Космічна наука і технологія. 1996. Т. 2. № 3—4. С. 95—99.

Space Technology for National Development — India's Example

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Надійшла до редакції 17.09.96

Короткий нарис про національну космічну програму Індії.

On November 21, 1963, a two-stage sounding rocket called Nike-Apache was launched from Thumba, near Thiruvananthapuram close to the Earth's magnetic equator. It was a small rocket — weighing just 23.3 kg and reaching a height of about 200 km — but an important first step in India's space programme. Later, in 1972, the national space programme was formally organized with the setting up of Space Commission and the Department of Space and Indian Space Research Organization (ISRO). Dr. Vikram Sarabhai, who is known as the father of Indian space programme, had said:

"There are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of purpose. We do not have the fantasy of competing with the economically advanced nations in the exploration of the Moon or the planets or manned space-flight. But we are convinced that if we are to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society".

It is this vision that has guided the growth of Indian space programme into a diversified effort with a long list of capabilities and achievements probably unmatched elsewhere in the developing countries. The growth of space programme has been quite systematic in developing indigenous capabilities on the one hand and demonstrating the efficacy of space systems for national development on the other. India has benefited in this task through international cooperation. For example, the US satellite ATS-6 was used for conducting Satellite Instructional Television Experiment (SITE) to telecast a series of educational programmes on health, family planning, agriculture and the like to over 2.500 Indian villages during 1975—1976. It is the largest sociological experiment ever carried out in the world. Another example is the conduct of Telecommunication Experimental Project (STEP) using the Franco-German Symphonie satellite during 1977—1979. Likewise several remote sensing experiments using aircraft mounted cameras were conducted which were followed up with the application of data received from the US satellite, Landsat. By the end of 70's India had demonstrated without any ambiguity the efficiency of space system for developmental needs.

Simultaneously, space hardware were being developed with the aim of achieving self-reliance to sustain a viable national space programme. Aryabhata, the very first Indian satellite was launched on April 1975. It was followed by two experimental remote sensing satellites Bhaskara-I and Bhaskara-2 launched in June 1979 and November 1981, respectively. All these three satellites were launched by the Russian intercosmos Rocket. APPLE, an experimental communication satellite, was launched on June 19, 1981, by using the opportunity offered by the European Space Agency, ESA, to launch the satellite on the third developmental flight of Ariane.

The first operational space system of the country was commissioned in 1983 through the multipurpose satellite, INSAT-1B. Four satellites in the INSAT-1 series were procured from the US. INSAT-1D, launched in June 1990, is the last in the INSAT-1 series, still operational. INSAT is quite unique in concept combining telecommunication, television and radio broadcasting, and meteorological services on a single platform. The follow-on satellites, namely, the INSAT-2 series are all built within the country. Three of them, INSAT-2A, INSAT-2B and INSAT-2C, are already commissioned and are performing well in orbit. The first two, launched in July 1992 and July 1993, respectively, have enhanced capabilities when compared to INSAT-1 satellites in terms of communication transponders and the resolutions of its meteorological imaging camera, the Very High Resolution Radiometer (VHRR). Besides, they incorporate a transponder for distress alert services. INSAT-2C, launched in December 1995, has enabled additional services to be provided like mobile satellite services and business communication in Ku-band. The high-power transponder on INSAT-2C has made it possible for the Indian television to reach population from South-East Asia to the Middle-East. The satellite has been collocated in the geostationary orbit along with INSAT-2B, thus making an efficient use of the allotted orbital slot.

India is well on its way to launch INSAT-2D, identical to INSAT-2C, by the end of this year. INSAT-2E, with an improved meteorological payloads, besides the communication payloads, is planned for launch during 1997—1998. It is significant that the International Telecommunication Satellite Organisation (INTELSAT) will be leasing capacity from INSAT-2E under a commercial agreement.

