International Workshop on Lean Satellite – 2019

Day 1 (Wednesday, December 4, 2019)

9:30~ Tomohisa Kunisawa, Ministry of Economy, Trade and Industry, Japan
Sponsor's speech

9:40~ Mengu Cho, Kyushu Institute of Technology
Project Introduction

10:10~ Fernando Aguado Agelet, University of Vigo
Analysis of the impact of Cubesat interfaces in small satellite missions: LUME-1 and WipTherm cases.

10:40~ Coffee break

11:00~ Alexander Kramer, University of Wuerzburg
Experience with the UNISEC Europe Electrical Interface Bus

11:30~ Herman Steyn, University of Stellenbosch
Hints and tips for the ADCS Design and Commissioning of Nanosatellites

11:50~ Fabio Santoni, DIAEE-Sapienza University of Rome
Cubesat activity at Sapienza Space Systems and Space Surveillance Lab

12:10~ Lunch & Group Photo

13:10~ Sangkyun Kim, Kyushu Institute of Technology
BIRDS BUS - A Standard CubeSat BUS for Annual Educational Satellite Project

13:40~ Dennis Elgaard, GOMSPACE
GomSpace - Missions with multiple payloads

14:00~ Andrew Kalman, Pumpkin, Inc.
Pumpkin Lean Satellite Engineering

14:30~ Haley Doyle, Innovative Solutions In Space
CubeSat Vendor Perspective for Optimizing Platforms

15:00~ Coffee break

15:20~ Nicola Sparvieri, GAUSS Srl
GAUSS activities in lean satellites interfaces

15:50~ Daniel Rockberger, NSLCOMM
Integrating complex Payload to Bus provider Platform an Interface Challenge?

16:20~ Chisato Kobayashi, AAC Clyde Space
TBD

16:40~ Han Dapeng, School of Aerospace Engineering, Tsinghua University
A practical solution to power supplies for lean satellites

17:00~ Mengu Cho, Kyushu Institute of Technology
Survey on CubeSat Interfaces

18:00~ Reception at Tower's Dinner in Tokyo Tower

Day 2 (Thursday, December 5, 2019)

9:20~ Makoto (Mac) Kanazawa, Space BD Inc.
Making "Access to Space" Easier by Commercial Driven Approach

9:40~ Paolo Marzioli, Sapienza University of Rome
LED-based boards for optical CubeSat early identification and improved tracking

10:00~ Wang Zhaokui,School of Aerospace Engineering,Tsinghua University
Latest progress of Q-sat: a Leansat for Sceintific and Education Purposes

10:20~ Evelyn Honore-Livermore, Norwegian University of Science and Technology
HYPSO ? protecting the oceans

10:40~ Coffee break

11:00~ Pooja Lepcha, Kyushu Institute of Technology
Development of Robust and Compact Low Cost Sensor Station for Remote Data collection using LoRa modulation

11:20~ John Michael Bellardo, Cal Poly、San Luis Obispo
Standardization Opportunities for Protocols and Software

11:50~ Fernando Stancato, Embraer
Electrical Cubesat interface issues and an industry investigation

12:20~ Lunch

13:20~ Ji Hyun Park, ISEE, Nagoya University
High density common connector for extended connectivity in NUCube system bus

13:50~ John Michael Bellardo, Cal Poly, San Luis Obispo
Benefits of a Unified Propulsion Standard for CubeSats

14:20~ Cesar Bernal, ESA
SmallSats at ESA

14:50~ Coffee break

15:10~ Free Discussion

Name: Fernando Aguado Agelet
Affiliation: University of Vigo
Title:*Analysis of the impact of Cubesat interfaces in small satellite missions: LUME-1 and WipTherm cases.*
Abstract:
This presentation shows an analysis of the impact of Cubesats interfaces in small satellite missions based on the lessons learned obtained by the University of Vigo Aerospace Group during the definition、 design、 manufacturing、 testing、 and operation of the UVIGO's Cubesats: Xatcobeo、 HUMSAT-D、 Serpens and LUME-1、 launched in December 2018 within the SUDOE-Interreg FIRE-RS program. It will also be presented a preliminary analysis of the interface requirements for non-standard power subsystems、 that will be addressed within the H2020 project“Innovative Wireless Power Devices Using Micro-Thermoelectric Generators arrays (WiPTherm)".

