



United States Department of the Interior

GEOLOGICAL SURVEY
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IN REPLY REFER TO:

OC 7-23

July 26, 1985

To: Distribution
From: Chief, EROS Data Center
Subject: U.S. Satellite Land Remote Sensing Program

Attached is a summary of the current status of the U.S. Satellite Land Remote Sensing Program, along with a very early and preliminary draft of the current Survey and NOAA thinking concerning the establishment of the historical satellite data archive and collocated cooperative research activity.

You may find these interesting reading, and I would welcome any comments that you may have. Eventually these papers should evolve into a persuasive proposal that the Survey and NOAA can jointly use to approach OMB or to originate new budget initiatives.

Allen H. Watkins

Attachments

Distribution:

- Chief, National Mapping Division
- Acting Associate Chief, NMD
- ADC for Research
- ADC for Plans and Operations
- Acting ADC for Information & Data Services
- Senior Advisor for Remote Sensing
- Research Cartographer
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7/25/85

STATUS OF U.S. SATELLITE LAND REMOTE SENSING

- o Landsat 1 (first of 5 Landsat satellites) was launched in 1972 by NASA; simultaneously, Interior established the EROS Data Center in Sioux Falls to produce and distribute products in cooperation with NASA and to carry out research and applications development in support of Interior's use of remotely sensed data.
- o November 1979 Carter Administration directive (PD-54) assigned operational Landsat management responsibility to NOAA (NOAA, NASA, and Interior were the serious contenders) and directed NOAA to prepare a "Transition Plan" for the eventual transfer of satellite land remote sensing operations to the private sector.
- o NOAA assumed operation of Landsats in 1982 with Interior's EDC continuing product generation and distribution responsibility under a cost reimbursable agreement with NOAA.
- o In March of 1983, the President, following a review by the Cabinet Council on Commerce and Trade, decided to move directly to commercialization and in January 1984, NOAA released a Request for Proposal to industry soliciting interest in private sector ownership/operation of the U.S. satellite land remote sensing system.
- o In 1984, Congress passed the "Land Remote Sensing Commercialization Act of 1984" which was signed into law as P.L. 98-365 and which authorized the competitive selection of a private sector owner/operator and stipulated the requirements for the initial phases of commercialization:

- o Initial operation of Government-owned Landsats 4 and 5.
 - o Development, launch, and operation of future privately owned satellites with Government subsidy support.
 - o Eventual phasing out of subsidy to a full commercial operation.
 - o Nondiscriminatory data distribution.
 - o Continued Federal R&D.
 - o Requirement for a Federal archive.
 - o No commercialization of weather satellites.
- o In August of 1984, following a lengthy source selection process, Commerce announced the selection of EOSAT, a joint partnership of Hughes Aircraft and RCA Astroelectronics, as the successful competitor for private sector ownership/operation of the U.S. system.
 - o Subsequent OMB and congressional funding activities, limited the Government subsidy to \$250 million (plus Government-furnished launch) to support the development and operation of 2 satellites (Landsat 6 and 7) to provide data for a minimum of 6 years.
 - o Pending final congressional action on NOAA FY 85 supplemental funding appropriations, NOAA now estimates a contract can be signed by August 1985.
 - o The last NOAA satellite (Landsat 5) will complete its 3-year design life in March of 1987. The earliest possible launch of EOSAT's Landsat 6 will be in late 1988/early 1989.
 - o Current transition planning involving NOAA, Interior, and EOSAT, proposes that Interior's EDC continue to support NOAA and EOSAT with data processing,

product generation, and data distribution services through FY 87, with little or no reduction in the existing level of NOAA reimbursable funding support of \$6+ million per year.

- o EOSAT plans to shift all Landsat data handling activities to a new Maryland ground facility prior to the launch of Landsat 6 in 1988. EOSAT also plans on implementing a ground data receiving station for Landsat 6 in Norman, Oklahoma.
- o Landsat data handling and associated NOAA funding of \$6+ million account for roughly one-third of the total current funding and activities at EDC. Other activities at the Center include data archiving, processing, and distribution of a wide variety of USGS aerial photographic and geophysical data, the support and development of advanced digital cartographic software and systems, and a substantial research and applications development effort in the fields of remote sensing and geographic information systems.
- o P.L. 98-365 requires the Secretary of Commerce to establish and operate a historical land remote sensing archive for the long-term preservation of valuable scientific data from domestic and foreign satellite systems and encourages the Secretaries of Commerce, Interior, and Agriculture to implement an enhanced program of applications research and development leading to increased use of satellite land remote sensing data.
- o Recent and continuing conversations with NOAA have centered on the use of EDC as the location of the archive and the establishment of a joint NOAA/USGS/university consortium cooperative research effort collocated with the archives, with participating researchers having unrestricted access to

the archives for research purposes. Strategies for funding initiatives are being discussed with NOAA. (Background document attached.)

