AN OVERVIEW OF ISRO SATELLITE PLATFORMS

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India, a late starter in telecommunication satellite, leap frogged adopting a multimission approach of accommodating telecommunication, TV broadcasting and meteorological services in one satellite and the Indian National Satellite System (INSAT) has emerged as one of the largest domestic communication system in the world.

While in the first generation of INSAT-1, 4 spacecraft were procured from USA, the second generation of 2 ton class of satellites were developed indigenously with the launch of INSAT-2A in the year 1992 being a major step in the area of communication satellite technology. Five of these were launched and the third generation of communication satellite was then evolved with higher mass and power upto 3 ton Kg and 3 kw of power. This series is now called I3K and is the workhorse of the INSAT system with 4 spacecraft in orbit catering to the national needs in 'C', 'S' and 'Ku' band services, two of them are supporting meteorological services.

To make use of the capability of PSLV in GTO, a new spacecraft bus with nominal 1 ton in GTO has been developed and employing this a dedicated meteorology satellite, Kalpana-1 is put into service. Further, the INSAT-2 series has been optimized to make effective use of the 2 ton capability of GSLV and the new I2K series has been developed with GSAT-2 in orbit for last one year. Subsequent spacecraft of this series like EDUSAT is due for launch in September 2004 and high power Ku band INSAT-4C in mid 2005 will augment the present capacity.

The I3K is now being further augmented to facilitate handling up to 6 kw of power with 3.1 ton weight in GTO to cater to the increased service demands and is compatible to the current generation international launch vehicles. The I3K has been evolved as an optimized bus over the years.

Thus, ISRO has evolved 3 standard GTO spacecraft buses to offer a very cost effective, competitive space segment and is adaptable to the varying needs of missions and payloads, realizable in fast turn around time and also capable of catering to the new challenges.

In the process of developing these satellite buses, a very comprehensive and integrated spacecraft production and testing facility has been evolved with all facilities under one roof and one management. A new spacecraft integration facility including the associated test facilities is also being built and will be ready by the end of 2004. ISRO has also built a sophisticated facility and infrastructure for supporting the spacecraft in-orbit including the transfer orbit operations and catering to multiple satellites at a time.

ISRO is the only single body which supports communication spacecraft activity from very initial conceptualization of mission with detailed system design, realization, testing, pre-launch support, post launch operations, in-orbit checkout and even on-orbit support if within the visibility from Master Control Facility (MCF), Hassan.

Session on Satellite Communication Technology:

Technical Challenges for the Next – Generation Communication Satellites

Jim Simpson, Boeing Satellite Systems

Abstract

The recent past has witnessed a dramatic increase in the use of space for commercial enterprise: GPS navigation satellites, telecommunication satellites for global telephony, multimedia video and high-speed Internet connectivity and Earth imaging satellites for resource monitoring and weather information. These contribute high-growth revenues to the global economy.

The very success of the technical innovations in the satellite arena such as large size and power, reliability and long life, has resulted in stagnation in demand. New commercial space products and services, such as high speed internet and data services (handheld, aircraft and maritime, direct to home/small office), telemedicine and distance learning distance learning are emerging, and hold the promise of contributing to new growth and revenue streams. However, the high cost of satellites remains a major inhibitor. This presentation projects our views on the key issues/challenges that must be overcome to realize this potential.

Strategic initiatives to exploit synergies with industrial partners to produce cost-effective solutions to the customer are described. Technological developments for realizing high efficiency and high power satellites and the use of DSP technology to realize flexible, and re-configurable payloads are highlighted. Some system solutions that leverage Boeing's overall capabilities such as CONNEXION and ATM/WAAS are then described.

The applications and markets are there if we can pool our resources and come up with innovative and low cost solutions.

ADVANCES IN PLATFORM ELECTRONICS & STABILIZATION TECHNIQUES

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Today, INSAT has become a vital component of the national system, providing services in the field of communication and meteorology. Though INSAT 1 series of spacecraft were bought out, the next generation of INSAT spacecraft have been indigenously designed and developed. ISRO is already into the design/fabrication of fourth generation of INSAT spacecrafts, first of which is likely to be launched in the early part of 2005. ISRO has developed three versatile spacecraft buses. These are: I-1K with a lift off mass of 1.1 ton compatible with PSLV, I-2K with a lift-off mass of 2 to 2.3 tons compatible with GSLV & I-3K with a lift off mass of 3 tons compatible with ARIANE and other standard launch vehicles.

This paper deals with the latest developments in ISRO in the area of electrical Bus Systems consisting of solar array power generation, power distribution, battery technology, propulsion system both chemical and electric propulsion as well as attitude control/stabilization techniques with better pointing and stability. These consist of integrating several electronics functions like attitude and control electronics, telemetry, telecommand and thermal heaters management into a single bus management unit. The BMU design is based on MIL std. MA-31750 processor with 1553 bus capability.