Name: Alexander Kramer
Affiliation: University of Wuerzburg
Title: ***Experience with the UNISEC Europe Electrical Interface Bus***
Abstract:
The standardization of geometric dimensions led to the initial success of CubeSats, based on the well defined interface between launcher and payload. With more and more countries, companies and universities becoming part of the "CubeSat Community" in recent years, the demand for specification and standardization of the electrical interfaces is emerging. The widely utilized PC/104 approach is not well-defined and therefore interpreted differently among all users. This entails significant drawbacks regarding subsystem exchangeability and is therefore not very suitable and efficient in the pico-satellite context, especially in the education domain.
However, a well defined standardized electrical interface would shorten development time while increasing robustness and enable subsystem exchangeability between different partners. Especially Universities in joint projects could benefit a lot from such standards, allowing them to focus on their specific core competency without the need to reinvent the wheel. There have been first attempts towards an electrical interface definition. A standardized electrical interface for generic pico-satellites was promoted by UNISEC Europe and was first implemented in the UWE-3 mission, which accumulates excellent in-orbit experiences since November 2013. The successor mission UWE-4 is now in orbit since December 2019 and extends the in-orbit experience of this interface. Together with the Birds-I and Birds-2 constellations, the NetSat Formation, TOM, QUBE and CloudCT, there are now more than 30 pico-satellites announced utilizing the UNISEC Europe CubeSat Interface Definition (CSID).

Name: Herman Steyn
Affiliation: University of Stellenbosch
Title: *Hints and tips for the ADCS Design and Commissioning of Nanosatellites*
Abstract:
Nanosatellites normally have low resources and limited redundancy available when implementing an ADCS. This fact and typically the very low earth orbits available, will place additional constraints on the reliability and performance of these small satellites. The presentation will focus on the unique challenges to face during the attitude control design and commissioning of especially CubeSats, giving some practical in-orbit results. It will be shown that low power and safe mode detumbling from high spin rates are possible using only magnetic control actuation. Furthermore high performance attitude pointing can be obtained from nano reaction wheel actuators with nano star trackers.

