Commercialization of remote sensing – Issues and perspectives

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Today, remote sensing (RS) technology has reached a level of operationalization and does not need to be promoted as it is being used for a variety of applications for resource management by Government and private agencies for their routine work. How the technology needs to be sustained in the future is the need of the hour. While the continuity of the RS services has been recognized as an important element for sustenance, the stage is now set for sustaining the RS technology by initiating commercial use of space-based RS. A change from a 'facility concept' of the operational era to 'services concept' for the RS technology is needed. The thrust has to be towards developing an independent sector for spatial information with the active involvement of users, private entrepreneurs and other agencies to develop space-based RS market segments.

The path to market development demands programmes with a strong business and marketing plans towards providing innovative solutions to spatial information demand through effective packaging of mature technologies. In this article we discuss the transitions that RS technology has seen in the past from an experimental programme, where the stress was on promotion of RS, through an operational programme, where the stress was on adopting RS as a facility, to a commercial development, where the stress is on services and making RS a part of the users activities. The strategies that will have to be adopted – encompassing technology, applications, manpower development, infrastructure development, marketing, etc. have been discussed in this article.

REMOTE sensing (RS) observations from satellites provide data on the Earth and its natural resources in a spatial format. The RS data have benefits from the synoptic view and large-area coverage. The easy availability of repetitive data in the temporal domain from RS techniques, provides a new dimension to spatial information processing and monitoring the features of the Earth and generates a large volume of information. Satellite-based RS has become an invaluable source of spatial data on natural resources which can provide timely information on their present status as well as their dynamical changes. Remotely sensed satellite imageries provide the most authentic information to map and monitor land features, natural resources and dynamic aspects of human activities needed for the preparation of thematic resource maps. Stereoscopic RS data are now available which are best suited for generating Digital Elevation Models (DEM) to extract elevation information at desired scales.

The efforts have started bearing fruits and the benefits of space technology have started touching every facet of human endeavour. RS technology has reached a level of operationalization in India and is being used for a variety of applications for resource management. With the operational services from IRS satellites, user agencies – Government agencies and a few private agencies are using RS data for their routine work. The need now is to look at how the technology needs to be sustained in the future.

The stage is now set for sustaining the RS technology by encouraging commercial use of space-based RS. Orientation needs to change from a 'facility concept' to 'services concept' for the RS technology towards developing an independent sector for spatial information with the active involvement of space agencies, private entrepreneurs, other agencies to develop space-based RS market segments. Encouraging commercial use of space-based RS markets fits in the overall plan of most space programmes and is in consonance with the overall economic liberalization and active private sector participation policy of the different governments. The intent must be to catalyse industry to participate in systems and technology integration for promoting a robust spatial information industry based on RS data. This calls for suitable development and tie-ups for global markets. There is a need to expand the current scope of RS in response to the increasing demand for spatial information, which RS is best suited to provide.

Remote sensing market

Much of the RS activities are rapidly evolving based on Government designed, owned and operated RS satellite systems and upon foreign data supplies, especially Landsat and SPOT. One result of this situation is that the 'industry' has been largely identified with the Government sector. Traditional RS and the 'industry' itself appears poised for significant change and diversification with the changing policies towards liberalization and active private sector participation. Principal drivers of change include proposals for truly commercial supply/

services systems, growth of the Geographical Information System (GIS), and the Government's emphasis on domestic economy and supporting global competitiveness.

Governments have played an important role in planning and administrating RS systems and market developments have been constrained by administrative decisions concerning the allocation of economic resources to space and ground segments. Market development has been restricted to a small number of industries associated in the R&D and design activities under publicly subsidized contracts. Therefore the perception of economically viable markets has been limited.

The global RS data market is estimated to be made of a 90% aerial RS segment and only a 10% satellite RS segment. Out of the satellite RS market, about 50% are data and 50% are services. In future as resolutions increase to sub-meters, a part of aerial market shifts to satellite and also proportion of services market could increase to as much as twice data sales (in next 3 to 5 years).

With the technological maturity of RS and also an ambience of market-opening in the commercial sector participation in developmental activities, the environment is apt for addressing the commercial aspect of RS data and its utilization. Some of the driving factors for commercial ventures in RS are:

Space segment market

Space agencies buy satellites and associated support systems through contracts and services from key industry segments. The cost of this segment is ever-increasing. For example, the costs of various civilian satellites, with the cost of launch services, is given below:

Landsat-6	310 million US$ (221 million ECU)
ERS-1	1000 million US$ (713 million ECU)
SPOT-4	192 million US$ (137 million ECU)
IRS	80 million US$ (112 million ECU)
Landsat-7	~ 700 million US$.

