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ABSTRACT

AN HISTORICAL EXAMINATION OF THE LANDSAT TRANSFER

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This is a study of the United States' Landsat earth remote sensing system and its transfer from government hands to those of private industry. Landsat was born in 1972 as an experiment of the National Aeronautics and Space Administration (NASA) and soon became a widely used and valued earth sciences research tool. Its enduring utility ultimately led to the decision to commercialize the program. Formulated by the Carter Administration in 1977, Landsat commercialization was seen as a response to future foreign competition and a rapidly evolving remote sensing industry. The Reagan Administration, which activated the transfer, saw commercialization both as a possible boost to the U.S. economy and as a measure to reduce the mounting federal budget deficit. This thesis proposes that Landsat commercialization was initiated to enhance America's interest in satellite remote sensing but was implemented, without sufficient regard to that interest, chiefly for budgetary reasons.

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Director of Thesis

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CHAPTER I

INTRODUCTION

The U.S. Landsat program has by itself transformed the technology of satellite remote sensing from a limited term NASA experiment to a demonstrated, reliable means of assessing and monitoring the world's natural resources. With applications in virtually every earth science, Landsat's value to commodity traders, geologists, environmentalists and a host of other resource managers has climbed steadily in its sixteen years of service.

At the same time, Landsat evolved into a powerful instrument of U.S. foreign policy and diplomacy. When many nations were learning through experience to avoid our offers of technology and assistance, Landsat has been a standing reminder that the sterotype of the self-interested American is not always deserved. To the contrary, the system has fostered competence and pride among its international users, creating U.S. allies rather than technological dependents.

As Landsat's cost to the taxpayer began to mount and plans for competing systems were being finalized in France and Japan, U.S. officials determined it prudent to initiate a change of course in the program. After seven thorough years of study and

debate, the Land Remote Sensing Commercialization Act of 1984 was signed into law. It confirmed Landsat's primacy in remote sensing and declared "the national interest of the United States lies in maintaining international leadership" in the technology. It also spelled out Landsat's new direction: "Competitive, market driven private sector involvement in land remote sensing is in the national interest of the United States."

The Carter Administration, which proposed the commercialization option in 1977, laid down a rather cautious, gradual formula for Landsat's private sector incorporation, one less concerned with short order commercial viability than with the greater need to guarantee data continuity and program maintenance. The rationale was that an invaluable research project with measurable foreign policy and national security implications should not be damaged or lost because it cannot make it on its own in the marketplace. A phased shift from public to private operation of Landsat would allow ample time to understand user requirements, market characteristics, competitor practices and the proper role of government in a commercialized environment. Only then, Carter said, could the new Landsat parameters be defined and a successful future be insured.

When President Reagan took office, Landsat's gradual swing to commercialization was significantly shortened. Professing to scale back "big government" and enhance the private sector whenever and wherever possible, the Reagan Administration saw a

Landsat transfer to private industry as a vivid, show-and-tell example of the conservative philosophy at work.

The Department of Commerce was given authority to seek "as soon as possible" institutional arrangements for business' acquisition of Landsat. The onus would be almost exclusively on a competitively selected, private entity to build markets, provide replacement satellites to those presently in orbit and maintain government commitments to data access and foreign ground station operators. System users would have to step forward to help finance the shift by paying higher prices for data.

To offset slow market development and the enormous capital requirements of a civil land remote sensing system, the firm that won the contract was to be paid $295 million in subsidies over a five year period for the construction of a two satellite follow-on system to Landsat. But after funnelling an initial $125 million in seed money, the government terminated further support on the grounds that extension of the program beyond that already funded by NASA was "inconsistent with the need for across-the-board fiscal restraints."

From this abbreviated summary, we can see that two distinctly different commercialization approaches have emerged from White House handling of Landsat. Carter policy appeared to be inspired by Landsat's value to the Untied States, both in terms of its technological/research importance and its international relations benefits. Reagan policy, on the other

hand, seemed driven chiefly by budget considerations and an unwavering faith in private industry's ability to create markets.

This thesis will focus on those differences in an attempt to determine what effects they had on the U.S. remote sensing program. The central question will be: Which policy was more in line with the national interest?

Two preconditions of commercialization will be presented in the quest for an answer. It will be established and documented that satisfying the preconditions is in the United States' national interest. The preconditions state:

A. A continuous supply of data from a civil remote sensing system must be assured, regardless of who operates the system, to maintain U.S. competitiveness in the field. This is due to the following factors:

1. A future in which the continuity of data is uncertain curtails the use of a remote sensing system.
2. If data are unavailable from one system, users will naturally seek the products of a comparable system.

B. A phased shift from public to private ownership of Landsat was necessary for commercialization to succeed. This is due to the following factors:

1. The private sector was not in the position to solely develop a fully operational remote sensing system.
2. A phased shift allowed time for a commercial operator to understand the market.

If it can be shown that the satisfaction of these preconditions was in the United States national interest, then the following hypotheses will be valid descriptions of the treatment Landsat has received by the last two Presidential Administrations:

1. The Carter Administration's satellite remote sensing policy was influenced by the national interest in a healthy Landsat.
2. The Reagan Administration's commercialization policy was insufficiently considerate of the national interest in Landsat.

If it cannot be shown that data continuity and phased commercialization are minimum requirements of the Landsat transfer policy (or to put it another way, that they are minimum requirements of the national interest), then it must be said that both hypotheses are invalid and therefore, incorrect.

CHAPTER II

REMOTE SENSING TECHNOLOGY

Although satellite remote sensing is a familiar technology to those who manage and monitor the world's natural resources, its rather low key successes have left it largely unintroduced to the general population. Therefore, it becomes difficult to present the political issues of Landsat commercialization without first laying the technological foundation which gave rise to those issues. It is the objective of this chapter to 1) define remote sensing and the principles governing it; 2) examine the satellite systems directly affecting commercialization, and 3) provide examples of satellite remote sensing applications.

Principles of Remote Sensing

Satellite remote sensing derives its usefulness from man's fairly recent awakening to the limits of his environment. He now understands that the rampant urbanization of farmland and razing of forests is unaffordable, that his use of minerals and petroleum products must be tempered by conservation and efficiency. A report issued by the Subcommittee on Space Science and Applications of the U.S. House of Representatives Committee on Science and Technology explained remote sensing's role in earth resources research:

> Though man's need for food, minerals and shelter is increasing in geometrical proportions, global resources such as water, minerals and arable land are finite and are being rapidly depleted. This increasing demand in conjunction with a diminishing supply requires current and accurate information for global resource monitoring...Resource observation via satellite is the only technology that is capable of providing global resource data on a timely, repetitive basis, making possible the detection of resources and resource change. The value of remote sensing of earth resources has been proven experimentally, and is being further developed for operational uses in geology, oceanography, meteorology, urban planning, crop prediction and a host of other areas.[1]

The term "remote sensing" was coined in the early 1960's by geographer Evelyn L. Pruitt of the Office of Naval Research.[2] At that time remote sensing was defined as "the observation of a target by a device some distance away from it,"[3] which generally referred to aerial photography, still photos taken with conventional photographic equipment aboard hot-air balloons, helicopters or airplanes. But as scientists developed photo-interpretation techniques beyond the range of standard photography, a revised definition was conceived, one better representing emerging methods and technologies: "The use of electromagnetic radiation sensors to record images of the

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[1]U.S. Congress, House, Subcommittee on Space and Applications of the Committee on Science and Technology, report: "Civil Land Remote Sensing System," December, 1981, 97th Congress, 1st Session, Washington, D.C., p. 5.

[2]Fischer, William A., et al, "History of Remote Sensing," in Manual of Remote Sensing, 1975, American Society of Photogrammetry, Falls Church, VA, First Edition, Volume I, p. 27.

[3]Barrett, E. C. and Curtis, L. F., Introduction to Environmental Remote Sensing, 1982, Chapman and Hall, New York, NY, p. 5.

environment which can be interpreted to yield useful information."[4] It is these sensing methods and the satellite systems that employ them which hold the greatest potential for effective resource management. The systems discussion will come later, but for now it will be useful to briefly explain the principles governing the sensors.

All constituents of the earth's surface above 0 K (absolute zero) radiate electromagnetic energy,[5] the main source of which is either reflected light or emitted heat.[6] Each material can be distinguished from one another, under ideal conditions, by its own particular reflection or emission of that energy, measurable in terms of wavelength, frequency or velocity.[7] (Wavelength is, by today's technological standards, the most common means of measuring electromagnetic energy because the differences in radiation among surface materials are more measurable using wavelength).[8] Quartz, for instance, radiates energy at a different wavelength than granite. The same can be said for wheat and corn, asphalt and cement, water and ice. It is the

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[4]Curran, P. J., Principles of Remote Sensing, 1985, Longman House, New York, NY, p. 1.

[5]Lo, C. P., Applied Remote Sensing, 1986, Longman, Inc., New York, NY, p. 2.

[6]Curran, p. 9.

[7]Feinberg, G., "Light," Scientific American, Volume 219, September, 1968, pp. 52-53.

[8]Lindgren, D. T., Land Use Planning and Remote Sensing, 1985, Martinus Nijhoff Publishers, Dordrecht, The Netherlands, p. 3.

measuring and recording of this radiated energy that is of fundamental importance to today's remote sensors.

The qualification of electromagnetic radiation is arranged into a continuum called the electromagnetic spectrum. It contains all the sources of energy capable of conveying and propagating information, ranging from cosmic or gamma rays at the high frequency/short wavelength end of the spectrum (frequency and wavelength are inversely proportional) to simple alternating current at the opposite end.[9] Most remote sensors operate somewhere in the middle - the visible (which includes what the human eye sees), infrared and microwave regions,[10] although the x-ray and ultraviolet regions are increasingly being exploited in earth resources research.[11]

Satellite Systems

There are several spaceborne remote sensing systems in orbit today incorporating a host of complex senors. The fields of meteorology, oceanography and the military sciences all use remote sensing to accomplish separate, unique objectives and have thus required systems just as separate and unique. To remain within the bounds of this thesis, however, it is necessary to

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[9]Lillesand, T. M. and Kiefer, R. W., Remote Sensing and Image Interpretation, 1979, John Wiley and Sons, New York, NY, p. 5.

[10]Lindgren, p. 3.

[11]Suits, G. H., et al, "The Nature of Electromagnetic Radiation" in Manual of Remote Sensing, 1983, American Society of Photogrammetry, Falls Church, VA, Second Edition, Volume I, pp. 40-41.

restrict the system examination to those directly related to U.S. satellite remote sensing commercialization efforts: America's Landsat satellite series and Landsat's chief competitor, the SPOT satellite flown by the French.

Landsat. When man propelled himself into space for the first time, his view of the Earth was obviously a novel one. For reasons of curiosity and later of publicity, American astronauts were supplied with cameras to document what they saw.[12] The first successful photographs of the earth's surface produced from a U.S. spacecraft were taken during the fourth Mercury mission in 1961.[13] By the ninth Mercury mission, when photos revealed previously unmapped reaches of southwest Asia and Tibet,[14] the potential for gleaning useful information from space photographs became very real. More work in that area was accomplished aboard Gemini and Apollo spacecraft, which eventually led to NASA's launching of the Earth Resources Technology Satellite (ERTS-1) on July 23, 1972.[15] Nine days prior to the launch of the second ERTS in 1975, the family of satellites underwent a name change -- it was now to be known as "Landsat".[16]

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[12]Curran, p. 132.

[13]Ibid, p. 133.

[14]Lowman, P. D., "Space Photography-A Review" Photogrammetric Engineering, Volume 31, January, 1965, p. 76.

[15]Harper, D., Eye in the Sky, 1983, Multiscience Publications, Ltd., Montreal, Quebec, Canada. p. 2.

[16]Freden, S. C. and Gordon, et al, Manual of Remote Sensing, Second Edition, Volume 1, p. 517.

So far, five Landsat satellites have been launched, with the final two still in orbit and functioning. The launch and retirement dates of all five are as follows:

SATELLITE	LAUNCH DATE	RETIREMENT DATE
Landsat 1	July, 1972	January, 1978
Landsat 2	January, 1975	January, 1983
Landsat 3	March, 1978	September, 1983
Landsat 4	July, 1982	---
Landsat 5	March, 1984	---

[17]

Landsat satellites utilize a near-polar, sun-synchronous orbital plane, meaning the "satellite precesses about the earth at the same angular rate as the earth revolves about the sun."[18] This orbit was chosen so the satellite will traverse the majority of the earth's surface on a schedule that facilitates the observations of most interest.[19]

The first three Landsats circled the earth every 103 minutes from an altitude of about 920 KM (570 miles) and imaged the entire earth every 18 days.[20] Landsats 4 and 5, while remaining in the same orbital configuration, were lowered to an altitude of 705 KM (438 miles) cutting its circuit around the earth to 100

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[17]Curran, p. 140.

[18]Lindgren, p. 68.

[19]U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Satellite Task Force, Planning for a Civil Operational Land Remote Sensing System: A Discussion of Issues and Options, June 20, 1980, Rockville, MD, p. 17 (hereafter referred to as "NOAA Document, Issues and Options").

[20]Lillesand/Kiefer, pp. 531-32.

minutes and its complete coverage cycle to 16 days.[21] The lower altitude improved Landsat's spatial resolution significantly.

