MSS 6000 puts the Aircraft in the Oil Spill Tracking Network

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Abstract

Swedish Space Corporation has developed a new generation of their airborne surveillance system. The new MSS 6000 System could be a useful tool for offshore operators as well as for the traditional coastguard users.

Earlier generations of the Swedish Space Corporation Maritime Surveillance System have integrated SLAR, IR/UV, FLIR and video sensors into a combined overview of the spread and distribution of oil spills.

With the MSS 6000 this technology is taken one step further. It becomes possible not only to put all the sensor imaging into the digital map but also to tie in the observations from the aircraft into the ground based network for tracking, control and cleanup response of oils spills.

In the new system not only radar and infrared images but also AIS and satellite transponder information is integrated in the electronic map to give the system operator a detailed up to date overview of the situation on the sea surface. Map overviews with geographically referenced observations as well as FLIR and video images can be transmitted via data link to ship or shore for real time management information.

It is the opinion of the authors that this new version of the airborne system has the potential to become an integrated component in a comprehensive sea information system.

Background

Accidents such as the Torrey Canyon tanker spill in 1967 outside Lands End, U.K., started a growing awareness of the potential threat from oil transports at sea. The increasing volumes of oil transported, together with the formidable development in offshore production, has necessitated a lot of work in many different fields to arrive at a quite impressive preparedness for dealing with oil spills today. Swedish Space Corporation (SSC) started supporting the Swedish Coast Guard in the mid-1970s in experimenting with remote sensing equipment on board the two small Cessna 337 aircraft then in use by the Coast Guard. The purpose of these experiments was to investigate how airborne systems could help the coast guard in carrying out efficient oil spill surveillance.

Figure 1 SSC Maritime Surveillance Systems were recently installed on two Bombardier CL 415 aircraft for operation by the Hellenic Air Force, Greece.

This pioneering work led to the development of an integrated multi-sensor system: the SSC Maritime Surveillance System or MSS. Already the early versions of the MSS provided on-board real-time presentation and registration of surveillance data. Mission-supporting functions such as integrated digital maps, target database and mission reports have subsequently been added.

Over the years the system has become more and more of an operational tool for collecting and updating of sea information to provide a situation overview to the operations management in the Coast Guard. Today, the MSS exists in its sixth generation, MSS 6000.

Figure 3 An Ericsson SLAR antenna on one of the CASA 212 aircraft that are operated by the Portuguese Air Force for fishery protection.

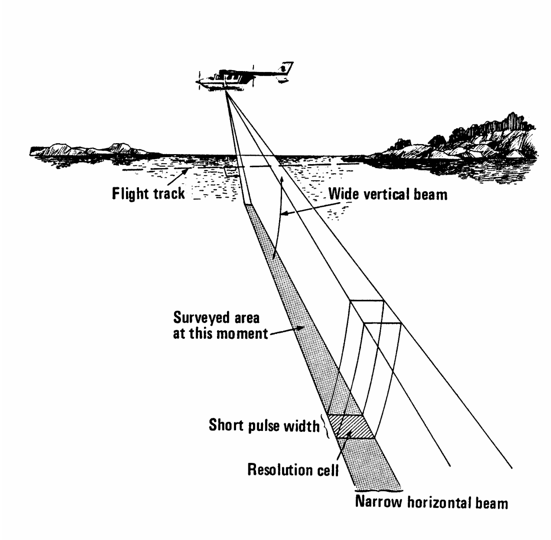

Figure 3 The basic principle of the Side-Looking Airborne Radar (SLAR).

Sensors for Detecting Oil Spills

The main sensor of the MSS is the Side-Looking Airborne Radar (SLAR): a mapping radar for surveillance of large sea surfaces. Figure 2 shows an Ericsson SLAR antenna mounted on the aircraft. As the aircraft is flying the radar scans the surface underneath, creating an image of the sea structure, see Figure 3. The basic principle is that of comparing signal returns from different areas of the sea surface. Oil floating on the sea surface has a dampening effect on the sea clutter (capillary waves) resulting in less reflection back to the aircraft from an oil slick than from an undisturbed water surface. Objects that rise above the sea surface will instead give a more intense reflection, and the resulting image will therefore show not only oil spills but also ships, boats and other objects against a background picture of the sea surface. The SLAR may be operated in all light and weather conditions.

