

Cospas-Sarsat: a quiet success story

Richard J H Barnes and Jennifer Clapp

This article will look at the origins of the Cospas-Sarsat international cooperative space program and its transition in the mid-1980s from a technical demonstration to an operational program. It will then attempt to identify some of the reasons for its success, with a view toward determining their applicability to other joint space applications projects.

Richard Barnes was Director of International Relations when he retired in 1990 after 29 years with NASA. He can be contacted at 1503 Dumbarton Rock Ct, NW, Washington, DC 20007, USA. Jennifer Clapp participated in the Cospas-Sarsat project from 1974 to 1988, first at NASA as Canadian and French Desk officer and Deputy Chief, International Planning and Programs, and then at NOAA's Satellite Service as Director, International Affairs Division.

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The ability of satellites to detect signals from an emergency beacon on a downed aircraft was first demonstrated in 1975 in Canada, a country whose vast forested and mountainous areas make it an obvious candidate for such a capability.¹ Early tests led to agreement among Canada, France and the USA – all of whom had strong interests in maritime as well as aircraft search and rescue – to carry out a systematic demonstration and evaluation. The space platform selected was the US polar orbiting weather satellite to which were added a transponder/repeater unit provided by Canada and a multifrequency processor provided by France. Line of sight signals detected from beacons on downed aircraft or vessels in distress are relayed by the satellite to ground receivers in Local User Terminals (LUTs), which process the signal for location and send this information via the Cospas-Sarsat Mission Control Centers (MCC) to the nearest Rescue Coordination Center (RCC), usually operated by national armed services or coast guards, which have the responsibility for dispatching rescue forces.

The partners decided early on that the project would consist of demonstrations at two distress frequencies: (1) 121.5 MHz, the frequency then currently in use on emergency beacons carried on most aircraft, but far from optimum for a space-based detection system, and (2) 406 MHz, a frequency better suited for space-based detection (and so allocated, along with L-band, by the ITU in 1979), but with the disadvantage of not being in operational use in the late 1970s and early 1980s.

In retrospect this decision was vital to the later successful transition to an operational system. Selling a space-based system to political leaders, the public and to the search and rescue community would require real world 'saves', not just technical demonstrations. This required the use of the distress frequency on operational beacons, in spite of the fact that it would not be the ultimate choice for a space-based system. The wisdom of having conducted demonstrations at two distress frequencies would be shown by the fact that the first actual 'save' using 406 MHz transmissions occurred in 1987, almost five years after the initial September 1982 rescue using 121.5 MHz.

¹B Gallagher, 'Cospas-Sarsat a beacon for those in distress', *Journal of the British Interplanetary Society* June, 1989.

A Soviet dimension

As this trilateral collaboration was being planned and negotiated, US and Soviet space planners were looking for opportunities to expand bilateral cooperation between the two space powers as a follow-on to the successful Apollo-Soyuz 'handshake in space' in mid-1975. Search and rescue satellite-aided tracking (abbreviated to Sarsat) experimentation, already on NASA's agenda, was attractive to the Soviets because of their world-wide fishing fleet and because it provided them with an opportunity to demonstrate their space capability in a humanitarian application. So they decided to provide their own space segment by putting a compatible emergency beacon signal receiver/relay package on an existing Soviet maritime navigation satellite and adopted the acronym Cospas (Russian abbreviation for Space System for Search of Vessels in Distress). From the Western partners' point of view, the addition of a Soviet space segment was advantageous because the additional spacecraft increased system reliability and reduced emergency signal detection time.

East-West discussions led in late 1979 to a Cospas-Sarsat Memorandum of Understanding calling for interoperability between the two systems, thus allowing participants in both programs to use both space segments to detect and locate distress beacons. The initial four signatory agencies were NASA; the Canadian Department of Communications; CNES, the French space agency; and MORFLOT, the Soviet Merchant Marine Ministry. In addition, agencies in Norway, Sweden, Finland, Bulgaria and the UK participated in early Cospas-Sarsat demonstrations to evaluate the system's effectiveness in their respective areas of search and rescue responsibility.²

From the very beginning an important feature of this cooperation was that no funds passed among the national participants; each party paid for its own hardware and services. Space segment costs were minimal – estimated at less than \$10 million per spacecraft for the Sarsat space segment, split roughly half and half between the USA on one side and Canada and France on the other – because the package for detecting and relaying the beacon signals was flying as a secondary payload on spacecraft designed primarily for another mission, polar orbiting weather observations, which bore the main cost of the spacecraft and launch. Local User Terminals cost between \$500 000 and \$1 million after initial prototypes, and were built in a lively competitive environment by firms in Canada, France and the USA. The emergency beacons carried aboard aircraft and ships cost anywhere from several hundred (for the 121.5 MHz transmitters) to several thousand dollars (for the 406 MHz beacons), depending on their sophistication and the amount of data they transmit.