Landsats 1 through 3 were equipped with sensors called return bean vidicons (RBVs). The RBV on Landsats 1 and 2 consisted of three television cameras, each filtered into a different waveband in and around the visible portion of the electromagnetic spectrum.[22] A single image covered 185 KM by 185 KM (115 miles) and had a ground resolution of 80 meters.[23] The RBV on Landsat 3 consisted of two television cameras which filtered into a broad green to near infrared waveband, had a smaller image area (98 KM by 98 KM) and a finer ground resolution (30 meters).[24] Consistently uninterpretable data and insuperable shading however, brought about the termination of the RBV with the demise of Landsat 3.[25]

The instrument which proved to be more useful than the RBV was the multispectral scanner (MSS). Flown on all five Landsats, the MSS scans each scene side to side across the spacecraft's southward orbital path by way of an oscillating mirror. The mirror reflects the radiation from the ground surface through a set of fiber optics onto a bank of 24 detectors. The detectors

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[21]Lindgren, p. 74.

[22]Curran, p. 149.

[23]Ibid.

[24]Ibid.

[25]Ibid.

record and convert the radiance into a continuous electrical signal which is sampled at fixed time intervals and converted into a six bit number.[26] The MSS has a ground resolution of 79 meters, scans a distance of 185 KM west to east[27] and can record 64 levels of radiance or shades of light.[28] The spectrum coverage of the MSS ranges from ultraviolet light to the thermal infrared.[29]

Replacing the RBV aboard Landsats 4 and 5 is the thematic mapper (TM), an advanced version of the MSS. The TM is a seven band, earth looking, scanning radiometer, utilizing 100 detector channels covering the visible, near infrared and thermal infrared regions of the spectrum.[30] Like the MSS, it scans a distance of 185 KM but has an improved ground resolution of 30 meters.[31] Perhaps the most significant refinement over the MSS is the thematic mapper's ability to detect 256 separate levels of radiance, making the differentiation between vegetation types, degrees of succulence and soil variability considerably less

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[26]Slater, P. N., Remote Sensing: Options and Optical Systems, 1980, Addison-Wesley, Reading, MA.

[27]Freden/Gordon, p. 525.

[28]Lo, p. 29.

[29]Ibid.

[30]Hord, R. M., Remote Sensing Methods and Applications, 1986, John Wiley and Sons, New York, NY, p. 84.

[31]Barrett, p. 77.

troublesome.[32] Unlike data from the MSS, the difference between corn and rice, rice and soybeans and so on is now readily detectable.[33]

The total Landsat system, like any satellite system, consists of the flight segment and the ground segment. At the program's start up in 1972, the flight segment included only the Landsat satellites. The ground segment consisted of the Operations Control Center at NASA's Goddard Space Flight Center in Greenbelt, Maryland, where system command and control decisions were made as well as the monitoring of sensors and satellite tracking.[34] The Goddard Center also doubled as a data receiving station. Other receiving stations were and remain located in Fairbanks, Alaska; Goldstone, California and Prince Albert, Saskatchewan, Canada.[35]

Data were automatically transmitted in real time by the satellite as it passed within line-of-sight of a ground station, where the information was stored on magnetic tape. If there were no stations within the satellite's range, the data were stored on two on-board tape recorders until a ground station was within reception range.[36]

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[32]Covault, C., "Landsat 4 Boosts Remote Sensing Uses," Aviation Week and Space Technology, February 7, 1983, p. 77.

[33]Ibid.

[34]Lillesand/Kiefer, p. 54.

[35]Harper, p. 114.

[36]Lindgren, p. 73.

The demand placed on the onboard recorders began to diminish though as satellite remote sensing's usefulness became better known around the world. Among other nations, Brazil (1974), Argentina (1980), Sweden (1979), India (1980), Italy (1976), Japan (1979) and Australia (1980) have all become part of the Landsat family by investing in and constructing, with U.S. help, their own Landsat earth stations.[37] In 1986, China[38] and Saudi Arabia[39] switched on their ground stations. Thus, the unfolding of the ground segment has left little of the globe unreachable by a Landsat signal.

With the launch of Landsat 4, the need for onboard recorders was eliminated altogether by the installation of a new data handling system called the Landsat-D system.[40] Now, instead of being received by only the nearest ground station, the digitized data stream emanating from the MSS and TM has two destinations: 1) directly to the ground station over which the satellite passes and 2) to the Tracking and Data Relay Satellite (TDRS) system.

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[37]Freden/Gordon, p. 545.

[38]"Eosat Will Market Landsat Data from Chinese Ground Stations, Aviation Week and Space Technology, July 20, 1987, p. 52.

[39]Foley, T. M., "Congress to Provide a $62.5 Million for Landsat Follow-on Program, Pending Compromise with Administration," Aviation Week and Space Technology, July 6, 1987, p. 29.

[40]Bracken, P. A., et al, "The Design and Application of the Landsat-D Assessment System," Computer Mapping of Natural Resources and the Environment, Patricia Moore, ed., 1980, Harvard Library of Computer Graphics, 1980 Mapping Collection, p. 5.

The TDRS system, when fully operational, will consist of two geostationary satellites (one parked above the Atlantic Ocean, the other parked above the Pacific) and an associated ground system.[41] (At this time, however, only the TDRS above the Atlantic has been operating. The second TDRS was lost aboard the Space Shuttle Challenger).[42] The TDRS is designed to automatically transmit the information it receives from Landsat to a ground station in White Sands, New Mexico. The signal is then beamed back up to another satellite relay, the Domestic Communications Satellite (DOMSAT), which in turn retransmits the signal to Goddard.[43]

At Goddard, all data are processed through the Master Data Processor which corrects radiometric and geometric distortions related to the satellite detection and viewing procedures and converts the corrected data to high density digital tape.[44] These tapes are then sent, via DOMSAT, to the EROS Data Center in Sioux Falls, South Dakota, where the EROS digital Image Processing System converts the tapes to film and digital products[45] which are archived and sold either to the general public or to the proliferating number of value-added firms.

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[41]Lindgren, p. 76.

[42]Foley, p. 30.

[43]Bracken, p. 5.

[44]NOAA Document, Issues and Options, p. 24.

[45]Bracken, p. 5.

Value-added firms, by their own individual brand of computerized image enhancement and interpretation, tailor raw or preprocessed Landsat data to meet the needs of a variety of users.[46]

Elaborate and seemingly well-planned, the Landsat-D system, as explained by NASA's own project evaluators, "promises to provide greater responsiveness, higher resolution and improved capabilities for applying remote sensing data to the solution of problems in monitoring and managing the earth's resources."[47]

Congress and the Reagan Administration have unfortunately qualified those predictions. The hedging of the early 1980's to see commercialization through - first on the decision to transfer ownership or not, then on the decision to adequately fund a private operator or not - has cost the Landsat program immeasurably. Since both Landsats currently in orbit have met or exceeded their expected expiration dates and a continued lack of support and vision has precluded the launching of a new satellite until at least 1991,[48] present and future Landsat customers are now necessarily looking to alternate systems to fulfill their remote sensing data requirements into the next decade.

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[46]U.S. Congress, House, Hearings before the Subcommittees on Natural Resources, Agriculture Research and Environment and on International Scientific Cooperation of the Committee on Science, Space and Technology, April 2, 1987, 100th Congress, 1st Session, Washington, DC, Statement by Charles Sheffield, Earthsat Corporation, p. 308.

[47]Bracken, p. 11.

[48]"Eosat to Mount Challenge to Landsat Restrictions," Aviation Week and Space Technology, November 2, 1987, p. 27.

SPOT. Building upon the advances made by the Landsat program, the French government's Centre National d'Etudes Spatiales (CNES) designed the SPOT (System Probatoire D'Obeservation De La Terre) satellite. With participation from French industry (as well as several French banks and institutions), the Swedish Space Corporation and Belgian public and private shareholders,[49] SPOT-1 was launched from French Guiana on February 22, 1986 and began transmitting high-resolution panchromatic and multispectral images shortly thereafter.[50]

Like Landsat, SPOT utilizes a near-polar, sun-synchronous orbit but is placed higher in the atmosphere (832 KM or 516.7 miles) and has a complete coverage cycle of 26 days.[51]

The sensors aboard SPOT-1 represent the latest in multispectral scanner technology: two high resolution visible (HRV) imaging instruments that sense radiation in the visible and near infrared portions of the spectrum.[52] The HRVs can operate in either panchromatic mode (black and white), which observes one broad band of the spectrum at a resolution of 10 meters, or in multispectral mode (color), which observes three narrow spectral

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[49]"Spot Earth-Resources Program Accelerates to Commercial Use," Aviation Week and Space Technology, June 25, 1984, p. 148.

[50]Lenorovitz, J. M., "France's SPOT-1 Satellite Transmits Multispectral Images following Launch by Ariane," Aviation Week and Space Technology, March 3, 1986, p. 21.

[51]Curran, p. 154.

[52]Lenorovitz, p. 22.

bands at a resolution of 20 meters. A total of 256 radiance levels are detectable, the same as the thematic mapper.[53]

Known as a pushbroom scanner, the HRV contains 6,000 detectors (charge coupled devices) arranged in a one-dimensional linear array.[54] As the satellite moves forward, the detector array, perpendicular to the spacecraft's crosstrack, images successive 60 KM lines or strips of land, simulating the movement of a pushbroom.[55]

The HRV system, in addition to its higher resolution capability, is judged superior to the mechanical line scanners of the Landsat series because it is less costly, requires less power, has a longer life expectancy and greater geometric and radiometric accuracy.[56] And although the HRV is inferior to Landsat's spectrum coverage (the TM senses radiation in the thermal infrared) its most attractive feature may be a plane mirror that can be pointed 475 KM left or right of SPOT's orbital path upon command from the ground.[57] The steerable mirror allows the HRV to 1) obtain coverage of the same area on several successive passes; 2) obtain stereoscopic or three-dimensional

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[53]Hord, p. 114.

[54]Lillesand/Kiefer, p. 590.

[55]Lo, p. 364.

[56]Colvocoresses, A. P., "Proposed Parameters for Mapsat," Photogrammetric Engineering and Remote Sensing, Volume 45, April, 1979, pp. 503-505.

[57]Williams, R. S., et al, "Geological Applications," Manual of Remote Sensing, Second Edition, Volume 2, p. 1914.

coverage - the different detection angles make the relative height of various topographic features discernable; and 3) sense alternate cloud free areas when the primary area is not viewable.[58] None of these options are presently available with a Landsat satellite.

Still in its infancy, the SPOT system uses two ground receiving/data processing centers, one in Aussaguel, France, the other in Esrange-Kiruna, Sweden.[59] Both stations will receive direct data transmission when SPOT traverses the North polar regions, Europe and Northern Africa and recorded data of the rest of the world that are stored on two onboard image recorders.[60]

Fully committed to land remote sensing, France has funded the construction of three more SPOT satellites to ensure data continuity into the next century,[61] with SPOT-2 ready for launch and on a priority call with the French Ariane launching system should SPOT-1 fail prematurely.[62]

Among other proposed systems which will compete with Landsat and SPOT is the Japanese JERS satellite series. Presently on a

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[58]Curran, p. 156.

[59]"Spot Earth-Resources Program Accelerates to Commercial Use," Aviation Week and Space Technology, June 25, 1984, p. 148.

[60]Ibid.

[61]Lenorovitz, J. M., "France to Fund Two Additional SPOT Remote Sensing Satellites," Aviation Week and Space Technology, August 5, 1985, p. 74.

[62]"Growth, Stability Predicted for Commercial Space Ventures," Aviation Week and Space Technology, March 14, 1988, p. 108.

1990 launch schedule,[63] JERS will probably be the field's next entrant. It will be followed by any one of a number of systems being developed by the European Space Agency (ERS-1), West Germany (Modular Optoelectric Multispectral Scanner), India (IRS) or Canada (Radarsat).[64]

Applications

Absent from the discussion thus far has been a summary of the many ways earth resources satellite data are used. What follows is by no means an exhaustive rundown of remote sensing applications, but it can nevertheless serve as an indication of the impact the technology has had on resource management and related fields in just sixteen years.

Agriculture. In 1974, two years after the launch of Landsat, the Large Area Crop Inventory Experiment (LACIE) was undertaken by the U.S. Department of Agriculture (USDA), NASA and the National Oceanic and Atmospheric Administration (NOAA). Among the various questions the experiment addressed was whether Landsat MSS imagery, weather information and computer models could be used to improve crop production estimates and forecasting.[65] Although it

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[63]U.S. Congress, Office of Technology Assessment, Remote Sensing and the Private Sector, Issues for Discussion, March, 1984, Washington, DC, p.42 (hereafter referred to as "Remote Sensing and the Private Sector").

[64]Ibid, pp. 41-42.

[65]Hord, p. 280.

yielded some inconclusive results, wheat production in several areas of the world was accurately and objectively forecast.[66]

Building upon the LACIE experience was a permanent research program called AGRISTARS (Agriculture and Resource Inventory Surveys through Aerospace Remote Sensing), initiated in 1980. It has become an effective means of forecasting crop production changes and yield estimates, greatly assisting commodity traders throughout the world.[67]

Using Landsat data, USDA operates the Foreign Agricultural Service, which monitors farm production abroad, and the Statistical Reporting Service, which measures domestic acreage in cultivation. Both services provide crop estimates to farmers, traders and government planners.[68]

Other agricultural applications involve rangeland management, the monitoring of desertification and erosion and livestock census taking.

Forestry. The most essential function of managing the world's forests is forest protection.[69] For that reason, Landsat data

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[66]Office of Technology Assessment, Remote Sensing and the Private Sector, p. 54.

[67]Ibid.

[68]General Accounting Office Report No. 83-111, "Costs and Uses of Remote Sensing Satellites," March 4, 1983, Gaithersburg, MD, Appendix I, p. 4.

