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SIMULATION OF 13 PANELS PHASED ARRAY ANTENNA BY USING STK TOOL

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ABSTRACT

In order to receive signal from GPS Satellites, a Phased Array Antenna geometry has been considered with 13 panels and Visibility Gap Analysis has been carried out. The Geometry of PAA is hemispherical with the 8 panels on the base forms a octagonal shape and rest of the 5 panels on the top forms Pentagonal shape with minimum gap over Bangalore. Further it has been analyzed that after passing a constellation of 24 GPS Satellites over hemispherical geometry of PAA minimum 5 GPS satellites and maximum 11 GPS satellites are visible at a time for two days Satellite Tool Kit has been used for the analysis where we have considered Sensor Objects instead of Panels, with azimuth of 45 degree separated for base panels and 60 degree for the top so that it covers entire 360º.The satellite tool kit software is utilized to determine the coverage patterns for the satellites and the software is employed to visualize the satellite orbits around the Earth.

KEYWORDS: Global Position System (GPS), Medium Earth Orbit, Phased Array Antenna (PAA), Satellite Tool Kit (STK), Two Line Elements (TLE)

INTRODUCTION

The Phased Array Antenna Geometry has been configured using STK with a single point of origin and combination of 13 sensors in the hemispherical shape on the ground with respect to Bangalore in India. The13 panels used for PAA, forming 13 cones where the base cones having the cone angle of 45° and top cones having the cone angle of 60° which performs the hemispherical coverage for the satellites. The Bangalore Coordinates are given below in WGS-84 Datum. Latitude: 13.04^0 Longitude: 77.51^0. The STK helps to perform these simulations in real time. We can predict or know when the satellite is passing over some strategic place on the Earth such as the ground stations, bases and facilities that process all the information collected from the satellites [3].The STK software is used for simulate in real time. The STK offers different options for different sets of data input, one for the basic properties, one for the graphic visualization in two dimensions and three dimensions, and other modules for the constraints imposed on the problem. For these simulations, GPS satellites constellation are employed to demonstrate the communication between the satellite and ground station.

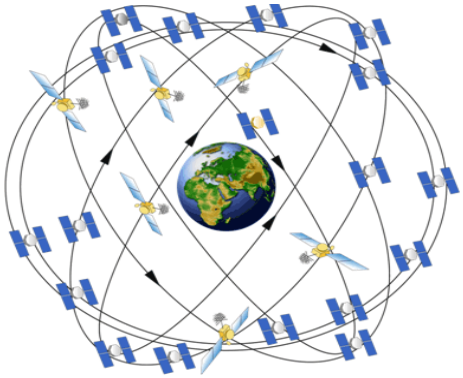

Figure 1: GPS Constellation

The GPS constellation consists of twenty-four satellites in circular polar orbits distributed in six different planes. This constellation is used for Beacons-satellite communications. This constellation gives complete coverage around the Earth and this constellation has been operational around the Earth.

LITERATURE SURVEY

Xi Wu Guangya et.al (2010) carried out a recognized research work on 3D visual operations based on stk [1]. He proposed the need of visualization operations, this paper focuses on to achieve the visualization of information operations through STK methods and techniques.

Geng Chen et.al (2010) proposed a new measuring method for GPS ground coverage rate based on STK. Here he innovately uses STK software to measure the coverage rate of GPS. He also is commenting on different requirement of accuracy in different regions of military & commercial perspective [5].

Zhang Guang-hua et.al (2010) carried out a recognized research work on the service range of reference receiver in ANGNSS mobile positioning. In this work he including spatial constellation of global navigation satellite system (GNSS) and the ground facilities is established by satellite tool kit (STK)[3].

Pedro A. Capo-Lugo et.al (2004) proposed about communication or coverage patterns in different kinds of orbit and the calculations to determine the link access time between the satellites and the designated ground stations [4].

