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The Mechanism of Deliberate Jamming On the Broadcast Satellite Service.

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ABSTRACT

A direct broadcast satellite is making maximum efforts to transmission the TV signal from the source to the receiving in the small home earth stations, especially the important events of a widespread public demand. The power and the nature of the television signal affected by losses resulting from the length of the path and the natural noise , thus the signal's loss part of its power at the reception, but the most influential is the possibility of deliberate jamming, thus the signal of reception has loosed completely. So we are in this research analysis of the technical side to transmit the signal from the Earth station to the satellite, which is the line upward and then receive that signal and processed by machines effector inside the satellite and re-sent as a line downward to the receiving stations. The statement of the impact of deliberate jamming on that process by attacking the line upward by the largest power after the completion of the integrated analysis the original signal using sophisticated of high technology equipment. Based on that, we can see the statement of the used method to deliberate jamming on satellite's channels and methods of prevention ,then it used the simulation program (MATLAB) according to the laws relating to communication satellites, taking into account the latitude and longitude and geographic location of ground stations, satellites, sending and receiving. The results were important and productive because they determine the ability and nature of the signal for a private reception with deferent effects.

Introduction

A power's budget is the ability of the signal sent from Terrestrial Source (T.S.) to the ground station for each recipient (Single Function Stations), which is determined signal transmission path starting from the ground station and then sent to the satellite placed on coverage areas , that has the duty of receiving and re-send the signal by respondent transponder, but in the case of absence a satellite's joint coverage between countries, so will be used for communication between satellites [Intersatellite-link (ISL)] to transmit the signal for covering each region Figure 1 this meaning to use of technical work of satellites as a cooperative (Satellite Constellation) and this will lead to add space to the general path distance between the satellites [1].The expense of loss of track (Free-Space Path Loss) and profits of the antennas have a main role in determining the power of the reception and transmission, this also requires determining the value of power sent from the ground station [Effective Isotropic Radiated Power from Earth station toward Satellite. (EIRPu)]and later can determine the power of signal received at the satellite [The power of signal received at the satellite from Earth station (PRsat)] . The purposes of direct transfer of the events , which is in orbits geographical fixed for the site ground a certain Geostationary Satellites which means that their

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position relative to the longitudinal variable, but the latitude constant (00) , that is they revolve around the equator, so to know that is very important because the account is greatly affected by geographic location , latitude and longitude. The jamming of satellite channels, especially during direct transport of the events (the World Cup for example) is an act of sabotage, carried out by others, using the complex devices, it is made by sending a signal [Effective Isotropic Radiated Power from jammed Earth station toward Satellite (EIRPj)] more strongly to the satellite (EIRPj>EIRPu) on the orbit, its own from anywhere within the coverage area[2].

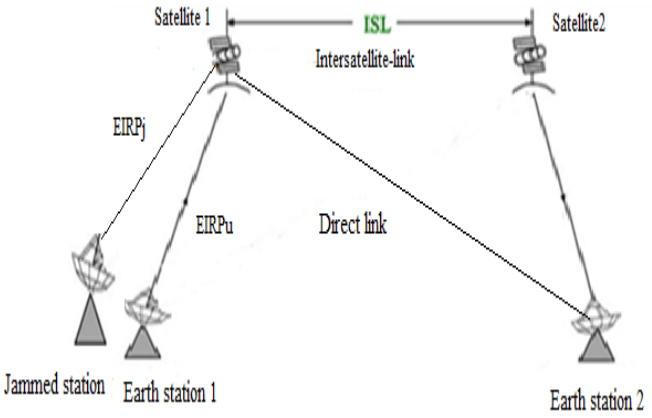

Figure1. Dimensional distance between satellite and fixed earth stations[1].

Geostationary Earth Orbit(GEO)

A geostationary orbit is a circular orbit in the equatorial plane with zero eccentricity and zero inclination. The satellite remains fixed (stationary) in an apparent position relative to the earth; about 35784 km away from the earth if its elevation angle is orthogonal (90^0) to the equator. Its period of revolution is synchronized with that of the earth in space. The amount of coverage is an important feature in the design of earth observation satellites. Coverage depends on altitude and look angles of the equipment, among several factors [3].

