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Satellite Based Education for Distance Education through EDUSAT

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Abstract

Electronic Learning **(E-Learning)** is a type of education system where the medium of instruction (Teaching and Learning) is through computer. EduSat is a satellite designed **by ISRO** and it is exclusively devoted to the field of education. E-Learning refers to the use of networked **Information and Communication Technology (ICT)** in teaching, delivering and learning in education anytime and anywhere. E-Learning is a broad set of applications and processes which includes web-based learning, computer based learning, multimedia learning, online learning and virtual learning.

This paper focuses on the Indian education scenario, e-Learning content preparation and presentation tools, application of e-Learning to spread education to the remote areas in India. India has launched a 1950 kg **EDUSAT** from the Satish Dhawan Space Centre at Sriharikota (ISRO). In this paper, the author discusses the role of satellite, ICT infrastructure as well as various issues and challenges in usage and setting up of ICT infrastructure in distance learning for E-Learning.

Key words: EDUSAT, e-learning, ICT (Information Communication Technology), rural India, distance learning.

Introduction

EDUSAT, launched by Indian Space Research Organisation in September, 2004, was India's first thematic satellite dedicated exclusively for educational service to provide distance education service in remote areas of India with a total investment of Rs. 549 crores.

Information Communication Technology also known as **ICT** is a commonly referred to branch of Engineering. It involves the use of computers and software to operate and manage information. ICT deals with storage, data transmission, manipulation of data and retrival. Information Communication Technology uses computers and computer networks in various fields including education. It also includes other technologies that are used to distribute communication and information

through telephone, television, mobile phone, multi- media, bluetooth and other telecommunication equipments in general. Various scientific and technological applications like mobile communications, Direct-to-Home services, meteorological observations, telemedicine, tele-education, disaster warning, radio networking, search and rescue operations, remote sensing and scientific studies of the space are also included.

ICT developed after the development of **Space Launch Vehicle** and **Satellites**. Launch Vehicles are used to transport and put satellites or spacecrafts into space. In India, the launch vehicles development programme began in the early 1970s. The first experimental **Satellite Launch Vehicle (SLV-3)**[(2,9-12)] was developed in 1980.

Broad definition of the field of e-learning includes the use of technology to deliver learning and training programs such as CD-ROM, Internet, Intranet, wireless and mobile learning. Some include Knowledge Management as a form of e-Learning.

The Launching of Satellite

With total dedication to the cause of education, the **Indian Space Research Organisation (ISRO)** successfully launched a rocket that carried a 1950 kg satellite, 'EDUSAT', from Satish Dhawan Space Centre, at Sriharikota on 21st September, 2004. **EDUSAT**[(9-12)] is the first Indian satellite built exclusively to serve the educational sector. It is mainly intended to meet the demand for an interactive satellite-based distance education system for the country. The rocket was launched from the country's only spaceport at Sriharikota and placed its payload on a designated orbit, 5000 km away minutes later.

EDUSAT had an expected life of seven years in space, during which it will help educational institutions make up for, among other things, the dearth of good teachers by providing connectivity with classrooms far away. The universalisation of education has become the top priority in India, and for other developing countries.

The 1950 kg EDUSAT was launched into a **Geosynchronous Transfer Orbit (GTO)** by ISRO's Geosynchronous Satellite Launch Vehicle (GSLV)[(2,9-12)]. From GTO, EDUSAT was directed to the 36,000 km high Geo Stationary Orbit (GSO) by firing, in stages, it's on board Liquid Apogee Motor (LAM). In Geostationary Orbit, the satellite was steered to co-locate with KALPANA-1 and INSAT-3C satellites at 74° East longitude.

The satellite had the benefit of radiatively cooled **Ku-band** Travelling Wave Tube Amplifiers (TWTAs) and dielectrically loaded C-band Demultiplexer for its communication payloads. Satellites

can establish connectivity between urban educational institutions and a large number of rural and semi-urban educational institutions to provide an educational infrastructure.

With the success of the INSAT based educational services in the eighties, a need was felt to launch a satellite dedicated for educational service and the ISRO conceived the EDUSAT Project in October, 2002.