This segment of the market is mainly with the Government sector and generally no commercial recovery is made of this investment. However, the US administration has announced a new policy in 1994 to give license to private companies to build and operate RS systems and sell those images to domestic and foreign markets. A few such private RS satellite system ventures have been announced by Eyeglass International, USA; Worldview International, USA and many others. These commercial ventures are offering space segments and data sales market where the space segment is purported to be about one-tenth the cost of civilian systems.

Satellite data market

The global sales of satellite data have been steadily increasing over the past few years. In 1980–84 global data sales were less than 20 million US$ which increased to about 160 million US$ in 1985–88. During 1990–94 this grew to about 350 million US$ and the global sales during 1995–2000 is expected to be about 700–800 million US$. The break-up of data sales (in million US$) is given below:

Year	Landsat	SPOT	IRS	Total
1986	19	5	–	24
1987	21	10	–	31
1988	23	16	–	39
1989	25	22	1	48
1990	30	32	1	63
1991	32	40	1.3	73.3
⋮				
1994	All together about 100 million US$			
1998	Including radar data estimated to 200 million US$.			

Value addition market

The value addition market is the key market segment which develops useful information from the satellite data and is marketed to a wide variety of users. The value-added market segment is part of a much larger information industry that employs GIS and other tools like GPS, surveying, etc. Industry products include maps and resource information.

For the next several years, commercial ventures providing value-added services are likely to derive greater profits when compared to constructing and owning satellites. This factor also determines the larger number of players in this market segment which has had an exponential growth trend over the past few years. The size of the market is estimated to be about 250 million US$ as of 1994 and is estimated to grow to 500 million US$ by 2000. By region, the greatest growth in market potential is in Asia/Pacific with regions of Europe and the America having the greatest potential at 34% and 36%, respectively.

Commercial perspective and issues

The path to commercialization demands programmes with a strong business and marketing plans towards providing innovative solutions to spatial information demand through effective packaging of mature technologies. RS technology needs to be amalgamated with a wide range of applied technologies to open up new vistas of applications. The emphasis is on defining the framework for business ventures involving commercial applications of RS and related information technology services.

Some of the issues that will define a vibrant commercial programme are:

Financing the RS venture

This is possibly the major issue facing the commercial sector. With the costs of satellites itself ranging to about 1000 US$, the ability of private sector to raise private/public capital would determine the commercial programmes. Even though private and commercial satellites are 'claimed' to be orders lesser in costs, the trend would be to:

- Consortia-based commercial programmes, where more than one company has a stake in the programme. This is what is happening with the announcements of commercial satellite systems the world over. The consortia not only shares the costs but also the risks associated with the high-technology.
- Increasing-dependency on data—both by government and private sectors from commercial ventures as against the systems constructed and owned by governments. This would, however, give greater discretion to commercial ventures to serve the user community in a manner contrary to what the government perceives for public and research programmes.

Reducing costs of systems

This has to be the major concern of commercial programmes and this would require appropriate government support to research programmes for cutting costs of satellites, sensors, launchers and ground segments. Reduction in costs could bring in greater competition in the commercial market for RS systems.

Return on investments and data pricing

Return on investment and data pricing, which is of the order of 500–1000 US$ as in the case of civilian satellites, would mean an increase in costs of data. However, while recognition of this requirement is essential, there is a need to maximize return on investments in a non-monetary sense. While data sales provide monetary returns, research and operational monitoring return value to government which may be of a high societal value.

Receptive to different market segments

Different market segments—private, government or international—need to be addressed as markets and the technology has to cater to these market needs. While government agencies are using RS data in a major way, in-roads into the private sector and the international users will be a major element. Market segments for commercial programmes will be characterized by geographic regions and also by the nature of users. The target market segments will be where there is the greatest growth potential for commercial services. Four major segments of market can be identified:

- Market segments for the commercial services is basically determined by the application areas for which value-addition is being done. Most of the RS data utilization is for natural resources management which are under the control of *government sector* in most countries (private sector may only be involved in implementation). Thus, areas like forest management, land management, water resources management and so on may involve government agencies.
- Another segment of the market exists as part of the various *funding agencies* like UNDP, ADB, IMF, ODA, FAO, UNEP, World Bank, etc. which are the key players for funding assistance for development in most countries. One of the key elements of their decision-making for funding assistance is the evaluation of the proposals; this evaluation would call for the requirement of information natural resources/ ancillary data. The provision of resource information to these agencies will be a major market development activity.
- However, there are a set of key areas where *private sector* is involved in a major way – oil and gas exploration, mineral targeting, mining, civil engineering projects—highways, power projects, urban transport, tourism projects, industrial projects, etc; publishing industry—specially the map publishers and so on.
- Another segment is the *education sector* which would require services from education and training point of view—at school, college and professional level.

