International Journal of Latest Trends in Engineering and Technology
Vol.(9)Issue(4), pp.141-145
DOI: http://dx.doi.org/10.21172/1.94.23
e-ISSN:2278-621X

AN IMPROVISED SCATTERING STUDY FOR ELEVATION RELIANT ON 3G COMMUNICATIONS THROUGH HIGH ALTITUDE PLATFORM (HAP)

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Abstract: Together with satellite and terrestrial communications, High Altitude Platform (HAP) evolved as a communication segment acting like a lower amplitude repeaters. As like satellite, HAP has wider footprint and maintains high elevation angles over a coverage area than terrestrial systems. Hence, distribution of HAP antenna gain significantly varies toward the edges of coverage area as elevation angle deviates. Besides, a change in spacing radius causes change in elevation angle, which ends up with dissimilar gain distribution over coverage. A high HAP antenna gain expected at user end to enhance quality of service, especially at the edges. Therefore, it is essential to study dependency among system parameters like spacing radius, elevation angle, subtended angle and distribution of gain. The paper enlightens on such dependencies and to be more specific, picked up three different spacing radii to search out best fit of spacing radius at stratospheric platform in terms of gain distribution. Additionally, three different HAP antennas bore point concepts, like bore pointing at SPP, at half of subtended angle and at center of cell, have proposed to adjust gain over coverage area while necessary.
Keywords: Antenna bore point; QOS; Edge of coverage; Spacing radius; Radiation pattern; Subtended angle.

1. INTRODUCTION

Seamless integration has become a regular practice in modern technology. With no exception, a new concept, well known as High Altitude Platforms (HAPs), is integrating with terrestrial and satellite systems in wireless communications infrastructure. There, requirement of high link budget for satellite communications has minimized by implementing lower altitude repeaters. Concurrently, advantages like high receiver elevation angle, line of sight transmission, large foot print and mobile deployment have made HAPs appealing over terrestrial and satellite system [1, 2, 8, 14]. The ever increasing demand of high speed mobile internet leads toward developing High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA) with an idealized speed up to 14.4 Mbps and 5.76 Mbps respectively [1, 4]. Currently, 3G services are on a peak of demand for high speed multimedia communications, mobile services and a set of innovative features. The quasi-stationary platform, HAP, has suggested for providing 3G services at a platform height of 17-22 km [1, 2, 10, 12, 14].

HAP has capability of providing 3G services over a large coverage area (or cell), hence, a wide range of change in elevation angle becomes under consideration [1, 2, 5, 14]. A higher deviation of elevation angle causes larger fluctuation of HAP antenna gain at receiver end, followed by link budget fluctuates. Typically, long link length and high data rates emphasize to use highly directive antennas which also cause significant change of gain over small space variation [3, 5-7, 13]. Aperture and patch are the common type of antennas which have been used in regular practice for the requirement of high directivity characteristic [6, 7, 15].

Distribution of the paper illustrates that section II come up with relative consequence among system parameters based upon a designed system. The elevation angle, Subtended Angle (SA), antenna bore point, Spacing Radius (SR) and antenna gain are taken into account as the system parameters. In section III, comparative study of gain distribution has analyzed for different spacing radii and bore points. Finally, in section IV, the paper concluded with discussion on progressive outcomes and future intends.

2. RELATIVITY OF PARAMETERS WITH SYSTEM MODEL

2.1 System Modelling and simulation:

descriptive elevation dependent system model of HAP has displayed in Fig. 1. The scenario is based on a single HAP system, intending to provide 3G services over a certain coverage area. Concurrent to current research, the HAP considered at stratospheric platform of height 17-22km where diverse spacing radii are highlighted. Relativity among parameters, like SR, SA, elevation angle and platform altitude, could be specified through Fig. 1. Thus, we may formulate SR considering the geometry of HAP system in Fig. 1 as illustrated in (1),

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SR□ CR□ Hcot□ ele (1)

where CR is radius of the coverage area, H is the platform altitude and θ_{ele} is the elevation angle at Left Edge of Coverage (L-EoC).

Moreover, three distinct bore point concepts at Sub-platform point (SPP), at half of SA and at center of coverage are also presented in Fig. 1. Maintenance of heterogeneous bore point gives different distribution of gain over target coverage area. Thus, by varying the bore point of an antenna, it is possible to fine-tune of gain distribution over the target area.

