

CONCEPTUAL PLAN
FOR A DOD MANAGED AND OPERATED LANDSAT 7
WITH DATA PROCESSING, ARCHIVING, AND DISTRIBUTION
PROVIDED BY THE USGS

INTRODUCTION

In June 1989 the National Space Council (NSpC) requested (copy attached) the Department of Commerce (DOC), the Department of Defense (DOD), and the Office of Management and Budget (OMB) to develop and recommend appropriate options for Landsat 7 based on the following early findings of the NSpC.

- (a) full commercialization of Landsat is not possible in the foreseeable future
- (b) DOD is the only Department that finds Landsat data essential to its mission
- (c) continued government support is justified based on the needs of global change research, environmental monitoring, law enforcement, economic intelligence, national security, and foreign policy implications
- (d) there is substantial user dissatisfaction with current high data prices and use restrictions, which have resulted from commercialization

The DOC, DOD, and OMB have been unable to reach agreement on a recommendation for implementation of Landsat 7. One alternative for continuation of the program would be for Landsat 7 to be managed and operated by the DOD with data processing, archiving, and distribution provided through DOI. This paper presents a conceptual plan, including cost estimates, for a Department of the Interior (DOI) U.S. Geological Survey (USGS) operated Landsat Central Data Handling Facility (CDHF) to support a DOD managed and operated Landsat 7. The USGS operation would be carried out at the USGS' EROS Data Center in Sioux Falls, South Dakota.

SPACECRAFT, SENSOR, AND MISSION ASSUMPTIONS

The sizing, cost, and schedule estimates in this paper assume that the current plan for Landsats 4, 5, and 6 will be played out, i.e., that Landsats 4 and 5 will continue to be operated until their demise by EOSAT with NOAA providing operations funding and that Landsat 6 will be built and launched in mid-1992. Funding for the Landsat 6 satellite and launch is also provided by the Federal government.

It is assumed that funding for Landsat 7 will be initiated in the FY 1992 or FY 1993 budget with launch availability by 1996, thus providing some overlap

with Landsat 6. Landsat 7 is, at a minimum, assumed to be a technical repeat of the Landsat 6 spacecraft, sensor, and mission.

Note: Highly desirable technical improvements include the addition of a 5- to 10-meter spatial resolution panchromatic band with a 40-60 km swath width and a technology update to a push-broom linear array CCD sensor with along-track stereo and data compaction techniques.

Global data will be acquired via on-board tape recorders or through the NASA Tracking and Data Relay Satellite System (TDRSS) with the decision based on cost and reliability studies (Landsat 4 and 5 use TDRSS and Landsat 6 will use tape recorders). Downlink of real-time and stored imagery will be to a domestic data acquisition facility (X-band) or White Sands (Ku band). Transmission of real-time imagery to foreign ground stations (10 to 12 locations) is assumed. Provisions will be made for encryption of the data stream in cases of national emergencies.

A rough-order-of-magnitude estimate of spacecraft, sensor, and launch costs for such a system is on the order of \$200-\$300 million depending on the technical improvements in sensor capability.

SPACECRAFT COMMAND, CONTROL, AND DATA ACQUISITION ASSUMPTIONS

Spacecraft command, control, and monitoring will be from a Spacecraft Operations Center (SOC) at an existing DOD location (Sunnyvale, Colorado Springs, etc.). Telemetry, tracking, and communication (TT&C) and data acquisition likewise will be accomplished by augmenting existing government facilities. Orbit determination and flight dynamics will be provided by DOD or NASA.

Raw data, as received, will be relayed from the Data Acquisition Facility (DAF) to the Landsat Central Data Handling Facility (CDHF) at the USGS' EROS Data Center at Sioux Falls via communication satellite (DOMSAT) link.

The Spacecraft Operations Center will be a 24 hour, 7 day week operation and the Data Acquisition Facility will be a 16 hour, 7 day week operation.

Table 1 presents cost estimates for these SOC, TT&C, and DAF ground system facilities.

TABLE 1. COMMAND, CONTROL AND ACQUISITION COST ESTIMATES

Non-USGS Costs	Capital (one-time) Costs	Recurring Costs
<hr/>		
Spacecraft Operations Center (SOC)	\$4-\$5 mil	\$2.5-\$3 mil
Telemetry, Tracking, and Communication (TT&C)	\$1 mil	\$1 mil
Flight Dynamics	n.a.	\$0.5 mil
Data Acquisition Facility (DAF)	\$4-\$5 mil	\$1 mil
Data Relay	<u>n.a.</u>	<u>\$1-\$1.5 mil</u>
Total	\$9-\$11 mil	\$6-\$7 mil