METHODOLOGY

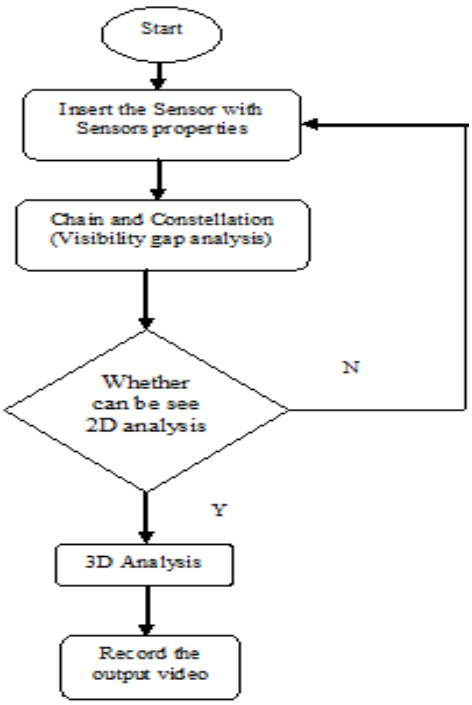

Figure 2: Representation of the Proposed Design Flow

Initializing the STK tool, install the ground station it provides longitude, latitude and range. Accordingly place the sensors to ground station then it specifies the azimuth angle, elevating of all sensors to cover a range of 0 to 360. Begin with the new file and place into a ground station. A path between generates the file and sensors, then check for the proper chain constellation if so, open a 2D window and connect to each individual sensors in a panel to all satellites. Once 2D verification gets over with respect to time which initialize 3D window to check varies angle of view of the different planets.

SIMULATION RESULTS OF PAA

STK software is used for simulation. Here we used 13panels to satisfy the satellite requirements for data reception and accurate calculation**.** In this type of antenna design, 8 panels are placed at the bottom and 5 are on the top. The lower panels produce a beam 45^{o} cone angle and elevation 38^{o}, whereas the upper panels produces beam of 60^{o} cone angle and elevation 67.5^{o}are tabulated in Table 1 and Table 2 respectively.

In 8+5 panel design a total of 13 panels are used for the coverage. There is more overlap between the panels. In 8+5 antenna design we can observe that the whole hemisphere is covered using 13 panels without any gaps. Thus the signals are received properly from all satellites, as shown in Figure 3.

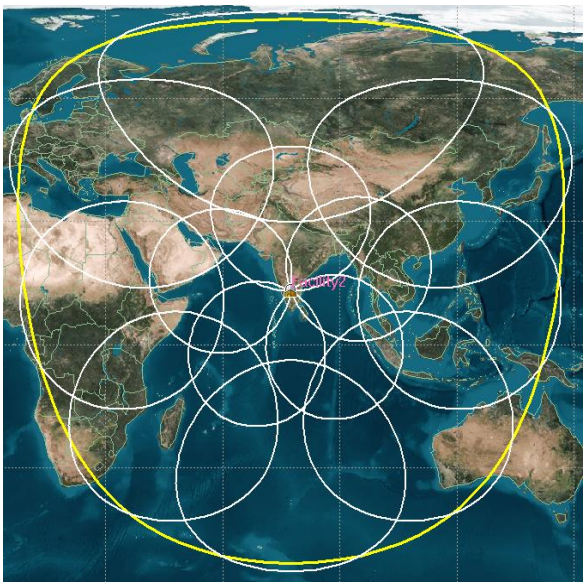

Figure 3: PAA8+5 Design Using STK

Table 1: Coverage by 8 Panels of Base of PAA for 0° to 360^{0}

Base Panel	Azimuth (Deg)	Cone Angle (Deg)
1	-22.5 to 22.5	45
2	22.5 to 67.5	45
3	67.5 to 112.5	45
4	112.5 to 157.5	45
5	157.5 to 202.5	45
6	202.5 to 247.5	45
7	247.5 to 292.5	45
8	292.5 to 337.5	45

Table 2: Coverage by 5 Panels of Topside of PAA for 0° to 360°

Top Panel	Azimuth (Deg)	Cone Angle (Deg)
9	-36 to 36	60
10	36 to 108	60
11	108 to 180	60
12	180 to 252	60
13	252 to 324	60

The below diagram shows the 3D view of beams produced by bottom panels, that is 45 deg cone angle and top panels 60 deg, it is not covering below 10 deg. This also produces an efficient coverage preventing the signals to be missed out.

