

# **e –Learning or Virtual Learning or Virtual Learning Through VSAT**

**Venkatesan RAVICHANDRAN, India**

**Key words:** VSAT, HUB, DTE, TDM/TDMA, Control Server

## **SUMMARY**

E-learning through VSAT network consists of a HUB station, which is a satellite earth station and a Studio for video broadcasting of the lectures and many remote classrooms. The HUB will interconnect the VSATs at various geographical locations establishing the communication link in C or in Ku bands. The Studio room consists of Control Server, Agent Server, AV (Audio/Video) Streaming Server, Presentation Capture Server apart from other servers like Media Control Recording Server, Whiteboard Server, Text interaction Server, Live Voice Room Server, Private Voice Call server etc. The Control Server is at the heart of the E-learning through VSAT and it acts as a gateway to all remote classrooms. The remote virtual classroom is a receiving agent and must have registered students with computer systems along a dedicated Internet dial up line. The advantages are - video and audio output of the lecturer/teacher, return audio and video from the student for a unique teacher-student interaction, option for displaying animated content during the live lecture with unique interactive tools for making the lecture livelier, text chat option for students to ask questions and to get reply, audio chat for teacher-student interaction through audio mode, option for the student to join or leave a particular lecture session, whiteboard option for the teacher/lecturer to write any content during the live presentation, option for the teacher/lecturer to surf for content from an online library which all students can view at the same time during the live presentation. VSAT network is easy to implement and is secure.

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## **1. INTRODUCTION**

E-learning or Virtual Learning - The convergence of the Internet and learning, or Internet-enabled learning is revolutionizing the way in which education is imparted to students. It uses the satellite based network technologies to create, foster, deliver, and facilitate learning anytime and anywhere. It enables delivery of comprehensive, individualized, and dynamic learning content in real time and aids in the development of communities of knowledgeable persons, linking learners and practitioners with experts. E-learning through VSAT network consists of a HUB station, which is a satellite earth station and a Studio for video broadcasting of the lectures. The HUB will interconnect the VSATs at various geographical locations establishing the communication link in C (4GHz - downlinking and 6GHz. - uplinking) or in Ku (12 GHz - downlinking and 14 GHz - uplinking) bands.

## **2. WHY E-LEARNING THROUGH VSAT?**

There are a few key reasons to implement e-Learning or Virtual Learning through VSAT:

- VSAT technologies employing the latest SCPC (Single Channel Per carrier), TDMA (Time Division Multiple Access) or CDMA (Code Division Multiple Access) are better than many types of terrestrial leased line services in the light of corporations/institutions shifting to become more IP-centric and while continuing to support their legacy protocols.
- The technical advancements in VSAT earth station equipment and higher-powered satellites have made VSAT communications extremely reliable (up to 99.9% or more) and capable of providing nearly error-free ( $<10^{-7}$  BER or better) digital transmission throughout the entire network of remote sites.
- VSAT network operates at speeds from a few Kbps to many Mbps - easily supporting any mix of voice, data, video or facsimile services that may be required, now or in the future.
- VSAT networks are easy to install and operate and network expansion can be accomplished quickly and painlessly - additional VSAT earth stations (remote site terminals) can be added to the network at any time, virtually on a plug-and-play basis.
- VSAT networks that are capable of supporting a wide variety of circuit connectivities and protocol requirements, such as: point-to-point, point-to-multipoint, broadcasting, uni-casting, and multi-casting services over dedicated circuits, switched circuits, IP, Frame Relay or ATM.
- The potential cost savings and operational advantages of satellite communications over many types of leased terrestrial carrier services cannot be overemphasized. It is one of the main reasons for the phenomenal growth of the VSAT industry in the past decade.

