# REMOTE SENSING TECHNOLOGY AND THE MEDIA

## Mediasat Described

At present, the news media obtain data from two commercial remote sensing systems, EOSAT —formerly the U.S. Government's Landsat system[10]—and SPOT, a French system.[11] Neither of these commercial systems was designed to meet the specific needs of the media and neither firm has plans to buy new satellites or alter its business structure to allow it to meet these needs. Consequently, media experts have begun to examine the feasibility and desirability of a "mediasat;" a spacecraft owned and operated—in whole or in part—by the news media and dedicated to news and information gathering activities [see box A and figures 3 and 4; box B and figure 5]. Although individual conceptions of a "mediasat" vary, as it is most often described, a mediasat would differ from the current commercial systems in three important ways:

1. *Spatial Resolution:* Spatial resolution of 5 meters or less [see box C] is often identified as the principal performance requirement for a mediasat.[12] By comparison, the TM and the MSS sensors on EOSAT's satellite yield 30 and 80 meter resolution, respectively. The French SPOT system provides 10 meter panchromatic as well as *20* meter multispectral imagery. At present, neither SPOT nor EOSAT has plans to fly sensors capable of approaching the 5 meter resolution sought by the media.[13]

Box A.—A **Remote Sensing Satellite System**

**A remote sensing satellite system consists of four major components, each of which is critical to producing useful data:**

1. ***The Spacecraft. Sensors, and Transmitters The spacecraft*** **provides a stabilized platform and power for the sensors and their optics, the receiving and transmitting antennas, and the associated electronics necessary to control the spacecraft and to deliver data to Earth. Some remote sensing *spacecraft may also carry* tape recorders to store data until the spacecraft is within sight of a receiving station.**
2. **The *Receiving Station and Other Communications Components:* A ground station may receive data in digital form directly from the satellite as it passes overhead, or, if the satellite is not in a position to communicate with the ground station, through a system equivalent to NASA's 3-satellite Tracking and Data Relay Satellite System (TDRSS).* In the latter case, data are passed from the remote sensing satellite to a communication satellite in geosynchronous orbit and then retransmitted to a ground facility. From the ground facility, the data are then passed directly to a processing laboratory.**
3. ***The Data Processing Facilities: Before* the raw data can be converted into photographic images or computer tapes capable of being analyzed by the end user, they must be processed to remove geometric and other distortions inevitably introduced by the sensors. For the purposes of newsgathering, high-speed mainframe computers maybe required to process the data from current spacecraft.**
4. ***Interpretation of the Data: After the* raw data are processed and converted to computer tapes or photographs, they must be interpreted. Part of the interpretation process may invoke merging or integrating other data either directly on the computer tape, or comparing such data with photographs. At this stage, computer analysis could be performed by micro-or mini-computer. A variety of advanced techniques (see box G) are available to turn remotely sensed data into new products for different users.**

*Only one TDRSS satellite is currently in orbit.

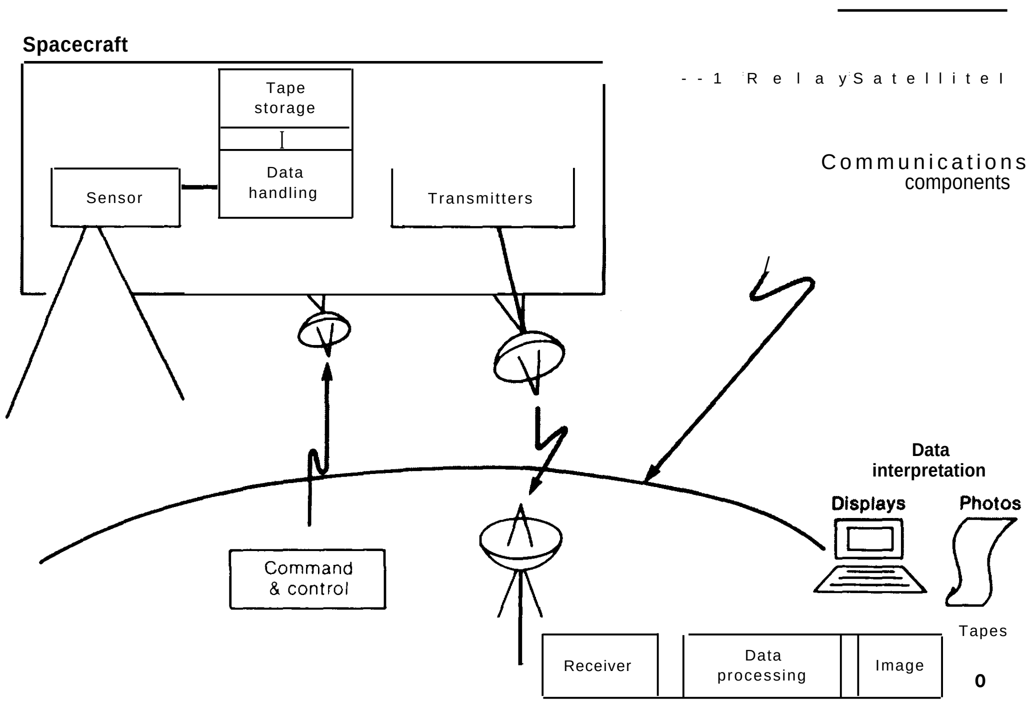
[10] For a history of the U.S. Landsat system and the details of its somewhat stormy transfer to the private sector, see: U.S. Congress, Office of Technology Assessment, *Remote Sensing and the Private Sector: Issues for Discussion—A Technical Memorandum*, OTA-TM-ISC-20 (Washington, DC: U.S. Government Printing Office, March 1984); National Research Council Space Applications Board, *Remote Sensing of the Earth From Space: A Program in Crisis* (Washington, DC: National Academy Press, 1985).

[11] The French Government controls the SPOT satellite and a private French company, Spot Image, S. A., and its American subsidiary, Spot Image, Corp., market the data.

[12] At the workshop it was clear that the media's desire for sensors allowing a resolution of 5 meters or less is not based on experience or research. The exact *number* is flexible and could be *more* accurately stated as "that degree of resolution which is better than either the SPOT or EOSAT systems but which is still affordable. "

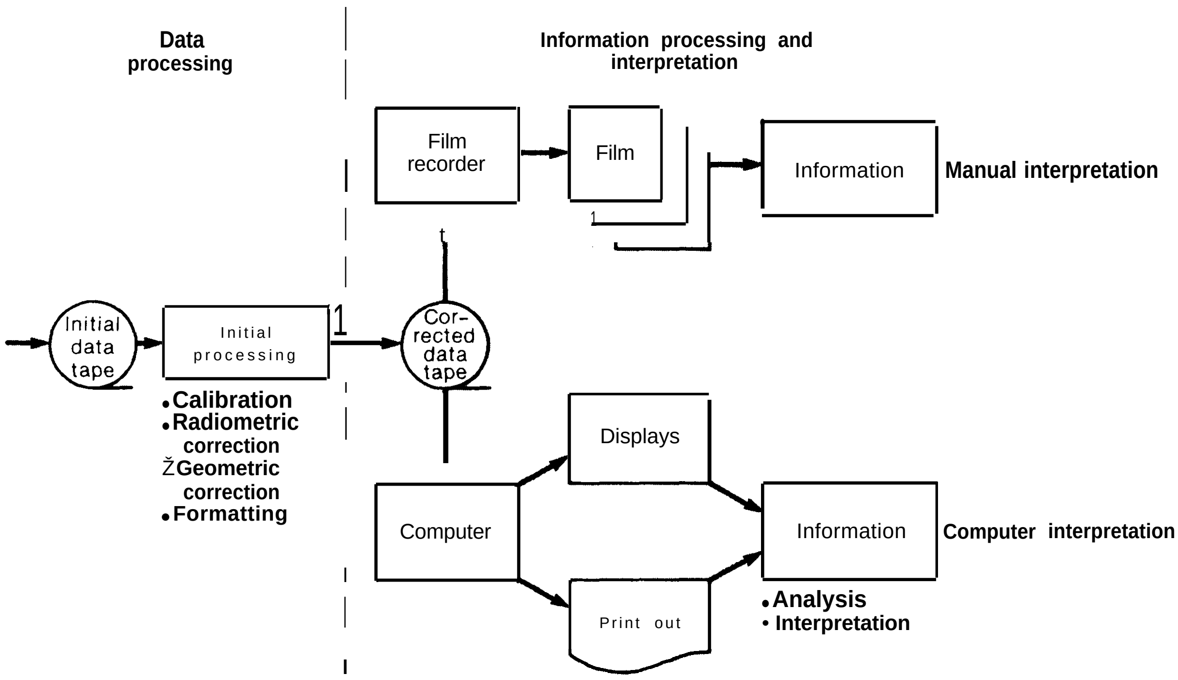
[13] It is important t. note the relationship between resolution and the width of coverage (swath width). Had the French chosen a 20 km by 20 km swath width instead of their current 60 km by 60 km coverage, they would have had a resolution of 3.3 meters, assuming the same number of minimum picture elements (pixels) in their sen-

