

Report of the

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**EXPERT CONSULTATION ON THE USE OF VESSEL MONITORING  
SYSTEMS AND SATELLITES FOR FISHERIES MONITORING,  
CONTROL AND SURVEILLANCE**

**Rome, 24–26 October 2006**



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## PREPARATION OF THE DOCUMENT

This document contains the report of the Expert Consultation on the Use of Monitoring Systems and Satellites for Fisheries Monitoring, Control and Surveillance, which was held in Rome, Italy, from 24 to 26 October 2006.

FAO.

Report of the Expert Consultation on the Use of Vessel Monitoring Systems and Satellites for Fisheries Monitoring, Control and Surveillance. Rome, 24–26 October 2006.

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### ABSTRACT

This document contains the report of the Expert Consultation on the Use of Monitoring Systems and Satellites for Fisheries Monitoring, Control and Surveillance, that was held at FAO headquarters, Rome, Italy, from 24 to 26 October 2006. The Expert Consultation was convened by the Director-General of FAO to review and assess technical, legal and institutional aspects concerning the use of vessel monitoring systems (VMS) and satellites in monitoring, control and surveillance (MCS) with the goal of facilitating the wider use of this type of technology and promoting and strengthening international cooperation among States for its use. The Expert Consultation furthered collaboration with the International Maritime Organization (IMO), as called for in paragraph 90 of the 2001 FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated [IUU] Fishing. The Experts undertook an inventory and assessment of the status of VMS and satellites in terms of the technology and equipment employed and legal and institutional considerations. This work was complemented by a review of options to enhance the use of VMS and satellites in MCS by addressing the enhanced use of technology and strengthening the development and implementation of national legislation and international instruments to foster enhanced international cooperation for the wider use of VMS technology. The Consultation also considered issues relating to the special requirements of developing countries, the use of VMS in support of port State measures, a comprehensive record of fishing vessel and the role of the International MCS Network. The Consultation did not recommend a binding international VMS agreement although additional mechanisms such as an international plan of action, declaration or strategy to guide and facilitate global implementation of VMS might be considered. The Consultation also made recommendations, *inter alia*, concerning the use of VMS as a MCS tool to combat IUU fishing, the further development and implementation of VMS and the need for MCS to be enhanced particularly with respect to closer cooperation among regional fishery management organizations. The Consultation was funded by the FAO Regular Programme and by the FAO FishCode Programme through the FishCode Trust (MTF/GLO/125/MUL) and the FishCode SIDS Project (GCP/INT/823/JPN), “Responsible Fisheries for Small Island Developing States”.

### Distribution:

Participants in the Consultation

Other interested nations and  
international organizations

FAO Fisheries and Aquaculture Department

Fishery Officers in FAO Regional Offices



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## **OPENING OF THE SESSION**

1. The Director-General of the Food and Agriculture Organization of the United Nations (FAO), Mr Jacques Diouf, convened an Expert Consultation on the Use of Vessel Monitoring Systems and Satellites for Fisheries Monitoring, Control and Surveillance. The Consultation was held at FAO headquarters, Rome, from 24 to 26 October 2006.
2. Nine of the eleven invited experts participated in the Consultation in their personal capacities together with four resource persons and two consultants. A list of the participants (experts, resource persons and consultants) is attached as Appendix B. The documents placed before the Consultation are listed in Appendix C.
3. The Technical Secretary, Mr David Doulman, called the Expert Consultation to order.
4. In his Opening Statement the Assistant Director-General for Fisheries and Aquaculture, Mr Ichiro Nomura, welcomed participants to FAO and Rome and outlined the purpose of the Consultations. He noted that illegal, unregulated and unreported (IUU) fishing continued to be high on the international fisheries agenda and that it was being addressed in many international fora. Mr Nomura referred to the 2005 Rome Declaration on Illegal, Unregulated and Unreported Fishing, pointing out that Ministers had stressed the central role of fisheries monitoring, control and surveillance (MCS) and vessel monitoring systems (VMS) in combating IUU fishing. He outlined the issues to be addressed by the Consultation and wished the Experts well in their deliberations. Mr Nomura's Opening Statement is attached as Appendix D.

## **ELECTION OF OFFICERS**

5. Mr Martin Tsamenyi, Professor of Law and Director of the Centre for Maritime Policy, University of Wollongong, Australia, was elected Chairperson. He expressed his gratitude to the Experts for their confidence in electing him to the Chair.

## **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION**

6. The Consultation adopted the Agenda attached as Appendix A. The Chairperson outlined the timetable for the Consultation and the Secretary described the arrangements to be followed.

## **AN INVENTORY/ASSESSMENT OF THE STATUS OF VMS AND SATELLITES FOR FISHERIES MCS**

### **Technology and equipment**

7. A FAO Consultant introduced the paper entitled "Current Status of Vessel Monitoring Systems, Satellites and other Technologies for Fisheries Monitoring Control and Surveillance". The document is attached as Appendix E. The presentation, *inter alia*, provided a history of VMSs, their operations and widespread expansion. It was pointed out that the basic concept of VMS, developed in the late 1980s, whereby a vessel determined its position from the Worldwide Global Navigation Satellite System (WGNSS) and transmitted that position by electronic communication to a fisheries monitoring centre (FMC), had not changed. However, the options with respect to the capability of equipment and choice of

service providers had increased considerably while communication costs had fallen dramatically, resulting in the extension of VMS to a large number of fishing vessels. Regional fisheries management organizations (RFMOs) in the management of high seas fisheries, now generally required VMS usage.

8. The Consultation agreed that VMS was a valuable tool in the MCS toolkit. It complemented and strengthened existing and traditional MCS mechanisms but could not, nor should, replace them. VMS was not a panacea for all MCS challenges nor had it eliminated IUU fishing but it had increased the efficiency of MCS operations and had made traditional means of surveillance more cost effective. The Consultation noted that some fisheries management authorities, including some of those responsible for MCS, were under the mistaken impression that VMS would eliminate the need for other MCS tools.

9. The Consultation agreed on the need to incorporate VMS into national fisheries management programmes and that this issue had not always been well considered. Without analyzing the role VMS would play in achieving compliance objectives and management programmes, undertaking VMS programmes could not be used to their full potential.

10. Although VMS programmes were often first initiated in high value industrial fisheries, the Consultation recognized that the success and popularity that VMS had achieved had led to a view that all VMS data communications were satellite based and should be utilized in all fisheries regardless of their characteristics or locations. The Consultation concluded that one type of remedy did not fit all situations and that satellite-based VMS may not be a well suited control mechanism in all fisheries. Alternative VMS technologies should continue to be explored, as appropriate, in particular for small-scale fisheries.

11. The Consultation reiterated the importance of integrating other databases with VMS information, so its full potential could be realized. This integration should unite VMS, the MCS knowledge framework and the management regime. Additionally, the importance of an institutional framework of policies, laws and practices, particularly at international level, was stressed, if the value of VMS was to be maximized.

12. Pursuant to national requirements, a wide variety of information was presently collected, such as vessel registration data, fishery management data regarding catches, effort, gear, license information and logbook data, including other available maritime information. The Consultation noted that integrating these information systems with VMS maximized their value and provided authorities with a near real-time profile allowing them to act quickly, if needed, in the MCS context to investigate or apprehend violators. Timely fishery management decisions could be taken, such as determining when quotas had been exceeded, or maritime rescue coordination centres responded based on the data.

13. Since the early days of VMS usage, tampering incidents have been documented. Simple methods of tampering such as blocking the antenna or disconnecting the power supply have been recorded for years. Recently, more sophisticated ways of tampering had been observed, which required advanced knowledge of programming and circuitry, resulting in simulated position information which reported that the vessel was in one location whilst it was actually elsewhere, sometimes thousands of miles away. Manufacturers have responded to these troubling developments with a number of design innovations in hardware and software but constant vigilance will be required. The Consultation recognized the need for

setting guidelines or standards with regard to equipment performance and use, with a view of reducing the possibility that data be tampered with, as well as to enhance data security.

14. It was noted that the FMC played a central and essential role in VMS data utilization and verification. The Consultation stressed that there was a need for substantial improvement in the operation of FMCs and that capacity building for FMC personnel was of high priority. An effective FMC did not only gather data and store them, but analyzed them in order to evaluate the current situation in a fishery. For instance, it was pointed out that FMCs should use incoming data to detect possible anomalies in fishing operations.

15. As one means of VMS verification, the Consultation heard from the resource person from the Joint Research Centre of the European Commission regarding the research and pilot work associated with satellite imaging of vessels (remote sensing). It was pointed out that it used imagery (principally radar) to verify VMS reports, a system known as Vessel Detection Systems (VDS).<sup>1</sup> The work had demonstrated its potential to detect non-compliant vessels and other vessels that might be reporting a false position and that could be investigated subsequently by surveillance platforms.

16. The Consultation focused considerable attention on the issue of tampering with VMS equipment and position reports. It was agreed that it would be extremely difficult to eliminate tampering completely. The use of independent verification systems such as Vessel Detection Systems (VDS) as well as of surface and air platforms could be used to verify false position reporting.

17. There were additional presentations on other existing technologies of interest, including a brief presentation by the resource person from the International Maritime Organization (IMO) on the status of the Long-Range Identification and Tracking (LRIT) system, a global identification and tracking system for ships used for maritime safety and search and rescue purposes. The Automatic Identification System (AIS) was also described, which provided information about vessel identity and movements within Very High Frequency (VHF) range for vessel identification and collision avoidance. Concerns about possible AIS system overload due to a large number of small craft using AIS were highlighted including the availability of real-time AIS data for the public. In discussion following the presentation, the Consultation noted that due to LRIT being primarily designed for the vessels covered by the International Convention for the Safety of Life at Sea, its value for fisheries purposes was considered limited. To the extent that LRIT was applicable to fishing vessels, every effort should be made to avoid duplication with VMS.

18. The Consultation acknowledged the necessity of data sharing and considered many aspects of the issue, such as data formats, methods of sharing, sharing architectures and models, internet based data transmission, data access, confidentiality, electronic signatures, problems with data quality and reluctance to share data.

### **Legal and institutional considerations**

19. A FAO Consultant introduced a paper entitled “Vessel Monitoring Systems, Use of Vessels Monitoring Systems and Remote Sensing (VDS): Legal Aspects, Trends and Options”. The paper is attached as Appendix F.

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<sup>1</sup> VDS can also use optical imagery. See Appendix E.

### *International framework*

20. The Consultation agreed that an international legal framework existed for the implementation of VMS by States, including the 1982 United Nations Convention on the Law of the Sea (1982 UN Convention) and the 1993 FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, at least implicitly, as well as explicitly through the 1995 UN Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (1995 UN Fish Stocks Agreement). Other important soft-law instruments included the 1995 FAO Code of Conduct for Responsible Fisheries and the 2001 FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU), which also provided bases for VMS implementation. It was further agreed that advocating the further ratification of the binding international instruments and ensuring the implementation of these and other non-binding instruments would enhance VMS implementation.

21. The Consultation recognized that within areas under national jurisdiction, existing international instruments gave sufficient law-making and enforcement authority to the coastal States, particularly with respect to requiring the installation of VMS equipment as prerequisite for the issuing of fishing licenses. On the other hand, it was pointed that there was uncertainty with regard to the power of coastal States to require the installation and use of VMS, regarding unlicensed foreign fishing vessels in transit through their respective exclusive economic zones (EEZs), or for vessels undertaking non-fishery specific activities (e.g. bunkering). However, coastal States had sufficient legal basis to board and inspect such vessels within their EEZs, as a means of verifying compliance with their fisheries laws and regulations.<sup>2</sup>

22. The Consultation acknowledged that the current international legal framework for fishing on the high seas was addressed adequately by flag State responsibilities and the duty of States to cooperate, including through RFMOs, as elaborated in the 1995 UN Fish Stocks Agreement. It was pointed out that the duty to cooperate as an enforceable rule under current international law was often overlooked.

### *National frameworks*

23. The Consultation recognized that many States implementing VMS had adequate legislation to support VMS use. It also noted that many of these laws and regulations required compliance with VMS as a prerequisite for granting a license to fish.

24. The Consultation was advised that the basic VMS provisions reflected in existing national legislation tended to be the obligation to install VMS equipment on fishing vessels, confidentiality requirement, the use of VMS as evidence in legal proceedings and sanctions for non-compliance with VMS specifications and requirements.

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<sup>2</sup> See Article 73 of the 1982 UN Convention on the Law of the Sea.

## **OPTIONS FOR ENHANCING THE USE OF VMS AND SATELLITES FOR FISHERIES MCS**

### **Facilitating the enhanced use of technology**

25. The use of alternative, non-satellite data communications systems for vessel monitoring technologies were considered, especially for small-scale fisheries. The Consultation acknowledged that undertaking a case-by-case analysis of each fishery was an important consideration prior to implementing a VMS system. It was determined that there were many tools that could be used in monitoring artisanal fisheries but that there was no universally applicable solution.

26. The Consultation discussed the possibility of using AIS to monitor coastal fisheries. AIS transmitters could be placed on vessels and one or more coastal sites could be set up to follow the vessels, although the system range was only up to a maximum of 50 nautical miles. This transmission medium could be the most appropriate taking account of cost and ease of use for transmission and other relevant factors. Alternatively, VHF or cellular technologies could be used for the transmission of data.

27. Outsourcing of various functions relating to data was considered by the Consultation. In one example, the North East Atlantic Fisheries Commission (NEAFC) was serving as the FMC for the South East Atlantic Fisheries Organization (SEAFO), which had not yet purchased VMS equipment but was in the process of assessing its needs through NEAFC, in order to make a later and more suitable decision concerning the acquisition of equipment. As another example, it was also pointed out that some countries did not have their own FMC but were able to utilize the FMCs of other countries. However, legal frameworks were needed to consider the acceptability of allowing the data to be handled in this manner. The Consultation recognized that the results from the processing of data were what was needed, not access to all raw data, making outsourcing an attractive option.

28. The feasibility of alternative technologies was also reviewed, including the use of “off the shelf” products such as relatively inexpensive and portable WGNSS units. The Consultation noted that these units were able to receive near real-time position data and log it for later retrieval by authorities when fishers returned to shore. The labour costs involved with shore side, physical inspections, needed to be factored into the financial considerations as well as other issues such as whether the coverage of all points of landing could be monitored. The Consultation acknowledged that any VMS systems should be ready to absorb the inevitable evolution of equipment. Costs and other factors should be considered.

29. The monitoring of small undecked fishing vessels was discussed in the Consultation. Several issues that needed to be addressed were identified, including; the large number of these vessels, perhaps as high as 2.7 million; the need for reliable power supplies (such as solar and batteries) in addition to the use of devices with low power consumption; rethinking necessary specifications that could operate in such fisheries and whether fisheries managers would consider it necessary to monitor these vessels for both management and safety purposes, were identified as issues that should be addressed.

30. Enhancing VMS data through verification was also raised in the Consultation. It was noted that false VMS positions could be generated by WNGSS simulators and detected by analyzing the vessel’s behaviour over periods of time. This analysis could be an enormous

and costly task. It was proposed that international cooperation to fund research programmes in this area could be appropriate. The Consultation agreed that further protocols were required to respond to claims of failed equipment and the certification of repairs and testing to ensure that equipment was operating properly prior to allowing vessels to leave port.

31. During the discussion on electronic logbooks, the Consultation noted recent developments in respect of port state measures and traceability. The Consultation appreciated fully the significance of these developments and noted the need for further development of electronic logbooks. It was agreed that the transmission of multiple data would be much facilitated by standardisation of data formatting, also with regard to reducing the cost of transmission.

### **Strengthening the development and implementation of national legislation and international instruments to foster enhanced international cooperation for the wider use of technology**

32. The Consultation emphasized that the VMS legal framework should incorporate minimum requirements to ensure the effective implementation of VMS and the avoidance of downstream problems. It was noted that the framework should provide, *inter alia*, for the use of information gathered through VMS as evidence in legal proceedings, the types and activities of fishing vessels that could be subjected to VMS requirements, system specifications, confidentiality and provision for adequate penalties for non-compliance with VMS requirements.

33. The Consultation highlighted the need to define the type of fishing vessels and their related activities that could be subjected to VMS in legislation. Vessel size, the fishery, and geographical areas were referred to as some of the factors that should be addressed in implementing VMS. Of particular importance were the definitions of “fishing” and “fishing vessels” and the need to ensure that support vessels and their activities (e.g. bunker, cargo and transshipment vessels and vessels in transit) were covered by the definitions.

34. The Consultation’s attention was drawn to the jurisprudence of the International Tribunal for the Law of the Sea (ITLOS) relating to VMS. It was noted that the *Volga* case examined the right of the coastal State to impose VMS requirements under the 1982 UN Convention. ITLOS ruled that while coastal States could impose, as part of their regulations, VMS requirements on foreign vessels fishing in areas under national jurisdictions, coastal States could not impose VMS requirements as a bond or condition for the prompt release under Article 292 as the VMS requirement was not financial in nature. In relation to the application of VMS requirements to the types of vessels or their activities, the Consultation recognized that the two *Saiga* cases touched on the issue of defining “fishing vessel”. However, it was pointed out that ITLOS had not taken a position on the status of “bunkering”.

35. With respect to the use of VMS information as evidence in legal proceedings, the Consultation noted that countries gave different status to VMS data as evidence. Some countries treated VMS data as establishing a *prima facie* case or rebuttable presumption of vessel position leading to a shift in the burden of proof, while other countries treated the use of VMS data as evidence in administrative, as opposed to criminal proceedings, noting that there was widespread use of VMS data as evidence in legal systems that permitted administrative proceedings and that many cases were settled due to the reliance on VMS data.

It was underscored that the ability to effectively use VMS data as evidence in administrative and legal proceedings depended on how well the requirements were enshrined in legislation.

36. The Consultation recognized that VMS data confidentiality remained a significant concern for the fishing industry. Issues of concern focused on, *inter alia*, the nature of data supplied, the ownership of the data, the use that would be made of the data, and the authorized access to VMS premises and data. These issues needed to be considered in crafting VMS legislative provisions on data confidentiality. The Consultation noted that many countries lacked adequate legislation on the confidentiality of VMS data and that a model provision on confidentiality to be incorporated into legislation and reflected in fishing agreements could be developed by FAO to assist countries in the development and revision of legislation.

37. A further issue that was highlighted concerning the implementation of VMS related to ensuring that sanctions for the non-compliance with VMS requirements were sufficiently severe as to deter non-compliance. The Consultation agreed that it was essential that severe penalties be specified in legislation.

38. With respect to the specifications of VMS systems and equipment in legislation, the Consultation agreed that it was important that the specifications focus on functional rather than hardware specifications.

39. The Consultation considered the desirability of concluding a binding international VMS instrument. It was noted that there were many international agreements in force that already sought to promote and strengthen the implementation of VMS. It was also observed that the use of VMS was already widespread in EEZs and mandatory in many RFMO convention areas.

40. The Consultation recognized that the conclusion of a binding international VMS instrument would require extensive negotiations beyond the fishery sector as it would also involve issues relating to, *inter alia*, security and the freedom of navigation. Such an instrument would, by its nature, take a long time to negotiate and an even longer time to enter into force. With the current rate of VMS implementation around the world, and taking into consideration the establishment of new RFMOs, the utility of a binding instrument would be significantly reduced.

41. The Consultation agreed that rather than promoting a new binding international VMS instrument it would be more effective to encourage closer regional cooperation in MCS, including the implementation of VMS. It was reiterated that VMS was only one component of MCS and that for this reason other avenues should be pursued in implementing VMS. Moreover, the Consultation noted that a binding international VMS instrument would not achieve universality as it would not be applicable to non parties.

42. The Consultation stressed that RFMOs played a key role in the implementation of VMS and that they should be encouraged to adopt uniform VMS standards as a means of strengthening cooperation and making the use of VMS more successful. It was agreed that there should be a continuing sharp focus on the use of regional port State schemes to promote sustainable fisheries and to combat IUU fishing as such an approach would be more effective than a binding international VMS instrument. The Consultation noted that regional port State schemes were likely to be addressed at the next session of COFI together with the possibility

of promoting a binding international instrument on port State measures, based on the FAO model schemes.

### **Addressing the special requirements of developing countries**

43. The Consultation addressed the special requirements of developing countries with respect to VMS. It was noted that many developing countries faced problems in implementing VMS. It was reiterated that a MCS framework should be in place prior to moving to VMS implementation because the efficiency of VMS would be greatly enhanced if it was part of an established MCS structure.

44. The Consultation recognized that cost considerations were a constraint for developing countries in planning and implementing MCS programmes. It was pointed out that VMS start-up costs were sometimes met through development assistance but a lack of resources in many countries to meet ongoing costs undermined its effectiveness. High rates of personnel turnover, the need for regular equipment upgrades, human resource development, institutional strengthening and support as well as other costs burdened developing countries. For these reasons, the Consultation proposed that donors and recipient countries and institutions should try to ensure that VMS projects were structured in a sustainable manner and that maximum use was made of regional MCS cooperation, especially in terms of asset pooling and sharing, and, as appropriate, the outsourcing of VMS data handling. The Consultation noted that cooperative MCS and VMS arrangements were possible having been established in several regions including the Indian Ocean and the Pacific Islands.

### **RECOMMENDED FUTURE ACTION ON THE USE OF VMS AND SATELLITES AND IN PARTICULAR THE DESIRABILITY OF AN FAO TECHNICAL CONSULTATION**

45. Having considered that the current international legal framework provided an adequate basis for VMS adoption, the Consultation did not recommend an additional binding international agreement. However, considering that there were gaps in VMS implementation, the Consultation recommended that COFI considered developing additional mechanisms such as an IPOA, declaration, or strategies to guide and facilitate enhanced global implementation of VMS. The Consultation further recommended that the FAO Technical Guidelines for Responsible Fisheries: Fishing Operations: 1. Vessel Monitoring Systems, should be revised to support existing or future VMS implementation.

46. To achieve the effective use of VMS as a tool for MCS and to combat IUU fishing, the Consultation recommended that all States should cooperate to ensure the existence of a comprehensive MCS policy framework at the national and regional levels that integrated the legal, institutional and technical aspects of VMS. FAO should develop a checklist of legislative requirements for the implementation of VMS including access, use and sharing of data, such as model clauses and templates.

47. The Consultation recommended the further development and implementation in the following areas: independent VMS data verification through more effective use of VDS, AIS and other monitoring technologies; data security and means to detect and prevent VMS tampering; software for detecting data anomalies and improved data analysis and harmonization of data management, transmission procedures and e-logbooks.