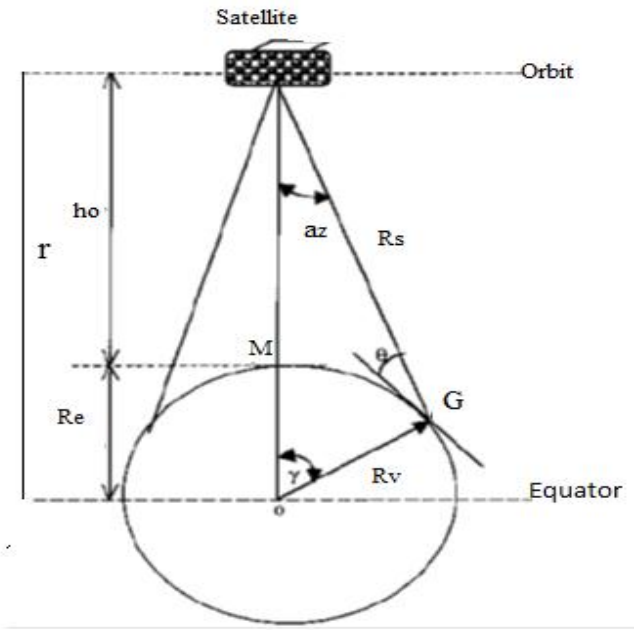

Figure 2. An illustration of coverage area and apex angle[3].

Refer tofigure 2 the parameters are following :
Rv =OG = geocentric radius of earth at G latitude
Θ = elevation angle of satellite from the earth station.
M= location of subsatellite point. This location's longitude and latitude are determined from a satellite ephemeris table. Nominally, latitude is taken as 0^0 for geostationary satellite.

γ = central angle, α = azimuth angle .
r = radius of the orbit = OM + MS= $R_e + h_0$.
The maximum geometric coverage can then be defined as the portion of the earth within a cone of the satellite at its apex, which is tangential to the earth's surface. The view angle has a mathematical physical function given by ; Degree(1) Using values (Re = 6378 km, r= 42162 km), the apex angle 2α equals $17{:}33^0$, the planar angle beamwidth. It follows that an ''earth coverage'' satellite antenna must have a minimum beamwidth $\Theta_{BW}$of $17{:}33^0$. The beamwidth of the satellite antennas determines the area of the earth serviced or covered.

Using the notations in Fig. 2 as a guide, the coverage area A_{cov} from which the satellite is visible with an elevation angle of at least Θ can be established as:

$A_{cov} = 2\pi R_e^2(1-\cos\gamma)$ square kilo meter (2)

By considering the geometry of the geosatellite's orbit, we will be able to calculate.

1. The distance between the satellite and earth station, called the slant range, Rs.
2. The azimuth and elevation angles, collectively called the look angles.

Using the spherical trigonometric relations, we determined the central angle from:

$\gamma = \cos^{-1}(\sin L_{SAT}\sin L_{ET} + \cos L_{SAT}\cos L_{ET}\cos\Delta)$ degree(3)

L_{ET} = latitude of the earth station. This value is positive for latitudes in the Northern Hemisphere (i.e., north of the equator) and negative for the Southern Hemisphere (i.e., south of the equator).

$\alpha = \sin^{-1}\left(\frac{R_e}{h_0+R_e}\right) = \sin^{-1}\left(\frac{R_e}{r}\right)$

L_{SAT} = latitude of the satellite.
Δ = difference in longitude between the earth station and the satellite.
Using cosine law, we find the slant range equation to be:

$R_s = \sqrt{R_e^2 + r^2 - 2rR_e\cos\gamma}$ kilo meter (4)

The elevation angle Θ may be written as:

$$\theta = \tan^{-1}\left(\frac{\cos\Delta\cos L_{ET} - (R_e/r)}{\sqrt{1-\cos^2\Delta\cos^2 L_{ET}}}\right)$$ degree(5)

and the azimuth angle is

$$a_z = 180 + \tan^{-1}\left(\frac{\tan\Delta}{\sin L_{ET}}\right)$$ degree(6)

For the Southern Hemisphere azimuth angle, the 180-term is deleted[3].

Transponders

Each satellite has a number of transponders (receiver-to-transmitter) aboard to amplify the received signal from the uplink and then to convert the signal for transmission on the downlink. That is why it is easier to jam the uplink signal, these transponders perform a signal processing as a high power gain down converter, using a traveling wave tube amplifier (HPA) . Most transponders are designed for a bandwidth of 72 MHz., being the standard use for the 14,5/11,8 GHz television relay service. Satellite communication systems do differ from terrestrial microwave links in the techniques used for multiple access of a single transponder by multiple uplink and multiple downlink stations [4].