Space Launch Vehicles

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Figure 1 : Space Launch Vehicle

Augmented Satellite Launch Vehicle **(ASLV)** was developed to act as a low cost intermediate vehicle to demonstrate and validate critical technologies. With a lift off weight of 40 tonnes, the 23.8 m tall ASLV was configured as a five stage, all-solid propellant vehicle, with a mission of orbiting 150 kg

class satellites into 400 km circular orbits. The Polar Satellite Launch Vehicle, usually known by its abbreviation **PSLV** is the first operational launch vehicle of ISRO. PSLV is capable of launching 1600 kg satellites in 620 km sun-synchronous polar orbit and 1050 kg satellite in geo-synchronous transfer orbit. Figure: 2 shows the view of the Polar Satellite Launch Vehicle while launching the satellite to the space. In the standard configuration, it measures 44.4 m tall, with a lift off weight of 295 tonnes. PSLV has four stages using solid and liquid propulsion systems alternately.

Figure 2 : Polar Satellite Launch Vehicle

Geosynchronous Satellite Launch Vehicle **(GSLV)**[2,9-12] is capable of placing INSAT–II class of satellites (2000 – 2,500 kg) into Geosynchronous Transfer Orbit (GTO). GSLV is a three stage vehicle GSLV is 49 m tall, with 414 t lift off weight. It has a maximum diameter of 3.4 m at the payload fairing.

Figure 3 : Geostationary Satellite Launch Vehicle

Geosynchronous Satellite Launch Vehicle for EDUSAT Launching

EDUSAT was launched by the third flight of ISRO's Geosynchronous Satellite Launch Vehicle. The 1950-kg satellite was lofted into an elliptical geosynchronous transfer orbit looping from 180 km at its closest point to 35,985 km at its farthest, with an orbital inclination of 19.2 degrees to the equator. In the coming days, the liquid-fueled onboard engine will be used to maneuver EDUSAT in a circular geostationary orbit 36,000 km above the planet. It will match Earth's rotation and appear parked above 74 degrees East longitude over the equator, and be co-located with the Indian KALPANA-1 and INSAT-3C satellites.

The 49 metre tall GSLV is a three stage vehicle. The first stage, GS1, comprises a core motor with 138 tonnes of solid propellant and four strap-on motors each with 40 tonnes of hypergolic liquid propellants (UH25 and N204). The second stage has 39 tonnes of the same hypergolic liquid propellants. The third stage (GS3) is a cryogenic stage with 12.5 tonne sof Liquid Oxygen and Liquid Hydrogen.

Figure 4 : GSLV While Launching EDUSAT

Launch Station for GSLV

Satish Dhawan Space Centre (SDSC) SHAR, the launch station for GSLV, is located at 80 km north of Chennai on the east coast of India.

Satellite communications play a vital role in the global telecommunications system. Approximately 2,000 artificial satellites orbiting Earth relay analog and digital signals carrying voice, video and data to and from one or many locations worldwide. There are three types of communication services that satellites provide, viz., tele-communications, broadcasting, and data communications.

Telecommunication services include telephone calls and services provided to telephone companies, as well as wireless, mobile, and cellular network providers.

Geosynchronous Satellite Launch Vehicle

Geosynchronous Satellite Launch Vehicle (GSLV) is an expendable launch system operated by the Indian Space Research Organization (ISRO). It was developed to enable India to launch its satellites without dependence on foreign rockets and providers. GSLV has attempted eight launches to date, since its first launch in 2001 through its most recent launch in 2014. EDUSAT was launched by the third flight of ISRO's Geosynchronous Satellite Launch Vehicle.

The 49 metre tall GSLV is a three stage vehicle. The first stage, GS1, comprises a core motor with 138 tonne of solid propellant and four strap-on motors each with 40 tonne of hypergolic liquid propellants (UH25 and N204). The second stage has 39 tonne of the same hypergolic liquid propellants. The third stage (GS3) is a **cryogenic stage** with 12.5 tonne of **Liquid Oxygen and Liquid Hydrogen.** Figure 4 **: GSLV** While Launching EDUSAT into the space**.**

To date, India has used both of its multipurpose INSAT satellites to provide long distance education information alongside their telecommunications, broadcasting and weather-forecasting functions. It will use the virtual classroom concept to offer education to children in remote villages, quality higher education to students in areas without access to good technical institutes, adult literacy programmes and training modules for teachers. EDUSAT will be a boon to synchronous method of learning.