48. The Consultation recommended that in order to enhance the implementation of MCS, particular attention should be paid to closer cooperation among RFMOs, increased flag States participation in RFMOs, capacity building for developing countries, sharing of MCS assets (data collection and processing capabilities, aircraft and vessels) particularly in respect of developing countries, the application of VMS on small vessels for improved safety and to support fisheries management, development assistance, as appropriate, with emphasis on sustainability and the provision of financial resources to FAO to support these recommendations.

## **ANY OTHER MATTERS**

### **VMS in support of port State measures**

49. The Consultation reviewed the linkage between the use of VMS and port State measures. It was noted that the exercise by port States of their competences and responsibilities under international law was of real (not sure what this word is supposed to be) importance. In particular and depending on cooperative frameworks, VMS data could be exchanged to support port State measures including harmonized regional port State schemes. With respect to catch documentation schemes designed to track the movement of fish, it was stressed that port to port tracking was highly important. It was also pointed out that fishing vessels could falsify catch and offloading data in part by engaging in the unauthorized transshipment of catch and that VMS could assist in minimizing the incidence of such transshipments. However, it was agreed that unless flag States acted responsibly, it would be difficult if not impossible to carry out follow-up actions against such vessels.

### **Comprehensive record of fishing vessels**

50. The attention of the Consultation was drawn to the fact that the 2005 Rome Declaration on Illegal, Unreported and Unregulated Fishing included a call “to develop a comprehensive record of fishing vessels within FAO, including refrigerated transport vessels and supply vessels, that incorporates available information on beneficial ownership, subject to confidentiality requirements in accordance with national law”. It was noted that UNGA Resolution A/RES/60/31 encouraged and supported this outcome. As a consequence of the 2005 Rome Declaration, FAO had undertaken a study to determine the feasibility and viability of developing such a comprehensive record. The main findings of the study were presented to the Consultation. These were that:

- the development of a Global Record was technically feasible;
- flag States and economic entities would have to be prepared to make a firm commitment to accept relevant recommendations of the study concerning the provision of vessel details and their ownership that would be essential, both administratively and technically, to ensure a workable and useful system;
- there would be a need to introduce a system through which any vessel could be uniquely identified over time, irrespective of change of name, ownership or flag; and
- the costs of the development and maintenance phases would be significant and that a phased approach would be desirable.

51. The Consultation noted this development and expressed views on how such a Global Record could enhance the effectiveness of RFMOs and in particular, how it could enhance

cooperation between them. It was further noted that these views would be drawn to the attention of the twenty-seventh session of COFI in 2007 when further developments relating to the Global Record would be addressed.

52. It was pointed out that data transmission and cooperation between RFMOs might be facilitated by the existence of a unique identifier. The Consultation was informed that the only existing unique and permanent identifier for vessels was the IMO number, that was derived from the Lloyds number, and that it applied only to vessels over 100 GT. It was pointed out that there were many vessels below that tonnage that were fishing in areas covered by RFMOs and on the high seas. It was also noted that the vessel radio call sign, which was sometimes used as an identifier, could change in the event that a vessel changed flag.

53. The Consultation agreed that the Global Record could be a valuable tool to combat the practice of IUU fishing vessel owners who reflagged with the intention of avoiding compliance with international conservation and management measures, as long as it was properly updated on a regular basis. As an example, it was noted that vessel lists presented annually by NEAFC Contracting Parties were normally prepared during the preceding year and that some lists might be outdated when the Commission updated its register.

54. In conclusion, the Consultation agreed that the development of a Global Record could be of value but caution was expressed about not underestimating the magnitude of the tasks of creating and maintaining such a record and the costs involved.

### **International MCS Network**

55. The Consultation was informed about the status of the International Monitoring, Control and Surveillance Network for Fisheries (Network). The Network was a global, voluntary arrangement of MCS professionals that has been dedicated to cooperating and coordinating to combat IUU fishing. The Network has expanded to 50 members and continues to provide a forum for law enforcement professionals. Recently, the Network was recognized by the High Seas Task Force on IUU fishing and was provided with financial resources for a three year project to enhance the services the Network provided to its members.

### **ADOPTION OF THE REPORT**

56. The report of the Expert Consultation was adopted on Thursday 26 October 2006.

**Agenda**

1. Opening of the Session
2. Election of Officers
3. Adoption of the Agenda and Arrangements for the Session
4. An inventory/assessment of the status of VMS and satellites for fisheries MCS
5. Options for enhancing the use of VMS and satellites for fisheries MCS
6. Recommended future action on the use of VMS and satellites and in particular the desirability of a FAO Technical Consultation
7. Any other matters
8. Adoption of the Report

## List of participants

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**Documents**

**Cacaud, P.** Vessel monitoring systems, use of electronic reporting systems and remote sensing (VDS): legal aspects, trends and options

**Gallagher, R.** Current status of vessel monitoring systems, satellites and other technologies for fisheries monitoring, control and surveillance



**Opening statement**  
**by**  
**Mr Ichiro Nomura**  
**Assistant Director-General,**  
**FAO Fisheries and Aquaculture Department**

Distinguished Experts, friends and colleagues:

On behalf of the Director-General of FAO, Mr Jacques Diouf, it gives me much pleasure to welcome you to FAO and to Rome for this Expert Consultation. I hope that while you are here your time will not be taken up entirely with work and that you will be able to see some of the sights of this great city.

As you probably know, Expert Consultations are an important means for channelling quality, technical advice to the Director-General. Each Expert participates in his personal capacity. You have been selected because of the geographical and professional experience you bring to the meeting. FAO is pleased to have assembled such an eminent group of people. The outcome of the meeting will assist the Organization further its understanding on monitoring, control and surveillance (MCS) and vessel monitoring systems (VMS).

Illegal, unreported and unregulated (IUU fishing) and its effects on fisheries sustainability continues to be high on the international fisheries agenda. As you know it is being addressed in many international, regional and national fora including those of the United Nations, FAO and regional fisheries management organizations (RFMOs). In 2001 the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing was endorsed by the FAO Council and countries were urged to implement it as a matter of priority. MCS is one of the cornerstones of the Plan. Indeed, at the Twenty-sixth session of the FAO Committee on Fisheries (COFI) in 2005 the importance of effective MCS and VMS were highlighted as primary defences against IUU fishing.

Immediately following COFI, the FAO Ministerial Meeting on Fisheries on 12 March 2005, adopted the Rome Declaration on Illegal, Unreported and Unregulated Fishing. While noting the harmful and global consequences of IUU fishing on sustainability, on the conservation of marine living resources and marine biodiversity and on the economies of developing countries and their efforts to develop sustainable fisheries management, Ministers stressed the central role of MCS and VMS in combating IUU fishing.

Furthermore, the Ministers recognized the need to establish MCS and VMS programmes where none currently exist; to strengthen and harmonize existing international VMS cooperation; to ensure that all large-scale fishing vessels operating on the high seas be required by their flag State to be fitted with VMS by December 2008; and for RFMOs to work to facilitate the exchange of VMS and observer data. The Ministers resolved to provide financial and technical assistance to developing countries to enhance and implement MCS and VMS and to consider the establishment of a special voluntary fund for this purpose. Importantly, United Nations General Assembly resolution 60/31 on sustainable fisheries, adopted on 29 November 2005, urged flag States to meet the 2008 deadline mentioned in the 2005 Rome Declaration.

The Expert Consultation will address some of these critical MCS and VMS issues. In particular, it has been tasked to review and assess technical, legal and institutional aspects of the use of VMS and satellites with a view of facilitating the wider use of this technology and promoting and strengthening international cooperation among States for its use. In doing so the Consultation will:

- Undertake an inventory or assessment of the status of VMS and satellites for fisheries MCS in terms of the technology and equipment deployed and legal and institutional considerations;
- Propose options for enhancing the use of VMS and satellites for MCS in terms of facilitating the enhanced use of technology and strengthening the development and implementation of national legislation and international instruments to foster enhanced international cooperation for the wider use of technology including the desirability and practicality of any binding international agreement that is global in nature for the use of VMS; and
- Recommend future actions on the use of VMS and satellites and in particular the desirability of convening a FAO Technical Consultation.

The Consultation's work is heavy and concentrated given the time available. However, I am sure that you are all proficient and diligent, accustomed to working to tight deadlines. I am therefore confident that it will be possible to achieve the objectives set for the Consultation.

To assist the work of the Consultation FAO staff are on call during the meeting to provide clarification on technical issues should such clarification be sought. I can assure you that I will follow the deliberations with keen interest and I am certain that other Fisheries Department senior staff will be do likewise.

The Report of the Consultation will be made available to COFI at its Twenty-seventh session in March 2007. It will be of considerable benefit in the event that COFI opts to proceed with a Technical Consultation.

Let me conclude by wishing you all well for a fruitful and successful meeting. If my colleagues or I can be of assistance during this intense three-day period please do not hesitate to call on us.

Thank you very much.

**VESSEL MONITORING SYSTEMS, USE OF ELECTRONIC REPORTING  
SYSTEMS AND REMOTE SENSING (VDS): LEGAL ASPECTS,  
TRENDS AND OPTIONS<sup>1</sup>**

by  
**Philippe Cacaud**

**INTRODUCTION**

Comprehensive and satisfactory conservation and management of marine living resources remain illusive. Despite the relative success in drawing the attention of the international community to illegal, unreported and unregulated (IUU) fishing as a major problem in conservation and management of resources, fish stocks continue to be subjected to heavy fishing effort. In certain cases, these stocks are fully exploited or depleted.<sup>2</sup>

Many initiatives have been undertaken to combat IUU fishing.<sup>3</sup> In recent years, notable improvements in the area of fisheries monitoring control and surveillance (MCS) were made, with many States adopting individually and collectively (through regional fisheries management organizations (RFMOs)) measures relating to, *inter alia*, licensing of vessels to fish on the high seas, registers of fishing vessels, positive list and negative list of vessels, satellite-vessel monitoring systems (VMS), electronic reporting systems and catch documentation schemes.

The rapid development of VMS since the late 1980s has had a major impact on the way in which fisheries are managed worldwide. Technology has become more affordable and the availability of the Inmarsat, Iridium, and Argos satellite communications systems globally, combined with the more select coverage of the Euteltracs and Globalstar systems has created a competitive market for tracking vessels of many types. The public availability of the Global Positioning System (GPS) added a new dimension to positioning accuracy. In 2008 the European Galileo system will go into operation and will provide additional capabilities. Many coastal states have or are in the process of adopting and implementing VMS. The perceived importance of the technology as a central pillar of enforcement and compliance schemes has led to it being referred to in recent international fisheries instruments. These include the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (Compliance Agreement), the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UNFSA) and resolutions of the United Nations<sup>4</sup> and the Food and Agriculture Organization of the United Nations (FAO).<sup>5</sup>

There is no doubt that VMS, where it is introduced, has greatly assisted in the detection of illegal fishing activities and has enabled a better use of enforcement assets. A decrease in certain types of violations (e.g. incursion in prohibited fishing areas) has been reported. FAO's International Plan of

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<sup>1</sup> The paper was prepared by FAO Consultant Philippe Cacaud. The author gratefully acknowledges the review and input by Blaise Kuemlangan, FAO Legal Office.

<sup>2</sup> See State of the World Fisheries and Aquaculture, FAO 2004 at p.32

<sup>3</sup> For example, the commitments by USA, Australia, Canada, and EU.

<sup>4</sup> In May 2006, the proposal was made by the US delegation at the UNFSA Review Conference for all vessels fishing on the high seas to be required by their flag states to be fitted with VMS by 2008. See paragraph 104 of the Report of the Review Conference of the UNFSA, General Assembly, A/CONF.210/2006/15, July 2006.

<sup>5</sup> In March 2005, many members of FAO's Committee on Fisheries (COFI) stressed the importance of effective fisheries MCS tools, including VMS as primary defences against IUU fishing. See paragraph 22 of the Report of the twenty-sixth session of the Committee on Fisheries, Rome, 7-11 March 2005, FAO Fisheries Report No.780, Rome, FAO 2005. 88p.

Action to prevent, deter and eliminate illegal unreported and unregulated fishing (IPOA-IUU) identifies and adds to the array of enforcement measures. The IPOA-IUU, within the framework of the FAO Code of conduct for Responsible Fisheries (Code of Conduct), also highlights the role of and possible effectiveness of VMS relative to the other enforcement measures.

The perceived value of VMS in enforcement and compliance has also led to the multiplication of MCS Projects with a VMS component by donors (e.g. EU projects in Africa). However, the fact that VMS can also be used for management through communications of data (e.g. the communication of catch reports or enabling the fisheries management authorities to determine fishing grounds through the accumulation of data), enjoys a lesser degree of appreciation. Added to this unfortunate misunderstanding is the erroneous belief by many, particularly in certain developing countries, that VMS is the panacea for IUU fishing and other fisheries management problems. VMS can only be effective in compliance, enforcement and fisheries management in general if its value, as well as its limitations, is recognized. The use of VMS must be well planned for and executed and must be properly integrated into the general MCS system to compliment other MCS tools.

The purpose of this paper is to identify the legal and policy problems that States, in their capacity as coastal, flag and port States, are confronted with in the implementation of the VMS. The paper will review and analyze the options to cope with such problems in the context of the applicable rules of international law as reflected in the 1982 UN Convention on the Law of the Sea (LOSC) and major global fisheries instruments, namely the UNFSA, the Compliance Agreement, the Code of Conduct and the IPOA-IUU. This paper then discusses the development of electronic reporting systems (ERS) and use of remote sensing technologies to complement VMS and discusses, as appropriate, the legal issues associated to them. Lastly, this paper reviews the options for promoting and strengthening international cooperation among States for use of VMS.

## **PRACTICAL POLICY AND LEGAL ISSUES IN THE IMPLEMENTATION OF VMS ARISING FROM STATE PRACTICE**

In view of the recent work done on VMS by the High Seas Task Force (HSTF) and other work, particularly the analyses of the legal bases for use of VMS<sup>6</sup>, this section takes a different approach by focusing on legal and policy problems faced by States in implementing VMS - the practical approach. This approach is adopted in order to identify the questions that have to be answered by decision makers including legislators.

The policy and legal issues are discussed in this paper in the context of the developments in State practice on the use of VMS for fisheries management.<sup>7</sup> The paper also examines VMS-related measures adopted by certain RFMOs in their regulatory areas (CCAMLR, CCSBT, IATTC, ICCAT, IOTC, (GFCM) NAFO, NEAFC, SEAFO, SIOFA and WCPFC). Although there are more than 30 regional fishery bodies worldwide, this report focuses on RFMOs that have the authority to establish conservation and management measures<sup>8</sup> and significant level of competence over high seas areas.

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<sup>6</sup> The analysis of the legal bases for use of VMS is well documented in previous work by Cacaud. (See Cacaud 1999). Likewise, a useful analysis of States' rights and obligations under international law with respect to satellite-based VMS for fisheries is undertaken by Molenaar and Tsamenyi (See Molenaar and Tsamenyi 2000). Reference to these works will be made as the options available to state legislators/regulators for VMS implementation is reviewed in this paper.

<sup>7</sup> The detailed documentation of the review on State and RFMO practice is not incorporated in this paper due to space constraints. While the review is intended to be global in scope, it is not exhaustive. Some States, which have established a VMS, are not included in the review due primarily to lack of available information and time.

<sup>8</sup> FAO lists 16 RFMOs as having competence to establish conservation and management measures. RFMOs with a very specific mandate or dealing with singles species such as the International Whaling Commission, the North Atlantic Salmon Commission and the International Pacific Halibut Commission are not included in the review.

## INTEGRATING VMS IN FISHERIES MANAGEMENT

In most important fishing nations, VMS coverage is global in scope. Fisheries management authorities are able to continuously track fishing vessels flying their flag wherever they operate, either on the high seas or in the maritime zones of a third country. Adoption of more stringent MCS measures has led vessel owners to register their vessels in countries maintaining an open registry and imposing few restrictions. In recent years, the international community has stressed the need for every state to fulfill its flag State obligations as reflected in global fisheries instruments<sup>9</sup>, particularly with respect to fishing activities on the high seas. Adoption of MCS schemes by many RFMOs has obliged many more member States to modify their fisheries law to incorporate binding resolutions into national legislation. A number of States have adopted new fisheries legislation in recent years, or initiated the review process to, *inter alia*, extend the jurisdictional scope of their legislation.<sup>10</sup> By extension of such scope, national vessels authorized to fish on the high seas or in the maritime zones of a third country are required, through license conditions, to be fitted with VMS tracking devices to monitor their position.

Once the decision to use VMS has been made, it must be integrated into fisheries management. Fisheries management authorities (FMAs) must determine how VMS can be best used to help achieve the agreed goals of their fisheries policies. VMS can assist in both data gathering and ensuring compliance with conservation and management measures. Previously, VMS has been used primarily as a compliance tool for the detection of zone violations such as incursion of fishing vessels into no-take zones, closed areas or exclusive zones (e.g. incursion of industrial fishing vessels into zones reserved for artisanal fisheries), implementation of days-at-sea programs and for monitoring compliance with closed seasons. As will be shown in section 3 of this paper, the use of VMS for data gathering is slowly developing through the establishment of electronic reporting systems.

In developed coastal States, fisheries management plans were developed to ensure the sustainable utilization of principal fisheries. The role played by VMS is generally specified in such plans or in MCS schemes. Enhancement of VMS is also one of the strategies outlined in national plans of action to prevent, deter and eliminate IUU fishing.<sup>11</sup> An example of this is the French Maritime Fisheries Directorate which establishes, through a circular, an annual MCS plan for maritime fisheries which specifies annual MCS priorities. In 2005, fisheries inspectors were, among other things, directed to make increasing effort to verify the proper functioning of VMS tracking devices installed on board fishing vessels. Another priority was using VMS information to increase at-sea inspection of fishing vessels registered in France but which never land their catches in a French port.

Canada is implementing an integrated national approach to the application of VMS, which is one of a number of complementary strategies that constitute Canada's MCS program.

In the USA, Regional Fisheries Management Councils continue to implement compulsory carriage of VMS, in their fishery management plans. This is beneficial for the USA Coast Guard as it significantly improves its ability to efficiently manage fisheries resources. Through the use of VMS data the movement of fishing vessels in dozens of regulated areas from one site are effectively monitored and responses are made to confirmed incursions.<sup>12</sup> VMS is considered key to the future of fisheries

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<sup>9</sup> See article 18 of the UNFSA, article III of the Compliance Agreement and sections 34 to 50 of the IPOA-IUU.

<sup>10</sup> This is done, for example, by ensuring that the legislation applies to areas beyond national maritime zones and subjecting fishing on the high seas to an authorization. See Fisheries Law No. 31 of 2004 in Indonesia. Note that in the Western Indian Ocean Comoros, Mauritius and Madagascar have undertaken to review their fisheries legislation.

<sup>11</sup> See Canada's National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, §2.3.1, March 2005 (<http://www.overfishing.gc.ca>).

<sup>12</sup> This was acknowledged as a much better use of resources than having a cutter out patrolling in one area while an incursion is happening in a completely different location. (See Witherell Ed. 2003 at p. 32)

enforcement. There have been a number of enforcement cases decided solely on VMS data,<sup>13</sup> proving the validity of the system, its usefulness as an enforcement tool, and a way to increase presence through technology.

In stark contrast to the situation in developed coastal States, lack of rigorous planning plagues the initiatives of many developing coastal States to combat IUU fishing. While many developing coastal States have established a VMS or are in the process of acquiring one, very little planning has been made by FMAs to determine how VMS is going to be used and what purpose it will serve to make a valuable contribution to fisheries management. In some developing coastal States, basic planning instruments such as fisheries policy and strategies are still lacking let alone fisheries management plans. Under such circumstances, VMS guarantees little. If VMS is to contribute significantly to ensure compliance with conservation and management measures, it must be integrated to fisheries management. The first step should be for FMAs to develop comprehensive fisheries policy and strategies and fisheries management plans.<sup>14</sup> Based on these instruments, meaningful MCS schemes, including VMS, could be developed and proper legal frameworks can be put in place. In Madagascar, for instance, all fishing vessels operating in Malagasy maritime zones are required to be fitted with tracking devices. This measure has been used effectively to monitor zoning restrictions in the coastal shrimp fishery which is the only fishery for which a management plan has been adopted in Madagascar.<sup>15</sup> By contrast, VMS has so far proved to be of little use as a compliance tool in other fisheries.

The need to assist developing countries in planning and implementing MCS schemes and fisheries management plans, which VMS makes a valuable contribution to, is widely recognized. In its effort to combat IUU fishing, the EU has designed projects aimed at strengthening MCS schemes at regional and national levels. Several initiatives were undertaken in Africa.<sup>16</sup> Of particular interest is the recent devising of a draft regional MCS plan of action to apply to the maritime zones of the Indian Ocean Commission's member countries.<sup>17</sup> The EU is also assisting the Seychelles in formulating a national MCS plan.<sup>18</sup>

The integration of VMS in MCS, enforcement and in general fisheries management may involve enhancing capacity of fisheries monitoring centers (FMCs) to analyze VMS information and to use them effectively. An example would be to direct or redirect conventional MCS resources to areas where a physical presence is needed to verify suspect activity. VMS information would then be used in enforcement proceedings as evidence. Thus, there is a need to determine the evidentiary value of VMS information and in assessing the amount and location of fishing efforts.

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<sup>13</sup> See *infra* note 64.

<sup>14</sup> As stated by the High Seas Task Force in its Final Report, "Success will be the result of rigorous planning and application of monitoring control and surveillance schemes and fisheries management plans into which VMS makes a valuable contribution". See "Closing the Net", Stopping Illegal Fishing on the High Seas, Final Report of the Ministerially-led Task Force on IUU Fishing on the High Seas, March 2006.

<sup>15</sup> Note that there is currently no fisheries policy in Madagascar. However, one should soon be drafted with the assistance of the World Bank. The management plan for the coastal shrimp fishery was adopted under pressure of the GAPCM, which is the umbrella organization representing the interests of industrial fishing companies involved in shrimp fishing based in Madagascar.

<sup>16</sup> For instance, the EU SADC MCS Programme completed earlier in 2006 ongoing EU technical assistance to the Malagasy Fisheries Monitoring Center.

<sup>17</sup> Comoros, France (Réunion, Mayotte, Iles éparses), Madagascar, Mauritius and Seychelles are members of IOC. Note that the MCS regional plan of action is designed to apply to the EEZs of Comoros, Madagascar, Mauritius and Seychelles. France, however, will be instrumental in the implementation of this plan.

