FUTURE PROCESSING AND ARCHIVING NEEDS

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1.0 INTRODUCTION

Remote Sensing Technology has grown by leaps and bounds ever since it made its entry as a reconnaissance tech-nology using aircraft scanner in the late fifties and early sixties of this century. Many national and international programmes extending this technology to satellite platforms have been realised. Many more, new and exciting missions are under construction and planning. A recent phenomenon has been the attempt of private, commercial ventures to build, launch and operate Remote Sensing Spacecraft, offering data of unique characteristics that have not been available to civilian users so far. On the other hand, the users have learnt to exploit this technology skillfully coming a long way from the state of being excited by the pretty colour pictures. Very rapid advances in computer hardware, software, communications and information handling using geographic information systems have also taken place. In spite of all these developments, the cost effectiveness is still to be felt, especially by the decision makers. Also, many users still consider Remote Sensing Technology as a difficult and complex route to meet their requirements. Most of the data users still feel that the data availability is not guaranteed, nor is it available quickly, besides it being very expensive. It is from this background, that it becomes necessary to address the requirements on future processing and archiving facilities particularly with an emphasis on how to fulfill the user needs.

2.0 Background.

There are several challenges for the Remote Sensing satellite ground stations who collect, archive and distribute data in a routine manner. There are only a limited number of civilian remote sensing satellite ground stations around the world. The first ones were in U.S., Brazil and Canada for Landsat in the early 70s. After nearly two and a half decades, now there are about 20 facilities for the IRS, Landsat, SPOT and other missions like ERS and a few more will be operational in the near future. By and large, the antenna receive system (upto recording) has been a fairly standard set up and after the transition to X band with Landsat in 1982, there have not been many significant performance improve-ments due to technology, especially in the areas of R.F., servo and tracking. No doubt, miniaturisation, ease of operations due to automation, and the associated benefits of easy maintenance have resulted. The data processing system on the other hand have had to be developed for each sensor/mission and they could also benefit continuously to a large extent from the rapid technological advances in the computer hardware and software. During the last few years the archival medium of high density tape which was in vogue for nearly two decades, is giving way to alternate media like digital cassettes, optical tapes etc. The number of missions to be handled, data rates, data acquisition, recording and archival policy, are the primary issues governing the approach of the ground station operations for the archival media.

3.0 CURRENT SCENARIO

Many areas of technical complexities/difficulties are with regard to data recording/archival media and sensor specific hardware for synchronisation and decommutation of the unique telemetry format. These are very much dependent on the manufacturer and the long term operations and maintenance of the HDTRS/DCRs etc. is very expensive and subject to uncertainties. Since the archival is on HDTs and in a sensor specific format, availability of HDTRs and the sensor format

stripping hardware are required for retrieval of data. Thus any long term archival has the associated problems of ensuring availability of these equipment. Hence, storage and retrieval of data from the HDTs are proving to be quite demanding and posing severe problems besides huge amount of labour and expenses. In the recent past, a few ground stations including India have decided to go in for newer technologies and modified system engi-neering approach. The approach is to record the data in real time during satellite pass on computer disks. The data after demodulation and bit synchronisation will be frame synchronised and decommuted by software before being written on to the disk. Thus the data when available on standard computer disk in a random accessible format, offers tremendous flexibility to manipulate and handle the data as required. It is then transferred on to a storage media. For later retrieval one does not require special purpose equipment like HDTR/DCRs etc. nor any sensor specific hardware. Thus, the easeness of long term retrieval of the data with standard computer hardware becomes possible.

4.0 NEEDS AND DEMANDS

The primary functions of remote sensing ground stations are to acquire the data as per the desired needs, assess the quality of data, generate and populate accession data base to include cloud cover and quality characteristics, generation of browse, and archive the data. Sub-sequently, other functions like transfer of browse image for easy access to remote users, retrieval, processing and supply of data against standing requests or new requests are the other functions.

