WHITE PAPER: Vessel Monitoring with Hybrid Communication Technology

Vessel Monitoring with Hybrid Communication Technology: Reliable Positioning Data and Predictable Costs

Abstract

Fisheries Monitoring Centres (FMC) rely upon communication devices to receive positioning information about their fishing fleet's activities on the seas; enabling them to sustainably manage their fish stocks and marine reserves for future generations. Many FMCs have chosen satellite-only vessel monitoring devices to receive vessel positional data. However, choosing a hybrid communication device which uses both the satellite and the GPRS/2G/3G network offers many advantages. This white paper aims to show why FMCs should look to hybrid technology devices to manage their fisheries and the obvious benefits that they provide.

Introduction

Fisheries Monitoring Centers (FMCs) need vessel positioning data to ensure that their fishing fleets are not overfishing the seas and that the marine reserves in their care are sustainably managed. To achieve this FMCs use vessel monitoring devices to transmit: GPS location, speed and heading data for each and every vessel in the fleet. While it is critical to have the information, FMCs do not want to force fishermen into paying unpredictable or exorbitant prices for the costs of data transmission.

Some FMCs rely solely upon either satellite-only vessel monitoring systems (VMSs). However, those that choose vessel monitoring systems with hybrid communication technology (with both GPRS & satellite communication channels) can reap many additional benefits.

With hybrid communication systems, when vessels are out of GPRS coverage, the VMS device will switch over to the satellite communication channel ensuring that the FMC will always receive data about when and where their fleets are fishing. However, when in GPRS coverage the hybrid communication technology allows the FMC to receive a larger amount of data for a similar cost when compared to the cost of satellite message transmissions. The additional increase in data can either provide FMCs with a greater understanding of their fleets movements upon the seas or help to reduce costs when performing additional tasks such as synchronizing geozones; High Resolution Data Requests or simply the basic 'housekeeping' of the device.

Why do Fisheries Monitoring Centres need VMS systems?

Fisheries Monitoring Centers are charged with sustainably managing the fish stocks and marine reserves in their care by national and international authorities. They do this in a variety of ways; either by imposing quotas for the fleets (limiting the amount of fish being taken out of the sea) or setting closure zones (e.g. spawning grounds need to be protected). To effectively manage their fleets, they need to receive reliable timely information about the fishing efforts of their fleets and also have the ability to further investigate their vessels to monitor whether the rules and policies are being followed.

Vessel monitoring systems are devices that on mounted directly onboard the fishing vessels and calculate the position; speed and heading

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of a vessel. This information then needs to be transmitted back to the FMC.

FMC requirements for VMS data

As the fishing vessels travel on the seas there are a number of different ways in which the data collected can be transmitted back to the Fisheries Monitoring Centre. However, for the FMCs to operate effectively there are certain requirements that the VMS systems need to fulfill:

Availability

Wherever a vessel travels on the seas there needs to be method of reporting the positioning data back to the FMC.

Reliable data

The flow of data back to the FMC needs to be reliable as otherwise the FMC cannot receive a full picture of their fleets and so cannot make informed decisions.

Timely data

FMCs need to receive timely information about their fleets as otherwise they would be unable to ensure that their policies are being upheld. For example, if the data gets delayed by 24 hours then the vessel might already be back in port by the time a suspected infringement (e.g. Transshipment) can be investigated (in which case it would be too late to do anything).

Polling or Interrogation possibility

The FMC will occasionally want to take a closer look at vessels movements, in order to do this they need a method to request further information from the vessels VMS system. If this is not possible then there is the potential for illegal or illicit activities to go unnoticed.

Secure

The data that is sent needs to be secure for a number of reasons. Primarily, commercial fishing operators are reluctant to give away their fishing locations to other fleet owners as the data and maybe techniques would be considered too commercially sensitive. Secondly, with the threat of piracy there would be dangers in transmitting vessel positions and headings for everybody to see.

