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RF SOLUTIONS FOR

BORDER SECURITY MONITORING INTELLIGENCE, SURVEILLANCE & RECONNAISSANCE

CRFS

EXTRAORDINARY
RF TECHNOLOGY

BORDER SECURITY MONITORING **AT A GLANCE**

Strategic intelligence gathering, early warning, signal-based detectors, and accurate geolocations can all help avoid conflict, manage hostile neighbors, and detect terrorist activity or unauthorized movement of goods and people. CRFS develops, produces, and supports border security monitoring solutions that allow governments, militaries, and border agencies to enhance national security by protecting land, airspace, and sensitive infrastructure.

To prevent criminality and protect homeland security, border forces and border security agencies across the globe are faced with the considerable challenge of gaining accurate intelligence and complete situational awareness. Achieving this involves three key elements: physical patrols, cutting-edge technology, and building protective 'walls'.

Physical walls are helpful for strategic locations but impractical across large areas. However, virtual walls can act as a protective barrier across land and airspace—they can be monitored continuously and provide reliable intelligence to enable border forces to adapt in real time to dynamic situations.

Passive radio frequency (RF) sensors are an important component of virtual walls, helping to gather intelligence against threats to national security—hostile neighbors, land border crossings, coastal surveillance, and illicit goods or people smuggling. RF technology also provides border forces with air defense, drone detection, and port protection capabilities.

CRFS provides multi-functional integrated solutions based on state-of-the-art RF technology to record and capture RF (long duration, wideband I/Q data) and monitor, identify, and geolocate detected threats. Our solutions extend sensor coverage and surveillance capability, support command and control, integrate with commercial and military systems, and are operating across Europe, MENA, Asia Pacific, and the US.

- Extensive experience in border security
- Advanced passive RF sensors
- Fixed, tactical, and mobile deployments (including sub-systems)
- Continued operation in GPS-denied environments
- Integrated communications and signals intelligence capability
- Highly configurable technology (including APIs)
- Automated operator alerts and security intelligence
- Strong integration expertise

RF TECHNOLOGY SOLUTIONS FOR **BORDER SECURITY CHALLENGES**

SHORT RANGE

People smuggling at land border crossings – Monitor or detect / hunt for devices emitting RF signals (such as push-to-talk radios). Classifying and geolocating these emissions provides intelligence and rapid response, with vehicle and UAV-mounted deployments in hard-to-reach territory where fixed towers are impractical.

Detecting drones at close range (less than 3km) – Operators can hunt for COTS, modified, and military drones flying at close range by detecting their RF-emitting components using real time signal detectors. UAVs can be geolocated using 3D TDoA to enable countermeasures.

Narcotics smuggling – Detect the electronic signatures commonly used in package drops that communicate their position. Alert authorities to suspicious activities in real-time by continuously monitoring radio frequencies. 2D TDoA enables direction finding and accurate geolocation.

Protecting ports – Continuously monitor for signatures associated with communications devices, electronic equipment, drones, 'dark ships' and USVs that may pose a threat to port security. 2D TDoA enables direction finding and accurate geolocation.

Protecting critical infrastructure protection – From covert surveillance devices to drones and unauthorized communication equipment near sensitive sites, RF monitoring can detect unauthorized signals or jamming enabling an appropriate response.

'The wall' – Passive RF sensor networks installed across towers, buildings and mobile platforms provide different advantages compared to radar and acoustic sensors—they increase detection distance, and build a reliable intelligence and situational awareness pattern of life. This increases C2 operational flexibility and enables more efficient use of patrol and ISR resources.

LONG RANGE

Hostile neighbors – Deploying tactical and mobile RF sensors in strategic positions along the border enables operators to monitor everything from hand-held communications to vehicle and airborne emitters, capture signals in high fidelity (I/Q data) to drive classification and demodulation capability.

Coastal surveillance – Detect a wide range of RF emissions from ships, small boats, and even airborne targets potentially engaged in suspicious activities. Protect offshore assets. Combine land and airborne ISR to extend line of sight and accurately geolocate threats.

