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Hybrid Beam Steerable Phased Array Antenna for Satcom OTM with 16 GHZ Feed Signal

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Abstract: ***Now a day there is a great demand for communication On the Move (OTM). OTM antenna is system which is mounted on a vehicle such as boat, train, car, flight, and this system is used to track the satellite link and maintain the link between the terminal and satellite even when the vehicle is moving. The antenna always steer to track the satellite link while motion. Phased array antenna with hybrid beam steering method is proposed in this paper to achieve effective communication. The beam Formed in phased array of 100 isotropic elements has a wide beam width. But, to fetch satellite communication applications, the beam width a narrow beam width is required. Hence a parabolic reflector is chosen to sharpen the beam. But, for the ease of simulation, in place of the array of antennas, a horn antenna design to operate at the same operating frequency, 16 GHz is given as a feed to the reflector antenna and the simulation is done using HFSS.***

Keywords: ***Phased array antenna, beam steering, parabolic reflector, HFSS.***

I. INTRODUCTION

Mainly satellite applications employ highly directive antennas. To avoid complexity in antenna structures we go for low profile antennas. The phased array antenna is the best option for SATCOM applications. Phased array antennas are broadly used within the regular satellite communication packages to attain slim beam width. Conversation on the circulate prefers this phased array to gain non-stop link, coverage, and green statistics transmission. Phased array antenna is a couple of-antenna system wherein the radiation sample may be strengthened in a particular route and suppressed in undesired directions. Those exclusive abilities have determined phased arrays a vast range of applications because the appearance of this era. Phased arrays were conventionally used in navy programs for several a long times. Latest increase in civilian radar-primarily based sensors and communication systems has drawn growing interest in utilizing phased array technology for business applications. Phased array antennas are not unusual in communications and radar and offer the advantage of a ways-area beam shaping and steering for specific, agile operational conditions. They are in particular beneficial in current adaptive radar systems where there may be a trend closer to energetic phased arrays and extra superior space time adaptive sign processing.

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In phased arrays all of the antenna factors are excited concurrently and the principle beam of the array is instructed by making use of a modern section shift throughout the array aperture. Reflector is used to convert the wide beam area to narrow which is fetching for satellite communication applications especially when the vehicles are on the move.

Figure 1: SATCOM On the Move Terminal

II. SATELLITE TRACKING MECHANISM:

Hybrid beam steering is used in this phased array for OTM where it uses both electronically for elevation and mechanically for azimuth. As antenna terminal's steering plays major role in acquiring satellite link, initially phased array antenna was used in the system in order to eliminate mechanical motion and frequently consider electronic steering. This solution uses the combination of both electronic and mechanical steering. However there are a few essential issues associated with this method. To dispose of those troubles a unmarried parabolic reflector antenna and horn with mixed waveguide feed is used. This antenna gadget gives each round polarizations for the downlink in addition to for the uplink frequency degrees in Ka-band.

III. METHODOLOGY:

There are two methods for this system.
1) Open loop approach
2) Closed loop approach

In open loop approach [2] the antenna is oriented towards the known position of the geostationary satellite. This approach depends on the inertial movement of the vehicle on which antenna is placed. As vehicle is on the move, the antenna will reorient to current position to maintain the link with the satellite. During this process there is chance of occurrence of pointing error. Accuracy cannot be completed within a fragment of tiers in this open loop device due to its dependence on inertial measurement gadget to steer the antenna. In the Closed loop approach [2], the antenna tracks the satellite link by considering the strongest receiver signal or becon signal from the satellite's own transmission. To find the maximum signal strength, mechanical scanning of conventional reflector antenna across the sky is required. A deliberate pointing error is to be introduced to verify or check the maximum receiver signal strength. Due to this the system responds too slowly for speedy vehicle movements. Instead mono pulse tracking system [4] can be used to find the accuracy in finding the precise direction. This system has ability to estimate pointing error without any mechanical scanning and without deliberately mis-pointing. Dual feed method is used in this mono pulse antennas, one feed generates normal radiation pattern of the antenna, while the other feed internally generates radiation. The output signals from two feeds are compared and antenna can be precisely pointed to eliminate pointing error.