<sup>18</sup> *Proposition de plan national de surveillance, d'inspection et de contrôle pour les Seychelles*, Specific Agreement No. 23 Seychelles, European Commission, DG Fisheries, Unpublished report, (May 2006).

## THE FISHERY VERSUS TYPE OF VESSELS TO BE SUBJECTED TO VMS

Since VMS programs were first tested in the mid-eighties and early nineties, two main approaches have been utilized by States for the deployment of VMS, namely, the fisheries-specific approach and the vessel type specific approach.<sup>19</sup>

Countries with a long tradition of fisheries management and sound fisheries management plans in place have generally implemented VMS programs incrementally, fisheries by fisheries, in consultation with the fishing industry. In Canada, for instance, the total number of vessels that are currently being monitored is numbered just over 2000 and consultations are continuing into expanding the VMS program.<sup>20</sup>

In many developing coastal States, it is common practice to require that all industrial and artisanal fishing vessels carry a VMS unit as a condition of the fishing license.<sup>21</sup> Traditional fishing vessels are generally exempted from this requirement.<sup>22</sup> In practice, implementation of these programs is often hampered by a lack of planning by the FMA and a lack of consultation with the industry. As a result, compliance with VMS requirements, in particular, by the artisanal fishing fleet is a slow process. In addition, VMS may not necessarily be the appropriate tool to monitor the activities of artisanal fishing vessels especially in coastal fisheries involving a large number of vessels.

The issue of types of vessels to be covered by VMS needs to be adequately addressed. It is widely recognized that the activities of support vessels should be closely monitored as these vessels may be used to evade fisheries management measures. While it is within the purview of coastal States to impose VMS requirement on only certain types of or all fishing vessels engaged in fishing within the coastal States' maritime zones,<sup>23</sup> it is not necessarily the case for vessels that are not directly engaged in fishing but give support to vessels that are.

### *Fishing vessels and support vessels*

The first issue to be dealt within this context is that of definitions. What is meant by "fishing vessel" and "support vessel"? The LOSC uses "fishing vessel" or "fishing" and also refers to "fishing activities" without offering any definitions. Fisheries instruments adopted in the nineties recognize, in one way or another, that flag State obligations extend to vessels that are not directly engaged in fishing operations. Only the Compliance Agreement explicitly defines "fishing vessel" as "any vessel used or intended for use for the purposes of the commercial exploitation of living marine resources, including mother ships and any other vessels directly engaged in such fishing operations".<sup>24</sup> Sections of the Code of Conduct distinguish "fishing vessels" from "fishing support vessels" without providing definitions.<sup>25</sup>

At least two recently adopted regional fisheries conventions incorporate broad definitions of "fishing vessel". Article 1(e) of the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPOC)<sup>26</sup> stipulates that "fishing vessel" means "any vessel used or intended for use for the purpose of fishing, including support ships, carrier vessels and any other vessel directly involved in such fishing operations". Article 1(j) of the

<sup>19</sup> Australia, Canada, New Zealand and the USA, among others, belong to the first category, whereas the EU, Norway, Seychelles and Indonesia, to name a few, fall into the second category.

<sup>20</sup> Personal communication by Mr. Trevor Fradsham, Project Manager, VMS, Fisheries and Oceans.

<sup>21</sup> Note that there are no universal definitions of industrial and artisanal fishing vessels. Therefore, it is up to each State to provide for such definitions in its national legislation. Criteria used to distinguish between these two categories of vessels include length overall and power of engine.

<sup>22</sup> While there is no universal definition of a traditional fishing vessel, it generally refers to a small-scale vessel with no engine used for traditional fishing activities.

<sup>23</sup> Based on the provisions of articles 56.1(a) and 62.4(e) of the LOSC.

<sup>24</sup> Article I (a).

<sup>25</sup> See sections 6.10, 6.11 and 7.8.1.

<sup>26</sup> Adopted at Honolulu, Hawaii, USA, on 5 September 2000.

Convention on the Conservation and Management of Fishery Resources in the South-East Atlantic Ocean<sup>27</sup> provides that “fishing vessel” means any vessel used or intended for use for the purposes of the commercial exploitation of fishery resources, including mother ships, any other vessels directly engaged in such fishing operations, and vessels engaged in transshipment.

These conventions also contain precise definitions of “fishing” encompassing not only fishing operations *per se*, but also activities in support of these operations.<sup>28</sup> Transshipment of fish is expressly mentioned as a fishing activity in the definition provided under the WCPOC. It is worth noting that article 24.8 of this convention provides that each member of the Commission must require its fishing vessels, including support and carrier vessels as well as vessels used for transshipment, that fish for highly migratory fish stocks in the Convention Area to use near-real time satellite position-fixing transmitters while in this area. Several RFMOs such as NEAFC<sup>29</sup> and IOTC<sup>30</sup> have adopted measures that subject vessels of contracting parties (CPs), and cooperating non-contracting parties (CNPs) used for transshipment, to VMS requirements. A similar requirement is imposed on these types of vessels by certain coastal States.<sup>31</sup>

There seems to be an emerging trend in coastal states and RFMOs to broaden the scope of the definition of “fishing vessel” in an attempt to regulate activities of vessels used for support operations, transshipment and transport of fish to the first place of landing. The question to be considered here is whether international law provides coastal States with the competence to regulate the behavior of foreign support vessels while in their maritime zones.

### ***Transshipment and bunkering***

In their analysis, Molenaar and Tsamenyi demonstrated that transshipment and bunkering<sup>32</sup> could not be regarded as an exercise of the right of innocent passage<sup>33</sup> for failure to meet the requirements of passage under article 18(2) of the LOSC. Consequently, coastal States are entitled to regulate such activities in their territorial sea. With respect to the EEZ, there is less certainty. However, one may argue that it could be deduced, from the broad way in which article 56(1)(a) of the LOSC defines a coastal state’s sovereign rights in relation to living marine resources, that the LOSC provides sufficient legal basis for coastal States to regulate transshipment activities in their EEZ. This would include the requirement for foreign vessels used for transshipment to carry a VMS unit. State practice offers ample support to back up this interpretation.<sup>34</sup>

As for bunkering, the matter is not as straightforward as its link with fishing is less obvious. This has not stopped some States from regulating bunkering for the purpose of fisheries management.<sup>35</sup>

<sup>27</sup> Adopted at Windhoek, Namibia on 20 April 2001.

<sup>28</sup> See article 1(d) of the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean and article 1(h) of the Convention on the Conservation and Management of Fishery Resources in the South-East Atlantic Ocean.

<sup>29</sup> See article 9 NEAFC Scheme of control and enforcement and IOTC Resolution 06/03 adopted on 26 May 2006.

<sup>30</sup> IOTC Resolution 06/03 (2006).

<sup>31</sup> This is the case, for instance, in Indonesia, Norway, Madagascar and South Africa.

<sup>32</sup> For the purpose of this section bunkering is to be construed as entailing not only refueling of a fishing vessel but also as including activities such as provision of food, water and other goods to the crew.

<sup>33</sup> With respect to the territorial sea and archipelagic waters.

<sup>34</sup> See, for instance, in the EU, articles 28(a) of Council Regulation (EEC) No. 2847/93 of 12 October 1993 and article 17 of Commission Regulation (EC) No. 2244/2003 of 18 December 2003; See also sections 1(xx) and 1(xlix)(a) of the Marine Living Resources Act 1998 of South Africa and section 76(1) of Fisheries Regulations 2003 in terms of the Marine Living Resources Act, 1998. Note that in Indonesia an estimated 236 support vessels have been equipped with a VMS transmitter.

<sup>35</sup> See, for instance, the definition of “fishing vessel” in the Coastal Fisheries Protection Act of Canada (section 2(1)) which includes: “any ship or boat or any other description of vessel used in or equipped for ... (c) provisioning, servicing, repairing or maintaining any vessels of a foreign fishing fleet while at sea”. See also the definition of “related activity” in the Fisheries Management Act, 1998 of Papua New Guinea (section 2(1))



Molenaar and Tsamenyi noted that the International Tribunal for the Law of the Sea (ITLOS) addressed the issue of bunkering in the *Saiga* Case but that its findings were not conclusive. They concluded that if bunkering could not be regarded as an activity which is an exercise of freedom of navigation or an associated use, and is not covered under the coastal State's jurisdiction under the LOSC either, the issue becomes one of "residual rights".<sup>36</sup> As at the date of publication, no international institution has formulated any authoritative conclusion on this matter.

### *Unlicensed foreign fishing vessels in transit or calling into a port*

Another issue of importance to be addressed is that of foreign fishing vessels (FFVs) not authorized to fish in a coastal State's maritime zones transiting through the maritime zones of such State. Traditionally, state practice has been to require these vessels to stow their fishing gears. This requirement is very difficult to enforce especially if the vessel is not obligated to declare its entry into/exit from the coastal state. It also means that States have to make regulations setting forth the stowage conditions for each type of gear (which is rarely done, especially in developing countries).

An increasing number of states are exploring ways to address the issue effectively. To this end, these states envisage subjecting FFVs to the obligation of declaring their entry into/exit from their EEZ (e.g. IOC member countries). While some states are still reluctant to subject these vessels to VMS while in their waters lest they be in breach of international law (freedom of navigation), there is indication that other states are willing to take this direction. Seychelles, for instance, requires unlicensed FFVs that enter its waters to offload catch in Victoria harbor to be fitted with VMS and report their position to the Seychelles Fishing Authority (FSA) while in Seychelles waters. South Africa is doing the same with respect to FFVs using any of its ports more than once.

The question to be considered here is whether or not a coastal State has the competence to require an unlicensed FFV to carry a VMS unit as a pre-condition to transit through its maritime zones (or for the purpose of calling at its port). Molenaar and Tsamenyi argue that the LOSC does not permit a coastal state to subject unlicensed FFVs to VMS in their waters unless it could be demonstrated that this requirement is a generally accepted rule or standard.

In the territorial sea, foreign vessels while exercising their right of innocent passage are required to comply with the laws and regulations enacted by the coastal State in accordance with article 21(1) of the LOSC.<sup>37</sup> Paragraph 2 of this article contains an important restriction on the coastal State's legislative powers by stipulating that "laws and regulations shall not apply to the design, construction, manning or equipment of foreign ships unless they are giving effect to generally accepted international rules or standards". It should be noted that this limitation applies to any type of rules or standards, irrespective of the purpose of regulation. Within the EEZ, the coastal State enjoys the sovereign rights laid down in article 56 of the LOSC. Its legislative competence with regard to equipment standard is limited to the prevention, reduction and control of pollution from vessels.<sup>38</sup>

Can the requirement to carry a VMS unit be considered as an equipment standard? In support of the view that the VMS requirement is not an equipment standard, Molenaar and Tsamenyi argue that all a VMS unit does is facilitate the verification of compliance with lawful national and/or international regulatory measures. They drew an analogy with the requirement for unlicensed FFVs to give prior

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which includes: "(c) refueling or supplying fishing vessels, selling or supplying fishing equipment or performing other activities in support of fishing".

<sup>36</sup> Article 59 of the LOSC provides that "In cases where this Convention does not attribute rights or jurisdiction to the coastal state or to other States within the exclusive economic zone, and a conflict arises between the interests of the coastal State and any other State or States, the conflict should be resolved on the basis of equity and in the light of all the relevant circumstances, taking into account the respective importance of the interests involved to the parties as well as to the international community as a whole".

<sup>37</sup> See in particular article 21(1)(d).

<sup>38</sup> See article 211(5) of the LOSC.

notification of entry into a coastal State's maritime zones even if they merely intend to transit. Such a requirement is fraught with controversy particularly in relation to warships and vessels carrying hazardous cargo. They concluded that flag States were likely to object to such a measure in the fisheries context as it may set a precedent. While it cannot be denied that introduction of prior notification for the purpose of fisheries management might meet some resistance by flag states, it should also be acknowledged that an increasing number of coastal states have shown interest in monitoring the movement of unlicensed FFVs entering their maritime zones as such vessels are often seen as potential IUU fishing vessels. South Africa, for instance, has enacted legislation authorizing the Minister responsible for fisheries to prescribe "the operation of, and conditions and procedures to be observed by, any vessel which enters South African waters for any purpose, including transiting the South African fisheries waters".<sup>39</sup> In the Indian Ocean, IOC member countries<sup>40</sup> are contemplating introducing similar provisions in their fisheries legislation.<sup>41</sup>

Since it might be difficult to make a case to support the view that the requirement of a VMS unit is an equipment standard, one is left with the difficult task of showing that this requirement has become a generally accepted rule. Pursuant to article 94 of the LOSC a flag state has the obligation to exercise effective jurisdiction and control over ships flying its flag.<sup>42</sup> Molenaar and Tsamenyi argue that neither this general norm nor the norms contained in global fisheries instruments in relation to VMS amount to a generally accepted rule.<sup>43</sup> In view of the rapid expansion of VMS throughout the world, one may advocate, however, that there might be growing support for this requirement to be recognized as a generally accepted rule.

Of interest are the recent developments in the sphere of maritime security. Following the event of 11 September 2001 in New York, the international community undertook to review the international maritime legal framework in order to enhance measures and procedures to prevent acts of terrorism that threaten the security of passengers and crews and the safety of ships. This led to the adoption of the International Ship and Port Facility Security Code (ISPS Code) in December 2002<sup>44</sup> and the introduction of special measures to enhance maritime security in the International Convention for the Safety of Life at Sea (SOLAS). As part of this global effort to prevent acts of terrorism, the IMO Maritime Safety Committee (IMO MCS) adopted a new regulation making it a mandatory requirement for flag States to operate a long-range identification and tracking system (LRIT) for passenger ships, cargo ships of 300 GT and over, and mobile offshore drilling units.<sup>45</sup> The SOLAS regulation on LRIT establishes a multilateral agreement for sharing LRIT information for security, search and rescue purposes, amongst SOLAS Contracting Governments, in order to meet the security needs and other concerns of these Governments. It maintains the right of flag states to protect information about the ships entitled to fly their flag, where appropriate, while allowing coastal States access to information about ships navigating off their coasts. The LRIT information ships will be required to transmit include the ship's identity, location and date and time of the position. Data derived through LRIT will be available only to the recipients who are entitled to receive such information and safeguards concerning the confidentiality of those data are built into the regulatory provisions. SOLAS

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<sup>39</sup> See section 77(2) (j) of the Marine Living Resources Act 1998.

<sup>40</sup> Comoros, France (Réunion Island) Madagascar, Mauritius and Seychelles.

<sup>41</sup> IOC member States (except France) have undertaken to review their fisheries legislation with the assistance of the EU in the framework of the Pilot Project for monitoring, control and surveillance of large pelagics in the Indian Ocean.

<sup>42</sup> With respect to fisheries, see article III of the FAO Compliance Agreement and article 18(2) of the UNFSA.

<sup>43</sup> See, *inter alia*, article 18(3)(g)(iii) of the UNFSA and section 24.3 of the IPOA IUU. Note that newly adopted regional conventions such as the 2001 Convention on conservation and management of fishery resources in the South East Atlantic Ocean and the 2000 Convention on the conservation and management of highly migratory fish stocks in the Western and Central Pacific Ocean contain provisions with respect to VMS. See provisions of article 14(3)(e) and article 24(8) respectively.

<sup>44</sup> The ISPS Code was adopted on 12 December 2002 by the Conference of Contracting Governments to the International Convention for the Safety of Life at Sea, 1974.

<sup>45</sup> The new regulation on LRIT is included in SOLAS Chapter V on safety of navigation. It was adopted at the 8st session of the IMO MSC in May 2006.

Contracting Governments will be entitled to receive information about ships navigating within a distance not exceeding 1000 nautical miles off their coast. The LRIT regulation is expected to enter into force on 1 January 2008.

With the adoption of the SOLAS regulation, LRIT, which like VMS is an identification and tracking system, has become a generally accepted rule for the purpose of maritime security. The question that comes immediately to mind is whether in the sphere of fisheries management a similar agreement may be reached by the international community in respect of VMS. The events of September 11 have made possible quick and profound changes in the approach to maritime security by the international community, which, under normal circumstances, would have taken many more years to materialize. Is the current international environment favorable to the recognition of VMS as a generally accepted rule? While IUU fishing is not comparable to tragic events of September 11, it is nonetheless recognized by the international community as a serious issue that needs to be addressed urgently and effectively.<sup>46</sup> It is therefore in this context that initiatives to establish VMS requirement as a generally accepted rule could be pursued.

An additional issue concerning LRIT is whether or not it can be integrated with VMS or used independently for fisheries MCS purposes. The potential for verifying a fishing vessel position at any given time using a mandatory vessel tracking system within the system's range (1000m) appears vast. However, a difficulty may be posed where it is considered inappropriate to use a system that is established for safety of lives, navigation and security for secondary purposes such as fisheries MCS. The results of trials of LRIT by IMO may present some answers. Moreover, the anticipated meeting of the FAO/IMO Ad Hoc Working Group on IUU Fishing presents a valuable opportunity to clarify this issue.

## **VMS DATA SECURITY**

Ensuring data security has proved to be a major challenge for fisheries management authorities. It is of paramount importance for compliance and management purposes that VMS information that is transmitted to FMCs is reliable and cannot be falsified. State practice shows that two approaches have been applied to achieve this goal.

The first approach adopted by Australia, Canada, New Zealand, Pacific Forum Fisheries Agency (FFA) and the USA is to type-approve specific models of equipment that have been vetted for their resistance to tampering. Under this scheme, vessel operators are required to use any models of equipment that have been listed by the competent authority as satisfying agreed security standards. In New Zealand, vessel operators wishing to use a device other than those listed may apply to the Director General of Fisheries for a type approval in respect of such device. If it complies with the appropriate standards and requirements the Director General of Fisheries may grant a provisional type approval in respect of that device.<sup>47</sup> A similar approach was adopted in Brazil, Chile, Peru and Indonesia however, during the first phase of implementation of the VMS program, vessels covered by VMS were required to use one specific type of equipment. Once this system had been properly tested after a few years and technical specifications for VMS equipment developed, vessel operators were entitled to use any equipment satisfying the required standards and norms. Some States may also require use of satellite systems that permit independent external data verification. This feature is extremely useful for compliance purposes as it permits the competent authority to verify the accuracy of vessel position data transmitted by any VMS unit. Currently, ARGOS and Euteltracs<sup>48</sup> are the only two satellite systems to offer this possibility. Another option would be to use satellite imagery to verify authenticity of VMS information relating to vessel positions.

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<sup>46</sup> See supra notes 3 and 4.

<sup>47</sup> See section 5 of Fisheries (Satellite Vessel Monitoring) Regulations 1993

<sup>48</sup> And soon the European Galileo system.

The second approach adopted by most other States allows the vessel operator to select the equipment that will be used on the vessel from a range of commercially available models provided that it is compatible with the coastal State VMS and that it is tamper proof<sup>49</sup> or not capable of being manually overridden.<sup>50</sup> While the first requirement is straightforward, the second is more problematic and may prove difficult to enforce in the absence of a clear definition of “tamper proof”. Should this concept be interpreted *stricto sensu* to mean that the equipment on board any vessel should be incapable of being tampered with or should it be interpreted less restrictively as being indicative of the equipment on board the vessel meeting certain agreed security standards? Technically speaking, it is quasi-impossible to ensure that a device is 100 percent tamper proof. Practice has shown that this is not the case as vessels operators have found ways to interfere with the equipment currently in use.<sup>51</sup> While improvements in technology might make it more difficult in the future for vessel operators to tamper with VMS equipment, it would be illusory to think it will ever be 100 percent tamper proof. In any case, it is doubtful that manufacturers or suppliers would guarantee that their equipment is inviolable. Since it is clearly unreasonable to require that the equipment on board vessels should be 100 percent tamper proof, action would have to be taken at the international level to develop acceptable universal security standards for VMS equipment. It was proposed that once agreed upon these standards could be submitted to one of the international standards organizations such as ISO for publication. Once this is accomplished, the competent authority need only adopt the agreed standards as part of its VMS specifications. As for tracking devices already installed aboard fishing vessels, the solution would be to require the operators of these vessels to upgrade their VMS equipment within a specified period so as to bring them in line with internationally recognized standards.<sup>52</sup>

Another issue to be tackled by fisheries authorities is that of verifying system technical reliability (i.e. how to verify that VMS equipment on board vessels meet recognized international security standards). This may prove to be a major challenge for coastal States, particularly in countries where FFV fleets do not call at local ports to land their catches or use other port services. In practice, very few coastal developing States, including countries where technical inspections prior to fishing campaigns is required by law, undertake inspection of FFVs to verify whether the tracking devices fitted on board these vessels are in good working order. Competent authorities in these countries generally rely on the information furnished either by the flag State or directly by the fishing company with little guarantee that the information provided is accurate. One solution to this could be for these developing coastal States to require a statement from the flag State certifying, on a case-by-case basis, that any VMS unit installed on board any fishing vessel flying their flag is in conformity with recognized international standards.

From the compliance and enforcement perspective, the technical requirements that ensure VMS data security need to be incorporated in principal or subsidiary legislation to ensure enforceability.

## **VMS DATA CONFIDENTIALITY**

While fishing companies resisted the installation of VMS equipment on board their vessels in the early days of VMS, nowadays there seems to be a general acceptance of such equipment as vessel operators now understand the benefits that can be derived from this system (e.g. safety at sea). Confidentiality of VMS information nonetheless remains one of the major concerns for the fishing industry. Fishing positions have a commercial value and should therefore be protected accordingly. While most developed countries have enacted legislation providing adequate protection of commercial and electronic data and taken action to regulate access, disclosure and use of such data, this is not the case for all countries. Many developing countries still lack the proper legal framework to ensure the

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<sup>49</sup> See section 76 (2) (b) (i) of Regulations in terms of the Marine Living Resources Act, 1998 of 1998.

<sup>50</sup> See article 5.2 of Commission Regulation (EC) No. 2244/2003 of 18 December laying down detailed provisions regarding satellite-based vessel monitoring systems.

<sup>51</sup> See Navigs 2005, Fishing Vessel Monitoring Systems: Past, Present and Future, Paper prepared for the High Seas Task Force, OECD, at pp. 11-21 for a detailed account of VMS equipment tampering.