Satellite Working Principles

A satellite works by receiving radio signals sent from the Earth and resending the radio signals back down to the Earth. In a simple system, a signal is reflected, or "bounced," off the satellite. For example, it is possible to bounce a signal off the surface of the Moon back down to Earth. Because the Moon is very far away, for this to work the signal from the Earth must be very strong and the receiver receiving the signal must be sensitive enough to detect the very weak signal receive back from the moon. Geosynchronous orbiting satellites, those located 36,000 kilometers above Earth, are mainly used for fixed satellite services, namely for broadcasting and for communication. INSAT (Indian National Satellite System) is an example of such satellite. Currently, INSAT-2B, 2C, 3B and EDUSAT operate from this orbit.

In satellite communication, signal transferring between the sender and receiver is done with the help of satellite. Satellite communications play a vital role in the global telecommunications system.

Approximately 2,000 artificial satellites orbiting Earth relay analog and digital signals carrying voice, video, and data to and from one or many locations worldwide.

There are three types of communication services that satellites provide: **telecommunications, broadcasting,** and data communications. Telecommunication services include **telephone** calls and services provided to **telephone** companies, as well as wireless, mobile, and cellular network providers. Broadcasting services include radio and television delivered directly to the consumer and mobile broadcasting services.

Data Communications involve the transfer of data from one point to another. Corporations and organizations that require financial and other information to be exchanged between their various locations use satellites to facilitate the transfer of data through the use of **Very Small-Aperture Terminal** (VSAT) networks. With the growth of the Internet, a significant amount of Internet traffic goes through satellites, making ISPs one of the largest customers for satellite services.

Figure 5 : India's First Education satellite

To date, India has used both its multi-purpose INSAT satellites to provide long-distance education information alongside their telecommunications, broadcasting and weather-forecasting functions. Figure:5 shows the India's First Education satellite, **EDUSAT,** on space.

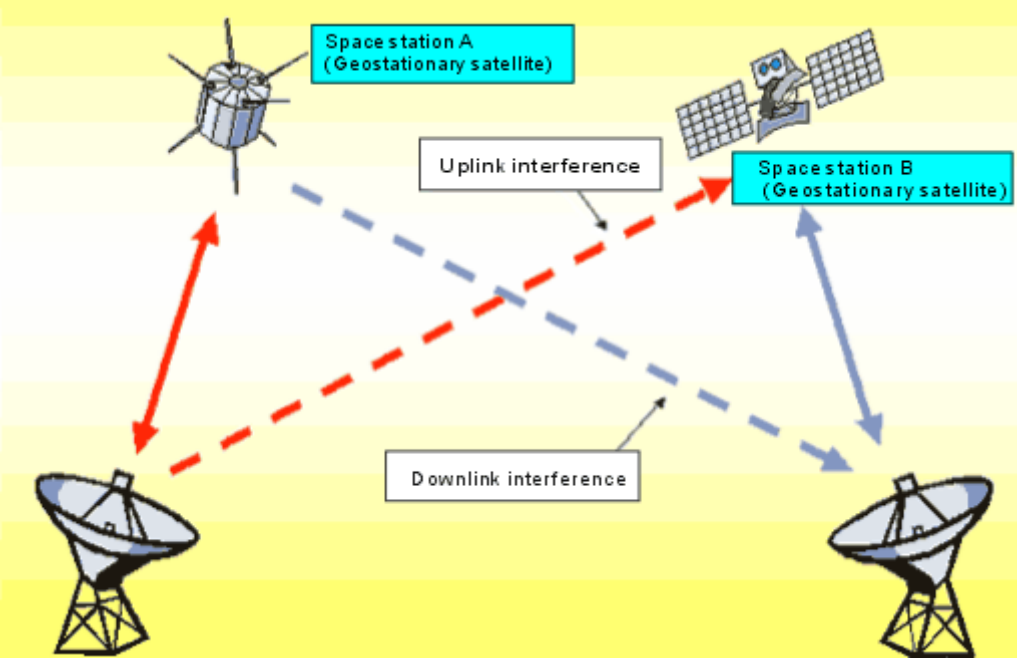

Figure 6 : Coordination of Satellite Communication Network.

