Phương pháp đánh giá nhiễu giao thoa từ tuyến feeder xuống của hệ thống vệ tinh di động quỹ đạo thấp đến mạng VSAT ở Việt Nam

An analytical method for estimating interferencefrom LEO MSS feeder downlink to VSAT network in Vietnam

Nguyễn Lưu Bình, Hoàng Xuân Nguyên

Abstract

Bài báo giới thiệu một phương pháp để đánh giá nhiễu giao thoa từ tuyến xuống của hệ thống vệ tinh quỹ đạo thấp LEO tới máy thu trạm mặt đất của mạng VSAT thuộc hệ thống vệ tinh địa tĩnh GSO khi làm việc trong cùng băng tần và cùng hướng. Phương pháp này tính phần trăm thời gian xuất hiện của vệ tinh LEO trong vùng nhìn thấy của antenna trạm mặt đất VSAT, đưa ra một quy trình đánh giá nhiễu. Phương pháp này có ưu điểm là tiết kiệm thời gian hơn phương pháp chạy máy tính trong chương trình mô phỏng trực tiếp. áp dụng để đánh giá nhiễu từ các vệ tinh trong hệ thống vệ tinh Globalstar đến các trạm mặt đất thuộc mạng VSAT của VTI ở Việt nam.

1. Introdution

For estimating interference from LEO MSS feeder downlinks into GSO VSAT system based on computer methods of simulation features high accuracy of the obtained results but they may require considerable runtime and may not be commonly available;

And interference between LEO MSS feeder downlinks and GSO VSAT systems may be estimated using time percentage for LEO satellites staying within an area into certain discrimination angles from a direction to a GSO satellite in relation to the VSAT earth station concerned.

However, the time percentage for a specified value of an angle between a GSO VSAT satellite and a LEO satellite in relation to the earth station concerned may be defined using either simulations or by the analytical method described in Recommendation ITU-R S.1257 or by using other methods,

This report may be used for estimating interference from LEO MSS feeder downlink into GSO VSAT systems co-frequency operating in the same direction.

The section 2 is described Analytical method for estimating interference from LEO MSS feeder downlink into VSAT networks operating co-frequency and co directionally. The section 3 is proposed the procedure for estimating the downlink interference. The section 4 is applied the Example of estimating interference from LEO MSS feeder downlinks of Globalstar system into existing VSAT system of VTI in Vietnam sharing the same C frequency bands in the same direction.

2. A analytical method for estimating interferencefrom LEO MSS feeder downlink into VSAT network operating co-frequency and co directionally

For estimating interference from LEO MSS feeder links and GSO VSAT system a criterion is specified according to which:

Interference power spectral density, I_0, from feeder links of an LEO MSS network (in uplink from earth station and in downlink from satellite being a result of feeder link transmissions to and from all the satellites in a constellation) at the input of receiver of a

GSO VSAT earth station shall not exceed a certain fraction, x, of receiver thermal noise power spectral density, N_O, within a specified time percentage, % t.

An example of criteria for interference from LEO MSS feeder downlinks to GSO VSAT receivers given in Table 1 (see column 4&8) is used in the example bellow.

The present method provides an estimation of the time percentage, % t, based on acceptable interference power spectral density, I_O, without using simulation methods.

For estimating interference between feeder downlinks LEO MSS networks and GSO VSAT system we consider the case that emissions from LEO MSS feeder- downlink space stations interfering into GSO VSAT receiving earth stations (see Fig. 1). We consider the case for the "downlink" of LEO satellite.

We have:

$$I_O = P_s + G(\alpha) - L_d + G(\varphi) \text{ dB(W/Hz)} \quad (1)$$

Where:

P_s : interfering LEO space station's transmit power spectral density (dB(W/Hz))

$G(\alpha)$:interfering LEO space station antenna gain in the direction of the wanted VSAT earth station (dB)

$G(\varphi)$:wanted VSAT earth station antenna gain in the direction of the interfering LEO space station (dB)

L_d : path loss from the interfering LEO satellite to the wanted VSAT earth station (dB).

This method is based on defining a part of space limited by a circular conic surface with a vertex angle 2φ (see Figure. 1). The vertex of the cone coincides with either the interfering or interfered-with earth station location and the axis of the cone is always aimed at the GSO VSAT satellite.