<sup>52</sup> *ibid* at p.20.

confidentiality of commercial and electronic data.<sup>53</sup> With the rapid development of e-commerce and the increasing volume of data that is transmitted electronically every day for many different purposes, it is likely that legislation regulating these activities will be enacted in years to come. Such legislation will need to incorporate the minimum requirements to assure confidentiality which may include: designating VMS information as confidential material; requiring that VMS information be used primarily for MCS and fisheries management purposes; clearly defining the situations in which secondary use of VMS information is permitted (e.g. for search and rescue); restricting access to premises where VMS information is processed or stored as well as the access to VMS information; and, making breach of confidentiality an offence punishable by severe penalties.<sup>54</sup>

## **FACILITATING THE USE OF VMS INFORMATION AS EVIDENCE IN JUDICIAL PROCEEDINGS**

A proven practical use of VMS is that VMS information is ultimately utilised as evidence in enforcement proceedings. Different legal systems have different standards and procedures for establishing the commission of an offence. However, most legal systems require the prosecution to adduce evidence before a judicial tribunal (e.g. a court) that is sufficiently reliable to establish wrongdoing with an appropriate degree of certainty.

From a legal perspective the question of whether or not VMS data is admissible evidence in proceedings relating to fisheries offences and the weight accorded such evidence, will ultimately depend on the applicable rules of evidence in the jurisdiction concerned.<sup>55</sup> The source of such rules of evidence varies from jurisdiction to jurisdiction. They may be found in a general code of judicial procedure,<sup>56</sup> code of criminal procedure,<sup>57</sup> in a formal set of court-made rules<sup>58</sup> or in specific legislation on evidence of general application,<sup>59</sup> or as regards specific sectoral offences, in provisions contained in the relevant sectoral legislation.<sup>60</sup> In any case the practice and decisions of the courts, particular the higher courts will also play an influential role.<sup>61</sup>

In common law systems, the difficulty in using VMS information (e.g. to establish the position of a vessel at a given time) is due to the general rule of evidence that dictates that "hearsay" is inadmissible. Although states have varying versions of the rules on "hearsay" evidence, the general idea is that courts are reluctant to accept evidence from witnesses who do not appear before the court in person, or who are testifying to matters that are not within their personal knowledge. A court may thus refuse to accept VMS data unless an expert in VMS technology appears before the court to

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<sup>53</sup> Note that there are signs of improvement. See, for instance, Ministerial Decree No. 29 of 2003 (Chapter VIII) of Indonesia.

<sup>54</sup> See Kuemlangan, 2000

<sup>55</sup> For example, the hearsay rule (See Ccaud, P. 1999).

<sup>56</sup> Such as the Swedish Code of Judicial Procedure (*Ratttegonsbalk*).

<sup>57</sup> Such as the French Code of Criminal Procedure (*Code de procedure penale*).

<sup>58</sup> Such as the Federal Rules of Evidence of the United States Supreme Court.

<sup>59</sup> Such as the Police and Criminal Evidence Act in the United Kingdom, as amended. Interestingly, in its original form section 69(1) originally provided that a statement in a document produced by a computer shall not be admissible in criminal proceedings of any fact stated therein unless it is shown - '(a) that there are no reasonable grounds for believing that the statement is inaccurate because of improper use of the computer; (b) that at all material times the computer was working properly, or if not, that any respect in which it was not working properly or was out of operation was not such as to affect the production of the document or the accuracy of its contents.'

<sup>60</sup> Such as the South African Marine Living Resources Act, 1998 which establishes a number of special rules of evidence relating to fisheries offences.' These provisions were in fact removed by section 60 of the Youth Justice and Criminal Evidence Act 1999, thus facilitating the use of VMS data as evidence in criminal prosecutions.

<sup>61</sup> In the United Kingdom and the United States the precedents created by court decisions are an important source of rules of evidence.

confirm the accuracy and reliability of such systems in general and confirm that the particular system was working properly, and that a qualified person interpreted the data correctly.

Nevertheless, certain legal systems may allow a court to take "judicial notice" of certain facts and accept them as true even in the absence of specific evidence. Courts generally take judicial notice of facts that are matters of general knowledge or are well-known (notorious) in the local area. As VMS becomes more widely used and understood, more courts may be willing to take judicial notice of the accuracy of data derived from VMS.

Where it is desirable to craft evidentiary provisions in the relevant sectoral legislation (i.e. fisheries legislation), careful drafting of the evidentiary rules and fisheries laws can help secure convictions in appropriate cases, while retaining safeguards to address due process issues and ensure that innocent parties are not convicted.<sup>62</sup> For example, the South African Marine Living Resources Act, 18 of 1998 (as amended), contains provisions designed to facilitate the use of evidence derived from new technologies.<sup>63</sup>

Recent success in securing convictions against offenders using VMS information as the only or primary evidence comes out of Iceland<sup>64</sup> and the United States<sup>65</sup>, however, it is observed that these are still early days. Research suggests that VMS data had been considered by the courts on less than a dozen occasions to date. Apart from the fact that VMS is still a relatively new technology another possible reason for the relative paucity of cases is that prosecutors are often careful in deciding which cases to bring before the courts when new legislation or new technology is in issue. More specifically a weak case that is lost can set an unfortunate precedent.<sup>66</sup> In this connection the type of charge preferred as well the particular case to take to trial is a matter requiring sound judgment by the prosecutor.

Probably the most significant point that is observed is that, to date, VMS data has never been rejected as evidence by a court. Furthermore, while the reliability of the data has been challenged in some cases this has not always been the case. In part this may be due to the careful manner in which cases involving the use of VMS data have been prepared by the prosecuting authorities. Another possible reason why VMS data has not been seriously challenged is that a key component of VMS, the GPS, is routinely accepted as evidence around the world.

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<sup>62</sup> Legislative intervention may be required to deal with the problem where the use of expert evidence to prove the validity and accuracy of all information of VMS information would be extremely difficult and would constitute a significant obstacle to prosecutions. Of course, legislative enactments to facilitate use of VMS information in judicial proceedings may be futile where there is an ineffective judiciary.

<sup>63</sup> Sections 74 and 76. (See Flewelling et al. 2003).

<sup>64</sup> To date three cases have been brought before the courts in Iceland in which VMS evidence was used. All three resulted in criminal convictions before the court of first instance (the District Court of East Iceland) and one case was re-affirmed on appeal by the Supreme Court of Iceland.

<sup>65</sup> The case was brought by the National Oceanic and Atmospheric Administration (NOAA) against the Respondents - a company 'Lobsters Incorporated' who were the owners of the fishing vessel Independence and the vessel's master Lawrence M. Yacubian. The Notice of Violation and Assessment (NOVA) alleged three separate offences: that on 9 December 1998 the Fishing Vessel Independence entered approximately 1.35 nautical miles into a totally closed area; that on 11 December 1998 the Independence again entered a totally closed area (this it was alleged to be approximately 0.65 nautical miles within the closed area); and that on 11 December 1998 after the vessel had been boarded by the U.S. Coastguard the master, Mr Yacubian unlawfully made a false statement to an 'authorized officer' concerning the harvesting of fish. As regards the first count the only evidence presented by NOAA was the VMS data. The Respondents were found liable in respect of all three counts. The Respondents appealed against the decision but the appeal was turned down meaning that the original court decision stands (See MRAG 2003).

<sup>66</sup> In the US case NOAA had been anxious for some time to test the reliability and admissibility of VMS data before a court. The problem they faced was that all of the early cases settled. The Independence case was carefully prepared because of the strength of evidence available to NOAA and also the past history of violations of the Respondent Yacubian whom NOAA were keen to see permanently removed from the fishery. At the outset, therefore, the high penalties sought by NOAA made it more likely that the case would go to trial.

The types of fisheries offences (which should be clearly specified in legislation) where VMS data has been accepted as evidence before a court can be broken down as follows: unlawful entry into a closed area; failure to properly maintain a log book; illegal fishing in a closed area; failure to properly maintain a functioning VMS transponder; tampering or interfering with the transponder; and, provision of false information to the relevant fisheries administration.

Other factors which may impact on the use of VMS data in enforcement proceedings include: the availability to impose criminal or administrative sanctions under national law for failure to maintain a VMS system in good operation and/or tampering with the VMS transponder; and the extent to which VMS data is systematically compared with logbook data to detect inconsistencies. The comparison process could be greatly simplified by the introduction of electronic logbooks and the technical set up of the transponder.<sup>67</sup>

### **SUMMARY OF KEY FEATURES OF VMS PROGRAM IMPLEMENTATION THAT REQUIRE LEGISLATIVE OR REGULATORY INTERVENTION**

In addition to the detailed review (above) of the aspects of VMS implementation which require action from a policy and legal perspective, the following summarizes State and RFMO practice on issues that are usually reflected in legislation or regulation.

#### *State Practice*

- (a) Specific legislation is usually enacted to enable VMS to operate as an integral and effective part of the MCS system and the general fisheries management framework. To this end, legislation should, for example, provide that:
  - fishing is subject to an authorization regime (e.g. a licensing system) that requires the installation of automatic location communicators (ALCs);
  - vessels must be clearly marked for identification purposes, allowing the comparison of visually acquired patrol sightings and the VMS data;
  - fishing vessels must report regularly on their position, activities and catches;
  - landings and transshipments must take place in designated ports or areas under specified conditions; and,
  - information derived from satellite-based VMS is confidential (e.g. precise locations and times of fishing activities).
- (b) Implementation of VMS programs using the two basic approaches namely: (i) on a fisheries basis; or (b) by vessel type/length.
- (c) The requirement for all FFVs, regardless of size or the fisheries they are involved in, which are authorized to fish in the maritime zones of a third party to be fitted with a VMS tracking device.
- (d) Extension of VMS requirements to vessels involved in transshipment and/or support vessels.
- (e) The requirement for the tracking device installed to be operational at all times, except when the vessel is in port provided that proper notification has been made.<sup>68</sup>
- (f) The Information required to be transmitted by a VMS tracking-device include: (i) vessel identification; (ii) vessel position (longitude/latitude) (the standard requirement is that the position communicated must be with a position error of less than 500 metres, with a confidence interval of 99 percent; (iii) the date and time of position fixing; and, (iv) speed and course of the vessel.<sup>69</sup>

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<sup>67</sup> In this connection the polling frequency and the ability to vary it would seem to have potentially important implications for the use of VMS data as evidence.

<sup>68</sup> In Canada the system must be turned on at all times including between fishing trips and in port, in Norway it is subject to a written authorization.

<sup>69</sup> Note that speed and course is not always required, however it is part of any Inmarsat-C and ARGOS messages.

- (g) Prescribed frequency for transmission of the information referred to in paragraph (f) are generally required to be transmitted once every hour or every two hours.
- (h) In the event of failure or non-functioning of the VMS tracking device, the procedure generally requires that: (i) the master or the owner of the vessel communicate the position of the vessel at regular intervals (varies from once every four hours to once every 24 hours by e-mail, fax, telephone or radio to the FMC<sup>70</sup>; (ii) repair of the defective or non-functioning device be made within a specified period of time.
- (i) It is often required that the VMS tracking device be tamper-proof (tamper-proof is generally defined as not permitting the input of false positions and not capable of being manually overridden).

### ***RFMO practice***

Most RFMOs have adopted resolutions or recommendations requiring the following:

- (a) CPs and CNPs are required to develop a VMS program. The General Fisheries Council for the Mediterranean (GFCM) is contemplating doing so while newly established RFMOs such as SEAFO (Conservation Measure 01/05) and Western and Central Pacific Fisheries Commission (WCPFC) (requirement under their respective Conventions) have already adopted measures to this effect.
- (a) VMS requirement generally applies to CNPs flagged-vessels exceeding 24 metres length overall or 20 metres between perpendiculars (NEAFC, ICCAT, IATTC), 15 metres length overall (IOTC as of 1 July 2007), any vessel (NAFO, CCAMLR).
- (b) Information required to be reported through VMS (i) the vessel identification; (ii) the current geographical position of the vessel, expressed in latitude and longitude, with a position error which must be less than 500 metres, at a confidence level of 99 percent; and (iii) the date and time, expressed in UTC, of the fixing of the position of the vessel (IOTC, NEAFC, ICCAT, NAFO, IATTC, CCAMLR).
- (c) Frequency at which information reports are required to be communicated varies from at least once every two (NAFO) to six hours (ICCAT).
- (d) Requirements for Flag States to ensure that the VMS tracking device installed on board their vessels are tamper resistant or tamper proof (NEAFC, CCAMLR);
- (e) Prescribed procedures in the event of failure or non-functioning of the VMS tracking device. The procedure generally require that – (i) the master of the vessel communicate reports to the flag State FMC at least once every six hours (NAFO, CCAMLR) or once a day (NEAFC, ICCAT); (ii) the defective or non-functioning device be repaired or replaced within a specified period of time (NEAFC, ICCAT, NAFO, CCAMLR).
- (f) The requirement for CPCs to ensure that their FMC is equipped with computer hardware and software enabling automatic data processing and electronic data transmission. Each Contracting Party shall provide for back-up and recovery procedures in case of system failures (NAFO, CCAMLR).

## **DEVELOPMENTS RELATING TO ELECTRONIC REPORTING SYSTEMS**

The duty for States (in their capacity as coastal, flag or port states) to require fishing vessels to report on their activities is well founded in international law. It is the same legal basis which facilitates the use of VMS. Global fisheries instruments adopted after the LOSC, being the Compliance Agreement, the UNFSA and the Code of Conduct, have more specific provisions relating to the provision of fisheries data by fishing vessels.<sup>71</sup> These are not limited to scientific or bio-ecological data but also

<sup>70</sup> In Canada the vessel must cease fishing and must immediately return to Canadian fisheries waters.

<sup>71</sup> For example Arts. 5 (j and k), 9(d), 10(d, e, f and g), 14 and Annex 1 of UNFSA; sections 7.4 and Art. 12 of the Code of Conduct.



information on fishery capacity and fishery related social and economic data (e.g. harvesting, processing and marketing).<sup>72</sup>

The requirement in the UNFSA to ensure the “timely collection, compilation and analysis of data” for effective fisheries conservation and management (with respect to straddling and highly migratory fish stocks) underscores the need to explore options that will ensure the element of timeliness. The current initiatives (in Australia, Canada, the EU, Japan, Iceland, Indonesia, Norway and the US and RFMOs e.g. IOTC, NEAFC) trialing or utilizing electronic reporting of catch and effort data through the use of, *inter alia*, electronic logbooks (e-logbooks) are consistent with the timeliness of the data transmission requirement and should be encouraged.

The benefits of electronic logbooks are noted to include reducing illegible entries, reducing data entry errors at the FMC, securing and verifying authorized data entries, timely submission of catch and other information in relation to management requirements, increased efficiency (concomitant reduction of costs) of data entry, timely verification from other data sources (e.g. landings) and access to electronic markets.

## **POLICY AND LEGAL ISSUES IN IMPLEMENTATION OF ELECTRONIC REPORTING SYSTEMS**

The use of e-logbooks presents design and implementation issues (as noted by the 2004 FAO Expert Consultation on Data Formats and Procedures for Monitoring, Control and Surveillance<sup>73</sup>). These issues which will need to be addressed are as follows:

- (a) the scope of the e-logbook (i.e. will they be limited to the replacement of the paper logbook in use, include activity reports, effort reports, observer/inspector data, etc.);
- (b) whether or not the e-logbook will be used in parallel with a paper logbook (for legal reasons of signature, etc.);
- (c) management of the process of converting to a totally electronic system;
- (d) the need for acknowledgement or confirmation of messages that had been sent from e-logbooks;
- (e) whether the e-logbooks would be mandatory or voluntary, i.e. allow individual fishers to decide if they want to switch from the paper logbook, or not;
- (f) means of integration into regulatory frameworks, with particular attention to the evidential value of the information obtained from the e-logbook;
- (g) compatibility and inter-operability of the flag State logbooks with the requirements of third countries and of RFMOs;
- (h) the issue of compatibility, particularly with regard to language;
- (i) choice of data standards (e.g. North Atlantic Format, XML, UN/ECE EDIFACT, etc.);
- (j) routing of the information (to flag State, to coastal State, to RFMO, etc.);
- (k) problems of back-up and recovery procedures in case of technical failures;
- (l) anti-fraud provisions;
- (m) Should e-logbooks be used only in specific fisheries or on board specific size classes of vessels?
- (n) Should e-logbooks be required only for vessels fitted with VMS, or also for non-VMS vessels?

A cursory review of the current State initiatives on e-logbooks also indicates some of the current policy and legal issues (which are similar to VMS implementation) as follows:

- the need for implementing legislation that allows the FMA to implement electronic reporting (Australia’s Electronic Transactions Act 1999);
- registration for use of e-logbooks;
- type-Approved or specifically developed hardware and software components;
- data security and confidentiality; and,

<sup>72</sup> See Molenaar and Tsamenyi 2000at p. 6

<sup>73</sup> FAO 2004a.

- authenticity/non-repudiation of electronic signatures (to be up to legal standards of proof)

It is noted from the practice of States, including Australia and Norway (see Box 1 and 2), that comprehensive research, standard-setting, trials, planning, implementation and review of plans before the global application of e-logbooks are common features of current ERS initiatives.

### **Box 1. Australia's Electronic Catch and Effort Logbook Reporting<sup>74</sup>**

#### **Background**

The Federal Government's Electronic Transactions Act 1999 provides the legal framework for business and the community to use electronic communications for transactions with Government agencies. The Australian Fisheries Management Authority (AFMA) commenced looking at options for electronic logbook reporting in early 2000.

Workshops were held for both the trawl sector of the Eastern Scalefish and Shark Fishery (SESSF) and the Northern Prawn Fishery (NPF), looking for the best solution for those fisheries. Trials of different electronic logbook technologies ran in those fisheries and currently electronic logbook reporting is operational in the NPF and further trials are occurring in the SESSF.

Electronic logbook reporting will extend to other fisheries, after consultation, as interest in electronic lodgement grows.

#### **AFMA approach**

AFMA does not wish to be involved in the development of a fisher's business software or to specify what software a fisher should use - changing to electronic logbook reporting will be a fisher's own business decision. Instead, AFMA is developing a set of specifications, including standard formats for logbook data, which will be available to all software vendors interested in developing electronic logbook reporting systems. AFMA has modified its computing and data infrastructure in order to accept electronic lodgements and has developed trial procedures for testing the receipt of electronic logbook data.

#### **Benefits**

Recent years have seen the introduction into the fishing industry of computerized vessel and fishing management systems. These systems are used by skippers and companies to assist with operating their business. The systems can record information on catch, trip planning, provisioning and maintenance. Users of these systems have found that they are now recording their catch data twice: once within their vessel management system and a second time within the paper logbook. An electronic logbook system should allow the catch information to be recorded only once using the catch data in the vessel management system, which would be sent on to AFMA electronically. Besides the obvious time saving because data need only be recorded once, there are potential efficiency opportunities for both the fishing industry and AFMA from the use of electronic logbook reporting. Computerized collection of catch, effort, fishing position and time, weather, marketing, bait, fuel and supply usage data will allow fishers to undertake better data analysis. This provides the potential for: better targeting of fishing effort; better management of boat and/or fleet operations; increased opportunities to engage in electronic commerce; and, efficiencies in reporting to and more accurate exchange of data between fishers and regulatory bodies including AFMA, state fisheries agencies and Environment Australia.

<sup>74</sup> Adapted from the internet site of the Australian Fisheries Management Authority (AFMA) [http://www.afma.gov.au/industry/logbooks/elogbooks\\_about.htm](http://www.afma.gov.au/industry/logbooks/elogbooks_about.htm)

**Box 2. Norway<sup>75</sup>**

The Directorate of Fisheries has developed software (SATRAP) that makes it possible for fishing vessels to set up and transmit mandatory reports to their FMC. Entry and exit reports along with standard catch-on-board reports and port reports can be transmitted electronically instead of fax. The FMC then sends the reports to the coastal State FMC in which maritime zones the vessel is operating. The use of the abovementioned software is voluntary but a large number of Norwegian vessels use it when operating in Norwegian maritime zones and in waters of third countries accepting this reporting format. It is envisaged to make the use of electronic reporting mandatory for all vessels carrying VMS when operating in Norwegian maritime zones. The development of e-logbook is an ongoing process. Tests were conducted on vessels using trawl nets in 2005. Additional tests are scheduled on vessels using different types of gear. An electronic reporting regulation is in the process of being drafted by the Directorate of Fisheries but no date has yet been set for its enactment.

**USE OF REMOTE SENSING TO COMPLEMENT VMS**

Vessel detection systems (VDS) employing wide swath synthetic aperture radar (SAR) for surveillance of commercial fishing grounds can be of assistance for detecting illegal fishing activities and provide more efficient use of limited aircraft or patrol vessels resources. With wide swath SAR, large ocean areas can be monitored on frequent revisit schedules, thus allowing detected vessels to be observed and identified by patrol vessels or aircrafts that are dispatched on these targets based on SAR information.

Space-based SAR sensors with wide swath capabilities, in conjunction with position-reporting beacons of VMS, are well suited to vastly improve the ability of coastal States to monitor the areas within the limits of their EEZ.<sup>76</sup>

Conventional sea and air surveillance can be made more effective if it is supplemented by remote sensing technologies (such as sonar and satellite imagery), but these are all expensive.

One of the few operational systems using remote sensing for fisheries compliance is that operated in the Indian Ocean by the operational center for rescue (COSRU) in Reunion Island, France. Of interest is its utilization for monitoring fishing activities in remote areas such as around the Kerguelen Islands, France, in the Southern Indian Ocean. The COSRU purchases SAR images provided by Radarsat 1. Images are “treated” by CLS ARGOS and sent back to the COSRU. The latter has acquired expertise in analyzing and identifying radar signatures enabling it to sort out points corresponding to whales, waves, algae and vessels. By comparing this information with that provided by VMS, the COSRU has been able to detect the presence of fishing vessels operating illegally in the Kerguelen Islands’ maritime zones. Australia and France have enhanced cooperation for surveillance purposes in the Southern Indian Ocean in an attempt to curb IUU fishing activities targeting the lucrative toothfish fishery.<sup>77</sup> Australian authorities use the services of the COSRU for analyzing images relating to contacts occurring in areas under Australian jurisdiction (Australia purchases satellite images by radarsat and submits them to COS-RU for analysis). The Australian/French cooperation is facilitated under the framework of the Australian/France treaty signed in 2003.

To evaluate the scale of IUU fishing in the EEZ of the Indian Ocean Commission member States, the IOC-MCS pilot project of large pelagics in the Indian Ocean has used wide swath SAR imagery. The experiment, involving acquiring 15 to 20 ENVISAT ASAR IM ISA4 images, was conducted in the vicinity of Mauritius Island within expected fishing zones and areas with highest densities (e.g. close

<sup>75</sup> Information provided by Mr. Gunnstein Bakke, Legal Adviser, Control Section, Directorate of Fisheries through personal communication.

