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Self Sustaning Solar Powered Cansat Exploiting the Power of the Sun

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***Abstract*—The Cansat is an experimental planetary atmospheric vehicle designs to test a self-sustaining power system using solar cells. The goal of the research project is to build a self-sustaining can sized vehicle that will have a payload of multiple sensors that will use energy generated by the solar cells to run the cansat mission operations. The Cansat is being designed keeping in mind the low power budget available to run the various tasks assigned to the payload. The payload will contain a group of sensors and a built in radio communication system all powered by harvesting the power from the sun. The project will be demonstrated the ability to work on a scheduling algorithm for the various set of sensors in the payload, keeping in mind the limited energy source. The data transmission will be done using Bursts operations, to optimize energy usage. We will in the project launch an autonomous CanSat that releases a payload. The Cansat will be deployed from a rocket at an altitude of at least 500 plus meters. The container and payload will descend at 12 meters per second using a passive descent control system. The payload will be released from the container at 500 meters. The payload descent rate will be approximately 10 meters per second or less. Telemetry data will be collected as much as possible at a minimum of 1HZ rate in burst or continuous form. As for the Power, it will be harnessed from the environment using underlined Solar cells in a transparent Payload structure. In this research project we have developed a novel sensing and transmission schedule, with optimal power usage.**

Keywords—Cansat, Communication, Mission, Atmosphere, Sensors.

I. INTRODUCTION

Questions are the driving force for exploring the unknown and some of those questions such as are we alone in this universe? How did human beings originate? To find the answer we have to go beyond human capabilities for knowing the unknown as in this way we can light up the darkness that surrounds us through exploration and taking up new challenges and making unique solutions to complex problems.

In this experiment we are not suggesting to replace present experimentation tools but the augmentation and implementation of micro-cansat for achieving knowledge of the galaxy and its system. As we know the undeniable contributions of Flag ship voyages and missions and its proof is seen from studies from information gathered from missions such as Galileo and Cassini but with its success it does cost a heft amount of capital and time with added bonus of various risks that in included in flagship missions.

A theory that is suggested is to add a bigger capacity of central science capital instead of a distinct bag of science and it's the basis of micro-cansat theory and its small size gives it the potential to 'piggy back' in bigger missions which makes satisfying and possible to have lots of spacecraft and vehicles placed in a carrier which symbolizes a seed pod (Fig. 1). The cansat's can be set free after a controlled delay considering time and space as advised by Pascal mission team [1] and because it can reduce the impact of collision it is preferred by Atromos team [7].

In this paper we see the progression for an optimally installed and deployable space probe which is long lasting and cost effective and is applicable for testing various flights. This also gives light for the hope of exploring more about the solar system.

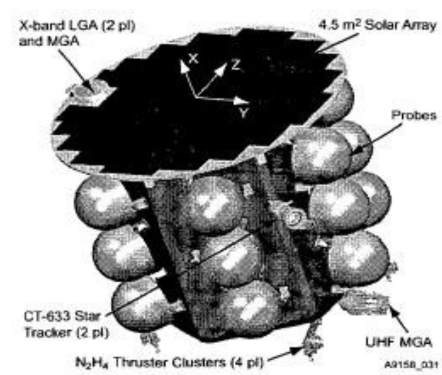

Figure 1: Pascal Cansat Carrier Spacecraft [6]

II. REVIEW OF MINIATURE CANSAT DEVELOPMENT

Here Deep Space 2 (DS II) has perfectly flown is space. DS II cansat shows perfection of variability and feasibility which related to the minimized theory of cansat and it possible that the needed technological equipment for more scientific exploration are very close to preparation. Below we get a thorough idea about some progression and advancements that have been made

A. Planetary Atmospheric Experiment Test

An equipped cansat got into Earth's atmosphere on June, 20th 1971 and named PAET (Planetary Atmospheric Experiment Test vehicle) whose goal was to calculate the design and constitution of the atmosphere (Fig 7a). Accelerometers were installed with temperature and pressure sensors with a mass spectrometer, also a radiometer and it suitable for other planet environments as well.