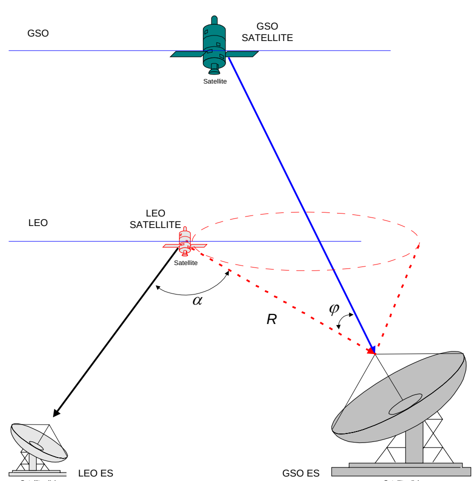

Figure.1 LEO MSS feeder downlink space station interfering into GSO VSAT receiving earth station

For interference in this case the interference power spectral density into a receiver changes as a function of angle φ, distance R and angle α. Analysis of variations in the interference power spectral density, I_0, as a function of φ, α and R shows that a slight increase in angle φ leads to a sharp decrease in the interference power, I_0, while small changes in distance R and angle α leads to virtually no change. Variations in $G(\alpha)$, L_d, that are functions of distance R and angle α, are therefore insignificant.

Based on these features it is appropriate to assume that $G(\alpha)$ and L_d are constant. This assumption leads to an insignificant error of the interference estimates. Therefore for interference above cases the variations in the received interference power spectral density are mainly a function of the angle φ.

The time percentage, % t, that LEO satellites are within the cone 2φ is a function of the required separation angle φ. For the specified features of the satellite networks concerned, every value of angle φ corresponds to a certain value of I_0 at VSAT receiver's input.

3. Procedure for estimating the downlink interference

For the purpose of estimating the uplink interference, the interfering earth station antenna pattern is used, while for estimating the downlink interference, the wanted earth station antenna gain is used. The procedure for estimating the downlink interference as follows

Step 1: An acceptable level of interference power spectral density for a specific VSAT earth station is derived from the following expression:

$$I_0 = 10 \log x + 10 \log(k\, T) \quad \text{dB(W/Hz)} \qquad (2)$$

where:

x : fraction of the specific receiver noise power spectral density within a specified time percentage, % t, criteria of Table 1 (see column 4&7)

k : Boltzmann's constant $= 1.38 \times 10^{-23} = -228.6$ (dBW/K/Hz)

T : noise temperature of the wanted networks VSAT receiving station (^{0}K).

Step 2: Using expression (1) and the earth station antenna pattern a value of angle φ, that corresponds to an acceptable interference power spectral density, I_0, defined at Step 1, is calculated.

Step 3: Based on the analytical method presented in the [5] or based on other methods, a time percentage % $t_m(\varphi)$ that LEO satellites are within a cone with a vertex angle $2\varphi_m$ is calculated. One of methods recommended as follows, to calculate the time percentage % $t_m(\varphi)$ we determine the probability by expressions (3) to (14):

where,

- L_0 : Latitude of the observation point (rad)
- L : Latitude of the area (rad)
- b : Length of the area in longitudinal direction (rad)
- i : Inclination of satellite orbit (rad)
- a : Angle between ground track and latitude line (rad)
- A : Area on a spherical surface (sterad)
- A_c : Area of a circle on a spherical surface (sterad)
- P_i : Probability to be inside the area if hit during the revolution (one satellite calculation)

P: Probability for a satellite to be inside the defined area (one satellite calculation)
P_C: Probability that any one of the satellites in a constellation is inside the area
N: Number of satellites in the constellation
k: $r / (r + h)$
Λ: Azimuth of the centre of the area (rad)
ε: Elevation of the centre of the area (rad)
r: Radius of the Earth
h: Altitude of the satellite
γ: Nadir angle from subsatellite point (see Fig. 4) (rad)
θ_ε : Geocentric angle in elevation direction corresponding to ε (rad)
$\theta_{\varepsilon 2}$: Geocentric angle for the highest point of the area in elevation direction (rad)
$\theta_{\varepsilon 1}$: Geocentric angle for the lowest point of the area in elevation direction (rad)
$\Delta\theta_\beta$ Geocentric angle difference in direction perpendicular to θ_ε (rad)
β: Width of the area in azimuthal direction (e.g. antenna beamwidth in azimuthal direction)
$\varepsilon_1, -\varepsilon_2$: The highest and lowest elevation of the area (rad) (ε_1, $-\varepsilon_2$ is e.g. the antenna beamwidth in the elevation direction, $\varepsilon_1 = \varepsilon - \varphi/2; \varepsilon_2 = \varepsilon + \varphi/2$)