**Figure 3.—A Remote Sensing System**



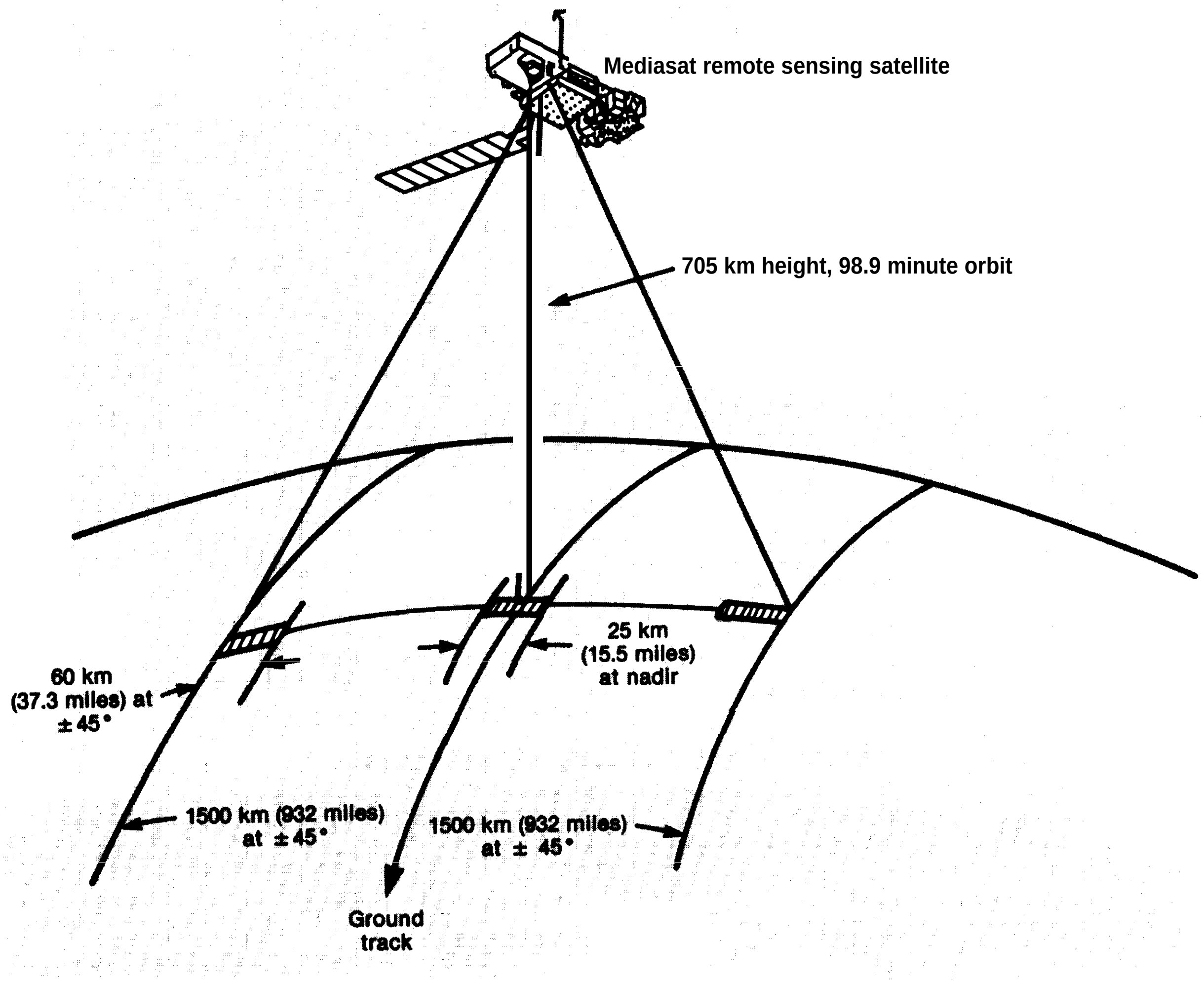

SOURCE Hughes, Santa Barbara Research Center

**Figure 4.— Data Processing and Interpretation**




SOURCE Office of Technology Assessment, 1987

Figure 5.—Polar Orbit Provides Global Coverage




SOURCE: Hughes, Santa Barbara Research Center

2. Timely Global *Coverage:* To be most effective, a mediasat would have to deliver news in a matter of hours from anywhere on the globe [see box D and figures 6-8]. Neither the satellites nor the business structures of EOSAT and SPOT are designed to produce imagery that quickly. Such timeliness would require new ground processing techniques and delivery methods and at least two satellites and supporting communication facilities to ensure that the media would have the opportunity to image every spot on Earth at least once a day.

3. *Media Control Over System and Products:* EOSAT and SPOT, although commercial systems, receive substantial financial support and guidance from their sponsoring governments and rely on the cooperation of those countries that maintain ground stations (see the following section, *National Security and Foreign Policy).* As a result, issues such as

*continued* from *page* **8**

**sor** array. Reducing swath width, however, would have greatly increased the time it takes to obtain global coverage with one satellite. It would also have reduced the synoptic view desired for many other uses of the data.

**Box** B.—Why **Remote Sensing Can Be Useful for Newsgathering**

From the technical standpoint, remote sensing from **space** provides **data** users with several key features:

- **ability to view remote, difficult, or denied terrain;**
- **view unaffected by political boundaries;**
- **synoptic view of large portions of Earth's surface;**
- **the possibility of near real-time data recovery;**
- **signals suitable for digital storage and subsequent computer manipulation into news-ready imagery;**
- **repetitive coverage over comparable viewing conditions;**
- **selected combinations of spectral bands for identifying and analyzing surface features.**

**In addition, data from space provide the following advantages:**

- ***Convenient Historical Record, Stored on Magnetic Media and Photographs:* Each image establishes a baseline that is of critical importance in recognizing the inevitable environmental and other changes that occur over time.**
- ***Tool for Inventory and Assessment:* Satellite images could be used whenever a major natural or technological disaster strikes an area and massive breakdowns of communication, transportation, public safety, and health facilities, prevent the use of normal means of inventory and assessment.**
- ***Predictive Tool:* Properly interpreted imagery can be used to predict the onset of natural and technological disasters.**
- ***Planning and Management Tool Imagery* can be used for a variety of planning and management purposes.**

**SOURCE:** Office of Technology Assessment, 1987.

limitations on sensor resolution and the release of sensitive data can be strongly influenced by government policy. A successful U.S. mediasat would have to eliminate such government intervention to ensure the degree of independence the media now enjoy in their other news gathering activities.

## The Media and the Uncertain Value of Satellite Imagery

During the course of the OTA workshop, it became clear that with the exception of certain trade publications and the magazine Aviation *Week and Space Technology*, the media's experience with satellite imagery—excluding weather satellite imagery-has been extremely limited (table 1). As a result, the media—especially the major television networks—have no clear idea of the type of imagery they want, how much they might need, or how much they are willing to pay. In short, the value of satellite imagery to the media is, at present, uncertain and is likely to remain so until experience and a more robust remote sensing market combine to define a stable market for these data. '4

Fundamental to this issue of uncertainty are questions concerning the type and quality of data needed by the media. Several of the media representatives at the OTA workshop brought examples of how SPOT and EOSAT data have been used in recent news broadcasts. After viewing several such news stories, one workshop participant commented that,

> The pictures themselves are unremarkable . . . most of these pictures are essentially illustrations of a story that you have to make up.

This comment goes to the heart of the media's problem—does it need images that the viewer can identify and interpret, or is there value in images that, although not identifiable by the viewer, hold important information when interpreted by an expert? One panelist noted,

> It is important to distinguish between information that has to be interpreted and . . . material the viewers at **home . . .** could draw their own conclusions from. There is obviously much more value in material that does not require interpretation.

[14] It is interesting to note, however, that the media's use of remote sensing imagery has increased substantially since the launch of the higher resolution SPOT satellite, This suggests that at even higher resolutions, such as 5 meters, there could be another substantial increase in the demand for satellite imagery.

### Box C.—Spatial Resolution and Spectral Resolution

**Spatial resolution refers to the ability of an optical device, such as the sensor of a remote sensing spacecraft, to separate objects of a given size. An instrument of high resolving power can separate two small objects very close together, or resolve the image of relatively small features on a larger object. For example, a spatial resolution of 1 meter (approximately 39 inches) could allow a viewer to distinguish between an automobile and a bus, but such resolution might not allow one to distinguish between an automobile and a pickup truck.**

**The best resolution available on images formed by civilian remote sensing satellites is the lo-meter resolution offered by the sensors and optical systems on the French SPOT satellite. * Such resolution allows one to see individual buildings and streets in a city landscape. It also permits one to pick out semi-trailer trucks on the streets or ships at a dock. It would generally not make it possible for the viewer to distinguish between the image of two semi-trailer trucks parked side by side and a building of similar dimensions, because the images of the two trucks would merge.**

**Overall resolution is limited by the resolving power of the sensor's individual picture elements. The minimum picture element, or pixel, of SPOT data, for example, corresponds to 10 meters (approximately 33 feet) on the ground. No amount of simple magnification of the remotely-sensed image will improve the resolution beyond this minimum pixel size. For an object with dimensions less than 10 meters, the sensor will effectively spread out the light emanating from such an object so that it is impossible to determine the position of the object within the 10 meter pixel. Structural details of the object will also be spread out in a similar manner.**

**However, knowledge of the general terrain, the detailed characteristics of particular objects, and experience in photointerpretation, can vastly improve an interpreter's ability to understand the details of an image. In addition, sophisticated and costly computer processing can improve on the theoretical resolution of an image by as much as a factor of 2.****

**Although the *spatial resolution* of a sensor provides a general guide to its ability to "see" objects on the ground, photointerpreters are also concerned with *spectral resolution. Since* all objects reflect light differently, an object's color or its contrast with the background environment can also be used to distinguish it. For example, the Great Wall of China is wide enough to be detected on Landsat TM images (resolution of 30 meters, or 98 feet). However, because the wall is nearly the same color as the surrounding countryside, it is extremely difficult to pick out in certain Landsat spectral bands. On the other hand, it is often possible to see a bridge or roadway of less than 30 meters wide when their contrast with the surrounding water or earth is extremely high. In effect, the bridge or road tends to "fill" each pixel with its reflected light, and because there are many such pixels spread out in a line across the scene, the eye links them together. Because objects that appear to have similar color characteristics as seen by the naked eye reflect light somewhat differently in different parts of the spectrum, it is often possible to distinguish objects on the image by subtracting the different color bands from one another. In this way, a field of corn can be distinguished from a field of soybeans, even though the sensors are incapable of resolving individual plants.**

* Early in their program, France considered building a system of higher resolution that could be used by both civilian and military data users. However, because of high costs and other priorities for research and development funds, it deferred such a program,

**See John A. Adams, "Counting the Weapons," IEEE *Spectrum,* July 1986, pp. 46-56, for a general discussion of spectral and spatial resolution.

