Feature

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Detecting distress

Signals intelligence is moving beyond the naval domain to help safe lives at sea and support maritime law enforcement.

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At the borders of Schengen

The European Union's (EU) European Border and Coast Guard Agency, better known as FRONTEX, has its work cut out. Tasked with patrolling the EU's Schengen Area of 26 countries, which have abolished all border controls, one of FRONTEX' missions is to patrol the Mediterranean. Refugees from North Africa regularly use this as a conduit to flee their poverty-stricken and war-torn countries for a better life in Europe. Much of this migration is facilitated by people traffickers. They charge refugees exorbitant sums to make the dangerous crossing on rickety, unsafe craft. FRONTEX' own figures underline the scope of the challenge in trying to protect the EU's southern borders from unauthorised migration into the Union. Several routes are used across the western, central and eastern Mediterranean. These roughly correspond with some of the shortest routes across the sea. The western Mediterranean route covers areas east of the Strait of Gibraltar. The central route stretches from the coast of Libya and Tunisia to Sicily. Finally, the eastern route goes from the western coast of Turkey across the Aegean Sea westwards to Greece. These routes see thousands of people every year attempting to make the dangerous crossing. FRONTEX says that in January 2022 alone 637 people from Algeria, Cameroon, Morocco, Mali and Syria crossed the western Mediterranean route. And 2,150 people from Bangladesh, Côte d'Ivoire, Egypt, Eritrea and Tunisia crossed via the central route. A further 1,162 from the Democratic Republic of Congo, Nigeria, Pakistan, Somalia and Syria arrived using the eastern route.

Those who successfully make the crossings are the lucky ones. Traffickers are unscrupulous to say the least regarding the craft they use for the crossings. Rubber dinghies are a favourite. They are often overloaded and can quickly founder in rough seas. Passengers may have little knowledge of how to navigate these boats which may put to see regardless of the weather. Some maybe unable to swim. Older people and children are at particular risk from drowning. FRONTEX' own statistics say that since 2015 over 20,000 people have died or are missing as a result of their attempt to reach the EU by sea.

Despite this appalling human cost, there is some good news. FRONTEX has three operations working to combat people trafficking and safe lives in the Mediterranean. Operation "Indalo" covers the western Mediterranean and Operation "Themis" covers the central Mediterranean. Operation "Poseidon" covers the eastern Mediterranean. FRONTEX says these three efforts have helped save over 566,000 lives between 2015 and 2022. This includes those saved via an EU military effort codenamed Operation "Sophia". This combated people smuggling from the Libyan coast between 2015 and 2020.

However, FRONTEX has been dogged by controversy. A May 2021 article in *The Guardian* newspaper alleged that FRONTEX has been complicit in pushing boatloads of refugees away from EU shores. This triggered an investigation by the European Union's *Office Européen de Lutte Antifraude* (OLAF; European Anti-Fraud Office). This March, OLAF concluded that FRONTEX officials had tried to conceal information that push-backs of migrant boats had been made by Greek personnel. OLAF recommended that FRONTEX's board take disciplinary action as a result.

Surveillance matures

EU member states makes assets available to assist FRONTEX' work. These include aircraft and ships which provided by respective EU border guard, police and coastguard agencies. Nonetheless, FRONTEX has some organic assets to help its work. These include an unmanned aerial vehicle (UAV) in the form of a single Israel Aerospace Industries Heron-1. Inhabited aircraft also support its efforts. These include Diamond DA-62 and DA-42 twin turboprop maritime surveillance aircraft (MSA). The DA-62s and DA-42s are supplemented by a single Beechcraft Super King Air-350 twin turboprop. The three aircraft are owned and operated by DEA Aviation

A DA-62 MPP special mission aircraft equipped with a Rohde & Schwarz communications intelligence/counter-ESM system for the detection, analysis and geo-location of signals of interest. The electro-optical/infrared gimbal can be automatically guided to the direction as well as to the source of the signals. (Photos: Diamond Aircraft)

but chartered by FRONTEX. DEA Aviation is a British company based in Nottingham, central England. Despite the United Kingdom's department from the EU, DEA Aviation continues to provide these services to FRONTEX.