DOI DATA PROCESSING AND DISTRIBUTION REQUIREMENTS

The Landsat Central Data Handling Facility will provide image data processing, distribution, and archiving and be located at the USGS' EROS Data Center. It will operate on a 16 hour, 7 day week schedule. The primary output product will be Level 1a and 1b digital data and associated film products. (See Table 2)

TABLE 2. PROCESSING LEVEL DEFINITIONS

Level 0:	Reconstructed raw sensor data at full resolution
Level 1a:	Level 0 data that have been referenced and annotated with ancillary information such as radiometric and geometric calibration coefficients and georeferencing parameters
Level 1b:	Level 1a data with radiometric and geometric coefficients applied

Browse products and scene indexes will be generated within the CDHF and the CDHF will provide for computerized data access, inquiry, and ordering functions. Data maintenance and archiving are assumed to continue to be provided through the National Civil Satellite Land Remote Sensing Data Archive co-located at the EROS Data Center and funded by an existing USGS line item.

Data processing throughput and cost estimates are based on the assumption that the DOI USGS Landsat CDHF will provide data products to all government (DOD and non-DOD) and non-government commercial users.

The existing Landsat system distributes approximately 8000-9000 digital scene products a year (25-30 scenes/day) along with a like number of film products. A reasonable estimate of digital data product needs for Landsat 7 from experience and recent studies is shown in Table 3.

TABLE 3. USER DEMAND ESTIMATES

User Category	Digital Products
DOD	4000-6000 scenes/year (15-20 scenes/day)
Civil Government	3000-4000 scenes/year (10-15 scenes/day)
Commercial Users	3000-4000 scenes/year (10-15 scenes/day)
Total	10,000-14,000 scenes/year (35-50 scenes/day)

These products would be produced in response to user orders from approximately 30,000 to 40,000 scene acquisitions a year. The current Landsat system acquires approximately 30,000 scenes a year. All acquired scenes would be archived in Level 0 format on cassette tapes or optical disks and Level 1a, 1b, and film products would be generated when ordered.

The CDHF would be designed to deliver about 5 percent of data products in 12-24 hours from acquisition or order in response to urgent user needs. Seventy percent of data products would be delivered in 7 to 14 days (assumed normal user requirement) and 25 percent of products would be delivered from the archive in 2 to 4 weeks. These estimates of data delivery times approximate the current Landsat 4 and 5 user needs.

Based on the above data acquisition, processing, and distribution requirements, staffing of the CDHF (16 hour day, 7 day week) is estimated at 60-65 FTE.

Note: User access to Landsat data managed by DOI could be accomplished by either (1) DOI oversight of a commercial entity via a contract, or (2) in-house data processing and distribution.

Estimated capital (one-time) and recurring costs for the CDHF are shown in Tables 4 and 5.

TABLE 4. CAPITAL (ONE-TIME) LANDSAT CDHF COST ESTIMATES

Hardware and Equipment	\$5-\$6 million
Software	\$3-\$4 million
System Integration	\$3-\$4 million
Facilities Modification	\$3-\$4 million
Total Capital Cost	\$14-\$18 million

TABLE 5. LANDSAT CDHF RECURRING COST ESTIMATES

Management and Administration	\$1-\$1.5 million
Operations (60-65 FTE)	\$5-\$6 million
Supplies and Materials	\$3-\$4 million
Miscellaneous Support	\$1-\$1.5 million
Total Recurring Cost	\$10-\$13 million

Comparable current Landsat central data handling costs are approximately \$12 to \$13 million annually.

Current Landsat 4 and 5 data sales are approximately \$12 million annually with an additional \$8 million in foreign station access and royalty fees. The current DOC contract (initiated in late 1985) with EOSAT provides for NOAA to pay all operations, data processing, and data distribution costs for Landsat 4 and 5 with all revenue from data sales and foreign station fees going to EOSAT. Table 6 shows historical user demand and revenue for the past several

years.

TABLE 6. HISTORICAL DATA DEMAND AND SALES REVENUE
(\$ in millions)

	Digital Scenes	Film Scenes	Sales Revenue	Foreign Station Fees	Total Revenue
1983	5,599	76,621	\$ 8.2	\$4.2	\$12.4
1984	5,042	34,964	\$ 9.9	\$4.5	\$14.4
1985	6,704	39,079	\$11.0	\$5.9	\$16.8
1986	7,100	19,061	\$ 9.4	\$5.9	\$15.3
1987	7,842	12,388	\$ 9.7	\$7.2	\$16.9
1988	7,992	9,088	\$ 8.7	\$7.4	\$16.1
1989	8,000	8,500	\$ 9.6	\$7.7	\$17.3
1990(est)	9,000	7,000	\$12.0	\$8.1	\$20.1

DATA PRICING AND COST RECOVERY PLANS

As pointed out earlier, there is substantial user dissatisfaction with the current high data prices and use restrictions, both inside and outside the government. A digital TM CCT scene is currently priced at over \$4,000. Use of the data by the scientific community has declined substantially due to these high data prices.

