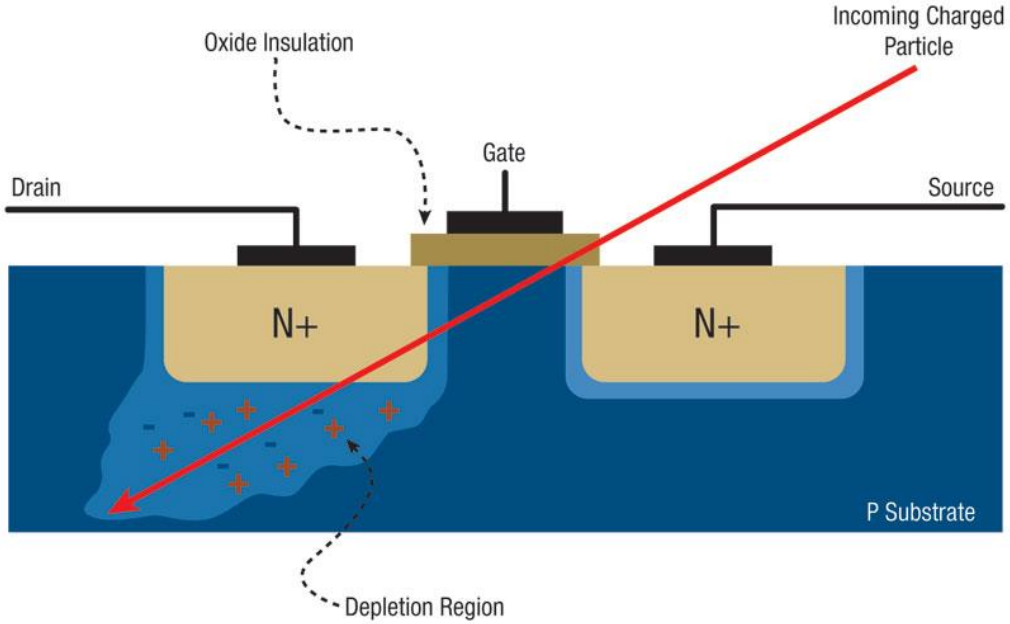


Figure 5: Single event upset

Ground station

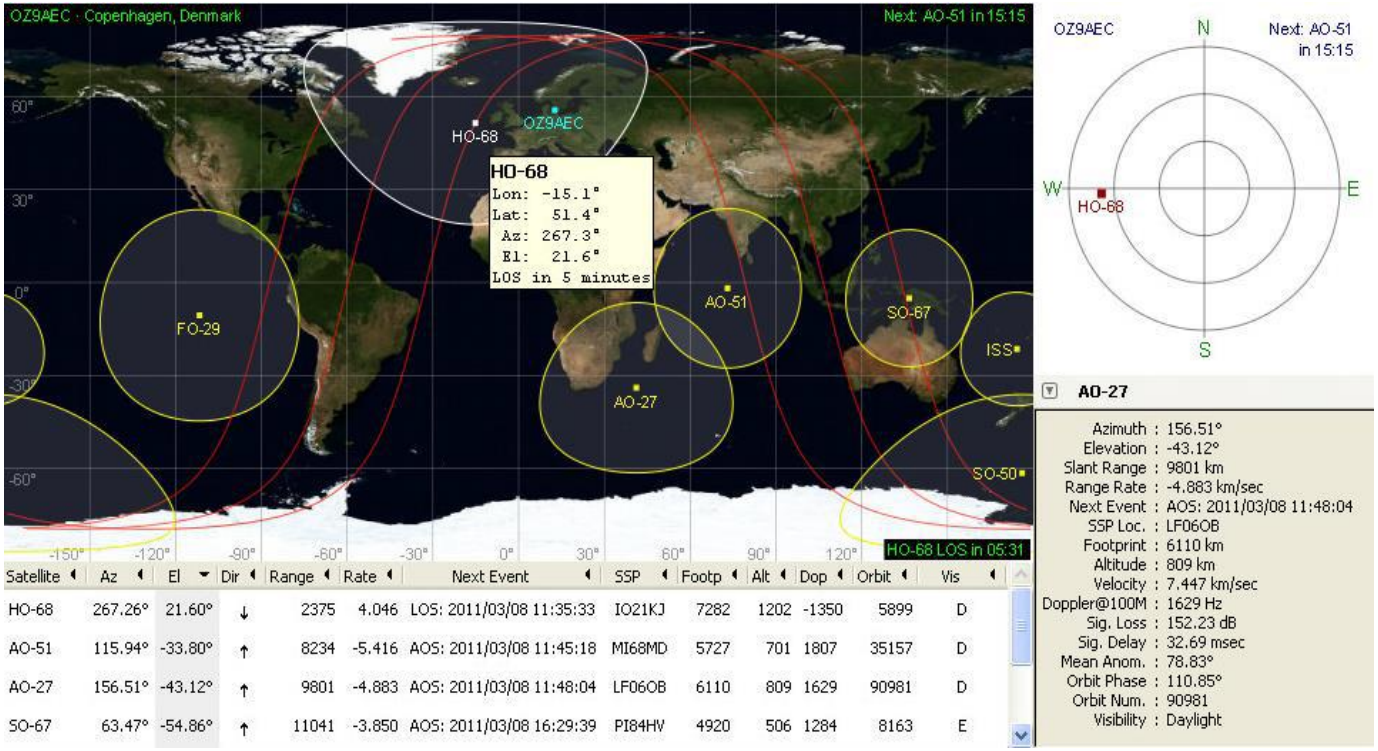
- Send Telecommand
- Receive telemetry (Whole Orbit Data)
- Language: Java
- Antenna Tracking
  - Change elevation and azimuth position
  - Increased or reducing the frequency (Doppler shift)