[69]Lindgren, p.127.

has been used to identify over-cutting and over-planting as well as mapping forest fire burn areas.[70]

Geology. The U.S. Department of Energy and many private firms involved in the petroleum industry use Landsat data to refine and lessen the cost of explorational techniques.[71] By determining subtleties in rock formations and fault zones undetectable by ground and aerial surveys, the existence of oil, natural gas and mineral deposits have all been discovered through research initiated by Landsat.[72]

The Department of the Interior's (DOI) U.S. Geological Survey uses Landsat to assist its Conterminous U.S. Mineral Resource Assessment Program. The DOI's Fish and Wildlife Service and Bureau of Land Management also use Landsat as a program tool.[73]

Hydrology. Water resources are more effectively managed through the use of Landsat imagery. Estimations of glacial inventories, snowmass run-off rates and snow cover variations all assist the hydrologist in irrigation planning and flood control.[74] Changes

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[70]NOAA Document, Issues and Options, p. 43.

[71]General Accounting Office Report No. 84-93, "Effects on Users of Commercializing Landsat and the Weather Satellites," February 24, 1984, Gaithersburg, MD, p. 47.

[72]The National Commission on Libraries and Information Science Report, "To Preserve the Sense of Earth from Space," August, 1984, Washington, DC, p. 12.

[73]GAO Report No. 83-111, pg. 5.

[74]Lo, p. 176.

in navigation channels can also be monitored with Landsat, providing assistance to the shipping industry and protection to boaters.[75]

Pollution Monitoring. The Environmental Protection Agency uses Landsat to keep industrial polluters in check.[76] By monitoring air and water quality, Landsat provides one more way of preventing the corporate polluter from surreptitiously endangering the ecosystem and the human populations surrounding it. Oil spills area also better controlled through the use of Landsat data.

Other satellite remote sensing applications include land use and transportation planning, population estimates, cartographic enhancement, basic scientific research and even advancements in flight simulator technology.[77]

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[75]NOAA Document, Issues and Options, p. 44.

[76]GAO Report No. 84-93, p. 48.

[77]"Growth, Stability Predicted for Commercial Space Ventures," Aviation Week and Space Technology, March 14, 1988, p. 108.

CHAPTER III

THE DECISION TO COMMERCIALIZE

Landsat's success in earth sciences research transformed the program into a de facto foreign policy instrument for the United States. The goodwill it generated and the interests it promoted became, in rather short order, priceless U.S. government assets. At the same time, the rising national debt and an evolving remote sensing industry mandated a shift in Landsat's direction away from a public service and toward a competitive, profit-seeking entity responsive to the demands of the marketplace.

Therein lies the dilemma decision makers faced in commercializing the program. On one hand, the unique foreign relations advantages accrued from the operation of Landsat justified its retention as a government function. On the other hand, developments both within and outside the program made some form of privatization a must. This chapter will examine that dichotomy.

The National Interest in Landsat: Diplomacy and Foreign Access

Landsat has been an international endeavor since the program's conception in the late 1960's. In three preliminary research projects spanning several years prior to the launching of Landsat 1, NASA included investigators from some 50 nations to

help assess the potential usefulness of land remote sensing data.[78] The assessment campaign and the relationships it conjoined led to a series of bilateral agreements between the U.S. and agencies from 13 foreign governments for future data purchases and the construction of foreign owned and operated receiving stations.[79] Almost by accident, Landsat had become a conduit of U.S. influence around the world.

In 1983, the U.S. State Department reported:

> The United States has not sought to explicitly utilize the Landsat program as a tool of foreign policy. However, the United States has enjoyed measurable international prestige from its conduct of the Landsat program over the past decade.[80]

However unintentional Landsat's birth as a foreign policy instrument may have been, it has promoted United States' interests in a variety of ways. In hearings before the Subcommittee on Legislation and National Security of the House Committee on Government Operations, Harry Marshall, Jr., a Deputy Assistant Secretary of State in the Reagan Administration, described three of them:

> First, the U.S. gains access to land observation data from parts of the world which would not be possible with ground stations located only in the Untied States. This enhances ongoing U.S. land remote sensing ground truth measurement campaigns. It assists our scientists in ongoing scientific study efforts. It also improves our technological edge by helping U.S.

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[78]NOAA Document, Issues and Options, p. 95.

[79]Ibid.

[80]U.S. Congress, House, Hearing before the Committee on Government Operations, September 28, 1983, 98th Congress, 1st Session, Washington, DC, p. 108.

> scientists and engineers develop new and more extensive applications for remote sensing and specific remote sensing instrumentation.
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> Second, through Landsat we provide land observation data to users worldwide, much to our advantage. With U.S. assistance, Landsat data are used in the developing world for estimating crop acreage; monitoring timber and range lands; deserts and water resources; mineral and oil exploration; land use planning; disaster assessment; and environmental protection. The international network the United States has spawned is demonstrable proof that the United States can help developing nations use space technology for practical applications.
>
> Third, foreign participation in the U.S. Landsat program encourages foreign governments and scientists to use and rely on the U.S. system for both practical and scientific application. Thus, politically, technologically and economically, Landsat brings countries closer to the United States.[81]

Of course Mr. Marshall neglects to mention the coin's opposite side: the claims of some Third World nations that Landsat is just another form of American neo-colonialism. Dr. Herbert Schiller, a noted critic of the United States' administration of Landsat, is one of many to express concerns about Landsat's effect on users in the less industrialized areas of the world. "The more developed technology becomes and the less adequately it is transferred," he writes, "the more likely the extension of dependency. Actually this is one of the central but concealed assumptions in the 'leadership' rhetoric continuously expressed by United States' policymakers. Leadership. . .is a euphemism for the maintenance of

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[81]Statement by Harry Marshall,Jr., Deputy Assistant Secretary of State, Department of State Bulletin, December, 1983, pp. 65-66.

domination. . ."[82]

It is indeed arguable that the system operator derives the lion's share of advantages from remote sensing technology. Do Kenya or Bangladesh, who perhaps reach a better understanding of the dangers inherent in desertification or deforestation, profit that significantly from such information? Or do the U.S. government and related parties (American multi-national corporations), who can use the same information in a multiplicity of computer-aided ways, receive the advantages windfall, the familiar "one for you, five for me" breakdown of "mutual benefits?"

An argument in line with the latter theory is described by Cees Hamelink in his 1984 essay on Transnational Data Flows in the Information Age:

> Although the primary data collected by the satellites are now made available to all sensed countries at low prices, the remote sensing bestows the greatest advantages upon those who have the adequate infrastructures for early access to data, their critical selection, their processing into analyzed information and their application. Such infrastructures are accessible to the large transitional explores and exploiters of energy and mineral resources and not to the developing countries.[83]

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[82]Schiller, H. I., Who Knows: Information in the Age of the Fortune 500, 1981, Ablex Publishing Corporation, Norwood, NJ, p. 128.

[83]Hamelink, C. J., Transnational Data Flows in the Information Age, 1984, Studentlitteratur, Lund, Sweden, p. 82.

While this may be true in terms of the extent to which remote sensing data are useful,the claim that customers cannot transform raw data into valuable information without spending hundreds of thousands of dollars is unfounded. Regional and national processing centers set up by the U.S. Agency for International Development (AID) and NASA have significantly reduced the cost and headaches the underdeveloped would otherwise incur in interpreting and manipulating remote sensing data.[84]

Without a doubt, the dependence argument has some validity. Very little of the technology associated with Landsat was developed by foreign users. Initial capital, system upgrades, replacement parts, training and retraining, etc., all had to come from U.S. sources.

To prove, at least in part, the theory of forced dependency, a few questions must be asked. Do nations become mired in technological quicksand when they begin using Landsat? Are there no means of self-determination regarding data purchases, applicability or interpretation? Do nations repeatedly have to rely on U.S. hardware, software and skill to achieve meaningful results from Landsat?

Various foreign officials from various nations would have different answers to each question. One factor though which has helped to loosen the bonds of dependency is the ownership and operation of Landsat receiving stations by the governments on

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[84]Office of Technology Assessment, Remote Sensing and the Private Sector, p. 39.

whose soil the stations rest. Certainly there is a large degree of U.S. influence pervading the very nature of those ground stations, but by staffing them with indigenous scientists and technicians, by providing foundation-up, legitimate hands-on experience, the nations and personnel involved with Landsat have had more than a good chance to pass system-wide expertise onto their countrymen, thereby subduing the pervasiveness of the American linkage.

A 1984 Congressional report stated that Landsat has been proven to foster independence, technological competence and national pride among the developing nations using the program,[85] an effect American transfers of technology do not always bear. It is this latter point which helps build substantial goodwill for the U.S. across the globe. "By providing a means for self-directed resources management, remote sensing systems help to create self-sufficient allies rather than technological dependents."[86]

Landsat is also a component in the national security of the United States. It serves as a backup to comparable classified systems in the event of an equipment failure or temporary overload; the worldwide distribution network Landsat has spawned

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[85]U.S. Congress, House, Committee on Government Operations Report No. 98-1108 "Sale of Landsat Could Adversely Affect International RElations," September 28, 1984, 98th Congress, 2nd Session, Washington, DC, p. 8.

[86]Office of Technology assessment, Remote Sensing and the Private Sector, p. 29.

allows U.S. intelligence agencies easy analysis of foreign purchases which may reveal patterns of resource use contrary to the interest of the U.S. or its allies; the pool of trained Landsat personnel can bolster the military's remote sensing capability in times of war; and Landsat imagery can be used as cover data in international fora when the original source may be of a sensitive origin.[87]

Perhaps as important as the combination of all those points is Landsat's perpetuation of the validity of the "open skies" principle. "Open skies" is a derivative of the 1967 Outer Space Treaty, the governing document of international space activity, which states: "Outer space and celestial bodies are not subject to appropriation by claim of sovereignty, by means of use or occupation or by any other means."[88]

"Open skies" has come under increasing criticism in recent years because it grants the U.S. unchecked permission to employ military reconnaissance satellites and other tactical spacecraft, a situation some say should warrant the overthrow of "open skies". But when the very voices who want to shelve the principle continue to benefit from Landsat and its "open skies" authorization, the criticism loses its punch and allows the American space defense initiatives to retain their legality.

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[87]Ibid, pp. 96-98.

[88]Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, October 10, 1967, Article II.

The claims of national sovereignty over information pertaining to natural resources, however, will not soon abate. Can we honestly deny a nation whose territories have been imaged the right to claim sovereignty over that imagery? The terms "prior consent" and "priority access" are products of international concern over the sovereignty issue. Both require that the sensed nation be given advance knowledge or possession of any data collected from its surface, followed by that nation's granting or denying of permission to the system operator to distribute the data.

The U.S. foil to prior consent and priority access has been the use of a guaranteed policy of nondiscriminatory access to all Landsat data, at the same price and under the same conditions, to all potential purchasers, friends and adversaries of the U.S. alike. Congress' Office of Technology Assessment explains: "The open availability of Landsat data to anyone, regardless of nationality or political persuasion is a powerful message to governments opposed to the open interchange of ideas and information."[89] As a result, criticism and talk of restricted data distribution flows have been effectively blunted.

Overall, Landsat's influence in U.S. foreign relations and national security has made its transfer out of government an extremely perilous proposition. As one U.S. representative remarked, Landsat "adds to the stability in the world and is as

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[89]Office of Technology Assessment, Remote Sensing and the Private Sector, pp. 32-33.

important as military strength. I think it is a very vital factor in the long run hope for a peaceful world."[90] Nevertheless, a transfer was necessarily in the works.

The Grounds for Commercialization

In a December, 1981 report, the Subcommittee on Space Science and Applications of the House Committee on Science and Technology officially suggested that a modification in Landsat's direction and duties was necessary:

> The United States has a preeminent position in remote sensing technology for monitoring and detecting earth resources and environmental quality which is a source of international responsibility as well as national pride.
>
> As the innovator of global remote sensing technology, the United States has an opportunity and an obligation to exploit this capability to promote more harmonious international relations and Third World development.
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> France, Japan, India and the European Space Agency are each involved in the development of spaceborne remote sensing systems with launches planned in the 1980s. Therefore, in the mid-1980s, the United States will no longer be the sole source of satellite remotely sensed data.[91]

It was determined that for the U.S. to retain its international lead in and the foreign policy advantages of satellite remote sensing (now that its lead was indeed under threat) a larger market for Landsat data had to be developed. The private sector, because it excels both at innovation and market development, was judged to be in the best position to do

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[90]U. S. Congress, House, Hearings, September 28, 1983, Statement by Representative Jack Brooks, p. 88.

[91]U. S. Congress, House Report "Civil Land Remote Sensing System," p. 1.

so.[92] The profit incentive would serve as a catalyst for wider data distribution and the generation of new applications which would, in turn, produce new markets and new benefits.

Primarily, three factors incited the decision to commercialize Landsat. As the Space Science and Applications Subcommittee indicated, impending competition was the foremost reason for the change. Secondly, as with any commercialization plan, the potential to save federal funds was by default a force in the rationale. And thirdly, some Landsat components were quite naturally suited for private operation, i.e., it produced goods and services which had a definable customer base and applicability. We will consider Landsat's cost and its private sector suitability first.

The now infamous federal budget deficit has made the privatization of public programs an exceedingly attractive spending reduction measure. Landsat was a prime candidate for privatization because it was a) very expensive to operate and maintain and b) "shiftable".

Its high cost was partly due to its success in resources research. As users lined up and applications expanded across a variety of disciplines, the system had to expand to accommodate the popularity, increasing day-to-day operating expenditures. Additionally, each of the five Landsat flights embodied new

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[92]GAO Report 84-93, p. 5.

technological capabilities which required changes in ground equipment and data systems.[93]

Another reason Landsat was expensive was because remote sensing technology itself is expensive. Launching requirements, the design and construction of the spacecraft and payload, ground system hardware and software, etc. all drove the total U.S. investment in Landsat to about $1.5 billion by 1987.[94]

Annually (by 1983 estimates), the U.S. spends an average of $50 million to operate and maintain Landsat.[95] Added to that is an average annual launching and hardware construction cost of anywhere between $75 million and $100 million,[96] amounting to an average annual cost of between $125 million and $150 million to build, launch, operate and maintain the Landsat system.