Name: Fabio Santoni
Affiliation: DIAEE-Sapienza University of Rome
Title: *Cubesat activity at Sapienza Space Systems and Space Surveillance Lab*
Abstract:
The Sapienza Space Systems and Space Surveillance Laboratory (S5Lab) research team at Sapienza University of Rome has successfully carried out student CubeSat projects, from concept to launch and operation.
URSA MAIOR is a 3U CubeSat developed in the framework of the QB50 program and successfully launched on June 23 2017.
The S5Lab team collaborated with the University of Nairobi to develop 1KUNS-PF (1st Kenyan University Nano-Satellite ? Precursor Flight), a 1-Unit CubeSat addressed at acquiring panchromatic images of the East Africa region and at performing the in-orbit test of commercial technologies for nano-satellite bus components. The nano-satellite was developed by a joint team of Italian and Kenyan students in 2017, with the support of Italian Space Agency (ASI, in the framework of the IKUNS Programme), of the Kenya Space Agency (KSA) and of several Italian companies (Roboptics and NPC) and selected for a launch opportunity from ISS for the KiboCube Programme, managed by UNOOSA (United Nations Office for Outer Space Affairs) and JAXA (Japan Aerospace eXploration Agency). The nano-satellite was launched on May 11th, 2018 and it is in operations after more than one year of mission.
LEDSAT (LED-based small satellite) is a 1-Unit CubeSat mission conceived by the S5Lab research team and the University of Michigan, aimed at testing a LED (Light Emitting Diode)- technology for optical tracking of actively illuminated targets. In particular, LEDSAT will equip 140 LEDs in three different colors on its six external faces. The LED boards will be commanded to flash with different flashing patterns to be tracked from ground-based optical observatories. The main mission objective is to enhance the optical orbit determination algorithms for space debris tracking, allowing a comparison between the currently used algorithms and methodologies, based on optical data stand-alone, and on-board instrumentation, such as orbital GPS receivers. The secondary mission objectives are related to attitude reconstruction related to specific pattern recognitions and back-up light-based communication. The satellite is currently under development at S5Lab. A launch opportunity will be offered
by the European Space Agency (ESA) in 2020, in the framework of the Fly Your Satellite! Educational Programme. LEDSAT is also part of the ASI IKUNS Programme, for the collaboration with Kenyan students during all the development phases.
GREENCube is a 3-Unit CubeSat conceived by S5Lab with ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and University of Naples “Federico II” for the cultivation of microgreen plants in space. The satellite is aimed at testing a Biological Life Support System (BLSS) that will autonomously manage the cultivation of the microgreens. The BLSS will control the pressure, air composition, nutrients flow, water recycling and condensation, humidity, temperature, day and night cycles for approximately fifteen days, completing a seed-to-seed cycle of the cultivar.
This paper will describe the 1KUNS-PF, LEDSAT and GREENCube missions, with details on the development and operation of the three described CubeSats.
Part of the activity os developed within the joint Postgraduate Course in Capacity Building in Astronautics, established in cooperation between Sapienza University of Rome, Italy, and Machakos University, Kenya.

Name: Sangkyun Kim
Affiliation: Kyushu Institute of Technology
Title: ***BIRDS BUS - A Standard CubeSat BUS for Annual Educational Satellite Project***
Abstract:
BIRDS projects are educational projects using 1U CubeSats for capacity building of non-space-faring nations carried out by the Kyushu Institute of Technology since 2015. The first generation, BIRDS-1, and the second generation, BIRDS-2, were launched and deployed to orbit in 2017 and 2018, respectively. BIRDS project members start the project without any experience in space engineering; however, they have to design, build and operate the satellite within two years to meet the master's degree timeline. A new BIRDS project starts every year. Each generation of the BIRDS project has to change the satellite design to accommodate the changing mission objectives of each new year. To meet the very rapid project pace, a standard CubeSat bus, the BIRDS BUS, is introduced in this study. The BIRDS BUS puts an emphasis on two key ideas for easy training: simplification and unification. The standard bus was applied to the BIRDS-3 project, the third generation. The BIRDS BUS has been tested extensively on the ground and has passed all environmental tests. Three BIRDS-3 satellites were launched to the International Space Station in April 2019. The final validation has already been successfully done in orbit after the satellites were deployed to orbit June 17, 2019.

Name: Dennis Elgaard
Affiliation: GOMSPACE
Title: ***GomSpace - Missions with multiple payloads***
Abstract:

Name: Andrew Kalman
Affiliation: Pumpkin, Inc.
Title: ***Pumpkin Lean Satellite Engineering***
Abstract:

Name: Haley Doyle
Affiliation: Innovative Solutions In Space
Title: ***CubeSat Vendor Perspective for Optimizing Platforms***
Abstract:
CubeSat vendors are in a constant competition to provide customers more performance and to host larger and more demanding payloads. In addition to selling stand-alone subsystems、 we want to provide more full platforms ? which slightly shifts the focus of which interfaces need to be standardized. While still remaining compatible with other CubeSat COTS items、 R&D efforts are focused in the direction of optimizing space in the platform and ease of AIV (assembly、 integration and testing). As "satellites as a service" becomes more popular、 implementing options for non-traditional CubeSat interfaces opens the door to new types of spacecraft and payload applications.