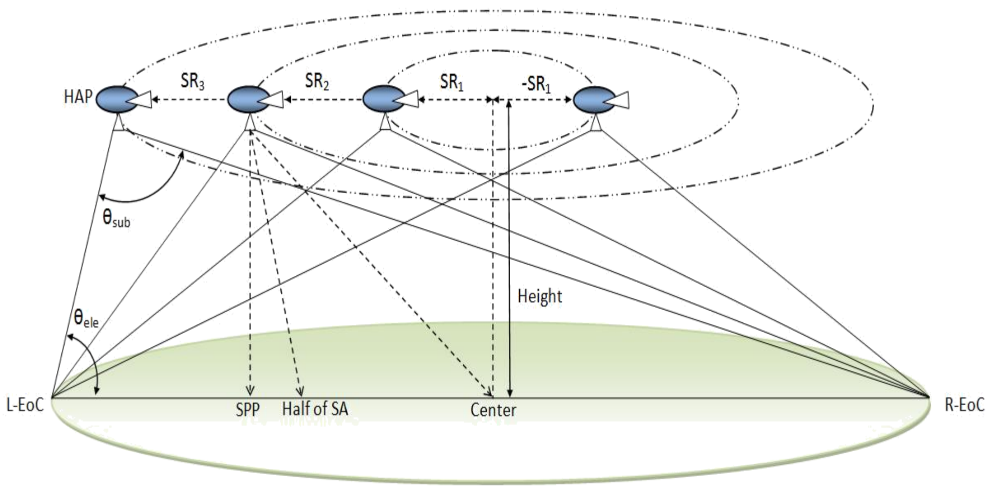

Fig. 1. Elevation reliant on system model

A SA (θ_{sub}) always refers to roll-off beam width maintained at the Edges of Coverage (EoC) [5, 9]. Generally, a varying SR causes variation of SA as clearly sparks in the system model where techniques like roll-off function used to adjust beam width at EoCs. A 3dB or 10dB roll-off beam width is a common practice for shaping HAP antenna main lobe while intending to illuminate a service area [5, 7, 9, 15]. The 3dB and 10dB HAP antenna roll-off beam widths are framed in Fig. 2 where a 10dB roll-off beam width results with steeper edges within the coverage.

2.2 Nature of relation among parameters:

Relations among system parameters, SR, elevation angle at L-EoC and SA, are highlighted in Fig. 3 and Fig. 4 based on (1). Accordingly, elevation angle at L-EoC maintains a proportional relation with SR as shown in Fig. 3. A group of three platform heights of 17 km, 20 km and 22 km has analyzed for the same system parameters. Relativity shows that a higher SR requires for a lower platform height intending to maintain same elevation angle at L-EoC. Though, maximizing elevation angle at L-EoC leads all platform heights toward maintaining same spacing radius of 30km which is the projection of SPP at L-EoC. The zero crossings of SR shows corresponding elevation angles maintained at L-EoC for the three platform height when SPP projects at the center of coverage. The negative SR values are confirming the existence of HAP toward R-EoC where elevation angles at L-EoC tends to minimize.

The relationship between elevation angle at L-EoC and SA has shown in Fig. 4. A proportionally increasing then decreasing change in SA has maintained for an increasing elevation angle at L-EoC. The relationship shows that lower platform heights have to maintain a wider SA than higher platform heights considering same elevation angle at L-EoC. Though, deviations of SA among different platform heights are higher while maintaining lower elevation angles at L-EoC and decreases for higher elevation angles.

The cross relation between SR and SA shows that the highest SAs are maintained in Fig. 4 while corresponding elevation angles at L-EoCs are maintained for zero crossings in Fig. 3. So, it is obvious that highest SAs are maintained while HAP's SPP projects at center of coverage. Therefore, SA decreases sharply for a slight decrease in elevation angle at L-EoC when SR has negative value. Whereas, contrarily, SA decreases smoothly for a large increment in elevation angle at L-EoC with positive value of SR.