Options for VMS data reporting channels

There are several ways in which a VMS might transmit data back to the FMC:

Satellite

There are currently two different satellite communication networks, which for the purposes of fisheries monitoring cover the entirety of the planet. Currently the two companies supplying coverage are Iridium and Immarsat. Satellite communication channel cover the whole planet, so FMCs are ensured of data coverage.

GPRS/2G/3G

The GPRS/2G/3G network is the same network that allows your mobile phone to operate. The signal coverage varies from country to country so to transmit data it is necessary to have sufficient signal strength for the FMC to reliably receive the data.

VHF

VHF radio (the radio frequency range between 156.0 and 162.025 MHz) which is already installed on many vessels. It is used for a wide variety of tasks but one of the principal ones is Automatic Identification System (AIS) which is a collision avoidance aid.

Benefits and drawbacks of the different VMS data reporting channels

In this section, we will look at the relative merits of each of the potential reporting channels in relation to the requirements as a potential method of reporting VMS data.

	Satellite	GPRS/2G/3G	VHF
Availabilty (High Seas/Coastal)	✓	*Coastal only*	*Coastal only*
Reliability	✓	✓	✗
Timely	✓	✓	✗
Secure	✓	✓	✗
Interrogation possibility	✓	✓	✗
Relative price per message	€€	€	*Free*

Figure 1: Benefits and drawbacks of VMS data reporting channels.

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Vessel Monitoring with Hybrid Communication Technology

Availability

The seas around an FMCs coastline can be divided into two different areas: coastal waters and the high seas. There are various different definitions of what these might are but for the purposes of this paper only the relative signal strength of each of the channels is the important factor. For both GPRS and VHF as a vessel ventures further out on to the high seas the strength of the signal decreases as they move further away from the base station.
If we look at Figure 1 we can see that there as the vessel moves further away from shore the only constant signal is the satellite signal. The other two: VHF and GPRS degrade as they move away from the coastline. There are various factors for this degradation:

- Distance from base station
- Age of the base station technology
- Obstructions

Additionally, the further from a base station the more a signal cannot be relied upon to safely transmit the message.

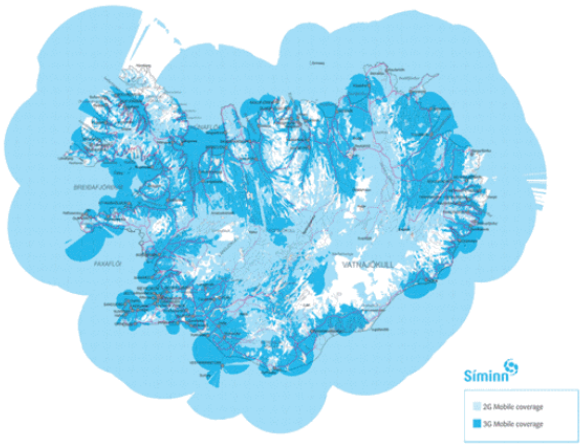

Figure 2: GPRS coverage of Iceland.

Looking at Figure 2 although there appears to be coverage covering the coastlines of Iceland it doesn't necessarily mean that they can be relied upon to provide safe message transmission. The only choice to safely transmit a message on the high seas is through satellite communication. So it is clear for reporting on the high seas the only technology that can be relied upon is satellite communication.

Reliability

Both Satellite and GPRS are unaffected by reliability problems as long as there is sufficient strength for the transmission of the message. For the VHF channel however, each device is assigned a 'timeslot' to transmit its message. TDMA (Time Division Multiple Access) technology allocates a share of the available airwaves on the AIS frequency. The AIS standard states that there are a fixed number of these slots for each of the two AIS channels: 2,250 on each channel every 60 seconds. This presents a potential problem, as if there are multiple vessels in the area then some might have the same timeslot. In areas around straits and nearby ports the potential of this happening greatly increases congested. If we look at Figure 3 we can see quite quickly how many vessels are in the area.