### 3. VSAT-TECHNOLOGY

#### 3.1 Overview of VSAT

Very Small Aperture Terminal (VSAT) is a low cost business terminal with small antenna. These VSATs are two way data terminals or one-way data link depending on the situation. In general, a VSAT network consists of a large high performance hub earth station (with an antenna of up to 9 m in diameter) and a large number of smaller, lower performance terminals. VSAT network can also be a mesh or point-to-point network. The most common VSAT configuration is the TDM (Time Division Multiplexing)/TDMA (Time Division Multiple Access) star network. These have a high bit rate outbound carrier (TDM) from the hub to the remote earth stations, and one or more low or medium bit rate Time Division Multiple Access (TDMA) inbound carriers. Remote user sites have several low bit rate data terminal equipments (DTEs) operating at 1.2 to 9.6 kb/s. These are connected through the VSAT network to a centralised host processor.

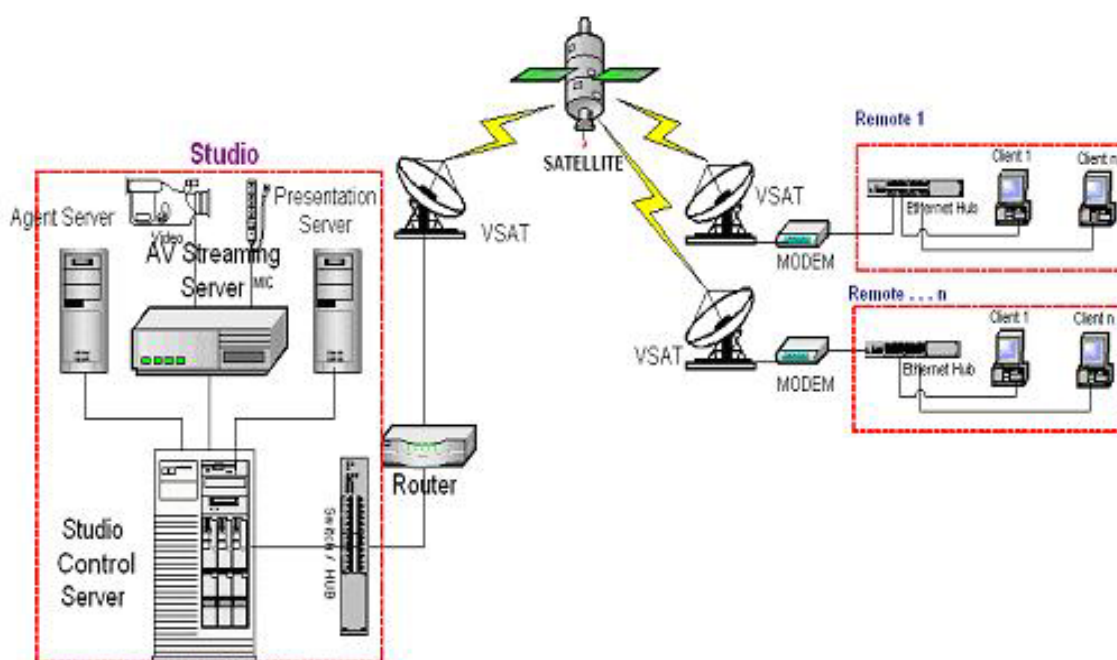
Three different transmission schemes are used for interactive hubbed VSAT networks:

- TDM/TDMA
- Demand Assigned SCPC
- CDMA

Of these TDM/TDMA is by far the dominant technique with only CDMA being used to a small extent. Demand assigned SCPC has been virtually abandoned as a transmission scheme for the present. All the established interactive hubbed VSAT systems use TDM/TDMA access as the primary access technique (TDM on the outbounds and TDMA on the inbounds).

## Network Architecture

### Studio and Remote Class Room



### 3.2 Hub Station

The hub station is the nodal point in the VSAT satellite communication. It is a high performance earth station with an antenna diameter of anything between 6 and 9m. The hub consists of a control center with redundant units to manage the network as well as microwave equipment, including an outdoor antenna for the transmission and reception of signals. Redundant units are connected to switchover in case of failure. Substantial amounts of interfacing equipments are necessary to support the wide range of terrestrial interfaces required at the hub. These equipments are usually mounted in several racks. Hub stations can also be shared between several networks, resulting in a sharing of costs.