The first 'save'

The Soviet Cospas 1 was launched in July 1982 and the first satellite-aided rescue took place two months later when three men were rescued in the mountains of British Columbia, Canada, following the crash of their single-engine light aircraft. The details of this 'save' dramatically illustrate the value of satellite-aided search and rescue in terms of both money and lives saved.

In July 1982 the Canadian government had conducted a massive but unsuccessful search for a pilot lost in northern British Columbia. The

²James Bailey, US National Oceanic and Atmospheric Administration (NOAA), 'Cospas-Sarsat', paper presented at a Seminar on Search and Rescue, Toulouse, France, March 1991.

search cost \$2 million before it was terminated. The father of the missing pilot continued the search using his own resources. He, a pilot and one other individual failed to return from one of their flights on 9 September. The regional Rescue Coordination Center (RCC) was notified that the flyers were missing but that no information was available on where their plane had gone down. The RCC was aware of the fact that the Canadian government was beginning to work with COSPAS-1 and called Ottawa to determine if any satellite data might be available. The next satellite pass over that area was expected on the morning of 10 September. Data from that pass was processed; and indeed, a beacon signal in northern British Columbia was detected. A search aircraft was dispatched to the predicted location and, almost immediately upon arrival at the scene, detected the faint emergency signal on its radio direction finder. After final 'homing', a rescue helicopter was called in. All three passengers had suffered serious injuries but had survived the crash.

The survivors were evacuated by helicopter to medical facilities the next day and eventually recovered from their injuries. Canadian authorities determined that the crash site was only ten miles from the satellite-determined location and that the timely rescue of the crash victims would have been impossible without satellite data. And, of course, the cost of the search was minimal.³

The cost of searches at sea can also be significant. For instance in 1984 seven crewmembers on a fishing boat were lost off the Atlantic coast. The ship apparently was not carrying an emergency beacon and the US Air Force and Coast Guard spent more than \$12 million in a futile search. Partly as a result of that accident, the Coast Guard decided to require in 1988 that all 127 000 US-registered fishing vessels must carry emergency radio beacons. The International Maritime Organization has decided that all merchant ships of more than 30 gross tons (about 60 000 ships worldwide) should carry the devices.⁴

The transition begins

Sarsat 1 joined two Cospas spacecraft in orbit in 1983, and within five years Mission Control Centers were operating in Australia, India, Norway and the UK, as well as the four original partners, plus some 15 operational Local User Terminals located around the world. In 1984 the agency-level MOU was revised and updated and, reflecting completion of the early technical demonstration phase, the US signatory transitioned to NOAA (the agency responsible for US polar weather satellites) and the Canadian signatory to the Department of National Defense (DND), the operating search and rescue agency.

Although the early years demonstrated the technical and operational viability of the system, and the increasing number of 'saves' (847 by mid-1987) received favorable international publicity, the transition to an operational system was not trouble free. During the early and mid-1980s there were extended discussions among the partners concerning various organization and management schemes for an operational Cospas-Sarsat system. Criteria for the system to be considered operational were discussed, including what assurance of continuity would be sufficient and what minimum capability (for example, number of satellites) should be required. Non-US participants expressed concern about continuity and reliability of US satellites in light of repeated Reagan Administra-

³Letter from NASA Administrator James Beggs to Congresswoman Lindy Boggs, 21 September 1982.

⁴Eric Weiner, 'Getting the kinks out of the global rescue system', *The New York Times*, 19 August 1990, p F12.

tion efforts to achieve budget savings by reducing the number of polar orbiting weather satellites operating at the same time from two to one. As noted above, the number of satellites equipped determined the wait time for detection of a craft in distress. In addition, the fact that the Sarsat package was (and still is) a secondary payload on these satellites gave the international partners additional concerns about whether the system would have sufficient priority to be considered operational.

A home at Inmarsat?