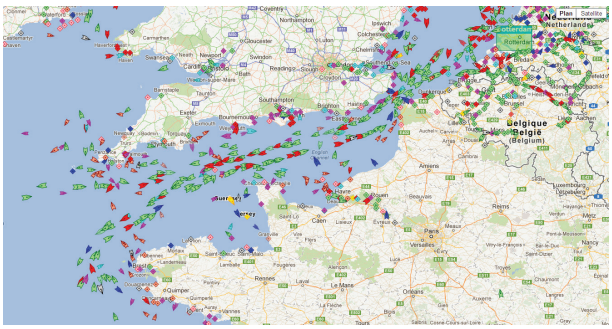

Figure 3: AIS reporting in congested seas.

If there is a delay in the information being sent back then there is a chance of a time delay for the information submission back to the FMC.

Timely

For both satellite and GPRS channels other than the transmission time there is very little delay in sending the information through to the FMC . One of the issues that arises for the VHF channels is there is no real-time roaming option. The VHF channel will use the closest AIS base station to transmit the data. If a vessel enters into foreign waters then it will use a base station of

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the foreign waters, this means that Equally with GPRS signals there is the precedent for 'r

Vessel interrogation

If an FMC does feel that infringements have taken place or they require further information to create a more comprehensive picture of fisheries then they will need to either use a Poll command (and receive an instant position of the vessel) or they can request more high resolution data (HRDR). With both Satellite and GPRS there is no restriction upon the amount of information that gets sent (though there is obviously a cost implication). However with the VHF channel, there is a restriction on the type of information that gets send but also the fact that there is no way of the FMC from interrogating the vessel for further information.

Secure

Both the satellite and GPRS messages can be encrypted to AES standards, this means that the message even if intercepted would unable to be read or ammended. Unfortunately this is perhaps the biggest flaw of VHF is that it is possible to hijack the AIS signal and manipulate the information (modification of ship info/create fake vessels/sending false information) Further information upon this can be found at the following link: http://blog.trendmicro.com/trendlabs-security-intelligence/vulnerabilities-discovered-in-global-vessel-tracking-systems/.

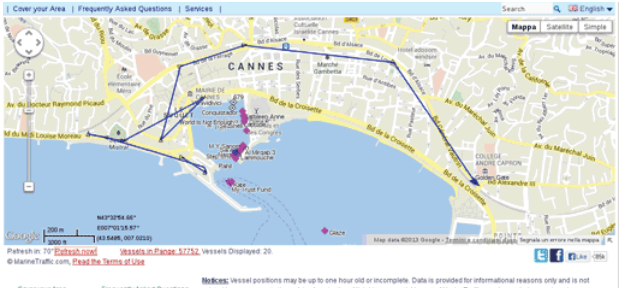

Figure 4: 300 ton ships should not drive down the main street of a city.

In figure 1 we can see the work of trendmicro whereby the manipulated the VHF signal of a 300gt ship to travel down the street in Cannes, France.

Why choose Hybrid Communication Technology?

The clear winner seems to be satellite technology; however VMS terminals which can only transmit data back to the FMC via the satellite network result in expensive and unpredictable costs for data transmission. These costs can potentially force a Fisheries Monitoring Centre into making a trade-off between data and costs. FMCs are acutely aware that an increase in the frequency of vessel reporting also means an increase in airtime costs.

Vessel monitoring systems with hybrid communication technology with GPRS means that FMCs no longer have to make these concessions. More data can be transmitted through the GPRS network than could be optimally transmitted through the satellite network.

Additionally, aside from the lower financial costs, having hybrid technology also provides FMCs with a redundancy option. If the primary channel of data transmission should fail, the device can simply switch to the secondary channel. This is not only applicable in the case of breakage or malicious damage, but should there be areas on the sea that have no signal coverage then the device can simply choose to transmit over the available channel.

Where can Hybrid Technology Communication benefit Fisheries Monitoring Centres?