Defending remote, vulnerable borders – Continual spectrum surveillance ensures constant awareness, localization, and appropriate response to insurgents, suspicious or unusual signal activity (virtual walls are both flexible and scalable).

Detecting drones at extended ranges – Operators can visualize a synthetic bearing form large commercial and military UAVs emitting ADS-B, for example, allowing them to detect and understand location and direction of travel. Signal detectors can automatically hunt and geolocate a specific signal in real-time.

Combining border security with EW – An RF sensor network can help gather signal intelligence from spectrum data by assisting operators to understand when a signal goes on air, what the signal is (by classifying it), who sent the signal (by capturing, demodulating, and decrypting it), and where it is (by geolocating it).

SIGNAL CAPTURE & ANALYSIS

I/Q recording – Recording, capturing, and analyzing long duration, wideband RF (I/Q data) providing operators with a complete picture of the RF environment and enhanced freedom of movement. Data can be managed by non-RF experts or highly trained signal analysts to support COMINT, SIGINT, and intelligence agencies.

Signal analysis and signal discovery - I/Q data can be used for forensic signal analysis, to create detectors and support 'protect' and 'manage' border control measures.

PASSIVE RF SENSOR TECHNOLOGY **DEPLOYED ON LAND, SEA & AIR**

DETECT

Communications between criminals and geolocate the devices transmitting the signal.

Drones via the RF signals they are transmitting, including transmitters, video downlinks, and telemetry modules.

Signal jamming equipment used to disrupt border security communications and navigation systems.

Ships by signals such as AIS, VHF signals, radar, and distress beacons.

Unauthorized devices at sensitive locations such as ports.

Aircraft by identifying and geolocating aircraft signals of interest (ADS-B, TACAN, IFF, tactical data links).

Spoofing by decoding AIS / ADS-B signals.

PROTECT

National security by detecting criminal communications and movements near borders.

Port facilities by detecting unauthorized electronic devices that could be used for trafficking, smuggling, or espionage.

Airports, as part of a counter-drone system, and to monitor the spectrum for interference detection.

Land borders where criminals are trafficking drugs or humans, communicating using devices such as push-to-talk radios.

Sea borders, by ensuring vessels are monitored and tracked.

Offshore facilities from deliberate interference and jamming and securing them from hostile vessels or drones.

MANAGE

Wide-area coverage by creating a technology wall over extensive areas, including rugged terrain and remote locations.

Command and control by maintaining full situational awareness, communications integrity, and the ability to rapidly deploy personnel to the correct location.

Situational awareness by integrating passive RF sensors with other surveillance systems (such as radar and cameras).

Interference in border areas where multiple security agencies operate.

Private mobile networks to ensure vital communications function correctly without interference.

Technology integration and scalability by integrating RF technology with existing security infrastructure.