### 3.3 Remote Center

At the Remote end, a dish antenna, outdoor unit (microwave electronics for terminal) and an indoor unit (for modulation, demodulation, multiplexing, demultiplexing and synchronization) are present. Remote terminals have now become very reliable, with MTBFs of typically 25000 hours. Link availability is also usually designed to be high, with an end-to-end availability of better than 99.7% being quite common.

## **4. E-LEARNING THROUGH VSAT**

### **4.1 Overview**

E-Learning through VSAT is convergence of technology, services and knowledge base. This provides a facility and framework for Tele-Education and enables the live classroom session to be broadcasted over the VSAT, WAN and Internet communication channels. It consists of a HUB station, which is a satellite earth station and a Studio for video broadcasting of the lectures. Apart from these, other related hardware and software are used to effectively deliver the contents across. The HUB will interconnect the VSATs all over the places where the colleges are present, establishing the communication link in Ku band. Virtual Tele ED™ is one such solution based on VSAT.

### **4.2 Virtual Tele ED™**

Virtual Tele ED™ is a combination of learning services and technology, using VSAT to provide high value integrated learning at any time and any place. The Virtual Tele-Ed Agent acts as a Teacher unit for presentation of the subject over the on-line. The significant features are:

- Support educational organization with any number of remote students
- Platform independent and modular architecture
- Robust and secure Java Enabled Framework
- Distributed, reusable, and integrated learning and training
- Integrated audio, video and data presentation in a live broadcast
- Extensive multicasting capabilities through TCP/IP channels
- Extensive synchronous and asynchronous collaboration tools for knowledge sharing
- A user-friendly interface and powerful data manipulation
- Usable both in intranet and internet
- Comprehensive integrated support for richer communication and activities

### **4.3 Setting up of Communication Center and Data Hub**

A Communication Center cum Data Hub will be set up at the University campus or any at suitable location, from where the live lecture transmission would be done to Remote Centers (colleges) at various locations. The communication center is the nodal point for all the electronic transaction between the host (University) and agents (Remote colleges). For this, very powerful servers with redundancy are set up with complete software and network infrastructure. This Communication Center will have a studio with control room and various audio and video recording and editing equipment. The lecture transmission is carried out with the help of Software. The Communication Center or Studio room has the following Servers.

- Control Server
- Agent Server
- AV (Audio/Video) Streaming Server

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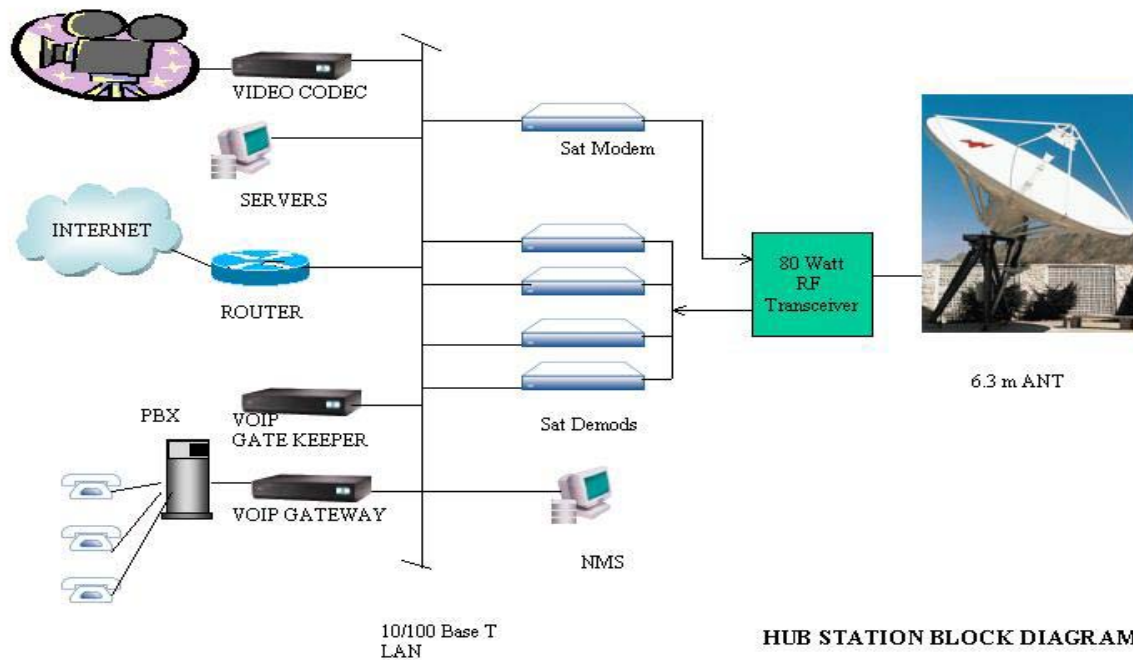
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- Presentation Capture Server
- Media Control Recording Server
- Whiteboard Server
- Text interaction Server
- Live Voice Room Server
- Private Voice Call server.