Name: Nicola Sparvieri
Affiliation: GAUSS Srl
Title: *GAUSS activities in lean satellites interfaces*
Abstract:

Name: Daniel Rockberger
Affiliation: NSLCOMM
Title: *Integrating complex Payload to Bus provider Platform an Interface Challenge?*
Abstract:
Many companies such as mine NSLComm have developed a unique payload that provides a unique capability and therefore use case and business case in different markets.In these cases the companies start with several demonstration missions or customer missions and are not yet launching multiple satellite constellations. This leads the companies to purchase the satellite bus from a well known provider and integrate the payload to that space proved bus Thus not building the satellite in house). This can be a challenge of interfaces of managerial、 budget、 planning and design aspects.The presentation will describe the lessons learned from the NSLSAT-1 satellite launched.

Name: Chisato Kobayashi
Affiliation: AAC Clyde Space
Title: ***TBD***
Abstract:

Name: Han Dapeng
Affiliation: School of Aerospace Engineering, Tsinghua University
Title: ***A practical solution to power supplies for lean satellites***
Abstract:
Power supply unit is the fundamental subsystem of any satellites. For lean satellites, it is possible to achieve 80% performance of traditional power subsystem with 20% of the cost. We present a balanced power subsystem design for Cubesat and similar satellites. Batteries utilizing Graphene technology are chosen as the power storage unit, whose special performance together with a set of battery filtrating strategy is combined for in-orbit operating. The power controller is built on an optimized power distribution strategy and an independent charging-recharging architecture. The design has been validated by a long-term flying test on ground, showing satisfactory reliability.

Name: Mengu Cho
Affiliation: Kyushu Institute of Technology
Title: ***Survey on CubeSat Interfaces***
Abstract:

Name: Makoto (Mac) Kanazawa
Affiliation: Space BD Inc.
Title: ***Making "Access to Space" Easier by Commercial Driven Approach***
Abstract:
Since 2018, JAXA has aggressively transferred the resources of The ISS Japanese Experimental Module "Kibo" such as satellite deployment platform and exposed experiment platform to the private sector as part of the initiative called "Kibo Utilization Strategy". Space BD Inc., one of the most evolving Japanese space startup, is the only company who has been successfully selected twice in a row by JAXA to become the commercial service provider of those two platforms. In our presentation, several representative projects related to the ISS Kibo platforms, both satellite deployment and in-orbit demonstration on the exposed experiment area, will be introduced.

In May 2018, Space BD won the bid to the Request for Proposal by JAXA about the commercialization of small satellite deployment from the ISS Kibo. Since this commercialization, Space BD has been delivering a user-friendly service from a private enterprise viewpoint. The launch service by Space BD is a turnkey solution to reduce the customer's burdens so that the customers can focus on their payload development and their mission success. So far, Space BD got more than 17 contracts with various types of small satellite missions. While most of the satellite missions are technical demonstration, there are various types of customers such as university, research institution, large space company, startup and non-professional organization.

Within less than one year from the first commercialization initiative taken by JAXA, in March 2019 Space BD also won the bid to the second Request for Proposal by JAXA regarding commercialization of ISS Kibo. The second initiative was about the commercialization of exposed experiment platform of the ISS Kibo. Space BD is now providing the in-orbit demonstration services using this platform. It enables customers to focus only on the mission payload development without being afraid of communication failure because the customer can use electricity and telecommunication infrastructures provided from the ISS side. Space BD got the first contract from Satlantis, an evolving Spanish startup, for its demonstration of their first optical camera device for small satellites. This project is the first overseas project which utilize the exposed experiment platform on the ISS Kibo in the ISS history.

As stated above, the presentation refers variety of usage of the ISS Kibo as very flexible testbed, and how Space BD promote its utilization by the power of commercialization.

In addition, this presentation explains how and why international collaboration is inevitable in order to make space sustainably growing industry.