<sup>76</sup> Montgomery 2000 at p.143

<sup>77</sup> See the Treaty between the Government of Australia and the Government of the French Republic on cooperation in the maritime areas adjacent to the French Southern and Antarctic Territories (TAAF), Heard Island and the McDonad Islands signed in Canberra, Australia, on 24 November 2003.

to Port Louis harbor). Information derived from SAR imagery was validated against information provided by AIS and VMS reports. It is an on-going project and results have not been published yet.

From 1 December 2004 to 31 January 2005, the Indonesian fisheries administration in partnership with CLS ARGOS conducted tests using Radarsat and ERS information to detect illegal fishing activities within the Indonesian EEZ. This information was compared to VMS report for validation and verification. There is currently no plan to use remote sensing as a compliance tool in Indonesia.

Navigs S.A.R.L.<sup>78</sup> positively reviews the European Commission VDS Project – IMPAST. It is reported that IMPAST has successfully demonstrated the potential of VDS, but it has also demonstrated that for reasons of both infrastructure and cost, it is unlikely that generalized VDS will materialise for some years to come.<sup>79</sup>

## **OPTIONS TO PROMOTE AND STRENGTHEN COOPERATION AMONG STATES FOR THE USE OF VMS**

It is generally accepted that VMS is an unqualified success by a majority of fisheries protection and compliance agencies that have put such a system in place and that at the national level, VMS is of sufficient maturity to offer something close to its optimal functionality.<sup>80</sup> However, it must be remembered that developing states continue to be weak in their fight against IUU fishing for lack of capacity and resources in reaching satisfactory implementation of their VMS program, let alone acquire one. It is noted at the outset of the discussion in this paper that VMS is not the panacea for IUU fishing and much more needs to be done particularly in terms of: (1) integrating VMS into the overall MCS and fisheries management frameworks; (2) developing VMS specific plans; and, (3) building analytical capacity in order to reap the benefits of VMS programs. In addition, interests seem to be waning in supporting MCS in developing countries including establishing and implementing national plans of actions (NPOAs) for the implementation of the IPOA-IUU. International cooperation for provision of technical assistance in MCS to developing countries such as that provided by EU to the African States would continue to be required. In this regard, developed states should, through technical assistance programs of international organizations such as FAO or through RFMOs, actively engage developing countries in genuine discussions and follow-up on how technical and financial assistance could be provided to establish national VMS and MCS programs and to effectively implement them.

Related to international cooperation for technical assistance at the global level is the need for focused regional or sub-regional assistance through RFMOs particularly where there is agreement that the RFMO shall establish its VMS program. All States, especially the well-to-do members of RFMOs, should assist in strengthening regional VMS programs developed by RFMOs by ensuring that all CPs and CNPs comply with this requirement. To this end, States should encourage the issuance of decisions, resolutions or recommendations within the framework of RFMOs to require that vessels flying the flag of a non-contracting party operating in the Convention Area be equipped with VMS. It is equally vital that assistance is provided to developing states that are parties to RFMOs to help them meet their obligations under regional VMS programs as required under UNFSA.<sup>81</sup>

The adoption through IMO of special measures and the SOLAS Regulation on LRIT to enhance marine security is incentive enough for attempting to achieve a similar binding undertaking at the international level for the implementation of VMS and electronic reporting of fisheries data to address IUU fishing. Mindful of the fact that safety of lives at sea and navigation and security cannot be equated with the need to combat IUU fishing, it would nevertheless be pragmatic to suggest that the

<sup>78</sup> Navigs S.A.R.L 2005 at p.27.

<sup>79</sup> In light of this finding by Navigs S.A.R.L, policy and legal issues relating to implementation of VDS is not discussed further in this paper.

<sup>80</sup> Navigs S.A.R.L 2005 at p. 31

<sup>81</sup> Articles 24, 25 and 26.

international community consider whether a global binding agreement on VMS can be negotiated or whether a soft law instrument should be developed under the auspices of FAO. It may be prudent, given the urgency of the matter to call for immediate and effective measures to combat IUU fishing, which may rule out the negotiation of a binding agreement as this may take years to achieve. Furthermore, such initiative may be objected to by certain States, particularly, those offering flags of convenience and those that may have an interest in the status quo. A phased approach may be advisable, commencing with the development of a voluntary scheme spelling out the general rules and standards that could be agreed upon by the international community for the implementation of VMS and later progress to negotiation of a binding instrument if need be. A consideration which counsels this approach is that in fisheries, unlike in the sphere of maritime security and safety, there is no regulatory institution/mechanism that is explicitly entrusted to establish general rules applicable to fisheries management.

The review of State practice on trials and use of electronic reporting systems and future integration with VMS (compared to VDS using SAR) indicates that the wider acceptance for use of such technology may not be too far off. The policy and legal issues related to the use of, for example, e-logbooks in fisheries are similar to those in VMS. This may therefore cause less difficulty in implementation. While entrepreneurship in developing better VDS/SAR technology should be promoted, it may still be too early to expect global use of VDS.

## **CONCLUSION**

VMS is developing rapidly and is fast becoming a mainstream compliance tool. The first phases of VMS development are nearly over as most coastal States have acquired or are in the process of acquiring VMS. The next phase, which has already started, focuses on implementation of VMS through, among other things, the devising of MCS plans and coordination thereof by fisheries agencies, specifying the role to be played by VMS and spelling out the responsibilities of various institutions involved in MCS. It is during this phase that policy and legal frameworks (which are crafted on the basis of sound planning for the role of national or regional VMS in the overall national or RFMO MCS policy) become important.

Extension of VMS use is likely to test the limits of international law. Coupled with the prevailing concerns over marine security, this may bring about some changes similar to what has occurred in the sphere of maritime law with respect to LRIT. The current environment (i.e. the push to eliminate IUU fishing) seems favorable to attempt these changes.

The use of electronic reporting of fisheries data systems is likely to spread rapidly once issues relating to data security and confidentiality and particularly to electronic signature are sorted out. Development of proper e-transaction laws will be a pre-condition for use of such electronic reporting systems in developing countries.

## REFERENCES

- Cacaud, P. 1999, Legal Issues relating to vessel monitoring systems, Report of a Regional Workshop on Fisheries, Monitoring, Control and Surveillance, Kuala Lumpur and Kuala Terengganu, Malaysia, 29 June – 3 July 1998, FISHCODE MCS, GCP/INT/648/NOR, Field Report C-1/Suppl.2, FAO, February 1999
- FAO 2004, State of the World Fisheries and Aquaculture, FAO Rome, 2004.
- FAO 2004a, Report of the Expert Consultation on Data Formats and Procedures for Monitoring, Control and Surveillance. Bergen, Norway, 25 - 27 October 2004, FAO Fisheries Report R761.
- FAO 2005, Report of the twenty-sixth session of the Committee on Fisheries, Rome, 7-11 March 2005, FAO Fisheries Report No.780, Rome, FAO 2005. 88p.
- High Seas Task Force 2006, Closing the Net: Stopping illegal fishing on the high seas, Stopping illegal fishing on the high seas. Summary recommendations. Governments of Australia, Canada, Chile, Namibia, New Zealand, and the United Kingdom, WWF, IUCN and the Earth Institute at Columbia University, 2006
- Flewelling et al. 2003, Flewelling P, Cullinan C, Balton D, Sautter R, Reynolds E, Recent Trends in Monitoring Control and Surveillance for Capture Fisheries, FAO Fisheries Technical Paper 415, Rome 2003.
- Kourti et al. 2005, Kourti N., Shepard. I, Greidanus. H, Alvarez. M, Aresu. E, Bauna. T, Chesworth. J, Lemoine. G, Schwartz. G, Integrating Remote Sensing in Fisheries Control, Fisheries Management and Ecology, 2005, 12. 295-307
- Kuemplangan, B. 2000, National Legislative Options to combat IUU Fishing, Document AUS:IUU/2000/9. 2000. 16p., FAO Fisheries Report No. 666
- Ministerial Declaration, Conference on the Governance of High Seas Fisheries and the UN Fish Agreement – Moving from Words to Action, St John, Newfoundland, Canada, May 2005
- Molenaar, E. and Tsamenyi, M. 2000, Satellite-based Vessel Monitoring Systems International Aspects and Developments in State Practice, FAO Legal On-Line Paper No. 7, April 2000, [www.fao.org/](http://www.fao.org/)
- Montgomery, D. 2000, International Fisheries Enforcement Management Using Wide Swath SAR, John Hopkins APL Technical Digest, Volume 21, No. 1, pp. 141-147, 2000
- MRAG. 2003. Evidential value of VMS position reports. European Commission, Brussels. in press.
- Navis S.A.R.L. 2005, Fishing Vessel Monitoring Systems: Past, Present and Future, Paper prepared for the High Seas Task Force, OECD, Paris, 17 October 2005, [www.high-seas.org/](http://www.high-seas.org/)
- Witherell D. *ed.* 2003, Managing Our Nation's Fisheries, Past, present and the future, Proceedings of a Conference on Fisheries Management in the United States, Washington, D.C., November 13 -15 2003.

## **CURRENT STATUS OF VESSEL MONITORING SYSTEMS, SATELLITES AND OTHER TECHNOLOGIES FOR FISHERIES MONITORING, CONTROL AND SURVEILLANCE**

**by  
Robert Gallagher**

### **BACKGROUND**

The emergence of vessel monitoring systems (VMS)<sup>1</sup> in world fisheries began in 1988 in Portugal, and the reasons that brought the Portuguese to establish their “MONICAP” system are very simple to grasp.

The Portuguese fisheries authorities, like all of their colleagues worldwide, had noticed a significant degradation in fish stocks as measured by volume of catches, size of individual species and research on available biomass. They reasoned that the first priority of control measures was to ensure that there was adequate enforcement of the current management regime, with its limits on catch (quotas) and effort (measured in days at sea). They also recognized that their resources dedicated to enforcement, measured in personnel, patrol vessels and patrol aircraft, were insufficient to ensure generalized compliance with that management regime.

The reason for this shortfall was that a significant percentage of the time the enforcement resources were active trying to locate fishing vessels, to verify the legality of their activities. Consequently, they decided that the remedy to this problem was to find a way of increasing the efficiency of their monitoring, control and surveillance (MCS) resources by remotely tracking the movements of their national fishing vessels. A research programme was initiated to develop a method of carrying out this tracking, and VMS was born.

When, in addition to the example cited above, the European Union, in 1996, mandated VMS for all European fishing vessels of 24 meters overall or longer, VMS was starting to achieve general acceptance.

Now, in 2006, most of the principal flag or coastal states are advanced in their use of VMS. A number of Regional Fisheries Management Organizations (RFMOs) also are requiring VMS usage or are doing so. The 2005 Rome Declaration on IUU Fishing by Fisheries Ministers calls for further expansion of VMS onto all large scale fishing vessels operating on the high seas by 2008. However, while most developing countries recognize the value of VMS in MCS operations, and some are using VMS or are participating in implementation projects, some developing countries lack the generalized capacity to implement or sustain a VMS program.

### **INTRODUCTION**

VMS technology is seen as meeting two basic functions for the management of fish stocks.

Typically, fisheries management rules are designed to achieve sustainable, harmonious and profitable fishing through a variety of methods. This usually includes some form of licensed vessel access to particular areas, restrictions on gear types, restrictions on fishing time, quotas on the amounts of particular species to be taken, etc. To enable these rules to be credible management tools, an effective MCS regime must be in place. To date VMS has been targeted on

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<sup>1</sup> A vessel monitoring system is the use of navigation and communications capabilities to provide data on a vessel's position and movements. It consists of three elements: a communications/navigation device aboard the vessel, a communications link and a fisheries monitoring centre where data is received and processed.

providing information on the position of vessels. Position information is sent from equipment on board licensed vessels to fisheries monitoring agencies at relatively frequent time intervals so that certain types of activities can be remotely monitored and targeted investigation can follow, if indicated.

In the area of fisheries protection, there is a growing file of documented cases where vessels fishing illegally have been brought to justice with the assistance of VMS. Furthermore, a number of fisheries officers have already observed the deterrent effect of VMS as vessels participating in a VMS scheme appear to be less likely to engage in detectable illegal activities, such as fishing in forbidden zones or at forbidden periods (source: presentations of Australian Fisheries Management Authority, New Zealand Ministry of Fisheries and United States National Marine Fisheries Service). There is no reason that this trend should not continue, so long as the VMS data received by fisheries authorities is reliable.

Nonetheless, it is important to note that VMS provides only position, speed and course of vessels and is, thus, a tool that is used to enhance MCS in the broader sense.

Catch and effort data are primary sources of information relating to the status of fisheries. Considerable benefits exist in collecting effort data via VMS. Benefits are derived from improvements in timeliness of delivery of data to the monitoring agency, reductions in cost of data entry and improvements in accuracy through minimising data handling and direct interaction between the vessel operator and the data entry/editing program.

Catch data and other fishing activity data such as reports about a vessel's intentions, may also have a compliance related function. For example, catch reports may be used to monitor a catch quota. Integrating catch and effort reporting has not been a major focus of VMS implementation to date, the major exception being the VMS implemented by Japan.

## **STATE OF THE ART OF VMS**

Currently VMS is a “cooperative” system where only participating vessels are monitored. It is cooperative because each participating vessel must carry an operating transmitter or transceiver (sometimes inaccurately referred to as a transponder) that is capable of fixing a position by calculating its own position and thus the position of the boat carrying it. An automated reporting system then executes the transmission of the position data and possibly other data via a communications system to a fisheries monitoring station.

Supporting this widespread implementation is the existence of the technology at an affordable price. The availability of the Inmarsat, Iridium, and Argos satellite communications systems globally, and a number of other systems with more selective coverage, has created a competitive market for tracking vehicles of many types. This has led to improvements in services, software, hardware and reductions in the pricing of all these items. The implementation of GPS has added a new dimension to positioning accuracy and this technology is now pervasive in its use, with hand held GPS and automotive navigation systems. In 2008 the European Galileo system is scheduled to go into operation and will provide its particular range of advantages, as will be covered later.

However, the real motivation to implement VMS comes not from the technology itself but from the benefits it provides for managing fisheries. The deterioration of a significant number of fisheries in the last decades of the 20<sup>th</sup> century has been well documented. The reasons are more difficult to pinpoint but depending upon the fishery in question could be due to developments like a proliferation of larger and more numerous fishing vessels, and the use of electronic, computing and satellite technologies that make the task of finding fish easier for vessel operators. Interestingly, these same technologies are now being seen as one of the tools available to fisheries managers for achieving sustainable fisheries.



## VMS SHIPBOARD EQUIPMENT

The transmitter or transceiver must have an integrated means of fixing a position and hence calculating speed and course. The Global Positioning System (GPS) used so successfully by the fishing industry is, at the moment, the generally preferred method because of its high level of accuracy, availability and relatively low equipment cost.

The automated reporting system achieves its purpose through a combination of computerised instructions in the transmitter and functions available in the communications system. The automated reporting system is capable of being programmed to send position reports at specified time intervals.

The communications system moves data between the transmitter/transceiver on the vessels and the monitoring agency. This may, or may not, involve the use of a satellite. Many tracking applications for land based vehicles use cellular phone and HF radio. China has trialled a VMS which uses Single Side Band radio as part of the communications system for fishing vessels. However, for MCS of fishing vessels, satellite based communications systems are considered the most suitable since they have the advantages of global coverage and high reliability.

In a satellite based communications system, data is transferred from the vessel to a satellite and then to an earth station. The earth station then forwards the data to the monitoring agency via a secure public data network or the telephone network using an international standard data communications protocol such as X.25.

Within a fisheries monitoring agency there is typically a computerised monitoring station capable of collecting the data received from the earth station, storing that data for subsequent review, analysing the data to detect and highlight anomalies to monitoring officers, and displaying that data in a meaningful way, typically against a background map. A specialised Geographical Information System is also a highly desirable element of the monitoring station, particularly for historical and statistical analysis of both position and catch data.

This mode of operation remains essentially unchanged from the earliest days of VMS. The improvements that have been made include more integrated shipboard equipment in that the earliest installations linked satellite communications terminals with external GPS receivers, whereas these two elements are now systematically integrated.

In addition, the accuracy of the GPS system has now reduced the maximum error for a position to less than 10 metres, from the 100 metre margin of error in the first VMS systems, though this improvement often provides little real advantage to the day-to-day operation of a VMS. Likewise, because a VMS deals in very small packets of data, improved speed in communications systems have provided little improvement in transmission times and speeds.

Perhaps the most significant improvements have been in cost. In 1988 an Inmarsat-C terminal cost upwards of \$US 10,000, whereas one can now purchase a VMS terminal for 10 percent of that price, or less. Likewise, the cost of delivery of a position report has fallen from approximately \$US 0.15 to less than \$US 0.05.

Operating costs vary and depend both on the type of VMS system and the frequency of usage, or polling of the fishing vessels. The operating cost of the South Pacific's Forum Fisheries Agency's (FFA)VMS is approximately US\$845 per vessel per year (polling every 4 hours) while recurrent costs of VMS in the USA are estimated to be about \$410 per vessel. The following table illustrates the cost savings to MCS authorities in the Hawaiian longline fishery through use of VMS.

Comparative pre- and post-VMS annual control costs of a closed area

Pre VMS (million US\$) costs		Post VMS (1,000 US\$) costs	
3000 patrol vessel hours / US\$1,000/hr	3.0	110 patrol vessel hours	110
350 air hours (C-130) / US\$7,500/hr	2.6	8 air hours	60
		VMS costs	200
<b>TOTAL</b>	<b>US\$5.6 m</b>	<b>TOTAL</b>	<b>370</b>

source: The Costs of Monitoring , Control and Surveillance of Fisheries in Developing Countries, Kelleher, K. FAO Fisheries Circular, 0429-9329, no. 976, 2002

### **VMS ON THE NATIONAL SCENE**

It is interesting to note that the reasoning behind the birth of the MONICAP system, as well as its technical solution, remains as valid today as it was 18 years ago. Many of the world's fish stocks remain in a precarious state and, though VMS has been adopted in every region of the world, the architecture of each VMS still bears a striking resemblance to the MONICAP system.

Following on the heels of the Portuguese success, a number of countries implemented VMS on small to medium scales, utilizing between 30 to 150 vessels. Australia, New Zealand, New Caledonia, French Polynesia and the USA all reported on successful implementations of VMS for MCS purposes. Many other countries conducted trials, and trials gave way to the introduction of VMS in at least some key fisheries of certain countries as a mandatory legal requirement during the past decade.

A recent FAO survey with regard to implementation of the Code of Conduct asked whether countries had implemented VMS systems. Fifty-seven countries answered the question and 24% had fully implemented VMS, 47 percent had partially implemented it and 28% had not implemented a VMS system.

### **VMS ON THE INTERNATIONAL SCENE**

VMS is a valuable MCS tool against IUU fishing in both national and international contexts. Its full potential can be realized in the context of widespread and timely sharing of the data gathered via VMS between coastal and flag states. Despite the penetration of VMS, there are not too many examples of such exchange and sharing at this time. Regarding data sharing and cooperative exchanges, regional projects, RFMOs and the Model scheme on Port state measures should be mentioned. The examples represented below present two differing structures. In other regions where these two experiences have been considered as possible models, a hybrid is often determined to represent a workable solution.

### **THE EUROPEAN EXAMPLE**

One example of widespread cooperation is in the European Union, where vessels report by VMS to their flag State. Then if the vessel is within the jurisdiction on another EU State, the VMS data is passed to that State. Such cooperation has been extended to flag States whose vessels fish in EU waters and to coastal states in whose waters EU vessels operate.

This situation exists because the states of the European Union are joined by a powerful central administration (the European Commission) and fisheries are governed by the Common Fisheries Policy. Furthermore, the EU is a potent entity in international relations, where it has access agreements in many developing countries.

## **THE SOUTH PACIFIC**

When VMS was first implemented in the South Pacific region, the Forum Fisheries Agency (FFA) developed what remains one of the most ambitious, and impressive, programmes for the implementation of VMS on a regional basis. This plan included extensive technical specifications for the equipment to be used aboard vessels, as well as for its installation.

However the FFA utilized a different structure linking the FFA countries compared to that of the EU and there were cases where member countries did allocate fishing rights outside the FFA's VMS requirements. However the FFA now carries on data exchanges, on an informal basis, with the fisheries compliance agency in French Polynesia and with the American authorities in Guam. Furthermore, the Pacific Ocean region could well turn out to be a model for data sharing and regional resource management in the not too distant future. The establishment of the Western and Central Pacific Fisheries Commission (WCPFC) will provide the organisational and jurisdictional basis.

All of this bears directly upon how the flag and coastal states that are collecting VMS data can organize their efforts to share what they have gathered. And this is a fundamental question, as the timely availability of the data will facilitate the identification of IUU vessels, particularly to coastal states that issue licenses to foreign vessels of the highly mobile distant waters fleets. Not surprisingly, there is broad agreement as to the utility and desirability of sharing data. The real challenge will be to find the institutional framework against which the data can be accessed and distributed.

## **INSTITUTIONAL OPTIONS**

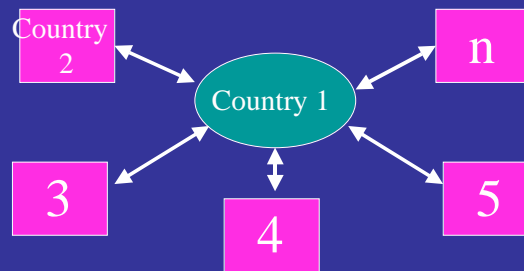
There is no overriding technical difficulty that should impede the data sharing process. There are, however, a number of choices to be made and structures to be put into place. The first of these is institutional. Under what auspices is the data to be made available? There would appear to be only two realistic approaches: either to create a centralized, international organization (or to task an existing one) to oversee or execute management of the data on a world-wide basis, or for coastal states to make the data available to each other using the structures of their regional fisheries organizations.

It is clear that, from a technical point of view, the first, centralized, approach would provide a simpler solution. Operating this way, coastal states, individually, or regional organizations, operating on behalf of their respective coastal states, would make agreed upon sets of data available to each other through the centralized organization after resolution of confidentiality issues.

In practice, this centralized approach could take place using one of two structures: the centralized organization would operate a database into which coastal states and regional organizations would systematically enter the agreed datasets from their VMS operations, thus providing access to all members (Figure 1). Alternatively, the centralized organization would provide a clearinghouse for queries on vessels, distributing the queries to all members and channelling the responses back to the originator of the query.