The content is captured through various Servers and transmitted to Remote Centers through VSAT, which are then received at the Remote Centers.



#### Studio/Control room requirements

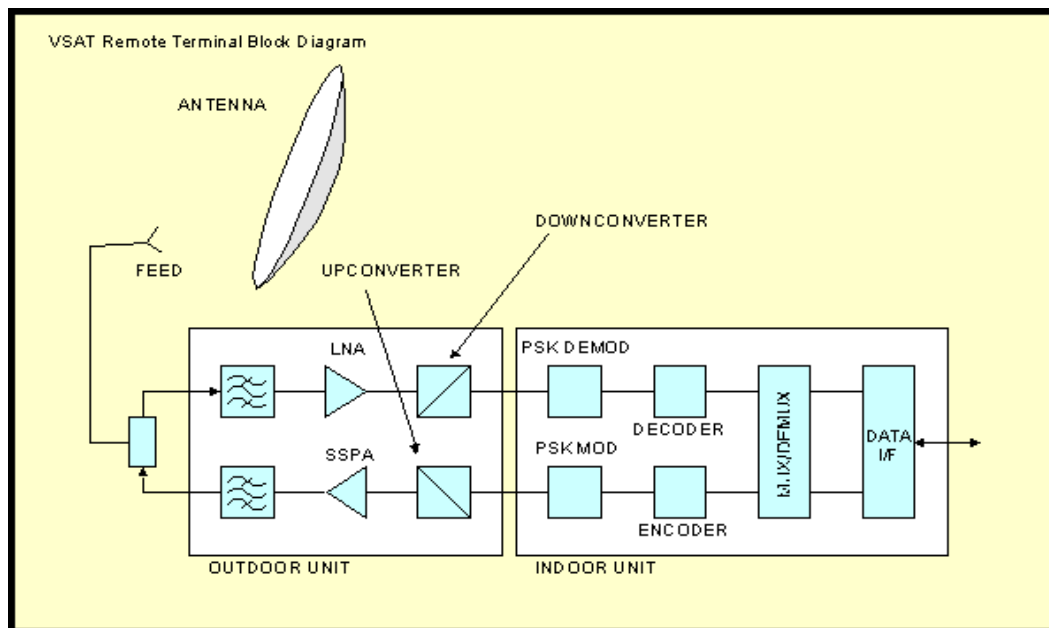
- Windows 2000 Advanced Server
- SQL Server 2000
- J2SE 1.3, JM Studio 2.1, JSDT 2.0
- CPU 2 GHZ, RAM 512 MB
- Audio and Video Capture Devices.
- VSAT/ Leased Line / ISDN / WAN / Internet Dialup / PSTN.

## 4.4 Setting up of VSATs at Remote Classroom

The Remote Classroom is equipped with a good quality digital video system and a large screen TV monitor in each classroom. The video is used to enable students in the various locations to view the live lectures conducted by the lecturers. Audio is provided for the students to interact with the lecturers during the live class sessions.