Revenues from data sales and ground station operator fees help to offset those costs, but through 1983 the most money the United States expected to raise in one year from Landsat was

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[93]U. S. Congress, House and Senate, Joint Hearings before the Subcommittee on Space Science and Applications of the House Committee on Science and Technology and the Subcommittee on Science, Technology and Space of the Senate Committee on Commerce, Science and Transportation, July 22, 1981, 97th Congress, 1st Session, Washington, DC, Statement by James Beggs, NASA Administrator, p. 59.

[94]U.S. Congress, House, Hearings, March 31, 1987, Statement by Representative Robert Roe, p. 9.

[95]U.S. Congress, House, Report by the Congressional Research Service, the Library of Congress, "U.S. Civil Remote Sensing Satellites: Commercialization Policy and Issues," for the Committee on Science and Technology, April 11, 1983, 98th Congress, 1st Session, Washington, DC, p. 13.

[96]Ibid.

$22.1 million.[97] That leaves Landsat's net cost to the Federal Government, by the most conservative guess, at about $100 million a year. It is not difficult to fathom the substantial sum of money the U.S. stood to save by transferring Landsat out of government hands.

But simply because a public program's cost is high does not automatically qualify it for privatization. It must also be suitable for private sector operation. In the words of Charles Schmidt, Vice President and General Manager of RCA Astro Electronics and a direct participant in the transfer proceedings, if Landsat presents "an ability to support a legitimate business with a reasonable return to investors without perpetual government subsidy," then it is indeed shiftable. "The Landsat system appears to meet those standards and is therefore a logical candidate for commercialization."[98]

Landsat was believed capable of eventual profitability primarily because the program achieves reliable, consistent and cost effective results in earth resources research. This is partially evidenced by the fact that total Landsat data sales have gone up every year but one from 1973 to 1983.[99] There is no

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[97]GAO Report No. 83-111, p. 11.

[98]U.S. Congress, Senate, Hearing before the Subcommittee on Science, TEchnology and Space of the Committee on Commerce, Science and Transportation, March 22, 1984, 98th Congress, 2nd Session, Washington, DC, p.69.

[99]Office of Technology Assessment, Remote Sensing and the Private Sector, p. 75.

arguing with its success. "I cannot remember a single instance", confided Senator Harrison Schmitt, a key legislator in the Landsat debate, "of anybody testifying, telling me private, public or otherwise, that when they made a commitment to look at the use of remote sensing data. . .that they backed away from it and said it was of no use and then terminated the commitment. I can't think of a certain circumstance, which bodes well for the future of the market."[100] So theoretically, as more people discover remote sensing and learn how to apply it, profits and market expansion will soon follow.

The other factor inciting the decision to commercialize Landsat was imminent competition. The existence of a competitive challenge was identified relatively early in Landsat's history and several years before any opposing system was actually to be flown.[101] These foreign systems rely on U.S. experience and technology for the basis of their programs but design them to be operational rather than R & D systems.[102]

SPOT, the earth observing satellite proposed in 1977 by France[103] presented the most immediate threat to Landsat's monopoly. True, it was scheduled for launch before any competing

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[100]U.S. Congress, Joint Hearings, July 23, 1981, p. 313.

[101]NOAA Document, Issues and Options, p. 44.

[102]U.S. Congress, Senate Hearing, March 22, 1984, Statement by Dr. John Gibbons, Director, Office of Technology Assessment, p. 100.

[103]U.S. Congress, House Hearings, April 2, 1987, Statement by David Julyan, SPOT Image Corporation, p. 243.

proposal, but it was the French approach to remote sensing that was the chief source of concern to U.S. officials: SPOT entered the remote sensing field to make money. Landsat was not equipped to play by those rules.

Technologically, SPOT was touted as superior to Landsat (see Chapter II, "Systems"). Its sensors were designed with a finer ground resolution than the U.S. system and it was capable of stereoscopic imaging, a feature Landsat did not have. (Stereoscopic imaging is of particular value to petroleum and mineral exploration interests, a potentially lucrative remote sensing market segment).[104]

Coupled with the hardware improvements was SPOT's aggressive marketing strategy. The French were convinced that the key to establishing a viable commercial system was a strong marketing effort. They left the technical systems management to the French Space Agency, CNES (which owns and operates the satellite), and created a separate entity, SPOT IMAGE, to undertake all sales and marketing duties.[105]

An indication of the French market expansion/profit motive was the fact that SPOT IMAGE started doing business in 1982, almost four years prior to the satellite's launch.[106] In 1983, an

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[104]U.S. Congress, Joint Hearings, July 23, 1981, Statement by Dr. Joseph Charyk, Comsat Corporation, p. 267.

[105]"Spot Earth-Resources Program Accelerates to Commercial Use," Aviation Week and Space Technology, June 25, 1984, p. 148.

[106]U.S. Congress, House Hearings, April 2, 1987, Statement by David Julyan, p. 242.

American subsidiary called SPOT Image Corporation was then installed near Washington, D.C. to capitalize on the large U.S. market.[107] Shortly thereafter, SPOT IMAGE boasted over forty data distributors across the globe.[108]

Here is just a sample of SPOT's marketing ethos:

> In the beginning period of the newly commercialized remote sensing industry SPOT is working to market the entire remote sensing package, rather than just the image data which are the program's main products. This involves working with all components of the industry, including hardware/software manufacturers and value-added companies, to insure that the entire technology becomes more affordable, accessible and user-friendly.[109]

Today SPOT grosses $30 million annually worldwide, 35-40% of which comes from U.S. sales.[110] Nearly 60% of that figure is from U.S. government customers.[111]

Landsat as a public entity possessed neither the resources nor the know-how to compete with SPOT. The program was hostage to the government's non-competitive management style and its historical failure to move aggressively into new areas of opportunity when the situation dictates.[112] Quite simply, Landsat

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[107]Ibid.

[108]Ibid, p. 246.

[109]Ibid, p. 250.

[110]"Growth, Stability Predicted for Commercial Space Ventures," Aviation Week and Space Technology, March 14, 1988, p. 108.

[111]Ibid.

[112]NOAA Document, Issues and Options, p. 75.

was not designed to be a commercial success. And in a rapidly changing, increasingly competitive technology like remote sensing, that flaw made a U.S. remote sensing program dangerously vulnerable to failure.

Enter private industry. Briefly, this is the bottom line rationale behind choosing the private sector to be guardian of American remote sensing interests:

> Business necessity will stimulate the private sector operator to be more responsive to customer needs. A premium will be placed upon developing procedures that deliver on time those data which diminish in value when not received promptly by the user. A commercial system will also best be able to accelerate changes in technology and delivery subsystems to meet the needs of its customers. A private operator will aggressively seek new uses with social and economic value as a matter of sound business practice, thereby broadening the variety of products and reducing per unit costs for all users.[113]

Under these assumptions and in the face of competition, a privately held Landsat was considered a decidedly more appropriate representative of U.S. remote sensing interests than was the U.S. government.

The switch to private ownership of Landsat, however, raises many concerns overseas and in the U.S. that the ability to pay will determine the kind of resource data the system eventually produces. Petroleum exploration and mining interests would most certainly have a heavy hand in directing which applications a Landsat operator perfects. Marginally profitable applications

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[113]U.S. Congress, Joint Hearings, July 23, 1981, Statement by Dr. Joseph Charyk, p. 265.

which serve infrequent users or those with small dollar amounts to spend on satellite remote sensing data (i.e., domestic state and local governments and Third World governments) would logically receive less than priority attention.

Ability to pay will also become an issue if data prices undergo a sharp increase in a commercialized environment. If total system costs are to be recovered by the operator (under public operation, the prices of data only reflected operational costs[114]) which will doubtless be the case if the U.S. does not somehow subsidize the private operator, the jump in Landsat product prices could be too steep for many present users to afford. Once again, we could see a situation where only those with the big money will be able to reap the benefits of high technology.

What complicates the decision to commercialize Landsat is that no one knows for sure whether or not a commercial operator can even survive, let alone succeed, on his own in the remote sensing marketplace. By all estimates, a market fruitful enough to meet procurement and operating costs does not yet exist. The competition is so heavily subsidized by their governments that an entirely private U.S. corporation would be competing against firms which are in effect backed by a blank check. And perhaps most damaging to the transfer effort is the U.S. failure to procure a follow-on satellite to Landsat 5, which should expire

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[114]GAO Report No. 84-93, p. ii.

sometime in 1988. Consequently, it will not be until 1991, at the soonest, when the U.S. has another remote sensing satellite in orbit, meaning at least three years will pass without an American supply of remote sensing data. Needless to say, it will be hard for a private operator to make a profit without a product to sell.

In the event commercialization fails, the U.S. would squander the leadership prestige, the foreign policy benefits and national security tools Landsat has forged. Jobs would be lost, spin-off industries in the hardware, software and value-added sectors would be injured, in some cases irreparably. The U.S. would also lose an important source of resource data, forcing us to rely on foreign systems for information on our soil and the soil of our economic and political adversaries.

Furthermore, France and Japan plan to use their earth observing satellites to fulfill the space reconnaissance needs of their intelligence agencies.[115] Relying on them to maintain "open skies", and the free flow of information is a choice few American leaders are prepared to make. Therefore, the U.S. commercialization policy is one that must be formulated with extreme care. The next section outlines what should be the minimum requirements of that policy.

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[115]U.S. Congress House Hearings, April 2, 1987, Statement by Dr. James Taranik, Chairman, Remote Sensing Subcommittee, NASA Space Applications Advisory Committee, p. 291.

The Preconditions of Commercialisation

Two statements will be made to explain the minimum prerequisites of a sound commercialization policy. These statements will also serve as premises to the basic argument of this paper: that the transfer of Landsat to the private sector was initiated to enhance America's remote sensing interests but was implemented chiefly to reduce the Federal budget, at the expense of those interests.

Both statements are predicated on paragraphs (2) and (3) of Section 101 of the Land Remote Sensing Commercialization Act of 1984, the Landsat transfer's legislative authorization. They read as follows: "(2) the Federal Government's experimental Landsat system has established the Untied States as the world leader in land remote sensing technology; (3) the national interest of the United States lies in maintaining international leadership in civil remote sensing and in broadly promoting the beneficial use of remote sensing data." Therefore, the national interest lies in maintaining some form of the source of America's remote sensing leadership -- the Landsat program.

To preserve a healthy Landsat, the following preconditions must be satisfied:

A. A continuous supply of data from a civil remote sensing system must be assured, regardless of who operates the system, to maintain U.S. competitiveness in the field. This is due to the following factors:

1. A future in which the continuity of data is uncertain curtails the use of a remote sensing system. This is supported by:

(1) Section 101, paragraph (7) of the 1984 Commercialization Act, which states: "Use of land remote sensing data has been inhibited by. . .the lack of assurance of data continuity."

(b) A Library of Congress Report that says: "The lack of a user market is in large part the result of the uncertain status of Landsat as an experimental program under NASA."[116]

(c) The NOAA determination that "users will not rely on satellite data until its continuity. . .is assured. Only then can users confidently invest in the personnel, training and processing equipment necessary to utilize the data. . .Without these assurances, growth in the utilization of the data will be limited and any new efforts at market expansion might be inappropriate and unsuccessful."[117]

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[116]U.S. Congress, House, Report by the Congressional Research SErvice, The Library of Congress, "U.S. Civil Remote Sensing Satellites: Commercialization Policy and Issues," for the Committee on Science and Technology, April 11, 1983, 98th Congress, 1st Session, Washington, DC, p. 15.

[117]NOAA Document, Issues and Options, p. 88.

2. If data are unavailable from one system, users will naturally seek the products of a comparable system. This is supported by:

(a) An Office of Technology Assessment determination that "if continuity of the data flow is not maintained and the resulting hiatus continues beyond the time when the French SPOT system is operational, many U.S. users will certainly turn to the French to supply some of their data needs. . .If users begin to use SPOT data in any significant way, they may be reluctant to switch back to Landsat."[118]

B. A phased shift from public to private ownership of Landsat was necessary for commercialization to succeed. This is due to the following factors:

1. The private sector was not in the position to solely develop a fully operational remote sensing system. This is supported by:

(a) Paragraph (9), Section 101 of the Commercialization Act, which states "There is doubt that the private sector alone can currently develop a total land remote sensing system because of the high risk and large capital expenditure involved."

(b) The financial support of a private operator guaranteed by the Federal Government in Section 304,

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[118]U.S. Congress, Joint Hearings, July 23, 1981, Statement by Dr. Ray Williamson, Office of Technology Assessment, p. 329.

Paragraph (6) of the Commercialization Act of 1984 which states the U.S. will provide financial support "for a portion of the capital costs required to provide data continuity for a period of six years. . ."

(c) There was no evidence that a market large enough to fully support a commercial operator existed. This is supported by numerous governmental and non-governmental studies on the subject (the Commerce Department's Request for Information from industry, the Working Group on Commercialization, the Business Evaluation Committee and the National Academy of Public Administration, among others).

2. A phased shift allowed time for a commercial operator to understand the market. This is supported by:

(a) The fact that no precedents had been set for a commercial remote sensing operator. Future profit levels, user requirements, market elasticity, competitor practices, pricing policies and total system costs have not been based on any concrete truth or actual experience, only predictions and conjecture. Discovering that a private operator indeed cannot make it on his own in the remote sensing marketplace after commercialization is implemented could severely damage or even kill U.S. remote sensing capabilities. This would lead to a loss of a firsthand source of sensitive data and an avenue of U.S. foreign policy.

