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Design and implementation of High Altitude Platform Systems to cover Diyala City

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ABSTRACT: *The improvement of sharing range between High Altitude Platform System (HAPS) and Terrestrial System (TS) in the 2.4 GHz band is the paper principle point. The High Altitude Platform System (HAPS) works in this apportioning affirming the assurance of existing administrations. The normal sharing situation in the specified band is between the HAPS framework and the Terrestrial System (TS). Both frameworks work in the nearby channel recurrence band; and in this manner, obstruction between these frameworks is a basic issue, which requires extensive range sharing review this paper examines the performance of HAPS and Terrestrial Systems at a height of 70m and 50m for the city of Ba'qubah. The study shows the interference caused by both systems for a victim link user. To avoid interference, the paper shows the desired distance and altitude at which the HAP and TS towers should be positioned. The reenactment comes about demonstrate that the HAP gives a superior flag quality at bigger scope regions than the TS. The consequences of this paper add to improving the connection between the two frameworks and better use of the range.*

Keywords: *HAPS, High Altitude Platforms, airship, Terrestrial Systems, interference.*

I. INTRODUCTION

The remote innovation field has encountered an enormous improvement amid the previous two decades. The expanding request on remote correspondences has prompt to the effective and quick advancement of both earthly and satellite systems. New advancements give individuals more accommodation and flexibility to interface with different correspondence systems. It is figured that the need for higher limits is expanded when the cutting edge applications are coordinated with future remote correspondence innovations. [1][2].

In evaluation to the two beforehand specified techniques for correspondences, another option has pulled in the consideration of the broadcast communications group. It depends on semi stationary ethereal stages working in the stratosphere referred to by various names as High Altitude Platforms. [3] (HAPs) or Stratospheric Platforms (SPFs). The High Altitude Platform System is an aircraft flying in the low thickness, non-tumultuous air stream at the stratospheric height of 17 ~ 22 km from the surface of the earth, as appeared in Figure 1 [4]. The instability of HAPS at this elevation is not annihilating; and it is equipped for conveying an extensive number of broadband administrations [5]. Correspondence stages arranged at high elevations can be dated to the most recent century. In 1960 a goliath inflatable was propelled in USA. It reflected communicates from the Bell research facilities office at Crawford Hill and Skiped the signs to long separation phone call clients. This inflatable can be viewed as a progenitor of High Altitude Platforms. [6].

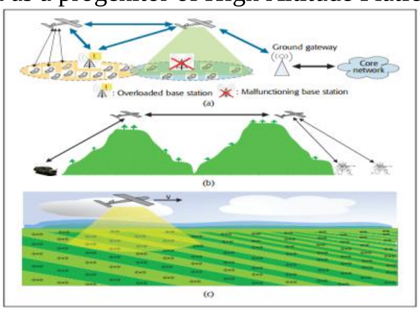

Figure1. Three typical use cases of UAV-aided wireless communications: a) UAV-aided ubiquitous coverage; b) UAV-aided relaying; c) UAV-aided information dissemination and data collection. [4].

II. SIGNIFICANCE OF THE STUDY

The basic element in communications via HAPS and Terrestrial Systems is the level of interference. To calculate the interfering and the desired signal strengths between HAPS and TS, some important parameters are essential. These parameters are summarized in Table 1. The communication scenario is shown in Figure 2. A HAP is located at a height of 70m in the middle between two Base Station towers of 20m height. The total distance between the two towers is 50km.

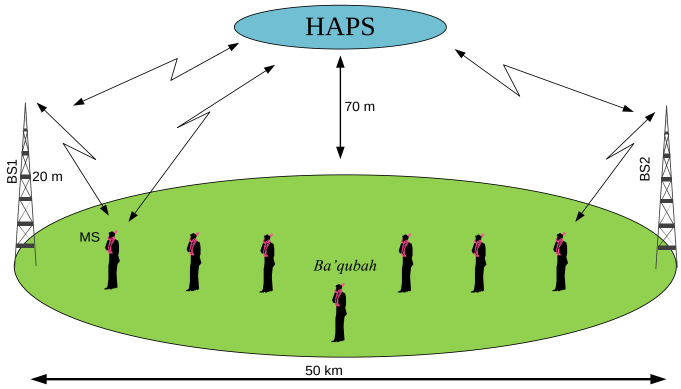

Figure 2. Position and Distance between HAP and Towers.

