Tamir Eshel describes how Israeli security technology is being applied to protect its borders against threats ranging from terrorists to people-smugglers

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Since its independence in 1948 Israel has faced existential threats by overwhelming military forces and irregular guerrilla groups waging terror campaigns on the young Jewish state. During 60 years of conflict this threat has changed and evolved, but never disappeared. Moreover, in recent years these patterns have changed dramatically. While the risk of attack by the regular military forces of Arab states has waned, the involvement of Iran, Islamic extremists or "hybrid" irregulars escalated, along with their access to new weapon systems, including advanced rockets, missiles and anti-aircraft weapons. Israel's borders remain highly vulnerable to infiltration, not only by terrorists but also by smugglers, human traffickers and other criminal elements and illegal immigrants.

For six decades this conflict was been waged relentlessly along the borders of the young state. In the early days, until the late 1960s, the porous borders were unguarded, leaving villages and settlements vulnerable to attacks. Since the 1967 Six Day War Israel has fortified its borders, gradually inhibiting cross-border movement, closely guarded by the Israeli Army and Police Border Guards. These measures, assisted by massive investment in physical obstacles (fences, minefields), sensors, observations and ground and air patrols, have limited terrorist movement into the country, diminishing the transfer of arms, explosives and financial support to local hostile elements.

The most familiar feature visible along Israel's borders is the physical obstacle – including walls, electronic fences, and barbed wire concertina deployed along the borders with Lebanon, Syria and Egypt. The means protecting those borders have recently been enhanced, responding to the deteriorating state of security in Egypt, Sinai and the civil war raging in Syria. The Lebanese border has been sealed for many years, to counter the possibility of soldiers or civilians being kidnapped by the Iranian-backed Hezbollah. Similar measures have been implemented along the Syrian border against potential penetration into the territory by extremists, protesters or refugees. Most visible on the Israeli-Egyptian border are the physical elements – fences, patrol road, and sensors covering the protected line.

These measures prevented most infiltrators (from Jordan, Lebanon or Egypt) from reaching Arab perpetrators inside the country and setting up subversive cells. Technologies developed to support those missions include the taut-wire fence, installed along hundreds of kilometers of borders along the Jordan River, Lebanese border and Golan Heights.

As the land borders became more secure, Palestinian terrorists groups turned to the maritime domain in an effort to hit at their enemy. In response, Israel invested significant efforts protecting its coastline, with additional measures deployed to protect the coastal area, ports and facilities and the maritime area in general. These measures proved extremely effective in preventing terrorist attacks and attempted activities over more than 30 years. Such measures include underwater sensors and obstacles. Sealing the coastal border, Israel's Navy implemented a comprehensive coastal security network, featuring coastal radars, aerial patrols and fast patrol boats.

Through the years the Palestinians and their supporters continued to fight the IDF on the borders – setting ambushes, planting improvised explosive devices (IEDs) along the border roads or attempting more complex operations, such as infiltrating into Israel to launch terror attacks against military and civilian targets or kidnap soldiers in exchange to incarcerated prisoners. But this struggle did not deliver the results they were hoping for.

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Mounted patrols on the Lebanese border are at constant risk of attack

The new fence erected along the Israeli-Egyptian border

Until the 1980s Israel's borders were "sealed", as the country was facing hostile Arab nations maintaining a state of war with Israel. Smugglers and terrorists alike knew they were risking their lives attempting to cross the line. Such procedures enabled the border guards (often military units manned by army reservists) to shoot first and ask questions later. In those years the military has depended on excellent scout and tracking skills maintained by recruiting the Bedouin minority and developing advanced ambush and manhunt techniques to prevent infiltrators from reaching their targets.

Defending against IEDs, Israeli patrols have been equipped since the mid-1990s with radio-frequency jammers to disable the remote-control activation of IEDs. Israel's defence industries have developed several generations of Counter-IED (C-IED) jammers, including man-portable systems protecting dismounted patrols. The latest generations are designed to coexist with other communications systems, for better integration in modern networked operations. To meet the threat of direct attack by small-arms, rocket propelled grenades and guided missiles, new defensive measures are being developed which provide the active protection of light armoured vehicles and instantaneous detection and localisation of all sources of fire. Coupled with remotely-operated weapon stations, patrol vehicles will be able to rapidly and effectively defend against, and respond to, direct or indirect attack, thus enabling continuous mission performance even in the presence of increased threats.

Eventually, the Palestinians and Lebanese Hezbollah abandoned their fight over the border in favour of indirect attack operations – particularly in weak countries such as Lebanon, the Gaza Strip, and Sinai – in areas where they achieved local dominance. As a result, the frequency with which mortars and rockets were launched at Israeli cities and villages, or anti-tank missiles were fired from long range at Israeli vehicles moving on inland roads, increased. Operating in countries where they maintain relative freedom of action means the militants get regular supplies of advanced weapons – the Lebanese Hezbollah having obtained huge quantities of rockets, including long-range rockets, anti-tank weapons and anti-aircraft missiles, mortars and drones. Islamic terrorists in Gaza are equipped with similar weapons, gathered from hardware abandoned by the Libyan military in 2011 or delivered by Iranians across the Sinai desert.