Name: Paolo Marzioli
Affiliation: Sapienza University of Rome
Title: ***LED-based boards for optical CubeSat early identification and improved tracking***
Abstract:
In the increasingly congested environment of Low Earth Orbit、 with the intensification of the small- and nano-satellite launches、 there is the need for early identification of the CubeSats and for a precise orbit determination for the benefit of the safety of the conducted operations.In particular、 spacecraft launched in large clusters are usually identified within several weeks from launch、 often without the possibility to manually operate the spacecraft during the delicate Launch and Early Operations (LEOP) phase of the missions. This problem is originated by the usage of RF-based systems (mainly radars) for the spacecraft identification、 which have a poor angular resolution and that can induce errors while identifying spacecraft in the same angular region with respect to the station.The introduction of LED-based (Light Emitting Diodes) boards on the external surfaces of lean satellites and small spacecraft can play a crucial role for the identification. If executing identification sequences (e.g. Morse identifiers or orthogonal codes sequences) when in eclipse、 VIS-band LED panels can be observed by optical networks of observatories and identified within hours from deployment、 gaining the accessibility of the satellites during LEOP and improving the TLE (Two-Line Elements) in the early mission phase.Moreover、 similar sequences can be used throughout the mission for tracking the satellites and improving the TLEs、 by providing information on the spacecraft orbit and attitude or even by down linking basic low data rate data in case of transceiver malfunctioning or temporary outage.The LEDSAT mission、 conceived by Sapienza University of Rome and University of Michigan and under development at the S5Lab (Sapienza Space Systems and Space Surveillance Laboratory)、 with the support of ASI (Italian Space Agency) and ESA (European Space Agency、 in the framework of the Fly Your Satellite! Programme)、 will test a LED-based payload for spacecraft early identification、 orbit determination、 attitude reconstruction and light-based back-up communication. The satellite is being integrated and tested at subsystem level and it will be launched in 2020.This presentation will describe the opportunities offered by LEDs for spacecraft optical tracking and it will present the features of the LEDSAT mission as study case.

Name: Wang Zhaokui
Affiliation: School of Aerospace Engineering,Tsinghua University
Title: *Latest progress of Q-sat: a Leansat for Sceintific and Education Purposes*
Abstract:
Due to its uniform face value ratio, spherical satellite is a good choice for atmospheric measurement, gravity detection, and calibration of Radar-cross-section detectors. Yet it brings challenge for systemic integration design, especially considering the coupling between thermal behavior and energy demands, and efficient utilization of inner room. We bring a multi-object optimization design on structure, thermal, energy and attitude control, based on careful calculation and simulation. Latest process shows a balanced satellite design utilizing just economic electronics. The design was carried out and validated by a series of ground test. We will also report how students are trained during the construction of the satellite, and will serve the education after launch.

Name: Evelyn Honore-Livermore
Affiliation: Norwegian University of Science and Technology
Title: ***HYPSO ? protecting the oceans***
Abstract:
Nearly 70% of the planet is covered by water. Understanding oceanographic phenomena is critical to enabling the sustainable management of our oceans. The Norwegian University of Science and Technology (NTNU) is developing a hyperspectral imaging CubeSat mission to increase the availability of ocean color data necessary to understand these oceanographic phenomena. Although the satellite bus itself is procured、 the scientific payload is developed in house at NTNU. The hyperspectral imager is built from commercial off-the-shelf components and uses an in-house developed electrical interface to communicate with the on-board processing unit. This talk will describe the mission and discuss some of the challenges encountered while integrating a COTS payload into a spacecraft bus and developing a project management process for a team without satellite experience.