INSAT has brought in a revolution in the telecommunication, television broadcasting, radio networking, meteorological services, disaster warning, and a host of other services. For example, the telecommunication network under INSAT is providing more than 4,500 two-way speech circuits with 162 ground stations set up in the country, including those located in inaccessible regions and the off-shore islands. There are private networks catering to corporate houses. Very small aperture terminals, V-SATS, have been installed by the National Informatics Centre. The television in India now reaches more than 65 percent of the geographical area of the country through INSAT. Regional services providing programmes in different languages have been introduced. Educational programmes for over 100 hours are telecast every week. It is important to note that a channel on INSAT system has been exclusively reserved for training and developmental education.

An equally important Indian satellite series, known as the Indian Remote Sensing Satellites (IRS), is now carrying out an indispensable task of resources survey and monitoring for India. IRS system, under the umbrella of National Natural Resources

Management System (NNRMS), is used for carrying out a variety of critical tasks like estimation of agricultural crop area and yield, drought warning and assessment, flood control, land use and land cover mapping for agro-climatic planning, waste land mapping, exploration of surface and ground water resources, marine resources survey, urban development, mineral prospecting, forest survey, etc. Also, data from IRS is now extensively used for Integrated Mission for Sustainable Development (IMSD) which was launched in the country in 1992. IMSD, covering 172 districts, is aimed at generating locale-specific prescriptions for development.

Today India has a constellation of four state-of-the-art remote sensing satellites in operation. The first satellite IRS-IA, had been launched in March 1988 and served for eight years. IRS-1B, launched in August, 1991 is still in service. IRS-1A and IRS-1B carried two cameras — Linear Imaging Self Scanners (LISS) with resolutions of 36 m and 72 m respectively. IRS-1C, launched in December 1995, carries a Panchromatic camera (PAN) with a resolution of 5.8 m — the best for a civilian remote sensing satellite in the world so far. Besides, it carries a LISS camera with 23.5 m and 70.5 m resolution and a Wide Field Sensor (WIFS) with a resolution of 188 m. These payloads form a unique combination providing data for a variety of applications. Further, IRS-1C has advanced capabilities such as stereo viewing and on-board recording. Another two satellites, IRS-P2 with a LISS camera of 36 m resolution similar to that of IRS-1B and IRS-P3 carrying a WIFS payload similar to that of IRS-1C but with an additional spectral band, have also been launched. IRS-P3 also carries a Modular Opto-electronic Scanner (MOS) developed by the German Space Agency, DLR, and an X-ray astronomy payload. Both these satellites were launched by India's own launch vehicle, PSLV. India has already planned the launch of IRS-1D, identical to IRS-1C, during 1997—1998 and the follow-on satellites in the IRS series will carry payloads for ocean resources survey, cartography, environment monitoring, etc.

It is important to note that India has made an entry into the international market in tile area of space-based remote sensing with the signing of an agreement between the Antrix Corporation of the Depart-

