CGMS-XXVIII
USA-WP-06
Agenda Item: C.1

NPOESS DIRECT BROADCAST CONCEPTS

Summary and Purpose of Document:

To provide a summary report of current planning for real-time direct broadcast of operational environmental data from the National Polar-orbiting Operational Environmental Satellite System (NPOESS) spacecraft.

Action Requested: None

NPOESS DIRECT BROADCAST CONCEPTS

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) under development by the U.S. tri-agency (Department of Commerce, Department of Defense, and the National Aeronautics and Space Administration) Integrated Program Office (IPO) has four primary Command, Control, and Communications missions: 1) Stored Mission Data (SMD) downloaded to high-latitude located Command and Data Acquisition (CDA) stations, 2) Tracking, Telemetry, and Command (TT&C) via high-latitude CDAs and via Air Force Satellite Control Network (AFSCN) ground stations, 3) High Rate Data (HRD) "Full Quality" data broadcast, and 4) Low Rate Data (LRD) broadcast providing limited, compressed image data for the tactical and field users. The total rate at which data will be generated by the NPOESS spacecraft is expected to be more than twenty times the rate for the current Polar-orbiting Operational Environmental Satellite (POES) and Defense Meteorological Satellite Program (DMSP) satellites, and will be formatted according to current Consultative Committee for Space Data Systems (CCSDS) conventions. Because of these significantly higher data rates, NPOESS will require equally significant increases in the bandwidth required for the communications links. Regulatory constraints on the current spectral allocations for POES and DMSP, as well as, constraints on power spectral density have significant impacts upon the trade space for the HRD and LRD links, in particular.

The HRD broadcast link will provide data from all of the NPOESS instruments at "full quality" (2:1 lossless compression for imagery from the Visible/Infrared Imager Radiometer Suite - VIIRS) at a data rate of about 20 Mbps, and will require a bandwidth of nearly 50 MHz. This broadcast will be similar to the POES High Resolution Picture Transmission (HRPT) data, except for the higher data rate. Because of the higher bandwidth requirement, the legacy spectrum at L-Band is not sufficient to support the HRD broadcast. The IPO has reviewed alternative spectrum availability and has determined that the WARC-95 EESS allocation at 7750-7850 MHz would be suitable for this application. This spectrum allocation has been selected by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) for SMD on their METOP series of satellites. For this reason, coordination will be required to avoid interference, especially at the Svalbard ground station, the proposed CDA for METOP, and one of the CDAs being considered for NPOESS. It is expected that the proper choice of orbital timing for NPOESS together with a division of the band such that METOP uses the lower portion, and NPOESS the upper, will mitigate any such interference during any co-visibility over the Svalbard CDA. This frequency band is also subject to constraints upon the power spectral density of the signal at ground receivers. For this reason, there is a significant tradeoff between receiver aperture size and link availability. Based upon analyses conducted by the IPO and two contractors, it has been determined that a two (2) meter aperture will be required to achieve 99.9% calculated availability in the "worst case" rain zone and at the lowest satellite elevation angle (5^o). For other conditions, the actual availability should be much better. If a one (1) meter aperture is used, the availability for the "worst case" rain zone at 20^o elevation is only 96%. This smaller aperture may be useful for some circumstances in which the rain zone parameters

are more favorable. It has also been determined that a "reduced" capability HRD link could be provided at L-band, where rain degradation is smaller, at a data rate of 5.8 Mbps. This would require more compression and would reduce the quality of the data.

The LRD link design exploits the existing spectrum allocation in the 400 MHz region, as well as, a simple remote, mobile terminal. The available spectrum at 400.3 and 400.8 MHz can support 230 Kbps with full CCSDS convolutional coding, Viterbi decoding, and Reed Solomon encoding/decoding. The remote terminal is able to close the link with an "OMNI" antenna, with acceptable accommodated transmit power on the NPOESS spacecraft. This data rate is about three times the current POES and DMSP LRD rates. With improved data compression on NPOESS, the LRD link is expected to provide significantly better quality imagery. This imagery is expected to be limited to two or three compressed VIIRS channels. Because the legacy frequency band will be used, the upgrades to user terminals should consist primarily of receiver upgrades and possible processor (laptop) upgrades. An abbreviated version of the NPOESS Integrated Data Processing System (IDPS) may also be used.