## Box D.—The Challenge of Timely Global Coverage

The Landsat satellite travels in a near-polar orbit at a distance of 706 kilometers and circles the Earth every 98.9 minutes. The SPOT satellite flies in a similar orbit, 832 kilometers above Earth, with an orbital period of 101.5 minutes. Because Earth is spinning, as a satellite travels from pole to pole, it flies over a different part of Earth on each orbit. Each of the two Landsat spacecraft, for example, passes over the same portion of Earth at the Equator once every 16 days. (Near the poles, the "footprint" of its sensors overlap in successive orbital passes, covering the same portion of Earth in as few as 8 days. ) SPOT repeats its orbit only once every 26 days. However, because the SPOT sensors can be pointed to the side (off-nadir), their ability to sense a particular area on Earth in successive passes is substantially increased. The SPOT sensors can revisit a site 7 days out of 26. The ability to point its sensors also allows the SPOT satellite to take quasi-stereo images.

For the purposes of a mediasat capable of providing daily coverage of the Earth, it is necessary to have several identical satellites with pointable sensors to ensure that one is always in position to see the area of interest.

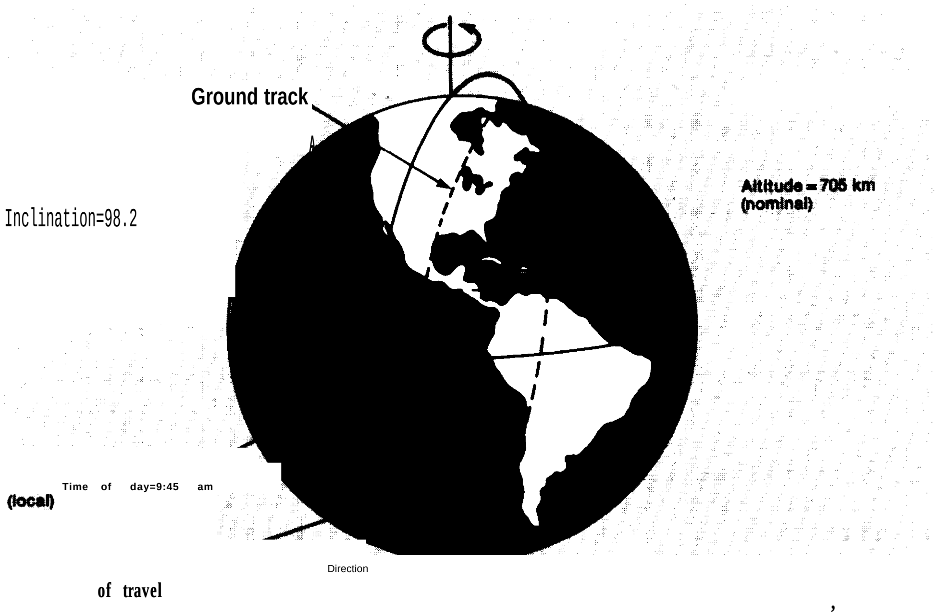
Delivering the data collected to Earth for processing is an important part of the overall process of land remote sensing. Because the satellite orbits the Earth, for some part of every orbit it will not be within "sight" of national ground stations. A satellite system must have one or more of the following capabilities:

1. tape recorders to store data until they can be played back as the satellite passes over a ground station,
2. space-to-space communications such as NASA's Tracking and Data Relay Satellites (TDRSS) to pass the information around the globe and then to Earth, or
3. ground stations in many foreign countries to ensure that data collected over other countries are eventually passed back to national territory.

None of these alternatives is without difficulty: high-capacity space-rated tape recorders have a high failure rate, historically, and are still not regarded as reliable; TDRSS cannot yet provide worldwide coverage (the second of three critical satellites was destroyed along with the Shuttle Challenger in January 1986), it is expensive to use, and commercial users currently receive very low priority; finally, receiving data from foreign ground stations can be slow and subject to political interference.

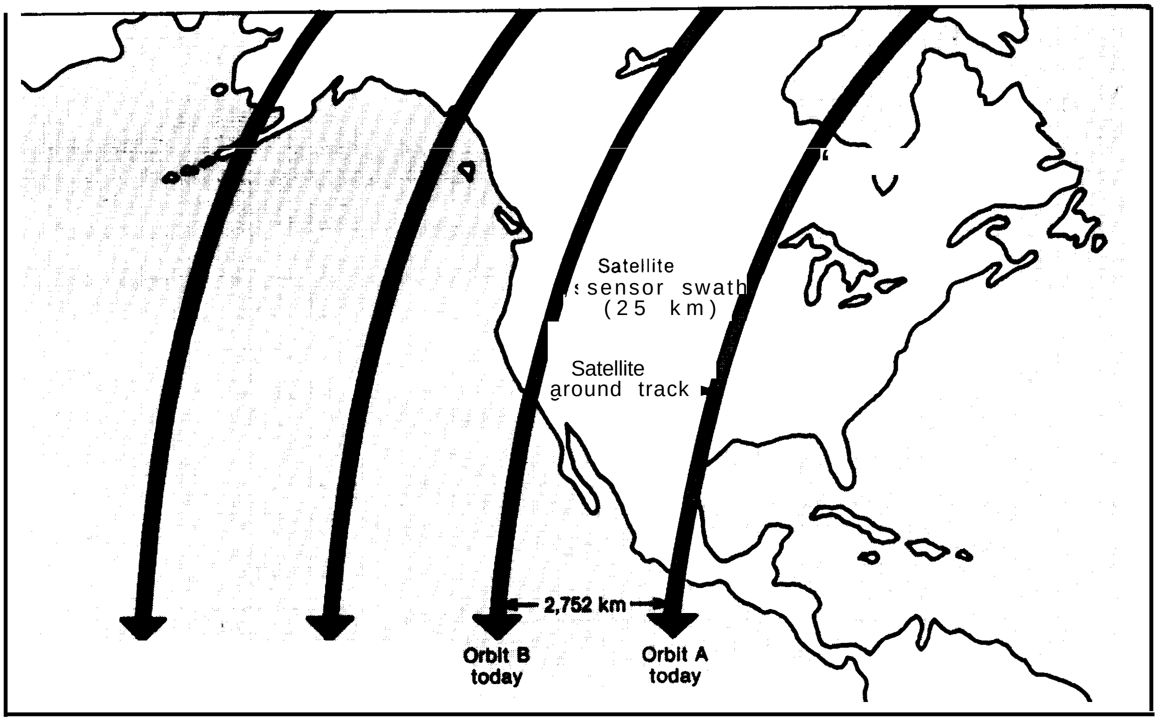
One of the most substantial impediments to timely delivery of imagery is the effects of clouds. On any one day, substantial portions of the Earth's surface are covered by clouds. Some areas can be obscured for weeks or even months at a time. Other areas are difficult to see even in "clear" weather as a result of smog or other obscuring atmospheric problems.

Figure 6.—The Orbital Path of Remote Sensing Satellite Is Sun Synchronous



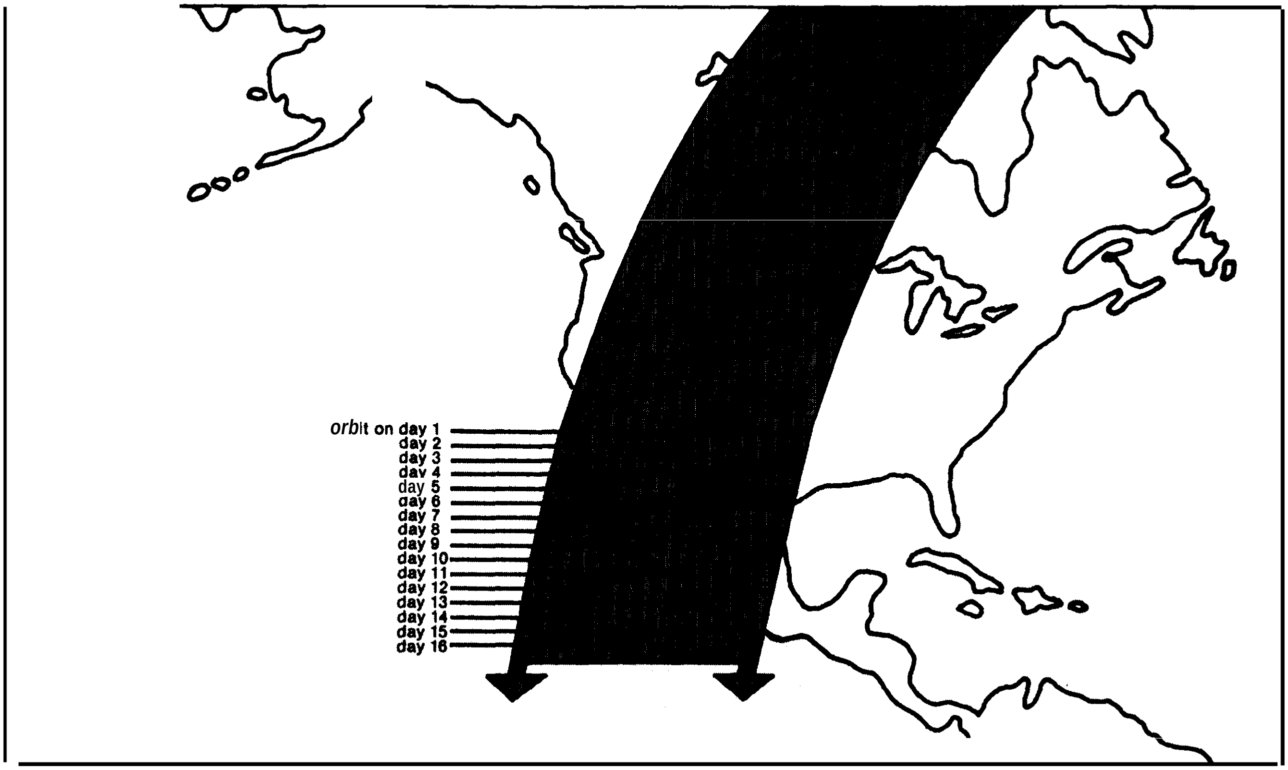

SOURCE: National Oceanic and Atmospheric Administration

Figure 7.—The Earth Revolves 2,752 km to the East (at the equator) Between Passes