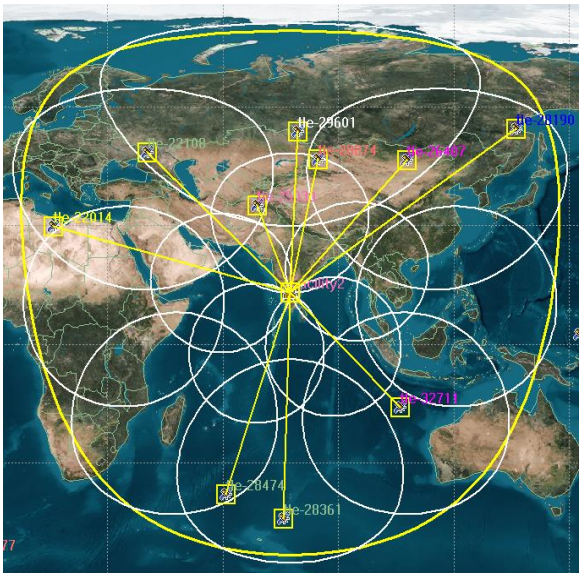

Figure 4: Maximum Number of Satellites

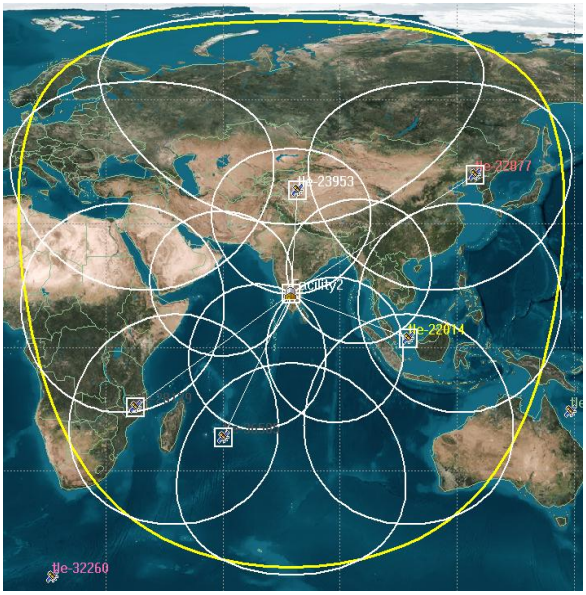

Figure 5: Minimum Number of Satellites

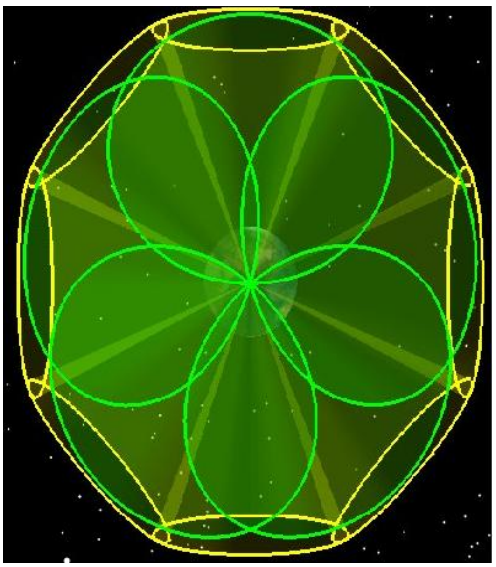

Figure 6: 3D Top View of 8+5 Antenna Design

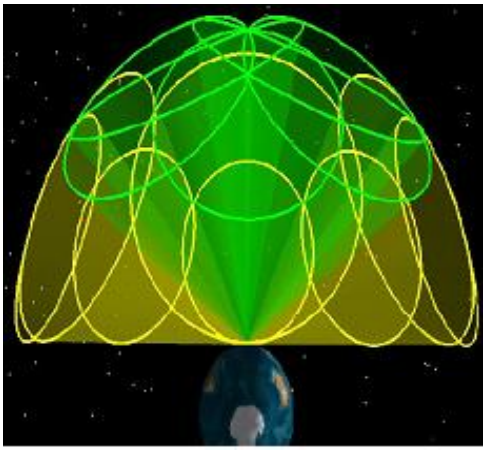

Figure 7: 3D Side View of 8+5 Antenna Design

In Figure 6 and Figure 7 shows the top view and side view of Phased Array Antenna beams. When the satellites comes in the any beams that satellite will tracked by that panel, according to the satellite selection criteria.

Visibility Gap Analysis

This analysis gives how many satellites covered or tracked by each Antenna Panel individually and minimum & maximum satellites covered by each panel individually. After insert GPS-TLE constellation file of 24 satellites from 1stFeb 2013 to 2ndFeb 2013, are considered for visibility gap analysis was made on 18th march 2013 using STK for the period of 2 days. Following analysis is performed [2].Visibility Gap over two days, Number of Satellites covered by each panels independently at a given time, Maximum 10 & Minimum 4 Satellites visible at a time over two days day.