It is assumed that data prices will be significantly reduced for Landsat 7 and "copyright" and other use restrictions will be dropped. Sales revenue can be expected to drop initially as lower data prices are put in place, but are projected to recover as scientific and other users increase demand for the data.

In recognition that "urgent" data requests impose significant extract costs on the system, a pricing structure that charges more heavily for extremely rapid delivery and much lower prices for older data (e.g., used by the science community) is logical and consistent with the burden placed on the system. A "strawman" DOI pricing scenario that embodies this principle and uses data demand projections presented earlier is shown in Table 7. The figures are based on a conservative "mature" data demand level of 12,000 digital scenes a year (film products are projected to add about \$1 million a year to the totals).

TABLE 7. PROJECTED DATA SALES REVENUE

Data Products	Sales Revenue
12-24 hour data delivery (1000/scene) (5% or 600 x 1000)	\$0.6 million
2-14 day delivery of data less than months old (\$450/scene) (70% or 8400 x 450)	\$3.8 million
14-30 day delivery of data older than 6 months (\$200/scene) \$0.6 million (25% or 3000 x 200)	\$0.6 Million
Film products	<u>\$1.0 million</u>
Total Revenue	\$6.0 million

In addition, it is proposed that the DOI administer the foreign ground station international agreements (in coordination with the State Department) including technical coordination, spacecraft scheduling, data downlink requirements, etc. In return, the USGS would recycle foreign ground station access and royalty fees to offset ground system costs. These access and royalty fees are currently about \$8 million annually but are being increased significantly by EOSAT in the very near future. An estimate of \$14 million annually from this source is considered reasonable.

Table 8 tabulates recurring ground system costs and projected system revenue. Total recurring operations costs are projected to be \$16 to \$20 million a year while system revenues are estimated at \$20 million a year. In summary, the ground system operations can be assumed to be recoverable and self-sustaining from system revenue.

Note: Alternative data pricing arrangements for DOD users could include:

- 1) DOD provide front-end funding for an annually negotiated mix and quantity of products, thus negating the need for item by item cost reimbursement, or
- 2) DOD absorb portions of SOC, TT&C, or DAF recurring operations costs thereby reducing annual costs to be reimbursed from sales revenue and in exchange would receive annually negotiated equivalent value of data

products, thus negating the need for item by item cost reimbursement.

TABLE 8. RECURRING SYSTEM OPERATION COSTS AND REVENUES

Operations Activity	Cost	Revenue
Spacecraft SOC	\$2.5-\$3 mil	
TT&C	\$1 mil	
Flight dynamics	\$0.5 mil	
Data acquisition facility	\$1 mil	
Data relay	\$1-\$1.5 mil	
USGS CDHF	\$10-\$13 mil	
Data sales revenue		\$6 mil
Foreign station fees		<u>\$14 mil</u>
	<u>\$16-\$20 mil</u>	<u>\$20 mil</u>

A comparison of projected costs for a ground system operated internal to the government with a commercial system similar to that planned for Landsat 6 is shown in Table 9. The government system is projected to be largely self-sustaining. The commercial system based on plans for Landsat 6 would result in costs of some \$16 million annually to the government.

TABLE 9. COMPARISON OF ANNUAL GOVERNMENT AND COMMERCIAL COSTS

Cost to the Government	Commercial Operated	Government Operated
Ground system operations	-0-	\$16-\$20 mil
Government data purchases	\$8 mil	\$4 mil
Data purchases for the Archive	<u>\$8 mil</u>	<u>-0-</u>
Subtotal cost to government	\$16 mil	\$20-\$24 mil
Data sales revenue to government	-0-	\$6 mil
Foreign station fees to government	<u>-0-</u>	<u>\$14 mil</u>
Subtotal revenue to Government	-0-	\$20 mil
Total cost (+/-) to Government	\$16 mil	Even to \$4 mil

in cost

in cost

A summary of advantages to the government of DOI USGS data processing and distribution include:

- (a) Lower annual operating cost (ground system costs are recoverable)
- (b) Increased flexibility in data pricing and product specification
- (c) Lower data costs (1/20 to 1/4 of current prices). The scientific community can increase use of the data to support global change and other environmental studies.
- (d) Data for the government archive is obtained at no cost. Under current arrangements some \$8 million in data would have to be procured from the commercial operator to assure availability to satisfy long-term scientific needs.
- (e) DOD and other Federal data requirements are fully satisfied and foreign policy objectives are met.