ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)

Satellite Auto-Acquisition Antenna System (SAAS)

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Abstract

We, through the medium of this thesis, propose to design and demonstrate a system that shall enable a dish antenna setup to be directly controlled by a computer (laptop or desktop PC) with minimal human intervention thus burring the traditional method of manual antenna installation into history. The computer shall take care of all the movements of the antenna terminal to enable it to locate the satellite under consideration and hence allow for establishing one-way/two-way communication link between the satellite and the ground terminal in speedy and efficient manner. Such a computer controlled antenna setup shall also play vital role in service sensitive communication links where downtimes are strictly undesirable.

Keywords

Essence, Proposed, satellite receiver.

I. Introduction

Effective, timely, speedy and long distance communication is crucial to the growth of modern day Industries, Defense, Research and Educational institutions and the Nation as a whole. Satellite communication is being used for a couple of decades now and has led to the development of various technologies, modulation schemes and hardware within the satellite communication field. Locating a satellite from a random site on the globe, peaking the signal level and regular maintenance of the antenna terminal is still cumbersome for field technicians, site engineers, and enterprises that heavily rely on satellite communication link, because of the complexity involved in the setup, size of the antenna and lack of knowledge with the common man who is not trained to work with satellite terminals.

II. Problem Description in existing system

Locating a satellite from a random site on the globe, peaking the signal level and regular maintenance of the antenna terminal is cumbersome for field technicians, site engineers, and enterprises that heavily rely on satellite communication link, because of the complexity involved in the setup size of the antenna and size of the satellite.

Let us apply a trigonometric approach for better understanding. Consider an observer at any point on the equator who wishes to receive a TV broadcast signal from a satellite that lies 36,000 Km above him. Now that is the nearest distance the satellite can be to an observer on Earth since he is standing on the equatorial line. Even the largest satellite would appear smaller than a needle point to the observer from such a large distance. More so, there are hundreds of satellites spread across the horizon, each one of them radiating their own RF power which is difficult to be identified for a particular service. Finding a satellite from such a great distance looking into the horizon spread over 360 degrees is like finding a needle in the desert.

Now consider an observer 4000 miles away from the equator; the problem just got worse. On the North Pole? Forget it! The conventional method of locating a satellite and establishing a communication link requires –

- highly skilled personnel
- a bag full of tools – compass , inclinometer, tilt meter, maps, etc
- complex calculations and intuitive sense of direction of the satellite
- manual movements of the antenna
- extra man-hours and man-power (larger the antenna, heavier the setup, narrower the beam-width, more difficulty in movements and hence more time & muscle consuming)

The problem then is, *to install and maintain a satellite receive terminal that would facilitate many industrial clients, government organizations and end-user customers to use its architecture and get their subscribed services 'online' uninterrupted, very quickly, inexpensively and with minimal effort and downtime.*

III. What is proposed?

In this thesis, a SATELLITE AUTO-ACQUISITION ANTENNA SYSTEM is proposed.

- take the minimum necessary inputs from the terminal operator
- locate the desired satellite based on the calculated azimuth and elevation relative to the terminal location on the globe (site Latitude and Longitude)
- lock the desired service on the satellite
- And finally establish one-way/two-way satellite communication link