## Star (centralized) network

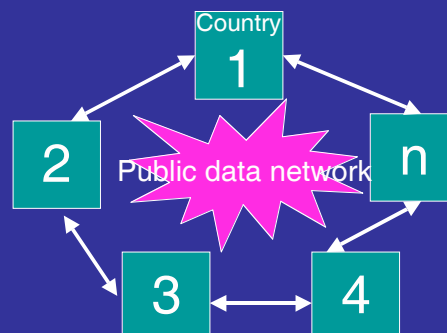
- One country takes central role in data switching and routing



**Figure 1** Centralized Network

## Decentralized network

- Each country maintains independence



**Figure 2** Decentralized Network

### NETWORKING SOLUTIONS

FAO held five Regional Workshops on Vessel Monitoring Systems in the period 2002 to 2004 (Senegal, Seychelles, Trinidad, Panama and Thailand) where networking options and other VMS issues were explored. The Workshops were aimed at raising the countries' awareness of VMS with regard to MCS.

In each of the Workshops, it was agreed that there was a need for regional cooperation in VMS and in MCS, in view of the high levels of IUU fishing across jurisdictions. However, most

countries felt that there was also a need for VMS to be based at a national level in view of the national responsibility to exercise control over the vessels flagged in their country.

In examining networking options, as there is no central organization, the most logical solution would be to serve the needs of data distribution by implementing a wide-area network consisting of data gathering systems operated by regional fisheries organizations. (Figure 2) This approach would require a higher degree of technical co-operation than the more centralized architecture in that it would require communication between an inevitably broad range of information technology installations, each developed according to an individual functional and technical specification.

On a functional basis, an overall network could consist of a series of connections between regional organizations. For security reasons, it is likely that data access would be handled on a query clearinghouse basis, rather than by direct access. In an operational scenario, a coastal state requiring data on a given vessel would address a request to its own regional fisheries organization. That organization would respond with any data it already held on the vessel and address the request to all of the other organizations that made up the network. These entities would, in turn, address their data to the original regional organization, which would forward the responses to their member.

The very complexity of such an operation underlines the fact that an advantage of such an implementation, in fact, would be expediency: there would be no need to reach international agreement on a single entity for world-wide data storage and distribution. Were it possible to reach such agreement, however, the overall effort would benefit from simpler, more reliable operations and lower operating costs.

## **EXISTING INTERNATIONAL COOPERATION**

Encouragingly, there is already some concrete indication of desire and willingness to share data on IUU vessels at the international level. Perhaps the most active organization at the moment is the North East Atlantic Fisheries Commission (NEAFC), based in London, which maintains two lists of vessels known, or suspected of, IUU activity.

When one of its contracting parties reports a vessel as likely IUU, it is entered into NEAFC's "A list". This puts the vessel operators on notice of the suspicions and gives them an opportunity to clear it. One year later, assuming that the vessel remains suspect, it moves to NEAFC's "B-list" where it remains "permanently", or at least until a decision is made by the NEAFC annual assembly, to remove it. The identities of vessels entered on both lists are available to the public on the NEAFC website.

Other regional fisheries management organisations are also moving toward transparency. The Northwest Atlantic Fisheries Organization (NAFO), the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the International Commission for the Conservation of Atlantic Tuna (ICCAT), Commission of the Conservation for Southern Blue Fin Tuna (CCSBT) and the Indian Ocean Tuna Commission (IOTC) have implemented or are considering implementing VMS measures within their areas of competency for their member States. Furthermore, there are strong indications that cooperation will continue to move in the right direction, as both the establishment of the WCPFC mentioned earlier, and an on-going initiative in the Indian Ocean, under the auspices of the Indian Ocean Commission (IOC) would indicate.

## A QUESTION OF CONTENT

Regardless of the administrative framework chosen for sharing VMS data, there are a number of technical decisions, relating to form, content and methodology that must be made before the first files are transferred.

The content is a potentially complex issue, particularly when future manifestations and improvements in VMS are taken into consideration. It is also key to recognize that the data sets necessary for a fisheries management operation will be gathered from two basic sources: the fishing vessel itself and the management authority monitoring that vessel. Regional organizations are additional potential sources of data.

Furthermore, the inputs from these sources will be of two kinds: data provided automatically by autonomous systems like sensors and navigation devices, or provided manually by either crews aboard fishing vessels or fisheries protection personnel. The following are examples of the most common data sets that could be found in a VMS operation:

- **Fishing vessel position:** the output of an automatic navigation system, most often Global Positioning System, transmitted over a mobile communications system. Position takes the form of latitude and longitude, normally either in ASCII or bit-mapped format. Position is usually accompanied by the heading and speed of the vessel being tracked. All three values are standard GPS output but their inclusion, or not, in a position report is determined by the size of the position report file chosen by the authorities.
- **Patrol vessel and patrol aircraft position and response zone:** Input will be identical in form and content to that provided by fishing vessels, but should be kept in a separate, ephemeral file to be compared with system generated events. The file on each patrol vessel and aircraft will contain a response radius figure, which is the maximum distance to which that mobile entity can practically travel to respond to a system alarm. Using this response radius as a reference, the system should be able to, with each position report received from a patrol vessel or aircraft, create a circular geographical area (see manual input data files below) which is known as a response zone.
- **Catch reports:** data files containing information on what has been caught on board a fishing vessel. Fields include: date of catch, fish species, quantity (can be expressed either in weight, i.e. pounds, kilos or stone, or in volume, i.e. number of boxes), and size. Note that, though input to the VMS is automatic (via the same means as position report data) on board the vessel it is keyed in manually. The specific format for this data varies significantly from country to country.
- **Boarding and sighting reports:** filed by patrol vessels and aircraft respectively, and based on boarding observations or remote sightings of fishing vessel activity. Will generally follow custom format with additional text panel for observations.
- **Vessel permanent data files:** The system will store separate files for each of the vessels under management which will include information such as: vessel name, length, date and place of building, tonnage, type (trawler, purse seiner, beam trawler, etc.), maximum fishing speed, normal position reporting interval, normal catch reporting interval, vessel owner, captain and permanent crew with address, etc., species normally fished, and species for which quotas are held. This list is not exhaustive and will vary from agency to agency. When this file is retrieved, it should also permit access to the vessel's previous record (a list of all boardings and the corresponding reports as well as a list of all violations and suspected violations, i.e. events and alarms) and quota status.

## **DEALING WITH STANDARDS**

Once it is decided which of these data sets will be available, and under which circumstances, there must be unanimous agreement upon the form in which they will be sent, the security measures to be used to identify the requesting party, and the means of sending the data.

This means that a family of norms and standards for data transfer will either have to be defined or adopted from an existing data sharing scheme. In all likelihood, the result will probably be a combination of new approach and adoption of a satisfactory operation already in service. Considerable help can be had from some existing data sharing efforts in the same area.

## **DATA FORMATS**

Under a protocol agreed by the European Commission, Norway, Iceland, the Faeroe Islands and two regional fisheries organizations (NAFO and NEAFC), a data exchange format, subsequently baptized the “North Atlantic Format” (NAF) was devised to define data fields sent when the vessel of one of the flag states was operating in the waters of a different coastal state.

The NAF has had a certain success and benefits from the support of a number of partisans amongst the countries that use it. The European Union’s SHEEL (Secure and Harmonized European Electronic Logbook), explored the possibility of transmitting and sharing fishing vessel operational and catch data in real time, as discussed later in this paper. The EU SHEEL project found that the NAF lacked flexibility for its purposes, principally due to the complexity of catch data compared to simple position data.

For this reason the SHEEL partners settled upon a format based upon Extensible Markup Language (XML), which permits greater use of hierarchal relationships between data sets. SHEEL’s implementation of XML does, however, bear a marked resemblance to the original NAF. These two approaches would give any programme designed to facilitate the sharing of fisheries data a clear head start.

## **EXPERT CONSULTATION ON DATA FORMATS AND PROCEDURES FOR MONITORING CONTROL AND SURVEILLANCE**

Recognizing the need to facilitate the increasing amount of data sharing, the FAO convened the Expert Consultation on Data Formats and Procedures for Monitoring, Control and Surveillance in Bergen, Norway from 25 to 27 October 2004. The Consultation noted an evolving and rapidly expanding spectrum of electronic reporting by vessels, ranging from the basic position reports to catch and activity reports and electronic logbooks.

In attempting to identify options available for standardized communication formats in MCS, it was noted that the data sets required for the electronic logbooks are determined by the information users. These are varied and include fish buyers, fisheries statisticians, fisheries managers and enforcement agencies. Additional considerations were economizing communication costs and taking advantage of pre-existing formats to facilitate international exchange of market information, or of data required under bilateral, or multilateral fisheries arrangements.

However, the experts were of the understanding that there appeared to be no formal procedure for establishing international standards for fisheries data and were of the view that FAO, through the Coordinating Working Party on Fishery Statistics (CWP), could propose a formal procedure to propose, review and recommend such standards.

## **Coordinating Working Party on Fishery Statistics**

At the twenty-first session of the CWP, March 2005, the meeting clarified that there are procedures in place for recommending standards however, the role of CWP does not cover the adoption of recommendations. Those are made by the individual RFBs and member States.

The CWP meeting noted that FAO should prepare and make available tables indicating the corresponding codes in different schemes with a view to harmonization. This recommendation was directed to FAO but the CWP determined that it would be appropriate to disseminate this type of information through the CWP channels, e.g. the CWP Web site. It was noted that the CWP Handbook of Fishery Statistical Standards already contains some code conversion tables.

With regard to the recommendation on CWP's involvement in MCS operational matters, it was felt that CWP should not be directly involved in MCS or legal matters, but that there are elements of MCS that are relevant to the work of CWP. Although VMS is currently mainly used for MCS purposes, the system is also being used for generating data for assessment of stocks and fisheries as well as for other scientific purposes. The meeting recognized that, in addition to not falling strictly under the CWP mandate, CWP does not have the technical expertise required for dealing with many of the technical MCS matters.

The possibility of cooperating with other organizations on aspects of MCS was discussed and the International Monitoring, Control and Surveillance Network for Fisheries Related Activities (MCS Network) was identified as a possible partner. The CWP agreed that it should take the initiative to contact the MCS Network with the aim to conduct a joint workshop.

## **TRANSMISSION MEDIA**

The issues of security and the means of sending the data are closely linked. Though the European Union, until now, has used the high-security X.25 system for data transfer, there are several reasons it is unlikely that this would be adopted on a broader, international basis. The X.25 system, long favoured by banks and financial institutions, is unlikely to remain in operation for very many more years, as its traditional users migrate to other less expensive means of communication.

A scheme to share VMS data with entities around the world would likely use the Internet as the transmission medium. This choice, whilst logical for its availability and low-cost, puts the onus of security on the users rather than on the operator of the network.

To specify an exact security approach for such a system is outside the scope of this paper as there are too many undefined variables (e.g. number of participants, characteristics of each host system, volumes of data, frequency of requests, etc.).

Nonetheless, at a very minimum it would only be prudent to orient the security specification around an active user identification protocol where, for example, data is only transferred outwards at the initiative of the server in which the data is stored. A passive identification system, such as one based solely on identification by password, is unlikely to provide a sufficient standard of data security.

## **FUTURE DEVELOPMENTS**

Inasmuch as existing systems very efficiently fulfil their role of providing highly accurate, quasi-real-time position, speed and course data on co-operative fishing vessels, future developments in VMS will inevitably be concentrated on remedying the two principal VMS related problems that continue to trouble fisheries compliance entities: a) the ability of seemingly co-operative vessels



to tamper with their VMS hardware and thus transmit intentionally false positions, and b) the inability to detect IUU fishing vessels that are not fitted with VMS or vessels that are not reporting.

Whilst some relief in the first of these difficulties will come from natural evolution of security measures implemented in the design of equipment used for VMS, the means of tampering with VMS data are likely to outstrip any security measures taken at the level of vessel equipment. The scenario mentioned later in this report, in which GPS simulators would be used to input false data at the level of the antenna, is a major concern.

There are several means of dealing with these weaknesses by providing some independent verification of VMS data. One key development in this direction will be the implementation scheduled for 2008 of the European Galileo navigation system. Used as either a substitute for, or a complement to, GPS, Galileo will make the simulation of VMS positions extremely difficult, if not impossible because it can supply independent position data. Already two satellite systems, ARGOS and Euteltracs, offer their own proprietary, vessel-independent navigation systems that provide a powerful means of verifying VMS GPS positions.

Another path to VMS data verification is the use of earth imaging satellites to provide corroboration for VMS data. Such an approach is designated a vessel detection system (VDS) to distinguish it from VMS. A VDS uses imaging or radar systems aboard satellites, to detect the positions and presence of vessels independent of whether a vessel is participating in a reporting scheme, such as VMS. The most advanced work in this area is being carried out in Europe with funding from the European Commission and is detailed later in this paper.

Other vessel detection systems can be based upon radar, as is currently in practice in Canada with a system of “over the horizon” radar, and in the Antarctic territory of Kerguelen. The principal limitation of radar is its physical range, a factor which restricts its use to very specific geographical and topological environments.

### **INDEPENDENT VERIFICATION AT THE FISHERIES MONITORING CENTRE (FMC)**

A final method of VMS verification could be carried out at the FMC and would be based upon rigorous analysis of VMS data, in an attempt to identify tampered data through the recognition of internal anomalies in that data. Though this approach might seem to be promising for its independence of other input, very little work has so far been done to advance such methodologies but this verification procedure is very common in other sectors.

By simply gathering and storing data, thus making it available in a timely manner to relevant personnel, VMS can significantly improve the efficiency of surveillance operations: when patrol vessels and aircraft know where vessels are fishing, the time required to find them for purposes of verification and control is reduced to a minimum.

### **FMC OPERATIONS**

Were this is the only advantage of VMS, it would probably still be worth the required investment in time and resources. But an FMC has the potential of supplementing this investment by taking an active role in detection of fishing violations. As many infractions of fisheries regulations have to do with fishing, or even being present in unauthorised zones, VMS data can identify violators with a very high degree of accuracy. Still, the actual detection of fishing activity remains a less than scientific activity for a number of reasons.

In its current state, data analysis at an FMC is limited to manipulation of the data sets that are received: position (latitude and longitude) speed and course from the vessel end, sea charts and

vessel records from the FMC end. A typical analytical script at an FMC might thus be to geographically delimit areas where fishing was restricted or forbidden, and then to create an alarm when a vessel reported a position that was 1) within the delimited area and 2) was reporting a speed that might be compatible with fishing activity.

Useful as such analysis might be, it does require a trained operator to respond to the alarm, call up the vessel's track, and make a personal determination as to the probability of actual fishing activity. In most cases, such judgements are relatively easy as the grid pattern movements of a trawler might be clearly visible, or the movements required for a longliner to lay out its line then return to its starting point and then retrace the path along which it was laid out, this time at much slower speed whilst fishing. The judgement of the operator becomes more important, of course, in cases where the patterns are less well defined or incomplete.

### **LIMITS OF MANUAL PROCESSING**

Such a manual process can work very well in terms of analytical accuracy, but it does suffer from serious limitations. The first of these will become evident in dealing with very large numbers of vessels. Currently, at most existing FMCs, no more than a few hundred vessels are being tracked at any one time, but these numbers are likely to increase dramatically as indicated by the development plans of most VMS systems around the world. It is unlikely, therefore, that the answer would be more specifically trained personnel, as the budget for additional posts at most government agencies is far too restricted to keep pace with an exponential increase in vessel numbers.

Furthermore, the analysis presented so far is applicable only to violations related to the direct detection of fishing activity. It does not take into account other violations such as over-fishing a quota, using illegal gear, illegal landings and trans-shipments. And perhaps most important, it is based upon the assumption that the data received by the system is accurate. As methods of falsifying VMS data by vessel operators become more sophisticated, that assumption will become equally more questionable.

### **VMS OVERLOAD**

It is reasonable to assert, therefore, that in the not very distant future, most FMCs that are not equipped with automatic analysis programs are likely to be obsolete or, at the very least, overwhelmed. All of this raises the question as to why the development of sophisticated analytical engines has not followed the development of FMC software, which has been evolving for more than 15 years.

The answer would appear to be twofold. Since, until now, the number of vessels being tracked has been relatively small, the physical requirement for automated data screening has not been fully felt. Furthermore, developing analytical programs that meet the requirements would be a technically formidable task requiring corresponding resources.

### **POSSIBILITIES FOR FUTURE DEVELOPMENT**

It is worth looking at some of the functionality from which an FMC would benefit in the future, and just what would be necessary to realise such functionalities. A good place to start might be with the image of an operator observing the screen to determine whether vessels are fishing. Incorporating some, or even a portion, of his reasoning and decision making process into an FMC, as an automated process, would require an expert to devise a schematic rendering of the movements that each type of vessel might make whilst fishing.

Once done, it would then be necessary to programme a computer to recognize those schematic renderings, knowing that each one will be, in some way, different from all the others: variations in speed, length, and directions would be significant. One might even use the analogy of programming a computer to recognize the handwriting or voices of different people. Anyone who has had to edit a text created by optical character recognition from even a printed text can begin to understand the complexity of matching unclassified movements to general visual patterns.

And with all of this complexity, there is an assumption that the data under analysis is correct. Suppose that the analytical process is applied to determining whether data might be genuine or falsified. This is a level of analysis that goes significantly beyond the relatively simple pattern recognition of fishing activity and would take the FMC software into areas used by financial institutions when they are trying to detect fraudulent transactions of, for example, credit cards.

In an area such as VMS where the systems suppliers tend to be very small companies with severely limited research activities, and where very large installations cost no more than \$500,000, it is simply unreasonable to expect that the entities involved underwrite such research using their own resources. The only solution is that the research be carried out for, say, consortia of fisheries compliance, protection and management entities, or by publicly funded research and development programmes.

## **GALILEO SYSTEM**

In developing and implementing its Galileo satellite communications system, the European Union is taking head-on what has been until now a monopoly of the government of the USA. Galileo will boast a significant number of advantages, compared to GPS, such as improved accuracy and institutional support, and one can expect that the advantages of these improvements will be routinely integrated into product offerings by manufacturers of maritime equipment.

But most important, for practitioners of VMS, will be a number of particularities of the Galileo system that can be used to assure the integrity of retransmitted position, course and speed data. These advantages are of such key importance that there is every reason to believe that Galileo will become the industry reference for maritime navigation in general, and VMS and other tracking applications in particular, in clear preference to GPS.

## **MULTIPLE SERVICE LEVELS**

The Galileo system will offer three levels of service, all of which can be of interest to entities planning, and operating secure tracking systems. The most secure approaches will take advantage of the characteristics of each of the three levels of service proposed for the Galileo system: the open service, safety-of-life service, and commercial service. On each step of this ascending ladder, the level of security will become increasingly reliable. Indeed, at the level of commercial service, it may well be close to inviolable.

The Galileo open service presents capabilities similar to those of GPS, albeit with the addition of a 250 bit-per-second channel that transmits system integrity data. Consequently, the integration of samples of this data into positions calculated with a Galileo receiver would provide a level of assurance that the position received is the result of a calculation using real Galileo signals.

## **LEVELS OF DIFFICULTY**

It should be pointed out that the security of such an approach would be less than total. This is because, theoretically, it would be possible to integrate data from the security channel into a simulated Galileo navigation signal. Still, as it would be necessary to do this in real time,

generation of the falsified signal would require a much higher degree of difficulty, with corresponding increased costs and the ever-present possibility of making an error in transmission that would raise suspicions as to data integrity. In addition, proprietary signal processing by the terminal would further increase the complexity. In any case, such a system would be a significant improvement over what is currently available and would have the advantage of being based upon an openly available, free-of-charge service.

With the safety-of-life service, and its characteristics that are Galileo specific, verification of the authenticity of retransmitted position data becomes more assured. It is beginning at this level that the Galileo integrity data channel is encrypted for decoding only by registered, identified users, thus making it a more solid platform for data verification. Position data based upon this encrypted signal, combined with the identity key of the user who has decrypted it, would provide a level of technical difficulty and cost orders of magnitude superior to the unencrypted signal of the open service.

The Galileo commercial service provides a 500 bit-per-second communications channel from satellite to receiver that transmits user-defined data. There is one such channel per satellite, and it must be shared amongst users. The ability to transmit, for example, random data to users and to create position reports based upon a proprietary algorithmic treatment of that data would provide a level of security that could be described as decisive.

#### **LONG RANGE IDENTIFICATION AND TRACKING (LRIT) AND AUTOMATIC IDENTIFICATION SYSTEMS (AIS)**

Long Range Tracking and Identification (LRIT) is a system very similar to VMS which was introduced by IMO in the interests of marine safety and search and rescue. Under this system cargo and passenger vessels are required to report their positions to their flag states at regular intervals and if, for any reason, such a report was not received, an alert is raised. The same type of system is used to monitor the movements of vessels in critical habitats or in traffic separation schemes where it is known as Ship Reporting Systems.

The recently adopted SOLAS Regulation on LRIT establishes a multi-lateral agreement for sharing LRIT information for maritime security and search and rescue purposes for cargo and passenger vessels, amongst SOLAS Contracting Governments, in order to meet the maritime security needs and concerns of such governments. It maintains the right of flag states to protect information about the ships entitled to fly their flag, where appropriate, while allowing coastal states access to information about ships navigating off their coasts. SOLAS Contracting Governments will be entitled to receive information about ships navigating within a distance not exceeding 1000 nautical miles off their coast. This regulation will come into force at the beginning of 2008.

However, given the potential for fishing vessels to be used for terrorism purposes, the extension of LRIT to fishing vessels may be considered in the future. If mandated, this measure is most likely to be imposed initially on fishing vessels above a certain size (e.g. 100 GT). In this case, fishing vessels that are equipped for reporting by VMS could easily meet the requirements of LRIT by the data being passed from the FMC to the LRIT centre in the flag state, the coastal state, or the regional centre, as required. This sharing of VMS information is already being communicated by flag states (or by vessels) to coastal states where fisheries agreements make this a requirement of access to fishery resources.