Remote Classroom requirements

- Windows 9X / NT / 2000 Professional / Linux / Unix / Sun Solaris
- CPU 800 MHZ, RAM 128 MB
- VSAT/ Leased Line / ISDN / WAN / Internet Dialup / PSTN.



VSAT Remote Terminal Block Diagram

## 4.5 Functions of various Servers

### 4.5.1 Control Server

The Control Server is at the heart of the E-learning through VSAT and it acts as a gateway to all remote classrooms. This control server manages and controls the Multicasting Servers such as Audio/Video Server, Presentation Capture Server, and Media Control Recording Server during the proceedings of the live broadcast through Control Agent Server. The teacher and the remote students can share their subject knowledge through the various interaction servers such as Whiteboard Server, Text interaction Server, Live Voice Room Server, and Private Voice Call server. Apart from this, the Control Server

- Allocates the specified port for the servers running in the studio and remote classrooms dynamically.
- Check and monitor the status of the all the studio servers.
- Maintains the Session - port, address, and index of the connected servers all through the live broadcast.
- Move the connectionless ports into the separate port poll for using the same once again, if required in time.
- Maintains all the current details of the daily presentation such as live session participants, subject, session duration etc.
- Streams and enables the content presentation, video capture of the teacher and the voice over the broadcast network
- The student attendance can be viewed based on the logon

#### 4.5.2 Agent Server

Agent Server manages the content through Database. All interactions between the remote classroom and the Hub are managed through this server via Control Server.

#### 4.5.3 Video and Audio Streaming Servers

The video and audio steaming server capture the video and audio from the capturing devices such as the web cam or digital camera in the studio to capture the real time live presentation. The captured video is encoded as MPEG-1 format and transmitted through the streaming server. Streaming is possible in Multicast and Unicast. The maximum of streaming server bandwidth is 256 Kbps to 5 Mbps.

#### 4.5.4 Presentation Capture Server

Through this server, any content with text, power-point slides, video clippings, multimedia, graphics, animation and drawings running in the teacher-unit PC can be captured and encoded for transmission. During the live broadcast session, the individual learner or learner groups in the remote classroom sees the same kind of presentation. During processing, this server writes the error and the current processing status in the log files for troubleshooting of the problems.

#### 4.5.5 Multimedia Recording Server

The archival of the live presentation is done through the multimedia-recording agent in the studio. All the daily proceedings and multimedia contents of the live session are recorded and archived through this agent for future repeat telecast. This server also maintains the status and error log files for future references.



## 4.6 Presentation controls

The Agent Server acts as a Teacher unit for presentation of the subject over the on-line. The following are the comprehensive collaboration tools provided for Teacher-Student interaction in the V-Learn Tele-Ed studio software. From this, the current presentation details such as subject, date, start time, and end time can be displayed. From the studio, a teacher can control and manage the Multicasting Servers such as audio, video, Presentation Capture Server and Media Control Recording Server. Some of the other features of the software include the following:

- **Student List:** The list of students those who are joined in the current presentation over the network are viewed from here.
- **View Questions:** A teacher can view the different questions coming all from the remote classrooms, in the text area provided separately here. In turn, a teacher can also send the reply to the selected question to the particular student.
- **Send Message:** From this area, a teacher can send the general messages such as assignments today, future references etc., asynchronously to a student in the particular remote classroom by selection or send the same to all through the network (message to every one) during the live presentation.
- **View Message:** During the live presentation, all the asynchronous text interactions between both sides taking place within that stipulated time of the session are displayed here.
- **Audio Chat:** The central studio system can place all the request calls for questions from the students of various locations, in the queue. A teacher can select and accept any one of the received requests that are in the queue for private chat. Then the audio interaction between the teacher and the selected student can be made live.
- **Text Chat:** Through this text interaction room, a teacher in the studio and all the remote students in on-line can participate in the text interaction on any specified subject. The specified text area is provided to view the participants' list and the interaction.
- **Whiteboard:** The Whiteboard facility provides both the teacher and remote students in the same platform to share the subject knowledge. Through this effective collaboration tool, a teacher can able to draw any relevant information at any instant of time during the live presentation. The teacher can also push some others like Power Point slides or whatever the teacher want into whiteboard.
- **Discussion:** This collaboration tool is just like an audio chat room. A teacher in the studio and all the remote students in the classroom can participate in the voice interaction.