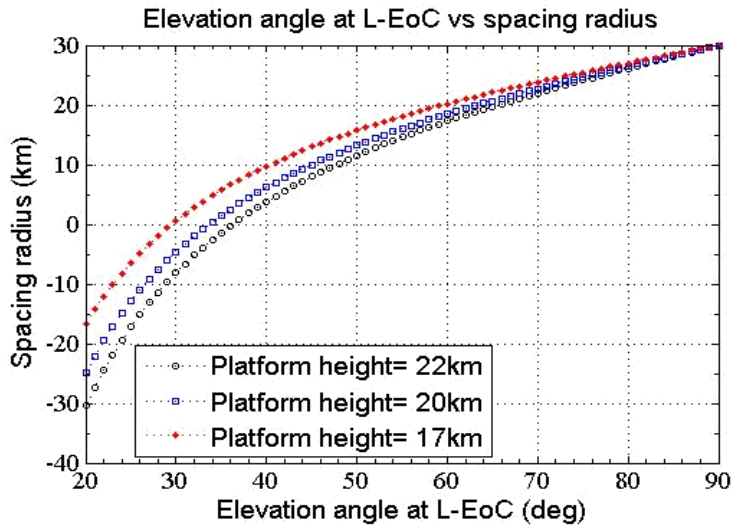

Fig. 2. Radiation pattern of HAP antenna with 3dB and 10dB roll-off beam width at EoC

Table 1. Parameter Specification Of The System For Simulation

Parameters	**Value**
Coverage Radius	30 km
Transmitter Height	22 km
HAP antenna roll-off	5
Antenna Efficiency	80 %
Frequency	2 GHz

2.3 Simulation:

To simulate the system, a 30x30km coverage area is illuminated by a 3dB roll-off HAP antenna beam width. 1km regular grids spacing are used on both x and y axis where highly directive user antenna placed on each grid line crossings to measure received gain at user end. The user antenna always points toward HAP to avoid mutual coupling among users [13, 14]. Collectively, the data at user end gives a gain distribution over the service area. At a glance, the specifications of simulating system parameters are tabulated in Table. 1

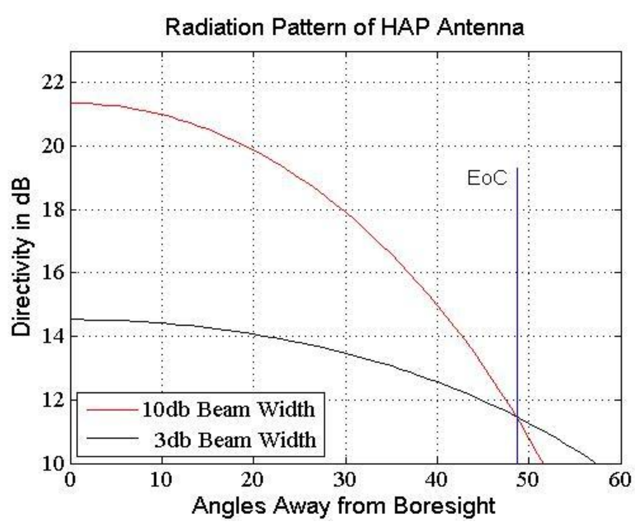

Fig. 3. Relation between elevation angle at L-EoC and spacing radius

3. AIN DISTIRIBUTION ANALYSIS

HAP antenna gain distribution over a coverage area varies for selection of distinct SRs as well as diverse antenna bore points while providing 3G services. Such aspects of gain distributions have discussed in this section for 10 km, 20 km and 30 km spacing radii based on Fig. 5, Fig. 6 and Fig. 7 respectively. The gain distribution dependencies for bore point at center of coverage, half of SA and SPP are also analyzed based upon R-EoC and L-EoC.

In terms of roll-off gain, bore point at center of coverage gives minimum roll-off gain and bore point at SPP gives maximum towards R-EoC for all SRs. On other hand, bore points at center of coverage and at SPP flips their status for roll-off gain performance toward L-EoC. Therefore, as SR increases from 10km to 20km and then 30km towards L-EoC, roll-off gain performance deviates towards R-EoC among individual bore points and shrinks towards L-EoC. Concurrently, bore point at half of SA gives a consistently moderate roll-off gain towards both EoCs with same amount of gain at the edges.

In terms gain at EoCs, as SR increases toward L-EoC, all bore points show increasing gain performance at both L-EoC and R-EoC. Though, bore point at SPP performs exceptionally at R-EoC where gain decreases about 1dB for each 10km SR increment. Additionally, it is observable that bore point at half of SA gives moderate but same gain performance at both EoCs. Moreover, bore point at center of coverage and SPP are sensitive to SR variation towards L-EoC for gain performance at both EoCs.