(b) The Department of Commerce and the U.S. Congress' determination that a minimum government provision of two satellites beyond Landsat 5 was required to calculate the commercial viability of a civil remote sensing system.[119]

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[119]U.S. Congress, House Hearings, March 31, 1987, Statement by Clarence Brown, Deputy Secretary of Commerce, p. 58.

CHAPTER IV

CARTER POLICY: PROCEEDING TOWARD COMMERCIALIZATION

The Landsat system was developed by NASA as strictly an experimental, research and development project, and although technical success was achieved rather quickly there were no long-range plans to convert it to an operational, user-sensitive system.[120] It was a condition perceived by outside observers as a lack of government commitment to Landsat, a perception which hindered investment in the program and limited the growth of the market for Landsat products.[121]

As procurement and operating costs increased and the dissolution of Landsat's monopoly came into sight, the Carter Administration determined it necessary to erase the look of ambivalence and proclaim an ambitious commitment to long-term U.S. involvement in the remote sensing field. This chapter traces the evolution of the civil remote sensing policy under President Carter.

The Presidential Directives

In 1977, the National Security Council (NSC) was directed by the President to review existing space policy and to formulate

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[120]U.S. Congress, Senate, Report by the Committee on Commerce, Science and Transportation, No. 98-458, May 17, 1984, 98th Congress, 2nd Session, Washington, DC, p. 2.

[121]GAO Report No. 83-11, p. 3.

overall principles to guide future space activities.[122] From that review came the first of three presidential directives to address civil remote sensing -- PD-37, a classified document written in May, 1978 and released in declassified form on June 19, 1978. Included among the provisions it set forth were the following:

1. The United States will develop and operate on a global basis active and passive remote sensing operations in support of national objectives.

2. The Untied States will encourage domestic commercial exploitation of space capabilities and systems for economic benefit and to promote the technological position of the United States; however, all United States earth oriented remote sensing satellites will require United States government authorization and supervision or regulation.

3. Data and results from the civil space program will be provided the widest practical dissemination to improve the condition of human beings on earth and to provide improved space services for the Untied States and other nations of the world.[123]

PD-37 also established a Policy Review Committee on Space (PRC (Space)) within the NSC which would serve as a forum for discussing proposed changes in U.S. space policy and for rapid referral of issues to the President.[124]

The first undertaking of PRC (Space) was to conduct a study assessing the needs and aspirations of the civil space program. The results of that study formed the basis of the second Carter

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[122]NOAA Document, Issues and Options, p. 19.

[123]Office of the White House Press Secretary, FAct Sheet, June 19, 1978.

[124]Ibid.

space policy directive, PD-42. Although it too was classified, a fact sheet was released on October 11, 1978. It specified three principal directions for the nation's civil space program.

1. Activities will be pursued in space when they can be more efficiently accomplished there;

2. U.S. space policy will reflect a balanced strategy of applications, science and technological development; and

3. An adequate federal budget commitment will be made to achieve the objectives of identified space applications.[125]

Specific to remote sensing, PD-42 contained an official affirmation of Landsat's broadening utility and growing list of customers and that the U.S. government would continue to provide data from Landsat for all classes of users.[126]

In addition, PD-42 directed NASA and the Department of Commerce to prepare plans on how to encourage private investment and direct participation in civil remote sensing systems.[127]

Months later, in the Spring of 1979, both Executive and Legislative attention was focused on civil remote sensing. On March 27, in his Science and Technology Message, President Carter once again pledged his Administration's commitment to the

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[125]Office of the White House Press Secretary, U.S. Civil Space Policy, Fact Sheet, October 11, 1978.

[126]Ibid.

[127]Ibid.

continuity of land remote sensing data, but this time stretched the promise through the 1980's.[128]

In the U.S. Senate, two major bills on land remote sensing were introduced, one proposing a permanent data and information service within NASA, the other a for-profit, earth resources government corporation.[129] The bills were put on hold when Dr. Frank Press, the President's Science Advisor, requested that no legislation be acted upon until further study is completed. "The President", he said, "is committed to the continuity of remote sensing data for civil application through the 1980's" and that "the Administration is committed to an operational remote sensing system, although yet undefined."[130]

President Carter's commitment to data continuity had been established. From these past few paragraphs, we can now identify at least partial confirmation of the validity of this paper's first hypothesis. It states: The Carter Administration's satellite remote sensing policy was influenced by the national interest in a healthy Landsat. Because it has been established that assuring data continuity from a civil land remote sensing system is necessary for the U.S. to remain competitive in the field and therefore in the national interest, it can be said that

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[128]NOAA Document, Issues and Options, p. 20.

[129]Ibid.

[130]Ibid.

the Carter remote sensing policy was partly influenced by the national interest in a healthy Landsat program.

The further study to which Dr. Press alluded was that conducted separately by NASA, the Department of Commerce and PRC (Space), collectively resulting in PD-54, the third and most extensive Carter Space policy statement. It pronounced the decision to convert Landsat, when appropriate, to full operational status which would clear the way for private involvement in the program. Here were the major elements of PD-54:

1. The formal establishment of an operational remote sensing system would commit the Federal Government to the development and maintenance of long-term systems, rather than a series of experimental missions, and should provide the user community with the assurance needed to invest the necessary fund for equipment and personnel training.

2. The Administration would request FY81 funding for NOAA to study ways to further private sector opportunities in civil land remote sensing activities, through joint ventures with industry, a quasi-governmental corporation, leasing, uetc. with the goal of eventual operation of these activities by the private sector.

3. In an effort to make certain that user needs were represented to NOAA, the Department of Commerce would establish and chair a program board for continuing federal coordination and regulation of civil remote sensing activities. The involved federal organizations would be represented. The National Governors' Association and the National Conference of State Legislatures would be invited to participate.

4. Users, who were then paying only for the costs of data reproduction, would have to bear a much greater share

of the operational system costs. These costs would increase for both foreign and domestic users.[131]

Mindful of the embryonic state of the satellite remote sensing data market, PD-54 called for a phased approach to private sector operation of Landsat, rather than a hasty, all-out transfer to commercialization. It provided for the eventual relief of NASA as the agency responsible for Landsat management, a move which would take place when Landsat's operational capability was confirmed.[132] The reasoning was straightforward.

Primarily a research and development body, NASA was not designed to be a service provider. It was geared more toward scientific investigation than the fulfillment of user needs[133] and more toward the optimization of spacecraft design than the enhancement of the data product.[134] In other words, practical applications were peripheral to proving out the technology. An operational remote sensing system had to be user/product oriented and Landsat under NASA was neither.

Evidently, restructuring the space agency to better fit Landsat was found to be more troublesome than simply finding a new Federal manager for the program. PD-54 did just that. To

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[131]Office of the White House Press Secretary, Fact Sheet, November 20, 1979.

[132]Ibid.

[133]Report of the Working Group on Commercialization, Land REmote Sensing Satellite Advisory Committee, November 17, 1982, Washington, DC, p. 5.

[134]U.S. Congress, Joint Hearings, July 23, 1981, Statement by Dr. Ray Williamson, Office of Technology Assessment, p. 326.

replace NASA, the policy directive designated the National Environmental Satellite Data and Information Service of the NOAA to be the interim, pre-commercial operator of Landsat.[135] Although other government agencies had expressed displeasure at the choosing of the NOAA, there were three major reasons why the decision stood.[136] First, the NOAA had efficiently operated the U.S. weather satellites for over a decade, practical, relevant experience no other contending agency could claim. Secondly, since the NOAA was already custodian of the civil weather system and more recently was given jurisdiction over U.S. ocean sensing systems, it was deemed wasteful to scatter space oversight across several agencies. And thirdly, had Landsat user-agencies like the Department of the Interior or Agriculture been awarded interim Landsat operations, they could conceivably modify the system to meet their own specialized, in-house data needs at the expense of other agency or user needs. The NOAA was not a consumer of Landsat data.

The Implementation of PD-54

The Administration commitment to an operational remote sensing system was now a matter of public record. But a great many details of the transition had yet to be defined. At Congressional hearings in the summer of 1980, the NOAA issued a

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[135]Office of the White House Press Secretary, Fact Sheet, November 20, 1979.

[136]U.S. Congress, House, Report by the Congressional Research Service, Library of Congress, "Land Remote Sensing: An Overview," April 11, 1983, p. 26.

document designed to address those details. "Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options," dated June 20, 1980, became the policy manual which would guide officials from an experimental Landsat to a pre-commercial, operational one.

Included in the document were the following statements which were to spell out the remote sensing objectives of the Carter Administration:

1. The Federal Government will ensure continuity of data during the 1980's;

2. A national civil operational land remote sensing satellite system should ensure continuity of data and the appropriate reliability and timeliness of standard data products;

3. User requirements projected levels of demand and the cost of meeting these requirements should determine the design of the operational system;

4. The Administration's goal is eventual private sector ownership and operation of the operational system, which includes the assumption of financial risk, as well as operational control by the private sector;

5. Prices for land remote sensing products should be set at levels that ensure maximum recovery of system costs consistent with the public good;

6. The practice of the widest practical dissemination of Landsat data on a public, nondiscriminatory basis will be continued for the data and standard data products for the Interim and Fully Operational Systems in accordance with prevailing U.S. national policies;

7. Eventual private sector ownership and operation of the U.S. system will be conducted under Federal Government regulation, consistent with U.S. policies and international obligations;

8. The civil operational land remote sensing satellite program is a national program responsive to federal interests and U.S. user requirements. Due regard will

also be given to foreign user interests and to foreign participation in the U.S. program; and

9. NOAA will manage the operational system until a new institutional framework is established.[137]

The NOAA's management responsibility of Landsat took two forms: technical management and organizational management.

NOAA's technical obligations for Landsat command and control were to take effect in January, 1983, when the new Landsat-D system (Landsat 4 and the associated ground segment) was to have met, by NASA's determination, all operational standards for the production of multispectral scanner data.[138] NOAA was scheduled to assume operational responsibility for the thematic mapper in January, 1985, when NASA was to have completed the algorithms necessary to produce these data.[139]

For the generation and dissemination of data and standard data products, NOAA was to relieve NASA and the EROS Data Center in FY 83-84. Also in FY 84, NOAA would become responsible for all archival material at the system's two data storage premises, the Goddard Space Flight Center and EROS.[140]

The organizational functions for which NOAA would be responsible included the following: It would manage all federal funds required for the operational system; evaluate the data

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[137]NOAA Document, Issues and Options, pp. 22-23.

[138]U.S. Congress, House Report, "Civil Land Remote Sensing System," p. 11.

[139]Ibid.

[140]NOAA Document, Issues and Options, pp. 31-32.

requirements of users to assure the operational system was tailored accordingly; and the NOAA would implement the Carter Administration's goal of eventual private sector ownership of the system by establishing appropriate pricing and market expansion efforts and by formulating an institutional framework based on private industry's willingness to invest and share in the risk.[141] The institutional framework would take one of the following forms:

1. A private corporation (or consortium) selected competitively to own and operate all or part of the civil operational land remote sensing satellite system and to sell data to federal agency users under a guaranteed purchase contract;

2. A for-profit private corporation, authorized by federal legislation, with private equity and privately and publicly appointed Board members;

3. A wholly owned government corporation authorized by federal legislation, with government equity, reporting to the Secretary of Commerce, with provision to subsequent transformation to a private stock corporation as system revenues warrant; and

4. Federal agency ownership with private contractor operation, and provision for subsequent transfer to a private sector owner as system revenues warrant.[142]

Options one and two offered the earliest possible transfer dates, options three and four could not be met until the 1990's.

The methodical, deliberate preparation the Carter Administration applied to Landsat's transfer was indicative of its resolve to predetermine the structure of commercialization --

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[141]Ibid, pp. 32-33.

[142]Ibid, p. 11.

before thrusting a private operator into a sea of uncertainty. This would decrease the likelihood of program damage or failure during the difficult transition period. Since a phased shift to commercialization was deemed necessary for the Landsat transfer to succeed and thus in the national interest, we can now fully confirm the validity of the first hypothesis. The Carter satellite remote sensing policy was influenced by the national interest in a healthy Landsat because it was his Administration's intention to both assure data continuity from and phased-in commercialization of the U.S. remote sensing program.

Also pursuant to the Carter objective of a Fully Operational System was the incorporation of user voices into the decision-making process. For federal users, the Commerce Department would establish and chair an Assistant Secretary level Federal Interagency Program Board. It would be composed of representatives from the Departments of Commerce, Defense, Energy, Agriculture, Interior and representatives from NASA, the Environmental Protection Agency, AID, the U.S. Army Corps of Engineers-Civil Works, Central Intelligence and the Executive Office of the President.[143]

The Program Board responsibilities included coordination and regulation of policy issues related to the civil remote sensing satellite program, NOAA's management of the program, international obligations, priorities among user data

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[143]Ibid. p. 34.

requirements, pricing policies, proposals for private sector involvement and federal regulation thereof, budget requests and necessary research and development. If policy discrepancies were to crop up between the NOAA and the Program Board, the PRC (Space) overseen by the NSC, would have the final say.