SOURCE: National Oceanic and Atmospheric Administration

### Figure 8.—Adjacent Swaths (moving westward) Are Imaged 7 Days Apart




SOURCE: National Oceanic and Atmospheric Administration

### Table 1.—Some Recent Uses of Remotely Sensed Images by the Press[a]

| | |
|---|---|
| ***Television news*** | |
| Date | Event |
| April 1985 | Iran/Iraq border area—ABC. |
| Janauary 1986 | Libyan military airfield and SA-5 sites—ABC. |
| February 1986 | Naval facility at Murmansk-ABC. |
| April 1986 | Chernobyl nuclear plant—all networks. |
| July 1986 | New York City harbor—ABC. |
| July 1986 | Soviet nuclear testing facility at Semipalatinsk some 1800 miles southeast of Moscow—ABC, CBS, CNN. |
| August 1986 | Soviet shuttle facility at Tyuratam in central USSR—ABC. |
| October 1986 | Soviet Submarine base at Gremikha—Swedish television. |
| January 1987 | Iran/Iraq war—ABC. |
| April 1987 | Soviet radar facility near Krasnoyarsk–ABC. |
| ***Newspapers, magazines*** | |
| March 1986 | Libyan SA-5 sites and military bases—New *York Post* |
| April, May 1986 | Chernobyl nuclear plant—many newspapers, magazines |
| September 1986 | U.S.S.R. Kola Peninsula—Jane's Defense Weekly |
| October 1986 | Soviet cosmodromes at Plesetsk and Baikonur—National *Geographic.* |
| March 1987 | Soviet Navy base at Murmansk and Soviet Air Force base at Severomorsk —Aviation *Week and Space Technology.* [b] |
| March 1987 | Pakistani nuclear processing facility—London *Sunday Observer* |

[a]These citations are representative only The news media have put remote sensing data to many other uses
[b]*Aviation Week and Space* Technology pioneered the use of remotely sensed images from space Since 1974, the journal has published more than 22 major news stories based on remotely sensed images

SOURCE Office of Technology Assessment, 1987

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Other panelists generally agreed with this comment and emphasized that material requiring interpretation is similar to a "source story;" that is, a story based on inside or expert information but lacking images to allow the viewer to draw his or her own conclusions. Although useful in the print media, "source stories" have a more limited value in television news where the viewer expects the picture to tell the story [see box E]. [15]

[15] One panelist felt that the attention given to the issue of "source stories" was unwarranted. He maintained, "Those of us who have lived through the technological developments that have affected the media over the last ten or twenty years would never attempt to neatly categorize the potential uses of remote sensing. Experience tells us that every time a significant technological advance has been made, its early planned uses either became secondary or were lost in the huge quantity of additional applications that developed once experience had been gained. Remote sending will simply open up a variety of options to illustrate all sorts of stories in different ways and in different media. "

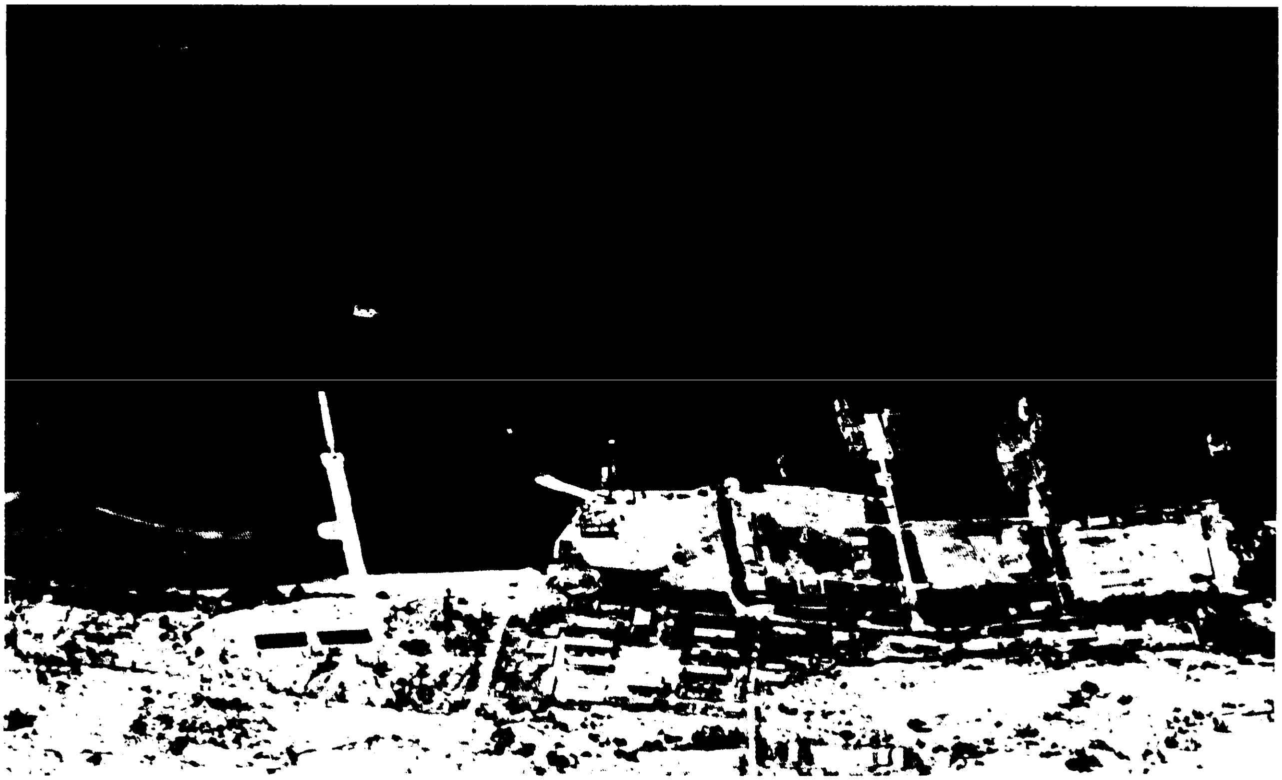
One panelist commented that the media "clearly had a lot of homework to do, " but that this learning process could proceed in stages. First, he suggested that the media should gain as much experience as possible working with current satellite images and within current government policies, This would allow the media to define the kinds of news stories that would gain from "eye in space" graphics every day. Second, the news media should test the ability of SPOT, EOSAT, or some other source of data to meet their needs. Third, examine the attitudes of readers and viewers toward the use of these new graphic displays to reach some conclusions regarding the comparative values of high- and low-resolution data. Finally, when they had gained sufficient experience regarding both the value of current imagery and the cost and future demand for high-resolution

**Box E.—Remotely Sensed Data and News Presentation**

**Remote sensing will open up a variety of options to illustrate stories in different ways and in different media. In particular, the news media will likely use satellite images to provide background information for stories and to illustrate the story directly. To elucidate this difference, imagine using images gathered from space to support a story that a country is amassing aircraft and other materiel on its border, possibly in preparation for invading its neighbor. Three broad levels of resolution capacity lead to different categories of stories:**

1. ***Story Requiring Extensive Analysis of the Image:*** **If the news media had access to images of 30 meter resolution, they could run a story showing a somewhat grainy image of runways and an amorphous mass of bright spots that, in the opinion of an expert photointerpreter, represent a buildup of aircraft. By carefully examining the images, the photointerpreter might be able to offer some judgments about the categories of aircraft and other objects reflected in the image. In such a case, however, the images convey little or no information to the untutored viewer, because from the image alone, he or she can make no independent confirmation of the expert's judgment.**
2. ***Mixed Story:*** **At 10 meter resolution, the image of the runway would appear much sharper and might even reveal navigation markings. In addition, large aircraft, such as cargo planes, would be readily identifiable as aircraft to the lay viewer, once the newscaster had drawn the viewer's attention to them. Smaller aircraft, such as fighters, would still appear as amorphous shapes to the uniformed observer. To be understood by the viewer, such an image would still require the analytical judgment of a photointerpreter.**
3. ***Story Allowing the Viewers To Draw Their Own Conclusions About the Images:*** **If, however, a mediasat existed with a resolution of much better than 5 meter, the evening newscast might be able to show a variety of aircraft on the runway, and perhaps even large objects being unloaded from cargo planes. In such a case, the image itself might carry most of the story, because viewers would be able to recognize that it contained many aircraft of different sizes and could draw their own conclusions about the country's intentions, especially as the media's audience becomes more sophisticated about viewing imagery from space.**

**In all three cases, photos or drawings of the various types of aircraft exist, and these could be shown on a split screen, with a news reporter or expert analyst pointing to relevant details.**



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imagery, the media could then make an informed judgment regarding the practicality of pursuing the mediasat concept.

The media's difficulty in assessing the value of satellite imagery is reminiscent of problems encountered by scientists in the 1970s when they first began to experiment with the Landsat data. Many experts believed then that with a little experience and a little government support, remote sensing could become a thriving commercial industry. It is instructive to note that, after nearly 15 years of experimentation, the overall market for remotely sensed data is still weak. This is true even for applications such as minerals exploration, forestry, and agriculture, where the history of experimentation demonstrates that remote sensing from space is cost effective compared to other means of gathering similar information.[16]

[16]See: *Remote Sensing and the Private Sector: Issues for Discussion*, op. cit., ch. 4, for a discussion of the development of the market for remotely sensed data.

## Alternatives for the Media

The media have at least two choices should they decide to increase the use of satellite imagery in their news coverage:

1. they could continue to use the images provided by the current commercial systems; or
2. they could fly their own satellite or **a** sensor on a host satellite.

Although these choices are not mutually exclusive they vary drastically in cost and complexity.

### Use of EOSAT and SPOT Images

**Several panelists bluntly stated their belief that the concept of a media-owned satellite system was** "just not economical" today, and that, "The best way to go is to get the [EOSATs and SPOTs] of the world to supply the data that the media need. " Although certainly the simplest and most economical path for the media to follow, the current com-

Photo redit US. Department of Defense

**Cam** Ranh Bay, Vietnam airfield. This photo, taken from an aircraft, was released Feb. 9, 1987, by the Department of Defense to refute Soviet and Vietnamese denials of the existence of Soviet forward-deployment bases in Vietnam. Shown in this image are Soviet TU-95 Bear aircraft, TU-16 Badgers, and Mig-23 Flogger aircraft. Photo resolution estimated to be about 1 meter.

mercial systems cannot provide timely access to data, assured access to data, and high resolution [see box F].