III. METHODOLOGY

The satisfactory level of INR is the primary parameter used in this paper to assess the execution of the framework. Likewise, it is the reference to apply the best possible balanced energy to decrease the obstruction level from HAPS to TS. HAPS transmit control must be balanced as per standards in which the impedance is satisfactory between the HAPS and the TS. In the system, a supposition has been considered to make the outcomes base on down to earth circumstance; since the 2000– 2400 MHz band is basically designated for TS, the HAPS is the new innovation that will possess a recurrence that is adjoining the TS, and will bring about obstruction[7]. The initial phase in the similarity count is to actuate the TS and accept there are no HAPS administrations to bring about meddle. Before long, the HAPS is actuated and begins to transmit with its most noteworthy transmit control. The HAPS enactment will bring about corruption of execution to the TS; henceforth the INR is figured in light of three stages [8]; First to ascertain the impedance from HAPS into TS, second to process the clamor level of the TS recipient, and third we discover the INR level of the beneficiary so as to concentrate the required adjusted to transmit control from HAPS. In the accompanying sub-area, each of the above strides is portrayed in subtle elements.

Calculation of the Interference from HAPS to TS

The interference level *I (dBm)* from the HAPSAS into the TS calculate from the following equation evaluates

$$I = P_H + G_H + G_T - PL_H \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

Where *PH (dBm)* is the transmitted power from HAPS. *GT (dBi)* is the gain of *TS, GH (dBi)* is the gain of HAPS and the *PLH (dBm*) is the desired signal dRSS calculated as follows [14]:

$$PL_H = 92.4 + 20\log(f) + 20\log(d) \;\ldots\ldots\ldots\ldots\ldots (2)$$

Where f *(GHz)* is the operating frequency and *d (km)* is the distance between HAPS and TS.

3.2. Calculation the Noise Power *(dBm)*

The Noise level *N (dBm)* is expressed as:

$$N = -114 + 10\log(B_W) + N_F \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where NF (dB) and BW (MHz) signify noise power and bandwidth respectively.

3.3. Evaluates the *INR* Level at the TS

Since the *INR* level determines whether the transmitted power of HAPS needs to be adjusted or not, the INR level at the TS receiver antenna is calculated as:

$$I/N = I - N \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.... (4)$$

After comparing the results with the interference threshold, the adjusting of the interference level is applied; at this stage, if the INR level is less than −10 dB, the transmitted power from HAPS needs no adjustment. Contrary if the INR is above −10 dB, then first interference level must be adjusted based on the following equation:

$$Iadj = INR\,desired \times NF \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (5)$$

Where *Iadj* is the acceptable interference level and *INR* desired. The HAPS has to transmit with newly adjusted power by the following equation:

$$Iadj = Iadj \,/\, GH(O)GT(Q)PLH \quad \ldots\ldots\ldots\ldots\ldots\ldots \ (6)$$

In which *GH(O) (dBi)* is the gain of HAPS at an angle of O degree away from bore sight and *GT (Q) (dBi)* is the gain of TS at angle Q degree away from its bore-sight.

