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An Systematic implementation to calculate Co-Channel Interference

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Abstract:- A User friendly software analytical tool is used for calculating co-channel interferences in the uplink and downlink for a base station due frequency reuse in coverage cells. The cells are arranged in hexagonal lattice and they are overlapped to provide complete coverage. Here we develop program code to which system parameters are given as input. An overall channel to noise plus interference ratio ($ChNIR_o$) with channel interference ratio (ChIR) for uplink and downlink paths is also calculated. Generally, it is noticed that co-channel interference increases as the reuse number in frequency reuse in the cell. It is also observed that co-channel interference can cause substantial degradation to the signal to noise ratio overall system.

Keywords: *uplink, downlink, co-channel interference,* $ChNIR_o$, ChIR.

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INTRODUCTION

Interference has adverse effect on the communications system. The system designer should be aware of the type of interference. Interference could be classified as intra-system or inter-system interference. The interference of band emissions of one system with band emissions of is an example of inter-system interference. Co-channel interference within a system is an example of intra-system interference. The focus of this paper is mainly on co-channel interference. In the case of a cellular mobile communications system, major priority is given to the adjacent channel interferences and co-channel interferences [1]. Adjacent-channel interference is static or other interruptions on a broadcasting channel caused by too much power on an adjacent channel on the spectrum.AM, FM and TV channels can all be affected by interference. On the other hand, co-channel interference or CCI is crosstalk from two different radio transmitters using the same frequency [2]. This type of interference is inherent in any system that employs a frequency reuse methodology. A system designer must be aware of frequency reuse and the potential for co-channel interference. If designers can calculate the co-channel interference, then they will be equipped with one more tool to manage their link budget calculations and to optimize their designs. This paper is a result of a analytical tool that can calculate the co-channel interference for telecommunications system which employs frequency reuse in different spot beams.

METHODOLOGY

The calculation of the co-channel interference is crucial for a system designer. Along with the channel interference ratio (ChIR), we also calculate the overall channel-to-noise-plus-interference ratio ($ChNIR_o$), which is useful performance The interference contributions are as follows

$$ChNIR_o = \frac{1}{\left[\frac{1}{ChIR_{up}} + \frac{1}{ChIR_{down}} + \frac{1}{ChIR_O}\right]}$$

Here, the overall carrier to interference ratio $ChIR_O$ is calculated as follows

$$ChIR_O = \frac{1}{\left[\frac{1}{ChIR_{coch}} + \frac{1}{ChIR_{adjch}}\right]}$$

The subscripts coch represents co-channel interference and adjch indicate adjacent channel interference. These are the two most commonly calculated interferences for a system that employs frequency reuse. The $ChIR_O$ may include all types of interferences that need to be calculated. But we concentrate only on co-channel interference. Therefore, the $ChIR_O$ hereafter includes only co-channel interference as follows:

$$ChIR_O = \frac{1}{\left[\frac{1}{ChIR_{coch-up}} + \frac{1}{ChIR_{coch-down}}\right]}$$

The downlink co-channel channel-to-interference ratio $ChIR_{coch-down}$ is primarily a function of the reuse number. On the other hand, the uplink co-channel channel-to-interference ratio $ChIR_{coch-up}$ is dependent upon the reuse number and the number of co-channel users transmitting simultaneously.

ALGORITHM FOR CALCULATION OF COCHANNEL INTERFERENCE IN THE UPLINK AND DOWNLINK TRANSMISSION

Step 1: Read System parameters
Step 2: Draw the base station uplink Antenna pattern
Step 3: Perform base station visibility and Minimum elevation tests to find the coverage
Step 4: If the tests pass, draw the coverage map else Go to Step 25
Step 5: Find whether the users location
Step 6: If users are present perform visibility and minimum elevation tests for the user location
Step 7: If tests pass, find whether reuse is done in uplink, otherwise find the users power received at the base station
Step 8: If reuse is done find the cochannel cells in the coverage map

Step 9: Find the worst and best cases and the randomly distributed interferers
Step 10: Find the total Interference power received at the base station
Step 11: Calculate the users power received at the base station
Step 12: Find the Noise Power
Step 13: Calculate the uplink $ChIR_{coch-up}$
Step 14: If reuse is same as in uplink then find the user locaiton, otherwise draw the base station downlink antenna pattern and go to step 17
Step 15: Perform visbility and minimum elevation tests for the coverage center
Step 16: If tests fails Go to step 25, otherwise draw the coverage map
Step 17: If tests pass, find the reuse done in downlink
Step 18: If reuse is done, find cochannel cells in the coverage map, otherwise find the users power received
Step 19: Find the total downlink interference power received
Step 20: Find the users power received
Step 21: Find the noise power
Step 22: Calculate the downlink $ChIR_{coch-down}$
Step 23: Calculate the overall $ChNIR_o$ and $ChIR_O$ including uplink and downlink
Step 24: END

CALCULATION OF UPLINK CO-CHANNEL INTERFERENCE

Uplink co-channel interference is calculated which is received by the base station. We assume that there's only one user in each co-channel cell actively transmitting in the desired channel. In order to calculate the total uplink co-channel interference power received by the base station receiver, a 3-step process is followed :

(1) Coverage map is drawn and co-channel cells are identified.
(2) Co-channel interferers angle is determined. Co-channel interferers make angle with the uplink base station antenna pattern for the spot beam that serves the uplink mobile user. It finds such interferers for three cases:

(a) Randomly distributed interferers,
(b) worst-case placement of interferers, and
(c) best-case placement of interferers.