For the purpose of focussed analysis and easy comprehension, the use of satellite data can be grouped as Real time/near real time use within 1-3 days of data acquisition, use within a reasonable period of few weeks to months, and long term of one year to several years. It has been the general experience of many ground stations that the probabilities of meeting the requirement of a user for a particular data set is not very high and is of the order of 50% only. This is in spite of the fact that most of the ground stations have gone in for routine acquisition, recording and long term archival of the data. Thus, a well planned strategy for assured collection of data when required by the user has to be evolved. This becomes slightly easier if the user informs in advance and makes prior requests. Here again the vagaries due to limitations of optical data obstructions by cloud cover has to be lived with. Only when one has the choice, freedom, capability and scope to acquire either optical and / or microwave data, this situation can be overcome to a large extent.

The real and satisfying way to meet the user needs would be to offer "On Demand Data Collection". This can be served by having the required number of spacecrafts positioned suitably so that the payload can be tilted for acquiring the data over any part of the coverage of the ground stations, within a day. The spacecraft would be in a near fixed orbit without any day to day shift, or drift slowly over a long period so that it is always within the central longitudes of the region. This can be expanded further and suitably designed at an international level to cover all anticipating countries to ensure acquisi-tions of data within a short time like a day or two. Provision of suitable sensors has to be made to overcome problems of cloud cover. This kind of an approach is really part of missions/programme planning and can bring down cost of G.S. operations drastically while meeting the requirement of collecting data when required.

5.0 ARCHIVAL AND BROWSING

The above scenario of collecting data when required may evolve in the coming few years. However, existing ground stations have to live with and manage with current realities. Archival policy is an important factor which plays a major role in determining the complexity and cost of ground station operations. Careful choice of media would assist in optimising the cost and ease of retrieval of data. Ideally, one would like to archive all data acquired at a reasonable cost and with assured quality over extended periods of several decades. With the recent advances in Magneto Optical Media technology, there are bright chances of achieving such an ideal situation. While the topic of suitable media is a

separate topic of discussion on its own, it suffices to point out here the advances made in such areas, starting with CD-ROM technology. M-O disks of greater than 2 GB capacity per unit are currently in use. Non industry standard of 4.6 GB also is in vogue. Technology advances forecast that 20 GB per media would be achieved in 1998 and 100 GB by 2000 or so. Major advantage in this technology is that the basic drive/unit is very inexpensive-about a few thousands of dollars. They are used for diverse applications towards digital mining with, digital library system. The critical areas are health, insurance, tax records etc. wherein the direct relevance of accuracy, speed and economics are much more crucial than that has been the case with Remote Sensing data so far. Once the random accessibility with speed and ease associated with long term reliability of large volumes of data using large digital juke boxes are assured, the ideal situation of ability to store all acquired data can very well be realised.

Having discussed the acquisition, recording and archiving of data so far, let us see the other areas of activities for the ground stations. On line acquisition catalogues soon after data acquisition is a very important requirement. In general, this is achieved within a few hours to a day after the data, acquisition by most of the ground stations. However, on line accessibility, especially using the advances of the internet technology is still evolving. A user would like to browse the data soon after its acquisition, ensure his geographic area of interest is generally cloud free or otherwise useable and then able to place the order. Technology is available today to carryout the above within a few hours of data acquisition. Operational procedures and standardised practices are under evolution/development for fully benefiting from even the existing technology. In generation of browse, one can apply efficient and reasonably lossless data compression techniques on the full resolution data. This can be used for transmitting data over communications links on a near real time basis. With advances in communications technology, the data can reach a remote user and get loaded on to his laptop.

6.0 DATA TYPES, FORMATS AND SERVICES

From an increased demand for data point of view, the ground stations have to see supply of data from two angles. One is from ease of usability and the other is from the point of view of routine extraction of derivable information. Besides, generating products on an urgent basis for critical applications like floods, crop modelling etc. on prior order/ request, one can think of scan service. This could involve inspecting the data on high resolution monitor at every pixel and scan line level for the required areas. Based on the problem & experience, automated techniques also could be developed for this type of scanning. Based on this inspection, the user can be informed suitably after which he can choose to go in for a detailed study by ordering and receiving the data of his interest. We can develop this kind of expertise and service in an interactive manner with the users and, in course of time.