Name: Pooja Lepcha
Affiliation: Kyushu Institute of Technology
Title: ***Development of Robust and Compact Low Cost Sensor Station for Remote Data collection using LoRa modulation***
Abstract:
For remote data collection、 the development of sensor nodes on the ground have been insubstantial because of its limitations in standalone operability and higher power consumption leading to higher cost and sparse area coverage. With the limitations in the number of observation stations、 the forecasting capacity has been impaired for issuing accurate weather and hydrological forecasts and warnings for extreme events、 monitoring long term climate trends also flood forecasting in Bhutan. This inability to predict accurately adversely affects the agricultural sector that provides livelihood and employment opportunities to approximately 56 percent of Bhutan’s population and have a long term implications on the food security. In this research、 the design and development of a low power、 low cost and a robust Ground Sensor Terminal (GST) with LoRa transmitters is proposed. The overall development of the GST is focused on making it low cost、 using the easily available COTS components and those that consume minimum power while making it robust and efficient. The research describes the development of the GST from scratch to a fully integrated system that are ready to be deployed at interested remote stations.Experiments and tests were conducted to confirm the functionality of the GST in terms of power budget、 adequate link budget and the overall development costs. The GST can operate for up to 25 hours without solar charging、 and start operating again when the sun shines. The communication link between the GST and satellite has also been met for elevations greater than 10 degrees. The overall development costs have been aimed below $150 and was achieved for just a little less than the amount. The standards for placing the GST outdoors considering all the environmental impacts were also studied and mandated to met.

Name: John Michael Bellardo
Affiliation: Cal Poly、San Luis Obispo
Title: *Standardization Opportunities for Protocols and Software*
Abstract:
CubeSats have evolved from the domain of tinkers to being readily available from many online vendors. This organic growth has resulted in a fractured ecosystem of components and satellite buses, many of which are incompatible with each other. These incompatibilities occur at all levels of the spacecraft, ranging from mechanical through software. This presentation specifically focuses on what can be done to help address the higher layers of incompatibility, primarily protocols and software. However it will also touch on standardization opportunities in other layers.

Name: Fernando Stancato
Affiliation: Embraer
Title: *Electrical Cubesat interface issues and an industry investigation*
Abstract:
Since the first Brazilian nano-satellite in 2001 there was an evolution on the use of electrical interfaces in nano-satellites. The use of COTS parts for the Cubesats brought an issue with the use of different standarts that creates difficulties or incompatibilities. It will be presented the evolution of the electrical interfaces in these last years among the nano-satellite Brazilian community and the faced issues. Also it will be presented an investigation on an electrical interface carried out in a aerospace company.

Name: Ji Hyun Park
Affiliation: ISEE, Nagoya University
Title: ***High density common connector for extended connectivity in NUCube system bus***
Abstract:
CubeSats using COTS (commercial off the shelf) components are exposed to failure risks in space environment. In order to overcome environmental risk issue、 NUCube employs a complex hierarchy to ensure a robust system. A rather slow、 but known to be strong against radiation PIC microcontroller is set as highest level while a faster ARM Cortex-M4 microcontroller performs heavy duty task in the lower level. These type of system architecture、 however、 requires high density common connector due to complex connectivity between the multiple microcontrollers、 and therefore conventional PC104 connectors cannot be used. As a solution、 a new bus interface FX10 series from Hirose is used、 which provides a higher pin count with a tradeoff of maximum current rating per pin. The pros and cons of the new bus interface is introduced with respect to conventional PC104 bus.

Name: John Michael Bellardo
Affiliation: Cal Poly, San Luis Obispo
Title: ***Benefits of a Unified Propulsion Standard for CubeSats***
Abstract:
It's well known that the CubeSat industry has been maturing rapidly over the last few years. As a result, CubeSat developers have been increasingly interested in developing more complex systems, including the incorporation of propulsion systems. Beyond the technical challenges this presents, there are a number of regulatory hurdles that the developer must navigate/overcome. Rather than only working from the available safety standards such as AFSPCMAN 91-710, there have been requests from the small satellite community for a condensed, CubeSat specific, document. This document would be used to guide the design of such propulsion systems so as to avoid setbacks in the design and production due to unanticipated safety concerns. Cal Poly proposes producing a set of guidelines or standards that would be complimentary to the CubeSat Design Specification, and would provide a single source of expectations for CubeSat developers as well as launch providers. The goal is to streamline the development process with regard to propulsion systems on a CubeSat bus.

Name: Cesar Bernal
Affiliation: ESA
Title: ***SmallSats at ESA***
Abstract: