Appendix C

COSPAS/SARSAT: A Brief Case Study

Description of the COSPAS/SARSAT System

COSPAS/SARSAT is an international cooperative program to demonstrate the use of satellite technology to detect and locate aircraft or vessels in distress. The United States, Canada, France, and the U.S.S.R. developed the system, based on a "Memorandum of Understanding" which was signed in 1979 and entered into effect in 1980. * Since that time five more countries—Norway, the United Kingdom, Sweden, Finland, and Bulgaria—have become participants. Brazil and Denmark are expected to join in the near future. There are four participating U.S. agencies: the National Oceanic and Atmospheric Administration (NOAA) administers the system; the Coast Guard and Air Force are referred to as "user agencies;" and the National Aeronautics and Space Administration (NASA) conducts technical evaluation and support. COSPAS is administered by the Soviet Merchant Marine (MORFLOT).

The acronym COSPAS refers to the Soviet component of the system (from the Russian for "Space System for the Search of Vessels in Distress"), SARSAT is the joint U. S .-Canadian-French component (from Search and Rescue Satellite-Aided Tracking). The project involves the use of multiple satellites to detect distress signals emitted on the ground by emergency transmitters aboard ships and aircraft in distress. The signals received by a satellite are relayed to a network of dedicated ground stations where the location of the emergency is determined by measuring the Doppler shift of the signal as received by the satellite. This information is then relayed to the appropriate search and rescue forces in the country nearest the emergency location.

The system thus consists of a number of separate but linked components:

- **Transmitters: Emergency Locator Transmitters** (ELTs) aboard aircraft in distress, and Emergency Position Indicating Radio Beacons (EPIRBs) aboard marine craft.
- **Satellites:** Detectors are mounted on U.S. NOAA and Soviet Cosmos satellites occupying medium-altitude, near-polar orbits to maximize coverage and detection sensitivity of the system.
- Local User Terminal (LUT): Dedicated ground stations within each participating country that receive satellite signals and perform initial processing.
- **Mission Control Center (MCC): Data are relayed by the LUTS to the MCC, which is responsible for system control within that country as well as for coordination with MCCS of other nations.**
- **Rescue Coordination Center (RCC):** The RCC is alerted by the MCC, and is responsible for coordinating the actions of local search and rescue forces.

Figure C-1 illustrates a COSPAS satellite. Figure C-2 depicts the various components of the COSPAS/SARSAT system and their interrelationships.

Within this general system, two experiments are being performed. The first is directed at aircraft and vessels equipped with commercially available emergency transmitters operating at 121.5 and 243 MHz. Signals emitted by these transmitters are relatively weak, and their frequency and modulation characteristics are not ideal for detection by spacecraft. The transmitters, however, are widely used and therefore offer the opportunity to test the concept in actual emergency situations.

The second experiment uses transmitters designed especially for satellite detection and operating at 406 MHz. These systems have been used successfully in meteorological data collection for many years, and in a number of SAR-type experiments. The 406 MHz transmitters have higher power and better frequency stability than current off-the-shelf emergency transmitters, and the frequency itself was designated at the

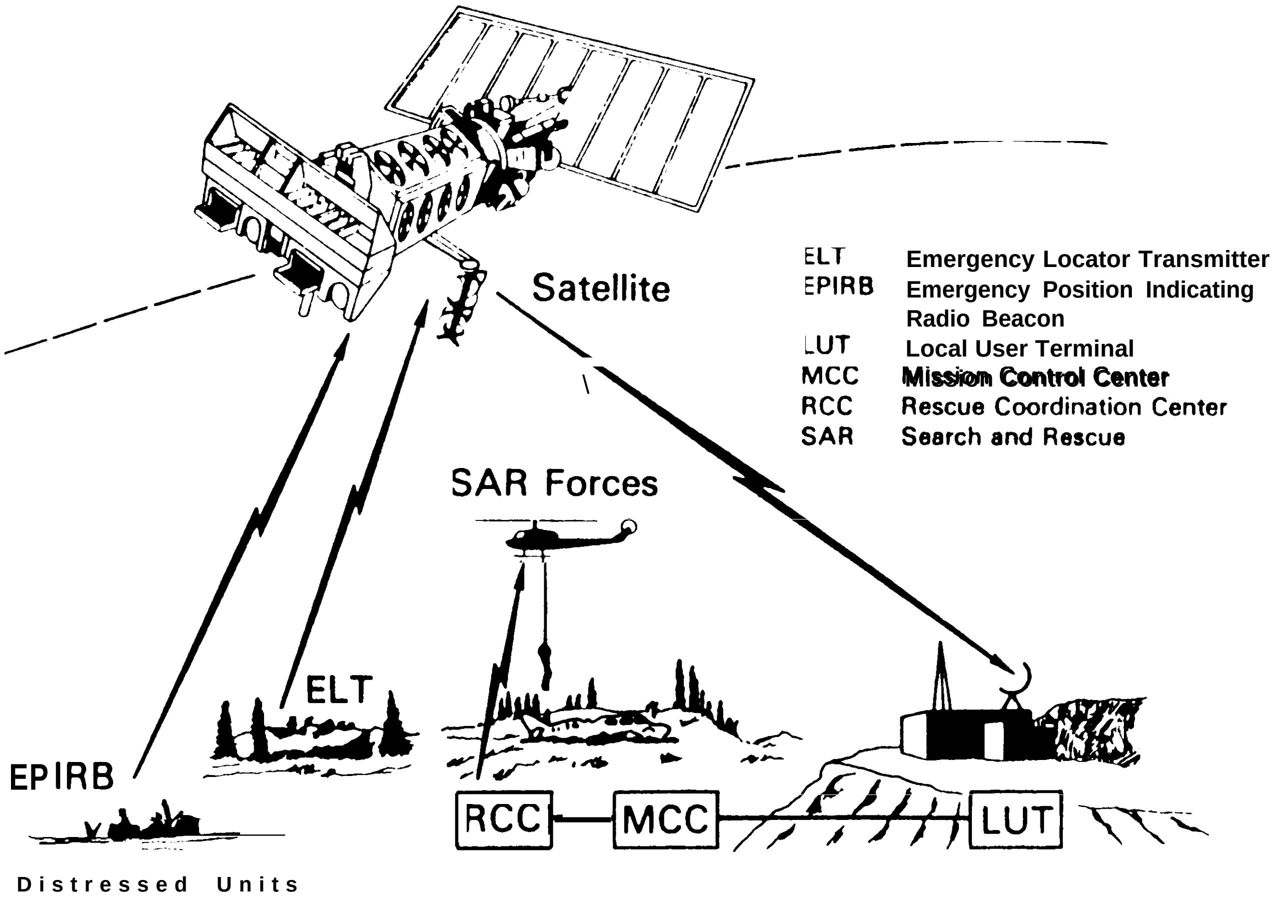
Figure C-1 .—Soviet COSPAS Satellite

Soviet COSPAS satellite, as displayed at 1985 Paris Air Show

SOURCE Charles P Vick, 1985

*The agencies that signed the Memorandum of Understanding were United States NASA, Canada Department of Communications (DOC); France Centre National d'Etudes Spatiales (CNES); and the Soviet Union Ministry of Merchant Marine (MORFLOT) A COSPAS SARSAT Coordinating Group (CSCG) was established to manage the joint efforts

Figure C-2.— Basic Operational Configuration of the COSPAS/SARSAT System Components