Automatic Identification Systems (AISs) are designed to be capable of providing information automatically about a ship to other ships and to coastal authorities at short range to facilitate traffic management near port and collision avoidance. This is done by transmitting vessel identity and manoeuvring data by VHF, which is then interfaced with radar data, so that the other vessel's

identity and manoeuvring data can appear on a radar type display on the initial ship, or in the Vessel Traffic Centres. The range of VHF is limited so that only vessels or monitoring stations in close proximity can be involved. The instantaneous information on the manoeuvring data and the radar fix on the other vessel are instrumental in avoiding collisions. FAO has in the past suggested that this technology might be useful for MCS because a fisheries patrol vessel or aircraft can pass quickly through or over a fleet of fishing vessels by examining AIS polling data and avoid the time consuming and sometimes dangerous procedure of boarding in bad weather to conduct on-board inspections. Recent experiments in Norway have shown the possibility of extending the range of AIS by using aircraft and the USA has used satellites to gather AIS data from a much wider range. However there has been concern on the part of IMO and others over AIS data being publicly available as it potential could be used by terrorists.

The two systems are very different. AIS calls for the very frequent transmission of positions, usually by terrestrial communications systems, whereas LRIT tends to be satellite based and requires less frequent reporting. In addition to differing range capabilities between the systems, AIS is a broadcast system, with data available to those vessels and shoreside stations in the vicinity and which have the necessary equipment. While data derived through LRIT will be available only to the recipients who are entitled to receive such information. Safeguards concerning the confidentiality of those data have been built into the regulatory provisions. Information on LRIT and AIS is available from the IMO Website which is being continually updated. <http://www.imo.org/>

Chapter V of SOLAS is the only section of SOLAS which specifically includes fishing vessels. However it only applies certain regulations to the extent to which the SOLAS Administration shall determine. This means that a national administration can choose to implement the regulations on LRIT and AIS for its own fishing vessels, if it so wishes.

### **VESSEL DETECTION SYSTEMS (VDS)**

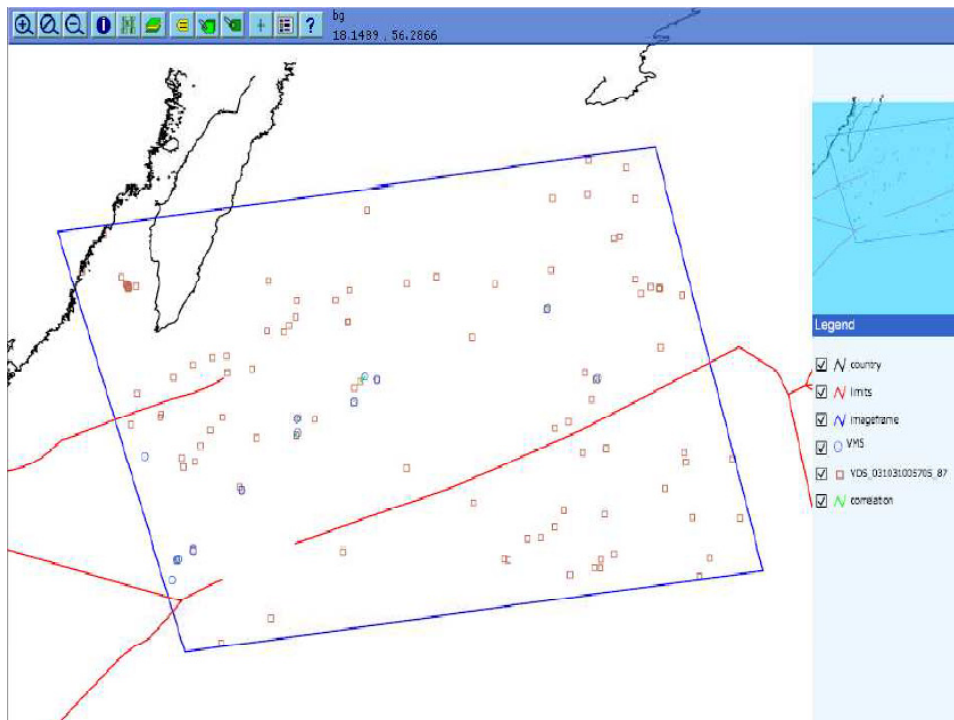
Despite the effectiveness of VMS it has to be remembered that VMS will only detect cooperative vessels. The vessels that do not report by VMS or that are not fitted with VMS cannot be detected by the system. For this reason a number of recent initiatives have centered upon finding a means of independently verifying VMS data. Most notable of these is the use of earth observation satellites to detect vessels. The resulting data, when collated with VMS input, could be a powerful tool against illegal fishing and filling in the gaps not addressed through VMS, such as detecting the range of activity occurring in contravention of VMS requirements. A project led by the Joint Research Centre of the European Commission, that is leading the way in this area, will be discussed later in this paper.

It is only prudent to assume that the VMS data at the level of the terminal will never be tamper-proof. For this reason, systems of independently verifying VMS data, by means totally independent of any of the VMS elements, are an attractive option. Until now, the only work being done on VDS has been under the auspices of the European Commission and a project called IMPAST. (Improving Fisheries Monitoring through Integrating Passive and Active Satellite Technologies).

This effort has successfully demonstrated the potential of VDS, but it has also demonstrated that for reasons of both infrastructure and cost, VDS is unlikely to be widely used in fisheries for some years to come.

The system developed under IMPAST consists of inputs from satellite synthetic-aperture radar (SAR: not to be confused with “search-and-rescue”) imagery that are subsequently processed into detected target positions that are, in turn, fed into a matching module for correlation against VMS records. The VMS data are input from FMCs whose fleet is active in the imaged area of interest.

The system outputs are the detected targets (VDS records) and the result of the matching with VMS records. The intended use of the system is the support to monitoring and control tasks in the respective FMCs through the provision of information on target positions for which matching VMS records exist or not, and on VMS records for which no matching target is detected.



**Figure 3 Vessels detected in the Baltic Sea using Synthetic Aperture Radar in IMPAST**

The system implementation of the prototype VDS addresses the necessary hardware and software issues that would be required for a VDS system to operate in an automatic fashion in order to provide output results in near real time though such performance, in VMS terms, is not yet achievable; data access is expected, nonetheless, to improve dramatically in the next two to three years. The Joint Research Centre (JRC) of the European Commission, co-ordinator of IMPAST, based the project upon open source components that are extended with scripts and functions based in open source application programming interface. Both a dedicated satellite communication module for large image file transfer and standard internet protocol are described, including secure functionality that allows it to be used in various arrangements of exclusive or collaborative use by FMCs. It extends the delivery of VDS outputs into the possibility to visualise and analyse in a web-based mapping application that also integrates access to the SAR imagery.

Conditions for operational use, other than those determined by system design and implementation, include the organisational scenarios in which VDS may be used, SAR data availability, state-of-the-art on the feasibility to run a near real time service for European waters, VDS quality and a number of other boundary conditions. Near real time supply of VDS outputs has been demonstrated with three different image suppliers and in an experimental campaign over all European waters, typically within one hour after satellite image registration, and including automatic matching with VMS records. Experiments have involved single FMCs or a group of collaborating regional FMCs.

### **SYNTHETIC APERTURE RADAR (SAR)**

At present, SAR image data is only supplied in an operational service set-up for the Canadian RADARSAT-1 and the European ENVISAT ASAR sensors. This limits, to some extent, the

frequency of area revisit and flexibility to programme and order acquisition on short notice. VDS quality is determined by the quality parameters of the input SAR imagery relative to the size of the detectable vessels, the detection and post-detection filtering processes, and sea surface conditions at the time of image acquisition.

System costs are relatively straightforward to estimate both in terms of hardware and software requirements and required labour. They range from 40000 to 130000 Euros per VDS production processing unit (the entire range of elements and services necessary to convert satellite images into useful data in the context of VMS) with annual maintenance costs of 28000 to 30000 Euros depending on a number of choices and options.

## **COST OF VDS**

Implementation of FMC capabilities to receive and analyse VDS outputs lead to marginal additional costs for individual FMCs, depending on the operational scenario. Data costs will constitute the bulk of an operational system, its relative size depending on the organisation and scale of the operations. Provisional numbers for an integrated VDS service organised by the image suppliers that cover European waters with a total data volume of 2,500 images per year would be 2,700,000 Euros (65 percent of which are for data), which would include all system and maintenance cost of the VDS production chain.

Under the assumption of the estimate, over 6 million km<sup>2</sup> would be imaged annually. The short and mid-term outlook on the conditions for an operational VDS is generally positive for 2006 and beyond. This is mostly due to the increase of the number of space-borne SAR sensors that are scheduled for launch in 2006 and beyond. The wider availability of SAR image data will lead to improvement in monitoring and control options and will, in the longer term, put a downward pressure on data costs. Developments in computing and communication technology are likely to lead to further improvement in processing speed and bandwidth, which would lead to a reduction in near real time delivery time, possibly to within 30 minutes of image acquisition.

This approach is not without its limitations. At the time of this writing, the resolution of SAR satellites is questionable for optimal use in VDS. Furthermore, passages of satellites are infrequent and the cost of images remains high. Nonetheless, a look at plans for future satellite launches and technical specifications of the images suggest that VDS should be an invaluable tool in the medium term, i.e. within about five years.

## **ELECTRONIC LOGBOOKS**

The success of VMS has led to initiatives to further develop and increase the information content of the communication system. There are a number of electronic catch reporting programmes in the process of implementation around the world. These break down cleanly into two categories: data filed by electronic means once a vessel has landed its catch and that supplied by a vessel at sea.

The former of these is simply a method for doing away with the paper catch report which, by its nature, is both slow and expensive to convert into electronic data. By implementing such a system, as has already been done, for example, in the USA halibut fishery in Alaska and a number of Australian fisheries under the management of the Australian Fisheries Management Authority, a government authority can improve its efficiency in handling data, as well as in resource management. The effect of such systems is positive on overall operational efficiency in fisheries management, but has a negligible effect on fisheries protection and compliance, as the data is available to authorities only once the catch has been landed and sold.

The latter category is significantly different in that catch data is provided whilst a vessel is still at sea. This commits the vessel in the sense that, if inspected, the catch must correspond, within

certain tolerances, to what has been reported. For this reason, providing catch data in this way enables the authorities to take an aggressively pro-active approach to management parameters, such as compliance with quotas.

It is interesting that, until now, though the technology exists and can be easily implemented, there are very few examples of such operational systems. Examples would include Iceland and Norway and, to a lesser extent, regional fisheries management authorities, such as the NAFO, NEAFC and the FFA. The principal difference between the two Nordic countries and the mentioned RFMOs is that the former provide their data using fully electronic forms, so that it is entered automatically and immediately in the receiving authority's database. The latter use electronic means of transmitting their data (e.g. satellite telephone or data systems) but without the use of electronic forms. Whilst this speeds delivery of the data to the authority, there remains a manual step required to enter it in the database.

It should be noted that, despite the existence of the technology, there is probably a very strong political reason that full electronic catch reporting from sea has been slow to be implemented: that the collation of real-time electronic catch data and VMS data is a highly sensitive point so far as the fishing industry is concerned. Vessel operators, correctly, consider this data to be commercially confidential. Until a means can be devised to assure them that this data will be completely safe from their competitors, they will resist its implementation. Resolving some of these concerns were objectives of the European Commission's SHEEL research project, which ended earlier this year.

### **EUROPEAN RESEARCH IN ELECTRONIC LOGS: THE SHEEL PROJECT**

The SHEEL project was based upon very ambitious goals: the strategic objective was to develop, implement and demonstrate a secure and harmonized European electronic logbook for fisheries, so as to drive European regulations, which will ensure exploitation of living aquatic resources in a sustainable manner, improve economic and social conditions in the fisheries sector and provide scientists with high quality data.

In more practical terms, it may be more productive to break out that global objective into four more concrete and manageable ones:

- to develop a technical specification capable of transmitting a European fishing vessel log in electronic form;
- to demonstrate the technical feasibility of an electronic log from the transmission end (vessel) to the reception end (fishing authority);
- to evaluate satellite communications resources for suitability, reliability and cost;
- to create a secure communications environment, end-to-end in terms of automatic acknowledgement of messages, data access to fisheries inspectors whilst on board a vessel, tamper proofing of data and security from interception from unauthorised parties.

### **Formats and Standards**

In terms of standards, the SHEEL project did result in the definition of a data standard based upon the North Atlantic Format (NAF) that had been used until now for exchange of data between European authorities and with certain inter-governmental fisheries organisations. Essentially, SHEEL converted the NAF into an extensible mark-up language (XML) data format so as to improve both flexibility and the capability to evolve with future developments. All of the SHEEL trials were based upon this specification and it is now a publicly available document.

When developing the SHEEL specifications the aim was to present a well-designed and flexible model which could be used both as a relatively simple tool and expanded to encompass more



complex features, according to the wishes of different users. An electronic logbook can be a very useful tool for the skipper and vessel owner, also for the fisheries monitoring authorities. It is fair to assume that designing the logbook as a service tool for the skippers/owners, rather than merely as a tool for fisheries surveillance and control, will facilitate its introduction to the fleet and acceptance by the users.

The e-logbook can easily be designed so that it serves as a comprehensive database for the skipper/owner, storing all sorts of information that need not all be required by the authorities. Queries can be made into the database e.g. on catches in a particular area in the past, what gear has given best results, etc. The authorities would have access to given parts of the database and the information they require could be extracted with a single command.

It is important at this point to discern between the e-logbook and reports from the e-logbook. Whereas the paper logbook served both as the record and the report of fisheries activities, the situation is different with the electronic logbook, where the record is stored in a database and then reports are extracted at some time either to give an overview of transactions over a period of time, or a snapshot of the status at any instance. Thus, the e-logbook resembles more a business accounting system. SHEEL is only concerned with the content and format of the reports and the constraints these put on the e-logbook database, but the format of the database itself is not an issue in the SHEEL context.

With this in mind, the SHEEL standard was designed so that the e-logbook reports can be organized in layers of increasing complexity, starting with the minimum information required by all authorities. More details can then be added to meet the specific requirements of individual authorities, scientists or vessel owners.

## **FORMAT**

The format of the logbooks must allow further development in the future and be backed up by and compatible with ubiquitous software solutions. To date, the NAF has been used for electronic reporting within NEAFC, NAFO and in pilot projects by the Norwegian Fisheries Directorate. These reports are mainly for monitoring purposes. The process is only partially automated and many of the reports must be entered manually into the transmission system. Although NAF has proven to be robust and flexible enough for the limited reporting done in this way, its format and content were not appropriate for the much more detailed reporting required for SHEEL. If NAF were to be used, it would have to be developed into a more complex and feature rich structure.

NAF is a tagged format language. It was deemed redundant to develop a tagged format further within the SHEEL project, when such a format language is available in the XML. XML has the advantage of being widely known and used as a standard by the software industry, being supported by multiple development tools at all levels. This is not the case for the NAF, which is not specifically supported by any software programs. One of the reasons why captains are forced to enter information manually is that there are no software tools available to the NAF. A notable exception is the VMS, where, in some cases, reporting is done automatically using the NAF format.

It must be noted that though the proposed format is standard format used by the systems at the ends of the network, it need not be used in transmission between any of the nodes in the network. The message is transmitted as electromagnetic waves that have no resemblance to the file format either at the source or the destination. Prior to, and following, transmission, the file may undergo multiple transformations, including recoding, compression, segmentation, and encryption.

SHEEL assumes that software developers and vendors have the opportunity to provide the tools for data collection and transmission to shore. SHEEL is to be used to report catches for scientific as well as monitoring purposes on a wide scale by the EU and possibly other nations. It would not

be appropriate to tie the development of SHEEL to a particular proprietary syntax, like NAF. Thus, XML was the format adopted by SHEEL.

## REPORTING

Data should be collected automatically as much as possible. This implies that instead of reporting manually about past events, data is, to a large extent, collected automatically in real time and stored in the database until it is retrieved into a SHEEL report and sent off. Thus the SHEEL system is modeled like an accounting system, which keeps track of all (chosen) events over a period of time and then can create, for example, a report at regular intervals.

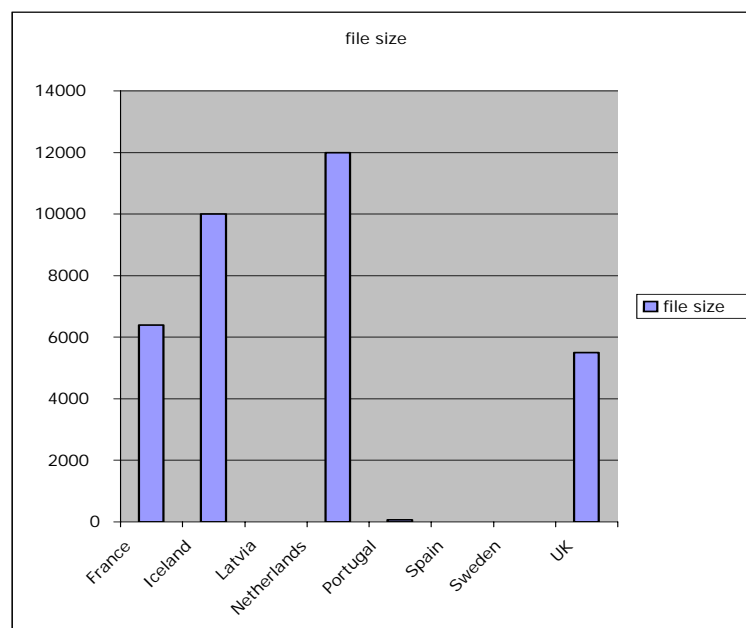
An effort was made to keep the XML tags short to preserve space and to keep a close resemblance to the NAF tags. Where possible, the SHEEL format uses standard reference values, e.g. for the names of species, countries etc. While working on SHEEL the need for an international identification system for harbours became apparent. This could be similar to the existing code for cargo harbours defined under the term LOCODE by the UN European Economic Commission.

Whilst this format has no official status, it is available for use in a public document that can be downloaded at: <http://www.unece.org/cefact/locode/service/location.htm>

## DEMONSTRATIONS AND TRIALS

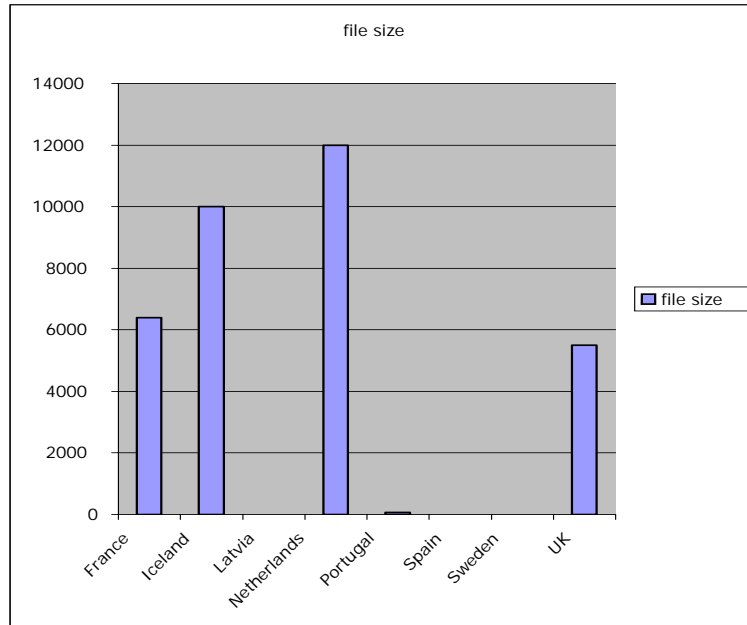
The demonstration of feasibility of an electronic log involved 8 European countries and more than 15 fishing vessels. Those fifteen covered a broad range of vessel types and gears, vessel crews working in several different languages and with a range of computer expertise. It is worth noting that there was general acceptance by the vessels, but it must be equally pointed out that as these vessels were handpicked for the project, it would be less than prudent to draw any conclusions from this acceptance.

Figures related to the reliability and cost of satellite communications are, by any measure, impressive. During the project, SHEEL vessels made more than 1600 transmissions of electronic log files, and not a single failure was logged.



**Figure 4 The Size of Data files from the different countries in the SHEEL Project**

The size of the data file for a single log varied from 68 bytes to 12 kilobits and the cost of transmission of a single log varied from Euros 0.05 to Euros 1.67.



**Figure 5 The Cost of Data files from the different countries in the SHEEL Project**

There are a number of reasons for these variations. The size of the data files was directly related to the effort in coding and compression made by developers and this, in turn was related to the communications system being used for transmission.

Developers who had the advantage of a broadband or voice-band communications systems were far less concerned about their file size as these communications links are so inherently inexpensive that making their file much smaller would unlikely make a significant difference in cost. This is visible for those who used the Inmarsat Fleet service and the Iridium system and were able to use the largest data files but still record the lowest costs.

On the other hand, developers who used the Inmarsat-C system used coding and compression techniques that reduced file size to as little as a handful of bytes, but still registered transmission costs that were significantly higher than the best achieved with systems offering higher data rates.

## **SATELLITE COMMUNICATIONS RESOURCES**

Developers in the SHEEL project were given a Communications Requirement Document as a reference to available satellite communications resources at the very beginning of the project. This document covered the entire range of mobile satellite services relevant to SHEEL objectives in terms of technical characteristics, costs and security. Four communications systems were tested during the SHEEL project: Inmarsat Fleet 33, Inmarsat-C, Iridium and Emsat.

## **SECURE ENVIRONMENT AND INSPECTION**

These were two aspects of SHEEL that achieved less significant results. The first was to create an end-to-end secure environment. This can most accurately be viewed as a failure of original planning in that the technical annex required a system with full encryption and a digital signature. Viewed in retrospect, this approach was probably far too ambitious to be appropriate for a fisheries environment, in that it would have added logistical difficulties as well as significant increases in transmission costs.

There was a consensus within the project that the question of security is best settled on a case-by-case basis, depending upon the nature of the data and the context in which it is being used. The other question that received less attention than originally intended was onboard inspection, mostly because of schedule slippage in the testing and demonstration phase.

## **GLOBAL ASSESSMENT**

Viewed globally, positive outcomes of SHEEL include the development of an electronic log specification capable of emulating the EC paper log, that specification having been tested on a broad range of vessels with an impeccable transmission success rate at reasonable cost. The only negatives were a failure to resolve the data security question and to take the onboard inspection capability to its conclusion.

Still, the goals of SHEEL were largely achieved and the most important of these is that it would now be virtually impossible for anyone to dispute the technical or economic feasibility of a European electronic fishing log.

## **VMS THE WEAKNESSES**

The equipment used aboard vessels to transmit VMS data has proved to be both reliable and accurate. With thousands of vessels already fitted with VMS equipment, and the number of fittings scheduled to accelerate in the years to come, some fishing vessel operators have found ways to corrupt the data transmitted by the VMS terminal on their vessels, so as to undertake illegal fishing activities.