Calculation expressions of probability

The following formulae are a collection of those and given here are only those which are needed for the probability calculation. Explanation is given for the calculated parameters.

$$k = \frac{r}{r+h} \qquad (3)$$

$$\theta_{\varepsilon_1} = \pi - \gamma - (\pi/2 + \varepsilon_1) = \arccos(k \cos\varepsilon_1) - \varepsilon_1 \qquad (4)$$

$$\theta_{\varepsilon_2} = \pi - \gamma - (\pi/2 + \varepsilon_2) = \arccos(k \cos\varepsilon_2) - \varepsilon_2 \qquad (5)$$

$$\Delta\theta_\varepsilon \square \theta_{\varepsilon 2} - \theta_{\varepsilon 1} \qquad (6)$$

$$\theta_\varepsilon = \frac{\theta_{\varepsilon 1} + \theta_{\varepsilon 2}}{2} \qquad (7)$$

$$\Delta\theta_\beta = 2 \arctan \frac{\tan(\beta/2) \sin\theta_\varepsilon}{\cos\varepsilon} \qquad (8)$$

$$L = \arcsin(\cos\theta_\varepsilon \cdot \sin L_o + \sin\theta_\varepsilon \cdot \cos L_o \cdot \cos\Lambda)$$
(9)

$$a = \arccos\frac{\cos i}{\cos L} \qquad (10)$$

$$P = \frac{A}{2\pi^2}\frac{1}{\sin a}\frac{1}{\cos L} \qquad (11)$$

$$P_C = N P \qquad (12)$$

For a circular area:

$$A = A_C$$

$$A_c = \frac{\pi}{4} \Delta\theta_\varepsilon \Delta\theta_\beta \qquad (13)$$

For a rectangular area:

$$A = \beta(\varepsilon_1 - \varepsilon_2) \qquad (14)$$

Step 4: Time percentage values calculated at Step 3 are compared with acceptable values (e.g. those given in Table 1). If the calculated value of time percentage % $t(\varphi)_m$ does not exceed a specified % t_m then the interference is acceptable (based on the criteria used).
An example of the given algorithm's application for estimating interference from feeder downlinks of an LEO MSS network into VSAT system is shown in the section 4 bellows.

4. Example of estimating interference from LEO MSS feeder downlinks into existing VSAT system of VTI in Vietnam while sharing the same frequency bands in the same direction

The example deals with a case of estimating interference from LEO MSS feeder downlinks into a GSO VSAT system. The assumptions used are characteristics of a Globalstar LEO satellite network (h = 1 500 km, $i = 52^0$, N = 48) and typical GSO VSAT satellite parameters. Estimations are performed for wanted and interfering earth stations at latitudes within 8^0 and 23^0, and with the satellite located at the same longitude as the earth station.
Estimation results for interference from the LEO MSS feeder downlinks to the GSO VSAT system are presented in Tables 1 for Space-to-Earth directions respectively. The estimation sequence is as follows:

Step 1: The first step is the estimation of the acceptable interference level expressed in fraction, x, of a specific receiver noise power spectral density, N_0, within the time percentage, % t_m, specified for the given frequency band.
The following formula was used:

$$I_0 = 10 \log x + 10 \log(\text{kT}) \quad \text{dB(W/Hz)} \qquad (15)$$

In Tables 1 the specified time percentage % t_m (column 4) have appropriate values of N_0 (column 6), x (column 7) and an estimated threshold interference value $(xN_0)_m$ (column 8).

Step 2: At the second step, using expressions (1) (for downlink) and the earth station antenna pattern,

Step 3: Based on the analytical method presented in the [5], to calculate the time percentage % $t_m(\varphi)$ we determine the probability by expressions (3) to (14).

Step 4: At the fourth step the calculated time percentage values were compared with acceptable values (those given as an example only in Table 1 - column 4).
The estimation results presented in Table 1 - column 14 or Table 2 - column 19 show that the interference levels from the LEO MSS feeder link stations into the GSO VSAT stations would not comply with the short-term criteria $(xN_0)_m$ using in this example.

