military operations in Beirut and the Persian Gulf, decisions were made to distribute information that had been held very tightly by intelligence officials in Washington. "It takes a commander in the field screaming for more information to get things to change," said Hagaman.

"Most of the imagery is declassified down to the level where it's just handled as 'secret,' " said Donald Latham, former Assistant Secretary of Defense for Command, Control, Communications, and Intelligence. "We can move imagery today, worldwide, with our communications systems. We've even got suitcase versions of these systems, where you can look at [an image] and do things with it—all with soft copy, without film."

It now takes only hours, said several sources, for a picture of a particular scene to get from the satellite to the military commander who ordered it. In the future, said Aldridge, field commanders may be able to look at a scene at the very moment that the satellite is photographing it.

These technical marvels have their price. "Data fusion systems are not cheap," commented Aldridge. According to the industry newspaper *Defense News*, the Army has spent somewhere between $840 million and $1 billion during the past decade on a single system, called the All Source Analysis System, that is designed to distribute information from various intelligence sources to Army commanders. Primarily because of problems with software, "it's 2 or 3 years, and a couple of hundred million dollars away," said Hagaman.

According to published reports, the White House has agreed to a demand by the Senate Intelligence Committee that it spend $6 billion on improving surveillance systems during the next 5 or 6 years. The FAS's Pike estimates that each KH-12 satellite costs between $1.5 and $2 billion, not including the cost of launch.

The irony of spending this quantity of money on spy satellites while cutting off funds for Landsat, the civilian earth resources monitoring satellite, was noted by Congressman Dave McCurdy (D–OK), a member of the House Intelligence Committee, which approves all secret reconnaissance projects. At a hearing on Landsat on 8 March, McCurdy complained that "the green eyeshade guys down in a basement [at the White House Office of Management and Budget] are running national space policy. If [Landsat] were a special access program, we wouldn't be up here worrying about funding." ■ DANIEL CHARLES

Daniel Charles is a free-lance journalist based in Washington, D.C.

DOD Lists Critical Technologies

The Department of Defense (DOD) has submitted to Congress a list of 22 technologies that it considers critical to the long-term superiority of U.S. weapons systems. In every area except one, the United States holds a lead over the Soviet Union, and in most cases the lead is substantial, according to the Pentagon's analysis. But among U.S. allies, technological leadership in some key areas has gone to Japan.

The list was prepared in response to legislation authored last year by Senator Jeff Bingaman (D–NM), who says he has grown increasingly frustrated because "technologies that seemed to be on everybody's list of truly critical technologies were severely underfunded in DOD [budget] requests." That experience, says Bingaman, "left a real question in my mind as to whether we had a very well prioritized science and technology program in the DOD."

Bingaman therefore attempted to force the Pentagon to consider its technological priorities by asking DOD, together with the Department of Energy, to list 20 technologies deemed especially critical for future weapons systems. (The Pentagon came back with a list of 22.) He also asked for an assessment of where the United States stands in relation to other countries in the development and use of these technologies.

The Pentagon's report* could prove important in budget deliberations on Capitol Hill. It has already been the focus of hearings, held on 17 March, by the Senate Armed Services Committee's defense industry and technology subcommittee, which Bingaman chairs.

The report indicates that the United States holds a clear world lead in technologies that have primarily military applications, such as sensitive radars and "stealth" technology. But in most areas that also have civilian applications, the United States is losing ground to allied countries.

In the area of microelectronic circuitry and the fabrication of microelectronics devices, for example, the report states that "if current trends continue, the United States can be expected to become dependent on Japanese suppliers of many key materials and production equipment by the year 2000." The same holds true for gallium arsenide semiconductors, a technology in which "Japan is the undisputed leader," fiber optics, and some areas of materials science.

As for the Soviet Union, the report indicates that the United States is technologically superior in all the key areas except for high-power microwave oscillators. In most cases, the Soviet Union's relative backwardness in state-of-the-art computing is a severe handicap. "In the USSR, software continues to be an area of serious deficiency," the report says, and "there is no evidence that the Eastern bloc has achieved any success in high-performance computing. . . . The Soviets lag the U.S. and can be expected to fall further behind due to a lack of capability in the underlying microcircuitry." These deficiencies affect Soviet capabilities in areas as diverse as robotics and fluid dynamics, the report says.

The report estimates that DOD will spend a total of about $2 billion this year on R&D involving 21 of the 22 key technologies it identified. (The budget for one technology—suppressing the radar signature of weapons systems—is classified.) In some areas, such as the development of sensitive radars and computer modeling, the Strategic Defense Initiative (SDI) provides the bulk of the funding. This led Bingaman to suggest that perhaps Congress should move some of the programs out of the SDI budget in order to protect them when the SDI request is cut back by Congress.

The critical technologies identified by the Pentagon are: microelectronic circuits and their fabrication; the preparation of gallium arsenide and other compound semiconductors; software producibility; parallel computer architectures; machine intelligence/robotics; simulation and modeling; integrated optics; fiber optics; sensitive radars; passive sensors; automatic target recognition; phased arrays; data fusion; signature control (stealth technologies); computational fluid dynamics; air-breathing propulsion; high-power microwaves; pulsed power; hypervelocity projectiles; high-temperature, high-strength, lightweight composite materials; superconductivity; and biotechnology materials and processing. ■ COLIN NORMAN

**The Department of Defense Critical Technologies Plan*, 15 March 1989.