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## Paper Session I-C - Landsat-7 Managing the Transition

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## **LANDSAT-7: MANAGING THE TRANSITION**

J. R. Hill, George Komar, Gregory Williams

### **ABSTRACT**

The Land Remote Sensing Policy Act of 1992, (Public Law PL102-555) recognized the importance of continuous collection and utilization of land remote sensing data from space. The Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA) were responsible as the Landsat Program Management. The program proceeded with DoD developing the satellite and NASA developing the ground system. Each agency was for responsible its respective technical and budget requirements.

In the fall of 1993 severe budget constraints, the loss of Landsat-6 and DoD's desire to withdraw from the program resulted in the reassessment of the Landsat Program by the National Science and Technology Council (NSTC). The Land Remote Sensing Strategy, Presidential Decision Directive (PDD)/NSTC-3, established the restructured program, ensured data continuity and extended collection of the 20-year Landsat data set. This strategy, signed in May 1994, established new roles for NASA, the Department of Commerce/National Oceanic and Atmospheric Administration (NOAA), and the Department of the Interior/US Geological Survey (USGS).

A joint NASA/DoD transition plan established the timing of the transfer of the development contract and associated funding. The Emergency Supplemental Appropriations Act (PL103-211) established the funding transfer limit from DoD to NASA, and required the NASA Administrator to certify the fiscal aspects of the program to Congress. A revised Landsat Management Plan established the NASA, NOAA, and USGS roles, funding commitments and program requirements. The NASA Administrator certified the plan to Congress on May 5, 1994, ensuring a launch as early as possible to minimize a data-gap risk.

The program has stabilized with a launch commit date of December 1998 which minimizes the risk of a data gap and ensures continuity of Landsat data into the next century.

#### **LANDSAT HISTORY: IN THE BEGINNING...**

The Landsat program, begun by NASA in 1969, has been in continuous operation since the launch of Landsat 1 (originally Earth Resources Technology Satellite, ERTS-1) in 1972. Four more Landsats were developed and launched by NASA (Landsat-2 in 1975, Landsat-3 in 1978, Landsat-4 in 1982 and Landsat-5 in 1984). NASA operated Landsat as an experimental system until 1979 when, pursuant to Presidential Directive #54, the National Oceanic and Atmospheric Administration (NOAA) assumed control over operations. The Land Remote Sensing Commercialization Act of 1984 (Public Law 98-365) mandated privatization of Landsat. In 1985, in response to the Congressional mandate, NOAA contracted with EOSAT Corporation to provide Landsat operations and marketing of the data. EOSAT, through agreements established by the Department of Commerce (DoC) also provides data from Landsats-4 and -5 via direct downlink to non-US ground stations. Landsat-6, was procured by NOAA through the EOSAT contract for launch in October 1993, but failed to achieve orbit.

#### **LANDSAT-7 DEVELOPMENT: THE WAY WE WERE**

Prices for Landsat data under the privatized arrangement, resulted in overly restricted access by researchers to a resource procured with public funds. Discontent with this situation resulted in repeal of Public Law 98-365 and replacement with Public Law 102-555 which returned development, operations and data distribution functions of the Landsat Program to the government. The new law established the Landsat Program Management (LPM) comprised of the DoD, responsible for the acquisition of the Landsat-7 satellite, and NASA, responsible for development of the ground system. This Public Law also recognized the role of the USGS in the Landsat Program as the agency responsible for archiving and providing user access to all Landsat data. The law requires establishing a data policy ensuring the price of unenhanced Landsat data be commensurate with the cost of fulfilling user requests.

Development of Landsat-7 proceeded as planned through the first year. DoD through a competitive procurement initiated a contract with General Electric (now Martin Marietta Astro Space (MMAS)) in December, 1992, for development of the space segment. The contract included the Enhanced Thematic Mapper Plus (ETM+) subcontracted to Hughes Santa Barbara Research Center (SBRC) as the "continuity" instrument and an option for a second, high technology instrument, the High Resolution Multispectral Stereo Imager (HRMSI). Landsat-7 was scheduled for launch no later than 5 years after the

launch of Landsat-6, as required by PL102-555. NASA developed plans for a ground system, integrating the work as much as possible with the ground system for the Earth Observing System Data and Information System (EOSDIS) and working closely with the USGS EROS Data Center (EDC) where the Landsat data would be archived, processed and distributed.