The solution, some partners said, was for the system to be operated by a new international organization or an existing international organization such as Inmarsat, either as a dedicated satellite system or a standard Inmarsat service. The maritime community, which constituted the most vocal user group, was comfortable with Inmarsat. The USSR played a significant role in Inmarsat and therefore leaned towards using it as an institutional base for an operational system. What is more the agency responsible for Soviet participation in Inmarsat was Morflot, the lead Soviet agency for Cospas-Sarsat. Other partners that were not large shareholders in Inmarsat (and therefore did not pay a large share of its costs) may have seen operation by Inmarsat as a way of maintaining the rescue service without committing to higher expenditures. On the other hand, to the USA and some other agencies, the possibility of transitioning from Cospas-Sarsat to an operational system run by Inmarsat or creating a new international organization to initiate an operational search and rescue satellite service meant increased national costs and decreased national control.

Search and rescue was compatible with Inmarsat's overall mission, and the organization had in fact studied the possibility of adding a search and rescue capability to future generations of its geostationary satellites. These studies, by German researchers, used a different, competing frequency (L-band). L-band experiments using NASA's ATS satellites had already been conducted. A geostationary system has one obvious advantage: having a satellite always in view enables instantaneous detection of an emergency beacon. On the other hand, the absence of relative motion between the spacecraft and the beacon precludes beacon location using doppler effect measurements. Thus, unlike Cospas-Sarsat, the location of the vessel in distress had to be provided on board the vessel by an independently functioning navigation system and transmitted as part of the distress signal. Though not an impossible requirement, especially for a commercial vessel, it added a requirement that smaller boats and aircraft would have a difficult time meeting in a distress situation. At a landmark Satellite and Search Rescue Symposium held in Toulouse, France in 1984 (two years after the first Cospas-Sarsat 'save') the search and rescue community expressed its preference for 406 MHz over L-band.

The satellite partners in Cospas-Sarsat and the search and rescue community in user countries also had an interest in protecting current user investment in equipment using the Cospas-Sarsat frequencies. The International Maritime Organization (IMO) had begun discussion of incorporating recommendations for the use of satellite capability into the Future Global Maritime Distress and Safety System (FGMDSS). Both the Cospas-Sarsat demonstration and Inmarsat L-band studies were being considered. IMO recommendations and prospective similar

International Civil Aviation Organization (ICAO) recommendations for aircraft would guide national regulatory actions for carriage of emergency beacons by aircraft and ships. In the interest of solidifying support for the allocation of Cospas-Sarsat frequencies in national and international regulatory fora, an interest shared by Cospas-Sarsat partners and users alike, Inmarsat had to be dealt with at the same time that a clear path to a reliable operational system had to be confirmed.

The end result of the extended debate about Inmarsat's possible role was a compromise. In 1987 the Cospas-Sarsat partners negotiated an agreement for Inmarsat to establish on their behalf a small (now five persons) secretariat at Inmarsat Headquarters in London. While Cospas-Sarsat system independence was retained, the system gained visibility and some tacit legitimacy with the international organization that the maritime community had come to trust for satellite service. (Though it is unlikely to have appeared in any formal position papers, another incentive for the Cospas-Sarsat operating agencies to strike a deal with Inmarsat was that a secretariat based there could relieve these agencies of the growing workload of organizing and running project coordination meetings for a relatively small incremental cost that could be shared among Cospas-Sarsat operating agencies and user agencies.) This compromise solution appears to have worked out satisfactorily: the co-location agreement with Inmarsat was recently extended to the end of the decade.

Elevating the agreement

To make the system operational it was necessary for a number of the participating nations to impose national regulations requiring their vessels to carry emergency beacons. Before implementing these regulations, they sought additional evidence of government-level commitment by the satellite providers to continue the system. In addition some partner agencies and some user agencies felt a government-level agreement would enhance prospects for continued funding of space and/or ground equipment or operations by legislatures in their own countries. For these reasons, and with the resolution of Inmarsat's role behind them, the Cospas-Sarsat partners concluded that an intergovernmental agreement that preserved cooperation among independent national technical agencies could provide the international community greater assurance of continuity of the system, without affecting cost or control issues.

Thus on 1 July 1988, only a year after the deal for an Inmarsat role was struck, formal transition from experimental to operational status came when the agency-level MOU which spelled out the initial cooperation was replaced by a formal intergovernmental agreement. It should, however, be noted that the intergovernmental agreement includes the same 'subject to the availability of appropriated funds' proviso contained in the earlier agency agreements.⁵ And although in the USA the Reagan Administration had by that time relaxed its pressures to reduce the number of polar orbiting weather satellites, Sarsat remained a secondary payload on them.