ISRO has expertise both for momentum biased system as well as zero momentum system. All the INSAT/GSATs are based on the momentum biased systems with two axis momentum storage capability while the remote sensing satellites with agile capability are based on zero momentum reaction wheel system. The various sensors like infra-red earth sensor, sun sensor, star sensor and the inertial reference unit besides a number of actuators like momentum/reaction wheels, magnetic torquers, thrusters and solar array drive mechanism, indigenously designed and developed, have been flying on various spacecrafts and have accumulated a very large flight heritage.
Some of the critical lives limiting elements like Gyros and Reaction wheels with continuous run-in have accumulated more than 90 and 180 years of life respectively. An indigenously designed and built Star sensor with proven heritage in IRS-P6 spacecraft is being planned for use in INSAT-3D, the next generation of advanced meteorological mission.

The INSAT-2E &INSAT-3A with both communication and imaging payloads have adjustable solar flap providing fine compensation of residual solar pressure torque from the Solar Sail/Solar Array over the season. Ku and Ka band payloads with multiple spot beams require that the on-board antennas are tracked .A system using a monopulse tracking with ground based beacon is being implemented in GSAT-4 spacecraft.

Finally, fault tolerance and autonomy in space system plays a very important role for commercial satellite systems in order to reduce the operational costs. A great deal of emphasis, including the improvement of processes and methods for satellite critical software development and overall testing is placed alongwith QA participation and surveillance in our programs. ISRO's experience in terms of the on-board software has been extremely successful.

Besides the techonological aspects of the spacecraft bus electronics and stabilization techniques, the paper also summarizes the vast and rich experience of mission analysis, management and the associated s/w development efforts.

Antenna Systems for Space Applications

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Abstract

There has been a rapid technological growth in the field of antennas for space applications for the last few decades. Indian Space Research Organization has achieved well recognized excellence in the area of antenna systems in accordance with its mission. It has taken a good lead in the research and development of new technologies in the field of antenna systems and associated feed systems. However, efforts are required to produce cost effective solution for developing existing and future antenna systems.

This presentation will highlight the expertise and achievements of ISRO in the field of antenna systems developed in various frequency bands ranging from UHF to Ka band . This also includes fixed, deployable and scanning antenna systems with special emphasis on aperture antennas like shaped reflectors, gridded reflector antennas active phased array antennas, planar antennas etc. This paper will elaborate the salient features of the advanced antenna systems developed for various satellite communication, microwave remote sensing, telemetry, telecommand tracking and ground segment antennas. ISRO capabilities in terms of CAD based RF/mechanical design, mechanical fabrication potential of associated Indian Industry/partners and automated RF alignment measurement facilities are highlighted. Presentation also identifies key areas of antennas where expertise may be imparted/required from other agency.

This paper will also address both present capabilities and future mission requirements where bilateral engagement between India and US can be extended. Emphasis is given on the technological potential and expertise and facilities available with ISRO and it's associated industry partners. Requirements of future mission and the technological areas for mutual cooperation are also addressed.

Recent Technology Developments for Communications Satellites

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Abstract

The past two decades have seen significant technology developments in communications satellites to address the demand for reduced on-orbit cost per transponder, increased service capacity from a single orbital slot, new services, and longer orbital life. Higher power and larger mass enable increases in satellite service capacity, and combined with longer service life and ease of operations improve annual cost per transponder, which has dropped by nearly a factor of 3 over the last two decades. Space Systems/Loral has been actively pursuing technological developments both in the satellite platform as well as the communications payload and has introduced several key technologies into commercial satellite programs.

This paper will review the development of technologies at Space Systems/Loral for communications satellites starting with INSAT-1 era capabilities and evolving to current leading-edge spacecraft missions. Growth in satellite size, power and payload accommodation is traced as supported by ever more capable bus technologies and ever more efficient and smaller payload components. This culminates in the latest bus subsystem technologies that have recently been flown or are nearing flight, and modern payload technologies, including Radio Frequency electronics and antennas. Several recent applications will be described of specific technologies that have enabled unique new mission capabilities.

STATE OF ART DEVELOPMENT IN COMMUNICATION TRANSPONDER SYSTEMS AND DESIGN

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ABSTRACT

The first communication satellite, EARLY BIRD was launched in 1965. Since then satellite communication has become a major means of international as well as domestic communication over long or moderate distances. A transponder is defined as the equipment which provides the connecting link between the receive and transmit antennas onboard the satellite and acts as a repeater.

Payloads with large capability and higher transmit power are growing and are oriented towards compact and cheaper user terminals and providing services directly to the ultimate user. More and more applications are introduced apart from FSS and BSS services with the new developments in communication payload technology.
Communication transponders onboard are classified accordingly to the function and services provided, such as Bent pipe or OBP type.

High capacity and high transmit power requirements of payloads call for higher number of transponders on board with higher packaging density through miniaturization.
MMICs, Multilayer MICs and Multi Chip Modules play an important role in miniaturizing of transponder active components as well as Ka-Band transponder realization.