- **Return Video:** This facility enables the teachers at studio to monitor the remote students. Through this effective monitoring the teachers at studio can able to observe the remote students presence and attention to the learning system. The Return video is based on Unicast.
- **Surfing:** The Surfing facility is given to the Teacher to refer the books or any other subject related sites online. If the teacher wants to send this reference to all the remote students, it can be send through the URL Reference functionality in Surfing module. Through this facility the teacher can use the online Library when the live session is going on.
- **Monitor:** Through this effective monitoring the teacher at studio can able to observer the remote students presence and attention to the learning system. The teacher can able to view the 4 students monitor at a time. This is based on Multicast.
- **Online Surveys:** With any of the above options, virtual surveys can be used. They can also be used in conjunction with a traditional assignment. To be clear, an online survey is a web page with boxes to fill in and submit with a computer keyboard and/or mouse. An alternative strategy, using e-mail to attach a survey document in a text format, is already familiar to most participants and is not to be confused with the online survey discussed here. Nearly any survey that is developed in a typical word processing format can be made into an online web page form. Once created, Students can contact respondents using e-mail with the survey's direct link. Respondents click on the link, complete the survey, and submit the form. The benefits here are the elimination of printing, faxing, and other paper-related steps, as well as time delays as the surveys pass through handling and sorting channels (e.g., inboxes and postal mail). The dissemination and collection of surveys is greatly streamlined using this option.
- **Online Fees Payment:** Students can pay their fees through the website. The transfer of money is done in a secured manner. Separate accounting software maintains the fees management. Students can pay their fees using their user id and password provided.
- **Digital content:** Study materials for all students of different years and different courses are uploaded in the website. Students can download their study materials from website and it will be useful for them to refer at any time. No need to go the study centers to get the book and study. The teacher who is taking the class can use this digital content to explain the students in real time. It will be very much useful for quick reference for the teacher while teaching.
- **Online Registration:** Any university or college or institution can upload the application in the website for admission forms, Examination forms etc., any one can download the application form from the website and they can fill it up and send back to the corresponding mailing address. This is the time saving process for both staffs and students.
- **MDI (Multiple Document Interface):** MDI allows the student to visualize all the media contents (Audio, Video and Presentation) in a single window.
- **SDI (Single Document Interface):** SDI is vice versa of MDI. It allows the students to visualize all the media contents separately in a new window.

## 4.7 Remote Classroom

The remote virtual classroom is a receiving agent and must have any registered student with a computer system or group of students in a classroom with each system along dedicated Internet dial up line. The software in the student system is having extensive collaboration tools as mentioned below for sharing the subject knowledge with remote teacher or with experts.

### 4.7.1 E-Learning Management System

The Learning Management System (LMS) is a tool using which a student can manage information like personal information, tracking of student schedules / timetable, personalising the student schedule using the personal organizer and most importantly surfing the content that is uploaded on the network. Each registered student is given a unique username and password form, which he/she can access his/her own space from which the various functions provided above, can be accessed. Since the solution is a web-enabled solution the same can be accessed by the student even from their homes or any browsing centre.



### 4.7.2 View Presentation

In this section, a student can select and view the current presentation title from the tree structure. From the student system, he can join / leave the live classroom session and also a provision to ask text question, request for voice interaction to the teacher. For invoking the above functionality, the following buttons are provided.