The workshop discussed two aspects of the timeliness issue: 1) the problem of getting the data from the satellite to the media user; and 2) the need for the human resources to interpret the data.[17] On the subject of timely access to data, one panelist pointed out that neither SPOT nor EOSAT is designed to meet the particular needs of the news media. The Landsat system, now operated by EOSAT, had been a government-designed research system that was never expected to-deliver data rapidly. "If you call today and ask for a scene from last year, EOSAT may be able to get it to you within a week if it's already been processed, " the panelist commented, but "if it's unprocessed it takes 4 to 5 weeks." The panelist pointed out that EOSAT had been able to provide the Chernobyl images in 24 hours only because it was lucky enough to have a satellite in position and it had been willing to suspend all its other activities. Most

[17] Both of these problems were illustrated by one newsman's experience in trying to obtain and use the satellite images of Chernobyl. He recalled: "I remember working the phones all day trying to get the Chernobyl images and finally at three in the afternoon they arrived and everyone was excited and we looked at the images and said, 'what the hell are we looking at?' So I called up EarthSat, the image processing company, and 1 said, 'Hey, can you send somebody down and help us interpret this stuff?' He said, 'Well, we can do it next *week*. You know they're used to dealing with geologists. I said, 'Next week? I'll send a helicopter this afternoon. ' "

**Box F.—The Status of Land Remote Sensing in the United States**

**The value of viewing Earth from space to provide crucial resource and environmental information on the atmosphere, oceans, and land masses was recognized early in this Nation's development of space technology. Two years after the National Aeronautics and Space Act of 1958 was signed, the United States received its first images from space, taken by the polar-orbiting weather satellite called the Television and Infrared Observation Satellite (TIROS).**

**Today the TIROS satellites, and their geostationary cousins, the Geostationary Orbiting Environmental Satellites (GOES) continually monitor weather systems within their field of view. Originally developed by NASA, both systems have been operated by the National Oceanic and Atmospheric Administration (NOAA) since 1970.**

**NASA designed and built the Landsat system in the early 1970s. Landsat 1 (originally called the Earth Resources Technology Satellite) was launched in 1972, followed by Landsat 2 and 3 in 1975 and 1978. All three satellites carried a multispectral scanner (MSS) capable of a spatial resolution of 80 meters in four spectral bands. The output of this sensor, transmitted to Earth, then corrected and stored, constitutes the primary archival library of Landsat data, extending back to 1972. Landsat 4, which NASA launched in 1982, carries both the MSS sensor and the more powerful Thematic Mapper (TM), capable of 30 meters resolution in 6 spectral bands, and 120 meters resolution in the near infrared. An identical Landsat 5 was launched in 1984, after Landsat 4 began to experience technical difficulties. Both satellites still provide both MSS and TM data, although Landsat 4 is limited in the amount of TM data it can transmit.**

**In the late 1970s, believing that the development of land remote sensing would fare better in the private sector, the Carter administration began to plan for the eventual transfer of the Landsat system to private ownership. The first stage in that process was to transfer the control over the system to NOAA.* Transfer to NOAA was completed in 1984. The Reagan Administration decided early in its tenure to hasten the process of transfer to the private sector. In January 1984, the Department of Commerce released a request for proposal (RFP) designed to solicit offers from private industry to own and operate the Landsat and any follow-on civilian remote sensing system.**

**Concurrently, Congress began to develop legislation to promote the transfer to private ownership and operation. The goal of both efforts was to assist the private sector in developing a self-sustaining, commercial land remote sensing enterprise. The Land Remote-Sensing Commercialization Act of 1984 was signed into law on July 17, 1984.**

**In October 1984, after examining a total of seven RFPs, the Department of Commerce accepted the proposal of EOSAT, a new company formed by RCA and Hughes Aircraft Corp. However, EOSAT and the Department of Commerce had difficulty reaching agreement on the terms of the subsidy. After considerable discussion, involving the Office of Management and Budget, the Department of Commerce, and Congress, the principals agreed on a government subsidy of $250 million for two follow-on Landsat satellites. The government agreed to launch Landsat 6 and 7 on the shuttle. In addition, the government also contracted with EOSAT (for a fee) to operate Landsat 4 and 5 and to market the resulting data. However, although Congress has generally supported the subsidy, the Reagan Administration has proved reluctant to complete the subsidy payments to EOSAT, believing that the private sector should shoulder a greater share of the burden of providing the data. Neither the 1987 nor the 1988 proposed budgets contained funding for the subsidy. EOSAT recently submitted a new proposal and a new budget to the Department of Commerce, which calls for a cost increase of nearly $50 million. In addition, space transportation costs will certainly be greater than earlier envisioned.**

**Some Members of Congress have expressed concern that the United States will lose its leadership in remote sensing from space if the civilian program is allowed to die for lack of funding. However, as of May 1, 1987, the issue of funding for Landsat 6 and 7 had not been resolved. The lack of a U.S. civilian system and the attendent value-added industry could seriously inhibit efforts by the U.S. media to make serious use of data taken from space for newsgathering and analysis.**

*For a more detailed account of the early steps taken to transfer the Landsat system, see U. S. Congress, OTA, *Remote Sensing and the Private Sector: Issues for Discussion-A Technical Memorandum, OTA-TM-ISC-20* (Washington, DC: U.S. Government Printing Office, March 1984), pp. 20-23.

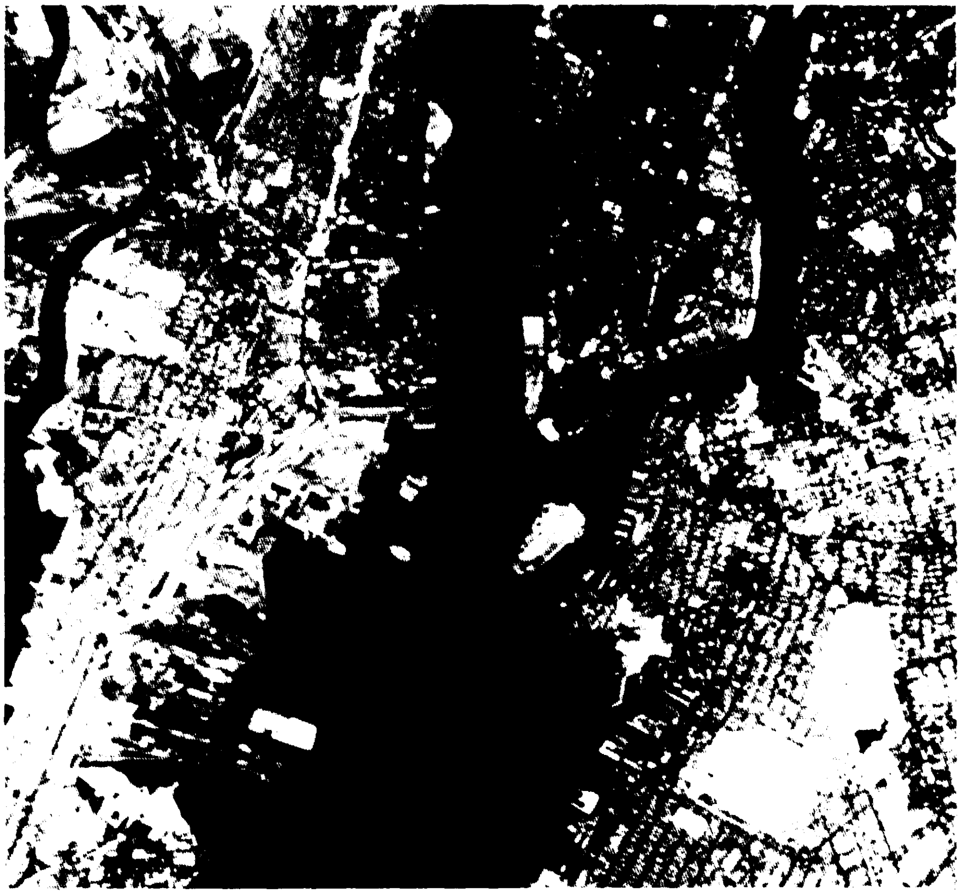


*Photo credit: Copyright © 1987 EOSAT. Provided courtesy of EOSAT*

New York City and Harbor, 1986. This image utilizes Thematic Mapper band 4 to differentiate urban and rural features of the City and Harbor. The detail of the 30 meter sensor allows clear definition of roadways, docks and ships in the Harbor, and the infrared illustrates parks and grassy areas in brighter shades, as opposed to the dark areas of urban New York downtown.

panelists felt that neither of these conditions would be repeated very often.[18]

Should the media decide that, even with their limitations, SPOT and EOSAT data were still valuable, they might negotiate special agreements for receiving raw data on a rapid basis and undertake the expense of doing their own ground processing and interpretation. One panelist estimated that a fully operational ground receiving and processing facility might cost on the order of **$10** million to $15 million. Even if the media invested in their own ground processing facilities, they would still not have solved the problems caused by the limited global coverage and resolution of current satellites.

There was considerable disagreement at the workshop regarding the press' ability to interpret satellite imagery correctly. One panelist stated that the media had done a poor job of covering Chernobyl and contributed to the general hysteria by announcing that two reactors were on fire instead of one. The panelist argued that any competent analyst looking at the images would have recognized that:

[18]It is useful to note that most of EOSAT's Thematic Mapper tapes have never even been processed to **image** format. The rate of data collection (100 scenes per day) far exceeds the rate of scene processing **(20 scenes per day).**

EOSAT's future business plans do include improvements that would allow a turn around time from acquisition to finished product of only one week. Although this is a substantial improvement, for most news stories, a delay of one week would probably be unacceptable.

*Photo credit* Copyright 1987 EOSAT Provided courtesy of EOSAT

Chernobyl, U. S. S. R., on Apr. 29, 1986. The first image collected by satellite of the nuclear reactor is illustrated using band 7 of the Thematic Mapper. The reactor facility (circled) and surrounding agricultural areas are clearly illustrated and defined, and the still-burning reactor can be identified by a bright pixel—whose digital evaluation helped the United States determine the correct status of the reactor during the incident. Evaluation of infrared and thermal imagery of the reactor cooling pond also confirmed U.S.S.R. reports of plant shutdown and startup.