Recent development in high power, temperature compensated cavity filter O-MUX and DR-filter O-MUX have shown good promise for the new generation communication transponders.

High temperature super conducting material R & D os progressing well. Highly stable HTS thin film MIC filters for I-MUX and low noise receiver front ends can be viewed for future transponders.

Developments in the areas of on board processing and on board switching (OBP & OBS) have enabled the design of regenerative and reconfigurable class of communication transponders.

Space Application Centre (SAC) of ISRO is the lead centre for all type of communication satellite payloads activity and application areas. Capabilities and modern facilities exist for complex communication payload system design and realization. INSAT-2 S/C series onwards all INSAT and GSAT series communication transponders are designed and realized indigenously.

This paper reviews the development various satellite communication transponders at ISRO and their growth in size and power over last several years. It also describes the various technologies and facilities available in house for realization of communication satellite payloads.

Communication Spacecraft Capabilities in Mechanical Systems

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Abstract

The development of technologies and systems for spacecraft at ISRO has been highly goal oriented and this has resulted in a spectrum of capabilities in spacecraft bus systems. In the mechanical and thermal systems area the ISRO capability meets the total requirements of advanced communication spacecraft in terms of technical and other requirements. The importance of a mass and volume efficient spacecraft bus structure catering to different spacecraft missions with differing payload needs (in terms of mass, power and other requirements) were well understood. Also the need for concurrent design and development of the systems for a number of spacecraft has been a major challenge. These pressing requirements helped in evolving the present systems and capabilities with several advantages. This paper is a brief summary of the mechanical system capabilities applicable to communication spacecraft with emphasis on spacecraft structure, mechanisms and thermal control. The features of these subsystems in terms of simplicity, reliability and efficiency are explained. The heritage of subsystems and the associated design, analysis, manufacturing and testing processes are also summarized.

The technical expertise, experience and capabilities for hardware, software and testing activities available in spacecraft structures are first outlined. Features of structures of the three major bus types –I I-1000, I-2000, I 3000 that were designed to meet the spectrum of ISRO requirements are explained to highlight the advantages. The I-1000, 2000 and I-3000 type bus structures are well proven. A new bus (I-4000) structure retaining most heritages from earlier structures and has all features required for future advanced communication spacecraft under development. The “mission definition to realization” process and its merits are explained highlighting the advantages with respect to not only schedule and cost but also in terms of flexibility in accommodating different subsystems and payload. The paper provides information on the different deployment, steering and tilting mechanisms developed and used with extensive flight heritage. Information on some recent developments is also provided.

The capabilities that exist in terms of spacecraft thermal control are indeed very comprehensive. The expertise and experience in design, analyses and testing in the area of thermal control together with associated infrastructure facilities that meets all satellite requirements are presented in brief. A variety of thermal control elements and processes are also available for use in present and future satellite missions.

The scheme in place for continuous up gradation of designs by adaptation of new proven technologies by elaborate offline qualification is also indicated. The paper concludes with a highlight on the potential of a synergy of ISRO capabilities in the spacecraft mechanical systems area with complementary capabilities elsewhere.

The Future of Mobile Satellite Systems with Ancillary Terrestrial Connectivity

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Abstract

The struggling Mobile Satellite Services industry recently received a much needed stimulus. Following a lengthy technical debate, the Federal Communications Commission (FCC) authorized the use of Ancillary Terrestrial Components (ATCs) by Mobile Satellite System (MSS) operators in order to expand and improve the reliability of MSS services in populous areas. This paper discusses an innovative architecture that will enable Mobile Satellite Ventures (MSV) to launch its hybrid network, comprising satellite and ancillary terrestrial connectivity, enabling its users to communicate from everywhere using one device. MSV's network will be based on mainstream mass-market technologies (GSM and/or CDMA) and will thus be the beneficiary of large volume production for its end-user devices. As such, MSV's terminal equipment will be aesthetically indistinguishable from cellular/PCS–only products, and very cost competitive. The aggregate level of co-channel and adjacent channel interference that may be generated by the ATC, as it terrestrially reuses the available satellite-link frequencies, has been shown to be insignificant by both MSV and the FCC. Furthermore, ground based interference cancellation can substantially reduce terrestrial interference into the satellite network. The hybrid system architecture that is contemplated by MSV, including its frequency reuse by space and terrestrial elements is discussed.

Thermal Design of NiH2 Batteries on-board INSAT-2E and 3E

Alok Shrivastava, Dr. R.A.Katti and Prof. K.G.Naryankhedkar

NiH2 batteries are very common in spacecraft application and ISRO has used them, with different capacities, starting from 60 A-h to 105 A-h, as a power back-up source. Though these batteries are proven themselves for high reliability and longer life for deep space missions, the temperature regime under which they perform efficiently is very low compared to the other spacecraft systems.

The thermal regime of batteries is -10 to +10^{o}C, and the temperature gradient within individual as well as amongst two batteries is restricted to 5^{o}C during the discharge phase. This narrow temperature range poses many placement and thermal control related problems in the spacecraft.