To assess the needs of non-federal domestic users, the NOAA conducted five remote sensing conferences within the United States to ascertain the domestic services offered by Landsat-D. Questionnaires were distributed, the results of which were analyzed and assimilated into system upgrades.[144]

Internationally, NOAA participated in regional Landsat user meetings in Africa, Asia and South America to inform foreign data users of products and services available from the Landsat-D system. NOAA also conducted seminars with foreign ground station operations on proposed increases in access fees and the initiation of other fees that would accompany commercialization.[145]

The Fully Operational System was to contribute to the international objectives of:

1. Fostering international receptivity to and acceptance of U.S. space remote sensing activities;

2. Developing a worldwide market for U.S. commercial data products and associated hardware and services;

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[144]U.S. Congress, House Report, "Civil Land Remote Sensing Systems," p. 12.

[145]Ibid.

3. Encouraging utilization of land remote sensing satellite data and techniques in the national and regional development programs of developing nations; and

4. Maintaining U.S. commercial and technological leadership in the field of space remote sensing.[146]

By this time it was clear that, as far as the Carter policy was concerned, the success of a commercial remote sensing system revolved around meeting user needs. And the key criterion to meeting those needs was and is the assurance of data continuity by the system operator.

Once again, we refer to the NOAA's Issues and Options document.

> . . .continuity of land remote sensing data is a prerequisite to the increased use of land remote sensing satellite data. Users will not rely on satellite data until its continuity, with adequate reliability and timeliness are assured. Only then can users confidently invest in the personnel, training and processing equipment necessary to utilize the data and standard data products in their operational programs. Without these assurances, growth in the utilization of the data will be limited and any new efforts at market expansion might be inappropriate and unsuccessful.[147]

Addressing continuity and user needs were the following minimum performance standards set forth by the Carter Administration, applicable to the Interim and Fully Operational System:

1. Sensors designed to generate data meeting a broad range of user requirements at a reasonable price;

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[146]NOAA Document, Issues and Options, p. 96.

[147]Ibid, p. 88.

2. Assured continuity of satellite coverage without break, with one back-up satellite in orbit at all times and another on the ground;

3. Ninety-five percent confidence that, averaged over a two-day period, all data will be processed and made available from the ground station within 48 hours of receipt; and

4. Ability to identify and process certain data out of order to meet urgent user needs.[148]

The earliest possible date by which all four of these standards could be met was 1989. To help realize them, President Carter committed the U.S. government to the construction and launching of two follow-on satellites beyond Landsat 5, thereby assuring remote data continuity up to 1994.[149] Without a follow-up on plan, the U.S. Landsat program, barring any unusual lifetime extension of Landsat 5, would cease to function in 1988.[150]

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[148]Ibid, p. 29.

[149]U.S. Congress, House Report "U.S. Civil Remote Sensing Satellites: Commercialization Policy and Issues," p. 5.

[150]Ibid, p. 6.

CHAPTER V

REAGAN POLICY: THE ESTABLISHMENT OF COMMERCIALIZATION

> The role of government should not include performing services and activities the can effectively be carried out by the private sector, and we will work for policies which increase reliance on the private sector.[151]
>
> President Ronald Reagan
> The White House
> March, 1983

The "less is best" atmosphere which arrived in Washington with the presidential election of Ronald Reagan in 1980 meant few government programs would escape a budget scale-back. Perfectly in line with that doctrine was Landsat. Already under groom for phased commercialization, the program was about to take the fast track out of government. This chapter will trace the steps of that process, beginning with the Reagan rationale for commercializing the U.S. civil remote sensing program. A description of the somewhat brief feasibility assessment will follow. Then the discussion will turn to the establishment of commercialization and the institution of Eosat as the civilian

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[151]Office of Management and Budget, Office of Federal Procurement Policy, "enhancing Governmental Productivity Through Competition: Targeting for Annual Savings of One Billion Dollars by 1988." A Progress Report on OMB Circular No. A-76, March, 1984, p. 2.

operator of Landsat. Finally, the reality of commercialization will be examined.

The Reagan Rationale

Shortly after President Reagan entered office, the Carter commitment to Landsat continuity was terminated.

> It is the Administration's judgement that the present NASA investment in Landsat is sufficient to permit evaluation of operational uses of Landsat data and, if these are cost effective, to attract a private sector owner/operator. NASA's program to develop, launch and test the two additional satellites (4 & 5) already in manufacture will continue as previously planned. Expansion and extension of the U.S. civil remote sensing program beyond that already funded by NASA is inconsistent with the need for across-the-board fiscal restraints.[152]

As a result, the two additional satellites promised by Carter were deleted from the federal budget.

From this information we can partly confirm the validity of the second hypothesis. It states: The Reagan Administration's commercialization policy was insufficiently considerate of the national interest in Landsat. Because the assurance of data continuity (according to the "Preconditions of Commercialization" in Chapter III) was found to be in the national interest and President Reagan terminated that commitment, it can be said that his Administration's commercialization policy was at least partially inconsiderate of the national interest in Landsat.

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[152]U.S. Department of Commerce, NOAA Report "Commercialization of the Civil Space Remote Sensing Systems," by John McElroy, Assistant Administrator for Satellites, August, 1982, Rockville, MD, p. 2.

By no means was the Reagan Administration abandoning Landsat. Not publicly anyway. It professed instead to subject the program, "as soon as possible," to the rigors of the marketplace. "We are encouraged," reported Deputy Secretary of Commerce Joseph R. Wright, Jr. in July, 1981, "by the commercial potential of the operational land remote sensing satellite business and believe that private industry has the ability and the desire to engage in the business with a minimum of government interference."[153]

The Reagan Landsat commercialization rationale has been dependent on one general Administration pledge. It is revealed in the opening of this chapter: the pronouncement to "get government off our backs". In his Economic Report of the President in February, 1982, Mr. Reagan admitted: "My first and foremost objective has been to improve the performance of the economy by reducing the role of the Federal Government in all its many dimensions."[154]

Specific to Landsat, the Reagan government reduction efforts were buttressed by an Office of Management and Budget (OMB) declaration that:

> In the process of governing, the government should not compete with its citizens. The competitive enterprise system, characterized by individual freedom and initiative, is the primary source of national economic strength. In recognition of this principle it

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[153]U.S. Congress, Joint Hearings, July 22, 1981, Statement by Joseph Wright, Deputy Secretary of Commerce, p. 6.

[154]Economic Report of the President, February, 1982, Washington, DC, p. 4.

> has been and continues to be the general policy of the government to rely on commercial sources to supply the products and services the government needs.[155]

The OMB circular goes on to say:

> The Federal Government shall rely on commercially available sources to provide commercial products and services. In accordance with the provisions of the Circular, the government shall not start or carry on any activity to provide a commercial product or service if the product or service can be procured more economically from a commercial source.[156]

In the eyes of the Administration, OMB Circular A-76 overwhelming applied to the Landsat program.[157]

Toward the Establishment of Commercialization

On July 13, 1986 President Reagan asked his Cabinet Council on Commerce and Trade (CCCT), chaired by Secretary of Commerce Malcolm Baldridge, to assess the best mechanism for transferring Landsat to the private sector.[158]

The next month, the CCT delegated authority to the newly established Land Remote Sensing Satellite Advisory Committee (LRSSAC), a body of non-federal Landsat users with an interest in the commercialization outcome. It was chaired by Michel

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[155]Executive Office of the President, Office of Management and Budget Circular No. A-76, (Rev.) August 4, 1983, Washington, DC, p. 1.

[156]Ibid, p. 2.

[157]NOAA Report, "Commercialization of the Civil Space Remote Sensing Systems," p. 4.

[158]U.S. Congress, House of Report "U.S., Civil Remote Sensing Satellites: Commercialization Policy and Issues", p. 6.

Halbouty, a consulting geologist and petroleum engineer from Houston, Texas.[159]

After nearly a year of careful study, the LRSSAC in June, 1982 advised Secretary Baldridge to issue a Request for Information (RFI) to solicit industry opinion on the feasibility of a privately owned and operated Landsat. The RFI was issued through the Commerce Business Daily on September 10 of the same year.[160]

A total of twelve responses to the RFI were received from private industry and two from the university community. To objectively evaluate the responses, Chairman Halbouty established the Working Group on Commercialization, which was made up of five members of the LRSSAC who had no conflict of interest in the responses or their evaluation.[161] On November 19, 1982, the Working Group's report, endorsed by the entire committee, was released to the public. Among its findings were the following:

1. It was agreed that the commercialization of Landsat would enhance the development of the economic base of the country.

2. The responses indicated that commercialization should occur gradually, beginning with the ground data handling segment.

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[159]Ibid.

[160]Report of the Working Group on Commercialization, Land Remote SEnsing Satellite Advisory Committee, November 17, 1982, p. 1.

[161]U.S. Congress, House Report "U.S. Civil Remote Sensing Satellites: Commercialization Policy and Issues," p. 7.

3. All responses indicated that the data market was not developed adequately to support commercial viability within the next ten years.

4. The most serious foreign competitors (France and Japan) write off the operating costs of the space segments so that their group segments can take greater risks in fostering new information technologies that will enhance the growth and development of their economies. "For this reason, it is doubtful that a United States commercial venture, which recovered the costs for operation of the space segment, will be able to compete on an international basis without government support."[162]

The report concluded that:

> The Administration has explicitly stated its intention to transfer its responsibilities for land remote sensing to the private sector in the mid-1980's or sooner if possible. To this end the land remote sensing program is not funded beyond Landsat (5), scheduled to operate until 1988. With the lead time required for development of new satellites a decision must be made in early 1983 to either request supplemental funding. . .or a viable corporate entity must be selected now to take over the entire program. . .Regardless of what decision is made, however, it is essential that the land remote sensing program continue without interruption.[163]

And:

> Government funding of the space and ground segment of the land remote sensing system will be required until 1995 and probably through the year 2000, if the United States expects to remain competitive in the international marketplace."[164]

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[162]Report of the Working Group on Commercialization, p. 3.

[163]Ibid, p. 7.

[164]Ibid, p. 10.

For a federal assessment of the RFI responses, Secretary Baldridge formed two government interagency panels to carry out technical and business evaluations.

The Technical Evaluation Committee (TEC) was chaired by Major General Earl Peck, Director of Intelligence and Space Policy at the Department of Defense. The Business Evaluation Committee (BEC) was chaired by Kathleen Charles, Deputy Comptroller at NASA's Goddard Space Flight Center. Both reports, submitted to the Department of Commerce on November 10, 1982, expressed reservations for a complete transfer of Landsat to the private sector, the TEC for national security reasons and the BEC on the grounds that "the user market for Landsat data is not presently large enough to support a private operation without a government guarantee or subsidy."[165]

Further examination of the commercialization plan was written into the NASA Authorization Act of 1983, Public Law 97-324. It required the Federal Government to determine a) current and projected data requirements of governmental agencies; b) the equipment, software and data inventory to be transferred; and c) the practicable financial and organizational approaches for such a transfer. In addition, four institutional alternatives were to be compared:

1. wholly private ownership and operation of the system by an entity competitively selected;

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[165]U.S. Congress, House Report "U.S. Civil Remote Sensing Satellites: Commercialization Policy and Issues," p. 9.

2. phased-in Government/private ownership and operation;

3. a legislatively chartered, privately owned corporation; and
4. continued ownership and operation by the Federal Government.

(It is interesting to note here that the "guaranteed government purchase" phrase from President Carter's institutional alternatives had been removed.) P. L. 97-324 also called for federal funding of at least two parallel studies outside the government to assess the same alternatives. Three studies were ultimately commissioned. The results of those studies were to be submitted to the Secretary of Commerce by April 1, 1983.[166]

The federal study, besides addressing the logistical questions of the transfer, warned that Landsat commercialization is not possible without continued federal regulation: "The extensive federal interests and international relations considerations lead to the need for a regulatory framework within which a private sector owner/operator provides services."[167]

The first of the three private studies commissioned by the Department of Commerce was undertaken by the National Academy of Public Administration (NAPA). It recommended a gradual shift of Landsat responsibilities to the private sector as markets develop. The NAPA report also endorsed the creation of either a

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[166]P. L. 97-324, Section 201, October 15, 1982, 96 Stat 1601.

[167]Marsh, A. K., "Reports Criticizing Plan to Sell Satellites," Aviation Week and Space Technology, April 4,1983, p. 48.

government corporation or a mixed public/private corporation as the institutional alternative to a wholly publicly held Landsat.[168]

Another private study, this one conducted by the Earth Satellite Corporation, concluded that successful Landsat commercialization required substantial subsidies or guaranteed government data purchases and that a fully commercial U.S. remote sensing enterprise was not possible for several years. The report also referred to the vast number of previous studies which essentially said the same thing. "If there is no legitimate basis for commercialization," the report said, "then varying the working assumptions and studying the problem again is as useful as rearranging the deck chairs on the Titanic."[169]

The third private study, conducted by ECON, Inc., also concluded that rapid transfer of Landsat to the private sector was not in the best interests of the United States.[170]

Meanwhile, the CCCT met again December 15, 1982 to evaluate the reports it had received concerning the responses to the RFI. Despite the repeated warnings of the near-term infeasibility of the Landsat transfer, the Council recommended the U.S. go ahead with commercialization anyway. The institutional alternative

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[168]Ibid.

[169]"Report Criticizes Landsat Commercialization," Aviation Week and Space Technology, May 9, 1983, p. 18.

[170]Office of Technology Assessment, Remote Sensing and the Private Sector, p. 22.

chosen was the first mentioned above: a wholly privately owned and operated system by an entity competitively selected.[171]

On March 8, 1983, President Reagan announced his endorsement of the transfer of Landsat to the private sector.[172] Secretary Baldridge promptly established an interagency policy-level body of federal Landsat users to oversee the commercialization initiative. Called the Interagency Board on Civil Operational Earth Observing Satellite Systems, its job was to set the policy framework for the first step in the commercialization process, the formal request for proposals (RFP) from private industry for its acquisition of Landsat.[173] A Source Evaluation Board (SEB) was set up to issue the RFP, evaluate the responses and report the findings to the Commerce Secretary, who would then select a contractor.[174]

The objective of the RFP was to establish as quickly as possible, with the least possible government regulation, a

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[171]U.S. Congress, House Report, "U.S. Civil Remote Sensing Satellites: Commercialization Policy and Issues," p. 11.