On 9 September 2021, a written question was tabled by Özlem Demirel, a Member of the European Parliament. He asked the parliament what satellite and mobile phone location equipment is deployed onboard MSA aircraft serving FRONTEX? It may be surprising to learn that electronic support measures (ESM) are an integral capability for some of these aircraft. The detection and location of mobile phone and satellite communications (SATCOM) signals play a key role in helping rescue those at sea. They can detect and locate these boats based on their occupants' communications systems. These small boats often put to sea with precious little equipment. If they are lucky, they may have a satellite phone onboard for use in an emergency. Likewise, passengers onboard may have their cell phones to stay in touch with friends or relatives in their country of destination, or at their starting point.

ESM can detect transmissions from these devices and determine their point of origin. Determining this point of origin will invariably indicate the boat's location. A panicked call from a satellite phone may be the first indication that something is amiss. Cell phone calls may also be made from by passengers calling for help. It then becomes a race against time to find the boats and rescue the occupants. ESM employs a very simple principle to detect and locate to source of these transmissions. The International Telecommunications Union is the United Nations' global custodian of the radio spectrum where satellite phones and cell phones reside. Frequencies of between 1.5 gigahertz (GHz) and 1.7GHz are reserved for some SATCOM. Cell phones, meanwhile, us a multiplicity of frequencies in the ultra-high frequency waveband of 300 megahertz (MHz) to three gigahertz.

ESM will be connected to antennas and be equipped with software which continuously monitors these wavebands. The software will be set to watch only these wavebands for specific types of transmissions corresponding to those used by cell phones and satellite phones. This helps to filter out all other signals in these frequencies which ESM might encounter in the maritime or littoral environments. For example, some global navigation satellite signals (GNSS) provide data in wavebands close to those of satellite phones. This is also the case for some radio navigation systems like distance measuring equipment and the tactical air navigation system used by military aircraft. Spurious signals like these must be filtered out by the software.

Once a signal is detected, ESM gets to work on ascertaining its point of origin. This will in turn provide information on the possible location of the boat. This process is done by measuring the time it takes for the signal to arrive at ESM antennas. All radio waves travel at 161,595 knots-per-second (299,274 kilometres-per-second), the speed of light. If you have two antennas a known distance apart, the same signal will arrive at a different time at each one. Put simply, the transmission will arrive at the antenna closest to its source earlier than the antenna further away. This will be an infinitesimally small difference, but it is a difference nonetheless. The gap between the two antennas and the respective lines of bearing from each transmitter to the source of the transmitter forms a triangle. It is then a matter of using trigonometry to compute the point where these two lines of bearing meet. This process determines the transmissions' source.

ESM computes how far away the source of the transmission is from the aircraft and in what direction. The aircraft can then head towards this location for further investigation. The crew can also alert other aircraft and surface ships of the location of a possible boatload of refugees. Aircraft are particularly suitable platforms for undertaking ESM tasks. Their altitude provides them an excellent vantage point for targets on the sea surface. For example, the DA-42 aircraft used

One of DEA Aviation's Diamond DA-62 aircraft – these planes have played a key part in assisting FRONTEX patrol efforts above the Mediterranean. This aircraft's optronics payload is clearly visible below the nose. (Photo: DEA Aviation)

by FRONTEX have a maximum altitude of 5,486 metres. ESM suites equipping these aircraft could potentially detect transmissions at ranges of over 162 nautical miles or 300 kilometres.

Other ESM sets use a different, but no less effective, approach. As detailed below, some satellite phones are equipped with a GNSS transmitter. The phone may receive position, navigation and timing signals from one of the myriads of GNSS constellations. These include the US GPS, Europe's Galileo, Russia's GLONASS and the People's Republic of China's Beidou networks. The phones receive these GNSS signals, compute their location based on this information and periodically transmit their location. This is vital in helping assist search-and-rescue (SAR) as it automatically identifies the phone's location. This can save precious time trying to locate those in distress.

Where are you?

