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Prospects Challenges of Bangabandhu Satellite-2

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ABSTRACT

The development of the Bangabandhu Satellite-1 has changed the direction of Bangladesh's satellite communication research. Bangladesh's dream project was the Bangabandhu Satellite 1. This satellite's primary goal is to maintain effective internet and communication services in remote places. First of all, we must concentrate to the depth of satellite communication system and its process to reach any conclusion. Our main goal of the research is to recognize a feasibility review on Bangabandhu satellite-2. So, for the feasibility studies we reviewed the most promising technical parts of Bangabandhu satellite-1. Here, we only focused the certain parts of the satellite such as coding, modulation, battery, purpose of ground station and the benefits of the satellite communication system. Then we moved on the main parts of the Bangabandhu satellite-2. As, Bangabandhu satellite-1 was Geosynchronous equatorial orbit (GEO) communication satellite and Bangabandhu satellite-2 will be Low Earth Orbit (LEO) observation satellite (LEO) so, some of configurations between them might be changed. Furthermore, we largely focused on Facts, efficiency, performance and noticeable difference between two satellites.

Keywords - **Bangabandhu Satellite-2, Battery, Bit error rate (BER), Modulation, GEO Satellite Networks, Turbo codes**

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1. INTRODUCTION

Satellite communication (artificial satellites) is mainly used to provide communication links between various points on Earth. Satellite communications play a significant role in the global telecommunications system. In this universe, around 2,000 man-made satellites orbiting Earth relay analog and digital signals transferring voice, video, and data to and from one or many locations worldwide. The first artificial satellite made by humans was launched by the Soviet Union on October 4, 1957, with Sergei Korolev serving as the spacecraft's principal designer [1]. The ground segment, which comprises of stationary or mobile transmission, reception, and auxiliary equipment, and the space segment, which principally consists of the satellite itself, are the two primary parts of satellite communication [2-4]. The transmission or uplink of a signal from an Earth station to a satellite constitutes a typical satellite connection. The signal is then obtained by the satellite, amplified, and transmitted back to Earth where it is obtained and amplified once again by Earth stations and terminals. Direct-to-home (DTH) satellite technology, mobile receiving equipment for airplanes, satellite telephones, and portable devices are examples of satellite receivers used on the ground [5-7].

Bangladesh's Bangabandhu Satellite is the nation's ground-breaking and most outstanding accomplishment [8]. But achieving this nation's ambition has not been simple. Bangladesh has now left its mark on space as a result of amazing long-term planning and achievements. This article details the outstanding accomplishments of a country, the father of the country's practical endeavors and vision, as well as the hopes and prospects this accomplishment has for the future. It also includes some significant historical details about satellite communication in space and the nation's economic situation at the time. The construction of a more effective roadmap for the nation's comprehensive communication sector has been supported in large part by the future scope and better exploitation of the satellite in all feasible areas. The country's first communication satellite, Bangabandhu Satellite-1 (BS-1), has already started revolving around its orbital slot in space. With this satellite, Bangladesh has become the 57th country in the world and fourth in South Asia, after India, Pakistan, and Sri Lanka, to have its nationally-owned satellite in space. The satellite was manufactured by Thales Alenia Space, launched on 12 May 2018 at 119.1°E longitude, and named after The Father of the Nation, Bangabandhu Sheikh Mujibur Rahman [9]. The visionary leader, Bangabandhu Sheikh Mujibur Rahman, established the earth station in Betbunia to develop the information technology sectors in line with the developed countries in the year 1975. With that initiation and in the process of `progress, Bangladesh has obtained the communication satellite, BS-1. This communication satellite is a crucial milestone in the country's scientific paradigm and a big step towards achieving self-dependency. The BS-1 would deliver a much-needed boost to the country's digital advancement, economic growth, job creation, and a wide range of services indifferent sectors like communication, disaster, socio-economic, and defense sectors. Besides providing Internet to rural communities, it would bring enormous potential and possibilities to improve agriculture, execute disaster planning, and ensure national security [9]. It has also created an environment for interest in space science and satellite technology. While Bangabandhu Satellite-1 was a communication satellite in Geosynchronous Equatorial Orbit (GEO) and Bangabandhu Satellite-2 would be an observation satellite in Low Earth Orbit (LEO), certain of their configurations may alter. Additionally, we mainly concentrated on the facts, effectiveness, performance, and distinguishing features of the two satellites. Although there are some challenges besides the more prospects. The main objective of this research is to find out the challenges and try to solve them through technological means.

2. IMPORTANCE OF SATELLITE COMMUNICATION

Satellite communication has some indicatory role in three areas: Safety, contingency planningand Efficiency [6].

- **Safety**- Being able to locate certain important personnel or assets when they are overseas is crucial since many parts of the world (particularly in developing nations) are not as safe as others. Satellite communication enables real-time, very precise GPS monitoring, allowing users to track down coworkers or automobiles at any moment and notify authorities if there is cause for concern. Additionally, it offers a variety of comforting features to support communication among coworkers, such as two-way texting, SOS notifications, and thorough reporting.
- **Contingency planning**-Being prepared for any conceivable situation might help avoid major disruptions and costly losses at business meetings or any type of international gathering. Downtime happens, even in the safest nations with dependable cell networks. For instance, relatives of those affected by the disaster experienced great pain and bewilderment when US cell networks were rendered inaccessible for 48 hours. On sometimes, equipment malfunctions or technological issues cause network disruptions. Even in the event of terrorism, extreme weather, or civil disturbance, satellite phones, which do not rely on terrestrial networks, are virtually always accessible. For this reason, many companies incorporate satellite communication options into their backup plans to prevent the financial and reputational harm brought on by the failure of mobile networks.
- **Efficiency**-Smartphones improve the capacity to work remotely in distant locations and on ships and make important business choices while traveling, although not in all (rustic regions) of the world. Smartphones immediately enable rapid access to coworkers, suppliers, and consumers. So, its equipment aids in operating independently from mobile networks so that crucial business calls may still be made in the event of a weak or missing signal or aboard a ship at sea. With the assurance that their work won't be hampered by weak or nonexistent signals, additional services like data packages and GPS tracking enable field personnel to check and send emails, livestream movies, or submit reports to head office.