In recognition of the new higher level commitment of the Cospas-Sarsat partners to continue the system on an operational basis (and of course the continuing practical success of the program), the International Maritime Organization (IMO) later that year incorporated Cospas-

⁵The International Cospas-Sarsat Programme Agreement, Article 6, para 1.

Sarsat into plans for the Global Maritime Distress and Safety System (GMDSS). In the following years, participation in the use of the system grew to 28 nations, and the total number of lives saved rose to 4310 by September 1994.⁶

Reasons for success

Within six years of the launch of Cospas-1, Cospas-Sarsat had become a permanent fixture on the world search and rescue scene, a truly remarkable accomplishment for an innovative space-based system without its own dedicated satellite. And this East-West partnership, begun as a follow-on to Apollo-Soyuz, the symbol of superpower detente, had survived and flourished during the pre-Gorbachev period in which 'Evil Empire' and Star Wars were the symbols of the international political climate.

That climate began to deteriorate even before the agency-level agreement for the initial demonstrations was signed in 1980. The text of this agreement had been negotiated and was initialed in (then) Leningrad, November 1979. Shortly thereafter the Soviets intervened in Afghanistan and new initiatives for cooperation with the Soviets were put on hold by both the US and Canadian governments. After some hesitation, both governments gave their approval for the agreement to be signed.⁷ Two years later, following the declaration of martial law in Poland the Reagan Administration announced its intention to allow the umbrella bilateral US/Soviet civil space agreement to lapse in May 1982.⁸ Again, Cospas-Sarsat was allowed to continue and four months later it scored its first 'save'.

How did Cospas-Sarsat survive? First, it was a relatively inexpensive, low political visibility project. Second, it was humanitarian in character; when it did make headlines, they were about lives being saved, not about cost overruns, schedule slips or transfer of advanced technology from West to East. Third, the USA and USSR were not the only nations involved – the project's multilateral character meant that a number of other countries had invested in, and were deriving benefits from, the system. Their national and regional search and rescue capabilities would have been seriously compromised if either the USA or the USSR had withdrawn their satellites from the system. For these reasons political judgements were made in Washington and in Moscow that continuation of this modest collaboration served US and Soviet national interests better than cutting it off.

Another question: why would the other participating governments, especially those in Western Europe, commit to this partnership with the USA when at the same time in other civil space contexts (Aerosat, Solar Polar Mission, Spacelab and Space Station) they were complaining openly about the USA being a domineering and unreliable partner? Some of the same considerations mentioned in the paragraph above (low cost, low political visibility, humanitarian character of the program) are relevant. In addition, from the very early tests in the mid-1970s this collaboration was international in character. Although the USA and the USSR were the two satellite launching partners and bore the major financial burden, no single partner dominated the effort operationally, technologically or financially. As a result, there were no debates in the Congress on this side of the Atlantic or in Parliaments on the other side about US 'leadership' or European 'autonomy'.

⁶*Aeronautics and Space Report of the President Fiscal Year 1994 Activities*, p 42.

⁷Personal communication from Bert Blevis, former senior official in Canadian Department of Communications.

⁸US Congress, Office of Technology Assessment, *US-Russian Cooperation in Space*, OTA-ISS-618, US Government Printing Office, Washington, DC, April 1995, p 43.

In a general sense, success in translating demonstrations of new technology into operational applications depends on receptivity by the prospective users and their ability to assimilate new processes and associated new costs into ongoing operations and budgets. In this regard, Cospas-Sarsat benefited both from good planning and fortunate circumstances. From the early demonstration period, Cospas-Sarsat managers in all participating countries (both space system partners and users) sought close involvement by search and rescue user agencies – mission agencies responsible for search and rescue operations. This personal involvement by user agency managers and personnel was crucial in aggregating support for continuing Cospas-Sarsat as an operational system.