- o In response to pressure from the South Dakota congressional delegation and to satisfy Interior and USGS needs, the USGS is continuing to evaluate alternatives for transferring other ongoing activities to the EROS Data Center as Landsat data handling activities transfer to EOSAT in the FY 88/89 time period:
 - o Distribution of digital cartographic data.
 - o Increased support of other digital cartographic activities.
 - o Expanded remote sensing support of a broad spectrum of Federal activities, i.e., a National Remote Sensing Center.
 - o Increased R&D in support of Interior's geographic information systems needs.
 - o Exploitation of classified source data for civil use.
- o Somewhat unrelated to the U.S. commercialization activities, the French will launch their SPOT earth-observing satellite late this year with improved spatial resolution over current or planned U.S. civil systems (10-meter ground resolution). The Japanese, Indians, Europeans, and Canadians have similar advanced systems planned or under development.
- o The Office of Science and Technology Policy (OSTP) is just completing a study of "Earth Sciences Research in the Civil Space Program" which recommends broadening NOAA's responsibilities for acquiring, processing, archiving, and making available long-term data bases related to land earth sciences and global processes. This report will be forwarded to the Senior Interagency Group on Space (SIGSPACE) for action.

- o The USGS believes that a continued substantial involvement in the satellite land remote sensing program, both as a primary participant and as a user, is in the best interests of the Department. Federal remote sensing technological leadership in data processing, analysis, and use is an open issue and in many ways is strongly related to a broad interpretation of the Survey's National Mapping Program and earth science missions and to Interior's interest in advanced and improved information systems for resource management.

- o The Survey recommends that the Department be reasonably aggressive, within the constraints of budget realities, in dealing with issues relating to future satellite land remote sensing mission responsibilities and related earth science issues. The Survey would like Departmental support in reaffirming its previous EROS Program responsibilities as the Departmental spokesman for issues concerning satellite land remote sensing, and requests the support of the Assistant Secretary in setting up a meeting of the other Bureau Chiefs and Interior participants to review the current status of commercialization, the need for remote sensing data, and to establish a continuing committee chaired by the Survey to coordinate Interior remote sensing activities and requirements.

7/16/85

PROPOSED JOINT USGS/NOAA PROGRAM
TO ESTABLISH AND OPERATE
A U.S.
LAND REMOTE SENSING SATELLITE
DATA ARCHIVE AND
COOPERATIVE FEDERAL RESEARCH FACILITY

Program Goal

Establish and operate a U.S. archive that will provide long-term protection and availability of an irreplaceable land remote sensing data set acquired over the past decade by the U.S. satellite system and future data to be acquired by U.S. and foreign land remote sensing satellite systems, and conduct a program of remote sensing research and applications development colocated with the archives. Colocation of the research activity with the archive is the critical characteristic of this program because it allows fulfillment of legislated responsibilities for both historical data preservation and for remote sensing research and development without duplication of facilities, equipment, and costs. Furthermore, it provides an effective mechanism for access to the different types and large volumes of historical remotely sensed global data sets needed for many research activities, including those requiring time sequential data. Significantly, it is an arrangement whereby researchers will have unrestricted access, for research and development purposes, to the large volumes of archival data necessary for a study of long-term global processes, thereby converting a "dead" archive into an invaluable data resource.

Program Justification

Title VI of Public Law 98-365 (the Land Remote Sensing Commercialization Act of 1984): 1) authorizes the Federal Government to maintain an archive of land remote sensing data for historical, scientific, and technical purposes, including long-term global environmental monitoring; and 2) directs the Secretary of Commerce to provide for long-term storage, maintenance, and upgrading of a basic, global, land remote sensing data set (basic data set); and to follow reasonable archival practices to assure proper storage and preservation of the basic data set and timely access for parties requesting data; and, to the extent practicable, use existing government facilities.