3. PRESENT STATUS OF WORLDWIDE SATELLITE COMMUNICATION

There have been 8,900 (roughly) satellite launches from more than 40 countries since the first Sputnik satellite was launched. A 2018 estimate places the number in orbit at 5,000. With the exception of these 5,000, 63% of active satellites are in low-Earth orbit, 6% are in medium-Earth orbit (20,000 km), 29% are in geostationary orbit (36 000 km), and the other 2% are in elliptic orbit. In reality, some huge space stations have been launched in pieces and put together in orbit. It is significant to note that only 1,900 of the 5,000 satellites in orbit were in service in 2018; the others have since degraded into space junk [10].

It is unfortunate but true that the space pollution brought on by this space junk is a major issue today. Space debris mostly refers to the organic waste that may be found across the solar system, such as (asteroids, comets, and meteoroids). Beginning in 1979, the NASA Orbital Debris Program addressed space trash or space rubbish as being produced by the abundance of purposefully made, dead objects in space, particularly those in earth orbit. These include old satellites, wasted rocket stages, and the pieces left over after their crashes and disintegration. Space debris has been created as a result of five spacecraft collisions (December 2016). Other names for space debris include orbital debris, space junk, space litter, and space debris. Today, a number of actions are being done to deal with this debris, and they are as follows:

Similar to the European Space Agency, the United States has a set of standardized procedures for mitigating orbital debris in the civilian (NASA) and military (DoD and USAF) sectors.

An international standard for reducing space debris is being developed by the International Organization for Standardization (ISO) (in 2007). Bonds have been placed by Germany and France to protect property from debris damage.

The third strategy was to plan the mission architecture such that the rocket second stage would always be in an elliptical geocentric orbit with a low-perigee. This would guarantee quick orbital decay and prevent the creation of long-term orbital debris from expended rocket bodies.

The "Remove DEBRIS" mission was launched in April 2018 with the primary objective of evaluating the effectiveness of several Active Debris Removal (ADR) systems in low earth orbit. It will do this by conducting a number of planned experiments, and the platform is equipped with a net, a harpoon, a laser ranging device, a dragsail, and two CubeSats as a result (miniature research

Volume: 14 Issue: 02 Pages: 5342-5352(2022) ISSN: 0975-0290

satellites). As part of the CRS-14 mission, "Remove DEBRIS" was launched on the SpaceX Dragon refueling spacecraft and docked with the International Space Station (ISS) on April 4, 2018 [2].

4. HISTORY OF BANGABANDHU SATELLITE-1

4.1 Background

The project is being carried out in conjunction with the United States-based Space Partnership International, LLC by the Bangladesh Telecommunication Regulatory Commission (BTRC). The government-owned Bangladesh Communication Satellite Company Limited, or BCSCL, will run the satellite. It bears the name of the nation's founder, Bangabandhu Sheikh Mujibur Rahman. [9]

4.2 Benefits

- The satellite will offer Ku-band coverage over the entirety of Bangladesh and the country's surrounding waters, including the Bay of Bengal, Nepal, Bhutan, Sri Lanka, the Philippines, and eastern Indian states (West Bengal, Assam, Meghalaya, Mizoram, Tripura, Nagaland (Arunachal Pradesh)). It will also cover Indonesia. For all of the aforementioned places, this is combined with C-band 15 coverage so, it will be able to count holdings as well as evaluate population density based on natural increases and decreases in birth rates and death rates in a given country.
- It employs cutting-edge, deployed technology like cameras to scan the population density per 1,000 km2. Bangladesh is quite proud of it.
- The last and most important aspect of this satellite is that it guarantees reliable internet and communication services in rural regions.

4.3 Construction

The Bangabandhu-1 spacecraft was planned and constructed by Thales Alenia Space. With a $188.7 million loan from HSBC Holdings plc, the satellite's total cost in 2015 was anticipated to be 248 million US dollars (Tk 19.51 billion). The satellite includes 40 Ku-band and C-band transponders in total, each of which has a 1600 Megahertz capacity and a lifespan of more than 15 years. [9]

4.4 Launch

On May 11, 2018, at 20:14 UTC, the SpaceX Falcon 9 rocket carrying the Bangabandhu Satellite-1 was launched from Florida's Kennedy Space Center. It was the first launch of cargo using SpaceX's brand-new Block 5 rocket. On May 10, 2018, the satellite was scheduled to launch. However, the rocket carrying the payload initiated an automated abort when it approached entity and supply at T-58 seconds. After a 24-hour delay, the rocket launch ultimately occurred on May 11, 2018.

4.4 Operation

The satellite is in contact with ground control centers set up in Gazipur, Telipara, by Thales Alenia Space and its partner Spectra. A secondary ground station is located at Betbunia, Rangamati. The first test signal was received by the operators after the launch on May 12, 2018. Two signals were sent to the two ground stations at Gazipur and Betbunia when Bangabandhu-1 was launched into orbit [9].

4.5 Communication System

The satellite communication can be divided into three sections:

- Uplink Section (Ground Station): Baseband Signal is the term for the signal that the user intends to transmit. It is sent to an intermediate frequency modulator (IF modulator), which modulates the baseband frequency into the intermediate frequency. 8-PSK transmitter was utilized in Bangabandhu Satellite 1. Three bits are encoded using 8-PSK, resulting in tri-bits and eight distinct output phases. The incoming bits are divided into tri-bits (23 = 8) in order to encode eight distinct phases.
- Transponders: Transponders are the brains of communication satellites. The transponder's primary job is to eliminate any signal noise by changing the frequency of the signals it receives. Additionally, increase the signal's power. Transponder on KU band satellites downconverts from 14 GHz to 1.2 GHz. There may be 20 or more transponders on a satellite. There are 40 transponders on the Bangabandhu Satellite 1.
- Downlink Section: The transponder's emitted frequency and the receiving antenna's received frequency are same. Using a band pass filter (BPF), the extraneous frequency components are removed. The Low Noise Amplifier (LNA) is then used to amplify the RF signal. The RF signal is then sent into a down-converter, where with the aid of a mixer and a downlink frequency microwave generator, the RF range (GHz) is reduced to an IF range (MHz). Intermediate frequency is converted to baseband frequency via the Intermediate Frequency (IF) Demodulator. This baseband signal was transmitted by the user from the uplink segment via transponder.