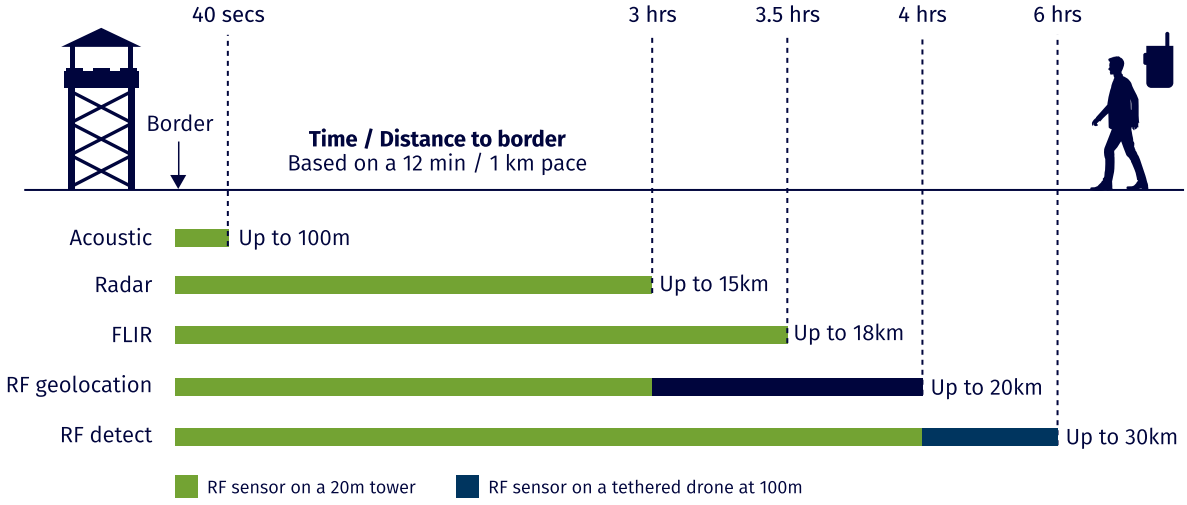
INCREASE YOUR **DETECTION RANGE**

An RF sensor network can act as an early warning system that provides border forces with enhanced situational awareness.

The below graphic illustrates the approximate detection range of several commonly deployed sensors. On average, acoustic sensors can operate up to 100m, ground-based radar up to 15km, and Forward Looking Infrared (FLIR) up to 20km.

RF sensors can detect a PTT (Push-to-Talk) radio transmitting at 50MHz at a distance between 20–30km and can geolocate the signal between 15–20km. However, the precise distance depends on the height of the sensor, the terrain, and the environment.

Assuming a person averages 12 minutes per kilometer, this information provides commanders with about two hours of decision space before employing the next sensor. RF sensors act as an early warning system, allowing decision-makers to proactively send resources to the areas of concern.



RFeye® Receiver (Node)

High-performance spectrum sensor (receive / record) to 40GHz

INTELLIGENCE, SURVEILLANCE & RECONNAISSANCE

Conducting short- and long-range ISR enables border security agencies to detect and monitor electronic signals across vast and challenging terrains.

To conduct ISR, border forces can strategically place a combination of stationary and portable RF sensors along a border. A fixed network at strategic locations provides continuous monitoring capability, which can be complimented for tactical applications with easily deployable vehicle-mounted, drone-mounted, man-portable, or dismounted options. CRFS can integrate these border security systems into EW systems and Command and Control centers.

RF sensors are designed to detect a broad spectrum of radio frequencies emitted by electronic devices, which may indicate nearby human activity. Although cell phones are the most widely used communication tool, VHF and UHF radios are commonly used—particularly in remote border areas with little or no cell reception. Criminal organizations use various modern radio data transmission technologies ranging from HF, VHF/UVF, SHF to SatCom. To effectively capture crucial information, border security agencies will want to deploy automated, highly adaptable, and integrated sensor systems.

Once detected, signals can be analyzed for characteristics that could signify illicit activities or unauthorized crossings. If necessary, geolocating the signals enables border forces to respond quickly to potential security breaches, effectively enhancing their capability to secure and monitor border regions against illegal activities.

SPECTRUM MONITORING

Spectrum monitoring is the key to detecting threats and gaining situational awareness: monitoring who is using the spectrum, where and when they are using it, and what they are using it for. Proactive, automated monitoring means any jamming, interference, or suspicious signals can be quickly identified and appropriate actions taken.

For border security operations, CRFS' spectrum monitoring hardware and software solutions help forces gain the upper hand when monitoring invisible threats.

- Highly sensitive RF receivers
- Wide dynamic range
- Identify signals of interest
- Real-time analysis
- Automated software
- Remote monitoring
- VITA-49 streaming

DF & GEOLOCATION

RF direction finding and geolocation techniques provide critical insights for effective decision-making. Knowing a transmission exists is important, but knowing the location of that transmission can deliver vital intelligence.

Direction Finding (DF) provides a bearing to a transmission by using an angle from the sensor to the transmitter. Conversely, Time Difference of Arrival (TDoA) geolocation pinpoints the precise geographic coordinates of a transmission in two or three dimensions.