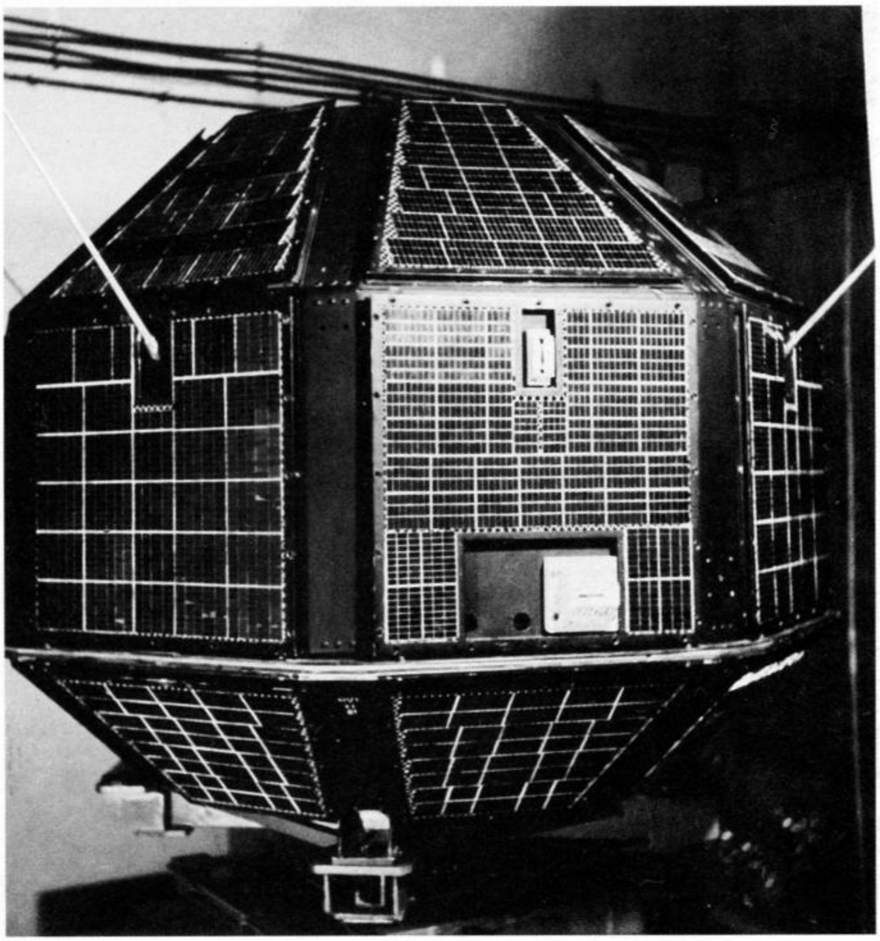


Fig. 1. Aryabhata, the first Indian satellite, was launched in April, 1975 by the Intercosmos Rocket

