STUDY OF SATELLITE ANTENNA TRACKING AND CONTROL SYSTEM

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ABSTRACT

Satellites in nominally geostationary orbits possess diurnal motion which causes the apparent position of the spacecraft to wander in the sky as seen by an earth station. If uncompensated this causes a variation in the performance of the communications link. The motion of the satellite therefore has to be tracked by the earth station antenna. During the past twenty years or so a considerable amount of work has gone into the development of tracking schemes for satellite communication systems. Here a review of the various techniques is presented. For each method used the principle of operation is described and the various salient features extracted. Comparisons are made where appropriate and practical implementations of the systems discussed. The application of intelligent control algorithms to tracking is also considered. The areas covered include, orbit determination, optimal estimation techniques, performance, and practical implementations. Recently introduced techniques are considered and likely future developments projected.

Keyword: - *C-Band Antenna, Antenna Control Unit (ACU), Thiacom-4.*

1. INTRODUCTION

Industry/sight Introduction [BSNL Earth station situated at Thane (Yeoor)] :-

Bharat Nigam limited (BSNL) Network. The network consists of a Hub located at Bangalore and VSATs located throughout the country. The VSAT communicates to the HUB through Express AM1 Satellite. All VSATs are connected in STAR topology and VSAT to VSAT communication is through the HUB at Bangalore. Ku band VSAT network of BSNL is capable of providing high speed data transfer up to 2Mbps (presently 512 Kbps) and voice communication ring the entire country.

1.1 Introduction (Satellite orbits):-

• **Geosynchronous Satellite:**
A Geosynchronous satellite is a satellite in geosynchronous orbit, with an orbital period the same as the Earth's rotation period. Such a satellite returns to the same position in the sky after each sidereal day, and over the course of a day traces out a path in the sky that is typically some form of Ana lemma.
• **Geostationary Satellite:**
A Geostationary satellite is an earth-orbiting satellite, placed at an altitude of approximately 35,800 kilometers directly over the equator, that revolves in the same direction the earth rotates (west to east).
• **Geostationary Orbit:**
A Geosynchronous orbit (GSO) is an orbit around Earth of a satellite with an orbital period that matches Earth's rotation on its axis, which takes one sidereal day (23 hours, 56 minutes, and 4 seconds).

1.2 Introduction and Motivation:

Satellite Communication is a kind of Microwave communication with a repeater placed in space. A Communication Satellite (also referred to as COMSAT) is an artificial satellite stationed in space for the purpose of telecommunications. Satellite Communication does not compete with but complements the terrestrial modes of communication like Optical Fiber and Microwave communication.

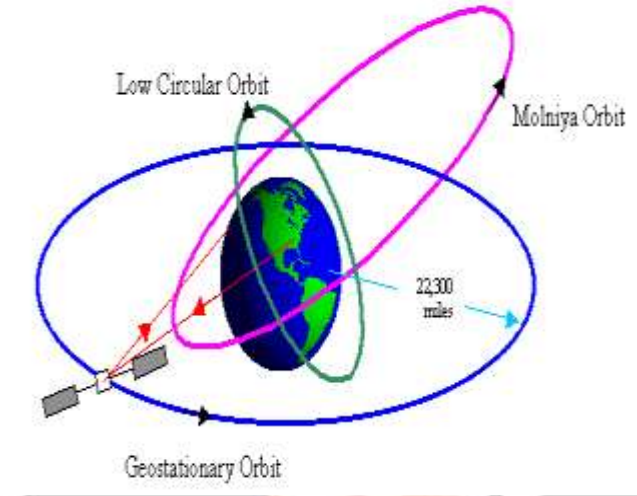

Fig-1: Earth Orbits

There are three types of Orbits are as follows:

Lower Earth Orbit(LEO) : 450Km- 1000Km
Medium Earth Orbit (MEO) : 15000Km
GEO STATIONARY ORBIT : 36000 km

1.3 Existing System:

The satellites are launched into the space, thousands of kilometres above the ground surface by using a satellite Launcher from various launching stations available in different countries of the world. After the launching of the particular satellite its services are fetched by setting up of "GROUND STATION OR EARTH STATION" on various locations in different countries having the signed and licensed agreement with the Company launching the Satellite.