The legislative report which accompanies and supports the Public Law notes that the baseline for the archive will be satellite data currently archived at the EROS Data Center (EDC), and that the existing Government facilities referred to are those located at EDC. Further, the report states that the personnel at EDC are experienced in processing, archiving, and distributing satellite land remote sensing data and the facilities are uniquely suited to the job of cataloging and archiving satellite remote sensing

data to assure preservation in an orderly manner. Finally, the report states that the Secretary of Commerce is expected and encouraged to utilize this unique facility and capability for maintaining and preserving the archive of data from land remote sensing satellites.

In addition, Title V of Public Law 98-365 authorizes and encourages a continued and enhanced research and development effort by the Federal Government in civil space remote sensing and applications. The legislative report which accompanies and supports the Public Law notes that the transfer of satellite land remote sensing to the private sector leaves to the Federal Government the responsibility for continuing high-risk research and development in remote sensing to ensure that the United States effort remains competitive in the world market. Title V of the Public Law encourages a vigorous Federal research and development program, and the report states: "...the program be broad in scope and that it include development of new technology, including sensors, communications, and spacecraft. The program should also include demonstrations of such new technologies."

The legislative report also recommends that the Federal research and development program include sponsored research at universities so that professionals in various disciplines will be able to make use of remote sensing data in their work, and applications research for those Federal agencies that could use information from remote sensing. The report also states that the objective of the research efforts should be on improving the applicability and utility of remotely sensed data.

The Department of Commerce is authorized via the 1984 law to conduct a strong remote sensing research and development program with particular emphasis on applications. This research would be carried out by NOAA working cooperatively with other Federal agencies, with recognition that NOAA has not established an aggressive land remote sensing research activity, but has expanding responsibilities in global earth science studies. The Departments of the Interior and Agriculture are authorized by the 1984 law to conduct programs of remote sensing research and development applied to the management and utilization of the Nation's renewable and nonrenewable resources. The USGS is among the world's leading authorities on the application of remote sensing to the earth sciences and mapping, and will carry out Interior's research and development responsibilities. Starting in the mid-1960's, the USGS made a major commitment to defining space remote sensing systems, developing new and innovative data acquisition, handling, processing, and analysis capabilities, and applying this technology to earth science and other land resource related problems. By engaging in a joint and colocated program, and thereby sharing equipment, facilities, access to data archives, and personnel expertise, NOAA and the USGS, (and other Federal agencies) could immediately initiate an integrated and

cost-effective program that would minimize overlap and duplication of effort and ensure areas of need are fully addressed.

A key ingredient of this cooperative research effort is that it be colocated with the historical data archives, with unrestricted access by the researchers and scientists to the long-term global data archives for research purposes.

The trend during the next decade within the land resource management and information collection agencies will be to more automated capabilities, and a research program in remote sensing technology is needed that is directed toward that end. An increasing need is foreseen for data that can be used more easily as input to predictive or managerial models that operate in a computer environment.

Improving remote sensing technology will provide new types of products during the next decade, which will be different and more useful to the sophisticated user than those products available today.

Furthermore, as resource management problems become more complex and as more and different kinds of information pertaining to those resources become available, an increased emphasis must be placed on information handling, merging, storage, and retrieval systems. Thus, research is required that focuses on ways in which satellite land remotely sensed data can be integrated with information from other data sources in a geo-based system which is both efficient and useful.

Program Implementation

The Secretary of Commerce will meet the data archiving and enhanced research requirements of P.L. 98-365 through an agreement with the Department of Interior to establish and operate the Land Remote Sensing Satellite Data Archive and research facility at its EROS Data Center in Sioux Falls, S.D. EDC has operated the final data processing, data archive, and data product generation portions of the Landsat ground segment since the launch of Landsat 1 in July 1972, and continues these functions at the present time.

The USGS, in cooperation with and oversight from NOAA, will develop and maintain a basic, global, land remote sensing basic data set consisting of selected data from Landsats 1-5, commercially operated Landsats 6 and 7, and future U.S. experimental and foreign satellites. The baseline for this basic data set will be the Landsat 1-5 data holdings and other satellite land remote sensing data archived by the Federal government. The Landsat 1-5 archive, for example, which currently resides at EDC, includes almost 650,000 unique scenes

or 2,200,000 frames (more than 1 band/frame per scene) and is expected to increase by approximately 100,000 scenes of Multispectral Scanner (MSS) and Thematic Mapper (TM) data by the end of the design life of Landsat 5 in mid-FY 87.