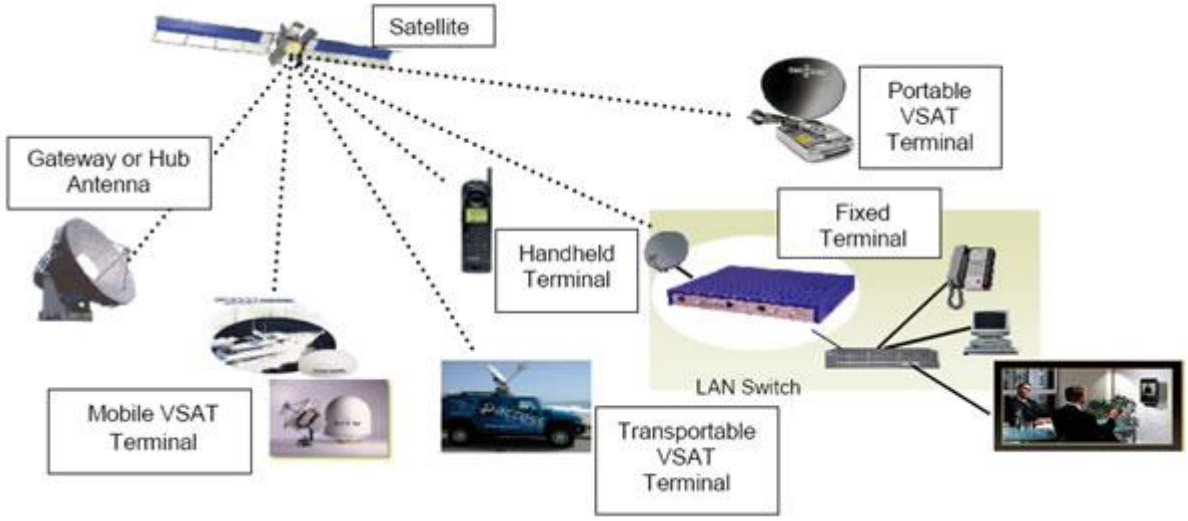

Figure 7 : Satellite Communication Module

EDUSAT

GSAT-3, known as EDUSAT, is meant for distant class room education from school level to higher education. This is the first dedicated "**Educational Satellite**" that provide the country with satellite based two way communication to class room for delivering educational materials. Figure 6. Shows the **Coordination of Satellite Communication Network.**

Basic Details of EDUSAT

Mission : Education

Satellite : EDUSAT (GSat 3)

Position : 74

Norad : 28417

Cospar number : 2004-036A

Spacecraft Mass : 1950.5 kg (at Lift-off) 819.4 kg (Dry mass)

Onboard Power : Total four solar panel of size 2.54 M x 1.525 M generating 2040 W (EOL), two 24 AH NiCd batteries for eclipse support

Stabilisation : 3 axis body stabilised in orbit using sensors, momentum and reaction wheels, magnetic torquers and eight 10 N & 22N reaction control thrusters.

Propulsion : 440 N Liquid Apogee Motor with MON - 3 and MMH for orbit raising

Launch date : September 20, 2004

Launch site : SHAR, Sriharikota, India

Launch vehicle : GSLV-F01

Orbit :Geostationary (74°E longitude)

Manufacturer : ISRO (Indian Space Research Organisation)

Model : I-2K

Mission Life : 7 Years (minimum expected life)

Beams :C-band South Beam

C-band West Beam

C-band Central Beam

C-band NorthEast Beam C-band North Beam

C-band Wide Beam

C-band National Beam

In a simple system, a signal is reflected, or "bounced," off the satellite. For example, it is possible to bounce a signal off the surface of the Moon back down to Earth. Because the Moon is very far away, for this to work the signal from the Earth must be very strong and the receiver receiving the signal must be sensitive enough to detect the very weak signal receive back from the moon.

Unlike a passive satellite such as the moon or the early ECHO satellite, a modern communications satellite receives the radio signal and sends it back down to Earth stronger than it was received. This process is called "amplification" of the radio signal.

People communicate to a satellite using an antenna on the ground, which called an "earth station" in technical terms. The earth station sends up radio signals to the satellite. Figure 7 shows the **Satellite Communication Module**

GSAT-3, known as **EDUSAT** is meant for distant class room education from school level to higher education. This is the first dedicated "Educational Satellite" that provide the country with satellite based two way communication to class room for delivering educational materials.

