Phased Array Antenna Design for L-Band GEO Satellite Communication Ground Terminal Applications

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Satellite Communication has served the mankind for more than 40 years and is still an irreplaceable technology in the commercial market. One of its kinds utilizes L-band and GEO satellite to provide narrow-band phone, SMS and basic Internet services covering almost every corner of the earth. As its nature determined, directional antenna is often incorporated in the ground terminals and while to be used on a moving platform, such as vassals or aircraft, the antenna pointing direction must be able to change, in order to constantly point to the satellite position. Such tracking antenna is usually made of a directional antenna fixed on a mechanical stabilized platform. However, the cost of the mechanically steered tracking antenna is considerably high and there exists a long known reliability issue as the mechanical parts wear. Consequently, the need of a new kind of tracking methodology is being urged by the industry.

The concept of phased array was developed for more than 100 years and has long been served as an important methodology in radar technology. As the technology advances, the cost of phased array antenna system is dropping recent years. Phased array antennas provide extraordinary high gain, directivity and beam steering capability. Using phased array in L-Band SATCOM was discussed in the 1990s, where a prototype of phased array antenna system for land vehicle satellite communication, was built and tested. (K. Sato, K. Nishikawa, and T. Hirako, 1992 Digest of IEEE AP-S Intl. Symp. 2, 1073-1076, 1992) However, the scanning angle of the phased array developed in the paper was concentrated at high elevation angles. The well-known side lobe effect, at lower elevation angles, was not addressed.

In this presentation, a wide variety of phased array structures will be studied including circular/polygonal in planar/volumetric alignment. From the array factor, the G/T (gain over temperature) of these structures will be numerically evaluated under industrial standard, covering wide scanning angle. Pros and cons of these structures will be analyzed. Optimal design and performance of a few selected antenna array configurations will be presented. After that, by method of “pattern multiplication”, results of the optimized structures with practical antenna elements will be showed and finally, further possible improvement to the antenna array will be discussed.