[172]U.S. Congress, Senate, Committee on Commerce, Science and Transportation Report No. 99-86, "Land Remote Sensing Commercialization Act of 1984 Authorization," June 14, 1985, 99th Congress, 1st Session, Washington, DC, p. 1.

[173]Department of State Bulletin, January, 1985, Statement by Harry Marshall, Jr., Deputy Assistant Secretary of State, p. 35.

[174]U.S. Congress, House, Hearing Before the Subcommittees on National Resources, Agriculture Research and Environment and Space Science and Applications of the Committee on Science and Technology, June 13, 1985, 99th Congress, 1st Session, Washington, DC, Statement by Anthony Calio, NOAA Deputy Administrator, p. 10.

commercial land observing satellite program. The RFP stated the government's willingness to provide financial support during the early years of commercialization to offset high operating and construction costs and the associated underdeveloped remote sensing marketplace.[175]

One condition of the RFP was that a private operator assure the U.S. that he will meet all existing foreign policy and national security obligations. But, evaluation factors which included costs to the Federal Government were "of equal importance to all other factors combined."[176]

Seven proposals were received by the RFP's official closing date of March 19, 1984. Of those, three were found by the SEB to be within competitive range. They were: Earth Observing Satellite Company (Eosat), Eastman Kodak Company, and Space America.[177]

On May 29, 1984, Secretary Baldridge narrowed the contestant field to two -- Eastman Kodak and Eosat. Both were told that their technical approaches were acceptable, but that their financial approaches had to be revised.[178]

Upon review of the revised proposals, it was concluded that "the refined financial analyses all confirmed that expected

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[175]GAO Report No. 84-93, p. 6.

[176]U.S. Congress, House Hearings, June 13, 1985, RFP, p. XI-I, quoted in statement by Anthony Calio.

[177]Ibid, p. 13.

[178]Ibid, p.14.

government liability over the life of the program would have an adverse effect on efforts to reduce the federal budget."[179] It was at this time that President Reagan, Secretary Baldridge and Budget Director David Stockman all agreed to limit federal subsidies to $250 million for the commercial follow-on system.[180] This figure represented about half of what was originally promised by the government.[181] When informed of the subsidy reduction, Eastman Kodak withdrew from the competition, leaving, by default, Eosat as the winning bidder.[182]

Serving as the foundation of the Landsat commercialization proceedings was the Land Remote Sensing Commercialization Act of 1984, signed into law July 17. It contained statements of federal remote sensing policies on foreign access and international obligations, the conditions and terms of the contract to be let, the conditions for the provision of data continuity and availability, marketing stipulations, the federal research and development role and data archiving requirements.[183]

The purposes of the Act were to:

1. Guide the Federal Government in achieving proper involvement of the private sector by providing the

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[179]Ibid.

[180]Ibid.

[181]U.S. Congress, House Hearings, April 2, 1987, Statement by Dr. James Taranik, p. 288.

[182]U.S. Congress, House Hearings, June 13, 1985, Statement by Anthony Calio, p. 14.

[183]P. L. 98-365, Land Remote Sensing Commercialization Act of 1984, July 17, 1984, 98 Stat. 451-467.

framework for phased commercialization of land remote sensing and by assuring continuous data availability to the Federal Government;

2. Maintain the United States worldwide leadership in civil remote sensing, preserve its national security and fulfill its international obligations;

3. Minimize the duration and amount of further federal investment necessary to insure data continuity while achieving commercialization of civil land remote sensing; and

4. Provide for a comprehensive program of research, development and demonstration to enhance both the United States capabilities for remote sensing from space and the application and utilization of such capabilities.[184]

The Installation of Eosat

In accordance with the Commercialization Act of 1984, the Federal Government entered into a contract with Eosat in the Fall of 1985.[185] Eosat is a joint venture between RCA Astro-Electronics (now owned by General Electric) and Hughes Aircraft. Both companies have equal controlling interest in Eosat, with Hughes responsible for sensor development and RCA assigned to the design and construction of the spacecraft.[186] Besides the two principal partners, the Computer Sciences Corporation and the Earth Satellite Corporation were added to the Eosat team for

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[184]Ibid, Section 102.

[185]Lowndes, J. C., "Commerce Dept. Transfers Landsat Operations to Private Venture," Aviation Week and Space Technology, October 14, 1985, p. 95.

[186]U. S. Congress, House Hearings, June 13, 1985, Statement by Charles Williams, Eosat Company, p. 36.

extra data distribution capacity and marketing experience.[187] The contract signed into law a federal commitment to two follow-on satellites to Landsat 5. It stipulated that Eosat would receive $250 million over five years ([in millions] $90 in FY85/86; $87 in FY87; $55 in FY88 and $18 in FY89)[188] from the Federal Government for satellite construction and $45 million for two launches on the space shuttle.[189] The Eosat satellites, designed with a five-year lifetime, would fly sensors identical to the thematic mapper on Landsats 4 and 5 as well as improved sensors with fifteen meter resolution capability.[190]

Beyond the construction and launch costs of the follow-up satellites and the operating costs of Landsats 4 and 5, Eosat had to fund all other expenses. This included overall market development, marketing and distribution for data products from Landsats 1 through 7 and data processing functions of Landsats 6 and 7.[191] Eosat would be entitled to retain all revenues from data sales and pro-rata share of access and royalty fees paid by

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[187]Ibid.

[188]Ibid, p. 57.

[189]U.S. Congress, House Committee on Science and Technology Report No. 99-177, "Authorizing Appropriations for Landsat Commercialization," June 20, 1985, 99th Congress, 1st Session, Washington, DC, p. 2.

[190]U.S. Congress, House Hearings, June 13, 1985, Statement by Anthony Calio, p. 18.

[191]Ibid, p. 19.

ground station operators.[192] Compliance with U.S. national security and foreign policy initiatives would also be required.[193]

Eosat was now ready to do business. Armed with the technological knowhow and the marketing aggressiveness to make the U.S. civil remote sensing program a success, the country's newest space venture began cutting hardware and selling resource management programs around the world. Unfortunately, there were some formidable obstacles along the way.

Prior the letting of the federal contract with Eosat, Congress had made certain that a private operator would be given an adequate level of federal funding. The Committee on Science and Technology, the House body responsible for an orderly Landsat transfer, warned that "the transition must be fully made and fully funded or not made at all, for partial funding would guarantee failure".[194]

Nevertheless, the Reagan White House did not deliver as promised. Besides an initial $125 million already appropriated for 1985, no funds for Landsat commercialization were included in the budgets for fiscal years 1986 and 1987, in spite of the

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[192]Ibid.

[193]Ibid.

[194]U.S. Congress, House Report No. 99-177, p. 2.

agreed upon contractual arrangements.[195] The Committee on Science and Technology was outraged.

> The failure to include funding in the FY86 and FY97 budgets has made it difficult for Eosat to make the long range business decisions that are crucial at this time. More importantly, however, this failure signals a lack of commitment by the Administration in establishing a commercial land remote sensing system. This lack of commitment seriously effected the willingness of potential users to make the investments necessary to become users. Ultimately in the absence of a strong U.S. presence, international competitors such as SPOT are certain to dominate the land remote sensing market. . .The original rationale for providing budget authority to carry out P.L. 98-365 remains unchanged and no feasible alternatives have emerged. Thus the Committee urges the Administration to exercise leadership and proceed expeditiously to support the entity selected under the commercialization plan. . .The indecision exhibited thus far should not be allowed to set a pattern for the future.[196]

Another impediment to Eosat's success was the loss of its launching means, which occurred when disaster struck the Space Shuttle "Challenger" in early 1986. At that point, all Landsat-type satellite launches would be pushed back to 1992 at the earliest.[197] Obviously another launching mode had to be sought, resulting in new strategies, more delays, higher costs to Eosat and subsequent request for increased federal funding.

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[195]U.S. Congress, House, Committee on Science and Technology Report No. 99-826, "Land Remote Sensing Commercialization Act, Amendments of 1986, September 16, 1986, 99th Congress, 2nd Session, Washington, DC, p. 10.

[196]Ibid, pp. 10-11.

[197]U.S. Congress, House Hearings, March 31, 1987, Statement by Clarence Brown, Deputy Secretary of Commerce, p. 56.

Which brings us back to the appropriations dilemma. Although somewhat tardy, the OMB responded to Congressional pleas for full funding. Joseph Wright, now Deputy Director of OMB, offered this explanation of that office's fiscal hedging:

> Quickly mounting pressure to reduce the massive budget deficit under the new Gramm-Rudman-Hollings law forced a reevaluation of the government's contribution to Landsat. The 1987 President's Budget proposed to accelerate the commercialization process by withholding additional subsidies above the $125 million in seed money that had already been appropriated. A policy was established that it would be up to the competitive market to determine whether the program would continue and further financing would be the responsibility of the private interests that benefit from the program.[198]

Indeed, shifting the funding burden towards users became the Administration's call. (The problem with depending on users to bear a share of the financial burden of commercialization is that data prices must be set high enough to recover entire system costs. The competition, which enjoys heavy government support, would only have to set prices high enough to cover, for example, the ground segment or data processing functions. Thus the U.S. operator would be at a significant competitive disadvantage. The users it depends upon to pay for the system would quite likely become users of a system requiring less direct customer support.) The OMB reasoning was echoed by the Department of Commerce:

> During the preparation of the President's fiscal year 1987 budget request, it became clear to the Administration that in recognition that the program primarily represents private interests and to meet both the President's desire to reduce the federal deficit

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[198]U.S. Congress, House Hearings, March 31, 1987, Statement by Joseph Wright, Deputy Director, Office of Management and Budget, p. 21.

> and to respond to the Gramm-Rudman-Hollings Act, government funding for Landsat 6 and 7 could not be provided beyond the $125 million already appropriated.[199]

In other words, the Federal Government was not going to honor the conditions of the Eosat contract. Its reluctance came to life when the Administration submitted a one-satellite proposal to Congress based on the philosophy that commercialization could still be achieved, but with increased private sector investment from Eosat and from federal and non-federal Landsat users.[200] The proposal was summarily rejected by the House and Senate Appropriations Committees on the grounds that a one-satellite program would not allow enough time to determine the potential commercial viability of a privately owned and operated civil remote sensing system.[201] The market was still unproven. Congress' Office of Technology Assessment reported in 1984 that:

> The major factor affecting the amount of subsidy required under private ownership is the rate at which the market can be developed. If the market can be expanded relatively quickly, the amount of subsidy required to sustain a profit-making corporation will decline at a similar rate. We have suggested it might take as much as ten years to develop sufficient market, but the future market is very uncertain. Until strong

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[199]Ibid, Statement by Clarence Brown, p. 51.

[200]Ibid, Statement by Joseph Wright, p. 22.

[201]U.S. Congress, House Hearings, April 2, 1987, Statement by Dr. James Taranik, p. 290.

> marketing efforts are tried, we will have little on which to base projections.[202]

From the above information, we can now fully confirm the validity of the second hypothesis. The slashing of the subsidy level "left it up to the competitive market to determine whether the program would continue". This does not represent a phased shift from public to private operation of the program in the fashion outlined by the "Preconditions of Commercialization" in Chapter III.

It was clear that a remote sensing "industry" would not materialize overnight. Some experts testified that it can take approximately five years for a new data set to reach full application development and another five years for full economic utility.[203] Patience then becomes a key ingredient in the transfer. Most analysts believe in the long pull, the market will enjoy steady incremental growth, but whether it grows large enough to support a private operator or to warrant continued government subsidy is an issue no one is prepared to resolve.

Bearing the uncertainty in mind, the Under Secretary of Commerce in March, 1987 went back to MB was a request for a $295

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[202]U.S. Congress, Senate Hearings, March 22, 1984, Statement by Dr. John Gibbons, Office of Technology Assessment, p. 103.

[203]U.S. Congress, House Hearings, March 31, 1987, Statement by Warren Nichols, Hughes Aircraft, p. 110.

million, two-satellite package, indicating the plan should either be accepted or commercialization cancelled.[204]

OMB would have nothing of either option, instead restating its commitment to the funding of only one satellite and further study of a second.[205]

Despite the efforts of Congress, the urging of the Department of Commerce and the commercialization contract the Federal Government signed with Eosat, the OMB proposal prevailed.[206] There would be one satellite, to be launched in March, 1991,[207] and the study of future technological requirements of a second satellite, scheduled for launch sometime in 1994 or 1995.[208]

What effect did the failure of the government to meet its contractual obligations have on Eosat? Peter Norris of Eosat delivered this testimony:

> On January 5,1987, Eosat had to notify all of its subcontractors that because of the limitation of funds in its primary contract, it was necessary to terminate all these activities for the sensors, the spacecraft and ground system. As a result, all Landsat 6 and 7

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[204]Letter from Clarence Brown, Deputy Secretary of Commerce, to Joseph Wright, Deputy Director, OMB, March 4, 1987, Washington, DC, pp. 1-2.

[205]U.S. Congress, House Hearings, April 2, 1987, Statement by Dr. James Taranik, pp. 289-290.

[206]Ibid.

[207]"Growth, Stability Predicted for Commercial Space Ventures," Aviation Week and Space Technology, March 14, 1988, p. 108.

