FORMOSAT-3 constellation deployment

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Abstract: FORMOSAT-3 mission, also known as COSMIC (Constellation Observing Systems for Meteorology, Ionosphere, and Climate), is an international collaboration of Taiwan and United States to deploy a constellation of six microsatellites equipped with GPS receivers in low Earth orbits to collect the GPS signal as passing through the atmosphere. The six satellites were launched on April 15, 2006 by Minotaur. The occultation occurrences of the constellation can be assimilated into numerical weather models for real-time weather prediction. The payloads are the GPS occultation receiver (GOX), the tri-band beacon (TBB), and the tiny ionospheric photometer (TIP). The required constellation is in six orbital planes with 800 km altitude and 30 deg right ascension of ascending node apart. The six satellites were launched together to a parking orbit with 516 km altitude and 72 deg inclination. With each satellite raises itself to higher altitude one by one, six orbital planes will form after a period of time with different right ascension of the ascending node (RAAN) utilizing the nodal precession due to the oblateness effect of the Earth. The difficulties of the constellation deployment are from four folds. The first is the large attitude errors near polar region due to geomagnetic stabilization. The second is the satellite entering the safe mode due to overheating of the battery in large solar beta angle. The third is the on-board coarse attitude sensors and lack of rate sensor may sometimes cause thrusting be aborted due to control system unstable. The fourth is the constraints of orbit transfer duration for the phasing of RAANs and the arguments of latitude (AOL). Through comprehensive team works, the operations team has achieved success in the constellation deployment. The 5th satellite reached first the mission orbit in July 2006, the 2nd in December 2006, the 6th in February 2007, and the fourth in May 2007. The other satellites, 1st and 3rd, are still on the parking orbits, but keep the AOL of 60 deg apart, which is to maximize the numbers of GPS occultation number and ground contact. It is expected that the FORMOSAT-3 constellation deployment will complete in December 2007. In this paper, a lesson learned from the deployment is addressed, and a make-up plan and a follow-up concept for the constellation are proposed.

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