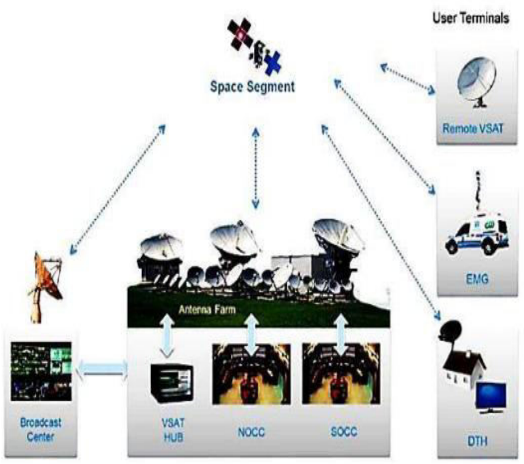

Fig: 4.5 Conceptual model of BS-1 Source: https://www.btrc.gov.bd

5. IMPORTANCE OF BANGABANDHU SATELLITE-2

The government has already started to work the launch of country's second satellite about three years after the first reached orbit and they also delivered the expected launch date which is in 2023. Bangabandhu satellite-2 will be a low earth orbit (LEO) observation satellite and it will be focused on environmental monitoring, meteorology, cartography, and defense sectors. Some importance of Bangabandhu satellite-2 is given below:[4]

- The new satellite will be used to monitor the vast maritime territories of Bangladesh and surrounding countries, as well as the country's land borders with India and Myanmar.
- The most crucial need is that, Bangladesh is currently paying for data from other observatory satellites but this cannot go on for long due to concerns over data security. To want absolute and direct access to the data and security for our country's maritime boundaries, maritime resources under the deep sea, and border territories this satellite is very important for Bangladesh.
- This satellite would be helpful to predict and prepare for flash floods, as water rushes to the rivers in the northern and north-eastern transboundary hills of Bangladesh from adjacent hills in India in the pre-monsoon season, between April and May.
- A large area of crop fields across the country can be monitored with the satellite, to protect growing crops from insects such as locusts.
- Lastly, the new LEO satellite orbit 500-2,000 kilometers from Earth so it offers faster communication with lower latency and provide higher bandwidth per user than GEO satellites as well.

6. TECHNICAL ASPECTS OF BANGABANDHU SATELLITE-2

6.1 Battery Solution

For Bangabandhu satellite -2 Lithium- Ion battery should be used because its technology development is well flourished in Europe. The qualification status is so satisfying for that in present, all new projects of Low Earth Orbit (LEO) applications consider Li-Ion as the prime factor. Here the battery mass is divided into four parts with regards to Ni-Cd, the thermal dissipation is reduced by a factor of about 5 and the energy efficiency goes from 80% for Ni-Cd to 95% for Li-Ion. To take the full advantage of these cell performance improvements, it is very important to finely design its electrical nature because it allows to optimize the solar array and electronics sizing. Li-Ion cells have been modelled for SAFT VES140 and AEA /SONY 18650 HC cell. Recently, most of the LEO Earth satellite is used SAFT Li-Ion cell model because it is cheap and reliable [10].

6.2 Structure of the Model

Here, the cell behavior is dependent on one cell intrinsic parameter, the state of charge, and on two parameters external to the cell, the current and the temperature. Furthermore, the ageing has an influenced on the cell performance but this ageing is related to the history of the battery in term of "Average" utilization during its life [10]. The Fig.6.2.1 represents the model structure and their mechanisms are given below:

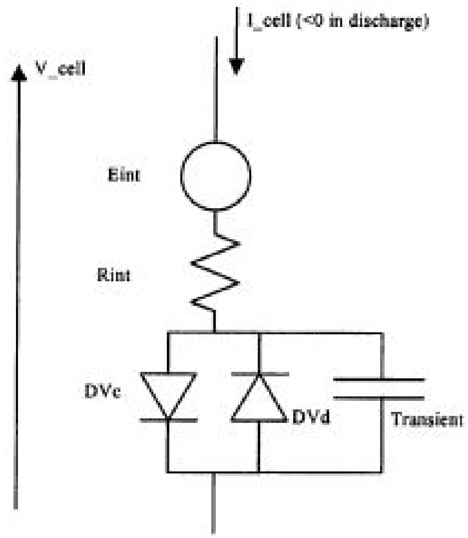

Fig 6.2.1 Li-Ion model

- An internal voltage generator, SOC dependent
- An internal resistance, SOC and Temperature dependent
- Voltage drop, current, SOC and Temperature dependent and different in charge and discharge
- For analyzing the transient of voltage drop -a capacitor is present.

Fig6.2.2 illustrates the influence of the model components of the voltage behavior is given below:

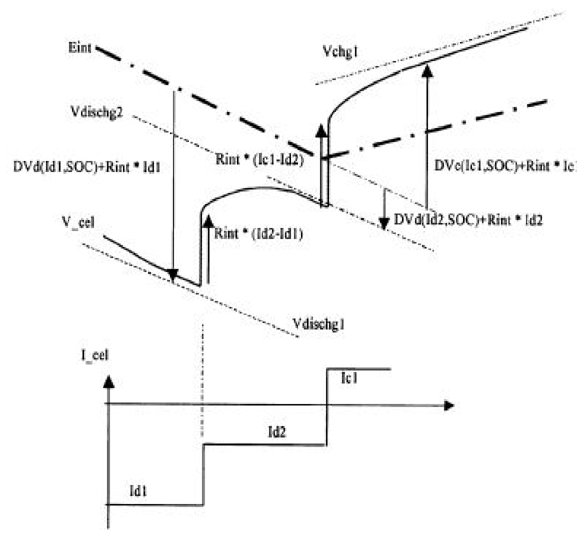

Fig.6.2.2The influence of the model components of the voltage behavior

- First of all, the cell voltage is related to the internal voltage (Eint)
- For instantaneous current transient the initial visible effect is the resistance (Rint)
- The voltage drop mentioned as Dvd during discharge and Dvc during Charge.