> . . . nuclear powerplants must have cooling ponds and effluents and no one looked at the imagery to say, "where is the effluent for the second reactor?"

Another panelist countered that it was one thing to say that:

> . . . any idiot knows that a nuclear reactor has an effluent pond, but what makes the problem hard is that you don't know which idiot to hire. If you're going to do lots of stories about nuclear reactors you hire people who know that nuclear reactors have effluent ponds. If, on the other hand, you are going to have a lot of stories about forest degradation you need to have people who know a lot about forests.

It was clear from the workshop discussion that if the media intend to use satellite imagery extensively they must solve the interpretation problem. This would mean either hiring photointerpreters —much as they now hire meteorologists—or relying on outside contractors (the so-called "value--added" industry) to turn the raw satellite data into newsworthy information. At present, the value--added industry is small and, like the commercial remote sensing companies, is not organized to respond to the needs of the news media. But, as one panelist pointed out, a news organization's most important asset is its credibility. Most panelists thought that the industry would be able to solve the interpretation problem once it had more experience with the technology.

Assuming the media could arrange to receive most data in a timely fashion and arrange for their interpretation, it might still be difficult to get assured access to politically sensitive data. Government support and control of the two existing commercial systems and the operational independence of the foreign ground stations create at least the possibility that governments could, on occasion, prevent politically sensitive data from reaching the media.

Both EOSAT and SPOT rely on foreign ground stations to collect data when the satellite cannot communicate with earth stations in the United States or France. The owners of the Earth stations pay an annual fee which allows them to collect the data from their region and sell it. The Earth station owners pay royalties on sales of the regional data. In the case of the Landsat Earth stations, the Memorandum of Understanding (MOU) is between the U.S. Government (with NOAA [the National Oceanic and Atmospheric Administration] as the U.S. representative) and the foreign government. Under the U.S. MOUs, foreign ground stations are supposed to provide nondiscriminatory access to all purchasers. In practice, however, the ground stations can refuse to sell data, delay the shipment of data, or deny that data even exist .[19] The only recourse after a ground station's refusal to honor the "nondiscriminatory access" clause of their contract is for the U.S. Government to terminate service to that ground station. This would mean a loss of the annual fee ($600,000 in the case of the U.S. MOUs) and, given the unreliability of on-board tape recorders and the uncertain status of NASA's Tracking and Data Relay Satellite System (TDRSS),[20] the potential loss of a great deal of data.

All of these problems notwithstanding, perhaps the biggest difficulty the media have with current systems is their limited resolution. Neither EOSAT nor SPOT has plans to provide the very high resolution sought by the news media. Several panelists pointed out that focusing on high resolution was, in some respects, misleading—the question is not what is the best technology the media can buy, but rather, what does the media need? If the media's primary use of satellites is to show a typhoon in Bangladesh, a volcano in Hawaii, or an oilspill off the coast of England, then there is no reason to incur the costs associated with very high resolution. If, on the other hand, the media wish to count tanks in East Germany or show the effects of street rioting in South Africa, then the news media would probably want the highest resolution they could afford.[21]

Other panelists suggested that the media had yet to make innovative use of the available low-resolution imagery. "Spatial resolution is only part of the game, " cautioned one panelist, "We are only beginning to understand spectral [see box C] differences. " Because different objects reflect light differently, certain objects are identifiable even though they are smaller than the spatial resolution of the sensor. For example, a road or a river might be less than 10 meters wide and yet still appear on an image of ***30*** meter resolution if the road or river reflected light in a substantially different manner than the surrounding area. One panelist recalled:

> When we looked at the high spatial resolution data from Chernobyl it was hard to tell how many reactors were damaged, but on the spectral data the fact that one reactor was burning popped out immediately.

Another panelist cautioned that, although spectral differences were important, when EOSAT brought back images of China, the Great Wall was not visible in certain spectral bands because the Wall was made from, and therefore reflected light in the same wavelength as, the surrounding rock. Panelists agreed that each system has its own specific strengths and limitations, and that to date, the media had not used the available images creatively.

[19]When a buyer asks EOSAT for data that were collected by a foreign ground station, EOSAT must request that the foreign ground station sell EOSAT those data. One panelist pointed out that certain countries were notorious for refusing to release data. For example, the panelist said that it was very difficult to purchase data from India, particularly if they contained scenes of the India/Pakistan border.

[20]It is important to note that, as a result of the cost, complexity, and limited access to TDRSS, EOSAT does not have plans to include TDRSS communication packages on its next two satellites.

[21]It is interesting to note that of all the remote sensing images used in *Aviation Week and Space Technology*— including many mages of the Soviet Union and of Soviet technology—the images that generated the most sustained interest were those of the Mount St. Helens explosion. Several panelists predicted that the media would find a large demand for satellite images of major natural events.

### Implement Mediasat Concept

If the media should decide that satellite imagery was very valuable, but that the operating procedures of the current commercial systems were too rigid or that access to high-quality data could not be assured, then the media might be driven to develop their own system. The exact nature of this system would be the product of two important considerations. First, the media would have to decide on the appropriate level of technology, which would include, but not be limited to, a choice of the resolution of the sensors to be used (e.g., 5 meter, 3 meter, etc. ) Second, the media would have to decide how much they could afford. These two considerations are very closely related.

If a mediasat is to become a reality, the news media must be able to assess the value of both current satellite images and successive technical improvements. As a result of the media's inexperience using satellite imagery, the uncertainties regarding the present market for data, and the lack of credible cost estimates for high-resolution imagery, deciding how good is "good enough" is a difficult task. During the workshop, several participants suggested that 5 meter resolution might meet the needs of the news media. Yet, when one panelist illustrated the effect of increased resolution by showing 10 meter and 5 meter images of Washington, D. C., several panelists were noticeably unimpressed. "You say that 5 meter resolution will produce good pictures, " commented one participant, "1 still say it's a source story [see box E]. You show that picture and you will have people saying: 'What is this? You're telling me this is Washington? It looked to me like New York. ' " Another panelist, familiar with satellite imagery countered that, "You ought to take a look at this under a magnifying glass. There is a great deal more information in this 5 m picture than in the 10 m picture. " This interaction highlighted one of the basic dilemmas facing the news media—how to assess the value of increased information when that information can be transmitted to the consumer only imperfectly .22

If cost were not a consideration, the media might want the highest resolution pictures they could get, but costs rise dramatically as resolution increases. This results, in part, from the fact that the data rate[23] rises as the inverse square of the resolution. This means that, assuming the satellite is covering the same area, as resolution improves from 10 meters to 5 meters, the amount of data that must be collected, transmitted, and processed increases by a factor of 4. Similarly, improving the resolution to 2.5 meters would increase the original 10 meter data rate by a factor of 16. This led some panelists to conclude that data rate could influence the ground segment costs for the mediasat system more than any other single element .24

Panelists cautioned that although increased data rate was a "problem, " it was possible to identify some potential solutions. Data rate, it was argued, could be greatly diminished by using the satellites to take pictures of specific, pre-identified events (e.g., an oil tanker beached on the California coast, a hijacked airplane sitting on the tarmac in Tripoli), rather than taking pictures of the entire Earth and then sifting through the raw data in the hopes of finding "news. " In addition, data compression techniques could be used to greatly diminish the data flow problem .25

[22]Following th workshop, OTA received a letter from Earl S. Merrit, Vice President of EarthSat, a corporation specializing in the "value-added" business of imagery processing. The letter, which called into question the value of even very high resolution imagery, stated:

> [T]he satell~te-acquired Information will always be source" material even If the resolution was I meter due to [ the need for expert interpretation ]. This fact would seem to provide a ' damper" on the network use of such source material since the number of "experts" in interpretation is limited. Thus, I see the networks eventually using the "source" to highlight a story but not to provide the bottom line. . . human-intelligence gathering "journalism' will continue to dominate news gathering.

23Data rate refers t. the flow of information about the picture "seen" by the satellite's sensor. At higher resolutions the pictures are more detailed and therefore contain more information. In order to transmit more information about the same scene in the same time period, the data rate must increase.

[24]EOSAT's 30 meter TM sensor has a data rate of *85* million bits per second (MBPS), The data rate for a 5 meter mediasat with the same swath width would be *3,060* MBPS, By narrowing the swath width (therby reducing the coverage) and using data compression techniques, the data rate could be reduced to the 100 to **150** Mbps range. Even this much reduced data rate would require more sophisticated data systems in both the sensor and the satellite than we now possess.

[25]Data compression is a process that reduces greatly the amount of data which must be transmitted from the spacecraft to the ground station. Although there are many data compression techniques, most operate by reducing or eliminating the redundancy that is inherent in raw data, Where the quality of the resulting image is to be judged by subjective criterion such as visual appearance—as may be the case with media images—the transmitted data need only be sufficient to construct a facsimile of the orginal data. Under these circumstances—and depending on the amount of redundancy in the data–compression ratios of more than a factor of 2 could be achieved.