Data was needed to sketch out thermal design of atmosphere from an altitude of 80 km. The radiometer but there was some dilemma with sampling function as mass spectrometer composed wrong formation of information [4].

PAET vehicle was innovative cansat equipment which functioned as reference geometry and instrument suite for other planetary atmosphere as Seen in Table 1 and Figure 1 for a mass and diameter distinction and the inner data achieved from PAET is needed for cansat models.

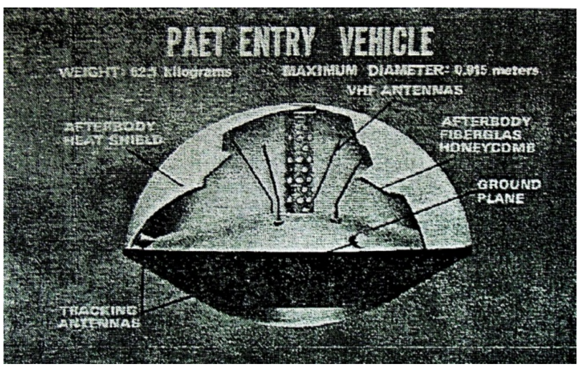

Figure 2: PAET configuration [10]

III. DISCUSSION OF MINIATURE CANSAT'S

We see the risk, cost, and science return associated with minimized models and the experiments are shown in practical terms but more centralized experimentation is needed.

A. Risk

Whole system configuration is not always needed in bigger spacecraft as we can see in Galileo high antenna which could not be released as needed and another lower receivable antenna was utilized to transfer information but some drawbacks are that lower receivable antenna gave 2000 times less data than higher receivable antenna [16, FAQ page] and this had almost risked a failed mission which shows the problem of depending on larger spacecraft for gathering scientific information.

Minimized concept of cansat has parallel equipment in a whole system and if we can think of a scenario where a spacecraft as a component for gathering data and 20 smaller spacecraft's are deployed and if 70% of spacecraft's don't do their tasks the mission will prosper from data received from 14 remaining spacecraft's.

Let says, mission has a 97% of success. Which means every vehicle is 97% accountable for mission life and let's suppose same gal can be done with a smaller spacecraft and its equation is shown as 1 [5], where P_{sc} is system dependable if mission is a success and if one "component" spacecraft finishes its job then all failures are independent from very other P_s is dependence of one aircraft and N is amount of spacecraft.

$$P_{sc} = (P_s)^N + \sum_{K=1}^{N-1} \frac{N!}{K!(N-K)!}(P_s)^{N-K}(1-P_s)^K \tag{1}$$

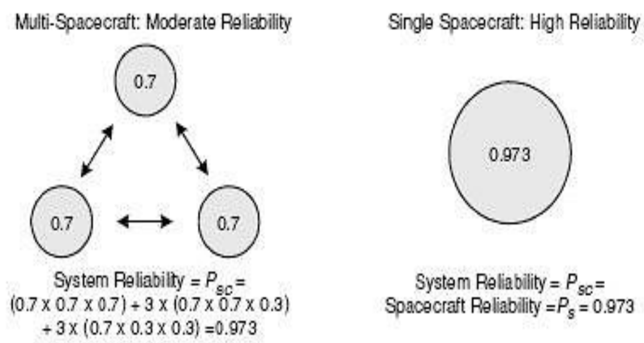

Figure 3: System reliability of one versus multiple spacecraft [5]

An example could be that miniature spacecraft has dependency of 70% to get system reliability of 97% (Fig. 8). As cost has non-linear relation with dependency but this experiment cannot by studied more and another important factor is that if one spacecraft completes their mission properly extensive data is achieved and how about if we give this theory to 20 or 100 spacecraft.

B. Cost

Cost is always a function of reliability [5] as we see that serious testing and competence build up a higher cost and with miniature spacecraft theory it's possible to utilize dependable materials as shown by example in earlier parts and If the required dependency is less, its

allowable to construct micro spacecraft with commercial or profit related off the shelf equipment (COTS) which can reduce other costs as they can be made with bigger capacities and a constructing line strategy can be done while fabrication to lower the costs even more.