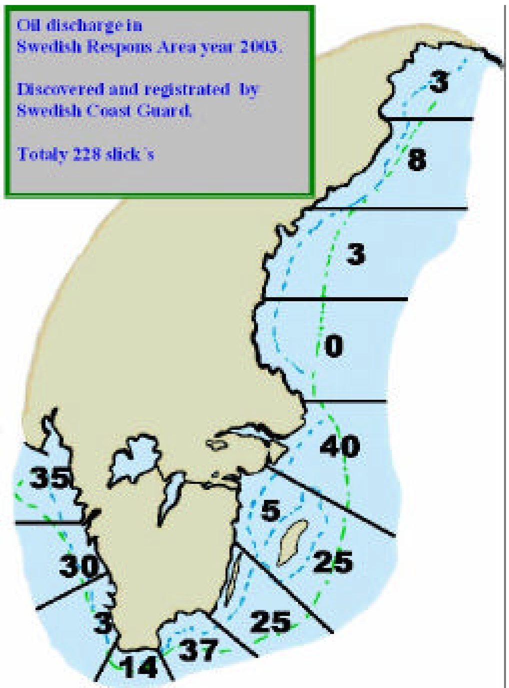

Figure 4 Number of oil spills detected by the Swedish Coast Guard in 2003. (Courtesy Swedish Coast Guard)

Typical data on SLAR performance parameters are

- range for oil detection: about 40 km to each side of the aircraft, depending on weather conditions;
- resolution: 60 m;
- surveillance capacity: about 15,000 km^2 per hour, depending on aircraft speed.

Today, most European countries with coastlines on the Baltic, the North Sea and the Atlantic Ocean use SLAR-equipped aircraft to protect their waters. As an example, the Swedish Coast Guard operate their three MSS-equipped CASA 212 aircraft more than 3,000 flight hours per year in order to fulfil their obligations of environmental, fishery and border control throughout the Swedish area of responsibility, an area covering more than 200,000 km^2 in the Baltic Sea alone.

A SAR satellite image from, for example, RADARSAT will give the same kind of sea surface information as the airborne SLAR. Norway was one of the pioneers in using the SAR satellite data on an operational scale for obtaining overviews of large sea areas for oil spills and ship traffic. This had the dual advantages of increasing the area covered and also making it possible to more effectively direct the airborne surveillance. The satellite data will, however, not replace the airborne surveillance for two reasons. Firstly, when a situation develops on the sea surface there is often a need for repeated overflights in a short time which can only be done with an aircraft. Secondly, there is often a need for more detailed documentation from low altitude using supporting sensors such as IR/UV scanner, FLIR, microwave radiometer, cameras etc. More information on the different types of sensors and their use can be found, for example, in the Bonn Agreement Manual for observation of oil pollution at sea.

The Breakthrough of GPS

Already in the first versions of the MSS, an interface to the aircraft's navigation system was used so that all sensor data, images (video and stills) and marked observations (targets) could be annotated with position and time determined by one single source, thus ensuring that all observations from the aircraft could be tied together and used as evidence material if necessary. With GPS, the accuracy of the annotation has been greatly improved.

Further and more importantly, the breakthrough of satellite-based GPS technology in the 1990s led to the availability of low cost equipment for accurate positioning which in turn created a vast market for digital maps with very high accuracy.

With GPS accuracy it was now possible to visually combine sensor registrations with the improved digital maps by overlaying the on-board digital map with a semi-transparent and geographically re-sampled sensor image. This facility was introduced in the MSS 5000 generation of the MSS in order to give the system operator in the aircraft, as well as any recipient to whom the image is distributed, a direct perception of the data's relation to surrounding geography and flight track (the time-stamped flown path during a mission).

High precision in data annotation and map data is furthermore a necessary prerequisite for entering the data into a Geographic Information System, where data is handled with regard to its geographic location rather than organised by date, initial letter or some other parameter. It is our firm belief that GIS systems will be used more and more as tools for qualified planning and implementation of programs for coastal zone management and EEZ protection.