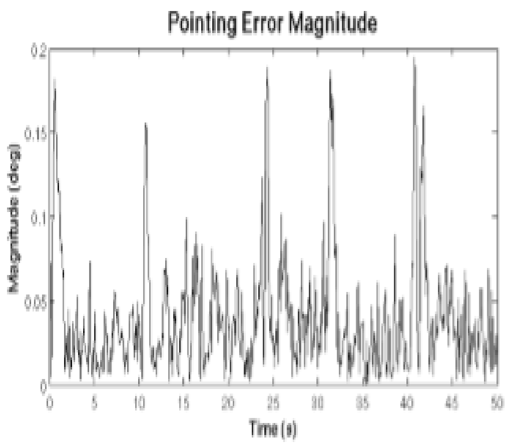

Figure 2. Pointing error magnitude

The pointing error [2] is generally less than 0.1 degree over a full elevation coverage, which indicates the perfect communication link even in demanding motion environment. Satcom On-The-Move terminal produce true mobility even under demanding and severe OTM conditions. This system is also used for operation in other bands like C, X, and Ku Bands by just replacing central feed, LNB and BUC assembly, without disturbing reflector and system mechanics. Apart from these advantages there are many challenges too. Here the platform is moving, the beacon signal used to generate the pointing error suffers with Doppler shift [2]. The beacon frequency UN certainty is quite large. The frequency offsets which occur can be eliminated internally by the system controller.

IV. SYSTEM BENEFITS

Benefits of closed loop tracking: By using closed loop tracking the pointing error results extremely small even during rapid vehicle motion

Improved performance: In this system highest G/T and best sensitivity of any SOTM design is achieved by using parabolic reflector

Flexibility in operating multi bands: It can be used for multi band operations by replacing whole RF section to allow for C, X, Ku as well as Ka-band operations.

V. RESULTS

The simulation for phased array antenna is done in HFSS. As the steering angle increases, the gain of the antenna is decreased by increasing the beam width. By steering the angles of the phased array antenna, the satellite link can be tracked and propagation link is also maintained even when the vehicle is moving. A slight pointing error is obtained by using OTM terminal can be eliminated by manual steering. So, both electronic and mechanical steering is used in the methodology.

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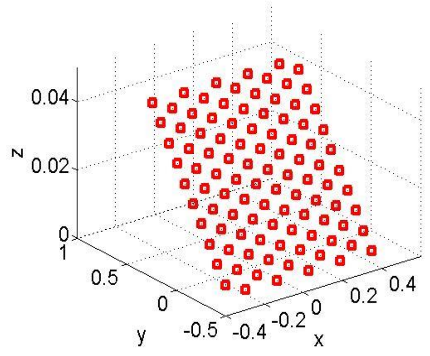
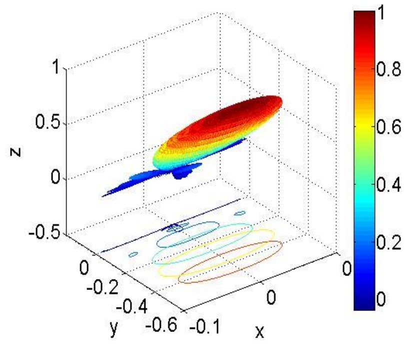
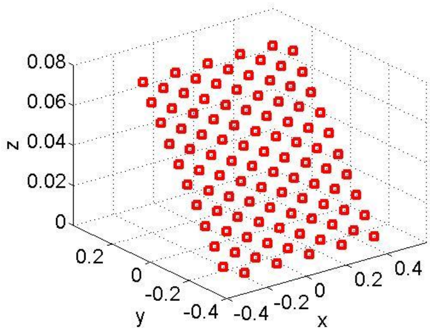
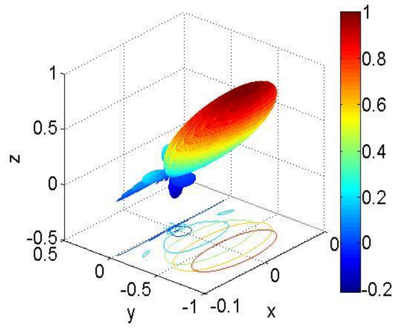
Plane orientation	Representation of the plane orientation	Radiation pattern representation	Results
Plane at an angle 300 with XY plane along X axis.			No change in gain , side lobe levels and also beam width.
Plane at an angle 300 with XY plane along X axis.			No change in gain , side lobe levels and also beam width

Figure 3: Phased array antenna with different steering angles

Apart from all the above benefits, the maintenance is reduced, and this kind of systems is easily configurable through a convenient software interface and low system profile.