This paper presents the exhaustive study conducted on both the batteries of low and high capacity. In INSAT-2E, separating the battery deck from the main panel and with the modified honeycomb facesheet structure arrived at the appropriate thermal design. The required radiator area was designed accordingly. This thermal design was likely to be chosen for the same bus for future spacecrafts, but due to rise in battery capacity in INSAT-3E (70 A-h) thermal design was augmented by heat pipe embeddedment in honeycomb battery deck and use of diffuser plate along with modified radiator area. The estimated data is compared to the flight data in order to validate the thermal model and the thermal design philosophy.

Temperatures of the battery can be controlled in a better way if the various parameters like placement of diffuser plate from the edge, length of the embedded heatpipe in the panel, radiative coating on the inside surface and the arrangement of the heat pipe (like cris-cross) is taken appropriately. This paper also describes the significant improvement in the battery temperature for the same bus, which is very essential if the battery capacity goes-up further like 105 A-h planned to be used in INSAT-4A spacecraft.

MEETING HIGH-QUALITY RWA COMMERCIAL DEMAND THROUGH INNOVATIVE DESIGN

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ABSTRACT

A changing satellite market, with an ever-increasing commercial presence, has driven industry to respond with minimal cost and high-volume production. This emergence fuels an increasing pressure on space component engineers to meet the high-volume, low-cost, short-cycle demand without compromising quality or performance. Honeywell is creatively meeting current commercial Reaction Wheel Assembly (RWA) component challenges with an evolutionary RWA design, the HR14, as part of its Constellation Class family of RWAs. This class of RWAs advances the state-of-the-art for large-volume, low-cost, high-producibility designs while preserving legendary Honeywell value in performance and expected on-orbit longevity.

Market Opportunities for India and US Educational Institutions in Satellite Based Distance Education- An Overview

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Both India and the United States have placed great emphasis on education. India has made significant strides in building education infrastructure in its post independence era. Some of the Indian universities have been recognized world over for their excellence in higher levels of engineering and information technology (IT) education. The US has built an excellent education infrastructure at all levels. Web-based interactive educational tools are being commonly used in the US by the universities.

In recent years, the Indian government has taken a few major steps to meet its growing educational needs. The literacy level is still at 70%, the female literacy being just over 50%. Opening up of the Indian economy to the global market has also generated significant requirement for training its manpower to operate internationally. In the areas of primary and secondary education there is a large requirement for training teachers exposing them to modern educational methods and tools. The need to provide on the job training to employees to upgrade their skills at their own pace and place is growing.

Recognizing these needs the India government is planning to launch a dedicated satellite (Edusat) to provide distance education programs across the country, including the rural and remote areas. India and the US have a rich heritage of having worked together on education and developmental communication projects through the Satellite Instructional Television Experiment (SITE) program in the 1970's using ATS-6 satellite.

This paper quantifies the demand and identifies several areas of opportunities for the educational institutions, both Indian and US, to work together in developing suitable content, common programs, web based tools, training, deployment of network infrastructure and systems. An approach to jointly build on commercial basis the necessary ground infrastructure to utilize the global and domestic satellite systems including the "Edusat" satellite system is outlined.

On Using Educational Satellite and IT Networks for In-service Teacher Training

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In recent years the formation and communication technologies (ICT) have been used with considerable degree of success to widen access to education, to raise its quality, to reform reposition and engineer it. Experience shows that teaching-learning through the use of new educational technologies has now become cost-effective. Encouraged by its success, the MHRD, Government of India and ISRO took a path-breaking policy decision to launch a dedicated educational satellite, which has no parallel and which provides immense possibilities for educating not only the non-literate/neo-literate work force in unorganised sector but also training and retraining the in-service personnel. In India, each of these segments is huge in absolute terms and the task is enormous. In this paper we share our experiences on the use of educational satellite and IT Networks for training teachers, para-teachers/Shiksha Mitras/Shiksha Karamis working in remote villages/educationally un-reached communities under Sarva Shiksha Abhiyan and also training untrained in-service primary and secondary school teachers all over the country, including North-East & Sikkim. With the availability of EduSat, instant, simultaneous, and transmission with wider bandwidth, it should be possible to achieve the goal of EFA and meet the commitments of E-9 initiative by 2010.

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Education Guarantee and Head Start Projects: Tele-Education Programme of India

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Abstract not available

Satellite Interactive Education: Nursing Degree Programs

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The University of Nebraska Medical Center (UNMC) College of Nursing (CON) is a leader in distance education within the United States. More than 80 courses are available almost totally online. Faculty members have successfully delivered these courses to remote and rural areas of the Midwestern part of the U.S. and internationally. The expertise of the CON faculty makes them uniquely prepared as a leader in distance education abroad. Several projects are currently underway at the CON.