In an oil spill incident today, a computer model for forecasting the drift of the spill is used in combination with sensor recordings from several overflights per day to achieve a very accurate and up to date overview for planning the activities of the oil spill combating team. In the ideal situation all of the necessary data would be available in real time to the team management in an easy to handle format.

The Revolution in Communications

With the digital mobile telephone networks that became widely accessible in the late nineties, it has become possible to not only send and receive information but also to connect to the internet as soon as the aircraft is parked on the ground. The information acquired in a surveillance mission can immediately after landing be distributed in the surface organization. The usefulness of the shared information is further enhanced by being distributed in a map-related format.

Until now, however, the data exchange with an aircraft in the air has been limited to voice channels and/or very slow data modems. The next step in connectivity, which is rapidly becoming available, is the commercial availability of high speed data connections via satellite, making it possible for the airborne crew to exchange data with the surface organization from virtually anywhere. The time when the instrument system in the aircraft can act as a node in the coast guard information system is not far away.

The Aircraft in the Oil Spill Tracking Network

Recent developments in maritime technology and legislation have made it possible to take the system concept far beyond that of supplying the user with precise real-time sensor data. The maritime transponder systems, AIS (Automatic Identification System) and VMS (Vessel Monitoring System) open up possibilities for complete and automatic satellite tracking of vessels with a high level of accuracy and reliability. The basic function is to track vessel movements and provide information on vessel speed and course.

Starting from year 2004, AIS-transponders are mandatory for all international sea traffic exceeding 300 tons while VMS-transponders are mandatory within the EU for all fishing vessels exceeding 18m (which is expected to decrease to 15m by the year 2005).

The Swedish Coast Guard’s three CASA-212 aircraft are already today able to monitor ship traffic using AIS tracking data. This gives the environmental protection officer in the aircraft access to MMSI (Maritime Mobile Service Identity), call sign and vessel type as well as information on the position and track of the ships on the surface. In the case of an oil spill detected in a shipping lane, as an example, the position and track of the ships in the vicinity could be correlated with the position and trajectory of the spill. In this way a ship suspected of spilling the oil might be established, after which one may proceed to take oil samples in the tanks of the ship as well as from the spill on the water.

Similarly, the VMS transponder data plays an increasingly important role in the tracking of fishing vessels. This is another example of how new satellite technology not only adds new capabilities but also opens up new possibilities for making the existing aerial surveillance more effective. The Portuguese Air Force is presently adding two MSS-equipped EH101 helicopters to their fleet of surveillance aircraft. The MSS 6000 software on board includes software functionality for interfacing to the VMS database in the fishery control centre in order to increase the effectiveness of the Portuguese Fishery Control. The Portuguese Fishery Control program involves the General Inspectorate of Fisheries, the Navy, the Air Force and the Fiscal Brigade of the Republican National Guard.

The direct access to vessel tracking data in the aircraft together with the precise digital sea charts now available will add significantly to the analysis of sensor data and situation overview. These technological developments together with the ability to communicate own observations, updates and reports to other units in the organisation (via, e.g., satellite data link) becomes essential in the surveillance aircraft's contribution to the oil spill tracking network and will lead to revised ways of working and to new possibilities for a more efficient co-ordination of resources.