An "Advisory Committee" consisting of Government and non-Government members will be established and maintained to assist in the selection of optimum data sets and to assure that the basic data set meets the requirements and needs of all data users.

Data stored in the archive will exist on both film and digital media for the near-term; however, the "long-term" archive should maximize the use of "efficient" digital storage and minimize the use of film. It is expected that optical disk capability should be available in the near future at which time the digital tape data would be transferred to optical disks to satisfy long-term data storage requirements.

Adequate space and shelving with appropriate environmental controls and the necessary handling procedures and standards will be provided to assure that long-term data integrity and quality can be maintained. Upon completion of minor facility modifications, archive capacity should be sufficient to accommodate digital and film data for the next 20 years. However, selective purging or compression of existing archived data will be done to maximize the use of environmentally controlled storage space and minimize archive costs.

The archived data will be inventoried on a computer-based catalog and inquiry system which allows user access and reference to data. Pertinent data characteristics important to users will include such information as satellite designation, sensor type, scene ID, geographic coverage, date of acquisition, data quality, cloud cover. Paper or microfiche catalogs of the data base would also be available.

Both digital and photographic processing capabilities will be maintained and operated to assure efficient reproduction of high quality data from the archive in formats and timeframes required by users.

In order to meet the intent of the Land Remote Sensing Satellite Data Archive specified in P.L. 98-365, the following general requirements must be met:

1. Archive will include basic, global, land remote sensing data (basic data set) needed for historical, scientific, and technical purposes, including long-term global monitoring.
 - a. Satellite data currently archived at EDC will be used as a baseline for the basic data set.

- b. Selected data sets from U.S. and foreign, experimental and operational, Government and commercially operated land remote sensing satellite systems will be added to the basic data set based on: technical and scientific developments and needs; advice of users and producers of land remote sensing data; and the public need for geographically duplicative data with varying seasonal, spatial resolution or spectral differences.
2. Archive will assure long-term preservation and availability of data archived.
3. Content and scope of the archive will be controlled to assure archive data quality, integrity, and continuity.
4. Archived data must remain distinct from any inventory of data which the Landsat commercial operator maintains for sales and other purposes.

To carry out an effective and coordinated research and applications activity, NOAA will assign a team of remote sensing specialists to the USGS' EROS Data Center in Sioux Falls, South Dakota. Assignment of these experts to the Data Center would colocate them with the historic archive of satellite data--a critical ingredient for a successful research and development program. Sophisticated data processing equipment, laboratory facilities, and personnel expertise are already in place at the Data Center, and these USGS resources would be joined with the NOAA team of experts to form a broad remote sensing research and development capability including a multidisciplinary core of scientific experts. The establishment of a resident NOAA team at the Data Center would complement the USGS team which is already in place, and this team of scientists would be responsible for conducting workshops and training courses, making use of advanced automated data processing and analysis equipment, conducting research and development in new and advanced remote sensing techniques, carrying out applications development projects, providing analytical services, and providing technical assistance and other consultation services.

Other Federal agencies, particularly the Department of Agriculture, would be encouraged to colocate remote sensing specialists at the Data Center and to participate in this joint research and development program. The activities carried out by the joint team would be international in scope (e.g., applications development directed at deforestation, desertification and urbanization problems, monitoring catastrophic events, providing international training workshops, etc.).

A consortium with colleges and universities in the Upper Midwest region (six-state area) will be developed, operated, and

maintained and will be another major element of this proposed program. This regional consortium of universities could ultimately be enlarged to a national consortium of universities and subsidiary research locations. Technological developments resulting from the joint NOAA/USGS program at the EROS Data Center will be transferred to these colleges and universities in support of their teaching, research and development, and public service programs. The consortium would be encouraged to develop and/or expand on-campus microcomputer laboratory facilities which also would support teaching and research and development functions. Undergraduate and graduate training at the EROS Data Center would be encouraged as well as residency programs at the Center for faculty members and post-doctorate fellows. Student internships would be available at the Data Center for undergraduate and graduate students. Remote sensing research and development programs will be supported at the universities using data available from the historic archive, and advanced telecommunication procedures would be implemented for the purpose of linking on-campus microcomputer workstations with computer facilities at the Data Center. Results of research and development conducted at the universities would be integrated into the training programs, cooperative projects, and other technology transfer activities conducted at the Data Center.