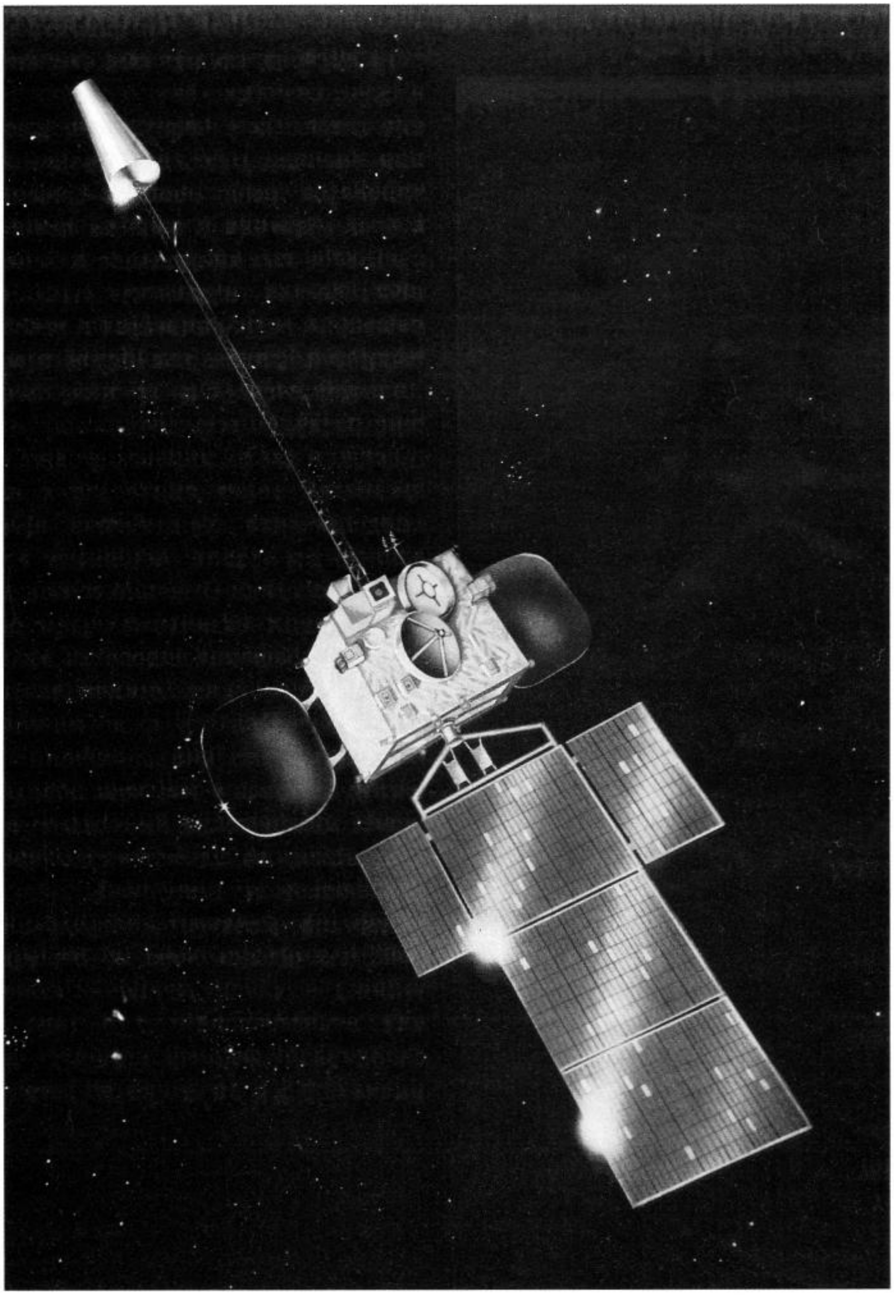


Fig. 2. One of the multipurpose satellites INSAT-2B was launched in July, 1993 (an artist's concept)