Figure 6 : Antenna bande X (CNES Toulouse)

Figure 7: Antenna UHF/VHF (Ecole Polytechnique)

Ground station

- Control command centers
  - Attitude handling
- Satellite tracking
  - Orbit determination



Satellite	Az	El	Dir	Range	Rate	Next Event	SSP	Footp	Alt	Dop	Orbit	Vis
HO-68	267.26°	21.60°	↓	2375	4.046	LOS: 2011/03/08 11:35:33	IO21KJ	7282	1202	-1350	5899	D
AO-51	115.94°	-33.80°	↑	8234	-5.416	AOS: 2011/03/08 11:45:18	MI68MD	5727	701	1807	35157	D
AO-27	156.51°	-43.12°	↑	9801	-4.883	AOS: 2011/03/08 11:48:04	LF06OB	6110	809	1629	90981	D
SO-67	63.47°	-54.86°	↑	11041	-3.850	AOS: 2011/03/08 16:29:39	PI84HV	4920	506	1284	8163	E

Figure 8: Satellite tracking (Gpredict)

Conclusion

CubeSats facilitate access to space and offer more opportunities to innovation

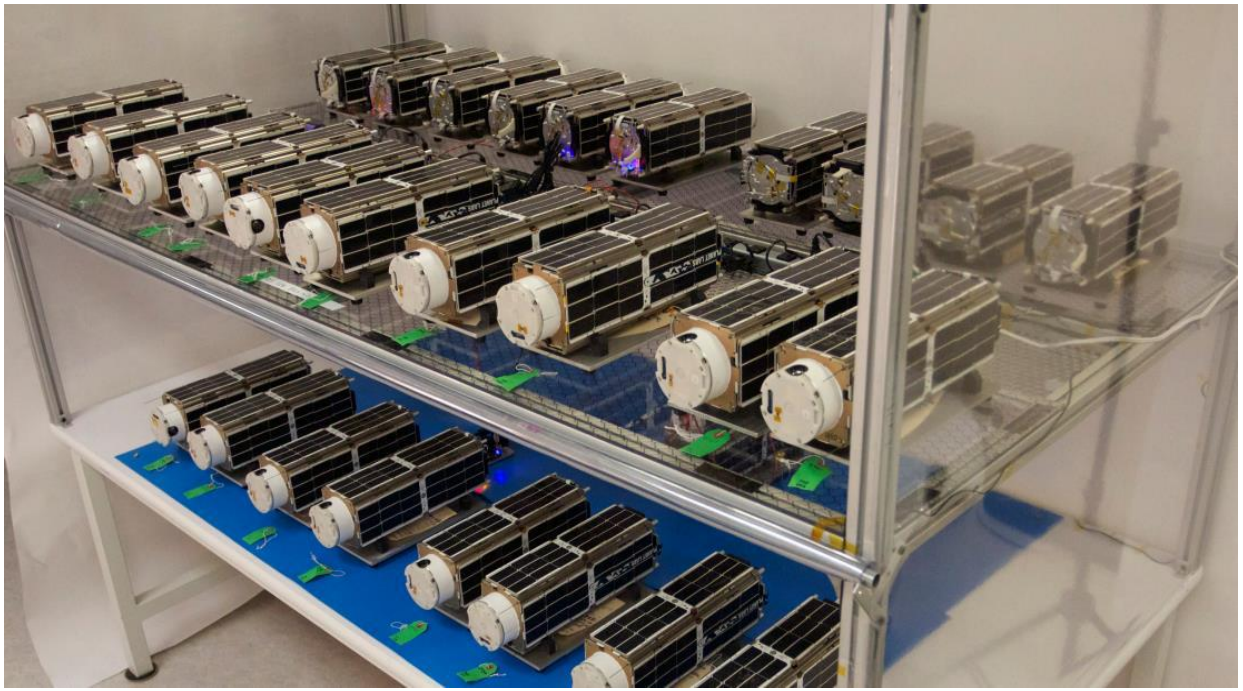
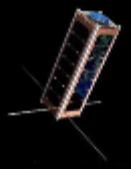


Figure 9: PlanetLabs CubeSat Constellation

References



- «*CubeSat: A new Generation of Picosatellite for Education and Industry Low-Cost Space Experimentation*», *H Heidt, J Puig-Suari, A Moore, S Nakasuka, R Twiggs, 2000*
- «*The cubesatapproach to space access*», *A Toorian, K Diaz, S Lee, 2008*
- «*Design and Qualification of On-Board Computer for Aalto-1 CubeSat »ElyasRazzaghi, 2012*
- « CubeSatsgetbig», *www.thespacereview.com. 2012.*
- « *Small Spacecraft Technology State of the Art », NASA 2015*
- « Satellite communication», *Henning Vangli2010*

Image
2nd Workshop CubeSat (2017)

Special thanks
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Thanks for your keen interest!

Any questions?

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