Events in the fall of 1993 caused a re-assessment of the Landsat Program by the National Science and Technology Council (NSTC). Landsat-6, a cornerstone of the reasoning behind the law was launched on October 5, 1993 but did not reach orbit. This loss presented a significant threat to Landsat data continuity, and prompted a re-examination of the capabilities of the remaining active systems (Landsats-4 and -5) and the development of Landsat-7.

The FY94 budget requests from DoD and NASA included funding in excess of the program baseline for costs associated with the development of HRMSI and the ground system capabilities necessary to acquire and process the HRMSI data. DoD was successful in obtaining funds to develop HRMSI, but the NASA appropriation did not include a commensurate increase for the ground system. Although DoD and NASA worked toward a realignment of the program that would allow inclusion of HRMSI within the total budget appropriated to the two agencies for Landsat, a program acceptable to DoD and NASA management could not be developed. Because of insufficient funding to include both instruments, and the emerging requirement within DoD for HRMSI-type data, DoD and NASA agreed the program should be restructured. This intention was communicated to the Administration in early December, 1993. At the direction of NSTC, the Office of Science and Technology Policy (OSTP) initiated a review and restructuring of the Landsat-7 Program.

#### **DEVELOPING OPTIONS: WHICH YELLOW BRICK ROAD?**

The time frame available for developing options was extremely constrained. All participants recognized the need to reach a decision as soon as possible in order to maintain the launch schedule, to incorporate any decision in the FY95 budget, and to address DoD's intention to withdraw from the program. As a result, NASA's ability to estimate the attributes and potential consequences of each option was limited, particularly in the area of cost and budget projections.

A number of other uncertainties remained at the time of the recommendation:

1. It was clear that the program could not be accommodated solely within existing or planned NASA resources. NASA explored a number of options to resolve this situation (including the transfer of funds from DoD and teaming with NOAA) and eventually developed an executable program concept.

2. NASA's options and recommendation relied on a number of anticipated actions by the Congress, including possible revision of the Public Law and transfer of funds from DoD to NASA. NASA made every effort to seek informal assurances from the necessary congressional staff that such changes could be approved.

3. Though NOAA expressed significant interest in participating in the revised program (through operation of the existing ground system with modifications to support data throughput requirements), at the time of the recommendation, there was no funding commitment from NOAA nor any formal indication of DoC support.

After extensive discussion with OSTP and comments from other participants in the program (NOAA, USGS, DoD), on February 7, 1994, NSTC recommended the option involving the continuation of the current contract as the basis for restructuring the program. Under this option, NASA would continue the current Landsat-7 Program with at least the ETM+ sensor and utilize, to the maximum extent practical, existing Landsat contracts, hardware, software, and facilities. NOAA would participate in the Landsat program through provision of a ground system operations capability that maximizes the utilization of existing resources. DoD would transfer its remaining FY94 funds for Landsat to NASA. In addition, this option provided a pathway for the inclusion of a high technology instrument in the 1998 time frame (subject to the availability of technical/financial resources) and it supported the inclusion of a high technology successor instrument approach for the EOS AM-2 mission in 2004.

This option was the quickest path to maintaining continuity with the earlier Landsat data and was less likely to meet Congressional resistance. It continued work already begun on the instrument and spacecraft, and maintained the earliest practical launch date. However, this option required more funds in FY94 and FY95 than other options.

## **MAKING THE TRANSITION: TRANSPLANTING A NEW LIMB**

### *Rescoping the Content*

Once the NSTC Deputies had made the recommendation to continue with the current contract, NASA began working with DoD to rescope the contract to reduce program costs. A direct wide band (X-band) data link was adopted rather than the Tracking and Data Relay Satellite (TDRS) data link, thus the TDRS antenna could be deleted. A NASA in-house ground system was integral to the restructured program. This permitted deleting the Flight Operations Segment from the development contract. The Global Positioning System (GPS) capability had been incorporated into the design based on accuracy requirements of the HRMSI. The HRMSI, a part of the DoD requirements was deleted and the GPS would no longer be required. In each case rapid trade studies were conducted to evaluate proposed deletions and modifications. These trade studies gave sufficient confidence for NASA to request DoD, who was still responsible for managing the contract, to execute a partial termination associated with these design attributes.