SOURCE NOAA

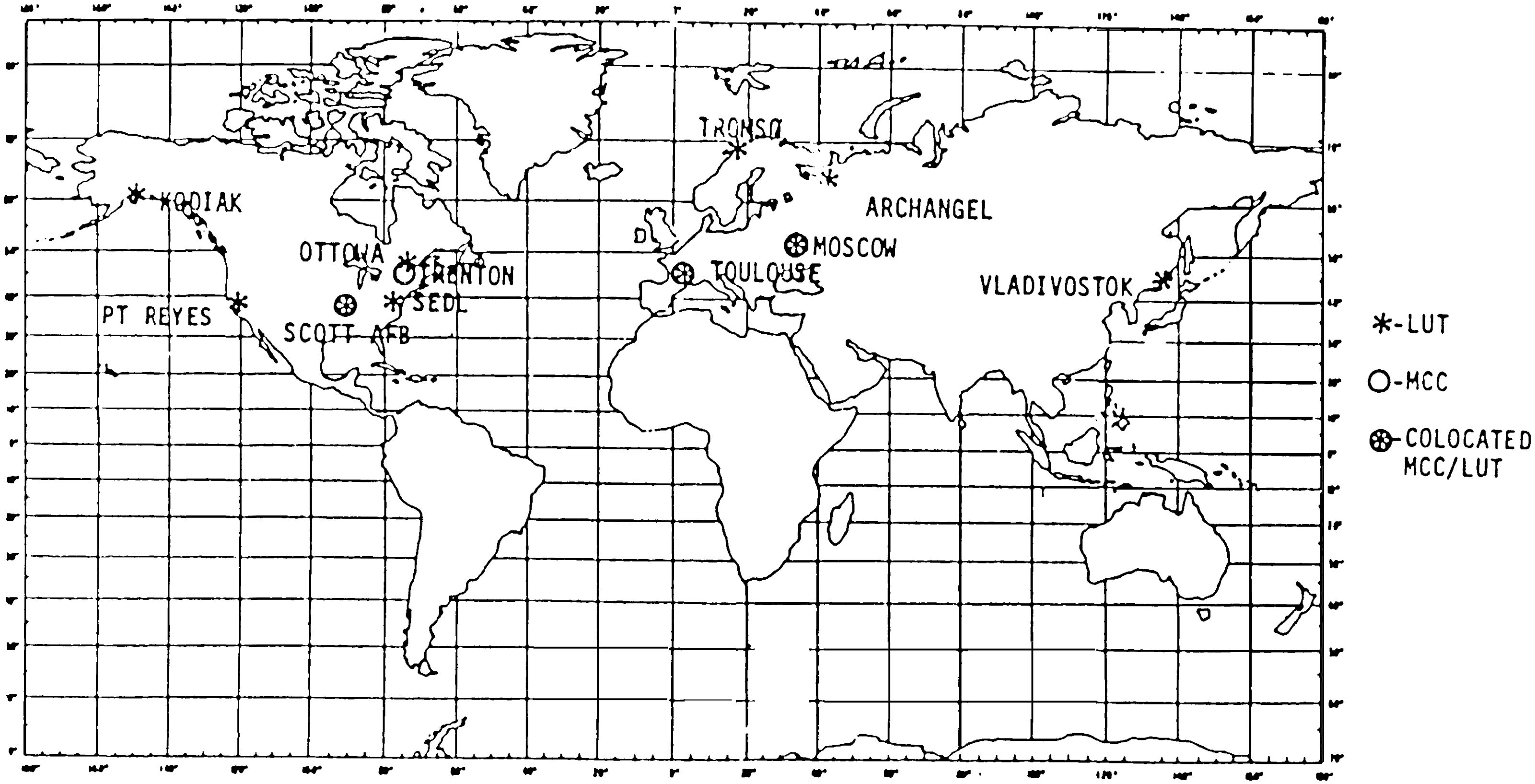
World Administrative Radio Conference (WARC) of 1979 for use in satellite-aided emergency communication worldwide.

Unlike the 121.5/243 units, these 406 MHz transmitters can include in their data message information on the type of aircraft or vessel, its identification and country of origin, the nature of the emergency or elapsed time since an accident, and even the location of the emergency. In addition, some of the signal processing can be performed by an onboard processor and either relayed to the LUT in real-time or stored for later transmission. This feature not only simplifies the ground operations but also eliminates the requirement for simultaneous visibility to the satellite of both the emergency signal source and the LUT while a signal is being relayed. As a result, full global coverage can be achieved with a smaller number of lower cost LUTS.

To accommodate both experiments simultaneously, two data systems and two coverage models are employed in COSPAS/SARSAT. A "repeater data system" relays received signals directly to the LUT for processing, while a "processed data system" is utilized to process and relay, as well as store and later transmit, the 406 MHz data. The first type of system permits regional (line-of-sight) coverage. The latter system provides a global coverage capability, since signals received when no LUT is in view can be stored until the satellite can transmit directly to an LUT.

The key to the effectiveness of the repeater system—especially in remote regions—is the number of LUTS. There are currently three of these stations in the United States, three in the U. S. S. R., and one each in Canada, France, Norway, and the United Kingdom. Each participating country has one MCC, with the

Figure C-3.—Through a Network of Satellite-to-Ground and Ground-to-Ground Communications Linkages, COSPAS/SARSAT Affords Coverage of the Entire Globe



U.S. MCC acting as the single point of contact for all SARSAT parties in coordinating system operations with the COSPAS MCC. Figure C-3 depicts the geographical layout of COSPAS/SARSAT ground components.

Demonstration and Evaluation

The first COSPAS satellite (Cosmos 1383) was placed in orbit in June 1982, followed in March 1983 by the first SARSAT satellite (NOAA-8) and a second Soviet satellite (Cosmos 1447). In June 1984 NOAA-8 prematurely failed; in the same month the Soviets added a third satellite, Cosmos 1574, to the system, NOAA-9, the newest U.S. addition, was placed in orbit in December 1984. Thus, the SARSAT system has relied heavily (and often exclusively) on Soviet satellites. The next four NOAA satellites will be equipped with SARSAT instruments, and two additional COSPAS satellites have already been built. The goal is to provide four-satellite coverage throughout the 1980s.

When system effectiveness had been adequately demonstrated, COSPAS/SARSAT began initial operational status; a new Memorandum of Understanding to that effect was signed by the participating nations in October 1984. This agreement establishes a commitment to provide operational services on the basis of the actual operating capability of the system through 1990. Authority for U.S. leadership in the program was transferred from NASA to NOAA at that time.