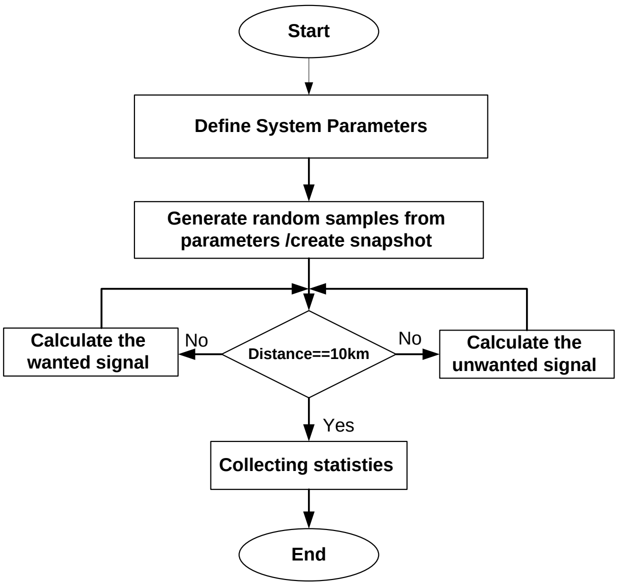

Figure 3. The simulation flow chart

IV. SYSTEM PARAMETERS AND SHARING SCENARIO

With a specific end goal to direct the sharing situation, the framework parameters are required. The LTE-A parameters that are utilized as a part of our reenactments are portrayed in Table 1.

For all the scenarios the distance between BS and MR is between 0 to 25km, as shown in figure 2.

Table 1. Shows the Input Parameters [9]

Parameter	Value	Units
Frequency of HAP	2.4	GHz
Frequency of Tower	2.4	GHz
Power (Tx)	33	dBm
Power (Rx)	33	dBm
Height of HAP	70	M
Height of Tower	20	M
Height of User	1.5	M
Coverage Area Radius	25	Km
Antenna Peak Gain (Tx)	14	dBi
Antenna Peak Gain (Rx)	6	dBi
Antenna Azimuth	0	degree
Antenna Elevation	0	degree
Propagation Model	Extended Hata	
General Environment	Rural	
Local Environment (Rx)	Outdoor	
Local Environment (Tx)	Outdoor	
Propagation Environment	Above Roof	
Wall Loss (indoor indoor)	5	dB
Wall Loss Std. Dev. Indoor indoor)	10	dB
Wall Loss (indoor outdoor)	10	dB
Wall Loss Std. Dev.(indoor outdoor)	5	dB
Loss Between Adjacent Floors	18.3	dB
Sensitivity (Rx)	103	dBm

V. RESULTS AND DISCUSSION

To understand and enhance the coexistence between HAPS and TS, it is essential to study different communications scenarios between the two systems and highlight the key differences in the dRSS and iRSS signal strengths. The simulation results are illustrated in the following subsections.

5.1 HAP AT 70m HEIGHT

5.1.1 First scenario:

The HAP at a 70m height acts as a victim link transmitter (Tx) sending the desired signal dRSS, the tower as an interfering link sending iRSS and the user as a victim (receiver). Table 2 shows the values of the dRSS and iRSS as received by the user. It is obvious that the signal transmitted from the HAP is stronger than that from the tower at the given height of 70m. As the user gets farther, the interference level from the tower increases and the signal strength from the HAP slightly decreases. At the height of 20m, it is shown in Figure 3 that the dRSS and iRSS curves interfere, because the altitude is almost identical, thus the values of the two signals will be very close.

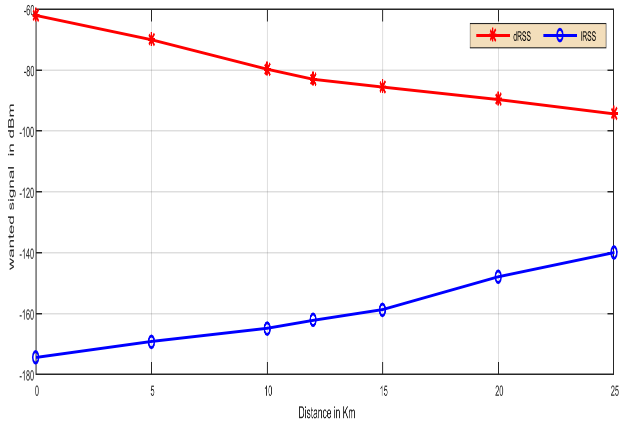

Figure 3. First Scenario Simulation Results

5.1.2 Second scenario:

The tower acts as a victim link transmitter (Tx), the HAP as an interfering link and the user as a victim (receiver). The signal strength from the tower is high at the height of 20m but it does not cover a large coverage area as the signal transmitted from the HAP. The curve in Figure 4 shows an illustration of the signal and interference levels as a function of distance. The curves again cross at the height of 20m as mentioned earlier.