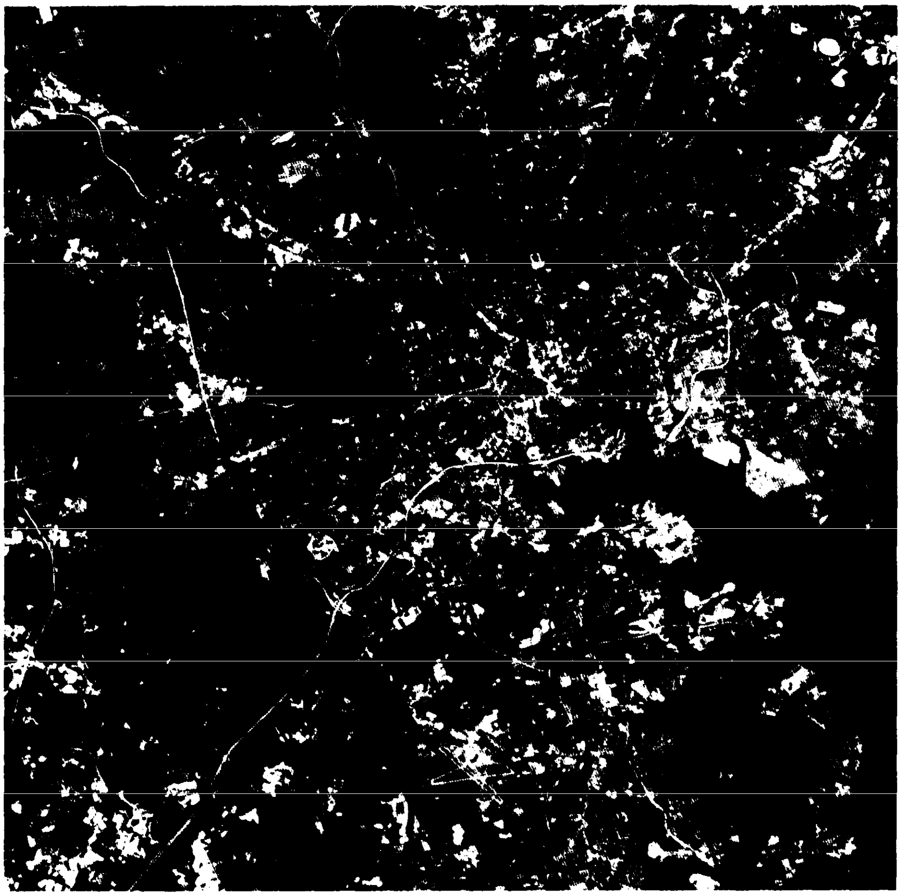


*Photo credit Copyright © 1987 CNES Provided courtesy of SPOT Image Corp,* Reston, *VA*

Baltimore city and Baltimore harbor. Ten meter panchromatic image taken by the SPOT satellite.

Increased data flow was not the only problem identified by the panelists. One technical expert noted that while a 5 meter sensor could be flown on a "host" satellite or a relatively inexpensive satellite bus, at very high resolutions, spacecraft stability becomes a problem. Therefore, flying a sensor of 3 meter resolution or better would require a more sophisticated and much more expensive satellite. The combined effect of increased data rate, more complex and expensive sensor systems, and more rigorous demands on the satellite bus, could mean that even slight increases in resolution could have a dramatic effect on costs. One panelist estimated that an entire mediasat system (i.e., sensors, satellite, communication links, ground processing and distribution) with a 5 meter resolution might be obtained for as little as $215 million for a one-satellite system. **A comparable** 1 meter system, on the other hand, might require a multi-billion dollar investment. (See app. A, table **A-3, for alternative cost estimates. )**

**Throughout this discussion, panelists made clear that cost, not the availability of advanced technology, was the limiting factor in achieving high-resolution images. As one panelist put it, "3 meters is do-able, just bring your checkbook. "**

**One panelist argued that, in light of the financial resources of the television networks, the cost issue was being exaggerated. He pointed out that ABC "paid $309 million just to buy the rights to the '88 Olympics and will spend another $300 million to produce it. " Others felt that the value of** such comparisons is doubtful, because such large expenditures are made only in light of a carefully

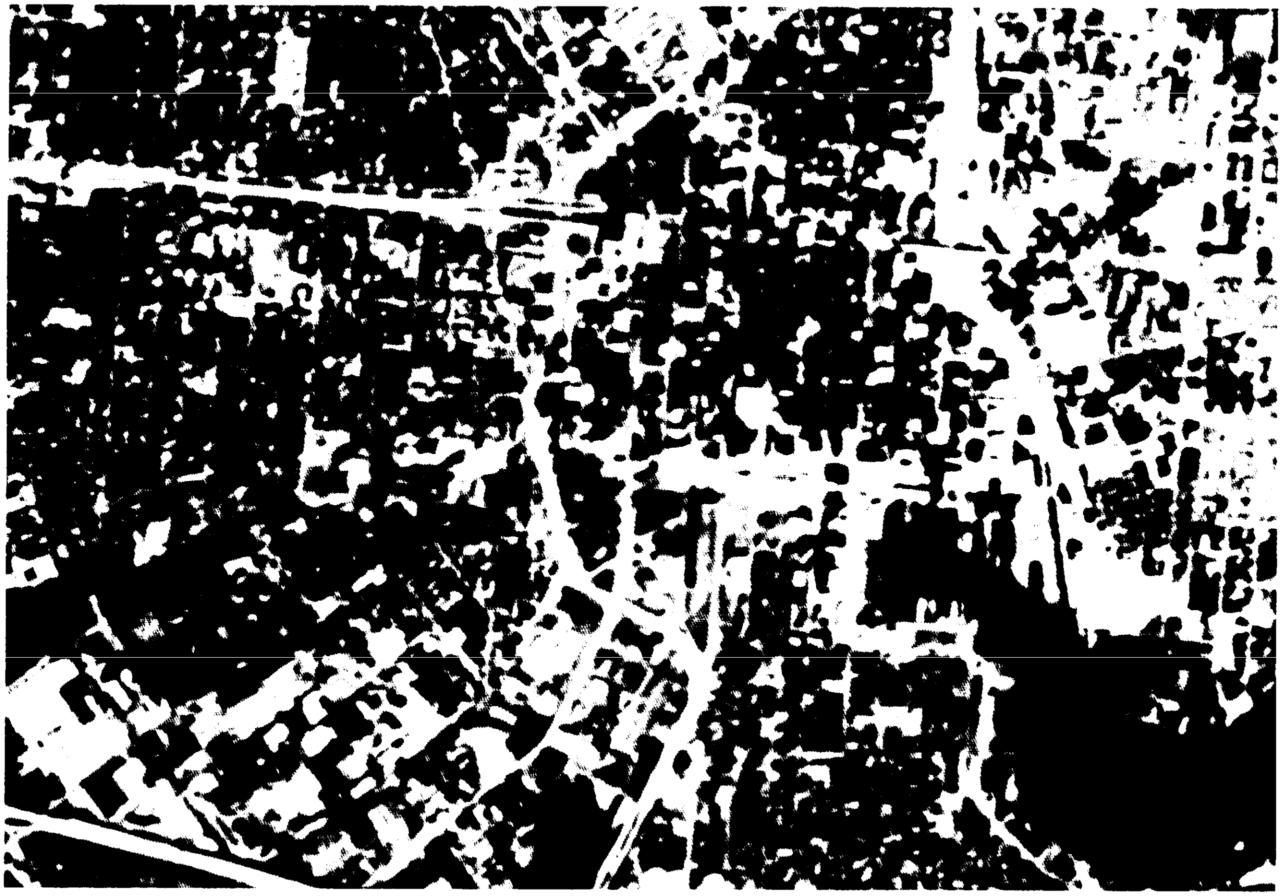


Photo credit Copyright 1987 CNES Provided courtesy of SPOT Image Corp.. Reston, VA

Baltimore harbor area. Ten meter panchromatic image taken by the SPOT satellite.

calculated expectation that they will increase revenues at least as much.

The hard question, then, is "what *value would satellite images add to current news stories ?*" or, more to the point, *"what additional news stories and revenue could be generated by the use of satellite imagery?"* Obviously, satellite images would not be useful in all of any given day's news stories. Even assuming that ABC, CBS, NBC, and CNN use one satellite image per evening every day of the year, it is difficult to imagine how revenues could be generated to offset the cost of a $215 million to $470 million satellite system. If all four major networks used 1 satellite image every night, this would mean that about 1,500 images would be used every year, If one assumes that a mediasat would cost approximately $215 million to $470 million to build and launch, and another $50 million to $75 million to operate over a period of 5 years ($10 million to $15 million per year), then the average cost over the 5-year period would be $53 million to $1.09 million per year, Putting these admittedly speculative figures together, one concludes that each satellite image would have to be worth about $35,000 to $73,000 to the networks (see app. A for cost assumptions). Given that the average network news story is produced for less than $5,000, it is hard to imagine how the networks could justify this additional expenditure.[26]

*'Several panelists felt that OTA cost and demand projections were too pessimistic. One panelist stated:

> I particularly want to challenge the assertion that each network would not use images every day It reminds me only too well of the similar statements made in the wake of the first Telstar feeds to the United States from Europe and the confident predictions that there was no possibility that such programming would ever become commonplace because the Intercontinental link would always be too costly.

There are ways that the news media might try to reduce the cost of a mediasat system: they could form a consortium—either domestic or international—to share the cost, they could resell data to other users to subsidize their own use,[27] or, they might wait until technical advances reduce the cost of sensors, satellites, and launch vehicles.[28] At present, it is unknown whether any of these measures, or combinations of measures, would reduce the cost of a mediasat to the point where it would be economically viable today. Two points, should however, be kept in mind: first, it is impossible to estimate accurately the future demand for remotely sensed data; and second, simple calculations that compare the cost of a mediasat and potential mediasat revenues could be misleading. It is difficult to describe the value of a press "exclusive," and, as banks have recently demonstrated with their electronic teller machines, there is value in providing new services.[29]

Some panelists expressed the view that interested governments should combine their resources in an INTELSAT-like organization to ensure continued, cost-effective access to remote sensing data. Inherent in this concept is the belief that a mediasat would not be economically viable even if funded by a consortium of news agencies. In one panelist's opinion:

> The money received from Chernobyl would fit in a thin wallet. When will there be another such accident located in a place where we cannot fly in with a good hand-held camera? An international governmental consortium is the best way to ensure the continued availability of remote sensing data, It could begin to form when EOSAT and SPOT get tired of throwing money at the problem, when Congress takes Gramm-Rudman-Hollings seriously, and when someone sees other countries as a set of partners eager to help share costs, and more importantly, help promote the use of [remote sensing] systems.

Finally, it should be noted that some experts see "mediasat" as one aspect of a more profound transition of the news networks from the status of news providers to a much broader role in the information industry. As one panelist noted:

> It is my belief that the largest market for medisat data will not be the news divisions but rather the secondary markets. Media companies will sell the interpreted data to buyers around the world . . . and will change their structure to become huge value-added entities . . . The media [will never] be able to spend the amounts of money for a mediasat without aggressively opening new markets around the world.