Volume: 14 Issue: 02 Pages: 5342-5352(2022) ISSN: 0975-0290

6.3 LEO test for SAFT VES140 cell modeling

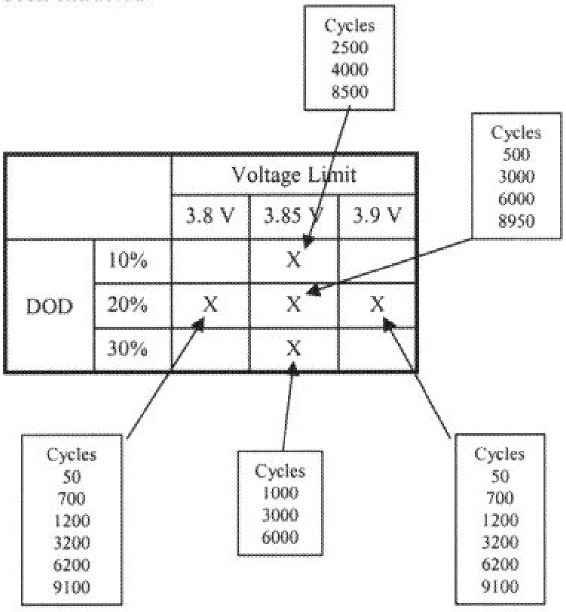

Fig. 6.3.4 LEO test matrix

- These tests covered three DOD (10%,20%,30%) with three different taper voltage (3.8, 3.85 and 3.9 V). Each test is done on three cells connected in series at temperature and at that time it reached more than 9000 cycles. This made it more significant database for satellite batteries [10]

6.4 Capacity Loss

- This graph is the evolution of the steady state voltage for different currents and internal resistance.
- The most meaningful information is that the evolution of all these parameters with life.
- From the structure of the model it has been found that the degradation of the capacity is directly derived from the cumulative discharge Amperes-hour and can be approximated by an exponential curve.

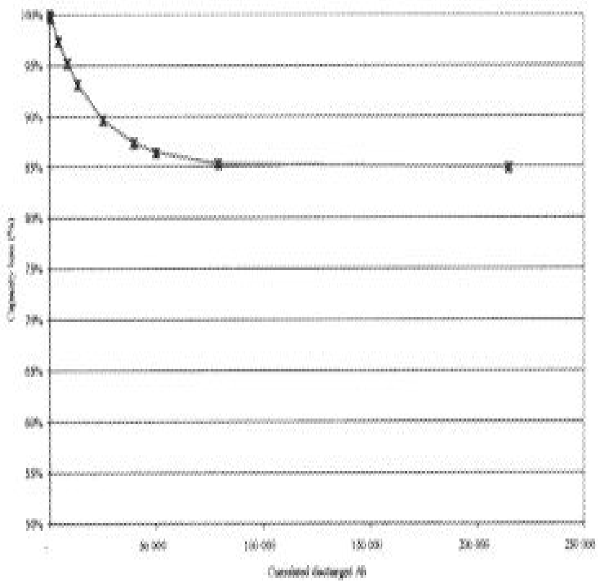

Fig6.4 Modelling of the capacity loss

6.5 Voltage Accuracy

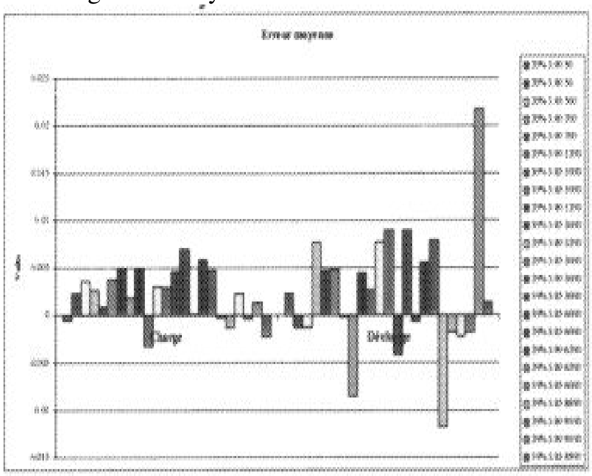

Fig. 6.5 Average voltage accuracy on LEO test

- The model accuracy is almost acceptable for all the test data and the precision is better than ±25 mV over the covered lifetime.
- And the average accuracy is ±8mV in charge and ±25 mV for discharge [10].

7. BEST MODULATION TECHNIQUE

According to the characteristics of another wave form, modulation is the systematic alteration of one wave form (also known as the carrier waveform) (called the modulating or the message). Modulation is the process of adding information to an electrical or optical carrier signal in order to turn it into radio waves. A carrier signal's waveform has a fixed height (amplitude) and frequency.

7.1 Mechanism of Modulation:

The carrier's amplitude, frequency, phase, polarization (for optical communications), and even quantum-level processes like spin can be changed to add information. The electromagnetic signals in computer networks, radio waves, and lasers and optics are only a few examples of how they might be modulated. Modulation can even be used to switch on and off a direct current, which is visualized as a degenerate carrier wave with a fixed amplitude and frequency of 0 Hz, just like in Morse code telegraphy or a digital current loop interface. Baseband m is one specific example of a no carrier response, which shows that an associated device is no longer linked to a remote system. Like power line networking, low-frequency alternating currents may be modified (50-60 Hz).

7.2 Modulation Types:

- Frequency modulation (FM), where the carrier waveform's frequency is changed to mirror the data's frequency.
- Phase modulation (PM), in which the carrier waveform's phase is altered to reflect changes in the data's frequency. While the phase with respect to the base carrier frequency is altered in PM, the frequency remains constant. It's comparable to FM.

- Polarization modulation, in which the angle of rotation of an optical carrier signal is varied to reflect transmitted data.
- Pulse-code modulation, in which an analog signal is sampled to derive a data stream that is used to modulate a digital carrier signal.
- Quadrature amplitude modulation (QAM), which uses two AM carriers to encode two or more bits in a single transmission.

7.3 For Bangabandhu Satellite-2

The Bangabandhu Satellite-1 uses 8-PSK modulation techniques (BS-1). Modulation is the process of converting data into electrical signals that are best suited for transmission [11]. In its simplest form, modulation is the act of changing a signal's property by adding a data signal on top of a high-recurrence signal. This approach uses audio, video, and other data. The transporter wave signal may be DC, AC, or bit train depending on the application. A sine wave with a greater frequency is typically utilized as the carrier wave signal. Initially, satellite communication used analog modulation techniques; however, today, digital modulation is the standard.