Jamming

The jamming is the (usually deliberate) transmission of radiosignals that disrupt communications by decreasing the signal to noise ratio. Originally the terms were used interchangeably but most radio users use this term (jamming) to describe the deliberate use of radio noise or signals in an attempt to disrupt communications (or prevent listening to broadcasts) whereas the term "interference" is used to describe unintentional forms of disruption. For communications to the polar regions of the Earth, satellites in polar orbits are used, which require Earth stations with tracking antennas[5]. The Ku band satellites use 14.5GHz on the uplink and(10.7- 11.8 GHz) on the downlink with orbital spacing of 3 degrees. Some new Ku band satellites have High Power Amplifiers (HPA) that feed 120 to 240 Watts into their transmitting antenna, as compared with 20 to 40 Watts for low-or medium-power satellites. High power satellites called Direct Broadcast Satellites (DBS) [6], provide TV service directly to the homeowner that has a small receiving antenna (1.5 m or less in diameter) . The jamming is an act of sabotage carried out by others, through the devices are complex , and are made by sending a signal more strongly through the (HPA) to the satellite

in orbit (EIRPj>EIRPu) and can anyone do so from any location covered by the geographical area of the satellite because the satellite receives frequency tags from any location via a force larger, it does not matter where it comes from him the signal. The group hackers receive the original channel by Low Noise Converter (LNC) ,then search for the particular reference frequency and work on the analysis of public information for the channel to be jammed by devices which can be complicated to know what type of encryption and modulation and thus create a new channel on the same frequency and with greater power for the purpose of preventing the channel from the original access to users(Figure 3), alternative to attacking force is greater than the load signal from the source ground to the satellite's channel so it is reserved frequencies floor of each group or a bouquet of channels[7].

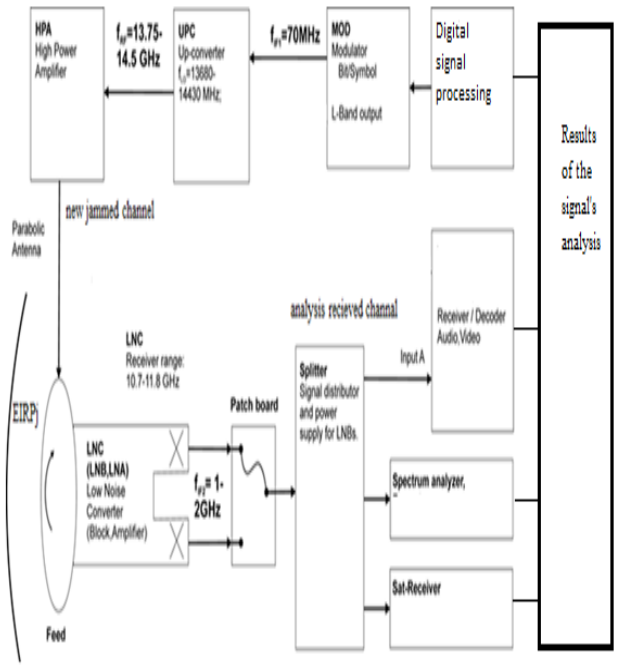

Figure 3.The block diagram for the jamming by the analysis of received signal[7].

Satellite news gathering (SNG) is a broadcasting (usually television), it can mean anything from a lone broadcast journalistreporter taking a single professional video camera out to shoot a story, to an entire television crew taking a production truck or satellite truck on location to do a live televisionnews report for a remote broadcastnewscast. Figure 4 shows the equipment required for the process jamming uses collecting news (SNG), what a team of any channel by carrying the equipment and move to the locations under the coverage area via satellite ,then send them new jammed channel [8].