IV. Essence

The essence of SAAAS* lays in the fact that it –

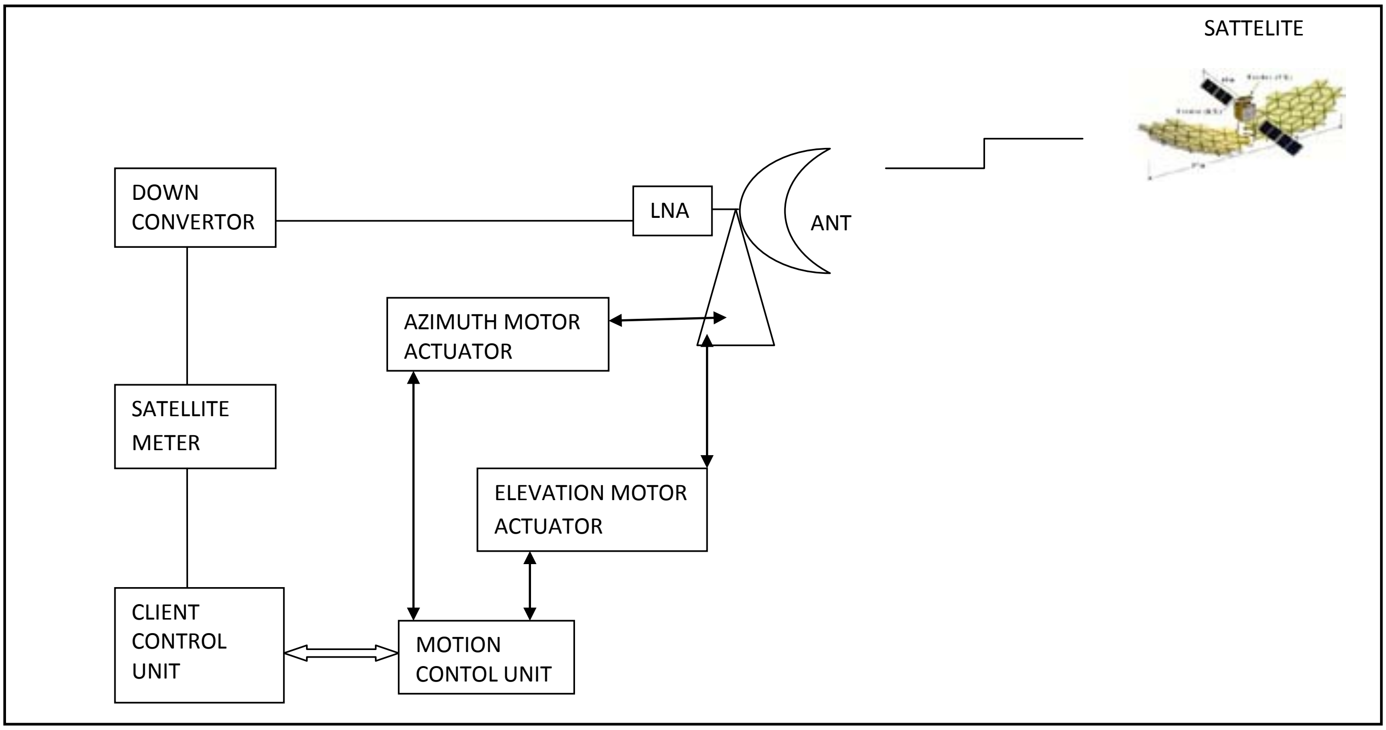
- does not require highly skilled personnel
- reduces the number of discrete components used on-site
- reduces dependency on the past experience of the operator
- saves man-hours can be extended to any size of antenna terminal
- reduces downtime losses of crucial enterprises (stock-exchange, railways, etc)
- helps in quick change-over of satellites without loss of critical time

* *Satellite auto-acquisition antenna system is referred to as SAAAS, henceforth*

- allows terminals to be mounted on mobile platforms and vehicles
- allows complex calculation and precise movements to be taken over by PC and stepper motors
- reduces imprecision introduced by human errors

V. Working Description

BLOCK DIAGRAM



VI. Hardware Kit

The client control unit board has been fitted within the cabinet of the satellite signal meter and common supply and ground connections has been made as shown in figure 6.4