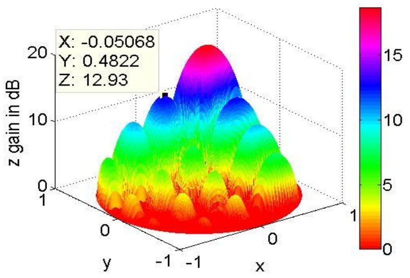
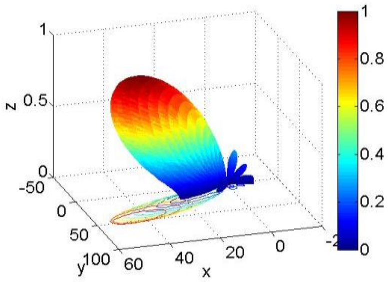
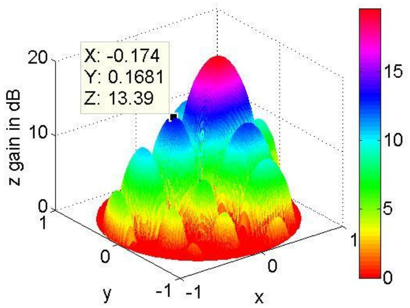
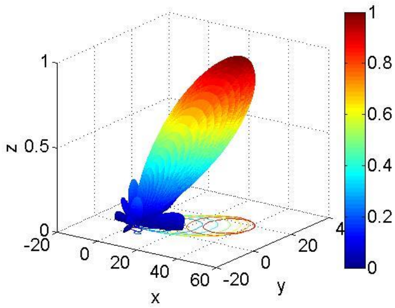
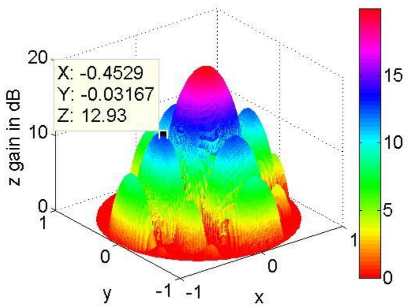
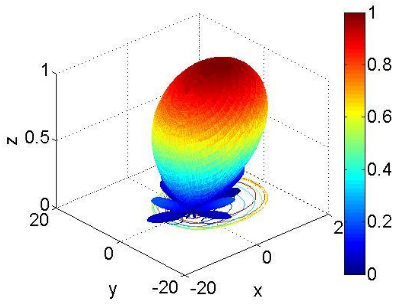
Azimuthal and elevation steering angles	Cylindrical radiation pattern representation.	Spherical radiation pattern representation.	Results
ϴ = 45⁰, Φ = 45⁰			Gain= 18.64 dB First side lobe level is at, 12.93 dB Beam width is 63.9^0 .
ϴ = 25⁰, Φ = 25⁰			Gain = 19.55 dB First side lobe level at, 13.39 dB Beam width is 57.977^0.
ϴ =5⁰, Φ = 5⁰			Gain = 19.98 dB First side lobe level at, 12.93 dB Beam width is 50^0.

Figure 4: The radiation pattern of phased array antenna for different steering angles

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VI. CONCLUSION:

Hybrid beam steering uses both mechanical and electronic steering to track the satellite link. It has been observed that mechanical steering does not show impact on the gain of an antenna but with slight pointing error which can be eliminated with displacement technique. Electronic steering shows the change in gain and beam width depending on the maximum signal receiving strength signal from the satellite at input 16 GHz frequency at the feed. This steering is used for On-The-Move antenna for continuous data transmission and link establishment. The results are obtained using MATLAB and HFSS.

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