[208]"New Landsat Plans Could Terminate Eosat Contract," Aviation Week and Space Technology, September 28, 1987, p. 139.

development have been curtailed and Eosat has reduced its direct work force by half.[209]

From there, the relationship between Washington and Eosat steadily deteriorated, each side accusing the other of a breach of faith. Plans to scrap the contract altogether and devise a new follow-on to Landsat 6 without Eosat have been bandied since mid-1987,[210] signalling at least a partial first round failure to commercialize Landsat.

Landsat's Future

There is no question that the U.S. government will continue to find uses for Landsat-type data. Officials from the Department of Defense "strongly believe that the Landsat system deserves the full support of the United States government,"[211] so much so that Defense offered the Department of Commerce close to $100 million of its own money to keep the program going through the time of uncertainty.[212] It was an offer apparently not taken seriously by Congress.[213]

Representatives from NASA testified that their mission has in the past and will in the future rely on Landsat data. "If

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[209]U.S. Congress, House Hearings, March 31, 1987, Statement by Peter Norris, Eosat Company, p. 102.

[210]"New Landsat Plans Could Terminate Eosat Contract," Aviation Week and Space Technology, September 28, 1987, p. 139.

[211]U.S. Congress, House Hearings, March 31, 1987, Statement by Donald Latham, Assistant Secretary, Department of Defense, p. 89.

[212]Ibid, p. 97.

[213]Ibid.

such data were not available, many of our research efforts would be hampered and some would be delayed or impaired by the lack of such data. While NASA may not be the largest user of Landsat data in the current environment, these data are still critical to many of our programs."[214]

The Department of State warned that the loss of Landsat would make the U.S. increasingly reliant on foreign sources for data and the absence of an indigenous system would reduce our leverage in not only seeking those data but in seeking other trade concessions as well. Furthermore, "we would lose the goodwill, credibility and trust of foreign ground station operators. If we chose to re-enter this field, we would find the cost of reconstructing that goodwill, trust and cooperation potentially high."[215]

The Department of Agriculture, the largest federal user of Landsat, stands to lose a great deal from failed remote sensing policies:

> The absence of Landsat data. . .would be a loss of an important data source for the Department[216]. . .That the loss of Landsat data would adversely impact our efforts to assess agricultural conditions in those countries where travel is restricted or denied, or

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[214]Ibid, Statement by Dr. Shelby Tilford, Director of Earth Science and Applications Division, Office of Space Science and Applications, NASA, p. 144.

[215]Ibid, Statement by Michael A. G. Michaud, Acting Deputy Assistant Secretary of State, p. 145.

[216]Ibid, Statement by James Donald, Chairperson, World Agricultural Outlook Board, USDA, p. 155.

> where existing agricultural statistical systems are poor or non-existent, is obvious.[217]

Yet, the Office of Management and Budget remained unconvinced that Landsat was an important research tool. Again, the OMB's Mr. Wright:

> If Congress were to decide not to continue Landsat, I question whether the impact on the users would be significant. As a result of Landsat's having mapped the earth continuously for the past fourteen years, there are nearly one million scenes and films available for use in the Department of Interior EROS Data Center. In addition, land remote sensing data will still be available from U.S. allies' satellites.[218]

In fact, OMB has directly encouraged a trend toward decreased federal use of Landsat.

> OMB has closely supervised purchases of Landsat data and required that money spent for this purpose by government agencies be accompanied by a corresponding reduction in funds allocated for alternative methods of data collection. Agencies are often unwilling to give up older methods when they are unsure about their ability to receive Landsat data as needed.[219]

The wisdom shown here by the Office of Management and Budget has touched more than one nerve within and outside the decision-making process. One interested participant advised Congress that

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[217]Ibid, p. 158.

[218]Ibid, Statement by Joseph Wright, Deputy Director, OMB, p. 24.

[219]Office of Technology Assessment, Remote Sensing and the Private Sector, p.75.

"If you let OMB run the technological decisions of the country, you may as well let the gargoyles run the cathedral."[220]

Landsat is more than simply a source of earth resources data. The program has subsidiary value to the fields of artificial intelligence, high-speed communications, computer enhancement, software development and electro-optical sensor innovations. The success of the value-added industry hinges on a strong Landsat, and we already know the benefits to foreign policy and national security at stake. Apparently the competition realizes the ancillary social, political and economic effects the technology spurs and they express it in terms of long running state support. We can presume that their entry into the satellite remote sensing field is based upon the entire package of advantages and that their considerable investment does not necessarily require direct commercial prosperity.

The American Society of Photogrammetry and Remote Sensing (ASPRS), academia's voice in the commercialization process states its position on the issues this way:

> We submit that the current uncertainty surrounding the funding of the(Landsat) program not only represents a breach of faith in the entire commercialization process, but also a situation that will insure that the U.S. remote sensing industry remains stillborn while existing and prospective foreign competition enjoys substantial success in the international marketplace. In terms of capturing our share of the global market for remote sensing products or services, uncertainty, lack of continuity and competitiveness simply do not mix. Ironically, we seem to be on a decision-making path that will preclude our reaping the benefits from a

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[220]U.S. Congress, House Hearings, April 2, 1987, Statement by Charles Sheffield, Earthsat Corporation, p. 309.

> highly technical industry that we in fact created -- at considerable taxpayer expense. In other words, at a time when Congress is focusing on enhancing our nation's competitiveness, we are by defunding Landsat, eliminating an important weapon form our domestic trade arsenal.[221]

Dr. Thomas Lillesand, the spokesman for ASPRS, sums up what he thinks should be the essence of Landsat commercialization:

> Certainly the cost of the system is at issue. But the potential benefits that are derived by industry and all levels of government and in the earth system science understanding, in composite lead us to think that really what's at issue here are our leadership, our spirit, our prestige in space related activities. But not only that, our vision for the future.[222]

Nevertheless, budget restraints seem to have won out over America's vision.

There are two compelling points to today's reality. One is that Commerce now pays the private sector may be willing to finance the next generation of Landsat satellites, particularly if the government will guarantee a certain level of purchases from the new operator.[223] Recall that the Carter Administration posed purchase guarantees as an option when it willed the Landsat commercialization plan to President Reagan in 1981. The purchase

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[221]Ibid, Statement by Dr. Thomas Lillesand on behalf of the American Society for Photogrammetry and Remote Sensing, pp. 208-209.

[222]Ibid, p. 205.

[223]"Three Firms Chosen to Study Remote Sensing Satellite," Aviation Week and Space Technology, March 7, 1988, p. 25.

guarantee was not among the provisions of the 1984 Commercialization Act.[224]

Also significant is the fact that Commerce now projects data sales, value-added services and associated products to be worth $6 billion annually in the next ten years.[225] Had its previous forecasting measures been slightly less conservative or askew, the length of the budgeting stasis and the approaching remote sensing data gap could have been shortened.

In retrospect, Landsat commercialization has been a glaring example of government mismanagement and inexcusable indecision. The tug-of-war over a relatively few million dollars and the Executive disbelief in the importance of a strong satellite remote sensing system will render the U.S., for at least three years, virtually unconscious in a multi-billion dollar industry it created by only minimally tapped. An despite the present administration's profession to loosen the federal grip on American wallets, the game of catch-up will undoubtedly leave the U.S. taxpayer holding the heavy bag. The entire exercise has been a well-taught lesson in budgeting, space policy and technological forecasting. Unfortunately, we have learned it the proverbial hard way.

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[224]P. L. 98-365, Section 304, Paragraph (4).

[225]"Three Firms Chosen to Study Remote Sensing Satellite," Aviation Week and Space Technology, March 7, 1988, p. 25.

CHAPTER VI

CONCLUSION

This thesis has established that it was in the national interest of the United States to maintain a strong presence in the technology of satellite remote sensing. This is supported by paragraphs (2) and (3) of Section 101 of the Land Remote Sensing Commercialization Act of 1984 which state: "(2) The Federal Government's experimental Landsat system has established the United States as the world leader in land remote sensing technology; (3) the national interest of the United States lies in maintaining international leadership in civil remote sensing and in broadly promoting the beneficial use of remote sensing data."

In maintaining the national interest, it was determined that, in the course of commercializing Landsat, the satisfaction of the following preconditions was required:

A. A continuous supply of data from a civil remote sensing system must be assured, regardless of who operates the system, to maintain U.S. competitiveness in the field. This is due to the following factors:

1. A future in which the continuity of data is uncertain curtails the use of remote sensing system. This is supported by:

   (a) Section 101, paragraph (7) of the 1984 Commercialization Act, which states: "Use of land remote sensing data has been inhibited by. . .the lack of assurance of data continuity."

   (b) A Library of Congress Report that says: "The lack of a user market is in large part the result of the uncertain status of Landsat as an experimental program under NASA."[226]

   (c) The NOAA determination that "users will not rely on satellite data until its continuity. . .is assured. Only then can users confidently invest in the personnel, training and processing equipment necessary to utilize the data. . .Without these assurances, growth in the utilization of the data will be limited and any new efforts at market expansion might be inappropriate and unsuccessful."[227]

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[226]U.S. Congress, House, Report by the Congressional Research Service, The Library of Congress, "U.S. Civil Remote Sensing Satellites: Commercialization Policy and Issues," for the Committee on Science and Technology, April 11, 1983, 98th Congress, 1st Session, Washington, DC, p. 15.

[227]NOAA Document, Issues and Options, p.88.

2. If data are unavailable from one system, users will naturally seek the products of a comparable system. This is supported by:

   (a) An Office of Technology Assessment determination that "if continuity of the data flow is not maintained and the resulting hiatus continues beyond the time when the French SPOT system is operational, many U.S. users will certainly turn to the French to supply some of their data needs . . .If users begin to use SPOT data in any significant way, they may be reluctant to switch back to Landsat."[228]

B. A phased shift from public to private ownership of Landsat was necessary for commercialization to succeed. This is due to the following factors:

1. The private sector was not in the position to solely develop a fully operational remote sensing system. This is supported by:

   (a) Paragraph (9), Section 101 of the Commercialization act, which states "There is doubt that the private sector alone can currently develop a total land remote sensing system because of the high risk and large capital expenditure involved."

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[228]U.S. Congress, Joint Hearings, July 23, 1981, Statement by Dr. Ray Williamson, Office of Technology Assessment, p. 329.

(b) The financial support of a private operator guaranteed by the Federal Government in Section 304, Paragraph (6) of the Commercialization Act of 1984 which states the U.S. will provide financial support "for a portion of the capital cost required to provide data continuity for a period of six years. . ."

(c) There was no evidence that a market large enough to fully support a commercial operator existed. This is supported by numerous governmental and nongovernmental studies on the subject. (The Commerce Department's Request for Information from industry, the Working Group on Commercialization, the Business Evaluation Committee and the National Academy of Public Administration, among others.)

2. A phased shift allowed time for a commercial operator to understand the market. This is supported by:

(a) The fact that no precedents had been set for a commercial remote sensing operator. Future profit levels, user requirements, market elasticity, competitor practices, pricing policies and total system costs have not been based on any concrete truth or actual experience, only predictions and conjecture. Discovering that a private operator indeed cannot make it on his own in the remote sensing marketplace after commercialization is

implemented could severely or even destroy U.S. remote sensing capabilities. This would lead to a loss of a firsthand source of sensitive data and an avenue of U.S. foreign policy.

(b) The Department of Commerce and the U.S. Congress' determination that a minimum government provision of two satellites beyond Landsat 5 was required to calculate the commercial viability of a civil remote sensing system.[229]

Since President Carter intended to assure data continuity through the Landsat commercialization trial and also devised a gradual, phased shift to private operation of the system, this paper's first hypothesis has held true: 1. The Carter Administration's satellite remote sensing policy was influenced by the national interest in a healthy Landsat.

Because President Reagan terminated assurances of data continuity and, through subsidy reductions, force-fed commercialization to private industry before it was certain that adequate profitability was achievable, this paper's second hypothesis has also held true: 2. The Reagan Administration's commercialization policy was insufficiently considerate of the national interest in Landsat.

As this historical analysis has shown, Landsat's commercialization was initiated to give the program future

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[229]U.S. Congress, House Hearings, March 31, 1987, Statement by Clarence Brown, Deputy Secretary of Commerce, p. 58.

strength in an evolving remote sensing industry, but was activated, without due regard to the technology's importance to the United States, by budget concerns and poorly formulated policy.

In the commercialization process, two national interests were pitted against each other. One was America's endearment to the present and future benefits of satellite remote sensing. The other was the nationwide desire to control the Federal budget deficit. The evidence presented in this paper supports the theory that the former interest should be paramount and the latter interest must be satisfied in other ways.

Reagan Administration behavior in the past two years seems to bear that theory out. Still mired in the worst deficit financing slump in the nation's history, the executive branch has nevertheless appropriated $1.5 million to study future U.S. remote sensing options.[230] On the drawing board is either limited decommercialization, the restructuring of Landsat into an international consortium (along the lines of Intelsat and Inmarsat) or the possibility of breaking Eosat's contract and recompeting the program, with revised stipulations, for Landsat 7 and beyond.[231]

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[230]"Three Firms Chosen to Study Remote Sensing Satellite," Aviation Week and Space Technology, March 7, 1988, p. 25.

[231]"New Landsat Plans Could Terminate Eosat Contract," Aviation Week and Space Technology, September 28, 1987,p. 139.

Independent of which option is chosen, it appears that the Federal Government under President Reagan has finally adopted the popular opinion that a U.S. presence in satellite remote sensing is non-negotiable.

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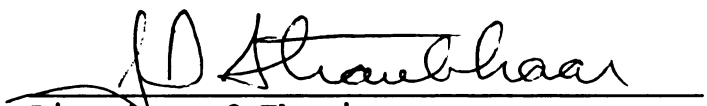

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