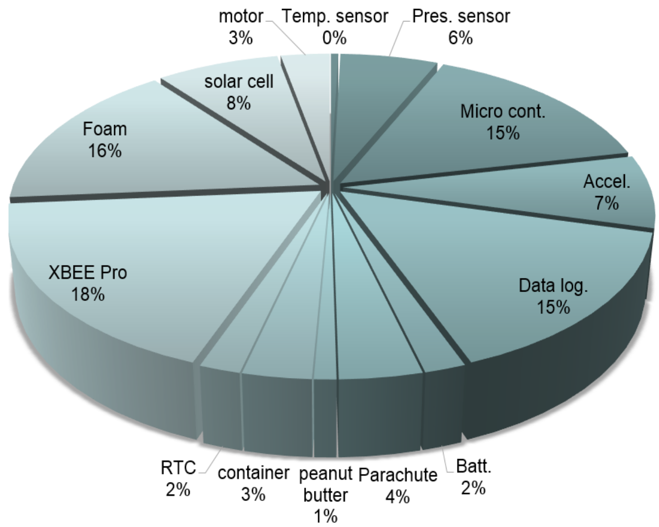

Figure 4: Cost Pie chart for development

Table 1: Mass Budget of the canasta

Component	Mass (g)	Source
Frame	50	Estimate
Separation Module	35	Estimate
Shell	40	Estimate
Egg	65	Requirement
Egg proctection Material	25	Estimate
Electronics	50	Estimate
Total	265	

Component	Mass (g)	Source
Frame	50	Estimate
Separation Module	35	Estimate
Electronics	75	Estimate
Parachute	80	Data Sheet
Total	240	

CanSat Total = 505 grams

As miniature spacecraft is made with a mass of 10 kg or even less, they can help in carrier's science performance with less cost and a different scene can have all miniature spacecraft's and in those cases payload can fluctuate with flexibility for enhancing deployment choices.

C. Science Return

Miniature cansat can use multiple sample statistics during testing information and this can enhance costs so to reduce risks is to have more samples with similar equipment where various spacecraft's can calculate same targets or different targets spread in space and time.

Various cansat's can be used at different parts of the globe to transport data and can be applied in meteorology and seismology and both needs need longer calculation and as we know Mars seismology has been of grave importance since the 1970's [13] but no mission has been possible so miniature canasta can do the impossible.

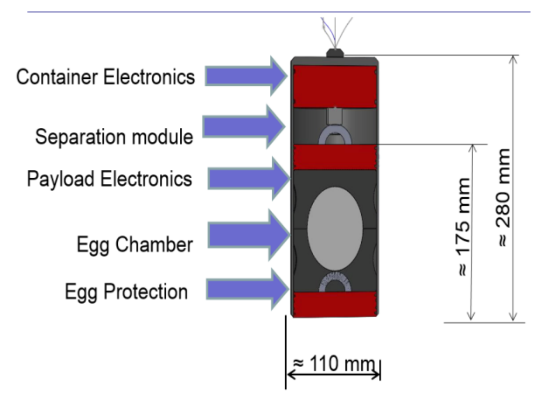

Figure 5: Cansat and Pay load View

D. Technology Development

Battery life has to long lasting and in case of landing in planets cansat's utilized batteries and landers need solar arrays where Thermoelectric Generators (RTG) is the main source and solar power from solar arrays are proportional to surface area vulnerable to sun light and needing launching equipment with augmented mass and risks and we know RTG is not efficient because of its expense and mass so we need and/or novel power production methods for example mill watt thermoelectric generators [15] for planetary cansat mission.