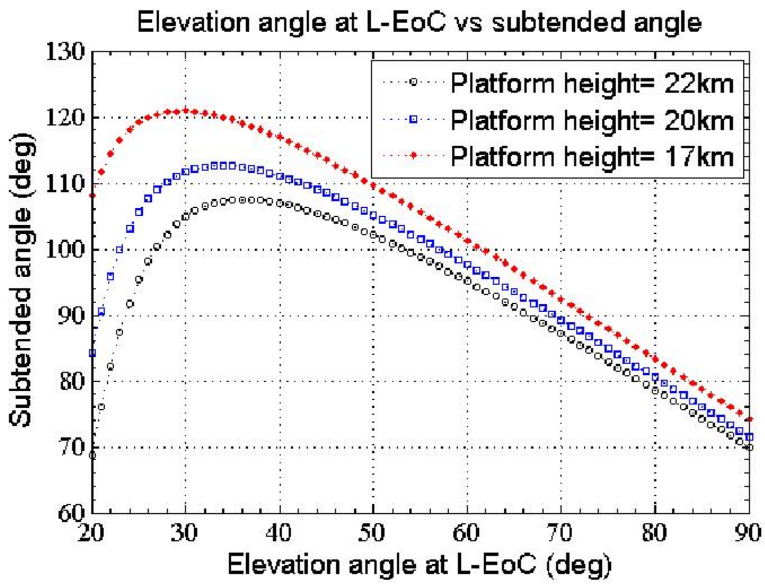

Fig. 4. Relation between elevation angle at L-EoC and subtended angle

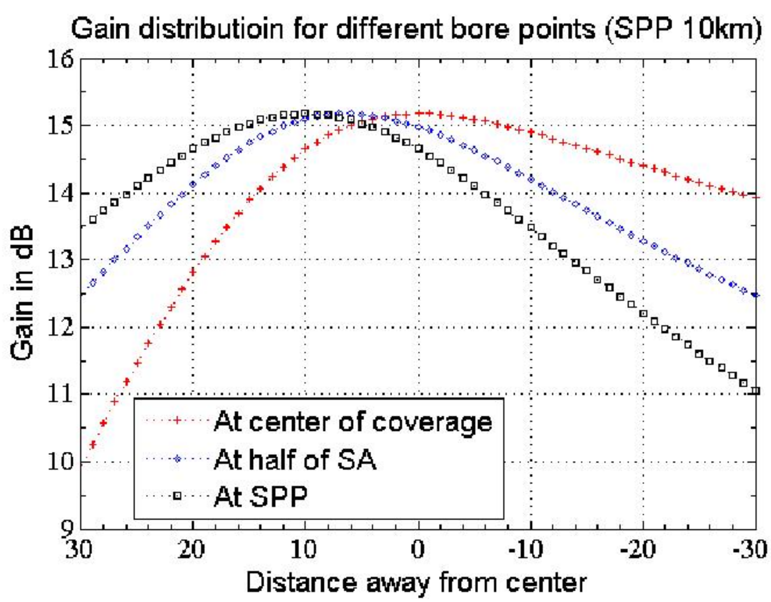

Fig. 5. Gain distribution for different bore points (SPP=10km)

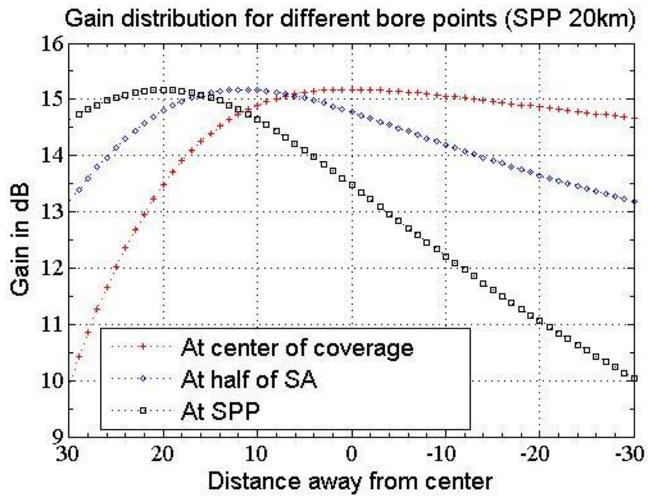

Fig. 6. Gain distribution for different bore points (SPP=20km)