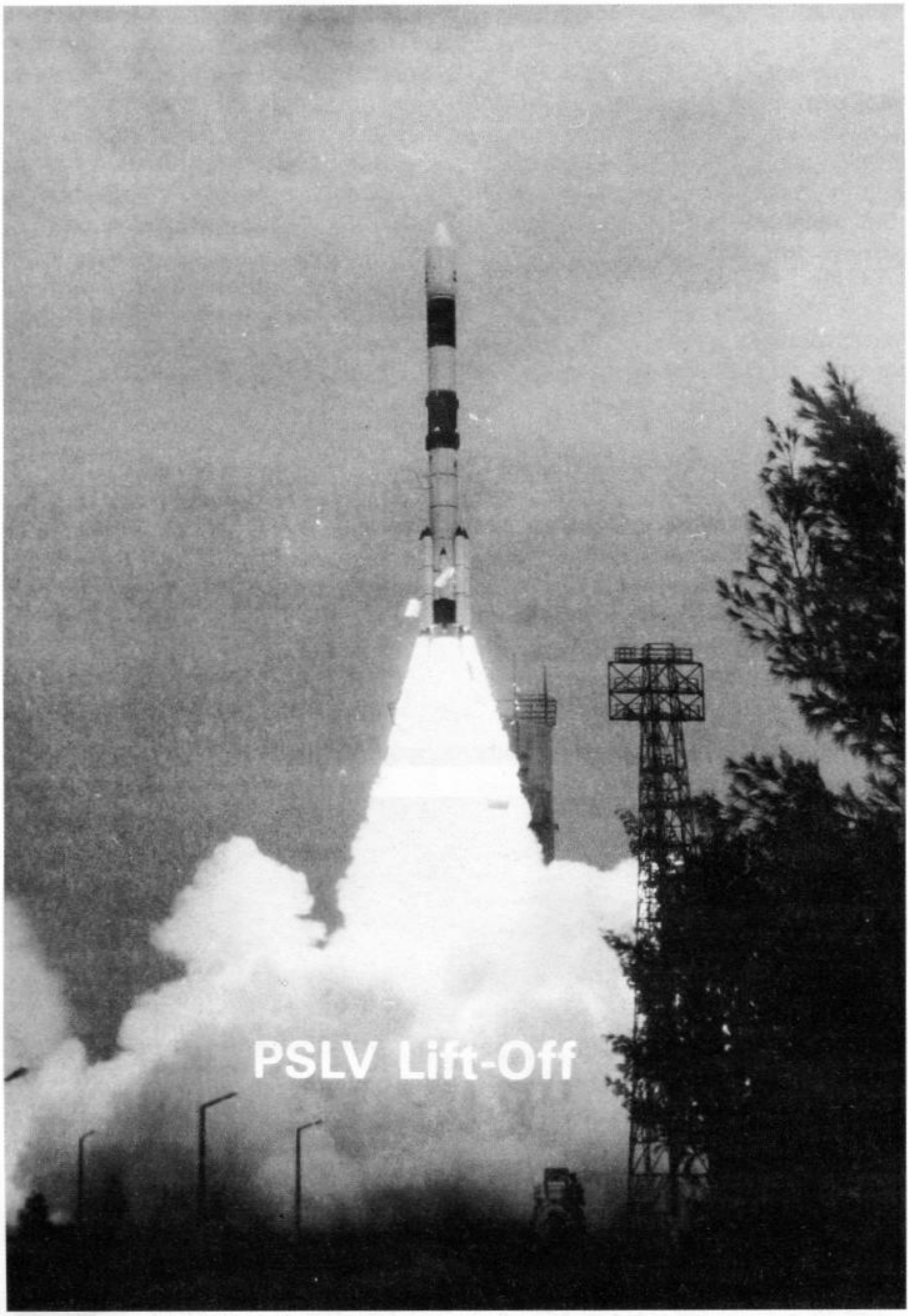
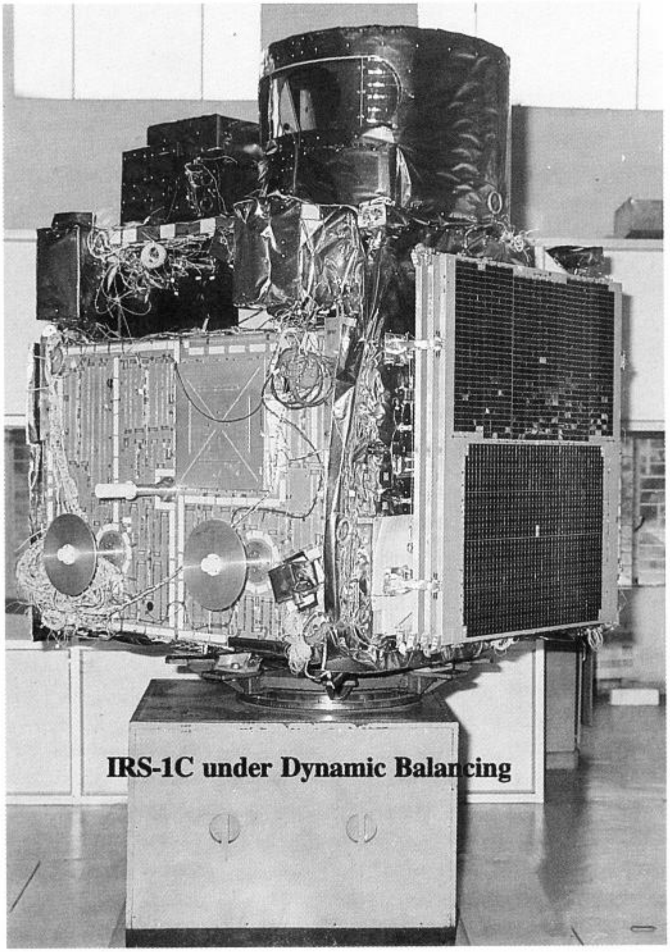
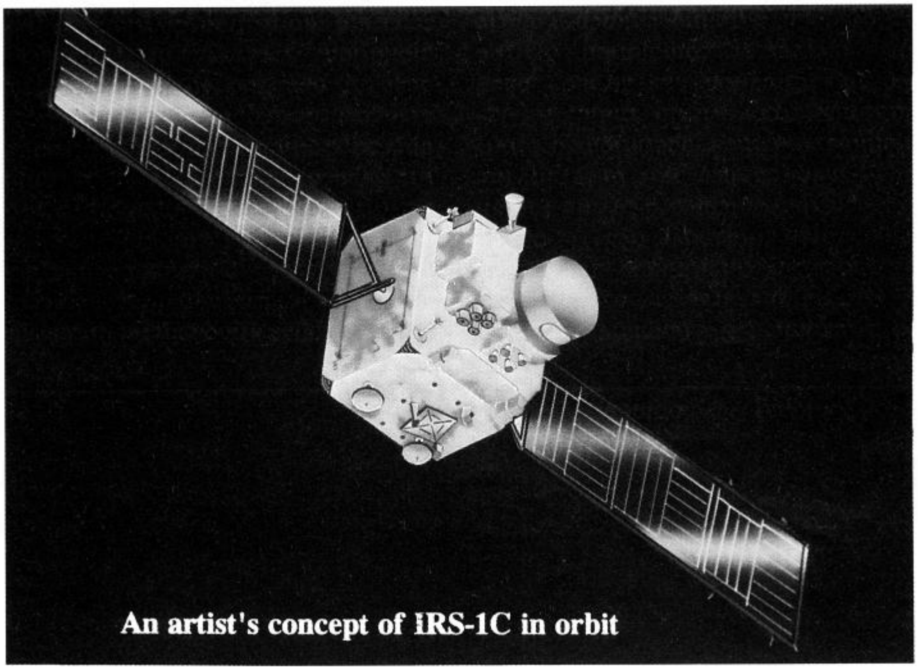