In the right place at the right time

In addition there is another, perhaps less tangible, factor that appears to have played a role in the success of Cospas-Sarsat: having the right people in the right place at the right time. In the USA not only was involvement by the US Air Force and the US Coast Guard, as search and rescue user agencies, critical but support for continuing use of the NOAA polar orbiting weather satellites was also crucial. As it happened, key personnel familiar with Cospas-Sarsat as a NASA demonstration project moved from NASA to key positions at NOAA around the time decisions on the system's operational future had to be made. One such manager was John McElroy. McElroy had been Director of NASA's Communications Program Division in the late 1970s and had therefore been involved in the early stages of the Cospas-Sarsat demonstration program, which was sponsored and funded by his division. In early 1982 McElroy was selected by NOAA to head its satellite activities and he remained in that position until 1985. He was thus able to serve as an *inside* advocate for Cospas-Sarsat, crucial because the predominant view within NOAA was skeptical of taking on non-meteorological obligations, especially at a time of increasing budget reduction pressures from the Reagan Administration. During his tenure McElroy proved to be a resourceful advocate, not only in gaining formal acceptance within NOAA for the Sarsat mission but also in successfully fending off repeated attempts by the Reagan Administration Office of Management and Budget to reduce the number of polar weather satellites in operation from two to one. In three successive years the Administration's budget request went to the Congress with funding for one satellite; each time Congress restored funding for the second spacecraft.⁹

Cospas-Sarsat had a number of supporters in the US Congress, none more effective than Lindy Boggs, a Democratic Congresswoman from Louisiana, another right person in the right place at the right time. Boggs was the widow of Hale Boggs, who at the time of his death in the crash of a light plane in Alaska in 1970, had been Democratic Majority Leader of the House of Representatives. Lindy Boggs was appointed and then elected to fill her husband's seat. Deceptively genteel, Boggs was persistent in pursuing her legislative priorities, one of which was improvement of aircraft safety and rescue. In the wake of national publicity following her husband's death she played an important role in enacting legislation requiring that all light aircraft carry emergency beacons. When NASA came along several years later with a request for

⁹John M Goshko, 'United States-Soviet Venture Using Satellites in Rescues May Be Disrupted', *Washington Post*, 13 September 1984.

Sarsat demonstration funding, Boggs, who served on the House Science and Space Committee which oversees NASA, became an immediate champion. Boggs' interest in and support for Cospas-Sarsat continued until her retirement from the Congress in 1990, and because of the esteem in which she was held by her colleagues, her influence was disproportionately great.

The unique, multi-hatted role played in the Soviet Union by Yuri Atserov also contributed significantly to the successful transition to an operational status. As Head of the Navigation and Telecommunication Department of the Ministry of Merchant Marine (Morflot) and then from 1976 Head of Morsviazsputnik (Satellite Communication and Navigational Aids), Atserov was one of the plankholders in the original experimental Cospas-Sarsat collaboration. Until 1989 Atserov was also the chief Soviet delegate to Inmarsat and to the International Maritime Organization, where the USSR was a major player. As noted above, the international maritime community initially inclined toward L-band, geostationary-satellite-based search and rescue systems; Atserov proved to be an informed and effective advocate for Cospas-Sarsat. At the same time, within the Cospas-Sarsat partnership Atserov was an advocate for Inmarsat playing a role in the operational system. Thus because of his multiple international positions, Atserov played a unique role in shaping the operational Cospas-Sarsat system and assuring its acceptance in the international maritime community.¹⁰

In reviewing the history of Cospas-Sarsat, the authors conclude that the project's unquestioned success can be attributed to a number of factors. While it would be difficult to duplicate them in any such collaboration in the future, they may be useful in analyzing the particular circumstances of other prospective cooperative programs. First, costs were kept low, both in the demonstration phase and by deciding to stay with a form of organization focused on cooperation among national technical agencies and utilizing a piggyback payload. Second, the project was designed to demonstrate clear practical – and in some cases dramatic – benefits which could be quantified in terms of money and lives saved. Third, the program's low political visibility and multilateral character allowed it to avoid some potential political obstacles. Fourth, the program benefited from strong supporters in key positions of influence.

It is notable that in discussing Global Navigation Satellite System (GNSS) institutional issues at a 1994 conference in Europe, the director of ICAO's Air Navigation Bureau cited Cospas-Sarsat as 'an interesting and potentially useful precedent for international cooperation with respect to funding, ownership, management, and operation of space systems'.¹¹

¹⁰This paragraph is based on personal communications from Thomas McGunigal, former NASA Program Manager for Cospas-Sarsat and from Yuri Zurabov, Vice President, Morsviazsputnik.

¹¹Phillip Butterworth-Hayes, 'Russia keeps faith with GLONASS', *Aerospace America*, August 1994, p 4.