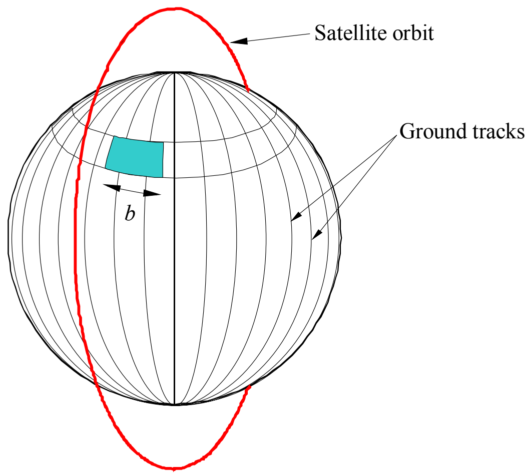

Figure 2
Tracks of polar orbit satellite
(Rectangular area for calculation)

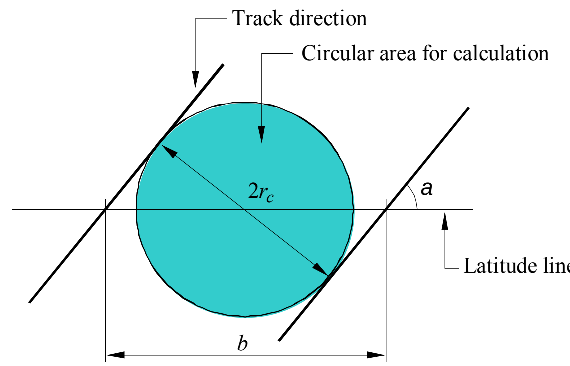

Figure 3
Length *b* of a circular area projection on latitude line

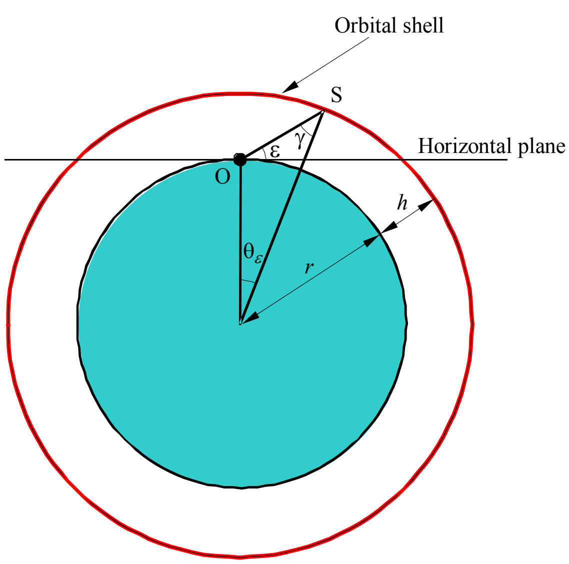

Figure 4
Angles in elevation direction

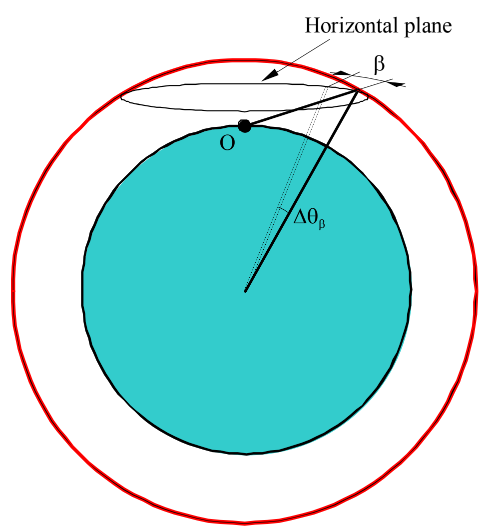

Figure 5
Angles for azimuthal movement of satellite

TABLE 1

The interference level of satellite systems resulting from computation based on results of possible interference duration (time statistic) in case of LEO network interference into VSAT network of VTI