(3) Total intereference power received by the uplink base station is found using the above cases.

CALCULATION OF DOWNLINK CO-CHANNEL INTERFERENCE

Downlink interference received at mobile user is calculated from the downlink co-channel spot beams that use the same exact frequency as the main downlink user(mobile receiver). The procedure is similar to that of the uplink case except that there are no different scenarios since the interferers here are the static co-channel spot beams instead of other base station as in the uplink case, and that the distance between each interfering source and the user receiver is the same as the distance between the base station and the mobile receiver.

PARAMETERS AND VALUES USED:

Calculations are performed for a simple scenario. The parameters and their values are taken from [3].

Base station parameters	
Elevation height of antenna masts	30 m
Number of Spot beams	37
Uplink frequency	890 Mhz
Downlink frequency	935 Mhz
Antenna Gain	2 dB
Receiver Noise temperature	290K
Atmospheric losses	0.5 dB
Mobile Terminal Parameters	
Elevation height of antenna	1.5 m
Transmitter output power	0.5 W
Antenna Gain (transmit and receive)	0 dB
Receiver Noise Temperature	100K

OBSERVATIONS:

The table shows values for different reuse values and different sidelobe levels. We can observe that as the reuse number increases, the overall co-channel interference power decreases. It is also observed that for the same reuse number , as sidelobe level of the spot beam antenna pattern decreases, the co-channel interference also decreases.

MINOR LOBE BEAM (dB)	DOWNLINK			UPLINK			$ChIR_O$ (dB)
	REUSE No	CELL No	$ChIR_{coch-down}$	REUSE No	CELL No	$ChIR_{coch-up}$	

-17.6	3	11	10.0	3	11	9.0	6.4
	4	8	10.6	4	8	10.1	7.4
	7	4	18.6	7	4	17.9	15.3
-24.6	3	11	19.2	3	11	16.2	14.4
	4	8	18.4	4	8	18.0	15.2
	7	4	28.2	7	4	29.8	25.9

CONCLUSION :

The overall channel to interference ratio depends mainly on the system parameters such as spot beam of side lobe level, frequency reuse number, number of active users and separation of active users from the main user. If the system uses antennas with low sidelobe levels and less frequency reuse mechanism will suffer from overall co-channel interference which becomes the limiting factor for link budget analysis. It is observed that the amount of interference received in the uplink and downlink by randomly distributed interferers is much closer to that of the worst case distribution than a best case distribution. As the reuse number increases, the co-channel interference decreases; consequently, the ChIR increases. As the base station antenna sidelobe level decreases, the co-channel interference decreases; consequently, the ChIR increases.

REFERENCES:

[1] A.I. Zaghloul and O. Kilic, "*Transmission Impairment Parameters in Multiple-Beam Satellite Communications Systems*," URSI General Assembly, Maastricht, The Netherlands, August 2002.

[2] United States. National Communications System Technology & Standards Division, "Telecommunications: Glossary of Telecommunication Terms," Federal Standard 1037C, August 1996, < http://www.its.bldrdoc.gov/fs-1037/>.

[3] T. Pratt, C. Bostian and J. Allnutt, "Satellite Communications," 2nd ed., pp. 128, 137-144, 2003.

[4] Tri T. Ha, "Digital Satellite Communications," 2nd ed., pp. 138-157, 1990.

[5] W. L. Stutzman and G.A. Thiele, "Antenna Theory and Design," 2nd ed., pp. 320, 1998.

[6] A.I. Zaghloul, F.T. Assal, B.H. Hutchinson and E. Jurkiewicz, "*Satellite Communications to Hand-Held Terminals from Geostationary Orbit*," 9th International Conference on Digital Satellite Communications, Copenhagen, Denmark, May 18-22, 1992.

[7] S. K. Rao, "*Parametric Design and Analysis of Multiple-Beam Reflector Antennas for Satellite Communications*," IEEE Antennas and Propagation Magazine, Vol. 45, No. 4, August 2003.

[8] FCC File Number: SAT-AMD-20040227-00021, *"Amendment to Application for Authority to Launch and Operate an L-band Mobile Satellite Service Satellite at 63.5°W,"* Mobile Satellite Ventures Subsidiary LLC, February 2004, Authority Granted on January 10, 2005.

[9] S. Chhabra, A.I. Zaghloul and O. Kilic, "*Co-Channel Interference in Satellite- Based Cellular Communication Systems*," URSI General Assembly, New Delhi, India, October 2005.

[10] O. Kilic, A. I. Zaghloul, M. Thai, L. Nguyen, "*Beam Interference Modeling in Cellular Satellite Communication Systems*," URSI General Assembly Meeting, 1999.