Should the networks undergo the radical transformation foreseen by this panelist, the assumptions and conclusions of this technical memorandum would have to be similarly modified. The likelihood and prospects of such a transformation are beyond the scope of this technical memorandum. Box G and tables 2 and 3 provide information on many of the possible uses for remotely sensed data beyond newsgathering.

**Table 2.—Remote Sensing Data Needs of Foreign and Domestic Users**

- *Agriculture* (Federal, State, and private): specific sampling areas chosen according to the crop; time-dependent data related to crop calendars and the weather patterns
- *Forestry* (Federal, State, and private): specific sampling areas; twice per year at preselected dates
- Geology and *nonrenewable resources* (Federal, State, and private): wide variety of areas; seasonal data in addition to one-time sampling
- Civil *engineering and /and use* (State and private): populated areas; repeat data required over scale of months or years to determine trends of land use
- *Cartography* (Federal, State, and private): all areas; repeat data as needed to update maps
- ***Coastal** zone management* (Federal and State): monitoring of all coastlands at selected dates depending on local seasons
- *Pollution monitoring* (Federal and State): broad, selected areas; highly time-dependent needs both for routine monitoring and in response to emergencies
- *Newsgathering* (private): selected areas; highly time-dependent needs in response to fast breaking news stories

SOURCE: Office of Technology Assessment

[27] It is significant t. note that total remote sensing data sales between 1979 and 1984 only produced a little over $30 million. See: "Landsat Data Users Notes," No. 35, March 1986, p.7.

[28] Many of the technologies currently being investigated by the Strategic Defense Initiative Organization (i.e., inexpensive launch vehicles, satellites, and sensors) could make mediasat a reality.

[29] One panelist, noting that the fortunes of the major networks had been in decline recently, argued that a mediasat might be justified partly on the grounds that while a network might be able to operate a mediasat, its affiliates could not do so on their own. Therefore, a network might want to operate a mediasat because it could hold the network together, thereby preserving other revenues.

## Box G.—Remote Sensing and the Public Interest

**U.S. land and meteorological remote sensing systems have from the beginning been intended to serve the public interest, whether primarily for research, as in the case of the Landsat system, or for operational weather forecasting and severe weather warning, as** in the case of the meteorological satellite systems.

The Landsat system has demonstrated to a small but dedicated group of customers, both inside and outside the government, that satellite data can be highly effective in meeting their resource information **needs. Land remote sensing systems serve a wide variety of data users (table z), most of whom require satellite data of 10 to 100 meters resolution on time scales of weeks to months. However, the agricultural community and those who monitor the courses of natural and manmade disasters have need for data on a more timely basis.**

**It is clear from examining table 3 that the public interests and those of the media are often synonymous. Data from a mediasat could make an important contribution in warning of and assessing natural and manmade disasters, as well as in managing disaster recovery.**

**The value-added industry has developed a number of techniques for converting data to information that would serve the public good. Some of these would be of interest to the media:**

- **use of time lapse images to compare scenes over time;**
- **overlay of black and white imagery with spectral imagery to bring out features not visible in either;**
- **use of ground-based images to illustrate features** close-up; and
- **using stereo pairs to generate three-dimensional images from different perspectives.**

**As one expert on photointerpretation and remotely sensed imagery has pointed out:**

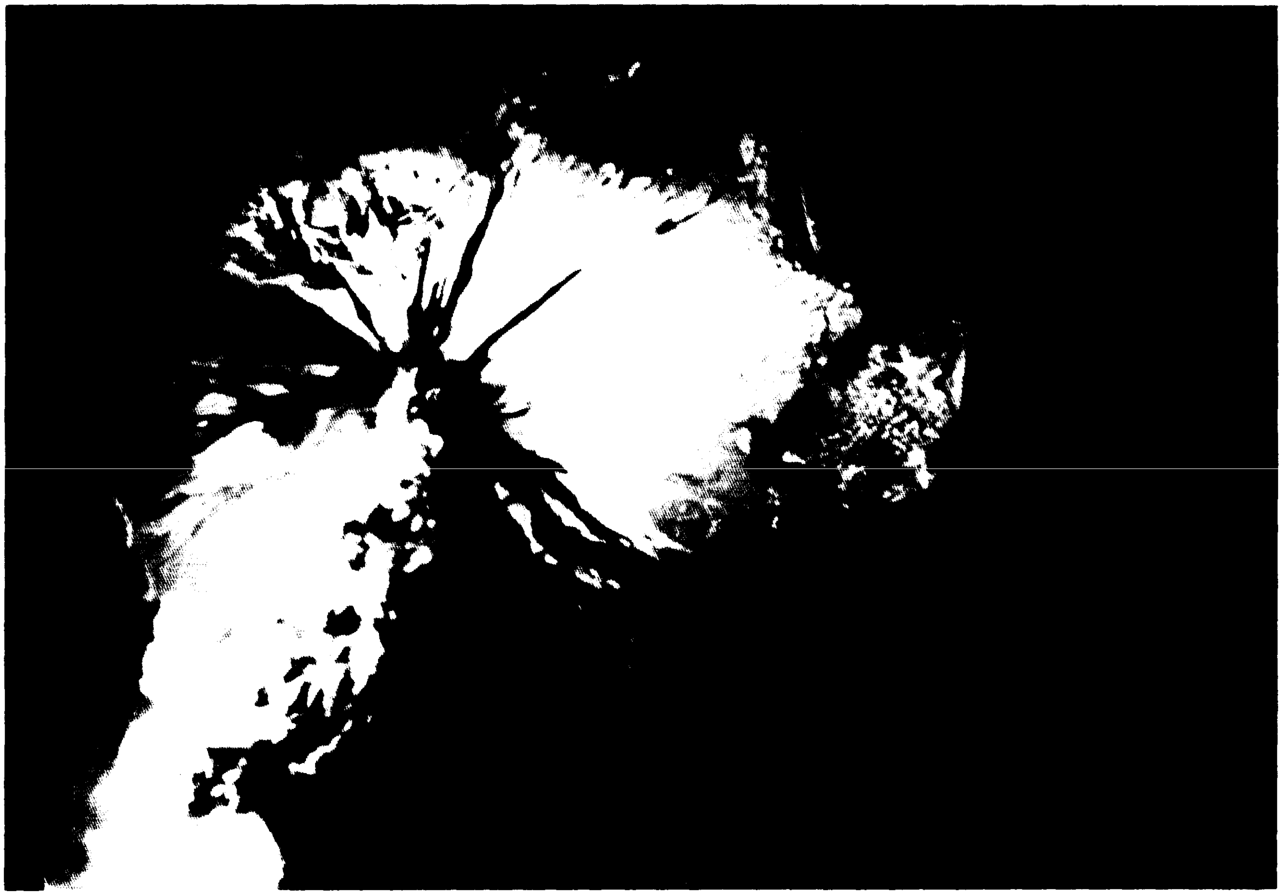
> . . . remote sensing technology, properly applied, could save countless lives and billions of dollars in property damage each year. Few outside the military and intelligence [communities] are aware of this resource. Fewer still know how to interpret that technology and even fewer know how and **when to apply it. Yet it is the same technology with which the United States monitors SALT and the Middle East Truce Agreement, observes and predicts crop yields in the Soviet Union, Australia, Canada, Argentina, and India, and assesses damage caused by such catastrophes as the Italian, Guatemalan, and Alaskan earthquakes.**
> **. . . If existing multisensory imagery had been analyzed, the plight of** $150,000,000 **in Ethiopia and other African countries could not only have been predicted, but actions taken before disaster struck. ***

● **Dino Brugioni,** *Air Force Magazine,* **October 1985.**

### Table 3.—Summary of Applications of Landsat Data in the Various Earth Resources Disciplines

| Agriculture forestry and range resources | Land use and mapping | Geology | Water resources | Oceanography and marine resources | Environment |
|---|---|---|---|---|---|
| Discrimination of vegetative types<br>Crop types<br>Timber types<br>Range vegetation<br>Measurement of crop acreage by species<br>Determination of range readiness and biomass<br>Determination of vegetation vigor<br>Determination of vegetation stress<br>Determination of soil conditions<br>Determination of soil associations<br>Assessment of grass and forest fire damage | Classification of land uses<br>Cartographic mapping and map updating<br>Categorization of land capability<br>Separation of urban and rural categories<br>Regional planning<br>Mapping of transportation networks<br>Mapping of land-water boundaries<br>Mapping of wetlands | 'Recognition of rock types<br>Mapping of major geologic units<br>Revising geologic maps<br>Delineation of unconsolidated rock and sods<br>Mapping igneous intrusions<br>Mapping recent volcanic surface deposits<br>Mapping land forms<br>Search for surface guides to mineralization<br>Determination of regional structures<br>Mapping linears (fractures) | Determination of water boundaries and surface water area and volume<br>Mapping of floods and flow plains<br>Determination of aerial extent of show and snow boundaries<br>Measurement of glacial features<br>Measurement of sediment and turbidity patterns<br>Determination of water depth<br>Delineation of irrigated fields<br>Inventory of lakes | Detection of living marine organisms<br>Determination of turbidity patterns and circulation<br>Mapping shoreline changes<br>Mapping of shoals and shallow areas<br>Mapping of ice for shipping<br>Study of eddies and waves | Monitoring surface mining and reclamation<br>Mapping and monitoring of water pollution<br>Detection of air pollution and its effects<br>Determination of effects of natural disasters<br>Monitoring environmental effects of man s activities (lake autrophication defoliation, etc.) |

SOURCE N M Short P D Lowman Jr and S C Freden *Mission to Earth Landsat Views the World* NASA Scientific and Technical Office 1976





Portion of Landsat 5 Thematic Mapper image showing Augustine Volcano, Alaska during eruption on Mar. 27, 1986. Band 4, in the near infrared, clearly defines snow/cloud area from surrounding vegetation and terrain, with 30 meter ground resolution.



The 120 meter thermal band on the Thematic Mapper displays the hot flow at the north end of the Augustine Volcano through the smoke and cloud cover. By combining the spectral bands of the Thematic Mapper, the clarity of 30 meter resolution is complemented by thermal information,