- QPSK: When two information bits (together as one signal) are modulated simultaneously using the Quadrature Phase Shift Keying (QPSK) phase modulation technique, one of the four potential carrier phase shift states is chosen. Different sorts of modulation techniques are employed in satellites to send signals from one location to another. However, some typical modulation techniques used in satellite communication include Frequency-Shift Keying (FSK), Binary Phase-Shift Keying (BPSK), Quadrature Phase-Shift Keying (QPSK) and Phase Shift Keying (PSK). Through simulations taking into account the downlink channel properties for LEO satellite communication, the performance of binary phase shift keying (BPSK), quadriphase shift keying (QPSK), offset QPSK (OQPSK), /spl pi/4 shifted QPSK, octaphase shift keying (8PSK), and 3/spl pi/8 shifted 8PSK has been thoroughly investigated [11]. Utilizing software, the modulators and demodulators were synthesized. The simulations showed that non-coherent demodulators must be used in order to combat the multipath fading that exists in the downlink channel. The above observation was supported by the non-coherent limiter discriminator demodulator of /spl pi/4 shifted QPSK, which demonstrated the best performance in fading simulations. The same approach was used to demodulate 3/spl pi/8 shifted 8PSK. However, it is not advised to apply 3/spl pi/8 shifted 8PSK because it requires more power than /spl pi/4 shifted QPSK modulation to get the same BER performances. Although the deployment of 3/spl pi/8 shifted 8PSK rather than /spl pi/4 shifted QPSK method could enhance the data throughput even further, power-restricted "small" LEO satellites prevent employing this higher order modulation for the downlink. The two QPSK coding were for operations at the threshold limits indicated in Table 1.[6]

Table 1 – Comparison of the QPSK modulation performance for the two coding concepts

Inner Code Rate (FEC)	QPSK Modulation (E_b/N_0) (dB) Reed-Solomon with convolucional code	BCH with LDPC code
1/2	4,5	1,05
2/3	5,0	1,88
3/4	5,5	2,31
5/6	6,0	2,99

Table 7.3.1- Comparison of the QPSK modulation for two coding concepts

The numbers in Table 7.3.1, demonstrate BER errors after internal decoding of the order of 10-4 and after external decoding of the order of 10-10. Table 1 illustrates the idea using BCH. Performance with LDPC present is at least 3.01 dB better than the Reed-Solomon process using convolution coding.

Description	Values
Mean orbital altitude	1000 km
Maximum link distance	3000 km
$(G/T)_d$	-14 [dB/K]
Operating frequency	2.5GHz

Table 7.3.2- Link parameters [12]

The parameters used for the calculations of the links are displayed in Table 2. The assumed satellite parameters are displayed in Table 3.

The operational frequency, typical power thresholds for power received and transmitted by low earth orbit satellites, and antenna gains at the ground station are among them.

Since the antennas used in LEO satellite radio communications should have wide beams, they will have relatively low gains compared to the antennas used in geostationary satellite links. For this application, a gain of 6 dBi has been chosen.

Description	Values
$(G/T)_{SAT}$	-16 [dB/K]
Ψ_{SAT}	-85[dBm/m^2]
Satellite RX Antenna Gain	6[dB]
Dynamic Range	120[dB]
Ground antenna gain	2dBi
Operating frequency	2.5GHz

Table7.3.3- Satellite Parameters [12]

8. BEST CODING

Channel coding is very important in satellite communication system. Different types of coding techniques have been established namely; block, convolutional and turbo coding. Earlier Gaussian probability density function was used to represent capacity analysis of LEO satellite communication system but the model was focused only an isolated city. But LEO satellite covered relatively large area more than one inhabited area can exist in the coverage area of three consecutive satellites. So, the idea of using Gaussian Distribution was dismissed. Later on, many coding techniques have showed its benefits but recently turbo coding has been selected as one of the promising candidates for the third-generation universal mobile telecommunications systems (UMTS). Turbo coding is a special type of convolutional code. Its length is increased, if we increase the length of the convolution then the signal will be more random and more secured. [11]

There are two components of a turbo encoding system.

- Inter-leaver
- Encoder: Turbo encoding is a concatenation of two or more encoders in parallel.
  Encoder structure consists of
- Recursive systematic convolutional encoder as constituent encoders in a parallel scheme.
- An interleaver rearranges message by changing bit position.

8.1 Probability of Error of Turbo coding:

As mentioned before that, a turbo encoder consists of two parallel concatenated convolutional encoders called constituent codes (Recursive Systematic encoders (RSC)) separated by an interleaver, with an optional puncturing mechanism. The probability of error for Turbo coding (T) is bounded by [11];

$$P_e \approx \max_{w\geq 2}\left[\frac{wn_w}{k}Q\left(\sqrt{\frac{2Rd^{TC}_{w,\min}E_b}{(N+I)}}\right)\right] \quad (1)$$

Here, n_w and $d^{TC}_{w,min}$ are functions of the particular interleaver employed.

w = weight of the data word,

$d^{TC}_{w,min}$ = minimum weight turbo codeword produced by w

R= code rate,

K= each block of incoming data bits.

8.2 Calculation of Capacity

An important performance measure in LEO satellite is the system capacity. To calculate the capacity, we need to determine the ratio of the bit energy-to-noise plus interference density for the$i$th satellite which is defined by [11]:

$$(E_b/(N+I))_i = \frac{BW/R_b}{(I_i/S_i)+(\eta/S_i)}, \quad (2)$$

Here,

E_b = the bit energy,

N and I =power spectral densities of the noise and interference respectively

I_i = total interference power reaching the ith satellite

S_i = signal received power at the ith satellite

η = background noise power

R_b= information bit rate and (BW) is the total bandwidth.

As, I_i is proportional to the total traffic load "B", therefore the maximum amount of traffic that the system can support for a given condition can be denoted as:

$$B_i = \frac{I_i}{[I_i]_{B=1}} \quad (3)$$

Here,

$[I_i]$B=1 is the interference $I_i$calculated at B = 1.

Solving (2) for I_i and substituting it in (3) we get;

$$B_i = \left[\frac{BW/R_b}{(E_b/(N+I))} - \frac{\eta}{S_i}\right]\cdot\frac{S_i}{[I_i]_{B=1}} \quad (4)$$

From this equation, we can derive the maximum traffic B_i (capacity) for a certain $E_b/(N+I)$ on the$i$th satellite for a given BW,R_b, η,S_i and. The capacity is therefore, dependent on $E_b/(N+I)$.