Geocoding/map compatibility of data is one major aspect that is now being met at least partially. Format, media, map overlay are the other aspects that need attention. Standardised pixel sizes, CD ROM as the media and map data base in a digital form are to be provided for and are slowly being realised. Suitable data formats enabling the user to read any data set without major programming effort need to be constantly evolved. It has now come to a stage where any remote sensing satellite data has to be manipulated on a GIS environment with other data. Hence, the format conducive to feed into GIS systems is to be provided for. Overlay with the map can be offered as an option or the overlay can be embedded in the data in a vector form and can be selectively displayed/used while analysing the data. These features along with standardised pixel sizes will also enable easy combining of data from different sensors. It is advisable that requirements like terrain corrections may be left to be attempted by the users especially for virgin terrains for which the user only may have the best available information. However, digital elevation model of the scene/area (as available) can be given along with the data,

again as an option. It may be borne in mind that most of the thematic applications can be handled without corrections for elevation effects.

Besides supply of data in a user friendly format and media, one can identify information/parameters that can be routinely extracted from the satellite remote sensing data. Seasonal and dynamic aspects only will fall under this category normally. The type of information would be governed by the state/district , its priority areas of monitoring and development, and the associated information desirable from Remote Sensing data. The actual interpretation / extraction of data can be planned to be executed at the user/state centre/regional centre facilities. The concept can be demonstrated by the ground station initially and then passed on to any one of the organisations mentioned above, depending upon various factors. In India, Forest cover inventory on a national scale was a major effort to demonstrate utility of satellite Remote Sensing. We have to now focus the same at smaller administrative unit levels like district/ mandal etc. on issues of specific concern in that particular area. The identifications of these along with parameters, scale, frequency of update, cost etc. can be done by suitable teams from local administration, state department and Remote Sensing Specialist from the ground stations. Careful identification of these initially, and fine tuning them with practical experience will provide valuable inputs to a Natural Resources Information system for the region. We can work out details of aggregating the data appropriately to enable their use at different scales.

7.0 FUTURE DIRECTIONS

We have so far discussed possible actions and steps that could be taken by ground stations for meeting the user needs in an efficient and economic manner. But the discussion has been restricted to data types that have been/will be available from a conventional type of Remote Sensing Satellite missions. There are many newer missions which are almost 'fancy' in their capabilities in terms of resolution, spectral bands, data rates and many other features. Since data availability when required is a crucial question, one would be well advised to await some sort of assured programme / availability and continuation of such missions before planning for any major upgrade or modifications to their ground system. In the meanwhile it is interesting to look at some of the recommendations projected by a study team for the "National Imagery and Mapping Agency" of U.S.A.

- Evolve a distributed heterogeneous, internet-like architecture that uses the geospatial data bases as its foundation.
- Institute a requirements process that prioritises user geographic information needs.
- Rapidly acquire access to install worldwide data bases using all available commercial sources and practices.

The above has been driven by a strategic direction to:

- provide seamless access to tailored imagery, imagery intelligence and geospatial information.
- make information available on very short timelines at the lowest possible classification level.
- obtain and use best available information - government or commercial.
- use private sector services and best available technology.

Significant technological advances in digital storage, monitoring, other communications, computing and displays have raised expectations among users that they should be able to know at all times, where they are, what is around them and how that affects their missions. Perhaps more importantly they now also expect everyone on their team to have consistent information. The same advances that are raising user expectations are creating technological opportunities for the geospatial community. The trends are:

- Overall demand for geospatial information is increasing.
- The importance of hard copy support, particularly for standard maps and charts is diminishing while that of support with digital

information is growing, but the need for hard copy is not going away.

- Within hardcopy support, tailored hard copy produced closer to the site of view and adopted to the situation will gradually supplement standard hardcopy products.
- Electronic displays of dumb maps, primarily raster versions of hard copy maps will yield ground to machine decision making and smart, interactive displays that operate on primarily vector data sets.

The main point to be noted from the above is that, efforts are under way to integrate many technologies using standard commercial equipment and by following geographic inter operability standards, the need of the different user segments are going to be met in a more meaningful manner. Needless to point out that the civilian Remote Sensing Satellite ground stations also will certainly gain from this evolution and would do well to keep track of the advances happening in this area in terms of technology and standards.