A number of vessels have been detected recently, and some of them seized and prosecuted, for transmitting tampered VMS data. And whilst a number of measures have been taken to improve the security of shipboard equipment used in VMS, it is inevitable, because of the potential rewards of illegal fishing, that maintaining the security of VMS data will be an ongoing problem.

It is necessary to ensure that the reliability of the VMS data is beyond question to ensure that the fishing industry complies with fishing regulations and to provide verified and accurate data for use as evidence in successful court prosecutions.

## **VULNERABILITY OF SHIPBOARD EQUIPMENT**

A cursory assessment of the likelihood of an operator to be able to corrupt the data sent from his vessel is a cause for significant concern. To begin with, in most VMS systems the vessel operator is permitted to select the specific equipment that will be used on his vessel from a range of commercially available models. This is particularly true of distant-water vessels that participate in VMS systems of several countries, most of which sell licenses as a means of earning income. Few coastal states that welcome foreign vessels have the political clout to impose stringent requirements as to VMS equipment, most of them being, in addition to the license fees received, net recipients of foreign aid from the countries whose fleets fish their waters.

The security quality of this standard equipment, in terms of tamper proofing, varies widely. Furthermore, from the time of purchase, this equipment is in the operator's possession, or under the operator's control, and is only relatively rarely subject to inspection. It is not difficult to imagine, in such a context, that an operator who participates in illegal fishing activities could conspire to corrupt VMS data so as to mislead the authorities by, in the first instance, choosing equipment which he deems most vulnerable to modification for this purpose. Having done so, he can then, virtually at his leisure, carry out the work necessary to corrupt the data.

## VMS EQUIPMENT TYPES

In this connection, it is useful to examine a number of different types of transceiver equipment commonly used around the globe in fisheries management. Typically, a transceiver is installed onboard a fishing vessel and used to record the position of the vessel at frequent intervals throughout its voyage. These position reports are then transmitted via satellite back to an FMC under the control of the local fisheries management authority. Reports may be transmitted either in real-time or on a store and forward basis, depending on the constraints imposed by the satellite communications system employed.

The use of this type of equipment for vessel monitoring displays one important constraint – the equipment must be installed on a fishing vessel and operate autonomously, relying on the good will of the vessel’s crew to leave the equipment undisturbed. Since large financial gain may be obtained by a fishing vessel that is able to fish in regions or at times when it is prohibited from doing so, there is considerable incentive to tamper with the transceiver equipment.

This tampering may aim to either:

- prevent position reports from being obtained;
- prevent position reports from being transmitted back to the VMS;
- falsify position reports without the knowledge of the VMS.

## TAMPERING SUSPECTS

Tampering may be carried out or aided by a range of parties with particular interests and resources to devote to tampering, including:

- **Fishermen themselves.** While the electronics and computing skills of the crew of smaller vessels may be limited, larger vessels are likely to have well trained radio operators and crewmembers with marine electronics skills onboard. However, the financial and human resources they are able to devote to the development of tampering methods will be limited.
- **Marine electronics organisations.** It is conceivable that a marine electronics company could devote sufficient resources to developing an “off-the-shelf” tampering kit to sell to fishing vessel owners. The resources available to devote to this are likely to be greater than those available to a single crew.
- **Fishing companies.** Larger fishing companies or co-operatives are likely to be able to devote greater resources to tampering than individual vessels. This could extend to commissioning the production of a tampering system from a third party electronics company.
- **Governmental organisations.** Finally, there may even, under exceptional circumstances, be the possibility that governmental organisations may perform tampering with position reporting or communications equipment. In such cases, the resources that may be devoted to the development of tampering techniques may be virtually limitless.

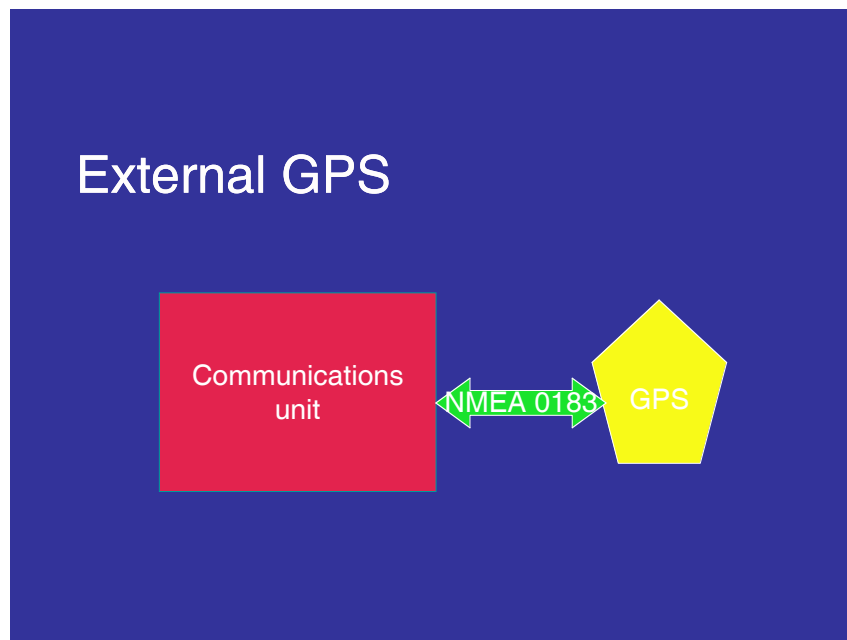
## VMS EQUIPMENT FROM THE INSIDE

To fully understand the risks of VMS tampering and data falsification, it is useful to consider a broad range of the equipment currently available for fishing vessel monitoring and analyze its

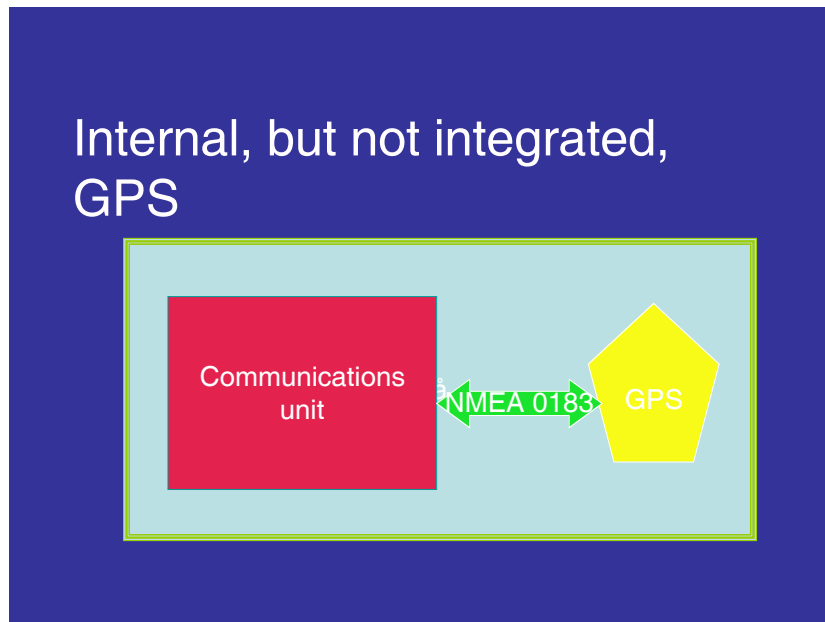
architecture for conceptual vulnerabilities. This will serve as the basis for identifying the likely tampering techniques available to these groups and try to determine which techniques are within the resources of each.

As the likelihood of attempted tampering is directly related to the cost of the tampering compared to the potential gain, an evaluation of the costs and technical expertise required for the various scenarios of data tampering and corruption and to make recommendations as how fisheries compliance authorities might keep one step ahead of those who would attempt to avoid the inherent security provided by VMS.

A look at nine of the satellite communications terminals most commonly used in VMS reveal that there are three global architectures based upon the relationship between the navigation system and the satellite communications terminal: either the two are fully integrated so that, at the level of the electronic circuitry, it is difficult to distinguish between the components of the communications system and the navigation system; or the two separate elements are contained within the same package, but are separate in terms of their circuitry; or the navigation system is external to the communications system package and connected by a cable.



**Figure 6** **VMS equipment with an external GPS (above) is most vulnerable**



**Figure 7** Housing two separate elements in the same housing (below) provides only marginally superior security



**Figure 8** When navigation circuitry is distributed throughout the communications equipment, security is optimized

These three architectures are of descending value in terms of security against tamper-proofing. Falsifying data through fully integrated systems requires a high degree of expertise and technical resource; an internal, but separate, navigation system requires only that the terminal case be opened to make it highly vulnerable to data tampering, and an external navigation system can be tampered with almost at will.

## **EARLIEST TAMPERING**

It is important to note that during the first years of VMS operation, all reports of illegal action – there were no exceptions – were identical in that they all included some method of disabling the VMS terminal by either disconnecting the power supply, disconnecting the antenna or, in some way, physically blocking the antenna.

There is a consensus that such actions present little danger to the integrity of VMS as inhibiting the reporting of a terminal simply draws the attention of the VMS authority to the vessel that is taking such action. Vessels displaying a chronic habit of failing to report through VMS tend to be more subject than others to boarding inspections and inspections at port. Furthermore, these inspections tend to be more rigorous than they would have been had the vessel been carrying out its VMS responsibilities without incident. Most of the above authorities report that, presumably for this reason, such forms of VMS infractions have been on the decrease.

## **TAMPERING GETS SOPHISTICATED**

In 2003-04, a new phenomenon developed that is far more worrying for the integrity of VMS. Fisheries authorities in Australia, New Zealand, South Africa and France (Réunion) have all either observed, or captured, vessels transmitting VMS positions that were at enormous variance with their real, physical positions. In one case, a vessel was observed reporting a VMS position some 3000 nautical miles from its real position.

In these specific cases, all of these vessels have been limited to operations in the Patagonian toothfish fishery. Examination of the circumstances indicate that vessel operators have been able to block out the integrated GPS equipment and to then use a manual GPS, or a GPS simulator to input false positions to the communications module of the VMS equipment. Such data falsification is undetectable without physical observation of the vessel or physical inspection of the terminal.

Furthermore, it has been documented that ready-made kits designed to permit a vessel to input false positions to a Thrane & Thrane terminal were readily available at a fixed price of \$2500. The existence of these kits, openly commercialized, would tend to indicate that such cheating by data substitution is likely far more widespread than the few incidents that have been logged by the authorities.

It is interesting that all of the above incidents involve vessels that were carrying the same terminal from the same manufacturer and that this is the very piece of equipment for which a tampering tool is available. Furthermore, it should be pointed out that, until these incidents, this piece of equipment, one of the fully integrated terminals that has been assessed, was generally considered “secure” by most compliance agencies. Analysis of one captured terminal shows that modification of only three new connections was necessary to input false data.

It would be an over-reaction to assume that the relatively simple modification of three connections means that the security breach was correspondingly simple to effect. Such a modification could only be the result of a substantial research effort that would have extensively tested components and connections in a successful effort to identify the path and protocol of data transfer from the GPS to the communications unit.

## **REACTIONS TO TAMPERING**

These incidents have provoked a number of responses. The most immediate was that the manufacturer modified the design of their terminals so as to make the tampering kit useless. Tests



of the new model have demonstrated that it is a far more formidable opponent for would-be “tamperers”. Furthermore, the manufacturer has developed another unit that is so highly integrated, it would be necessary to intervene at the interior of integrated circuit level to falsify data. The FFA is so convinced of the security of this terminal that it is considering incentives to vessels willing to fit it.

The second is that, following the incident of last year with two EU vessels that reported erratic positions and whose terminals, upon boarding, showed signs of tampering, the European Commission passed a regulation requiring all of its member states to assure that VMS terminals in use on the fishing vessels of its national fleet be secure. The result has been a significant improvement in security for a number of manufacturers in their effort to satisfy various national requirements.

The response to this regulation was varied. A number of countries launched full-fledged tenders for secure terminals to equip their entire fleet. Other countries did absolutely nothing. The real problem is that the word “secure” is insufficiently precise. Perhaps the only real security is to be had by restricting, or even prohibiting, access by vessel operators to the internal circuitry of their VMS terminals.

This could be done by a combination of sealing the terminals and passing a regulation making it illegal to open them, except by, say, the authorities, as Australia has done. This could impede data tampering until it becomes feasible to input data from the outside of the terminal. The capability of doing this is, unfortunately, firmly on the horizon, as the following section describes.

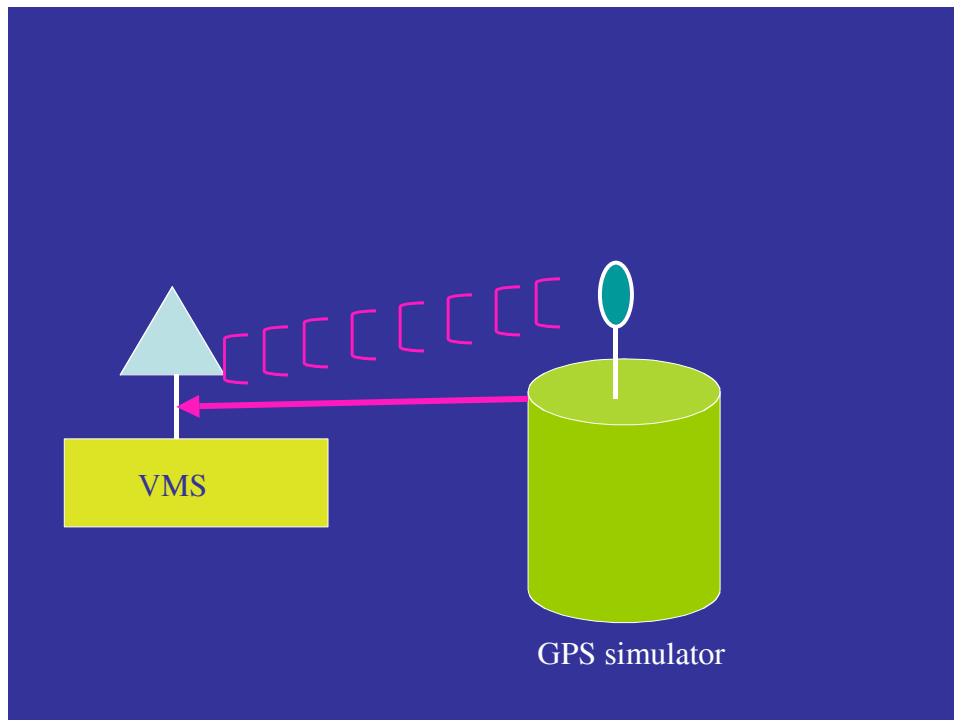
## **FUTURE TAMPERING ISSUES**

Whilst the incidents described above are sufficient to give pause to anyone’s reassurance as to the reliability of VMS data, there are, on the horizon for the medium- to long-term future, other developments that could prove even more worrying. A number of potential, future tampering techniques involve the generation of simulated GPS information. This could, in theory, take place in three places:

- a radio frequency signal similar to that transmitted by the GPS satellites could be broadcast in close proximity to the GPS antenna in order to create a false input to the GPS unit;
- an intermediate frequency signal could be injected directly into the GPS receiver via the antenna connection;
- the National Marine Electronics Association output of the GPS receiver could be simulated.

## **SIMULATING VMS DATA**

The first option involving a radio frequency simulator is very expensive. The cost of a simulator for putting a GPS receiver in the wrong position would be at least \$50,000 and more like \$100,000 if there were a need to change the fishing areas.



**Figure 9** **In the future, a GPS simulator might be used to input false data to even a sealed terminal**

There are about four companies in the world that build a simulator that could be used for this spoofing purpose. It would take a very sophisticated user to program the simulator but it could probably be done with sufficient training.

The output from the simulator would be fed either directly into the GPS receiver in place of the antenna connection or, it could be re-radiated from a small antenna placed inside a metal container that covered the GPS antenna. This latter approach would be difficult if the GPS is integrated with the antenna and also if the antenna is also an INMARSAT transmitter. It would require somebody to open up the antenna unit and detach the GPS antenna input to the receiver and connect, in its place, the feed from the simulator.

To prevent this type of tampering, it would be possible to send part of the GPS signal that would be ephemeral, and therefore impossible to simulate, as part of the position report. This could be used to validate the report by comparing, for instance, part of the broadcast ephemeris with a GPS receiver at the VMS control centre. All that is needed is a message that changes regularly, to be sent as part of the data verification, to make simulation nearly impossible.

The second approach is much easier. This less expensive approach involves disabling the GPS receiver and feeding data into the position-reporting transmitter from a PC on which messages could be generated. Interfacing the PC to the input to the transmitter is quite straightforward as they are both generally standard data streams.

## **SPECIFYING EQUIPMENT**

Architectural and physical tests serve only to underline the vulnerability of much of the equipment currently being used for VMS. Furthermore, so long as vessel operators have the right to choose their VMS shipboard equipment, it is essential that all available models be equally resistant to tampering.

## **TYPE APPROVAL**

In order to achieve this goal, there could appear to be two possible solutions: One would be the approach taken by Australia, New Zealand and the USA which is to type-approve specific models of terminal that have already been vetted for their resistance to tampering. The problem here is that some authorities, like the European Commission, have always resisted, for political reasons, naming specific equipment.

## **NORMS AND STANDARDS**

The other solution would involve creating a set of security norms and standards for VMS equipment and having these specifications accepted and published by one of the international standards organizations, such as the ISO. Once this were accomplished, the competent authority would then only have to adopt the standard as part of its VMS specification to assure that all new VMS equipment that is fitted be of that recognized security standard. It is not clear, however, which body might be willing to carry out this considerable work and to become the “guardian” of VMS norms and standards.

## **EXISTING TERMINALS**

As far as the thousands of terminals already operational aboard fishing vessels, the solution here would be to regulate that the operators of these vessels be obliged to upgrade their shipboard VMS units to ones that are in accordance with the new international standard within a specified period; say three, four or five years. As one would reasonably expect that any investments in shipboard equipment would be amortized by the end of five years at the very latest, it would be very difficult for fishing vessel operators to mount a credible challenge to such a regulation.

The use of, and reliance upon, VMS is expanding all the time, and several deadlines for expansion of the VMS will arise in a number of countries and regions in the near future. This is because several regional fisheries management bodies are now requiring that their members use VMS as a method of controlling their vessels. It is essential that definitive measures be taken to improve the reliability and security of VMS.

## **CONCLUSIONS**

Since the introduction of VMS in Portugal in 1988, the technology has been adopted as an important MCS tool by virtually every major fishing nation and coastal state, and required by an increasing number of regional fisheries management organizations. The value of VMS continues to be extended and the full potential benefits of the technology are still being explored and developed.

Major advantages of VMS include: that authorities are aware in near real-time of the accurate positions of all licensed fishing vessels and the efficiency of protection and compliance activities is improved, resulting in significant cost savings. Licensed vessels are aware that they are being tracked, thus changing the mentality of their operators and crew as to whether operating outside compliance with fisheries regulations is profitable.

The potential value of VMS can be increased by achieving cooperation among states on a bi-lateral or multi-lateral basis or through RFMOS, regarding the widespread and timely sharing of VMS data. Identifying an appropriate networking solution to share VMS data is necessary. In some regions, a hybrid of existing models has been chosen as an expedient, workable solution rather than a single entity for world-wide data storage and distribution.

The results of the EU's SHEEL electronic logbook project suggest an enormous potential synergy between VMS and electronic logbooks. There is a consensus that the combination of these services would improve fisheries compliance and management significantly, suggesting more work should be done in this promising area.

Given the efficiencies to be gained by standardized data formats, there is a need to follow up on the MCS Network/CWP joint workshop proposed by the CWP with regard to the international codes and standards used by CWP.

A number of wilful violations of VMS systems due to data tampering by vessel operators have been documented. Successful use of accurate VMS data in court prosecutions is critical to improving compliance, and underscores the value of VMS as an essential MCS tool.

There are a number of efforts underway to assure that future VMS operations will benefit from a higher, and more uniform, level of security. Nonetheless, it is clear that, given the potential financial benefits of illegal fishing, the entire VMS security issue will be on-going. It is essential that definitive measures be taken to improve the security and reliability of VMS. The establishment of international standards for VMS would be desirable.

VMS data should be verified by independent means (e.g. such as VDS or patrol craft) to ensure that the data received by fisheries authorities is reliable.

At present the costs of a single VDS image is estimated at 1000 Euros. However, plans for future satellite launches and the technical specifications of the images obtained suggest that VDS, with increased resolution and lower costs, should be an invaluable tool in the medium term, i.e. within about five years.

VMS verification could be carried out at the FMCs in an attempt to identify tampered data through the recognition of internal anomalies in the data.

Some developing countries lack the generalized capacity to implement or sustain a VMS programme, therefore special consideration should to be given to the needs of developing countries in technical cooperation projects and aid programmes dealing with enhancing their MCS capacity.

This document contains the report of the Expert Consultation on the Use of Vessel Monitoring Systems and Satellites for Fisheries Monitoring, Control and Surveillance, that was held at FAO Headquarters, Rome, Italy, from 24 to 26 October 2006. The Expert Consultation was convened by the Director-General of FAO to review and assess technical, legal and institutional aspects concerning the use of vessel monitoring systems (VMS) and satellites in monitoring, control and surveillance (MCS) with the goal of facilitating the wider use of this type of technology and promoting and strengthening international cooperation among States for its use. The Expert Consultation furthered collaboration with the International Maritime Organization (IMO), as called for in paragraph 90 of the 2001 FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated [IUU] Fishing. The Experts undertook an inventory and assessment of the status of VMS and satellites in terms of the technology and equipment employed and legal and institutional considerations. This work was complemented by a review of options to enhance the use of VMS and satellites in MCS by addressing the enhanced use of technology and strengthening the development and implementation of national legislation and international instruments to foster enhanced international cooperation for the wider use of VMS technology. The Consultation also considered issues relating to the special requirements of developing countries, the use of VMS in support of port State measures, a comprehensive record of fishing vessel and the role of the International MCS Network. The Consultation did not recommend a binding international VMS agreement although additional mechanisms such as an international plan of action, declaration or strategy to guide and facilitate global implementation of VMS might be considered. The Consultation also made recommendations, *inter alia*, concerning the use of VMS as a MCS tool to combat IUU fishing, the further development and implementation of VMS and the need for MCS to be enhanced particularly with respect to closer cooperation among regional fishery management organizations. The Consultation was funded by the FAO Regular Programme and by the FAO FishCode Programme through the FishCode Trust (MTF/GLO/125/MUL) and the FishCode SIDS Project (GCP/INT/823/JPN), "Responsible Fisheries for Small Island Developing States".

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