Based on a consideration of the future needs of earth resource specialists and land managers and planners for information which may be provided by means of remotely sensed data, and an assessment of current gaps in research being conducted in other Government agencies, academic institutions or commercial laboratories, several general objectives for the joint NOAA/USGS research program over the next several years have been formulated. These are:

1. Develop improved data analysis, interpretation, and integration techniques for geologic mapping, hazard assessment, and nonrenewable resource exploration.
2. Develop automated analysis of satellite and other data for hydrologic evaluation and prediction.
3. Develop optimized, cost-effective methods for inventorying and monitoring vegetation resources.
4. Develop automated microprocessor and telecommunications technology to provide fast, low-cost digital analysis capabilities to field offices of user agencies.
5. Implement and use geographic information systems (GIS) technology to conduct research on methods for handling remotely sensed and other types of data.

6. Develop techniques for correcting, enhancing, and classifying remotely sensed data for improved product generation and meeting resource analysis information needs.

Specifically, the program will provide:

1. Improved methods to inventory and evaluate lithology, structure, potential for mineral and petroleum occurrence, and environmental effects of industry extraction. Better methods for predicting geologic hazards, making improved land-use plans, and producing more accurate geologic information for other associated studies.
2. Improved methods to inventory, evaluate, and predict streamflow, surface water storage, flood inundation, estuarine circulation pattern, nonpoint source pollution, lake eutrophication, soil erosion, soil moisture, evapotranspiration, irrigation water use and ground-water occurrence.
3. Better basis for standardizing mapping of vegetation resources. Optimized utilization of base data for thematic assessment of amount and quality of range and forest resources. Improved methods for rapid and cost-efficient ecological monitoring, natural disaster assessment, and renewable resource allocation.
4. Increased usage of satellite remotely sensed data at the regional and local office level for planning the use and management of land resources.
5. New and/or improved techniques that permit satellite remotely sensed data to be used routinely in existing geographic information systems as well as advanced information systems of the future.
6. Evolutionary development and improvement of automated techniques to handle and process satellite remotely sensed data and to extract information from these data that will facilitate its operational use.

Funding

NOAA and the USGS will jointly seek the required funding to provide for archives operation, archive data acquisition, and the colocated research effort to be carried out at the USGS' EROS Data Center.

Major program elements and a preliminary estimate of FY 87 and FY 88 funding needs of P.L. 98-365 are as follows:

	<u>FY 87</u>	<u>FY 88</u>
1. Establish and maintain a data archive Advisory Committee made up of Government, industry, and university organizations.	\$ 40	\$ 40
2. Augment existing physical facilities to provide for required data archive space with suitable environmental control and protection.	1,700	0
3. Procure or otherwise obtain selected satellite land remotely sensed data from U.S. commercial operators, foreign satellite systems, and both domestic and foreign experimental systems.	1,000	3,000
4. Maintain Land Remote Sensing Satellite Data Historical Archive basic operations including receipt, digital and photographic data copy and reproduction, and appropriate data distribution functions.	\$1,060	\$1,000
5. Develop, establish, and maintain an efficient global catalog of data availability including accession aids and create a telecommunication network for user access.	300	350
6. Improve and maintain the required data processing and product generation facilities, equipment, and capabilities.	300	500
7. Purge, upgrade, reformat, and convert existing satellite land remotely sensed data sets to efficient and compatible media, content, and format.	300	500
8. Develop and implement data mass storage systems that increase storage density, improve data access ease, and improve data durability, integrity, and reliability.	0	1,000
9. Establish a colocated staff of NOAA and USGS scientific personnel at EDC to carryout a joint program of research and applications development directed at increasing the operational use of	950	1,000

	<u>FY 87</u>	<u>FY 88</u>
satellite land remote sensing data within the Federal Government and to enhance the probability of success of the U.S. commercial remote sensing effort.		
10. Provide for, enhance, and upgrade the necessary computer and analytical equipment and facility support to carry out the joint research activity colocated with the archives.	\$2,000	\$2,800
11. Provide for university cooperation and support of the colocated reserach facility.	\$1,000	\$2,000
Total Funding	<u>\$3,650</u>	<u>\$12,190</u>

Note: FY 86 supplemental funding of approximately \$2 million to initiate necessary facility preparation and start-up activities would be highly desirable.