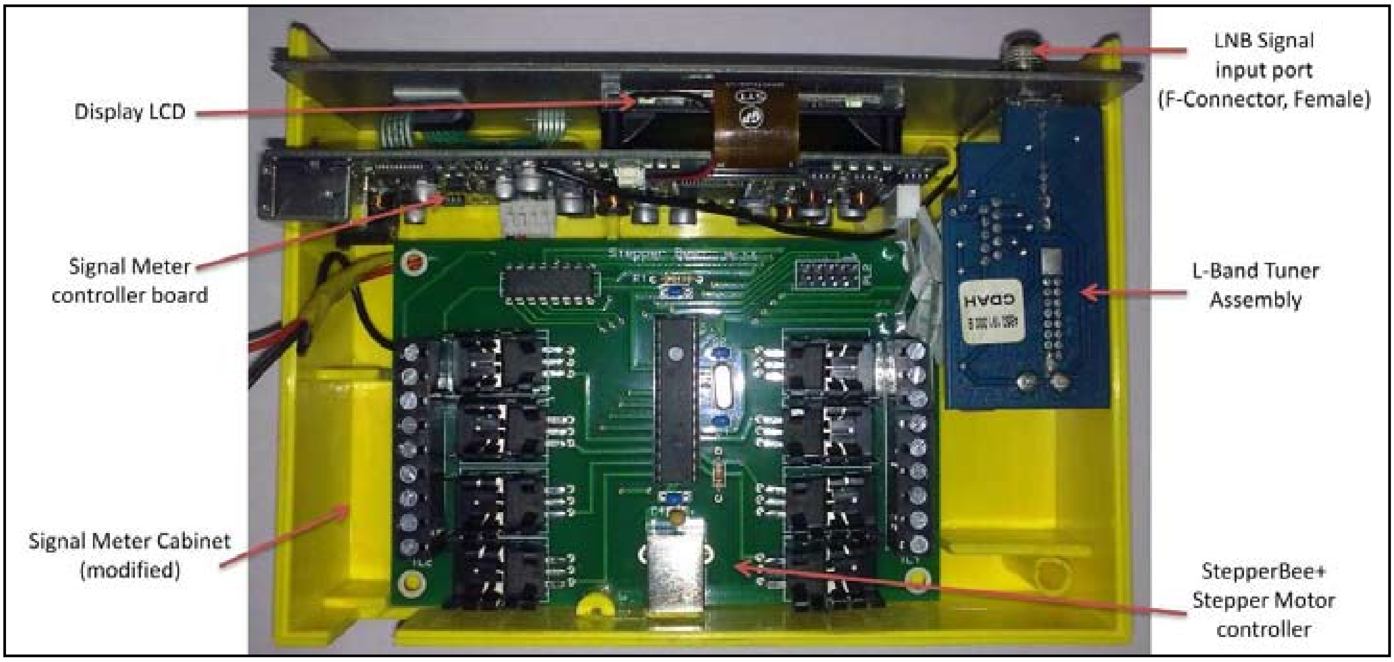


Fig. 6.1: satellite signal meter and client control board assembly in one cabinet

The wires of the stepper motors had been connected as shown in the connection diagram. The port TL2 controls motor 1 which has been selected to be the Azimuth motor and the port TL1 controls motor 2 which have been selected to be the Elevation motor.

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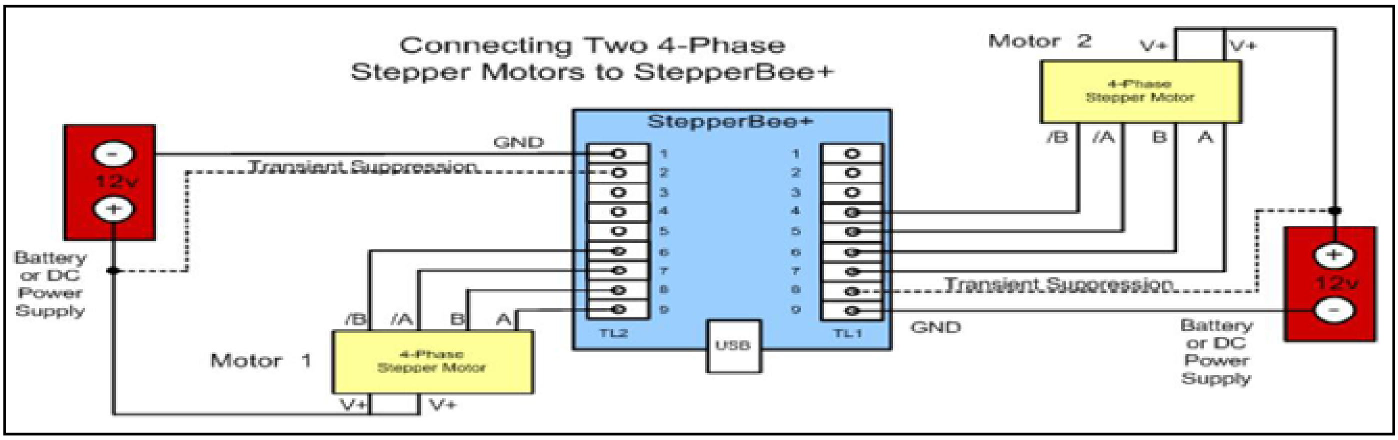


Fig. 6.2: Wiring diagram of stepper motors with control board

Two USB leads are used – one for interfacing StepperBee+ motor controller board and the other for interfacing the Signal meter – to the PC that runs the CIU (Satellite Auto-Acquisition Antenna System Control Interface) software.