High Resolution Data Requests

High Resolution Data Requests (HRDR) are commands that are issued by Fisheries Monitoring Centres and consist of a high number of vessel positioning samples over a given time period. HRDRs allow an FMC to more precisely understand the movements of a vessel on the sea which can allow them to better monitor their fisheries. HRDRs can often be a data file of significant size, which will obviously have financial costs for the fishermen. In instances when a vessel is out on the high seas and an FMC requires a HRDR to understand vessels movements (e.g. potential transshipment or vessel steaming through another vessels net) and an

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immediate transmission is required then data will be transmitted through the satellite channel. However, with a hybrid communication device if the vessel is in GPRS coverage then the FMC has the option to receive the data through the lower cost channel. HRDR commands issued over the GPRS channel will mean that the device will only report data back when in GPRS coverage. If the vessel is out of range of GPRS coverage when the command is sent, then the FMC's data server will store the command (for a period of 48 hours) and wait until a GPRS signal is restored. The onboard device will only receive the command and send the data, when a strong enough GPRS channel becomes available (removing the need for higher data transmission costs).

Below we can see two instances of an HRDR in action. In Figure 1, Vessel A is on the high seas (i.e. out of reach of GPRS coverage and using satellite communication) and passes suspiciously close to Vessel B. The FMC suspects that transshipment has taken place, so a HRDR command is issued over the satellite channel; data is immediately transmitted through the satellite network allowing the FMC to make a decision upon any further action required (e.g. penalties for the vessels).

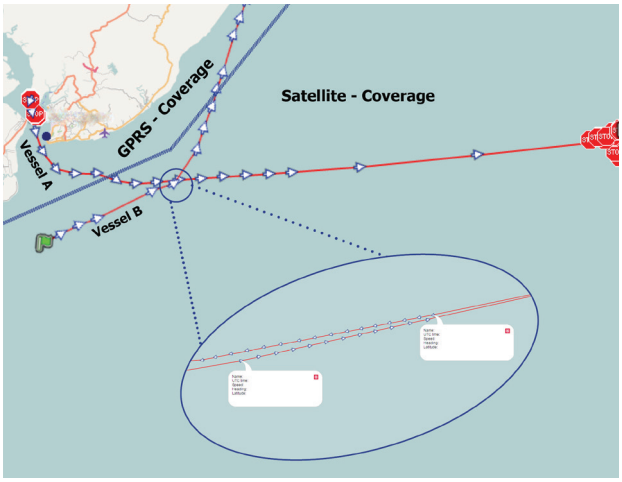

Figure 5: Suspected illegal transhipment.

In Figure 2, we see two HRDR requests. In the first HRDR request (HRDR 1) a vessel has entered a geozone (that is within GPRS coverage) that the FMC is watching (but does not have a short sampling period). The FMC notices a pattern and want to investigate further. In this instance the FMC issues a HRDR request over the GPRS network and the data is sent over the GPRS network.

In HRDR2 a similar scenario occurs but the vessel was out of GPRS coverage when the command was sent. The command is held in a queue at the FMC's data server until the vessel has returned to an area with GPRS coverage (point A). Meaning, the data is transmitted but at cost between 3-7 times cheaper than that of a satellite transmission.

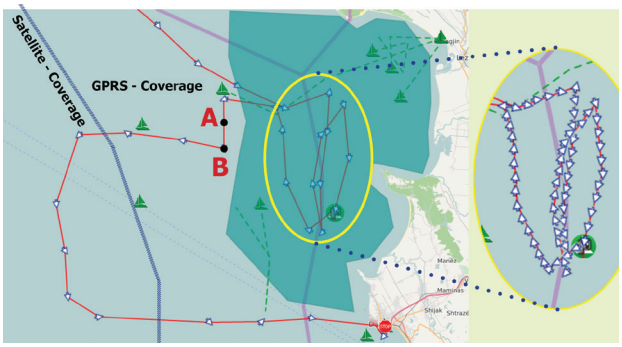

Figure 6: HRDR request within GPRS coverage.