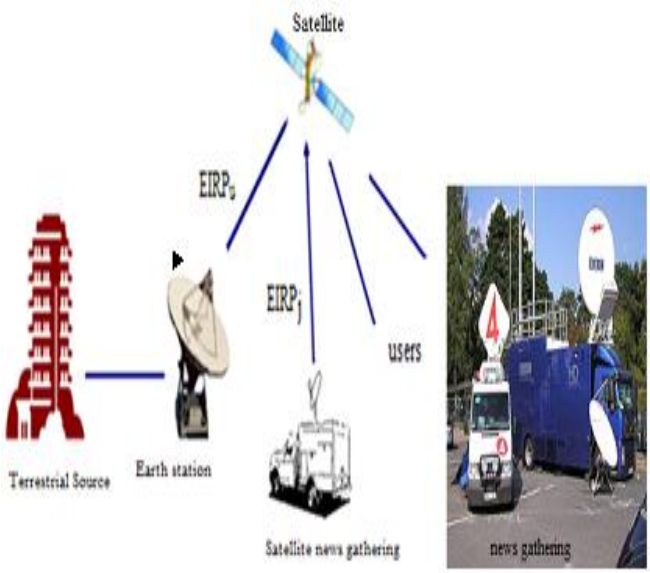

Figure 4.The method of jamming by using Satellite news gathering [8].

The up-link power budget from the Earth station toward satellites Nile sat , Bader and Hot bird:

Accounts, the power of the up- link is very important because the jamming depends on increasing the power of the up- link over the amount of the original signal to be jammed, so it will work of the satellites mission in the Middle East and Europe.

Ability to receive the ascending line of relations:

$$P_{Rsat} = EIRP_u - L_{PU} - AU + G_{RU} \quad (7)$$

P_{Rsat} as the reception power of the satellite, G_{RU} which the antenna gain, L_{PU} the path loss, A_U other losses and weather conditions , $EIRP_u$ transmission power (including transmission power and ground station

antenna gain its own). Antenna gain can be calculated in the satellite receiver as a rate equal to diameter (D=2 m).

$G_{RU} = 10 \log \pi^2 (D / \lambda)^2$ dB (8)
$\lambda = C / F$
$\lambda = 3.10^8 / 14.5\ 10^9 = 0.02$ m
$G_{RU} = 4\pi A / \lambda^2 = \pi^2 (D / \lambda)^2$

$G_{RU} = \pi^2 (2/0.02)^2 = 98596$
$G_{RU} = 10 \log 98596 = 50$ dB

To calculate the path loss (free space path loss) we adopt the following equation in the KU band (14.5 GHz) [9]:
$L_{PU} = (4\pi R / \lambda)^2$(9)
$L_{PU} = (4\pi R / 0.02)^2$
$L_{PU} = 20 \text{ Log } (4\pi R / 0.02)$
$P_{Rsat} = \text{EIRPu-[20 Log } (4\pi R / 0.02) + Au] +50$

Will adopt the average of the latitude and longitude of the western regions of Asia and southern Europe, with the amount of (° 30 ° N 30 E), yields by equations (3.4) we can calculate the length of Up-link distance for each satellite , as follows:

a. Nilesat: (7^0 W):
$\Delta = 7 + 30 = 37^0$
$\gamma = \cos^{-1} (\sin 0 \sin 30 + \cos 0 \cos 30 \cos 37) = 46^0$

$Rs = \sqrt{6378^2 + 42162^2 - 6378.42162.2. \text{ Cos } 46} = 38009$ Km (delay time equals 127 ms)

$P_{RNIL} = \text{EIRPu-[20 Log } (4\pi\ 38009.10^3 / 0.02) + Au] +50$

The rate value of (Au) in the Middle East accounted for 20 dB and the highest in Europe to reach the rate of 25 dB because of the high absorption resulting from the rain.

$P_{RNIL} = \text{EIRPu-[205,7+20]+50 = EIRPu-175,7 dB}$

b. Hot Bird: (13^0 E):
$\Delta = 13\text{-}30 = 170$, $\gamma = 340$, Rs = 37052 KM (delay time equals 123 ms)
$P_{RHOT} = \text{EIRPu-[20 Log } (4\pi\ 37052\ .10^3 / 0.02) + Au] +50$

$P_{RHOT} = \text{EIRPu-[205,6 +25] +50 = EIRPu-180,6 dB}$

c. Bader: (26^0 E):
$\Delta = 26\text{-}30 = 40$, $\gamma = 30.20$, Rs = 36792 KM (delay time equals 122 ms)

$P_{RB} = \text{EIRPu-[20 Log } (4\pi 36792.10^3 / 0.02) + Au] +50$

$P_{RB} = \text{EIRPu-[205,4+20]+50 = EIRPu-175,4 dB}$

To prevent the jamming must be the value of (EIRPu) is greater than any signal on the same frequency[10].

Matlabevolution

Accounts that were previously shown affected the power with band frequency, antenna gain and loss of the path that increases with the distance traveled to the transmitted signal, so the dimensions and signal's frequency between the transmitter and receiver have a major impact on the ability of the signal, so by using a simulation program (MATLAB) according to the equations themselves we can show the correct and matching previous calculations performed with the results obtained[11].