8.3 Capacity determined without coding:

Taking the probability of error without coding for a certain ω and substituting in Equation (1) and solving Equation (1) numerically, the corresponding $E_b/(N+I)$ results. Finally, by substituting this value in Equation (4) we could get the required capacity [11].

8.4 Numerical Result of Turbo Coding:

Let, the probability of error and the capacity are calculated for the three consecutive satellites S1, S2 and S3 for the case of one, two and three populated areas respectively and all of the received satellites power are equal. Now we compare numerically which code gives the best performance [11].

Assume, for turbo coding, the performance of a rate 1/2 for two different interleavers of size k = 1000, w = 3, and $d^{TC}_{w,min}$ = 9.

For, Block code case, the system uses (15,11) BCH code that can correct up to one error in each 15 bits codeword.

For, the convolutional coding situation a constraint length 7, minimum distance 10 and rate 1/2 is considered, and hard decision Viterbi decoding is assumed.

The probability of error for each satellite for the three distributions of users under consideration is shown in the following figures (8.4.2,8.4.3,8.4.4). It is clear from these figures that the turbo coding outperforms all other coding techniques for the three satellites.

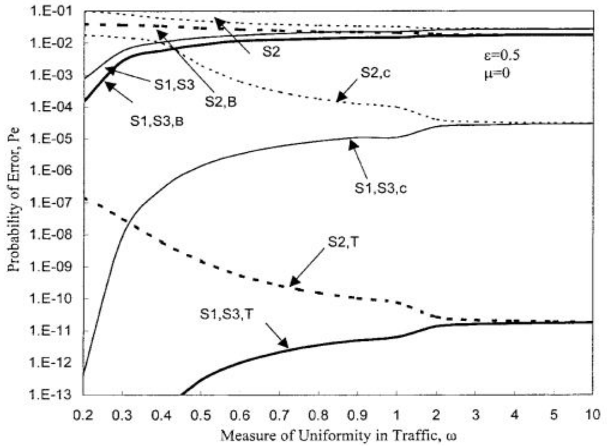

Fig 8.4.1 Probability of error of one populated area with block code (B), with convolutional code (C) and with Turbo code (T) for the three adjacent satellites (S1, S2, S3) (without coding) [11]

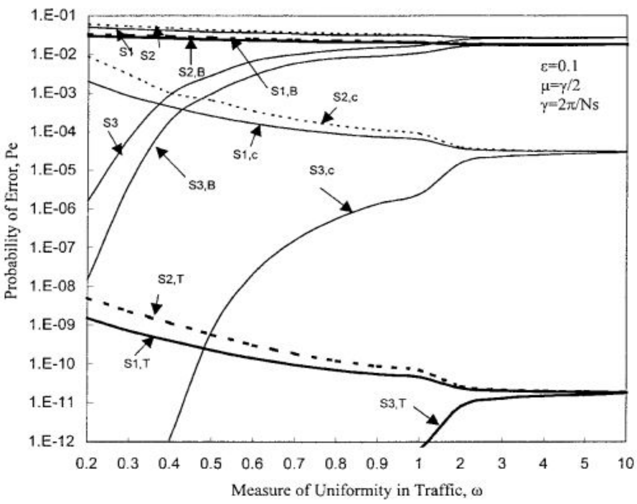

Fig.8.4.2 probability of error in the case of two populated areas (coded) [11]

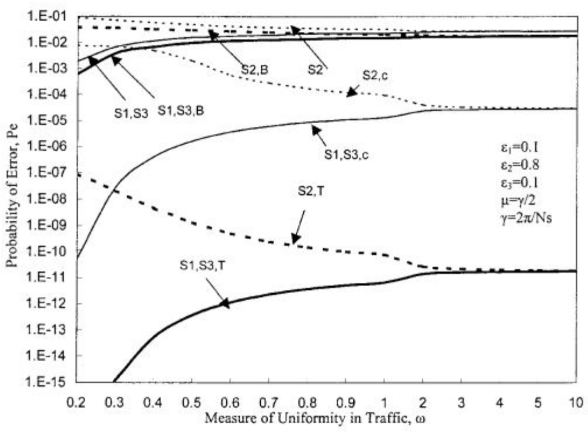

Fig. 8.4.3 probability of error in the case of three populated areas(coded) [11]

The effect of coding on the capacity of each satellite in the cases of one, two and three populated areas is depicted in the following Figures 8.4.5,8.4.6 respectively. Using turbo coding, the capacity of the satellite increases 4 to 7 times or more depending on the uniformity of the traffic. In the uniform case, the capacity increases from 14 when no coding is used to 21, 83 and 100 when using block, convolutional and turbo coding respectively. From these figures (8.4.5,8.4.6), it is clear that for turbo coding case, the capacity is identical for the three adjacent satellites and is independent neither on ω nor on the user distribution. [7]

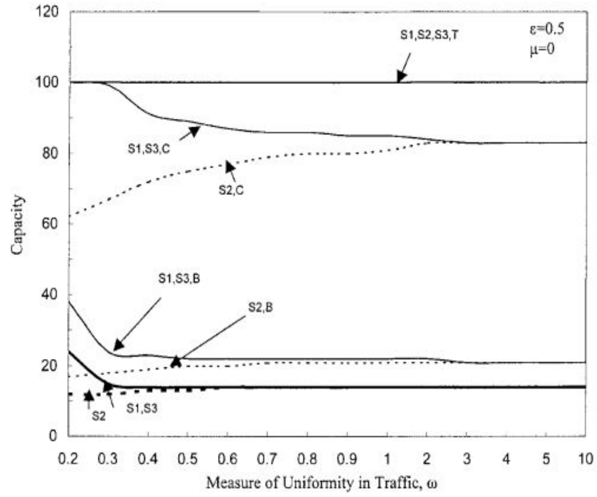

Fig.8.4.4 Effect of coding on the capacity in the case of one populated area

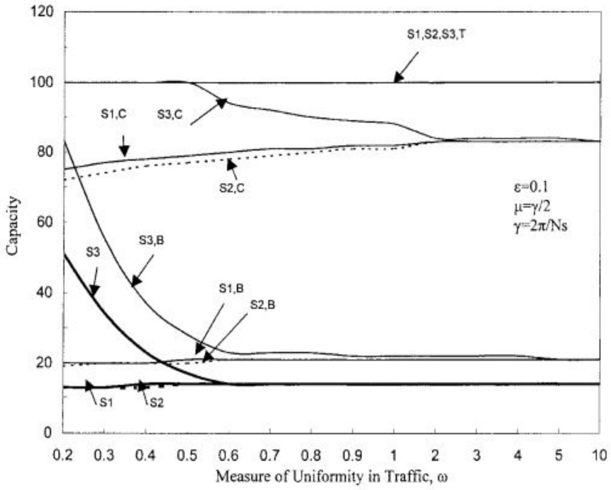

Fig.8.4.5 capacity of two populated areas (coded)