4. CONCLUSION

After In this paper, a HAP system model has designed intending to provide 3G services with certain gain distribution over a coverage area. The system model also used to seek relation among parameters like elevation angle at L-EoC, SR and SA. Further, gain distribution performances have analyzed for bore point at center of coverage, half of SA and SPP. Additionally, effect of distinct SRs on gain distribution has illustrated. As a result, gain performance over the coverage could be optimized through implementing bore points in an adaptive approach. We can exemplify that bore point at center of coverage on R-EoC and bore point at SPP on L-EoC could be selected while high spacing radius used to maintain. Whereas, bore point at half of SA could be tuned to maintain a moderate QoS for all SRs. Finally, a high SR has capability of providing high gain on both edges with proper selection of HAP antenna bore point towards individual EoCs. In future, CINR performances could be analyzed seeking for optimum antenna bore point and SR over different type of territory like suburban, urban and rural. Different channel models also could be analyzed by the concept of this paper. There are also scope of using different antenna roll-offs to improve system performance.

5. REFERENCES

[1]. Aragon-Zavala, J. L. Cuevas-Ruiz and J. A. A. Delgado-Penin, High Altitude Platforms for Wireless Communications, West Sussex, UK: Wiley, 2008, pp 156.

[2]. A. Mohammed, S. Arnon, D. Grace, M. Mondin and R. Miura, "Advanced Communication Techniques and Applications for High- Altitude Platforms," in EURASIP Journal on Wireless Communications and Networking, vol. 2008.

[3]. D. I. Axiotis and M.E. Theologou, "2 GHz outdoor to indoor propagation at high elevation angles for mobile communications served by high altitude platform stations," in Global Telecommunications Conference, 2002. GLOBECOM '02. IEEE, vol. 2, pp. 1865- 1869, 17-21 Nov. 2002.

[4]. G. Araniti, A. Iera and A. Molinaro, "The Role of HAPs in Supporting Multimedia Broadcast and Multicast Services in Terrestrial-Satellite Integrated Systems," in Wireless Personal Communications, vol. 32, 2005.

[5]. G. Chen, D. Grace and T. C. Tozer, "Performance of multiple High Altitude Platforms using directive HAP and user antennas," in Wireless Personal Communications, v 32, n 3-4, p 275-299, February 2005. (spacing radius)

[6]. H.H.S. Luh, "Circular aperture synthesis for maximizing gain-coverage area product," in International Symposium Digest: Antennas and Propagation, San Jose, CA, USA, 26-30 June 1989.

[7]. H. Kirchhoff, G. Schindler and H. Thiere, "Design and measurement of satellite reflector antennas with high coverage gain," in International Conference on Antennas for Aircraft and Spacecraft, 29-34, 3-5 June 1975, London, UK.

[8]. J. Holis and P. Pechac, "Provision of 3G Mobile Services in Sparsely Populated Areas Using High Altitude Platforms," in RADIOENGINEERING, VOL. 17, NO. 1, APRIL 2008.

[9]. J. Thornton, D. Grace, M.H. Capstick and T.C. Tozer , "Optimizing an array of antennas for cellular coverage from a high altitude platform," in IEEE Transactions on Wireless Communications, vol. 2, no. 3, pp. 484-492, May 2003.

[10]. P. Pace, "Call Handling Strategies for HAP system supporting 3G mobile Communications," in GLOBECOM Workshops IEEE, 2008.

[11]. Recommendation, ITU-R M. 1456, Minimum Performance Characteristics and Operational Conditions for High Altitude Platform Stations providing IMT-2000 in the Bands 1885–1980 MHz, 2010–2025 MHz and 2110-2170 MHz in the Regions 1 and 3 and 1885–1980 MHz and 2110–2160 MHz in Region 2, International Telecommunications Union, Geneva, Switzerland, 2000.

[12]. S. Karapantazis and F.-N. Pavlidou, "The role of high altitude platforms in beyond 3G networks," in Wireless Communication IEEE, vol. 12, no. 6, pp. 33- 41, Dec. 2005.

[13]. T. Hult and A. Mohammed, "The Effect of Mutual Coupling on a High Altitude Platform Diversity System Using Compact Antenna Arrays," in International Journal of Antennas and Propagation, p 492915 (7 pp.), 2010.

[14]. Z. Yang, A. Mohammed and T. Hult and D. Grace, "Downlink Coexistence Performance Assessment and Techniques for WiMAX Services from High Altitude Platform and Terrestrial Deployments," in EURASIP Journal on Wireless Communications and Networking, pp. 291-450, 2008.

[15]. Z. Wang, X. Liu and Z. Li, "Steerable antennas movement compensation for high altitude platform," in Journal of Electronics, v 28, n 2, p 154-60, March 2011.