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Paper Title: **Techniques to Optimize Usage of Satellite RF Power**

Abstract:

Power is a primary resource for a communication satellite. With conventional satellite payload design, one often encounters problems of under-utilization of RF power available on one channel (or one transponder or one downlink beam) that would waste available RF power and over-utilization requirement of RF power available on another, resulting in denial of services. The under-utilization and over-utilization problems can be avoided with any of the two techniques called Active Transmit Phased Array Antennas (ATPAA) and Matrix Amplifier and Routing System (MARS). With ATPAA or MARS, the available RF satellite power is automatically pooled together and automatically shared.

Other than power sharing, ATPAAs allow the beams to be shaped/changed via their Beam Forming Networks (BFNs). ATPAs also allow use of many small High Power Amplifiers (HPAs), vice a few high HPAs, to improve reliability. Iridium (S-Band, 1997) and Spaceway (Ka-Band, 2007) are two examples of satellites that implemented ATPAA.

Matrix amplifier has many other names such as matrix transponder, multi-port amplifier. It initially lent itself to the scanned radar technology by using the Butler matrix to automatically pool and share power among HPAs. It was later enhanced to also include its capability of routing signals to different downlink beams without placing any switches or muxes to HPAs and the term MARS was created to reflect its capacity enhancement. The first satellites to implement the MARS technology in L-Band were Inmarsat-3 (launched in 1995), AMSC/TMI's MSAT (1995), ETS-6 (1996), and SkyTerra-1 (2010). MARS has advanced to Ku-Band with Eutelsat's E172B to be launched in 2016.

This paper will describe the two techniques together with their principle parameters and characteristics. For ATPA, the characteristics include Intermod Beams (IBs) and regrowth of shaped beams due to amplifier nonlinearity. For MARS, the characteristics include the routing vectors and creation of inter-port intermodulation products.