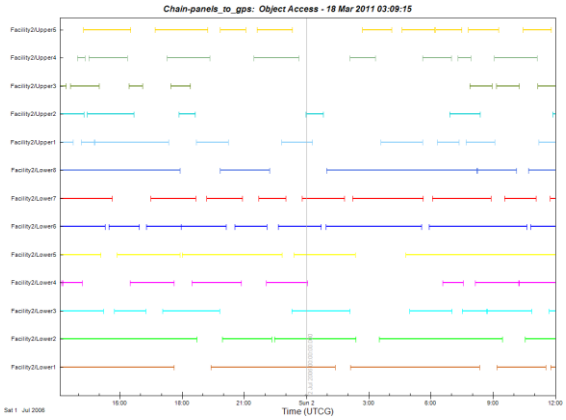

Figure 8: Visibility Gap Analysis over 2 Days

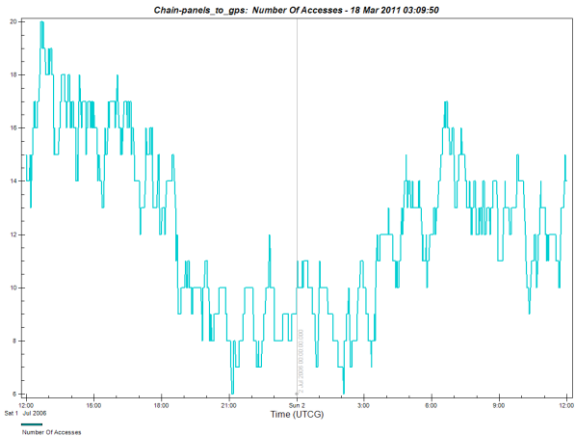

Figure 9: Number of Accesses by PAA with Respect to all Antenna Panels

Criteria for Selection of Satellites

In a hemispherical coverage by the panels it is required that 1 satellite is tracked by the panel at a particular time interval. So, when two or more satellites enter the same panel, the panel has to select an appropriate satellite.

- The Satellite present at lower edge of the panel is first eliminated.
- If the satellite is in between two panels, based on the direction of satellite, the panel will be selected.
- The Satellite which is at shortest distance from the center of the panel, that particular panel will be selected.

CONCLUSIONS

It is found that there is no Visibility Gap for PAA with 13 Panels over two days. Minimum of 5 and Maximum of 11 GPS satellites from a constellation of 24 GPS Satellites can be visible by PAA at a time over 2 days.

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