Horizon Technologies' FlyingFish family of signals intelligence (SIGINT) systems can be used to detect such transmissions and help search and rescue. John Beckner, Horizon Technologies' chief executive officer, sayd that people smugglers running boats across the Mediterranean will give the passengers satellite phones. These typically use the Thuraya SATCOM network. Thuraya is the satellite phone service provided by the United Arab Emirates' Yahsat satellite communications company. Yahsat owns the Thuraya-2 and Thuraya-3 satellites. These provides coverage over the Middle East, Africa, much of Europe and parts of Asia. This makes the network ideal for use by the smugglers given its coverage over the Mediterranean. Thuraya satellite phones use frequencies of 1.525GHz to 1.661GHz. Usefully, every Thuraya satellite phone has a built-in GNSS receiver. This means that the phone will periodically transmit its location to the Thuraya network.

"It is our understanding that smugglers give boats full of refugees Thuraya handsets with the phone number of the Italian coastguard pre-programmed," said Beckner. "When they call, they have no clue where they are," he added.

That the phones transmit a GNSS signal can be the difference between life and death for those on the stricken craft. When the call is made to the coastguard, the phone automatically transmits its GNSS coordinates. By detecting this signal, ESM systems like the FlyingFish series can immediately determine the location of the phone, and hence the boat's position. This information is then be shared with SAR assets in the vicinity to help get the boat's passengers to safety.

Beckner noted that, alongside Thuraya, the FlyingFish family can detect and locate transmissions from Inmarsat's IsatPhone devices. Inmarsat's SATCOM network uses frequencies of 1.525GHz to 1.646 gigahertz. The FlyingFish product family is augmented with BlackFish. Alongside the Inmarsat and Thuraya networks, BlackFish detects transmissions using the Iridium SATCOM network. This employs frequencies of 1.616GHz to 1.626 gigahertz. Horizon Technologies' product literature says that voice, data, facsimile, short burst data and Iridum's Global Maritime Distress and Safety Service (GMDSS) transmissions are detectable. The literature continues that BlackFish can monitor Iridium, Thuraya and Inmarsat networks simultaneously.

Cubesats

Horizon Technologies' SIGINT systems are now heading into space. On 21 December 2021, Virgin Orbit announced a partnership with the company with the former becoming Horizon's preferred launch partner. The company has developed a constellation of cubesats which will gather maritime SIGINT. Cubesats are miniature satellites with a mass not exceeding 1.3 kilograms. Horizon's Amber constellation of satellites will have SIGINT payloads detecting an array of emissions. These include radar signals from maritime navigation radars. Such radars transmit in X-band (8.5GHz to 10.68GHz) and S-band (2.3GHz to 2.5GHz/2.7GHz to 3.7GHz).

Furthermore, the Amber satellites will detect automatic identification system (AIS) transmissions. AIS is mandated by the International Maritime Organization (IMO) for all civilian vessels displacing over 300 tonnes. AIS provides details on a vessel's identification and voyage using 161.975MHz to 162.025MHz satellite transmissions. AIS transmissions take details of the vessel's location from its GNSS receivers and retransmit this. Anyone equipped with an AIS receiver be they on land, at sea, or in the air can thus determine a vessel's identity, location and voyage. However, in recent years, some vessel operators have been known to falsify their AIS data. The Global Fishing Watch maritime sustainability advocacy group has diligently tracked examples of what is known as AIS spoofing. The reasons for deliberately falsifying AIS transmissions are varied, but they boil down to a desire to show that a vessel is in a different location to where it actually is. This maybe to conceal the ship's involvement in illegal fishing or in sanctions busting. AIS data may lie. However, there is no way that the source of the transmission can be falsified. The Amber satellites will be able to cross correlate the reported AIS data with the actual source of the transmission. Any discrepancy may indicate that the AIS data is being deliberately falsified. Horizon's agreement with Virgin Orbit will see the latter using its LauncherOne space rocket to get these satellites aloft.

"FRONTEX and EU countries will have access to Amber data feeds" to enhance their search and rescue efforts, said Horizon Technologies' John Beckner. He continued that satellite phone geolocation capabilities are now routine requirements included in FRONTEX tenders for maritime surveillance aircraft provision. This underscores the fact that maritime SIGINT provision is moving into non-traditional roles like SAR. SIGINT-gathering at sea had long been the preserve of navies. It is now showing its mettle in helping save lives at sea as people fleeing war-torn and impoverished countries take desperate risks in search of safety.

NAFO

◁ One of Horizon Technologies' Amber cubesats is seen here during manufacture. These satellites will detect a host of signals to help assist search and rescue efforts and maritime law enforcement. (Photo: ACC Clyde Space)