### *Transition Agreement*

In parallel to the rescoping, NASA drafted and coordinated with DoD a plan for transitioning the contract and associated remaining DoD funding. Tasks for NASA and DoD were outlined and a timeline developed. The plan indicated transfer of the contract to NASA immediately following approval of the plan by both agencies.

Congress in the mean time was developing a disaster relief appropriation associated with the California earthquake and Mississippi River flooding. The Emergency Supplemental Appropriations Act, (Public Law 103-211) passed on Feb 11, 1994, provided new and unexpected guidance to the Landsat Program. This Public Law limited the funding transfer to NASA to \$90M, reducing the expected funding by \$13M. Additionally it required the NASA Administrator to certify to the Congress the fiscal year and total program funding to be within NASA's budget prior to the transfer of the program. This placed the resolution of funding issues in the critical path of implementing a restructured Landsat-7 program. Transfer of the FY94 DoD Landsat funds was crucial to maintaining a program schedule that supported data continuity and continuing the MMAS contract after transfer of contract authority from DoD to NASA.

Through March and April, NASA worked detailed program cost estimates for the satellite and ground system. The program cost estimates were based on the best estimates available, but most were "top down" addressing program descopes and

known areas of concerns. At this time NASA had not conducted a detailed analysis of the spacecraft design and the ground system was based on conceptual design estimates. Additionally, design, management and process changes resulting from the NASA Chief Engineer's Office review of recent spacecraft failures had not been included in the estimates. These factors added additional risk to the total program costs. Program reserves were adjusted to partially account for these risks as a final budget was determined.

Externally, discussions with NOAA resulted in a NOAA proposal to join the LPM and contribute funding to NASA's ground system development program. Agreement was reached with NOAA on the funding level and timing, and the DoC Secretary provided a letter to NASA committing support to the program.

On May 5, 1994 the President signed PDD/NSTC-3 "Land Remote Sensing Strategy" providing formal direction to all agencies involved. This formalized the withdrawal of DoD from the LPM and addition of NOAA and USGS. Concurrently, the NASA Administrator transmitted a certified budget plan, including the commitment letter from DoC, to the relevant Congressional Committees. With the PDD signed and the certified budget plan submitted, NASA requested the formal transfer of the program (contract and funding) from DoD. The contract transfer occurred in mid-May. The final transfer of DoD Landsat funding to NASA occurred in mid-July.

#### **TAKE THE BALL AND RUN**

NASA received the contract and immediately implemented the planned restructuring. The SBRC contract (ETM+ instrument) was separated from the MMAS contract and placed under direct NASA management reducing overhead costs and total program costs. Since this occurred later than planned, the near term program costs had increased.

A detailed review by NASA engineers of the spacecraft and instrument subsystems was initiated. Detailed design issues arose that were not known prior to budget certification. Design alternatives were explored to evaluate technical and program risks. As this review continued leading to the Preliminary Design Review additional program cost risks were identified.

A new Landsat Program Management Plan was written establishing the roles NASA, NOAA, and USGS. The Plan established the program requirements and funding commitments

to support the program. The plan, approved by all agencies in August 1994, established the basis for the agencies' budget submittals for FY96.

**CONCLUSION: STABILIZED AND RECOVERING**

The decision to proceed with the Landsat-7 Program was recognition by NSTC of the critical national priority of the program. The situation required a rapid and credible response; long periods for study were not available. Through exhaustive efforts by officials at GSFC and NASA Headquarters in the limited time available, NASA developed an option that met key requirements to preserve data continuity, minimize risk of a data gap, fulfill the data policy goals of Public Law 102-555, and reduce the total program cost. This formed the basis for the recommendation from NSTC and resulted in the Presidential Decision Directive.

The program has stabilized with Congressional support indicated by the FY95 Appropriation. The new Landsat Program Management has been established as evidenced by the Landsat Program Management Plan signed by the three partner agencies defining their roles and funding commitments. Needed design changes have been approved and the spacecraft is proceeding into the detailed design phase. The program has a launch commit date of December 1998 which minimizes risk of a data gap and ensures continued long term continuity of Landsat data into the next century.