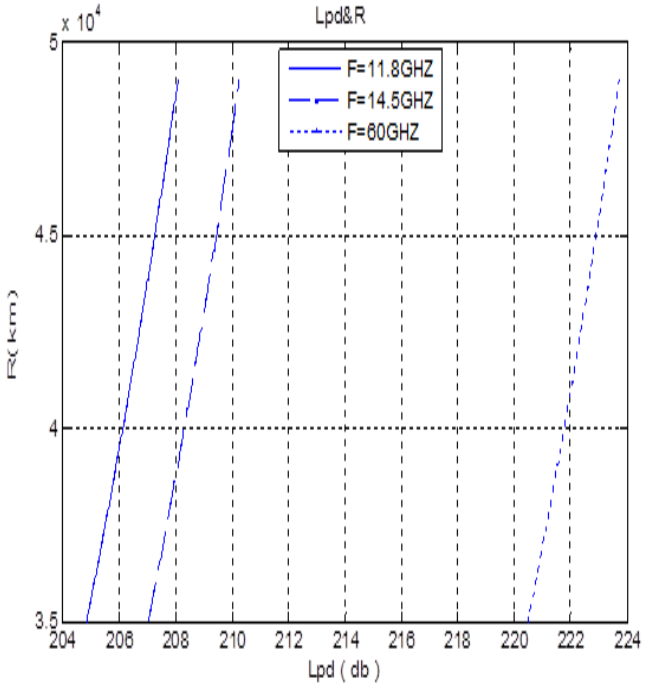

Figure 5.The relationship between path loss and traveled distance .

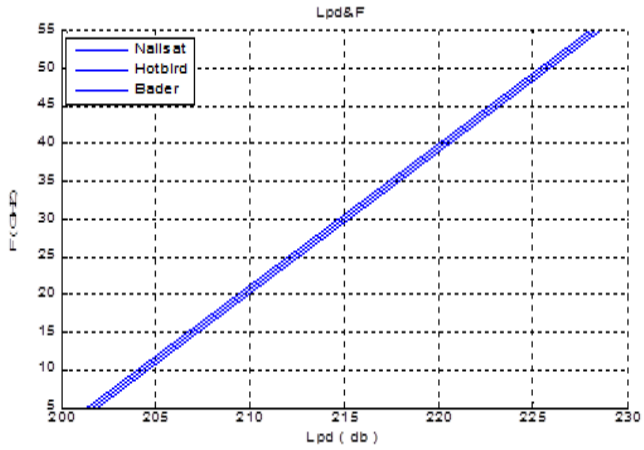

Figure 6. The relationship between the path loss factor and frequency of the up-link distance for satellites (Nile sat, Hot bird, Bader).

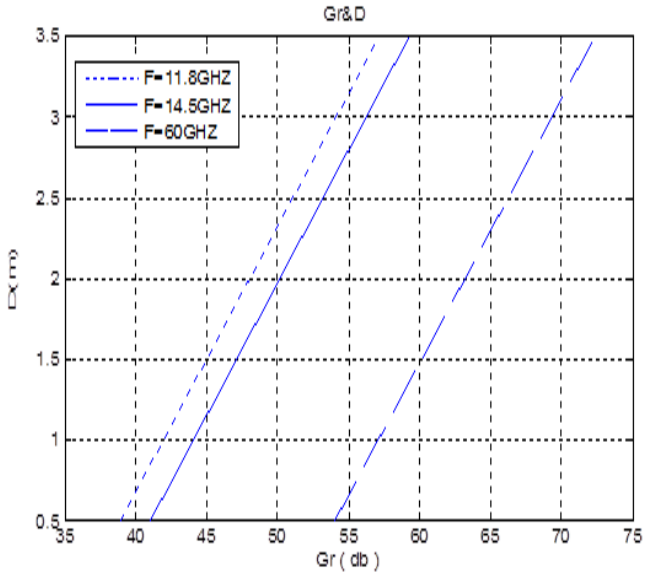

Figure 7. The relationship between antenna's diameter and gain of different frequencies .