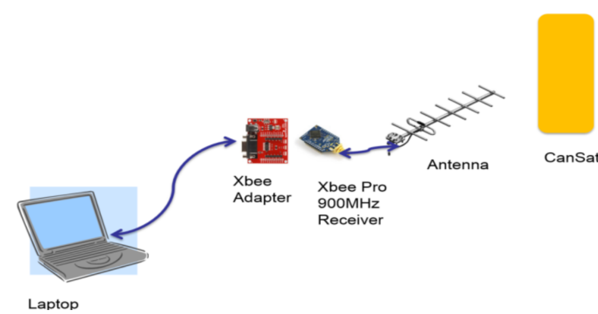

Figure 6 Ground Control Overview

For reducing mass of the power sub-system is to minimize the power needed by the C&DH (Control and Data Handling) links and thermal sub-systems and the spacecraft equipment but no low power Technology Readiness Level (TRL) are for sale and present studies are being conducted and examples are Micro-Inspector Avionics Module (MAM) [11] and Mars Proximity Micro-Transceiver [9].

Miniature cansat missions will be dependent upon communication relays for desired locations and another aspect antenna structure enhancing competence and saving energy and from research we can see possibility of minimized antennas with less mass and power necessities in miniature spacecraft [12].

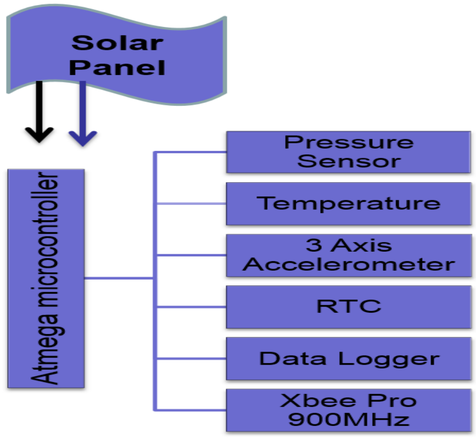

Figure 7 Electrical Block Diagram

Reducing mission life could reduce mass of batteries as they need non rechargeable cells as the only source of powers and Radioisotope Heating Units (RHU) can make it possible for lower mass thermal energy which can steady temperatures.

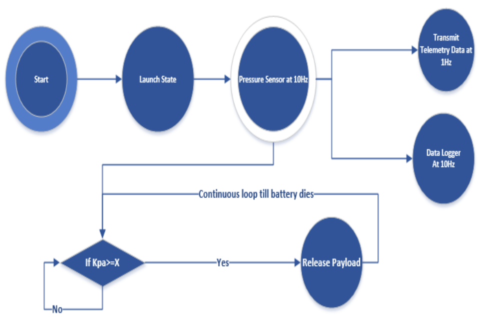

Figure 8 Container State Diagram

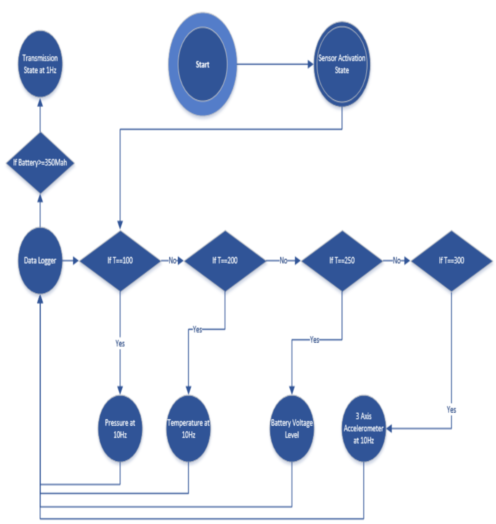

Figure 9 Payload State Diagram

As we see Low cost MEMs technology is used in lots of instruments such as tilted sensors, cameras and particular Frisbees [14] but we need to think that if they can be utilized in case of scientific exploration of space and what is required to convert and distribute technology for viable use of miniature space cansat's? Are some questions still lurking.

IV. CONCLUSION

We are still gazing upon the sky and thinking what is beyond those stars and this cansat can make future explorations possible. As we see the size is a plus point and lots of launches of cansat's can be possible to retrieve more information and can aid larger missions for giving required technological aid and it also comes with less cost and cansat possibilities in the near future is endless and other progression areas are lower mass power generators and some better investments, better equipment which can help us in making scientific breakthroughs.

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