CGMS XXVIII
USA-WP-15
Agenda Item: I.3

Code Division Multiple Access (CDMA) overlay system for GOES DCP

Summary and Purpose of Document

Provide an update on the spread spectrum demonstration on the GOES DCS system.

Action Requested: None.

Code Division Multiple Access (CDMA) overlay system for GOES DCP

Code division multiple access is most easily conceptualized in contrast to more conventional techniques, such as frequency division multiple access (FDMA) or time division multiple access (TDMA). In a conventional communication system where multiple users are sharing the same system resources, each user is assigned a separate subset of resources, disjoint from the other users. Assigning a unique time slot, frequency or both to each user forms these subsets. The current GOES DCP architecture uses this approach, assigning each user a frequency channel and a time slot.

In a CDMA system, each user operates on the same frequency. The data sent by a user in a CDMA system is spread over the entire system bandwidth using a noise-like spreading code. This spreading code is unique to the user, and has a chip rate typically orders of magnitude larger than the users data rate. (Wireless LANs are a notable exception) In this way, each user interferes with every other user, but to the minimum extent possible by spreading their signal energy over the whole system bandwidth. At the receiver, the channels are separated by the convolution of the received data with the known spreading code. One of the advantages of a CDMA system is that, if properly designed, it can make more efficient use of the system bandwidth by eliminating the need for guard bands and guard times found in FDMA/TDMA systems.

The CDMA overlay system proposed for GOES DCP provides additional channels for data transmission that do not occupy slots in the current system time/frequency allocations. Rather, the CDMA signals will raise the system noise floor about 0.25 - 0.5 dB in the center of the band (less at the band edges). The proposed CDMA overly system will employ non-linear interference cancellation techniques to remove the interference caused to the CDMA overly system by the current GOES DCP signals. This increases the capacity of the CDMA overlay system, allowing it to operate in a nearly noise-limited environment, as opposed to interference limited. Thus, the two systems should be nearly independent of one another.

The capacity of this system is inversely proportional to the required signal to noise (plus interference) ratio required to achieve the desired bit error rate. In order to maximize the capacity of the CDMA overlay system, forward error correction techniques will be employed. Self-interference and the receiver hardware limit the maximum number of simultaneous users the CDMA overlay system can support. The self-interference limit is given by the ratio of the spreading gain to the required signal to noise (plus interference) ratio. This limit is on the order of several hundred, depending upon user bit rate and the forward error correction scheme. The receiver for the proposed system is based on a software radio architecture, so the limit on the number of channels that can be simultaneously decoded depends on the speed of the processor and the efficiency of the software, but will be < 10 initially. For the proposed CDMA overlay system, the number of simultaneous channels does not impact the overall system throughput. Since the system is signal limited, five simultaneous channels will be limited to one-fifth the bit rate of a single channel for the same signal to noise ratio.

This system will use low power transmitters, and the downlink will only be received at the Wallops Ground station. The aggregate EIRP of all of the simultaneous CDMA system users will be limited to 35 dBm, which is about 12 dB below a single nominal DCP.