In cooperation with the American International Healthcare Alliance, Inc. (AIHA) in Washington, DC, UNMC began a pilot Internet-based faculty capacity building project in Armenia. Ten English-speaking faculty from Erebouni College are taking a total of six graduate level courses, delivered via the Internet. As faculty members gain additional capacity and expertise with online education models and advanced nursing education practice, they will develop outreach communities within Armenia to serve as satellite sites for sending these nursing education courses for RN to BSN from Erebouni College. A grant from AIHA provides funding for Phase I of this project.

UNMC CON is currently in process of implementing an RN to BSN program for online delivery to India. The program would be offered at two or three sites, with 30 students at each site. Passing NCLEX (US RN licensure) will be built into the three-semester program. Graduates from the program will receive a UNMC degree. Two large, private healthcare providers in India will contract with UNMC for the coursework. The online program could be made available to other healthcare providers or educational institutions willing to pay student tuition and fee costs.

Our Learning Resource Center (LRC) is developing a set of 200-300 Clinical Skills Modules available on CD. These two to three minute “show-and-tell” segments highlight separate health provider skills, such as sterile gloving or administering insulin. These segments will fill a critical need for the continuing education of nursing personnel and could provide standardized, replicable and repetitive field-study utilized internationally. Many countries could benefit from such clear, concise, and easy-to-use training.

Finally, a Center for Arabic Nursing Education in Amman, Jordan is being developed to transmit nursing education throughout the Middle East.

Telemedicine: Tailoring Space Communication Technology to deliver Quality Healthcare in a Developing Society

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Abstract

The healthcare scenario in India and many other developing countries can be broadly classified into the (i) primary health care center with minimum facilities available but which is the sector that caters to the majority of the rural population (ii) secondary healthcare center which has more facilities than a primary health care center but does not cater to specialized services and (iii) the tertiary healthcare with modern and sophisticated equipment catering more to the urban population. The main objective of Telemedicine is to provide the expertise available at tertiary centers to secondary care centers and in turn to the primary health care centers. With the goal of eventually ensuring delivery of quality medical care, a telemedicine system has been designed to make quality health care accessible at an affordable rate for people living in districts and smaller towns. The purpose of the system is to give health care providers at remote locations the ability to consult with specialists by integration of medical, communication and information technology enabling transmission of a combination of video, audio, and externally acquired images. The system can also be used for education purposes to support bi-directional video/audio communications for grand round lectures, classes, and case conferences. In order to maximize the utilization of the available transmission medium (ranging from land-based copper and fiber optic cable to satellite link) while providing the best possible video and audio quality, the compression performed by the system is adaptable to a wide variety of bandwidths. The telemedicine link between CARE hospital at Hyderabad and the district hospital at Mahaboobnagar has now been operational for the last two years and more than 5000 cases have so far been transmitted and diagnosis / treatment, been rendered to the patients without them having to travel to cities. The paper presents a comprehensive socio-economic clinical strategy for societal impact of telemedicine technology, which emerged from this experience.

Telemedicine: Applications of Healthcare Using Satellite Communications

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The very first commercial communication satellite used for healthcare was Early Bird, launched in 1965 by NASA. This satellite was used to support the transmission of television signals between Houston, TX and Geneva, Switzerland. Dr. Michael DeBakey was conducting a heart valve replacement from Methodist Hospital in Houston, Texas. Using Early Bird, video images were transmitted to Geneva, where an assembled group observed and discussed the procedure with Dr. DeBakey. The advent of telecommunications via satellite greatly enhanced interaction and created new opportunities for healthcare and education. This integration of telecommunications and medicine, termed telemedicine, grew out of this event. Conceptually, telemedicine has been the foundation of health care applications for space exploration since the late 1950's. The Soviet's/Russians and American space programs have been leading pioneers in this field over the past 5 decades. This has been driven by need and requirements. During this same period, the capabilities of satellites became much more robust. New capabilities provided new opportunities. NASA used satellite technology in the 1960's to support telemedicine in Alaska with ATS-1. During 1989, the US and the USSR partner to develop a 'spacebridge' between the two nations to support telecommunications from an area in Armenia affected by natural disaster. This effort, know as the Spacebridge to Armenia, was the first large-scale international event where satellite capabilities were used to support health. The use of satellite technologies has provided new opportunities or enhanced existing capabilities such that those individuals in remote locations can gain access to health information, education, and expertise not resident. Several examples of this have been written about in the literature, including telemedicine on Mt Everest and Ecuador using InMarSat phones. Ships at sea use satellite communications for health as well. The US military is using VSAT capabilities to support medical care in several operational scenarios, including Irag and Afghanistan. ISRO is also exploring the use of VSATs in Afghanistan for education. Additionally, satellite capabilities have been brought to bear for use in global health and disease monitoring. This of course can be scientifically-based as well as information reporting through such services as CNN or BBC. Clearly, satellite communications has had a profound impact on public health, our ability to respond to medical emergencies and to share knowledge between nations. Telemedicine is a significant tool in health care. It transcends the barriers of national boundaries, geography, time and culture. Throughout most of human history information took months if not years to move around the world. Satellites permit instantaneous access. Our ability to respond to international issues is much greater because of these enabling technologies.