Spatial information markets

SI markets with RS technology having the capability to provide spatial information for various resources, the thrust has to be on marketing these spatial information, in addition to the present marketing of RS data itself. There has to be a strong business and marketing plan to introduce innovative solutions to spatial information demand through effective packaging of mature technology. One could visualize a spatial information services centre which will market information derived from RS—either in isolation or combined with other ancillary data and packaged to the needs of end users. This will remove the user's need to process and analyse RS data to generate the necessary information. Some of the services that can be offered could be based on the

projects and programmes already completed—landuse, wasteland, coastal, groundwater, crops and so on. A systematic programme of updating these information could also be worked out so that the market needs of latest information could be met.

Economics of spatial information

This is derived from RS systems which can be defined from the perspective of their importance as *resource inputs* and as *commodities* which are 'traded' for making decisions. The economic benefit accrues from the improved decision-making that is possible through the use of such information. However, the economic value of such information is being disseminated to as many users as possible—'reselling' but the value dissipates once the information is widely available. Market motives push satellites to finer resolutions, thus making the spatial information of high-value.

Duality of RS information

Duality of RS information is characterized by perceptions of information as a commodity—which defines the commercial characteristics of the information, and the perception of RS-based information as a research input—which defines the public nature of the information available at subsidized or no-cost. This has been one of the main trace of arguments against the commercialization of RS so as to maximize the research use of RS data. Many research programmes for earth observation and process-based studies require volumes of repeated datasets from satellites, but the research community has only a limited capability to pay commercial costs for data. The trend is to subsidize data costs for research use and recover commercial value of data from uses which have operational or commercial considerations.

Classified nature of data and its non-conformity for commercial ventures

It would be essential to consider all published information so that legality aspects can be avoided. However, this may have an impact on 'authenticity' and 'acceptability' of information of commercial nature. Dove-tailing of classified nature of data and open, free access for research would be called for and a proper categorizing of what is 'classified' or of 'national security' needs.

The focus on commercial development would, however, help achieve goals in supplying products and services in a sustainable market place and further the overall Government policy of technology based competitive innovation. It does so based on a targeted understanding of the specific public and commercial opportunities seen in serving current demand and expanding the opportunities for the entire spatial information industry into information service markets which include, among others, agriculture, environment, urban mapping, natural resources monitoring and infrastructure applications—specifically, building upon existing, often unmet, requirements for spatial information. A foundation for global information solutions companies and end users to expand into new applications of digital information having significant economic value.

Commercialization – major goals

Developing an independent sector for spatial information with the active involvement of government, private entrepreneurs, industries and other agencies with suitable tie-ups with global markets will be an important element towards commercialization. The specific objectives could be to:

a) encourage small and large companies, through the appropriate sharing of public and private risk, to create profitable new RS products, processes and services
b) fully exploit the advances in and convergence of RS technologies, including airborne and space imagery, spatial data integration or fusion, data registration, information packaging and telecommunications.
c) promote the convergence of market niches towards an integrated RS industry through developing new commercial practices, standards and infrastructure.
d) support profitable new or emerging domestic and overseas markets for RS technologies
e) ensure commercial success of government and industry partners which in turn contributes to the economic benefit of programmes.

Scope of opportunities

The following technical and market opportunities may help develop market segments:

Newer applications of RS

With the availability of data from a wide variety of satellites – both in the civilian and commercial sectors, there is a need to look at newer applications. The thrust of the newer applications will have to be towards addressing resource management problems—both at global and local level. Apart from the present resource management applications, the newer applications could also include non-conventional applications like updating cadastral maps, landuse inventory at plot level, facility management applications, climatic cycles, global vegetation and landuse, etc. Applications in support to other

sectors like tourism as an aid to plan tourism facilities, route planning, tourist map generation, etc; education mainly as an awareness tool for all field-trips, dissertation work carried out at schools/colleges/universities; facilities management—sewerage management for cities, road/highway alignment, routing applications; oceanographic applications—operationalizing the present day applications of waves, winds, bathymetry, etc. will have to be worked upon.