The Indian National Satellite (INSAT) system which are placed in Geo-stationary orbits is one of the largest domestic communication satellite systems in Asia-Pacific region. INSAT space segment consists of 24 satellites out of which 10 are in service (INSAT-3A, INSAT-4B, INSAT-3C, INSAT-3E, KALPANA-1, INSAT-4A, INSAT-4CR, GSAT-8, GSAT-12 and GSAT-10)

The system with a total of 168 transponders in the C, Extended C and Ku-bands provides services to telecommunications, television broadcasting, weather forecasting, disaster warning and Search and Rescue operations.

In satellite communication, signal transferring between the sender and receiver is done with the help of satellite.

Virtual Classrooms

But EDUSAT's dedicated function will substantially improve the service provided. It will use the virtual classroom concept to offer education to children in remote villages, quality higher education to students in areas without access to good technical institutes, adult literacy program and training modules for teacher.

Once EDUSAT is commissioned in two months' time it will initially provide one satellite link per beam, with each link catering for up to 200 classrooms. When fully operational, 25 to 30 satellite links will broadcast to about 5000 remote terminals .

The launch marks several firsts for India's space program, says Nair. EDUSAT is India's first satellite dedicated for education. Others being planned include AGRISAT, to address the country's agricultural needs, and HEALTHSAT, for providing telemedicine services.

It is also GSLV's first operational flight. India will no longer depend on Europe's Ariane rockets to launch satellites of up to 2 tonnes, though it will continue to use them for heavier spacecraft.

Smart Classrooms

Smart Classroom is the use of modern Information and Communication Technology ie. EDUSAT to engage the students in a class rooms to learn lessons by presenting materials through intriguising on a multimedia system that incorporates the use of internet, power point, CD, DVD and VCR. It is designed to blend into the architecture, so that it becomes part of the class. Smart classrooms enable students and faculties to make use of every available resources from one point at the click on the button on the computers. Figure:8 shows the usage of EDUSAT in Information and Communication Technology

In general the smart classrooms are equipped with the following:

Ceiling mounted LCD Projector and a large Projector Screen

1. Laptop with all connectivity
2. DVD
3. VCR
4. Sound System
5. Video Camera
6. Touch Screen Control System
7. Landline phone, wireless radio, frequency mouse, key board, micro phone etc..

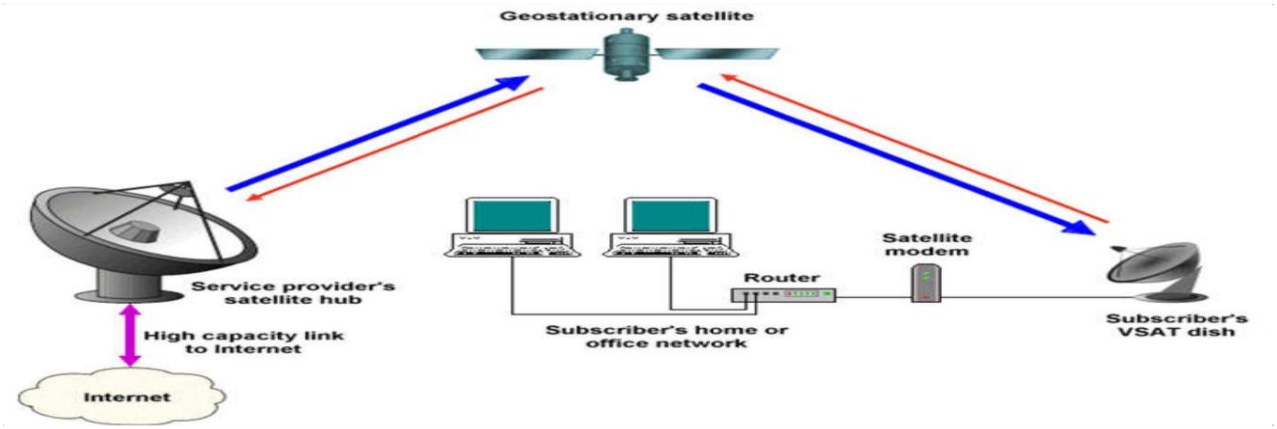

Figure.8: EDUSAT in Information and Communication Technology

Synchronous Methods

Virtual classroom duplicates the features of a real classroom online. Participants interact with one another and with the instructors online, instant messaging, chat, audio and video-conferencing, etc.