Getting Started

To begin with, the SAAAS is placed facing magnetic North direction with both the motors in the resting position. Based on the requirements of the satellite to be located its orientation and transponder parameters are obtained from sources as – www.lyngsat.com , Cable Quest and SCaT (Satellite and cable TV) magazines or other sources on the web. Usually, the ISP, Service provider and technicians performing the antenna commissioning have ready available data with them. In our case, we shall refer to the details in the SCaT magazine or from Lyngsat website.

Example, the INSAT4A is located at 83°E which is being used by TataSky for its DTH broadcast.

The Latitude and Longitude of the site where the antenna is located may be obtained from Google maps and GPS devices. The following details are now required to be fed into the SAAAS CIU –

- Site Longitude
- Site Latitude
- Satellite Longitude

– as shown in figure 6.7

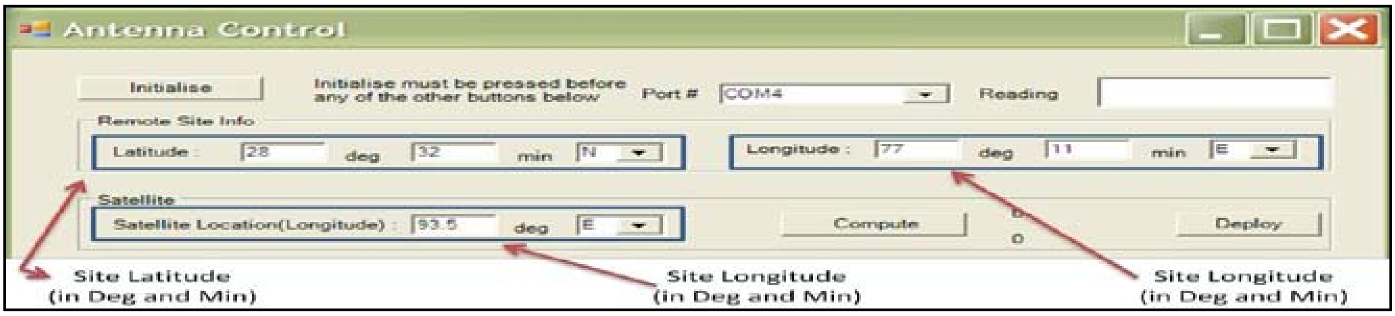


Fig. 6.3: Client Interface Unit taking user inputs

The Signal meter is fed with the transponder details as made available from the website or magazine.Once the details have been fed in by the user on CIU window and the signal meter, press the deploy button and the SAAAS will start auto-acquisition of the desired satellite. The signal meter will parallel monitor the signal status from the satellite.

Software Functioning & Algorithm

When the 'Deploy' button on the CIU is pressed, the software calculates the required Azimuth and Elevation. The value of Azimuth and Elevation are then apparently converted into Motor step movements. In our design, we have calculated motor steps as follows;

Motor1 (Azimuth motor) steps = Azimuth x 1 --equn.1

Motor2 (Elevation Motor) steps = Elevation x 1.4 --equn.2

where, the constants are the scale multipliers that are used to calibrate the movements of the motors in SAAAS based on its current design.

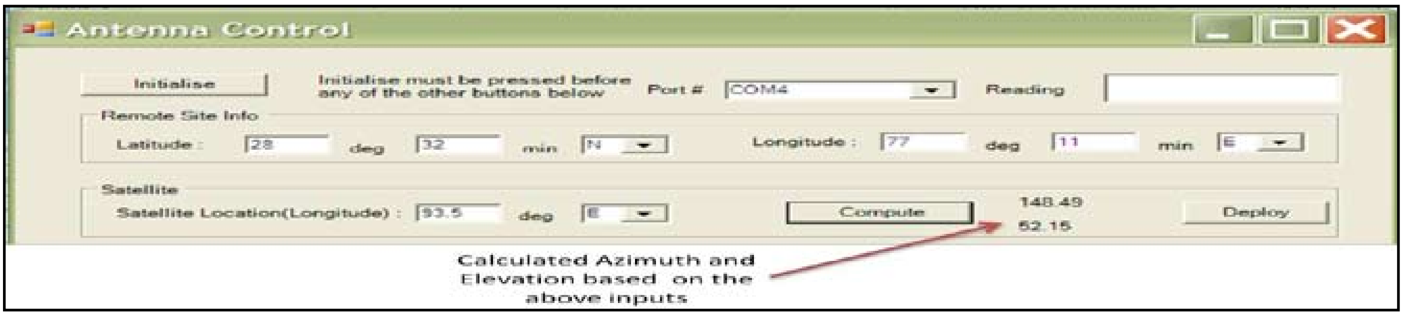


Fig. 6.4: Calculation of Azimuth and Elevation

First, the Azimuth motor is moved the calculated number of steps (equn.1) and then the Elevation motor is driven towards the target location (equn.2). This is called 'Coarse Movement'. Once the coarse movement is over, the software polls the signal meter through the USB port to check if the signal has been locked by the signal meter.