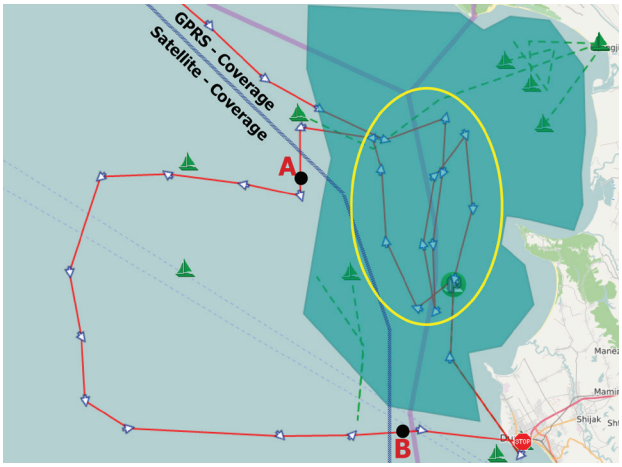

Figure 7: HRDR request outside of GPRS coverage with delayed transmission.

Geozones

A geozone comprises of a geofence consisting of multiple points (Latitude and Longitude coordinates) that defines an area that has specific operational rules and attributes. Geozones are

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created by Fisheries Monitoring Centres or Fleet managers to follow the rules and guidelines set out by national authoritiesFMCs will often use geozones as part of their sustainable fisheries policies. VMS devices that have hardware embedded geozones (which offer significant advantages over software geozones: more precise and accurate reporting of precisely when a vessel traverses a geozone) have to be dynamically changeable in the field by the FMCs. So, as FMCs try to maintain the delicate balance of fish stocks around their coastlines they need to be able to add, remove or modify the geozones over the air. To make these changes over the air requires a large amount of data transfer, which again will be more cost effective if sent over the GPRS network. Hybrid Technology devices can be programmed to only synchronize these changes when in reach of the GPRS coverage, ensuring that costs for fishermen are always optimized.
In Figure 3 we see two instances of geozone amendments:

1) An FMC recognizes that the annual spawning season within geozone A is going to be earlier this year. To ensure the fish in the area are protected, the FMC issues a geozone amendment over GPRS. When all vessels are within GPRS coverage this amendment is made.

2) The FMC calculates that the fishing quota for geozone has been reached and so imposes an immediate zone closure for that area and increases the reporting frequency of the zone over satellite to ensure that the restriction is adhered to.

Hybrid communication technology gives the flexibility to change hardware embedded geozones intelligently through different channels depending upon whether the amendment is critical or not.

VMS Housekeeping

All VMS terminals will have firmware embedded inside them which will occasionally need to be updated either due to changes or advancements in fishing technologies or fisheries management practices.
The upgrade process is normally done remotely over the air (FOTA or Firmware over the Air). Doing this remotely, which in itself is a cost saving measure (instead of physically sending installers to all vessels across the fleet,) can require significant amounts data to be sent to the devices. With hybrid technology the process can be done through the lower cost GPRS network. This eliminates the high cost that would be incurred should this routine but necessary procedure be performed through the satellite channel.

Redundancy

FMC need regular timely positional information from the fleets to ensure that their fisheries policies and procedures are being followed. Satellite communication channel provides global coverage, which is why in the past it has been the favored choice for FMCs to monitor their fleets. However, should an FMC rely solely upon this method data transmission it can lead to potential problems. For example, should the satellite communication channel fail or if there is tampering or malicious damage (such as the jamming of the signal) then there is a limited backup communication channel for the FMC to receive the data as otherwise the FMC will lose sight of their vessels.

Future Fisheries Monitoring Technologies on the Horizon

For many years, tracking and monitoring of telematics data from the vessels in the national fishing fleets has been the only way of deciphering whether their fleets are fishing or not. Many new technologies are on the horizon that will allow FMCs to see in real-time when, where and how their fishermen are fishing. For example, devices which transmit data such as: when a winch operation on board a vessel; the type and length of net being used; when a net is being deployed or hauled from the sea. All of this extra information will inevitably increase the amount of data that needs to be transmitted. So hybrid communication technology solutions look to be an ever more important factor when choosing a VMS device, if predictable costs are

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an important consideration for an FMC.

