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NEPAL'S NEXT GENERATION CUBESAT BUS: IMPROVING BIRDS OPEN SOURCE SATELLITE BUS SYSTEM FOR INCREASED PAYLOAD VOLUME AND REDUCED COST

Abstract

Antarikchya Pratisthan Nepal (APN) led the design of MUNAL, Nepal's first High-School CubeSat. The satellite is based upon Kyushu Institute of Technology's BIRDS Open-Source Bus standard for 1U CubeSat. The design has made space more accessible for non-space faring countries. However, the size, weight and power (SWaP) limitation of the 1U CubeSat inherently limits possible applications. Larger form factors such as 2U and 3U are needed to address the issue. This, unfortunately, also increases the mission cost and can be financially taxing for countries such as Nepal. A 1U bus standard with drastically lower volume occupancy and manufacturing cost would allow satellite developers with extremely tight budgets to support missions beyond technology demonstration. This paper focuses on a novel highly-integrated, highly-compact next generation CubeSat bus designed in-house by APN. The new bus combines Communications System (COM), On-Board Computer (OBC) and Electrical Power System (EPS) into a single 65x65x9 mm3 board. The COM is based on a STM32WL series RF microcontroller, a 32dB RF power amplifier and can transmit on the reliable amateur or licensed UHF band. The OBC is based on a flight-tested ARM Cortex M4 series processor. A 16-channel external Analog to Digital Converter for collecting housekeeping data and two 1Gb NOR flash is used for storage. The board has a built-in Inertial Measurement Unit and a digital compass for attitude determination. The rest of the bus system including the antenna board, battery board and the interface boards are all integrated as a single system. Compared to BIRDS open source bus, the new bus has reduced the overall Bill-of-material cost by 50%, increased the payload space by 50%, improved the integration time by 30% and improved the power budget by 20%. The paper also highlights improved software designs through the newly ported NuttX/PX4-based open source CubeSat operating system that has allowed APN to rapidly develop, iterate and implement flight software. By combining simplified hardware with plug-n-play software, the design can cut overall satellite development time by almost half. This has implications especially for nations with limited funding to bootstrap their space program or for organizations like APN to develop low-cost constellations for real-time ground data collection through store and forward missions.