Discussion & Results

The broadcast of signal transduction TV via satellite requires specifying the path most suitable for areas of coverage between both sides of the transmission and reception to ensure there is sufficient power to refer to access to the user without losing much of it through various types of losses the ability resulting mainly from the length of distance traveled and the amount of wavelength coming from the frequency factor, and the length of the path will lead to increased delay time for the arrival of the signal from the source to the receiver , according to the search results, the satellites that cover the regions of the Middle East and Europe (Nilesat, Hot Bird, Bader and also includes other satellites operating between them with the same orbit)[12]. From the foregoing that the reference vectors can be exposed to the risk of deliberate jamming , as happened in the World Cup the previous (2010, South Africa) , so it is supposed to take control measures and control the power transmitted effective isotropic radiated power (EIRPu> 175 dB toward Nilesat& Bader, EIRPu> 180 dB toward Hot Bird). The corporate monopoly of the broadcasting rights must take preventive measures and the corresponding electronic equipment to ensure that the power in the receiver any ground household stations (Single function stations) is comfortable , but when the satellite receive another (P_{Rsat}) from (EIRPj>EIRPu) ,this cause a nuisance to the receiving operator (jamming) . The reason for the use of jamming is political and sometimes because of commercial competition, especially in the direct transport's events. The process of being confusion often car mobile (SNG) has equipment of high technology can achieve the process of jamming and broadcast toward the satellite through the antenna is moving at the top of the car, after determining the geographical location and viewing angles(θ,α) within the satellite coverage area , the reason for using these cars are easy to navigate and escape from legal liability.Intentional communications jamming is usually aimed at radio signals to disrupt control of a channel. A transmitter, tuned to the same frequency as the opponents' receiving equipment and with the same type of modulation, can, with enough power, override any signal at the receiver. The most common types of this form of signal jamming are random noise, random

pulse, stepped tones, warbler, random keyed modulated CW, tone, rotary, pulse, spark, recorded sounds, gulls, and sweep-through[13].

Conclusions

Jamming illegal operation is used to prevent recipients from receiving channels to be jammed by sending another channel in the same frequency , with specifications of the largest power causes thus blocked and weaken that original channel, the purpose of jamming is to block out reception oftransmitted signals and to cause a nuisance to the receiving operator. To prevent jamming on the satellite broadcast service for radio or TV , must change the frequency on the spot, because it; change the carrier's frequency not change the signal of the voice and image, so it is based on two different frequencies, and must be adhered to international laws related to telecommunications ,in general should also increase power in a transmitter from the ground station (EIRPu).

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الية التشويش على خدمة بث الأقمار الصناعية

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الخلاصة

البث المباشر للإحداث عبر الأقمار الصناعية تؤمن نقلا للإشارةالتلفازية من المصدر إلى المستقبلين فيا لمحطات الأرضية المنزلية الصغيرة. القدرة وطبيعة هذه الإشارة تأثر بالخسائر الناتجة من طول المسار والضوضاء الطبيعية وبالتالي فقد انجز من قدرتها عند الاستقبال ،ولكن التأثير الاكثر سلبيا يكمن في التشويش المتعمد عليها وبالتالي فقدان الاشارة كليا في جهة الاستقبال .لذ اتم في هذا البحث تحليلال جانب التقني لنقل الإشارةا بتداء من المرسل الارضي الى القمر الصناعي والذي يتمثل بالخط الصاعد ومن ثم استقبال تلك الاشارة ومعالجتها بواسطة اجهزة المستجيب داخل القمر واعادة ارسالها كخط نازل إلى محطات الاستقبال الارضية المنزلية الصغيرة. أن التشويش المتعمد على تلك العملية تتم غالبا من خلال مهاجمة الخط الصاعد باستخدام قدرة اكبر لإشارة التشويش بعد انجاز عملية تحليل متكامل للإشارة الاصلية بواسطة اجهزة متطورة ذات تقنية عالية. وفقا لذلك تم في البحث بيان الاسلوب الاكثر استخداما في التشويش المتعمد على القنوات الفضائية وطرق الوقاية منه، ومن ثم محاكاة ذلك باستخدام برنامج ماتلاب وفقا للقوانين الخاصة باتصالات الأقمار الصناعية أخذين بنظر الاعتبار خطوط الطول والعرض والموقع الجغرافي للمحطات الأرضية والأقمارالصناعيةالمرسلة والمستقبلة وكانت النتائج مهمة ومثمرة لأنها تحدد قدرة وطبيعة الإشارة لجهة الاستقبال خاصة وتأثرها بعامل المسافة وخسائر المسار والتشويش المتعمد.