Choosing and investing in Hybrid Technology Fisheries Monitoring Centres VMS solutions

When selecting a VMS solution great care needs to be taken in finding the right solution to suit the needs of the FMC and in particular the method by which it transmits data.
When choosing a hybrid technology VMS solution the following need to be considered:

- Accuracy: How accurately does the device report its position?

- Geozones: Does the system rely upon software geozones or does it work with hardware embedded geozones? Hardware-embedded geozones have clear advantages in accuracy of reporting.

- Autonomy: Does the device work from the ship's power alone? If during a power outage is there a means of battery back-up, how long will the unit work without main power?

- Durability: Is the terminal capable of withstanding the conditions that can be experienced on the high seas: extremes of temperature, humidity etc.

- Installation vs running costs: What are the upfront costs of purchasing and installing the system, versus the ongoing monthly costs for airtime?

- Security and Safety: How secure is the data transmitted? What measures are taken to prevent any tampering or spoofing of the devices?

- Ease of operation: How well does the terminal integrate with back-end software applications?

- Housekeeping: How easy is it to upgrade firmware to keep up with advancements in technology? How can the device be checked to ensure faultless operation?

BlueTraker®'s Hybrid Technology VMS devices.

BlueTraker ® supplies two VMS devices the BlueTraker® vms and the BlueTraker® vms Arctic (which allow FMCs to track and monitor their fishing fleets even in Sea Area 4!)
Both devices have enabled FMCs around the world to sustainably manage their fish stocks and marine reserves. Capable of withstanding anything that the harsh maritime climate can throw at them; they come with hardware embedded geozones and are designed to protect against anything intended to compromise the integrity of the vessel's telematics data.
They can be integrated with custom back-end fisheries monitoring management software programs but also comes with their own fisheries management solution: SecondScreen, which enables FMCS to get the most out of these feature-rich terminals. BlueTraker® vms devices also come with a range of connectivity options that augment the abilities of the terminals: from safety alert buttons to in-port functions; to fuel monitoring and eLogbooks.
And if an FMC anticipates their fleets voyaging into the extremes of the A4 sea area then BlueTraker VMS Arctic with its integrated layer of heating element is the right choice. Designed to keep the electronics in the device from ever dropping below -40°C it also provides cold-start capability at temperatures as low as -50°C!

Conclusion

Satellite-only VMS devices allow FMCs to track their fishing fleets wherever they voyage on the seas but can result in costly data bills. GPRS-only VMS devices allow for more data to be sent for a similar cost but cannot be relied upon to always send data in a timely manner. Hybrid communication devices are the best of both worlds: always on satellite tracking for wherever your vessels go coupled with a GPRS to transmit 3-7 times more data for a similar cost. FMC can rely on knowing where their fleets are at all times but also gaining a deeper understanding of their activities and perform important commands/synchronizations as well as routine up-

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dates without the threat of incurring large data transmission costs.
Choosing a Hybrid Technology VMS device prevents FMCs from being forced into a trade-off between data and costs. As new fisheries monitoring technologies loom large on the horizon, increasing the prospect of even more data needing to be sent and received from the seas. It seems there has never been a better time to look at hybrid technology VMS devices.

About EMA

EMA, headquartered in Slovenia/EU, is a leading maritime tracking and traceability specialized company with 25 years of history. Its mission is to develop, manufacture and market a range of intelligent, remotely operable machine-to-machine equipment and systems.
Moreover, BlueTraker® solutions are applicable to a broad range of industries, mainly using satellite communications technology to monitor remote stationary or moving objects.
EMA provides turnkey solutions to end customers, technology providers, product providers and system integrators on maritime markets worldwide.

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