TT	Earth Stations	Latitude of E/S (deg.)	% t (%)	T (K)	No (dB(W/Hz))	x	xNo (dB(W/Hz)) (Io)	Ps (dB(W/Hz))	G(α) (dB)	Ld (dB)	G(φ) (dB)	φ (deg.)	% t(φ) (%) Pc
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Trung tâm1												
1	Cửa khẩu lạc nửa HT	18.34	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.2973493359
2	Bảo lạc-Cao Bằng	22.9	0.119	58.5	-210.928	0.28	-216.8	-78.6	5	177.3	34.1	3E-07	-6.91E-08
3	Mường lát-Thanh hoá	20.5	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-1.35E-14
4	Quan sơn-Thanh hoá	20.25	0.0004	58.5	-210.928	2.16	-207.8	-78.6	5	177.3	43.3	1.9E-16	0
5	Pắc miều-Cao bằng	22.9	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.0370568028
6	Vietmindo-Q.Ninh	21.12	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.0032488554
7	Na hang-Tuyên quang	22.5	0.119	58.5	-210.928	0.28	-216.8	-78.6	5	177.3	34.1	3E-07	-6.74E-09
8	Mèo vạc -Hà Giang	23.15	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-4.69E-14
9	Điện biên-Lai châu	21.25	0.0004	58.5	-210.928	2.16	-207.8	-78.6	5	177.3	43.3	1.9E-16	0
10	Mường lay-Lai châu	21.45	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.0034186653
11	HMF -Việt trì	21.17	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.0029359982
12	HMF-Sơn la	21.2	0.119	58.5	-210.928	0.28	-216.8	-78.6	5	177.3	34.1	3E-07	-1.27E-09
13	HMF-4DTT-Hà nội	21.01	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-2.27E-15
14	HMF-144LHP-Vinh	18.4	0.0004	58.5	-210.928	2.16	-207.8	-78.6	5	177.3	43.3	1.9E-16	0
15	HMF-Phù liễn-HP	20.48	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.028720336
16	Tate&Lyte-QH-Ng.An	19.2	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.0941197479
17	VOV-39Bt-HN	21.01	0.119	58.5	-210.928	0.28	-216.8	-78.6	5	177.3	34.1	3E-07	-1.60E-09
	Trung tâm 2												
1	Trường sa1-Kh.hoà	8.38	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.1267410444
2	Trường sa2-Kh.hoà	8.38	0.119	58.5	-210.928	0.28	-216.8	-78.6	5	177.3	34.1	3E-07	-5.50E-08
3	Phú quý-Bình thuận	10.32	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-9.57E-14
4	Phú quý 1-Bình thuận	10.32	0.0004	58.5	-210.928	2.16	-207.8	-78.6	5	177.3	43.3	1.9E-16	0
5	VOV-7NTMK-Tp HCM	10.47	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.0331483396
6	VOV-Ô môn-Cần thơ	10.05	0.119	58.5	-210.928	0.28	-216.8	-78.6	5	177.3	34.1	3E-07	-1.05E-09
7	Petro.Ca.-DH-TpHCM	8.29	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-5.98E-15
8	Dami-Hàm th-B.thuận	8.4	0.0004	58.5	-210.928	2.16	-207.8	-78.6	5	177.3	43.3	1.9E-16	0

9	Ma.Motor-KCN2-B.hoà	10.49	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.033876271
10	Dhnl-KCX-TT-B.hoà	10.45	0.119	58.5	-210.928	0.28	-218.8	-78.6	5	177.3	34.1	3E-07	-1.30E-08
11	Pouchen- Biên hoà	10.55	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-2.93E-14
12	A sixay-TTđồng-B.hoà	10.45	0.0004	58.5	-210.928	2.16	-207.6	-78.6	5	177.3	43.3	1.9E-16	0
13	HMF-NTMK-TpHCM	10.49	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.033876271
14	HMF-TrNKV-Đànẵng	16.2	0.119	58.5	-210.928	0.28	-218.8	-78.6	5	177.3	34.1	3E-07	-1.14E-08
15	HMF-Pasteur N.trang	12.15	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-2.48E-14
16	HMF-Hvương-Pleiku	13.59	0.0004	58.5	-210.928	2.16	-207.6	-78.6	5	177.3	43.3	1.9E-16	0
17	SamsungLH-BàrịaVT	10.23	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-2.931802694
18	Cônđảo-Bàrịa-VTàu	10.21	0.119	58.5	-210.928	0.28	-218.8	-78.6	5	177.3	34.1	3E-07	-2.22E-09
19	DonaVictor-ĐA-Đnai	10.55	0.029	58.5	-210.928	1	-210.9	-78.6	5	177.3	40.0	4.3E-13	-2.93E-14
20	Pouyuan-BC-TpHCM	10.47	0.0004	58.5	-210.928	2.16	-207.6	-78.6	5	177.3	43.3	1.9E-16	0
	Trung tâm 3												
1	Tà rụt-Quảng Trị	16.29.55	0.87	58.5	-210.928	0.06	-223.1	-78.6	5	177.3	27.8	0.7063	-0.025491092