- Geolocate the source of a signal
- Time Difference of Arrival (TDoA - 2D & 3D)
- Angle of Arrival (AoA)
- Detector-based TDoA

COMMUNICATIONS INTELLIGENCE & SIGNALS INTELLIGENCE

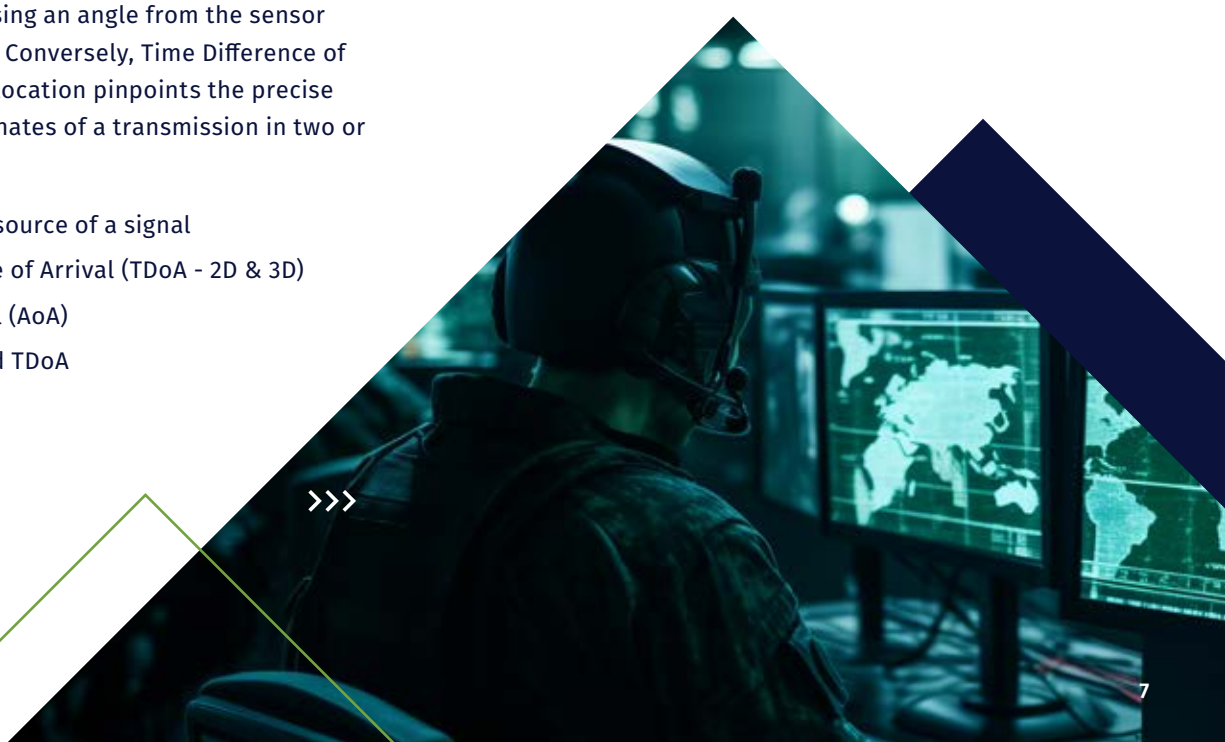
For their crimes to be successful, criminals depend on communication. As they often operate in areas with no public networks, they frequently rely on alternative devices, such as push-to-talk radios operating in the VHF / UHF frequency range and electronic navigation systems.

However, using RF sensors, border forces can detect transmitters to gain communications and signals intelligence: COMINT and SIGINT.

Enhanced detection and strategic intelligence gathering

- COMINT offers tactical insights into the behaviors and communications of individuals —crucial for understanding criminal planning.
- SIGINT provides strategic intelligence from non-communicative electronic RF emissions from radar, navigation systems, or other electronic devices—vital to understanding the capabilities and activities of potential threats.

COMINT and SIGINT provide a multi-layered understanding crucial for strategic planning and decision-making. They also give border security forces a technological edge, allowing them to stay ahead of criminals using sophisticated technology.



RF SIMULATION: **HOSTILE AIRSPACE MONITORING IN EASTERN EUROPE**

Passive RF monitoring of territorial airspace using a TRL-9 solution is paramount for border security.

Borders in Eastern Europe are highly sensitive as they are at the edge of NATO's front line. In this simulation, operators can passively monitor, geolocate, and capture signals of interest within a 60km range across borders. They can then build a signal library of signals of interest.

