Supporting Communication Needs of CubeSat Constellation Missions

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One of the most promising satellite observation strategies still to be developed is the capability to conduct simultaneous multipoint observations of the Earth system from space. These types of observations are required to understand the "big picture" of coupling between disparate regions: solar-wind, magnetosphere, ionosphere, thermosphere, mesosphere, atmosphere, land, ocean on a planetary scale. Affordable large constellations of scientific "space-buoys" can only be achieved through miniature spacecraft such as CubeSats due to the high cost of launching larger spacecraft. What has not yet been explored is how constellations of such satellites can be made effective for multipoint scientific studies. To be effective the architecture must: 1) Allow large amounts, Gigabits of data per day, of scientific data to be retrieved from the constellation and, 2) Address the orbital configuration and control of the constellation. The communications architecture, in which a constellation of "space-buoys" that are size, weight and power constrained addresses these needs, is lacking.

The "Dynamic Ionosphere CubeSat Experiment" or "DICE" mission was selected and funded by the National Science Foundation in October 2009 in response to a cooperative proposal from ASTRA LLC, Utah State University's Space Dynamics Laboratory (USU/SDL), and Embry Riddle University. DICE consists of two identical "CubeSats" launched on October 27, 2011 as secondary payloads from a Delta II rocket and released into an 809 to 457 km at 102° inclination with one satellite chasing the other. The DICE mission is not using traditional CubeSat communications systems, but is instead using government radio bands and high speed downlink rates that are consistent with a NSF funded mission. A half-duplex UHF modem developed for DICE provides a 3 Mbit/s downlink and a 19.2 kbit/s uplink. The ground stations are located at Wallops Island on the east coast and/or at SRI on the west coast. In this paper we explore how the communication systems developed for DICE could be applied to a large constellation of "space-buoys" for making multi-point observations of the space environment.