Preliminary Investigation of the Impact of Build Distortions on Large Shaped Reflector Antennas RF Performance

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The shaped reflector is recognized as a vital technology in the field of satellite antennas. The shaped reflector concept requires only a single feed to achieve a required contoured beam and due to its simplicity, shaped reflector contoured beam antennas are still the most requested antennas for telecoms in the satellite industry today.

With the increasing interest in the use of large shaped reflector deployable antennas operating at high frequencies and with very demanding gain and isolation requirements, the demands on reflector surface accuracy becomes a key factor in the success of a space program. Thermal effects usually result in important distortions on the surface of the shaped reflector and consequently in the degradation of the antenna pattern (Y. Rahmat-Samii, IEEE Aerospace and Electric Systems Mag., Vol. 6, Issue 6), especially in those areas of the coverage that require isolation. Surface distortions due to manufacturing as well can affect the antenna behavior, by causing antenna depointing and an increase in the side lobe levels. Periodic deformations (e.g. due to the supporting structure or to surface segmentation) give rise to specific sidelobe patterns linked to their spatial frequencies. Random surface errors as well, even if of relatively small amplitude, can be assumed to generally reduce the peak gain and increase sidelobes. The behavior of the distorted reflector can be improved by using different techniques to compensate the reflector distortions (B. Gonzalez-Valdes, et Al., EUCAP 2010 Proceedings). Sometimes however, distortions appear following a non predictable pattern which cannot be accounted for at the time of the antenna design procedure. In this case, which is quite common especially for manufacturing surface errors, distortion compensation techniques have a very limited applicability and don't bring a massive improvement in the distorted antenna behavior.

The objective of this study is then to systematically investigate the surface distortions due to manufacturing with the aim of understanding which physical surface features are causing the most important antenna pattern distortions, in order to build some guidelines for the surface design and for manufacturing. An as-build surface often presents random errors on top of the desired shape, but these distortions are usually a combination of a few main shape distortions that can be modeled and applied to a nominal shaped surface. Thereby, the RF analysis of a modeled distorted surface can help to understand which contributions are to be avoided and can therefore lead the antenna design to be more stable and resistant to manufacturing errors.