When signal is not locked

If the signal has not been locked after the coarse movement, the software routine is transferred to the 'Cyclic Pattern' routine. The cyclic pattern is used to find the signal nearby the calculated target location where the two motors has stopped after the coarse movement. In the cyclic pattern both the motors are moved one-by-one in sequence to result in the pattern as shown in figure 6.9. Between every two consecutive movements of the motors the signal meter is polled to check if the signal has been locked. Once the signal is identified and locked by the signal meter in the nearly rough direction of the satellite, both the motors ceases its movements.

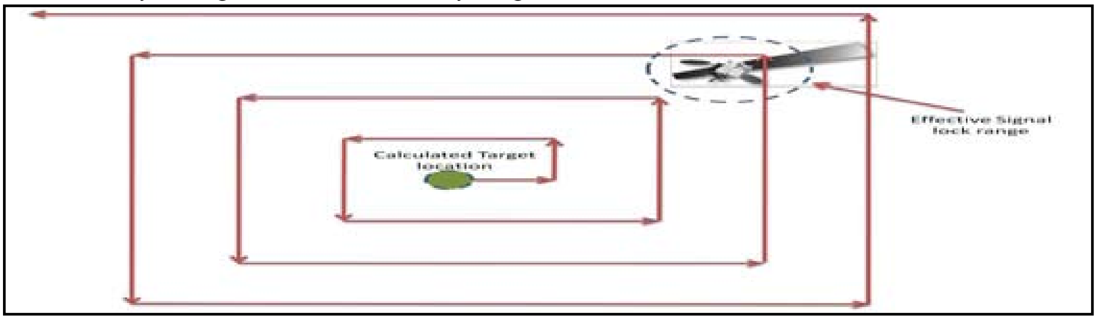
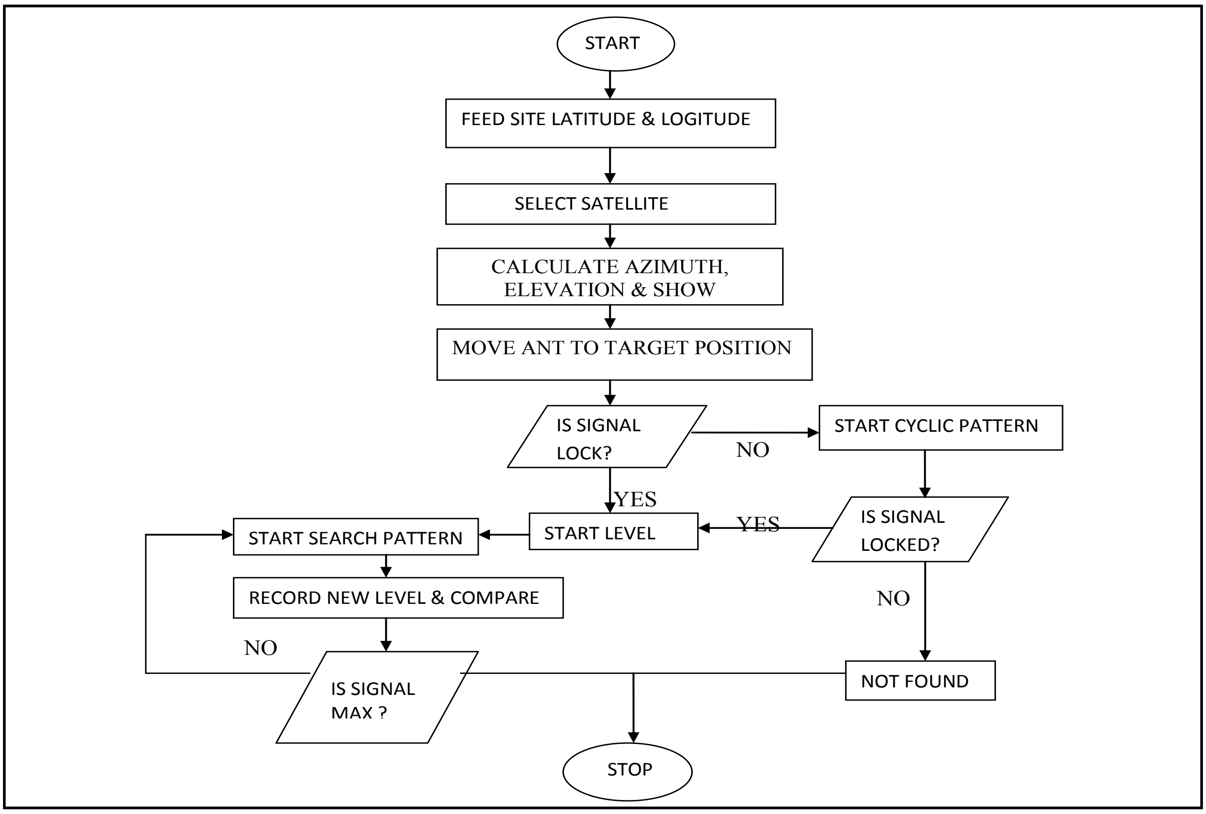