Value added services

Developing a full range of satellite and aerial data, specifically addressed to the vibrant local and international market. The emphasis will be on integration of convergent technologies such as digital imagery, geographic information systems, global positioning systems, and telecommunications. Two categories of value added services (VAS) are envisaged:

- *Value addition by processing to generate spatial information dataset (VAS-SID)* by providing satellites data along with thematic information—integrated with information from GIS, DTM, other resource information, non-spatial information and so on. The SID dataset generation would require an integrated mechanism of packetization of RS data and other datasets in a GIS environment. The SID could be marketed to users in digital format compatible to different image analysis and GIS systems.
- *Value addition by analysis to provide end application products (VAS-AP)* by modularization of applications. The modularization effort would be to prepare application manuals (AM) detailing the datasets to be used, methodology of analysis (including visual and digital analysis methods) and information presentation. Based on the AM, the value addition could be done for specific user needs and requests. A major need would be to market and publicize the AMs which should also include a few pilot-VAS studies. The mechanism of VAS could range through projects involving deputing technical personnel or directly marketing the AMs. Table 1 shows some of the possible areas for VAS.

High-volume data transfer

Present day technology demands timely availability of

Table 1. Possible areas for value added services

Value addition by processing to generate spatial information dataset (VAS-SID)

- Photo-image map. This is an ortho-image registered with a vector map and including relevant annotation. Optionally the image could be enhanced (e.g. edge enhancement)
- Image and DEM draped products. This will include both perspective products and fly-by products.
- Multi-media integrated data bases
- Merged products – PAN (IRS-1C, SPOT) – multispectral (IRS-1C, SPOT, TM) and SAR + multispectral
- GIS merged product as a spatial information packet. This will include GIS-based information packet of RS data with basic layers of cultural features, transportation and commission, census features, etc. for key region. Fine tuning for application needs can also be incorporated. To start, URBAN-METRO AREAS (1M + cities) and ENVIRONMENT-sensitive areas can be selected.
- Image maps for two or more oil/gas basins in the Indian footprint. Hard copy and digital data sets for inclusion in GIS.

Value addition by analysis to provide end application products (VAS-AP)

- Coastal zone environment. Baseline data base, procedure for studying changes in the coastal zone, suggests measures to be taken up for sustainable development of the coastal eco-system
- Change detection – Urban, forest, landcover and river courses
- Watershed characterization, prioritization, development and monitoring
- Crop production forecasting – Foodgrains (wheat, rice); horticulture crops (coconut) and for tea, rubber plantations this package provides preharvest forecasts
- Coastal zone management for brackishwater aquaculture
- Corridor data set for planned pipeline alignments
- Performance evaluation and diagnostic analysis of existing surface irrigation schemes
- Monitoring/change detection of landuse/land cover, wastelands, forest Plantations, water spread of reservoirs/reservoir capacity evaluation/surface water bodies, irrigation efficiency and impact due to industries/mining/urbanization.
- Assessment of forest cover – types/density/fire prone areas, wildlife habitat assessment, preparation of forest working plan and assessment of mangrove cover.
- Creation of land information system involving spatial as well as attribute database.

information. A computerized network could help users in remote accessing the database and as a mechanism of transfer of RS data reaching the user community, in addition to present methods of CCT, cartridges, CD-ROM and so on.

Merging RS data

Merging RS data with advanced concepts of expert system (ES), artificial intelligence (AI) and neural networks—all oriented towards automating the data analysis process in the digital domain by incorporating expert decision rules will be another area of research so that expert RS data analysis systems could be configured. Concepts of virtual reality (VR) can be applied to RS data to provide a new dimension of visualization product for users – specially when merged with other dimensions – DTM, spatial information and non-spatial data so on.

Management decisions

Management decisions, where the supply of products processes and services to investment, management and operational decisions associated with environmental, small-scale resource, infrastructure and event-response applications.

Hardware and software

Hardware and software for the use of satellite and aerial data and also for the conduct of end-user applications is one of the potential opportunities for the industry. The equipments for visual analysis of RS data; computer-based digital analysis systems; GIS software and customized solutions for applications has a market-potential that can be catered to by the industry.

Apart from this, there could be other areas which could be formulated to a commercial nature.

Conclusions

In conclusion, markets of spatial information products such as those produced from RS satellites, a mix of market-driven and government administration should be retained for commercial programmes to develop and flourish in the coming years. At issue are the best policy mechanisms and pricing strategies to create transparency to the commercial programme.

Programmes must also consider the wide diffusion of data in support of societal applications and research needs, operational resource management applications and others that are deemed to be in the widest public interest as against the applications that derive commercial value from the information use.

The development of commercial programmes in the value-added sector will however be the major thrust area and will serve the ever-increasing demands of user communities. The definition of a full-fledged policy and programme for the commercialization is of utmost importance and towards this issues have been addressed. Another important aspect is the environment in the government which needs to be conducive for private sector participation in the RS application activities and creating a services sector for spatial information. The cost of the technology is also coming down—specifically the equipments required for analysing and interpreting the data. Methodologies have also been standardized and techniques for applications are in operational use. The user segment is well aware of the technology and its potentials.