

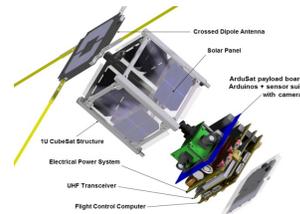
CUBESATS

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While many people will know more about Cubesats, this article is designed to help those with little or no knowledge to get a basic overview.

A **CubeSat** (U-class spacecraft) is a type of miniaturized satellite for space research that usually has a volume of exactly one liter (10 cm cube), has a mass of no more than 1.33 kilograms, and typically uses commercial off-the-shelf components for its electronics.



Historically Cubesats were developed at University level in 1999 by California Polytechnic State University (CalPoly) and Stanford University and eventually this was created as a standard and a general conformity by satellite builders became popular. Professors at CalPoly and Stanford worked on a student satellite Masters programs and wondered how they could limit building to a single year and also limit the number of components in a single spacecraft. The idea of a small sized spacecraft that can be built in a single course was developed. The standardisation was an attempt to build a single launch platform that could be placed on board a launch vehicle to launch multiple cubesats.

Cubesats are no more the sole domain of universities although they probably a big beneficiary, but now NASA, science organisations and also amateur radio groups use cubesats. Cubesats are now not only sized 10cm x 10cm x 10cm but are large some 50cm x 50cm x 50cm (about) called a 27U (vs a 1U).

A cubesat is built largely from standard specifications and parameters. It requires a minimum number of on-board functions which I will abbreviate and simplify for this article. Just remember as technology emerges – the development and specs can change. I am trying to set out the basics.

Frame:

The frame is usually the skeleton of the satellite, it is 10cm x 10cm x 10cm and is made from aluminium of space grade quality. The frame becomes the platform on which all components are mounted



On-board Computer:

The On-Board Computer is a purpose built micro processor which can do most things but have been preprogrammed to do certain things. So it is basically the command center. In the absence of human intervention, it makes the “decisions” based on instructions given

Beacon & GPS Unit:

The beacon and GPS unit helps the spacecraft (thus the user) know where it is vs the ground location. It also provides obviously the location in the sky to allow tracking. It acts similar to a transponder on an aircraft.

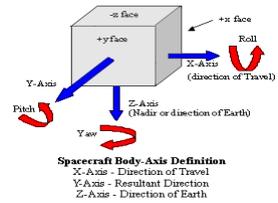


Telemetry and Management:

The Telemetry and Management is basically a two-way radio transmitting and receiving data so that the on-board computer can receive human intervention, report information on the status of the spacecraft and receive updated instructions on what to do. It is usually in the VHF or UHF bands.

Attitude System:

Since the spacecraft is in space and there is no top and bottom really, it rely on the “top and bottom” versus the earth and thus needs to point in the same direction. As it is small it cannot use rockets etc to position itself. So what happens is that it points in a north-south using a magnet usually and thus a spinning spacecraft will usually end up in the same position depending on the positions of the magnets as they move together with the magentic field of the earh.

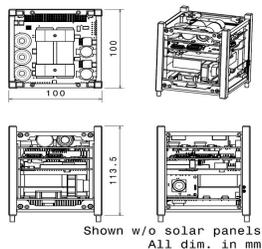
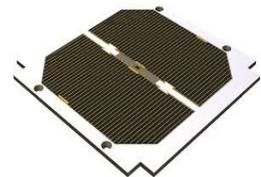


Power:

Power is DC power comprising of a set of batteries mounted to a PC board and a solar regulator circuit, measurement circuits and a heater/cooler for the batteries. This powers the whole spacecraft and ensures that all systems are working. It is switched off during launch and is switched on afterwards. It is in turn powered by solar cells.

Solar Cells:

When the batteries become low with power, the solar cells during their daylight power the batteries and ensure that the life of the spacecraft is extended. The more solar panels the further the life. Usually 4 sides and 2 extended bays are fitted with solar panels. The panels are mounted to the sides.



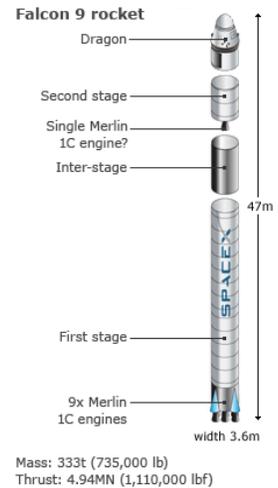
Payload:

This is the reason for the spacecraft mission, everything else will be worthless without it. In Amateur Radio satellites it is just a further radio transmission and receiving unit that acts as a repeater. In scientific or education missions it usually is a camera, sensor or other measuring instrument or set of instruments to do a certain project. In certain cases it serves to prove a certain idea.

Launch (Into space):

Usually cubesats are launched into Low Earth Orbit (LEO) which is anything from 120km to 700km high. The higher in that range the longer the spacecraft will last – Usually anything from a few months to up to 5 years. There are spacecrafts that have lasted longer.

It is done with a basic rocket that can be as small as sounding rocket which is 15m high to piggy backing and sharing a launch with an operator used by NASA or professional launchers



Launch (From the rocket to orbit):

Once a spacecraft reaches its required altitude it must be released into an orbit. CalPoly has designed a unit called a P-POD which holds the cubesat and a door will then be opened. The cubesat is in the P-POD with a spring behind it which will push the cubesat out at the right time.

Several P-POD's are placed on a “mother spacecraft” on the rocket and as a result they would be able to launch several as shown in the above pic.



Ground Station:

A ground station can be a simple Ham shack to complicated operations centers. However it is simply an array of computers, radios and antenna.

The purpose of the ground station is to transmit and receive data so that instructions can be given to the spacecraft and data received to inform of the status of the spacecraft.

Licensing and Operations:

Licensing of Cubesats is co-ordinated by the national regulator for telecommunications and the ITU but if it is an amateur radio cubesat, it is done through the national member body and the IARU.



Licensing and ongoing regulatory operations is not overly complicated



Software:

The cubesat is basically a computer, it operates with microprocessors which need to be programmed. Probably the biggest component is the software as the cubesat is digital and operates as a software radio and payload. The software operates the cubesat and the payload as well as the components such as telemetry, and other management.

Users:

A simple construction and a handheld can allow a person to be an amateur radio satellite user. The users can do several things with the radio beside voice. Users can decipher Slow Scan TV, morse and other amateur radio modes if the equipment on board permits that.

The idea is that the spacecraft needs to serve a purpose – in amateur radio there are several functions mostly dealing with communication. But with it being extended to scientific and educational appeal a host of experiments can be performed.

The aim of cubesats is to bring space experiments closer to the individual

As explained previously the original aim of cubesats was that it comes closer to individuals – it makes space and cubesats and such communication accessible. It allows high schools and universities to do space experiments, amateur radio operators can build repeaters and extend range.

Originally this was the ultimate in “DIY” or as amateur radio operators coin it “homebrew”. However in a bid to make the products more professional a number of smaller aerospace companies have emerged and created kits which have made cubesats very expensive and hence again inaccessible to those it was originally designed for. A cubesat without a launch can cost \$200,000 but with homebrewing can be lowered without lowering quality to \$20,000. Launch services can be anything from free to \$20,000 depending on the deals made.

There is a move to take cubesats back to “scratch building” using open source hardware and software. The sector has become collaborative and share ideas, plans, blueprints and generally help each other with sharing specialities and skills. This is the new challenge for this sector.

My aim with this article is to inspire the creation of cubesats and for the development of skills in the market.

* *Special thanks and acknowledgement to the copyright owners of pictures taken from several websites on the internet.*

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