Since the late 1980s, terrorists have also attempted to use gliders and ultra-light aircraft to try to cross the Israeli border from above, and since the late 2000s are also developing capabilities to use unmanned aerial vehicles for surveillance and cargo delivery, as well as for attack purposes. Israel has been aware of these developments and has developed the means to counter such threats.

Although Israel has suffered rocket and mortar attacks for many years, the military adopted a containment and retaliation strategy– including action and reaction that has only triggered an escalating cycle of violence. In 1991 the picture changed, however, when Israel suffered 39 hits from Iraqi ballistic missiles during the first Gulf War; some were aimed at population centres,

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while others were even aimed at the country's most strategic sites. This was a wakeup call for Israel to come up with countermeasures that would eliminate or, at least, diminish the effect of such lethal weapons. This recognition led to the development of Israel's national missile defence (BMD) system and the first deployment of the Arrow BMD system in the year 2000. Six years later, the country has faced the second lesson in indirect attack, suffering continuous rocket attacks for almost six weeks, during the Second Lebanon War in 2006. This conflict triggered the development of a new countermeasure system known as "Iron Dome", which was developed in record time (less than three years). Six years later, Iron-Dome dramatically demonstrated its capability to defend Israel's largest cities from over thousand rockets launched from Gaza in November 2012.

Defeating the rocket was not the only requirement for the Israeli military. Protecting and minimising the interruption to civilian daily life was equally important if Israel had to face continuous attacks that could extend over weeks, as it did during the 1991 and 2006 wars. That need drove the requirement for early warning sensors to warn of an imminent attack, detect a rocket launch, calculate its ballistic trajectory and compute each of the rocket's impact points, thus alerting only those areas that might be affected by specific attack. This service called for the development of several systems – including, electro-optical sensors, radars, regional and national operations centres and a sophisticated alerting system utilising smart sirens, broadcast and cellular phone networks – all developed by Israel's defence industries.

After suffering several attacks against border patrols, the IDF explored the use of unmanned ground vehicles (UGV) to replace or augment the manned patrols operating on vulnerable areas where attacks could place manned patrols in extreme danger. Following several years of development the first unit equipped with UGVs became operational, patrolling part of the borderline defence with Gaza. Additionally, remotely controlled weapon posts were established along the border, enabling operators to monitor the borderline and engage targets much faster than previously available, without risking soldier's lives.

Unmanned systems are also employed in the air and at sea, providing persistent surveillance of wide areas, providing intelligence, early warning potential attacks pre-emptive action by providing target acquisition and guidance of precision attacks. Unmanned surface vessels are also employed at sea, assisting in guarding areas where manned operations could be too vulnerable to attack.

For the past 30 years, most of Israel's borders are relatively "peaceful". This does not mean there are no threats, but the methods used to meet those threats are designed to minimise the potential risk they could cause. This requires a different view of the depth that a border security system should cover, and the delay such border obstacles are likely to cause, since no obstacle or sensor, sophisticated they are, could guarantee hermetically sealed border.

The evolution of Israel's border security networks has followed the maturity of sensor technologies, evolving

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from the basic ground surveillance radar of the 1970s to ultra-sophisticated active electronic-scanning arrays (AESA) of the 21st century. Radar technology also enables the large-scale fielding of low-cost sensors, connected into networked security systems covering the protected perimeter or borderline. Among these sensors are radio-frequency (RF) radars, electro-optical (EO) radars, or seismic sensors, creating "virtual fences" that augment or supersede the physical barriers. Such virtual fence methods are particularly relevant in areas where regular patterns of life would render video motion detection (VMD) or surveillance radar alerts too frequent and therefore ineffective.

Special effort is directed at securing border passages, considered to be one of the more vulnerable elements in Israel's border security system. In addition to extensive intelligence screening of people and goods, authorities have implemented biometric identification means and advanced image processing for personnel identification and vehicle inspection. Screening of vehicles and containers is utilised particularly to prevent smuggling weapons from Israel into Gaza and the West Bank, and stop potential infiltration of terrorists, explosives or car bombs into Israel. Such screening often relies on highly sophisticated image processing using change detection algorithms to detect modifications and changes made in vehicles; such tampering could indicate vehicles are being used to smuggle arms or explosives.

In the past 60 years Israel's borders have changed from an unmarked, open and porous line to an almost impregnable, fortified perimeter. Israel's military and border guards have mostly succeeded in preventing, repelling and defeating terror attacks away from the border. Israel's existence as a stable and prosperous country in a highly unstable region is attracting smugglers, human traffickers and illegal immigrants. The borders, opened after the peace agreements with Egypt, Jordan and the Palestinian Authority, have attracted criminal activity – ranging from smuggling contraband, narcotics or tobacco to human trafficking. The growing flow of illegal immigration, particularly of Africans trying to cross the narrow land gap along the Israeli-Egyptian connecting Africa, Asia and Europe, has also called for drastic measures to seal the borders once again.

Guardium unmanned ground vehicles on patrol along the Gaza border

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