EduSat Programme – Opportunities and Potentials

BS Bhatia
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Abstract not available

Real-time Telemedicine Solutions for Homes, Schools, Work-sites, Ambulances, Hospitals and Remote Locations

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TeleVital, located in California has used various telecommunication tools to support the delivery of health care. Browser-based software has been developed to deliver real-time remote medical services. Several examples and case studies will be presented. These include: (1) An elementary school for the management of asthma in Arizona; (2) A home for the management of chronic disease on a cable set-top-box in Texas; (3) The work-site for the assessment and triage of injuries in New Jersey; (4) An ambulance for vital-sign monitoring in Japan; (5) Hospitals and clinics for remote consultations by medical specialists (54 nodes in India) and remote intensive care unit monitoring in Nevada; and (6) Very remote locations in the jungles of Ecuador for anesthesia monitoring. Benefits of browser and server-based architecture will be discussed. Solutions for triaging real-time vital-signs, DICOM images along with audio and video over low bandwidth connections such as cellular, dial-up and satellite connections will also be highlighted.

SATELLITE COMMUNICATIONS TECHNOLOGIES FOR SOCIETAL APPLICATIONS

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Extended Abstract

In India, commitment to the use of satellite communications for development was as early as 1969 when the DAE-NASA agreement was signed for the use of the Applications Technology Satellite, ATS-F for the Satellite Instructional Television Experiment, SITE. The Satellite Telecommunications Experiment Project, STEP followed in 1977 and in 1981 India launched its first communications satellite APPLE. STEP and APPLE Utilisation Project, AUP introduced transportable and remote area communications as well as advanced techniques in digital communications, multiple access and computer communications. Further, in 1969 through membership in the Intelsat system India entered the area of commercial use of satellite communications. The operational INSAT series became available from 1982. Using INSAT several new societal applications have been demonstrated. These include interactive distance education, telemedicine, remote data acquisition, wide-band Internet access, and transportable and mobile communications. Apart from the INSAT series, India is working on the GSAT series for developing new technologies. From August 2004, GSAT 3 will provide high power regional beams in the Ku band for interactive distance learning under the EDUSAT project. GSAT 4 will bring in high power Ka band spot beams with onboard regeneration to provide switching services on board thus doing away with expensive hub stations and enabling small terminal to small terminal direct communications. The Advanced Communications satellite will expand the GSAT 4 services to cover more areas. Applications will move away from separate systems for telecom, broadcasting and datacasting to integrated IP based multimedia systems. The aim will be to provide multimedia access on a countrywide basis and mobile multimedia access in selected areas.

EDUSAT

The utilisation of GSAT-3 will be mainly to demonstrate and operationalise the concepts of multicast interactive multimedia for the education sector. The ground infrastructure will consist of 25 to 30 up links and about 5000 remote terminals per up link. The following are some of the main features and services of the proposed system.

- Multimedia
- Multicast with provision of interactivity from all remotes
- Secured access to transmission through registration and accounting
- Educational content archival service

The main technology to be used for realising the ground network is Digital Video Broadcast with Return Channel via Satellite, DVB-RCS. This technology provides the functionalities required in a very elegant manner. As the technology follows open standards it will be

available from several vendors hence its costs will be low and operations and maintenance will be well supported. We propose to tailor the technology to the needs of EDUSAT applications thereby further reducing the cost and complexity. We also plan to take up R&D in certain key areas to enhance the system, services and applications. It is also intended to look for collaboration with industry in India and abroad for the design, development and production of the technology and for making it commercially available in India.

Mobile Satellite Service

INSAT satellites have a CXS band MSS transponder that covers the Indian landmass and surrounding ocean region. Two different technologies on INSAT MSS systems have been developed to utilize this transponder. INSAT MSS Reporting system provides for one-way transmission of short message or position to pre-defined destination. The Reporting Terminals can be handheld, vehicle mounted or stationary. The terminal has a built in GPS receiver, message editing and scheduling facilities. The terminal has a near-omni directional antenna and a two-watt power amplifier that is used to transmit 40 character text messages or GPS position in ALOHA or TDMA mode to a hub station where a Network Manger automatically transfers data to the desired destination through Internet. This is a very low bit rate, thin traffic, messaging system. It is estimated that about 45000 Terminals could be accommodated in the one MHz spectrum allotted in each INSAT MSS transponder. This system is suitable for fleet monitoring, SOS messaging and remote data acquisition. A fleet monitoring GIS has also been developed to monitor fishing boat locations in India's Exclusive Economic Zone.

