OPEN TO ADMISSION!!!

Just message me (HenryRasia) on the KSP forums or email me at henryrasiam@gmail.com!

KSP Community CubeSat Project

Clarification: People "in charge" are absolutely preliminary and not fixed. Also, everyone can contribute with anything, you're not locked into your "department".

Participants

- **Confirmed**
    - HenryRasia
        - Created the doc. Highschool junior and aspiring aerospace engineer.
    - Nicholander
        - Middle school student. Suggested a few ideas, including the "Cushion" Phobos landing method
    - Mazon Del
        - In charge of biology?
    - KSat
        - Working on University cubesat.
        - Cubesat advisor/coach/general help guy (doesn't like titles :P)
    - NERVAfan
        - Designing, planning, and biology
    - Dharak1
        - Some electronics knowledge (non-wireless) and general help
    - WH40krules
        - Programming (medium-high knowledge in C++)
    - Oarum (Luke Logan)
        - Not-so-dumb 12-year-old
    - K^2
        - Created the now over 140 page forum thread. Description goes here!
    - deljr15
        - Manufacturing Engineer.
    - Lunniy Korabl
        - 3D and 2D artist, made our mission patch and signature.
    - Endersmens
        - High School Junior going into aerospace, making the website.
    - Paolo Chistè

        - Programmer in C++ and Assembly
    - LordQ
        - Graduating aerospace engineering student
    - MBobrik

- **Map**

Far future roadmap

1. Get LEO cubesat for growing moss at Moon and/or Mars gravity. Duration: 2-3 weeks.
2. More LEO tests. Bigger, better, longer missions.
3. Moon missions? There's money prizes for that…
4. Phobos mission!

NASA is developing a dedicated rocket capable of launching 3 Cubesats at a time. Might wanna keep an eye on that.
For the time being, then, we'll discuss only the first mission.

First Mission

- To Do List
    a. Recruit more people for the project (edit signatures and comment on reddit!)
    b. Iron out the design of the cubesat, hopefully before the end of this year.

- Mission Objectives
  a. **Primary**
     - Build a satellite that can:
       - Survive space launch conditions
       - Survive and be operational in LEO for a period of at least 2 weeks (too ambitious? Should this be secondary?).
     - Create functional logistics for a team of international members to contribute to the creation and operation of the mission.
       - Otherwise what's the point?
     - Create a global network (or at least one station) with the international members that can track the satellite around its orbit.
     - Successfully operate the satellite in orbit with respect to instrumentation, control, and the dealing with the inevitable problems.
     - Be able to carry out a successful and fruitful mission to gain recognition to ease out the process of future missions.
  b. **Secondary**
     - Be able to construct a functional satellite out of off-the-shelf electronics without professional assistance (read: hobbyist-only). (We may resort to just order the satellite with our specifications if worst come to worst).
     - Let this tracking-and-control network be mainly of amateur radio operators, again to acquire the know-how of orbital communication. (We may have to resort to using professional earth-to-orbit radio operators)
     - Successfully run experiments that yield trustworthy and relevant results.
  c. **Fine Print**
     - Bring together an international group of hobbyists with no real credentials (as a team) to plan, build, and operate a satellite.
     - Acquire the know-how of planning, building, and operating a space mission.
     - Lay the foundations for further missions by our "agency" (further LEO missions, lunar missions, and of course the Phobos landing! *excitement!* *explosions!*)

- MCU/Computer
  a. **Description**
     - *Needs to be able to survive radiation. Fortunately, there are some very reasonably priced MCU options that can survive space radiation for a few days. Basic mission wouldn't need much, but it's something that will have to scale up if we go for anything more advanced.*
     - Radiation buildup will not be much of an issue because of the short mission time (3-4 weeks). However, single radiation bursts from the sun or whatnot might overload the electronics and fry them. Therefore our main computing unit should remain off for as long as possible while an

auxiliary, less powerful computer, keeps with the helm. This second unit is radiation-hardened because it will have a chance of being struck by these single events.

b. **Requirements**
   - Radiation: ?
   - Temperature range: 25C - 35C
     -
   - Vacuum: 0 Pa ?

c. **Models**
   - Raspberry Pi
     - (which model?)
     - Pros:
       - Easily available
       - Most computing power per weight (and price)
       - Available peripherals (ie tiny cameras)
     - Cons:
       - Takes up too much space
       - ?
   - Intel MCS-51
     - AKA 8051
     - Radiation-hardened (cheap?)
     - Small and cheap
     - Backup/auxiliary computing unit
       - Always on, protected against radiation bursts, able to manage basic mission components and restart/debug large computer.