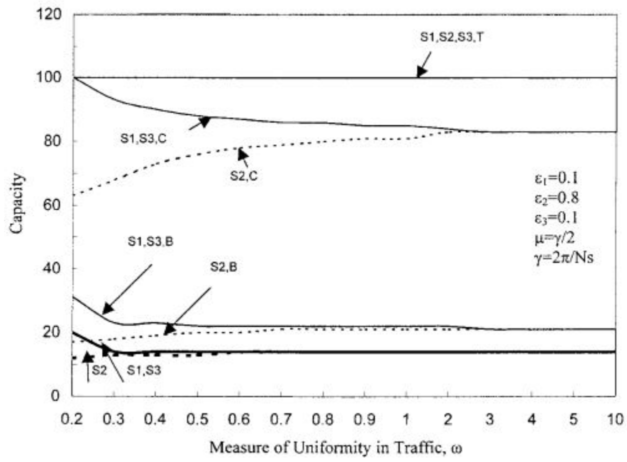

Fig.8.4.6 capacity of three populated areas(coded)

Volume: 14 Issue: 02 Pages: 5342-5352(2022) ISSN: 0975-0290

9. GROUND STATION

The Prime Minister formally opens the SajeebWazed satellite base stations for the Bangabandhu 1 satellite. Prime Minister Sheikh Hasina officially opened the SajeebWazed Ground Station at Telipara, Gazipur, which is close to the Telecommunications Staff College. It serves as the Bangabandhu-1 satellite's main ground station. In May of this year, the satellite was launched into geostationary orbit (GEO). A satellite named Bangabandhu 1 provides broadcasting and telecommunications services to Bangladesh's rural areas. It orbits at a longitude of 119.1 degrees east. Additionally, it encourages consumers to use commercial services like direct-to-home television (DTH).

9.1 Location- The placement of ground stations is one of the most crucial considerations since they depend on line of sight. How frequently and for how long you can connect with the satellite will ultimately depend on the distance between your ground station and its orbit. A ground station operating in the mid-inclination or equatorial zones will face more interference since the orbits of these satellites all cross over the polar areas. Additionally, due to the scarcity of available real estate and the extreme climatic conditions, infrastructure in the arctic area has higher operational expenses than infrastructure in the mid-latitudinal zones. If your operations base is limited to a single city or town, building a ground station at your company will affect the amount of time and frequency you interact. A ground station network can assist with this as it will comprise stations in many different places. The usage of ground stations is common.

9.2 Real-time telemetry and tele-command: One of the most important factors for ground stations is the mission requirement, which refers to how fast the end user needs the data from the satellite and how frequently you'll want to connect with the satellite [13]. If the end-user of your satellite application demands that they be given access to the craft's near-real-time data as soon as is practical, you're in for a fight. Access to a network of ground stations may be useful in this situation. You might be able to set up variable subscriptions based on your end-users' changing demands to guarantee that costs are kept to a minimum when employing a ground station network. You will have greater freedom to operate your own station, either by itself or in conjunction with network capacity, if your goal doesn't call for such real-time operations.

9.3 Observance of local laws and regulations:The ground segment may need some time to find a place to put the station and to get the necessary permissions to communicate with your satellite. To avoid interfering with other terrestrial radio frequency sources, you must be aware of the rules that apply to up-linking to your satellite at a specific frequency [14].

9.4 Distributed Satellite System: A space segment in which several spacecraft cooperate to achieve a shared purpose is referred to as a satellite network or distributed satellite system.The definitions above are used to distinguish between various topologies or control strategies when referring to a formation, constellation, or cluster. A ground segment is necessary for every space mission in addition to the space segment. One satellite and one ground station might be regarded as a distributed system in a simplistic manner (made of two nodes interacting with each other during contact). On the other hand, a multi-satellite network connected to a ground station network is more suited in the long run. As a consequence, it is possible to distinguish between two separate dispersed systems that are located near to one another, one in space and the other on the ground (see Fig.9.4.1). Despite the system's structure, this viewing point is typically ignored when multi-satellite systems are investigated.

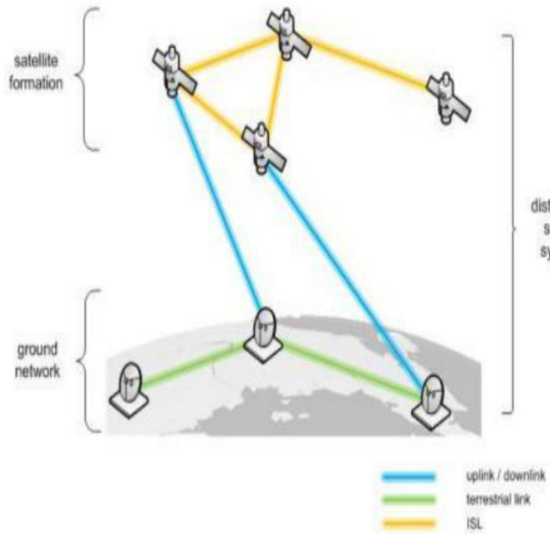

Fig.9.4.1 Distribution system of space [12]

9.5 Ground station networks with redundant scheduling:

In low Earth orbit, communication time is unquestionably one of a satellite's most limited resources. The contact window between a satellite and a ground station can be determined using the orbit elements and the location of the ground station. A LEO satellite normally has 6 to 8 communication periods per day, ranging from 5 to 15 minutes [Cakaj et al., 2007]. This has two big disadvantages: For starters, the satellite is only visible for a few minutes each day, severely limiting the amount of data that can be transferred. Furthermore, the ground station is not used for a significant portion of each day. Second, because to orbit geometry, the contact windows have set start and end timings, and an academic ground station can only support one satellite at a time. Because individual satellites' contact windows overlap (see Fig.9.5.2), the question of which satellite should be used arises.