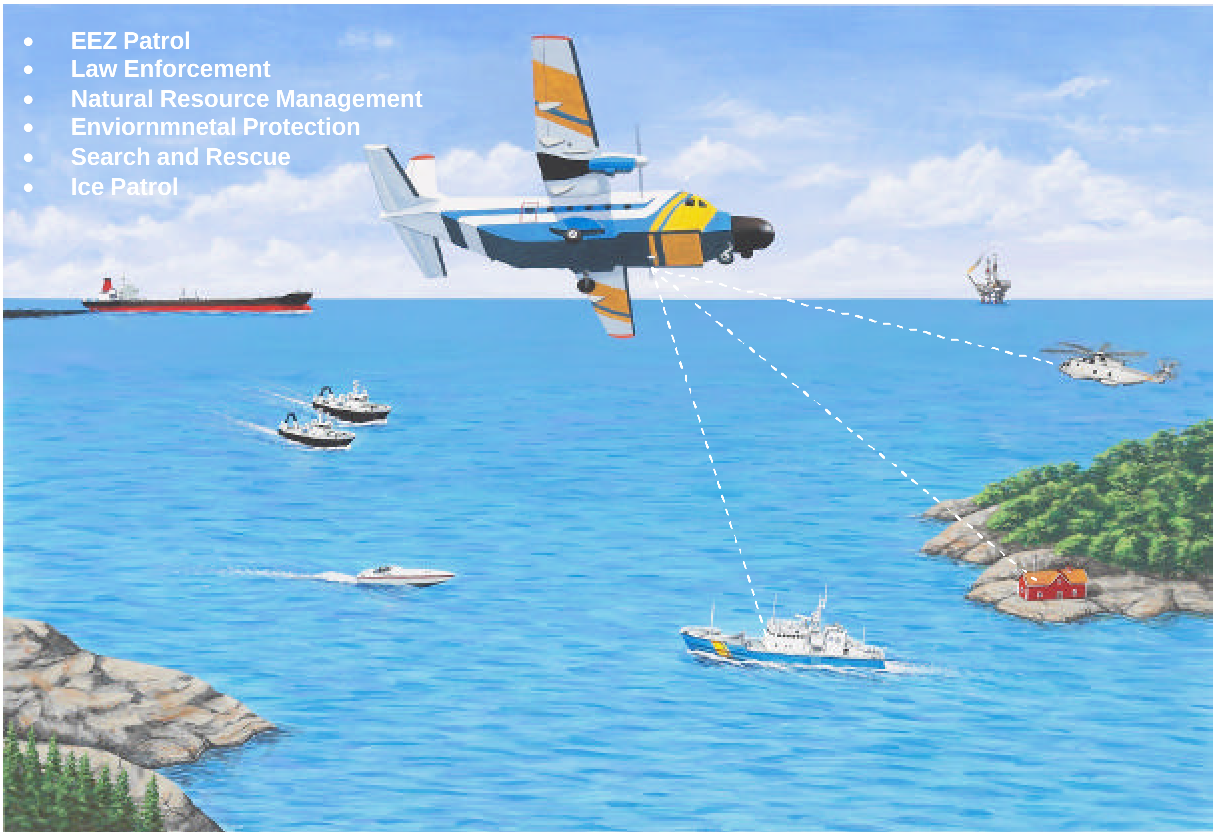

Figure 5 The MSS-equipped aircraft becomes an important actor in the oil spill tracking network through which the current situation overview will be distributed.

Conclusions

The development of the earliest generations of the Maritime Surveillance System was driven by an increasing awareness and concern about the environmental threats from illegal oil spills, and – consequently – was initially focused on functions for detecting, tracking and monitoring spills.

The breakthrough of GPS technology in the 1990s meant that high precision in the determination of position and time became readily available. The system's fifth generation, MSS 5000, benefited from this development in using map and sensor data with sufficiently high precision to be able to overlay the geographically re-sampled sensor image of the oil spill on the map image. This has made it possible to provide a much more easily interpreted set of information from the aircraft to the receiving organization.

The development of the current generation, MSS 6000, is primarily driven by

a) the emerging transponder technology (AIS- and VMS) which has made it possible to achieve a much more comprehensive situation overview with relatively small means;
b) the ongoing revolution in data communications, which makes it possible to share selected mission data with other units in the organisation in near real-time.

These technological developments will lead to revised ways of working and opportunities for a more efficient co-ordination of resources. The surveillance aircraft will need to be equipped with functionality for communications and transponder technology in order to carry into effect its full potential as one of the most important actors in the organisation's network.

It is our firm belief that these new ways of managing operations, made possible by emerging technology, will prove useful not only for the general coast guard law enforcement task but also for more specific tasks such as the tactical management of combating an oil spill on the sea surface. A fully equipped aircraft could in many operations cooperate with one or more helicopters or smaller aircraft carrying a more limited set of instruments. A smaller system dedicated for assisting an oil spill cleanup effort on the surface could for instance consist of a FLIR and/or video cameras, an electronic map and a data link to communicate the situation overview to surface units.

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