As a new initiative, the United States is now planning to put SARSAT equipment on future U.S. geostationary meteorological satellites. These satellites will provide instant alert capability for 406 MHz beacons in the Western hemisphere. The polar-orbiting NOAA satellites will continue to provide location of incidents and alert for 121.5 and 243 MHz beacons, as well as 406 MHz beacons not in the line of sight of the geostationary satellites.

Performance and Prospects

Thus far, the performance of the combined satellite/ground system has been effective. NASA officials report that "target" levels of locating accuracy have been achieved at both experimental wavelengths (i.e., 20 km at 121 MHz, and 2.5 km at 406 MHz), and sensitivity of reception is good. For example, even though the ELTs and EPIRBs transmit a signal no stronger than that of a garage-door opener, about 85 percent of the transmissions are detected on the first pass of the satellite.

Technical problems remain, but these generally have not stemmed from the COSPAS/SARSAT system itself. For example, illegal interference on the 406 MHz frequency (mostly in Europe) has been a continual problem, but strict enforcement is now reducing this interference. A 98 percent false alarm rate on the 121.5/243 MHz frequency—the result of faulty or damaged transmitters that operate intermittently without being turned on—has also been a major problem. Improved unit designs, however, are beginning to reduce false alarms. In the meantime, the strategy has been to wait until a signal is received on two successive passes and, if possible, to verify the information with Coast Guard, Civil Air Patrol, or other reports. As of April 1985, approximately 374 people have been saved from both aircraft and ships by rescue operations facilitated by the COSPAS/SARSAT system. Table C-1 shows a breakdown of rescues by country and category through October 17, 1984.

The COSPAS/SARSAT system has been successful because it consists of two separate projects joined because of their common objectives. SARSAT was originally a cooperative project involving the United States, Canada, and France. COSPAS reflects a Soviet interest to develop a system compatible with SARSAT, especially for use in the maritime fleet. The systems are not dependent on one another, yet they are mutually supportive in providing wider and more frequent coverage, and permitting a faster response time for emergencies. The coordination of spacecraft characteristics permits interoperability among the various satellites and ground stations, while coordinating launch dates and orbital parameters provides optimal coverage across time. The recent failure of NOAA-8 demonstrated the importance of the backup provided by satellites of other countries.

At the same time, security concerns seem to be minimized by the nature of the COSPAS/SARSAT operation. However sensitive the technology involved may

Table C-1.—Total Rescues to Oct. 17, 1984

	Incidents	Persons
United States:		
Aeronautical incidents	61	85
Maritime incidents	23	71
Canada:		
Aeronautical incidents	22	47
Maritime incidents	2	7
Europe:		
Aeronautical incidents	10	22
Maritime incidents	19	77
Total	137	312[a]

aTotal includes three hikers, not reflected In "incidents" column

SOURCE NOAA data.

be,[2] the fact that COSPAS and SARSAT are two separate systems has led to little, if any, direct interaction with the U.S.S.R. other than the communication between MCCs and the periodic planning meetings. Agreements have been made concerning broadcast frequencies, but no U.S. assistance has been provided, for example, in the development of non-U. S. ground stations, and no technology has been exchanged between the two systems.

While the COSPAS/SARSAT system boasts a significant number of rescues, it should be pointed out that none of those rescued have been Soviet or East bloc citizens. This is due to the fact that the Soviet Union does not routinely carry operational ELTs/EPIRBs on its own aircraft/ships at this time. By contrast, the United States alone has emergency locator transmitters on more than **200,000** civilian aircraft and 6,000 ships.

Regarding the cooperative interaction itself, however, participants report that there has been a "special spirit" in the project. Due largely to its humanitarian and multilateral nature, interaction between the SARSAT and COSPAS elements of the system has gone smoothly despite some ups and downs in launchings and funding, and despite negative events in U. S.-Soviet relations which have resulted in the termination of other space activities. For example, although the number of U.S. SARSAT satellites has fallen below the number planned–the U.S.S.R. has launched three satellites to the United States' two, and for a considerable period of time the system relied entirely on the Soviet satellites-cooperative activity has not appeared to suffer, even in light of the recent highly publicized debate in the United States over whether one or two (SARSAT-equipped) polar satellites should be funded.[3] Many observers have construed the COSPAS/SARSAT experience as an indication that U.S.-Soviet cooperation can be useful and viable in space activities with a practical purpose, equitable sharing of costs, and for the benefit of many people and countries.

[2] Technical areas of potential military sensitivity include such areas as information on signal frequencies and formats; satellite-mounted receivers, processors, and transmitters, ground-based data processing and communications capabilities; and spacecraft orbital ephemeris and general performance data

[3] See, for example, "U.S Will Negotiate With Soviets on Search and Rescue Satellite," *Aviation Week and Space Technology*, vol CXXI, *No 13* (Sept 24, 1984), p. 22

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