TABLE 2

Calculation of probability that any one of the satellites in a constellation is inside the area which ona spherical surface of LEO For VSAT network of VTI

Satellite system creating the interference – i
Satellite system subjected to the interference – w.

TT	Earth Stations	Latitude of E/S (deg.)	Long. of E/S (deg.)	Elevation of E/S (deg.)	Azimuth of E/S (deg.)	Avoidance angle of side lobe area								Latitude of the area		Area	Prob.	
		Lo	E	ε	A	φ	K	Φs1	Φs2	ΔΦs	β	Φs	Δφi	L	α	A	P	Pi
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Area 1																	
1	Kỳ anh-HTĩnh	18.34	105.16	67.85	196.04	0.706299383	0.01	-65.89	-67.15	-1.28328	0.635	-66.519	0.06	1.0259	1.893	-0.06	-0.000	-0.297345089
2	Bắc tạc.C. Bg	22.9	105.66	67.85	193.16	3.03E-07	0.01	-66.53	-66.53	-5.4E-07	0.635	-66.525	0.061	0.7575	1.797	-3E-08	-2E-09	-5.50998E-08
3	Mường lát.T. hoá	20.0	106.66	65.52	191.09	4.27E-13	0.01	-63.13	-63.13	-2.1E-13	0.635	-63.134	0.013	1.1091	2.026	-2E-15	-3E-16	-1.35018E-14
4	Quỳnh lưu.T.hoá	20.25	104.9	65.74	192.68	1.85E-16	0.01	-63.26	-63.26	0	0.635	-63.262	0.015	1.1979	2.035	0	0	0
5	Phố mới.C.B	22.9	105.66	62.85	193.16	0.706299383	0.01	-61.8	-62.49	-0.69088	0.635	-62.142	0.022	-0.6305	1.774	-0.012	-8E-06	-0.037609920
6	Việtnhật.Q.N	21.12	106.77	64.26	196.97	0.706299383	0.01	-62.73	-62.87	-0.14094	0.635	-62.802	0.007	0.8862	1.822	-8E-04	-1E-05	-0.003248504
7	Hà trung.T.Gg	22.0	105.57	63.06	193.06	3.03E-07	0.01	-62.4	-62.4	-2.1E-07	0.635	-62.298	0.015	-0.2983	1.749	-3E-09	-1E-10	-3.74114E-09
8	Mèo vạc .H.Gg	23.15	106.4	62.26	192.31	4.27E-13	0.01	-61.09	-61.09	-5.5E-13	0.635	-61.095	0.007	-0.0042	1.735	-2E-14	-1E-15	-4.60507E-14
9	Điện biên.L.C	21.35	103.35	64.93	187.6	1.85E-16	0.01	-62.94	-62.94	0	0.635	-62.94	0.007	0.005	1.808	0	0	0
10	Mường lay.L.C	21.45	103.5	64.93	187.6	0.706299383	0.01	-62.87	-63.04	-0.17282	0.635	-62.963	0.008	0.6132	1.771	-0.001	-1E-05	-0.003415093
11	HMF .Việt trì	21.17	105.26	64.46	193.38	0.706299383	0.01	-62.77	-62.91	-0.13536	0.635	-62.844	0.007	0.8231	1.813	-8E-04	-6E-05	-0.002958982
12	HMF.Sơn la	21.2	103.54	64.73	189.28	3.03E-07	0.01	-62.9	-62.9	-6.2E-08	0.635	-62.896	0.007	0.8303	1.816	-3E-10	-3E-11	-1.27613E-09
13	HMF.45TT.HN	21.01	105.51	64.85	194.94	4.27E-13	0.01	-62.88	-62.88	-8.5E-14	0.635	-62.88	0.007	1.0265	1.892	-5E-16	-5E-17	-2.25098E-15
14	HMF.Vinh	18.4	105.4	67.32	195.79	1.85E-16	0.01	-65.09	-65.09	0	0.635	-65.086	0.052	0.2237	1.739	0	0	0
15	HMF.HPhg	20.48	106.38	63.6	196.15	0.706299383	0.01	-62.51	-62.74	-0.2314	0.635	-62.626	0.01	1.3405	2.369	-0.002	-6E-04	-0.028120306
16	TdsaBLyen.HA	18.2	105.1	66.2	193.8	0.706299383	0.01	-63.43	-64.4	-0.96815	0.635	-63.917	0.033	-0.2082	1.743	-0.025	-0.001	-0.064197479
17	VOV.39Bà.HN	21.01	105.51	64.85	194.94	3.03E-07	0.8	-62.88	-62.88	-6E-08	0.635	-62.88	0.007	1.0265	1.892	-3E-10	-3E-11	-1.63118E-09