Fig. 3. Lift of the Polar Satellite Launch Vehicle (PSLV)



IRS-1C under Dynamic Balancing



An artist's concept of IRS-1C in orbit

ment of Space and a leading US Company, EOSAT, for reception, processing and marketing of data from IRS satellites world wide. Several stations all over the world have been augmented to receive IRS-1C data.

Self-reliance has been the watchword of the Indian space programme — self-reliance not only in the development of satellites and their operation in orbit, but also to launch them from within India. A significant progress in this direction has already been made through the successful completion of the developmental tests of Polar Satellite Launch Vehicle (PSLV) capable of launching 1000—1200 kg remote sensing satellites in the polar orbit. Two successful flights of this vehicle have been conducted — in October 1994 and March 1996 — when IRS-P2 and IRS-P3 satellites were placed in orbit. The launch vehicle programme began with SLV-3 capable of launching a 40 kg payload. It had its first launch in July 1980, and subsequently another two flights were conducted to place Rohini scientific satellites in low earth orbit. SLV-3 was followed by an Augmented Satellite Launch Vehicle (ASLV) capable of placing 100 to 150 kg class of satellites into low earth orbit. This also had two successful flights, the last one on May 4, 1994 when scientific satellites, SROSS-C and SROSS-C2, were placed in low earth orbit. India has now embarked on the development of a Geosynchronous Satellite Launch Vehicle (GSLV) which will be capable of launching 2,000 to 2,500 kg class of communication satellites into geostationary transfer orbit. The first developmental flight of GSLV is planned during 1997—1998.

Even as space technology and its applications have stolen the limelight, it is to be noted that space science is also pursued under the Indian space programme. The Gamma Ray Bursts (GRB) payload and Retarding Potential Analyser (RPA) flown on SROSS satellites and the X-ray payload flown on board IRS-P3 satellite have been providing valuable data to the scientists. A Mesosphere-Stratosphere-Troposphere Radar Facility, near Tirupati in south India has been established to benefit researchers in Earth's upper atmosphere. India has also participated in several international science campaigns.

Indian space programme has demanded participation of industries and this has been well-recognized since the beginning. In the process of contributing to the space programme. the industries have also upgraded their technological skills. Over 200 technologies developed for the space programme have been transferred to industries for commercial exploitation. A few major industries have even set up separate fabrication divisions to meet the demands of the space programme. Space programme has also a close linkage with the academic and research institutions in the country. Several reputed institutions have set up space technology cells to coordinate space research.

India continues to pursue international cooperation and has signed cooperation agreements with several space agencies in the world. Also, India has been active in the international space fora like the UN Committee Peaceful Uses of Outer Space (UN-COPUOS), the International Astronautical Federation and Committee on Space Research. The establishment of a UN Asia-Pacific Regional Centre for Space Education in India testifies to India's role in sharing its experience in the development and application of space technology for societal benefits.

India has committed to sustain and further enhance the space-based services. Space now forms a significant part of the country's infrastructure — for television and radio broadcasting, weather prediction and disaster warning, and in monitoring and optimum management of its vast natural resources.

SPACE TECHNOLOGY FOR NATIONAL DEVELOPMENT — INDIA'S EXAMPLE

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A brief description of India's space programme is given.