7/25/85

PROPOSED JOINT USGS/NOAA PROGRAM
TO ESTABLISH AND OPERATE
A U.S. LAND REMOTE SENSING SATELLITE DATA ARCHIVE
AND COOPERATIVE FEDERAL RESEARCH FACILITY

- o Public Law 98-365 - The Land Remote Sensing Commercialization Act of 1984.

- o Authorizes the Federal Government to maintain a Land Remote Sensing Data Archive for historical, scientific, and technical purposes, including long-term global environmental monitoring.

- o Directs the Secretary of Commerce to:
 - o Provide for long-term storage, maintenance, and upgrading of a basic, global, land remote sensing data set (basic data set).
 - o Follow reasonable archival practices to assure proper storage and preservation of a basic data set and timely access for parties requesting data.
 - o Use existing Government facilities to the extent practicable.

- o Directs the Secretary of Commerce to conduct a continuing program of research in applications of remote sensing, and:
 - o Encourages cooperation with other Federal agencies, universities, private industry, State and local governments, foreign governments, and international organizations.
 - o Encourages establishment of arrangements to foster such cooperation.
 - o Authorizes support of basic research at universities.

- o Authorizes and encourages the Secretary of the Interior and the Secretary of Agriculture to conduct programs of research and development in the applications of remote sensing, which may include:
 - o Cooperative activities involving other Government agencies, private sector parties, and foreign and international organizations.
 - o Basic research at universities.
- o NOAA and USGS agree that archive requirements of P.L. 98-365 will be met by establishing and operating a U.S. Land Remote Sensing Satellite Data Archive at the EROS Data Center in Sioux Falls, S.D.
- o NOAA and USGS agree to develop and conduct a joint NOAA/USGS cooperative program of research, training, technical assistance, and applications development collocated with the archives to facilitate a higher degree of operational use of satellite land remote sensing data and technology within Federal and State Government, academia, the private sector, and the international community.
- o NOAA and USGS agree to prepare a NOAA/USGS Memorandum of Agreement to establish and operate the U.S. Land Remote Sensing Satellite Data Archive and Cooperative Research Facility at the EROS Data Center.
- o NOAA and USGS agree to fully define FY 87-FY 90 program funding requirements and to jointly seek and obtain required funding through appropriate congressional and OMB channels.
- o NOAA and USGS agree to prepare a program definition and implementation plan with a draft due October 1, 1985.

- o NOAA and USGS agree to identify and address all relevant issues and requirements including:
 - o Organization and management institutional arrangements between NOAA and USGS.
 - o Facility and system modifications/additions and personnel needed to operate archive and research facility.
 - o Need for archive "Advisory Committee" consisting of Government and non-Government members.
 - o Definition of required basic data set:
 - o Upgrade existing data sets.
 - o Criteria for adding future data sets.
 - o Mechanism for considering user requirements.
 - o Distinction (separation) between archive data and Landsat commercial operator's working inventory.
 - o Arrangements for buying future U.S. and foreign (SPOT, etc.) data sets.
 - o Provisions for researchers' unrestricted access to archive.
 - o The collocation of NOAA researchers at the archive.
 - o Resident NOAA team (remote sensing specialists).
 - o Unrestricted access to and use of the historic archive for R&D.