	Area 2																	
1	Trường sa1.KH	8.38	111.55	73.2	232.4	7.06E-01	0.01	-70.84	-71.16	-1.22298	0.635	-71.15	0.053	-0.116	1.736	-0.001	-0.003	-0.128161944
2	Trường sa2.KH	8.38	111.55	73.2	232.4	3.03E-07	0.01	-71.13	-71.13	-5.3E-07	0.635	-71.134	0.054	-0.1015	1.735	-2E-09	-1E-09	-5.23445E-08
3	Phú quý.B.th	10.32	108.56	74.2	219	4.27E-13	0.01	-72.93	-72.93	-7.7E-13	0.635	-72.928	0.06	0.2916	1.747	-4E-14	-2E-15	-8.07126E-14
4	Phú quý 1.B.th	10.32	108.56	74.2	219	1.85E-16	0.01	-72.93	-72.93	0	0.635	-72.928	0.06	0.2916	1.747	0	0	0
5	VOV.HCM	10.47	106.41	75.4	210.1	7.06E-01	0.01	-74.34	-75.06	-0.70477	0.635	-74.692	0.023	-0.2646	1.745	-0.013	-1E-06	-0.033146596
6	VOV.Ômôn.CT	10.08	105.34	76.7	226.7	3.03E-07	0.01	-75.35	-75.35	-6.1E-08	0.635	-75.348	0.007	-0.8462	1.765	-3E-10	-2E-11	-1.03696E-09
7	Petro.Co..HCM	8.29	105.4	76.2	224.2	4.27E-13	0.01	-75.23	-75.23	-1.3E-13	0.635	-75.227	0.009	1.1702	2.008	-9E-16	-1E-16	-5.57501E-15
8	Bình.B.th	8.4	105.2	77.7	214.1	1.85E-16	0.01	-75.06	-75.06	0	0.635	-75.058	0.008	1.1614	1.993	0	0	0
9	Ma.Motor.B.H	10.49	106.29	75.4	209.9	7.06E-01	0.01	-74.34	-75.06	-0.70477	0.635	-74.692	0.023	-0.4157	1.75	-0.013	-1E-06	-0.033876271
10	Dhnl.KCX.B.H	10.45	106.44	75.4	210.4	3.03E-07	0.01	-74.77	-74.77	-3E-07	0.635	-74.772	0.02	-0.4009	1.749	-5E-09	-3E-10	-1.29618E-08
11	Pouchen. B.H	10.55	106.46	75.2	210.1	4.27E-13	0.01	-74.55	-74.55	-5.4E-13	0.635	-74.548	0.027	-0.2981	1.742	-1E-14	-6E-16	-2.93434E-14
12	A sixay.B.H	10.45	106.44	75.4	210.4	1.85E-16	0.01	-74.77	-74.77	0	0.635	-74.772	0.02	-0.4009	1.749	0	0	0
13	HMF.HCM	10.49	106.4	75.4	209.9	7.06E-01	0.01	-74.34	-75.06	-0.70477	0.635	-74.692	0.023	-0.4157	1.75	-0.013	-1E-06	-0.033876271
14	HMF.ĐNG	16.2	108.12	69.2	206.1	3.03E-07	0.01	-68.57	-68.57	-2.7E-07	0.635	-68.568	0.018	-0.5026	1.767	-4E-09	-2E-10	-1.13677E-08
15	HMF.Pas.Ntr	12.15	109.12	72.4	215.8	4.27E-13	0.01	-69.9	-69.9	-5.1E-13	0.635	-69.9	0.025	0.0793	1.735	-1E-14	-5E-16	-2.47612E-14
16	HMF.Pleiku	13.59	108	71.4	208.6	1.85E-16	0.01	-69.27	-69.27	0	0.635	-69.27	0.008	0.5552	1.859	0	0	0
17	Samsung.VTàu	10.23	107	75.4	212.4	7.06E-01	0.01	-74.34	-75.06	-0.70477	0.635	-74.692	0.023	-1.4067	2.018	-0.013	-0.001	-2.931802694
18	Cônđảo.VTàu	10.21	106.35	76.2	208.6	3.03E-07	0.01	-75.23	-75.23	-6E-08	0.635	-75.227	0.009	-0.8262	1.813	-6E-10	-5E-11	-2.21627E-09
19	DonaVictor.Đnai	10.55	106.46	75.2	210.1	4.27E-13	0.01	-74.55	-74.55	-5.4E-13	0.635	-74.548	0.027	-0.2981	1.742	-1E-14	-6E-16	-2.93434E-14
20	Pouyuan.HCM	10.47	106.41	75.4	210.1	1.85E-16	0.01	-74.77	-74.77	0	0.635	-74.772	0.02	-0.4435	1.752	0	0	0
	Area 3																	
1	Tà rụt.Quảng Trị	16.3	107.06.04	69.2	200.3	0.706299383	0.01	-68.17	-69.01	-0.8335	0.635	-68.489	0.021	-0.1516	1.735	-0.01	-5E-06	-0.025491092