The antenna is getting tracked in step track mode as per two criteria. In the ACU (Industrial PC Unit), tracking interval period has been fixed as 30 minutes. Also, the threshold signal strength voltage 5.9999 volt and the peak reference voltage is kept as 7.7 volt. The antenna gets tracked in every 30 minutes interval for peak signal strength or whenever the signal strength voltage reaches below the threshold voltage i.e., below 6v. When the signal strength voltage reaches on or above the peak reference value, i.e., 7.7v, the tracking stops and waits till the signal strength value goes below 7.7v.

In manual mode tracking, the AZ and EL motors can be tracked manually for peak signal strength with the ACU by controlling the speed of motors from 10% to 100%. Necessary logs are generated in the ACU for every 24 hours regarding the tracking history viz., date, time, AZ & EL angle, SS voltage.

Emergency Stop switches are provided at both indoor and outdoor sites for stopping the antenna tracking by disconnecting the power supply provided to AZ & EL motors in case of any emergency. With the installation and commissioning of this antenna control auto tracking system at Satellite Earth Station, the satellite beacon signal is getting tracked for its peak signal value thereby enabling the interruption free IDR traffic to Port Blair.

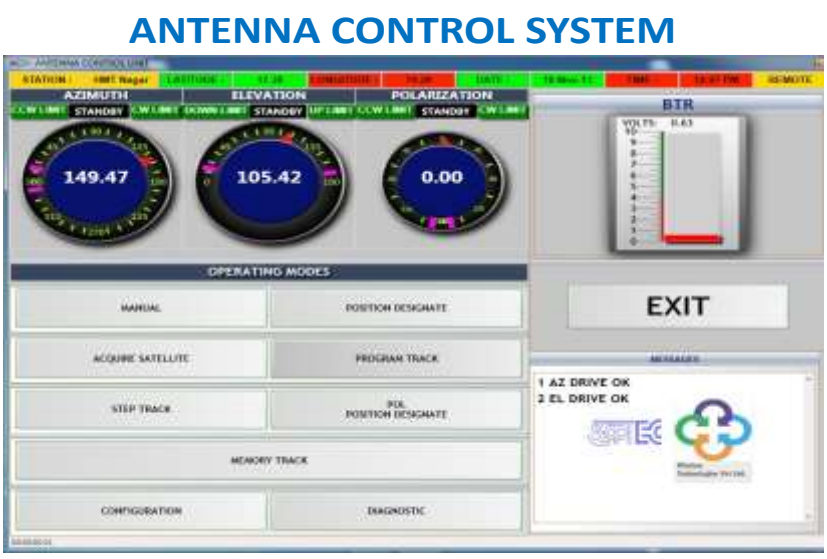

Fig-2: Antenna Control **Unit**

1.4 Proposed System :

For Bringing the betterment in the existing system of satellite tracking the high quality tracking antennas can be used. The high quality antennas having stepper motors and better consistency and performance can be used. The software programming can be enhanced in the indoor unit for more accuracy of the antenna tracking. For better communication through satellite system the use of the advanced frequency band i.e. the ku and ka band rather than typical c band is proposed.

2. Hardware Requirements :

The complete system will contain following components:

- Two antenna for bidirectional communication
- Antenna position control system
- UHF/VHF radio transmitter/ receiver
- Modem/ terminal node controller
- Software to track and send/ receive data

2.1 Antenna Control system:

The ACU003 antenna control system is an antenna controller / positioner with optional satellite tracking support. It may be operated as a standalone unit or in conjuction of the wisdom ACS-IDU, a PC indoor unit which offers extended tracking capabilities and a full featured visualization interface.

