COMPUTER SIMULATION OF PHASED ARRAY ANTENNA PERFORMANCE DEGRADATION AT WIDE SCAN ANGLES

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Abstract – Phased array antennas offer a number of advantages to NASA missions compared to traditional gimbaled reflectors including electronic and vibration free beam steering, graceful degradatrion, smaller volume and multibeams. However, the MMIC-based phased array antennas also present challenges to mission designers because of reduced power efficiency, higher costs, and system effects that result in link degradations. NASA Glenn Research Center (GRC) continues to pioneer aerospace communications technologies to address the challenges of array antennas to improve efficiency, reduce costs, and better understand system effects.

This abstract addresses the degenerative system effects between high-rate modulated data and signal timing delays caused by antenna beam steering at wide scan angles. Conventional phase shifters used in MMIC-based phased array antennas are physically limited to 360 degrees of phase shift. Often, depending on the size of the array or specified beam angle, the required phase shift may exceed 360 degree. In these instances, the actual phase shift obtained is the remainder of the phase request, modulo 2π. The modulo 2π result causes a delayed carrier signal radiated from the element whose phase shifter requires a phase shift greater than 360 degree. Multiple delayed signals can radiate from the antenna depending on the size of the array and scan angle. For each modulo 2π wrap, the carrier is delayed one cycle time, resulting in intersymbol interference (ISI).

ISI can be simulated in Matlab/SIMULINK by placing M delay blocks in parallel with the input signal, with M being equal to the number of elements in the plane of the scanned signal being analyzed. The amount of delay configured for each delay block is equal to the number of modulo 2π wraps that the element would experience at the angle being analyzed, multiplied by the ratio of the data rate to the carrier frequency. This simulates the ISI in the baseband system. The baseband representation of the system in SIMULINK is necessary to reduce computation time. The results of a range of ratios for an 11-element linear array scanned 60 degrees is shown in Figure 1. These results show that at the limit of data rate to carrier frequency ratio of 1/10, there would be a 3.25 dB loss due to ISI for a small array. Measurements are ongoing to determine if the actual system loss is the same as predicted.