5. Conclusion

This report may be used for estimating interference from LEO MSS feeder downlink into GSO VSAT systems co-frequency operating in the same direction. In this case, we choose proposed method to estimate interference from Globalstar LEO MSS feeder downlink into GSO VSAT system of VTI co-frequency operating in the same direction. Time percentage values calculated at Step 3 are compared with acceptable values (e.g. those given in Table 1-column 4). The calculated value of time percentage $\% \, t(\varphi)_m$ (those given in Table 1-column 14)does not exceed a specified $\% \, t_m$ then the interference, which from Globalstar satellites into VSAT earth stations of VTI, is acceptable (based on the criteria used).

References

[1]. Đặng Quang Hiệu, Lê Anh Dũng, 'A calculating methog to design earth stations and the satellite communication network - VSAT', DGPT - Posts and Telecoms Journal. *Special issue: Research and Development on Telecoms and Information Technology, Chuyen san [2]/12-1999.*

[2]. 'Reference radiation patterns for line-of-sight radio-relay system antennas for use in coordination studies and interference assessment in the frequency range from 1 to about 40 GHz', *Recommendation ITU-R F.699.*

[3]. 'Determination of the criteria to protect fixed service receivers from the emissions of the space stations operating in Non-Geostationary orbits in shared frequency band', *Recommendation ITU-R F.1108-2*.

[4]. Nguyen Luu Binh*, HXN, THQ, NBL, 'Procedure to Determine the Visibility of Space Stations Operating in Circular Low Earth Orbit System (LEO) as Seen by a Fixed Terrestrial Station (FS) in Vietnam', DGPT - Posts and Telecoms Journal. *Special issue: Research and Development on Telecoms and Information Technology, Chuyen san [3]/6-2000.*

[5]. 'Analytical method to calculate visibility statistics for non-geostationary satellite orbit satellite as seen from a point on the earth's surface', *Recommendation ITU-R S.1257.*

AUTHOR BIOGRAPHY

Full name: **NGUYEN LUU BINH**
Birthday: March 1st, 1960
Birthplace: Nghe An province, Vietnam
Present rank: Deputy Chief of Division, VTI
Graduated degree: B.E. degree in telecommunications engineering from Post and Telecommunications University, Vietnam in 1983
He has completed postgraduate program, Electronic-Telecommunication brand, and period of study from May 1997 to June 1999.
Affiliation: Vietnam Telecom International Company, Vietnam Post and Telecom Corporation
Current research interests: Satellite Communications, Interference
Postgraduate work: He is now working towards the Doctor degree in Telecom- Electron Department, Vietnam Post and Telecom Institute of Technology.