2.2 Earth Station:

An earth station, ground station, or earth terminal is a terrestrial terminal station designed for extra-planetary telecommunication with the spacecraft, and/or reception of radio waves from an astronomical radio source. Earth stations are located either on the surface of the Earth or within Earth's atmosphere. Earth stations communicate with spacecraft by transmitting and receiving radio waves in the super high frequency or extremely high frequency bands.

2.3Industrial pc with keyboard:

It is standard Industrial workstation, 19" rack mountable, 8U height attached 12" LCD screen with Resolution of 1024*768. A rack mounted keyboard with touch pad / full sized mouse also provided. Internal to unit is a SMPS Power supply, CD-RW, Solid state hard drive, CPU card & Mother board.The application GUI software is residing in the industrial PC.

3.Methodologies and working :

3.1 Communication of Earth station with satellite :

Earth stations communicate with spacecraft by transmitting and receiving radio waves in the super high frequency or extremely high frequency bands.

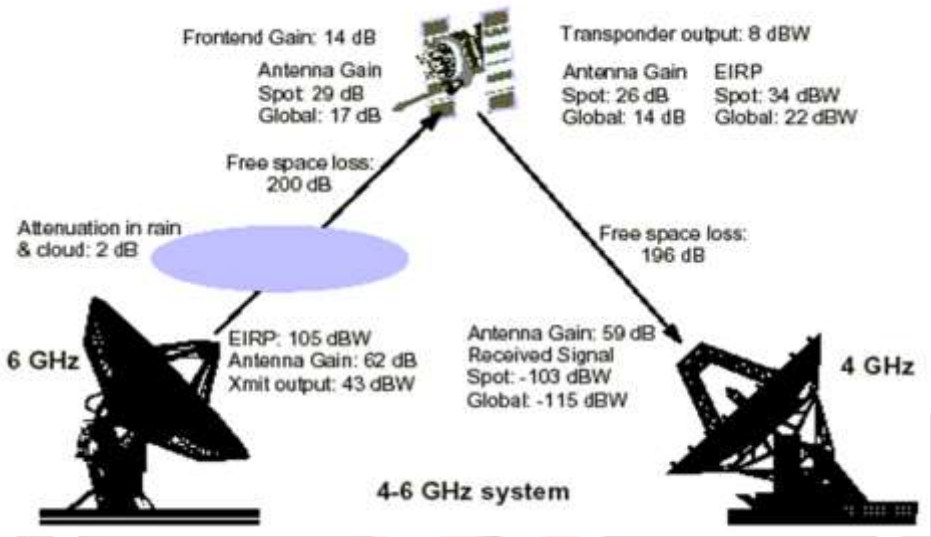

Fig 3: Communication between earth station and satellite

3.2Stand by mode tracking :

During initial Power ON, the system is in Standby mode which constantly monitors the whole system. From the operation point of view this mode is an inactive mode, where no movement is possible in either axis.

3.3 mode tracking :

In this mode user is allowed to move the antenna manually using mouse. This dialog window is obtained by clicking Manual mode item on the Main Screen. After displaying dialog window user has to select the speed and click on displayed to operate the antenna in that particular direction. This mode is used to move the antenna for smaller movements. This mode is very much useful to peak the antenna manually.

3.4Step tracking :

This mode is an auto track mode. In this mode the antenna will be tracked periodically depending upon the signal strength (i.e. if the signal level falls beyond the Threshold) or periodically (i.e. Step track interval - STPTINT). This mode will peak the antenna periodically. In Step track the motors will always run in Low speed. Once Step track is initiated, first Az angle is tracked and then El angle and again Az angle. In the graph shown below, is signal strength versus time.

4. Conclusion :

Thus existing tracking system at BSNL earth station Thane is based on the C-Band is costly and equipment size is too large to handle manually. For better communication through satellite system the use of the advanced frequency band i.e. the ku and ka band rather than typical c band is proposed.

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