- **Join:** Student can join the selected live presentation. The live content for the presentation from the teacher unit can be dynamically displayed in the student unit.
- **Leave:** Student can leave the presentation that he joined previously.
- **Ask Question:** Student can raise the question through the text area provided and the above question is queued up in the teacher's question queue and returns the queue id to the question.
- **Audio Chat Request:** A student can raise the audio chat request to the teacher. His request is queued up in the teacher's audio chat queue and wait for response from the teacher. Later teacher in the studio can select the student and allow him to interact through voice.
- **View Reply:** From this, a student can view the question and reply from the teacher for the already raised question. The reply message from the teacher is possible only when the teacher selects the particular question and responds to the same.
- **Send/ Receive Message:** A student can send the message to the remote teacher and view the general messages from the teacher.
- **Play Pre Recorded Program:** Students can select and browse the pre-recorded programs through this play option for further clarifications or for clear understanding.
- **Discussion:** During the live presentation, any student already joined in the discussion room can ask questions to the teacher or the panel in the studio. The audio interaction between the student and the remote teacher can be made live to those who are all joined in the room.
- **Text Chat:** Through this text interaction button, the remote students in a virtual classroom and teacher or expert in the studio can participate in the text interaction on any specified subject. It is possible to view the participants' list and the interaction from the specified text area.
- **Profile:** The Profile facility provides to view the user's personal information to the teacher.

## 5. ADVANTAGES

E-Learning through VSAT connects teacher and students through voice, video and computer based information networks, allowing them fast and secure access to rich unified information content. The content can be enriched by referral to experts in the field and huge spatial data libraries can be maintained which, can be accessed by the students and the lecture deliverer on line. Also many complicated models and concepts can be made easily understood by the students through multimedia contents delivered online. The salient features of Virtual Tele ED™ are:

- High quality video and audio output of the lecturer/teacher.
- High quality return audio and video from the student for a unique teacher-student interaction.
- Option for displaying animated content, during the live lecture with unique interactive tools for making the lecture livelier.
- Unique text chat option for students to ask questions, which would be given an ID and a reply for the same, would be sent back.
- Option for the student to join or leave a particular lecture session.

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- Provided with a unique whiteboard option for the teacher/lecturer to write any content during the live presentation.
- Audio chat for teacher-student interaction through audio mode.
- The teacher/lecturer can surf for content from an online library and all students can view the same during the live presentation.

For underserved regions, where the local voice telephony and Internet infrastructure is inadequate or simply does not exist, VSAT communications is the ideal solution. This makes the standard and quality education available even to students at remotest places. Apart from the above, there are the benefits of costs, efficiency and safety and convenience.

## 6. CONCLUSION

VSAT Technology has matured over years. With increase in communication speeds up to many Mbps and reduction in antenna size that can be easily mounted on rooftops or can be mounted from ground, it is most trusted and best suitable for e-learning. Expansion of education network to newer areas is very easy by simply plugging in new antennas at the sites. Virtual Tele ED™ is a complete E-Learning solution through VSAT that is being implemented by Mindlogicx Infotech Ltd in India.

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## BIOGRAPHICAL NOTES

Mr.V.Ravichandran is presently working as Deputy Director in Karnataka Geo-Spatial Data Centre of Survey of India, Bangalore. He is a Master degree holder M.Sc. in Applied Mathematics from Anna University, M.Tech in Surveying Technology from Jawaharlal Nehru Technological University and MBA in Finance from Indira Gandhi National Open University. The author has put in more than 25 years of experience in digital environment including the last 14 years in the field of Surveying and Mapping. He is Secretary of Indian National Cartographic Association, Bangalore Branch, National Executive Council Member of Indian Society of Geomatics and member of Indian society of Remote Sensing. He had published paper on “Large Scale Mapping using Satellite Imageries”, “Hand-held GPS and PDA in updating 50K topographical maps – an evaluation”, etc. He is involved in writing programs, developing databases, creating spatial datasets, teaching/training staff in various aspects of Surveying and Mapping, Planning and Executing Survey Projects including integration of RS, GPS and GIS. He had also personally conducted GPS campaign in Antarctica during Indian Antarctica Expedition in 1997-98 and participated in “Global Mapping – Contribution to Global Mapping Development by GIS” during 2004 at Geographical Survey Institute, Japan.

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Currently he is involved in the creation of digital spatial datasets for GIS and preparation of large-scale maps using remote sensing, aerial photographs and GPS for many cities in India.

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