- ## Receiver/Burst Transmitter

a. **Description**
   - *Power limitations will prevent reliable continuous signal, but burst transmissions of sufficient power are entirely within reason.*

b. **Requirements**
   - Range: at least ~100 km
   - KSat Here again. Range is a rather spooky term for communication , as the “range” depends on many variables. As i suggested with iridium constellation you only link to the next available satellite, as transmitting through the atmosphere will use to much power for a cubesat. For detailed picture see https://en.wikipedia.org/wiki/Link_budget#Equation
     The link budget describes the signal to noise ratio, which allows you to communicate, each term is a variable of your range, therefore range is a very uncertain term.
   - Bandwidth: 2.4 kbps (Iridium)
   - Power Consumption: (1W Iridium)

c. **Options**
    - Iridium Network
        - Link
        - Transmitter:
            - Quake Iridium 9603 SBD data module
        - Antenna:
            - 180° visibility
            - Hirschmann embedded Iridium patch antenna
    - Global Star Network?
        - Link
    - Our own ground stations, use public frequencies
    -

- Camera
    a. **Description**
        - *Ideally something that can survive radiation as well. But it's not as critical for the camera on a short mission. Image degrading over time is something we can probably live with. Of course, it might bite the dust all together, but hopefully not before we get some use out of it. At very least, it will need to take a few pictures of the sky after the launch to establish orientation of the cubesat. After that, gyro-integration can take over.*
    b. **Requirements**
        - HD video
        - Microscope (?X magnification)
        - Small (Able to fit inside CubeSat with reasonable space for everything else)
    c. **Options**
        - GoPro Hero 4: Source
            - Pros:
                - Resistant
                - Compact (cube 41 mm tall, 59 mm wide, 30 mm deep)
                - Light (88 g without casing, 152 g with)
                    - Interesting to note, the Hero 3+ has the same dimensions but is about 14 g lighter. It has lower quality video, though.
                - GoPro is an action/adventure company, so they may facilitate hacking into the camera (to make it space-worthy) and/or promote/sponsor us because, after all, it's SPAAAACEEEE.
                - 4k 30 FPS
            - Cons:
                - Too big?
                - ?

        - Replay XD: Smallest camera link
            - Other cameras links
                - 85 mm
                - 98 mm
            - Pros
                - Small (cylinder 94 mm long, 28 mm diameter)
                    - Updated: cylinder 69 mm long, 21.4 mm diameter
                - Light (3 oz, ~85 g)
                - 1080p 30 FPS
            - Cons
                - too long
        - Tiny Raspberry Pi camera
            - Pros
                - Easily available
                - Integrated programming with Raspberry Pi
        - Infrared camera with light
            - Pros:
                - Removes erratic sunlight from variables (complete darkness instead)
                - Infrared "nightvision" to see the sample without affecting it's lightless growth condition.
            - Cons
                - Needs IR light (more parts)
                - IR isn't visible light. So how much useful data can we collect?
        - Mini handheld Digital Microscope: Link
            - 15-30X Magnification, is that enough?
            - Does it have normal camera capabilities?
            - Size (cylinder 89 mm long, 32 mm diameter) Actually, like the Replay XD, too big. It's length takes up almost 90% of 1 side of the CubeSat to its opposite.
            - Mass (82 g)
            - 1280x1024 resolution
            - Built-in lighting (6 led ring)

- Magnetorquer
    a. **Replaces**:
        - Optical Gyros: *Maintaining orientation will be important for taking any pictures. Potentially for receiving/sending radio communications and getting extra power from the solar panels as well.*
        - Reaction Wheels: *Ditto. Nothing fancy here, though. For basic mission, I don't expect picking up enough rotation to need anything more than a weight on an electric motor. This is another component that will go from*

really cheap to really expensive rapidly as we try for more complicated mission.

b. **Requirements**
   - Torque ? N
   - Power consumption? W/h

c. **Options**
   - Integrated on solar panel (see solar panels)

- GPS
  a. **Description**
     - *An unlocked GPS unit will give us all the tracking we need for basic mission. It will be useless if we go past LEO, however.*
  b. **Requirements**
     - Altitude
     - Precision
     - What data could it provide? Velocity, direction, etc, what else?
  c. **Options**
     - ?