Fig. 6.5: Cyclic Pattern

AUTO ACQUISITION AND SIGNAL FEEDING FLOW CHART



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VII. Result

Sl No.	Satellite parameter	Site longitude parameter	Site latitude parameter	Receive level(signal strength)	Remarks
01.	80*E	70*N	21*E	No signal	Very poor
02.	85*E	75*N	26*E	No signal	Very poor
03.	90*E	76*N	27*E	-100dBm	Very poor
04.	93.5*E	76.5*N	27*E	-95dBm	Poor
05.	93.5*E	77.11*N	27*E	-85dBm	Poor
06.	93.5*E	77.5*N	27*E	-100dBm	Poor
07.	93.5*E	77.11*N	28*.E	-80dBm	Good
08.	93.5*E	77.11*N	28.32*E	-65dBm	Better
09.	93.5*E	77.11*N	28.42*E	-70dBm	Poor

VIII. Conclusion

Satellites have evolutionized communication. Satellite communication has served mankind in many ways for instance its is used to predict weather and broadcast storm warnings and also provides a wide range of communication services in the fields of relaying television programs, digital data for a multitude of business services. It might not surprise us if, in near future satellite links are used for voice and fax transmission to aircraft on international routes. As any invention develops with the passage of time, satellite communication has also moved a step ahead from what it was in the past with the use of several techniques such as frequency reuse, interconnecting many ground stations spread over the world, concept of multiple spot beam communications, these days lasers are effectively used for transmission through satellites. The latest development in satellites is the use of networks of small satellites in low earth orbits.

References

[1]. *Dennis Roddy, Satellite Communications, third Edition, 2001.*
[2]. *Bruce R.Elbert, Introduction to Satellite Communication, 2008 Edition.*
[3]. *William Stallings, Wireless Communications and Networks, Pearson Education, 2005 Edition.*
[4]. *David Hart, Satellite Communications, paper May 1997.*
[5]. *Satellite Communications Basics Tutorial [Online]. Available: http://www.radio-electronics.com/*
[6]. *Kamran Ahmed, Tutorial On Satellite Communication, University of Sind, IIT Pakistan.*
[7]. *Vanelli-Coralli, G. E. Corazza, G. K. Karagiannidis, Satellite Communications: Research Trends and Open Issues, Dec 2007.*
[8]. *The Nasa Website [Online]. Available: http://www.nasa.gov/*
[9]. *The Spaceflight Website [Online]. Available: http://www.spaceight101.com/*
[10]. *Global VSAT Forum [Online]. Available: http://gvf.org/*
[11]. *Satellite Communication [Online]. Available: http://web.uettaxila.edu.pk/*
[12]. *Joel Klooster, The Future of Satellite Communications, May 2002.*
[13]. *Howard Hausman, Fundamentals Of Satellite Communications, May 2008.*
[14]. *Igor Bisio Track: Satellite and Space Communications, IEEE GLOBECOM 2011 - Symposium on SAC.*
[15]. *Yongguang Zhang, Dante De Lucia, Bo Ryu, Son K. Dao, Satellite Communications in the Global Internet: Issues, Pitfalls, and Potential, November 1996.*