Volume: 14 Issue: 02 Pages: 5342-5352(2022) ISSN: 0975-0290

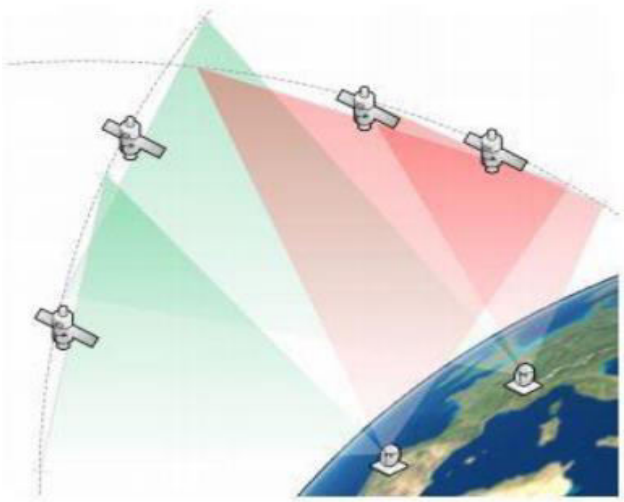

Fig.9.5.1 Overlapping Contact windows for adjacent ground station [12]

Even though the lines between planning and scheduling are occasionally blurred in literature, the separation between the two is maintained throughout this work. Developing a set of actions to accomplish a certain objective, such as path or task planning, is referred to as planning. Scheduling is a subset of planning, according to [Smith et al., 2000], when the actions have already been decided upon, leaving just the responsibility of selecting a feasible sequence. This fits perfectly with the idea of scheduling put forward by [Leung, 2004]. Numerous systems and applications require scheduling, such as job scheduling in industrial processes and process scheduling [13] Overlapping contact windows for neighboring ground station operating systems. The challenge of allocating satellites to ground stations, or arranging contact windows across a certain time horizon, is referred to in this work as scheduling. This kind of problem is referred to as "Satellite Range."

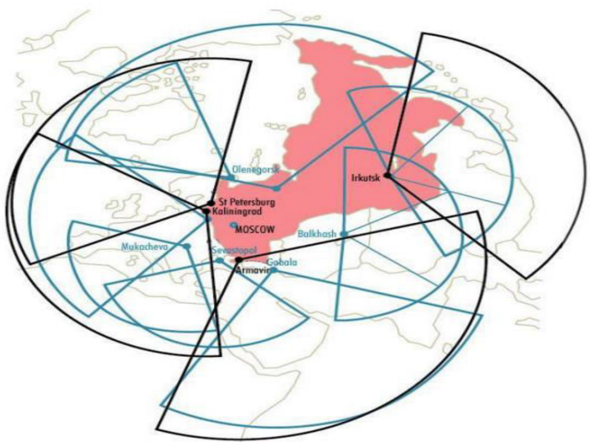

Fig.9.5.2 The field of view of ground-based station watching for rocket launches beyond the Russian territory circa 2010.

9.6 Requirement of another ground station

The positioning of ground stations is one of the most important factors since they depend on line of sight. The frequency and duration of communication with the satellite will ultimately depend on the distance between your ground station and its orbit. A LEO satellite normally has 6 to 8 communication periods each day, each lasting between 5 and 15 minutes. These imply two significant disadvantages: First off, the satellite is only visible for a brief period of time each day, thus reducing the quantity of transferrable data, Second, because of the orbit geometry, the contact windows have set beginning and ending timings, and an academic ground station can only support one satellite at once. However, geostationary satellites are visible all night, every night of the year, unlike the International Space Station and many other low-Earth-orbiting objects. They only disappear for up to 70 minutes every day when they enter Earth's shadow, which happens around two weeks either side of the equinox. However, we only have two ground stations. The data transfer rate can be maintained for time and cost efficiency if we schedule each of them equally for the two satellites. Additionally, we must be aware of the regulations that govern the frequency at which we uplink to your satellite in order to avoid interference with other terrestrial radio frequency sources. So, for the time being, we suggest that Bangabandhu Satellite 2 doesn't require the addition of a new ground station.

10. CONCLUSION

By launching Bangabandhu Satellite-1 into orbit on May 11, 2018, Bangladesh became the 57th country in the world to join the exclusive club of satellites. In2023, the nation's second satellite will be launched. The French business Price Waterhouse Coopers (PWC) has been chosen as the winner of the second satellite after submitting the lowest proposal. The second satellite will be a (LEO) Earth observation Satellite and it will be utilized for security, weather, or surveillance purposes. The satellite's main benefit is that, unlike the first satellite, it won't need to construct any new facilities

In this research we forecast feasibility study of BS-2. The country would become self-reliant in earth observation with optical and radar pictures and applications with the launch of Bangabandhu satellite-2. We research how to investigate the usefulness of the other spacecraft and create the Bangabandhu satellite -2's modulation and coding techniques. For battery, SAFT Lithium-Ion battery technology is well developed in Europe, it should be employed for the Bangabandhu satellite. The qualification status is so favorable that Li-Ion is being taken into account as the main factor in all new Low Earth Orbit (LEO) application projects. Here, the thermal dissipation is reduced by a factor of roughly 5, the energy efficiency increases from 80% for Ni-Cd to 95% for Li-Ion. It is crucial to carefully design the electrical nature of the cell in order to fully benefit from these cell performance gains because doing so enables the solar array and electronics sizing to be optimized. For the coding technique numerous coding methods, including block, convolutional, and turbo coding, have been developed. In the past, capacity analysis of the LEO satellite communication system was represented by a Gaussian probability density function, but

Volume: 14 Issue: 02 Pages: 5342-5352(2022) ISSN: 0975-0290

the model was limited to a single, remote city. Thus, the notion of use the Gaussian distribution was rejected. Here, we demonstrated the performance of turbo coding system compare to other two methods (Block, Convolutional code). In Bangabandhu satellite-1 8 PSK modulation were used this time we worked on QPSK modulation which came quite acceptable for the second satellite. Lastly, we focused on the necessity of another ground station which is not necessary as per as our assumptions because both of the satellite can operate alternatively.

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