- Solar Panels
  a. **Description**
     - *For basic mission, that's the most expensive part of the hardware, and it will remain among the most expensive even as we scale up.*
  b. **Requirements**
     - Power generation of ? watts
     - Passive thermal control, etc (since it wraps around the whole cubesat, we can stuff those behind the panels, from the inside)
  c. **Options**
     - Cubesat-specific solar panels with integrated magnetorquer: 1U Link
       - Pros
         - Two birds with one stone (solar panel an magnetorquer)
       - Cons
         - Possibly more expensive than non-CubeSat-specific panels

- Batteries
  a. Li-ion

- Experiment
  - **Biology**
    - Moss/Plant species
      - ?
        - Pros:
          - Grows in the dark

            - Cons:
                - ?
    - How much moss initially?
    - What are it's needs/capacities (whole culture)?
        - Food: g/day
        - Water: L/day
        - CO_2/O_2: mol/day
        - Pressure: min ? Pa
        - Sunlight: 0 Cd
        - Radiation: max ? Sv/day
        - Temperature: min? - max? C°
    - "Dirt"
        - Phytoagar
            - Pros:
                - ?
            - Cons:
                - ?
        - Must store and feed moss for mission duration and not overfeed it
        - Ability to withstand launch conditions
- **Petri dish**
    - Sealed against vacuum
    - Enough atmosphere for moss for 2-3 weeks
    - Temperature control. Must be passive.
    - Thin and curved to avoid gravity changes
        - Calculate acceptable gravity changes
        - Calculate shape and dimensions.
- **Microscope**
    - Camera with lens or microscope?
    - Camera with lens
        - Camera
            - (See camera)
        - Lens
            - Compact
            - As resistant as possible (including supporting frame)
    - Microscope
        - Which?
        - Pros: less movable parts (right?)
        - Cons: No "normal" pictures (for orientation, systems checks, pretty pictures, etc)
- **Other sensors**
    - Thermometer
    - Accelerometer? (or just trust the math?)

        - Atmospheric composition (for O_2/CO_2 production/consumption, to check plant is OK)
        - Attitude control (for rate of spinning in 3 axis)
        - Other?

- ## Structure
    - **Configuration**
        - Solar panels + magnetorquers
        - Computer
        - Batteries for burst of communication
        - Antennas and radio receiver/transmitter
        - Position of experiment
            - Could we do both Moon and Mars gravities in one go? How? We could do both by having half the petri dish be growing for half of the mission, while the CubeSat spins at Lunar gravity. And then, after half the mission time is done, it spins to Mars gravity and the other half of the petri dish starts growing for the rest of the mission.
                - Taking into account the microscope's ability to film it and other things. How will we be able to get the microscope to be able to film both sides of the petri dish?
            - Could we make multiple trials in one cubesat? How?

Resources

- NASA's cubesat launch initiative ("free launch" for educational purposes): Link
    - NASA's interplanetary cubesat challenge (3 million dollars prize for lunar orbit mission, guess what we're going for next!): Link
- Project Calliope (extensively documented DIY cubesat project + resources to help people who want to do cubesats): Project Calliope Homepage
    - This dude wrote 4 books on the subject,they seem very clear and concise!
        - His page
        - DIY Satellite Platforms
        - Surviving Orbit the DIY Way
        - DIY Instruments for Amateur Space
- Computer
    - Arduino or Rasberry Pi? (cellphones are horrible for our purposes): Readwrite article
- General info on cubesats: Makezine article
-
-
- And for fun, Akin's laws: http://spacecraft.ssl.umd.edu/akins_laws.html

Issues List

Create issues and respond to them by “suggesting” next to a free number, like in example #0

0
1 ← (in number, sorry)
2 Thermal control. The moss will have a much narrower acceptable temperature range than “normal” Cubesat electronics, so our Cubesat will need better than usual thermal control.2
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