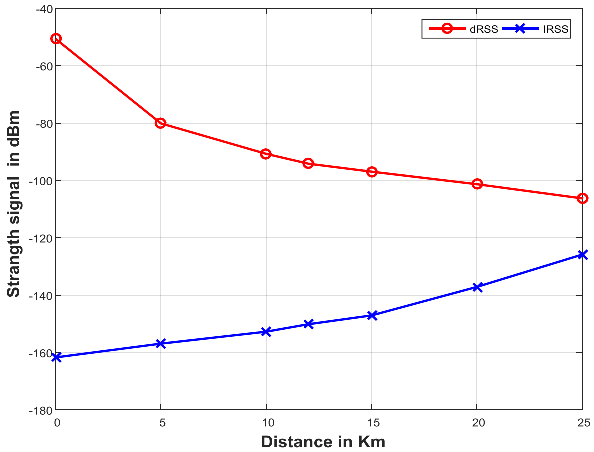

Figure 4. Second Scenario Simulation Results

5.1.3 Third Scenario:

The tower acts as a victim link transmitter (Tx), the HAP as a repeater and another tower as a victim (receiver). This scenario is useful when transmitting at very long distances and the signal from the tower is required to cover a distant area. Thus, the HAP here functions as a repeater to retransmit the same signal from the first tower and delivers it to the second tower at a high signal strength and low interference values. Figure 5. Shows the desired signal strengths when transmitted from the tower and then from the HAP.

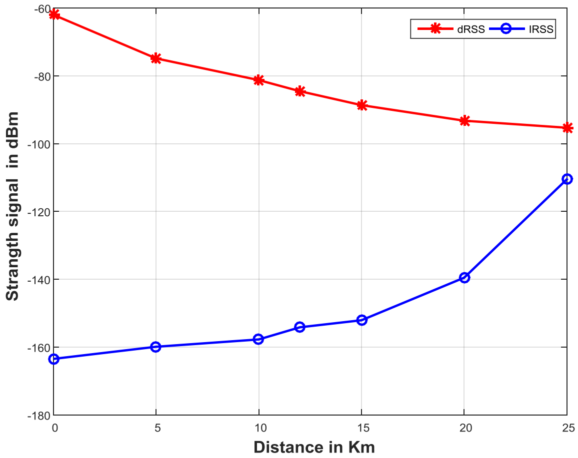

Figure 5. Third Scenario Simulation Results

5.2. HAP AT 50m HEIGHT

The HAP in this scenario acts as a victim link transmitter (Tx), the tower as an interfering link and the user as a victim (receiver). Table 2. Shows the results for this scenario which is almost similar to the first scenario mentioned earlier but at a lower altitude. The difference is that at this altitude of 50m, the coverage area will be smaller and the signal strength will be weaker at longer distances.

Table 2. Third Scenario Simulation Results

Case	Distance (km)	dRSS (dBm)
dRSS from tower to HAPS	25	-73.99
dRSS from HAPS to tower	25	-74.06

VI. CONCLUSION

The relationship between HAPS and TS was studied for the purpose of coexistence. The results obtained support the possibility of using both HAPS and TS in adjacent channels at certain distances. Three communication scenarios were considered at a height of 70m and one scenario at a height of 50m. The simulation results show that the HAP provides a better signal strength at larger coverage areas than the TS. The results of this paper contribute to enhancing the relation between the two systems and better utilization of the spectrum.

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