For voice and low rate data communications, small portable terminals operating on the INSAT MSS transponder for emergency communication purpose have been developed. The Hub system has DAMA switch and NMS to support terminal-to-terminal or terminal to EPBX communication. The system uses 20 KHz SCPC carriers supporting 6.3 Kbps G723.1 coded voice and data. The terminals use single modem for signalling and communications. The terminal weighs between 5 to 7 kg with built in rechargeable battery and antenna. The talk time is two hours with fully charged 12V battery.

Digital Sound & Data Broadcasting System

The Digital Sound and Data Broadcast (DSDB) system is a cost-effective, low bit rate data communication unit, which can broadcast a range of data rate from 9.6 Kbps to 2 Mbps and addresses non-TV users. The cost is kept low by using a commercially available Dielectric Resonance Oscillator (DRO) based Low Noise Block Converter, LNBC, which has the disadvantage of high drift, with an intelligent receiver that tracks the carrier over this drift. So it is possible to use cheaper DRO type LNBCs for the DSDB system and keep the total cost low. Another feature of the system is that it has a capability to operate in Multi Channel Per Carrier (MCPC) or Single Channel Per Carrier (SCPC) mode. The DSDB is a receive-only system and designed to operate with the high power BSS S-band transponder of INSAT. The broadcasting hub station can address receivers individually or in groups. The DSDB system is used by All India Radio to distribute CD quality sound over its backbone network. The system has been demonstrated for use in multimedia data dissemination e.g., Internet

data broadcast for rural areas, Cyclone warning system in coastal villages, Meteorological Data Dissemination system, etc.

Communications for Disaster Management

Cyclone Warning System

A combination of features of selective broadcast and acknowledgement is most suitable for providing an on-line warning system. This has been realised and is in operation in India as the Cyclone Warning Dissemination System (CWDS) of the Indian Meteorological Department, IMD. It provides early warning to cyclone prone coastal areas of India. The Cyclone Warning Centre of the IMD sends a cyclone alert and warning audio message in the local language of the area likely to be affected using the DSDB receiver in selective broadcast mode. The warning is provided in the form of audio alarm followed by detailed text and voice messages detailing the threat and the immediate actions to be taken. The acknowledgement of the reception of the warning is automatically sent back to the central or zonal station using the stationary MSS Reporting terminal. The receive system is configured around a 70 cm perforated reflector with ruggedised mount to withstand high wind loads.

WLL-VSAT Hybrid Network

Disasters usually disrupt conventional telecommunication systems for several days. An ad hoc network with a radio-trunking system connected to a portable VSAT has been developed, which can be a rapidly deployed, and which can support all essential communication requirements at the location of the disaster. Wireless Local Loop handsets with a portable base station can provide voice communications between handsets and between handsets to the base station. As this base station is connected to a VSAT, the wireless handsets can be used to communicate with the external world. To maintain high link availability C band operation is selected as it has low rain attenuation and low scintillation effects. Higher gain setting at the satellite transponder helps in reducing the aperture of the VSAT antenna and contributes to its portability. Two types of portable hybrid WLL-VSAT system have been designed, container based and vehicle based. The systems are completely self-contained consisting of the communications equipment, a tent and a generator and can be deployed in 90 minutes.

Future

Systems are being developed for the GSAT-4 regenerative payload utilisation. These consist of a VSAT and a USAT working in the Ka band. These terminals can be used for providing fixed and portable links. The VSAT can provide a switched connectivity of 2 Mbps whiles the USATs can provide 64 Kbps links. Applications are in the area of tele-healthcare, tele-education, location based services and e-governance.

VSAT Applications – Growth and Opportunities in Indian Scenario

S. Barathy

Since the inception of Very Small Aperture Terminal (VSAT), India has been exploring the possibilities of using VSATs for various applications. Even in 1980s, a low bit rate, CDMA based VSAT network in C band was introduced for connecting Government Offices. Knowing the potentials of VSATs for the country both in cities and rural areas, India opted for Extended C band and liberalized the service provision by private companies. However some of the Government networks continue to use C-Band VSATs. VSATs in India have been using C, ExtC and Ku bands. The total population of VSATs in India is more than 35,000 and is expected to grow at nearly 30-35%. Many Regulatory changes conducive to VSAT industry, have been effected to stimulate the market. Supportive regulation, price reduction of VSAT products, innovative solutions from service providers and availability of extensive service support have been responsible for the growth of this industry. Quality of service delivery has become more important and will be the prime reason for selecting provider by consumers. Service quality and not the technology will command premium.