Simulated environment:
Using RFeye Site v1.51.2, the simulation shows how two inter-connected surveillance areas can be joined together to provide a complete monitoring system as part of a national defense strategy.

Eight RFeye Nodes are illustrated on 20m tower (masts) based on geometry. The simulation shows RF Propagation Analysis with a simulated signal running at 1.09 GHz at a roaming height of 1,000m. This can be changed.

- TDOA and AOA
- Geolocate aircraft and drones

Simulated environment:
RFeye SITE v1.51.2 shows a line-of-sight solution offering 30km RF surveillance 24/7/365.

RF SIMULATION: **COASTAL SURVEILLANCE & OFFSHORE INFRASTRUCTURE IN WEST AFRICA**

Surveillance off the West African coast must consider three elements: oil and gas infrastructure protection, maritime and unmanned surface vessel security, and smuggling. In this simulation, passive RF technology is used to help protect critical oil and gas infrastructure from piracy. RF monitoring and signal geolocation enable a rapid operational response by combined border and security resources.

14 RFeye Arrays have been deployed on 15m tower (masts) based on geometry. The simulation shows RF Propagation Analysis with SOI running at 400 MHz with a power level of 44 dB at a roaming height of 10m. This can be changed.

- 30km line of sight to sea
- Surveillance and C2 solution for PMR, drone and USV threats, and smuggling

RF SIMULATION: **LAND BORDER SECURITY IN THE BALKANS**

Protecting national territory requires extensive border security, prohibiting the illegal entry of people and goods, and countering terrorist activity. Smart protection that leverages RF technology can greatly assist border police and border guard authorities.

Border in the Balkans are hotspots for illegal crossing into Europe. Passive RF surveillance can help border forces monitor, geolocate, and capture PMR, mobile, and drone signals and also see into neighboring borders (without being seen).

Two RFeye Array's have been deployed on 25m tower (masts) based on geometry. The simulation shows RF Analysis with SOI running at 400MHz with a roaming height of up to 2 metres. This can be changed.

- Line of bearing
- AOA detection for PMR and other targets

Angle Of Arrival (AOA)
Simulated environment:
Using RFeye SITE v1.51.2, we show how one potential border path can be monitored 24/7/365.

READ BORDER SECURITY **DEPLOYMENT STORIES**

ISR MISSIONS AT SEA & ACROSS HOSTILE BORDERS

How combining ground & air-based RF sensors improved ISR and target acquisition

Domain: Air

Application: Intelligence, surveillance & reconnaissance

Customer: Military end-user

REAL-TIME DIRECTION FINDING & FULL SPECTRUM AWARENESS

How a Southeast Asian government intelligence service secured multiple borders

Domain: Land

Application: Border security monitoring

Customer: Government agency

MOD BORDER SURVEILLANCE IN THE MIDDLE EAST

How a government agency secured its borders in a volatile region

Domain: Land

Application: Border security monitoring

Customer: Government agency

REAL-TIME I/Q DATA CAPTURE FOR ENHANCED INTELLIGENCE

How a national force secured its borders with reliable spectrum data

Domain: Land

Application: RF recording & signal capture

Customer: Government agency

FIND OUT MORE ABOUT CRFS
PRODUCTS & SOLUTIONS

RFeye® Receiver (Node)

High-performance spectrum sensor (receive / record) to 40GHz

RFeye® Array

Direction finding from 20MHz to 40GHz

RFeye® Site

Real-time spectrum monitoring & geolocation toolkit

RFeye® Mission Manager

Automated monitoring & mission management

RFeye® DeepView

Forensic signal analysis software with 100% probability of intercept

RFeye® SenS Remote

High fidelity RF Recording (I/Q data) for enhanced intelligence

RFeye® Integrated Vehicles

Mobile spectrum monitoring, geolocation & tactical deployments

RFeye® Integrated Drones

Lightweight, rugged RF sensors fitted onto drones

CRFS | EXTRAORDINARY **RF TECHNOLOGY**

CRFS is an RF technology specialist for defense, national security agencies and systems integration partners. We provide advanced capabilities for real-time spectrum monitoring, situational awareness and electronic warfare support to help our customers understand and exploit the electromagnetic environment.

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