Scope of e-Learning in India

E-learning can be examined at two levels. The first one is education and another one is training. The education can be used at both elementary and higher levels. In training it can be used by companies to train and upgrade their employees.

Looking at the population, the available universities are not enough to accommodate all the people seeking education. At this point distance education comes in and has already been quite popular. E-learning can play a major role even here.

Advantages of e-Learning

There are a number of advantages of e-learning[(5)]. First, we are using state-of-the-art technology and instructional strategies. Cultures can be shared through e-learning. Disabilities can be accommodated, with or without the knowledge of other participants. Gender may not be an issue, because in many situations, gender is unknown – or it can be. Because of global access, the classroom may be the world. Nothing can replace traditional classroom teaching, but e-learning complements the process and can help reach out to the masses. Figure:9 Potential Use of Educational Satellite in various fields.

The biggest advantage of e-learning lies in its ability to cover distances[(5)]. For an organization that is spread across multiple locations, traditional training becomes a constraint. All trainees need to come to a classroom to get trained. Additionally, the trainee‘s learning pace is not addressed as all trainees are treated as having equal abilities and there is little flexibility in terms of timing and completion of the course. The major advantage is the consistency that e-learning provides. e-learning is self-paced, and learning is done at the learner’s pace. The content can be repeated until it is understood by the trainee.

EDUSAT carries five Ku-band transponders providing spot beams that will focus on specific regions, one Ku-band transponder providing a national beam and six extended C-band transponders with national coverage beam.

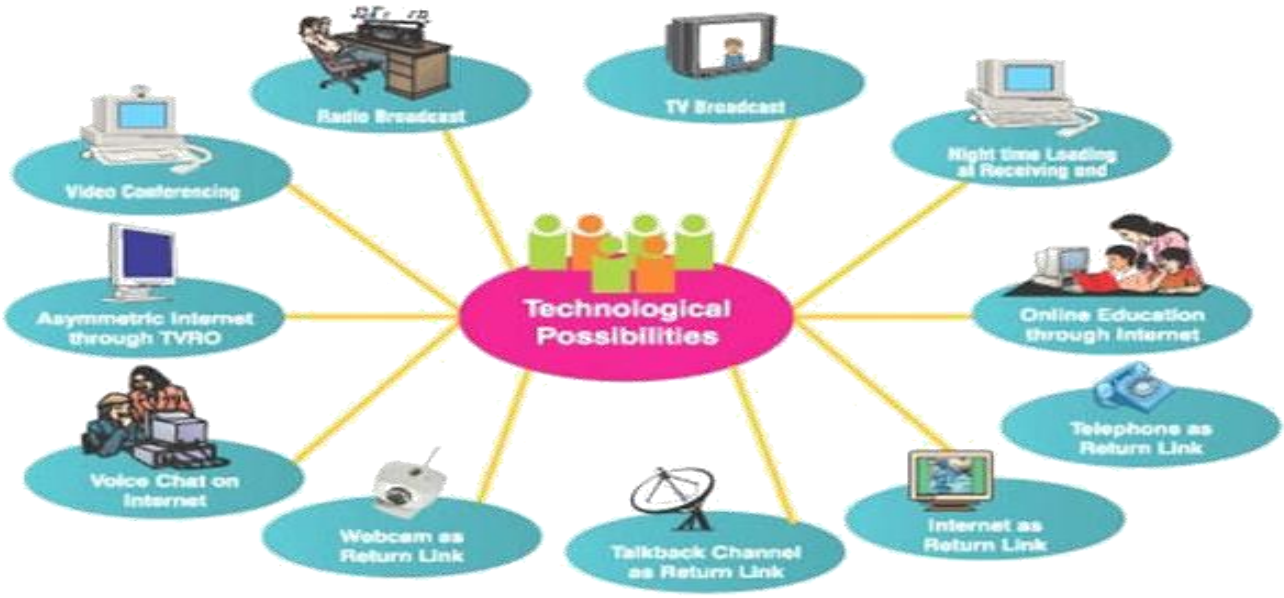

Figure.9: Potential Use of Educational Satellite

One of the common disadvantages to e-learning is that some students, especially those for whom English is not their native language, have difficulty communicating and being understood. Another group of students may experience computer or technology anxiety, which may in turn impact their learning and their final grades.