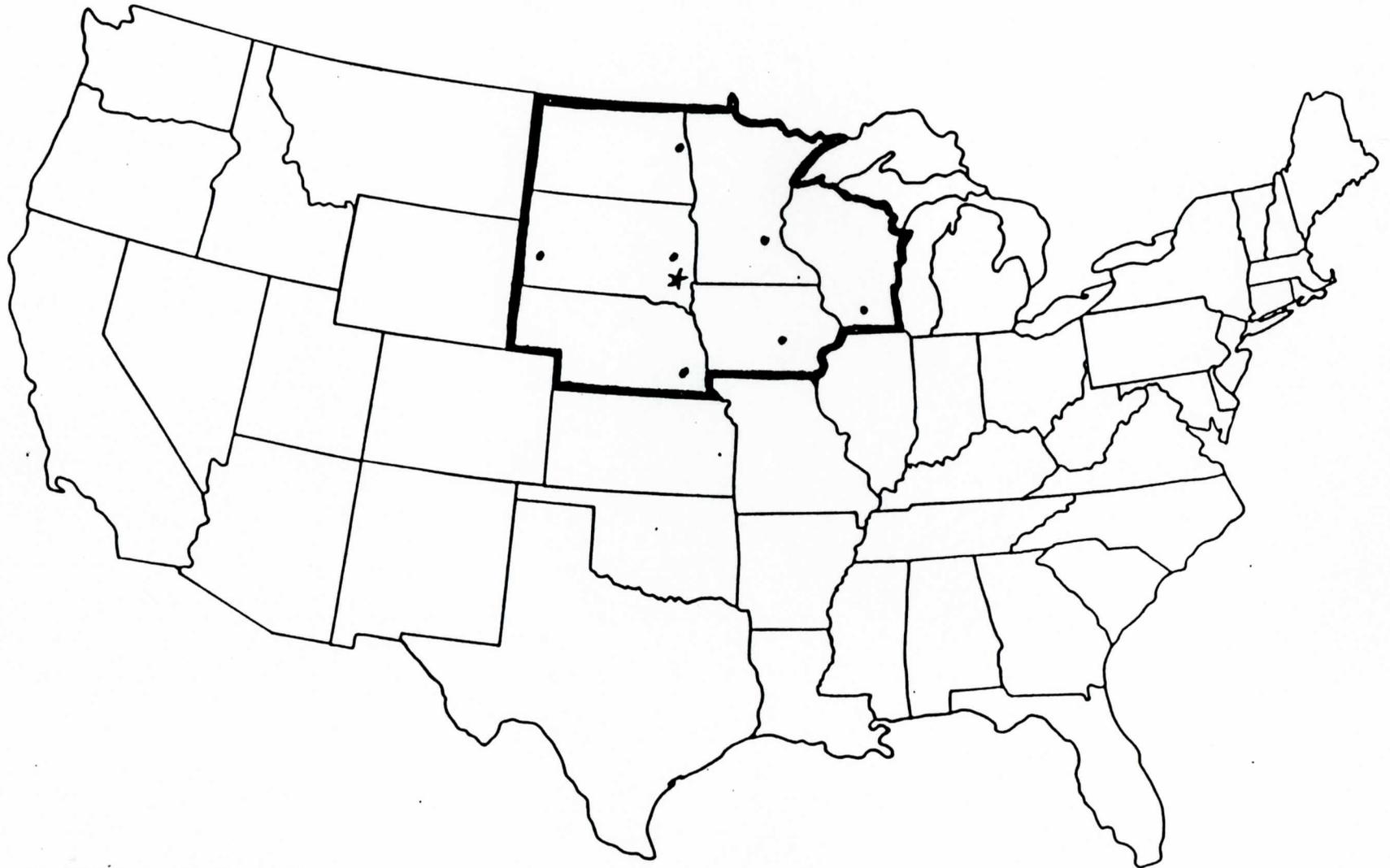
- o Use of state-of-the-art data processing equipment.
- o Collocated USGS personnel expertise.
- o Involvement of other Federal agencies.
- o Scope of national and international activities.

- o The implementation of a university consortium.
 - o Regional/national consortium of universities and research institutes.
 - o Develop and/or expand on-campus microcomputer laboratory facilities.
 - o Advanced telecommunications between computer centers.
 - o Faculty and post-doctorate residence programs.
 - o Undergraduate and graduate student internships.
 - o Remote sensing R&D programs at participating universities.

- o Research objectives:
 - o Develop improved data analysis, interpretation, and integration techniques for geologic mapping, hazard assessment, and nonrenewable resource exploration.
 - o Develop automated analysis of satellite and other data for hydrologic evaluation and prediction.
 - o Develop optimized, cost-effective methods for inventorying and monitoring vegetation resources.

- o Develop automated microprocessor and telecommunications technology to provide fast, low-cost digital analysis capabilities for field offices of user agencies.
- o Implement and use Geographic Information Systems (GIS) technology to conduct research on methods for handling remotely sensed and other types of data.
- o Develop techniques for correcting, enhancing, and classifying remotely sensed data for improved product generation and meeting resource analysis information needs.
- o Realize the full potential benefits offered by satellite remote sensing to land resource problems, through programs of research and development, capabilities in a broad spectrum of remote sensing topics, including:
 - o Sensor technology.
 - o Data capture.
 - o Data handling.
 - o Data processing.
 - o Data analysis and interpretation.
 - o Applications development.
 - o Physical bases of observation (fundamental R&D).

NOAA/USGS UNIVERSITY CONSORTIUM
UPPER-MIDWEST REGION



- ★ USGS EROS Data Center
- Potential University Participants