Intelsat and Space Commerce in India
A Satellite Communications Services Perspective

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Abstract

Intelsat is celebrating its 40th anniversary in 2004. During these 40 years Intelsat has grown from providing satellite capacity provision to a handful of countries (11 founding countries) to provision of satellite telecommunications services, and in many instances, combined with provision of terrestrial infrastructure to over 200 countries and territories, including India. Always in search of improving its service provision to its customers on a global basis and in particular in India where Intelsat saw a lot of opportunities for satellite telecommunication services, Intelsat embarked on two approaches to respond to the growing demand in this region and in India while cognizant of the regulatory environment. The first action taken by Intelsat was to deploy a fourth satellite in the Indian Ocean region by adopting a 2 degree satellite separation in the 60-66E orbital arc from 3 degrees and engage with Indian Space Research Organization (ISRO) for use of capacity at one of the Indian registered orbital slots (83E) when a new satellite (Insat-2E) would be deployed. The discussions for this latter approach took a while and our major customer (and share holder) in India, VSNL, played an important role of facilitator for these discussions to go smoothly. At the end, Intelsat played a major role in defining the satellite communications payload requirements and ISRO after about 3 years of manufacturing and testing the specified satellite, it delivered a payload that met and in many cases exceeded the specified requirements. This satellite has been in operation since 1999 and has delivered services to several of Intelsat customers within and outside of India. In addition to the long term lease arrangement for satellite capacity from India, Intelsat has also delivered either satellite capacity, or satellite managed services to a number of customers in India to a number of customers either indirectly or in recent years directly as the regulatory environment has changed. There are numerous opportunities in India for satellite service providers; however there are also regulatory hurdles that these service providers must cross. Intelsat experience has been positive so far and our forecast remains to be so as well. This presentation will discuss some examples of these opportunities and the potential obstacles in more details.

Satellite Role in DTH and Internet Services

Punit Goenka

The DTH and Internet are capable of providing services to public and hence they have very large potential for growth. The presentation discusses the satellite based DTH and Internet services scenario and in particular identifies the key benefits, which will enable large scale growth of these services in India and other parts of the world. For satellite based DTH services, various factors and benefits, which act as catalyst for growth are considered. They are high quality digital TV signals, faster access to market including cable dry areas, value added services such as pay per view etc. Regarding Internet services, at present the terrestrial based systems are predominantly used and this has inherent technical and operational limitations. To achieve the desired Internet targets, the presentation emphasizes the important role satellites play/are expected to play. The presentation also discusses the future directions for the growth of satellite based systems for providing DTH and Internet services.

On Demand Services via Satellite

David Ball
Vice President Asia-Pacific
PanAmSat Corporation

Traditionally satellite services for video and telecommunications services can only be acquired through a mutli-year contractual commitment for a fixed data rate. This contractual commitment imposes considerable financial and technical risk on end-users who may find themselves with a service which is not usuable in the longer term as their communications needs expand and contract in various geographic areas.

Newly developed IP centric VSAT systems permit the establishment of communication networks which can provide end-users with tremendous flexibility in communications throughput and usage patterns. These IP centric VSAT systems have substantial technical advantages over legacy VSAT systems which provide limited throughput from remote locations in periods of high utilisation. The IP centric VSAT network is able to provide dedicated clear channel capacity on demand to satisfy needy users while maintaining throughput for the remainder of the user base.

This paper will describe the architecture of the IP centric VSAT networks and will also examine the commercial applications for such networks – ranging from telemedicine, enterprise wide area network extension, overlays to existing terrestrial infrastructure to provide surge capacity for videoconferencing, large file transfer and voice over IP protocol.

Satellite Communication Insurance and Underwriters' perception on Space Insurance related risks.

K Rana, JB Boda Insurance Brokers, India

Insurance follows development of new industry by identifying new risks associated with it. Same is the case with space insurance. Market capacity fluctuates according to market experience. Adverse experience over the years had led to underwriters asking for detailed technical information in order to satisfy themselves about the product. Space Insurance industry avoids insuring Launch Vehicles during development stage since risks during this period are considered business risks connected with development of new product. Pre Launch Phase for satellites is considered more acceptable risk due to exposures being more controlled. Launch Phase risk is more dependent upon perception of underwriters about quality of Launch Vehicle and Launch operators. Loss is instantaneous. Post Launch and In-Orbit risks are affected by satellite manufactures/operators' reputation in the market since satellites have sufficiently long life to determine quality and reliability of product. The paper discusses all these aspects.

Manufacturing of Satellite Equipment – Challenges and Opportunities

Malav Mehta, Infinium India, India

Today, the Indian telecom market ranks as the second largest market amongst the emerging economies. India's 10th Five-Year Plan 2002-07 projects Rs. 1,750 billion rupees worth of investments in more than 50 million fixed lines, 30 million cellular lines and 20 million Internet connections. For the SATCOM industry, with the changes in the policies and relaxation in the licensing polices to allow uplink of higher data rates (broadband) as well as significant reduction in the cost of ground segment equipment, India appears to be a promising market for deploying VSATs. It has been forecast by market analysts and experts in the field of satellite communication in India that a reduction in the ground segment equipment pricing below sub-thousand US dollar level will have an exponential increase in the volume. As a strategy to bring about a reduction in the "pricing" based on its experience, Infinium is in the process of executing a business case for assembling/manufacturing "SATCOM" equipment in India. This would initially include "VSAT base-band" equipment. The challenges involved, the risks and the factors influencing the decision as well as it's economics and its viability based on the mutual expectations between a manufacturer and the market will be highlighted.