EDUSAT Application Technology

The DVB-RCS system supports communication channels that operate in two directions: a forward channel from the hub station to many terminals and a return channel from each terminal to the hub station.

Satellite Interactive Terminal (SIT)

A Satellite Interactive Terminal is a user terminal with the capability to communicate via a return channel. A typical SIT[(1,3)] with 1.2 m antenna for low data rates can be a connecting device into a computer or TV set for interaction. Satellite interactive terminal for high data rates with 1.8 m antenna can be used for video conferencing.

S.No	Customer	Total No of Nodes for each Agency	Installation and Commissioning Completed
1.	Indira Ghandhi National Open	134	**129**

	University		
2.	National Council of Educational Research and Training/ Central Institute of Educational Technology	100	71
3.	ARVN	11	11
4.	Indian Space Research Organization	9	9
5.	University Grants Commision/CEC	58	50
6.	All India Council of Technical Education	103	83
7.	Department of Space and Technology	20	10
8.	Others	6	43
	Total	**441**	**406**

Table 1: **Installation, Commissioning and Integration of S.I.T's**

SITs can be connected to several user PCs via a Local Area Network (LAN).EDUSAT is presently configured for 10 Mbps on the Forward Link considering satellite resources available and total traffic expected among all the SITs. **Table 1** presents the **Installation, Commissioning and Integration of S.I.T's** in education**.**

Receive Only Terminal (ROT)

The receive only terminal (ROT)[3], is a passive communication device making no provision for interactivity. In the EduSat context, such terminals are 0.75 meter dish antennas used for one-way TV and data reception.

Each user agency in EduSat can establish its own independent **Wide Area Network (WAN),** but will be expected to use TCP/IP protocols for communication.

Video conferencing can be initiated from the TE to achieve direct interactions between the teacher and students. The student database will be maintained there, as well as such administrative support as online registration, online examination, distribution of circulars and announcements.

ICT Enabled Education

Technology has great impact on what we can do. The printing press is an example. People were reading and writing even before the invention of the press but it was not that wide spread. Courses delivered via EDUSAT can meet immediate learning needs as well as help learners become more self-directed in their ongoing learning. Using the Web as an instructional medium is possible as more learners gain access to the Internet. EDUSAT incorporates a technology base that is appropriate for the widest range of students within a program's target audience.

Learners bring varied social and cultural backgrounds and diverse experiences to a distance-learning situation. The unique contexts in which learners live and work influences the way they think about and use EDUSAT network.

Consortium for Educational Commission (CEC) is one amongst the five primary users of this educational satellite. ISRO has adjudged the CEC as "the best EDUSAT National Beam User" in July 2008. At present, there are over hundred Satellite Interactive Terminals (SITs) and Receive Only Terminals (ROTs) under **CEC EDUSAT network**[(8)], installed at various colleges, Academic Staff Colleges and Universities across the country.

Many more are being added with the purpose of providing quality higher education to the remote areas through satellite network.CEC EDUSAT network (Figure 10) is empowering students through cutting edge technology and caters the needs of students across the country.

Figure.10: EDUSAT Network

E-learning (or e-Learning) is the use of electronic media and **Information and Communication Technologies (ICT) in education**. E-learning is broadly inclusive of all forms of educational technology in learning and teaching.

E-learning is inclusive of, and is broadly synonymous with multimedia learning, Technology-Enhanced Learning (TEL), Computer-Based Instruction (CBI), Computer Managed Instruction, Computer-Based Training (CBT), Computer-Assisted Instruction or Computer-Aided Instruction (CAI), Internet-Based Training (IBT), Web Based Training (WBT), online education, virtual education, Virtual Learning Environments (VLEs), i.e., the learning platforms, m-learning, and digital education.

E-learning includes numerous types of media that deliver text, audio, images, animation, and streaming video, and includes technology applications and processes such as audio or video tape, satellite TV, CD-ROM, and computer-based learning, as well as local intranet/extranet and web-based learning.

Conclusion

Satellite communication technology using EDUSAT is a strong tool for the development of distance education. The students visualize the teaching and methods from the video programs delivered through EDUSAT. Students gain knowledge and understanding of their subjects and they can classify their doubts then and there. The objective of information and communication technology by using EDUSAT has to bring quality education from primary to higher, technical and professional education to the unreached poor people of the country.

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