

# ISRAEL HIGH-TECH & INVESTMENT REPORT

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## Leading in Defense

### Israel's Defense Ministry unveils tomorrow's weapons

A stealth tank, unmanned submarine and sniper drone that can carry a 90-kilogram payload are among the new systems developed by the Ministry of Defense.

An especially agile and deadly stealth tank; an unmanned submarine for missions remote from Israel's borders; an unmanned helicopter capable of bearing supplies to forces on the battlefield; and a special system that will make every rifle shot accurate and deadly are only some of the new systems developed by Israel's Ministry of Defense Administration for the Development of Weapons and Technological Infrastructure (MAFAT) and unveiled yesterday in a special press briefing by MAFAT head Brigadier General (res.) Daniel Gold for reporters on military affairs.

MAFAT is currently conducting 1,500 research and development ventures. Yesterday's briefing shows how the IDF will deal with the security challenges facing it in the coming decades.

The main goal is preserving the IDF and Ministry of Defense's technological advantage over the countries in the region and the terrorist organizations operating in and from it. Billions of shekels are being spent each year on developments, most of them secret, which are aimed at facilitating the realization of MAFAT's vision: sealing Israel's borders,

including finding a solution for the underground threat - principally the tunnels in the Gaza Strip and on the Lebanese border; eliminating terrorism; destroying enemy targets in real time throughout the Middle East; improving the survivability, mobility, and maneuverability of armored fighting vehicles (AFVs) and tanks; and achieving superiority in cyberspace. A large proportion of this work involves close and intensive connections of MAFAT with startups making their first steps towards big solutions. Some of these ideas will take years before they mature technologically into a product. Some will never materialize, as is often the case with R&D plans.



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### In this issue

- Israel's Defense Ministry unveils tomorrow's weapons
  - Leading Edge Aerospace Capabilities
- Why Israel has the most technologically advanced military on Earth
  - IAF holds successful David's Sling missile defense system test
- 8th in the world in supply of defense systems
  - Israel's defense industries



### The future tank

Carmel, one of the impressive plans that MAFAT has been working on in recent years, together with the Ministry of Defense Tank Program Administration (TPA), involves the IDF's future tank. TPA is currently producing the most advanced version of the tank in use by the IDF Armored Corps - the Merkava 4. Dozens of these tanks rolling off the assembly line of the repair and maintenance center at the Tel Hashomer base each year are equipped with the most advanced technologies that make the Merkava an especially threatening, deadly, and well-protected war machine - due, among other things, to the Rafael Advanced Defense Systems Ltd.'s Trophy active defense system, which is designed to intercept threats like advanced anti-tank missiles and RPG rockets.

The Carmel, however, will be completely different. MAFAT's plans are for a tank that will be small, agile, lightweight, easy to operate, and cheaper than the expensive tanks currently being sold on the market.

The top-secret tank's performance so far has been impressive. Demonstrations have been confined to Ministry of Defense simulations. "Its maneuvering capabilities will be very good, the team operating it will be substantially smaller - perhaps two or three soldiers, it will be powered by a hybrid electrical propulsion system, and it will also have an unmanned and groundbreaking version," Gold told the reporters.

MAFAT believes that a final decision on progress in the future tank program is about three years off. The parties who will make the decision about the program will be shown a deadly war machine that is the stuff of science fiction. It will be equipped with "transparent armor," so that the crew, which will be invisible inside it, will see events outside through an advanced system of touch screens constantly

informing the crew of what the many cameras installed on it are photographing. Another possibility also currently under consideration by MAFAT is giving every crew member an advanced smart helmet, similar to the advanced helmets worn by airplane pilot, which constantly broadcasts and screen all the information needed by the soldier on the battlefield.

The future tank's most outstanding feature is its evasiveness, or as the Ministry of Defense puts it, its "invisible signature." For observation or detection systems, the tank's presence in the field will be so well hidden as to be completely invisible. "There are all sorts of methods that have enabled us to achieve this, but it won't happen tomorrow morning," Gold says. "The goal is to improve survival capabilities in the maneuvering of ground forces."

The future tank will be able to both defend itself with active defense systems and provide perimeter defense for vehicles following it if it is leading a battlefield convoy, including infantry forces operating around it. It will take

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the lead and detect the threat aimed at the forces, and destroy them in time. The tank will also have a solution for mines laid in its path; it will be able to detect and destroy them on the move. "As of now, we are not investing in the vehicle itself; we are investing in the technologies that will be installed on it. Several defense companies are involved in this," Gold says.

While the development of autonomous vehicles is attracting a great deal of fanfare, MAFAT is also looking ahead, with the aim of improving the capabilities of unmanned ground vehicles (UGVs), several models of which are already being used for missions such as border defense. The IDF has such vehicles, which are being used for border patrols, logistical transportation, and light engineering missions. Putting them into use is still slow, however, and their operational use is on a small scale.

The Ministry of Defense sees all the autonomous vehicle ventures being developed in the civilian sphere, but aimed at other purposes. While the future autonomous vehicles are designed to travel on paved roads, the IDF wants UGVs able to travel in field conditions and battle conditions, and which will have highly developed navigability capabilities, and also with remote firing capabilities.

Another development revealed yesterday by MAFAT is designed to make it possible to control an area without a presence there through the use of many hundreds of miniature sensors dispersed in it. The sensors will monitor, photograph, and listen to everything that moves in the area. "These sensors can be dropped from the air, which makes it possible to disperse them in the area and use them for monitoring. We're making great progress in this area, and have already conducted a very large and successful trial," Gold declares. Asked whether these sensors or others like them will also be able to explode next to a human target defined for them and destroy it, Gold said yes.

## Sea trial

Another program is for the development of an unmanned submarine. There are two such plans for an autonomous miniature submarine designed for scanning and mapping missions. The unmanned submarine is being developed together with a research team from Ben Gurion University of the Negev. A larger unmanned submarine, called Kisaron, is designed for covert missions, mainly intelligence gathering. Gold says that this intriguing vessel has already undergone a trial at sea.

Other programs in various development stages include a system called "First Bullet," aimed at dramatically upgrading the use of firearms. This electro-optical system will be installed on infantry assault rifles. It facilitates hitting the target accurately with a single rifle bullet in any situation and in any firing scenario.

By using the system, developed by a tiny startup, a combatant can press the trigger, but the rifle will shoot the bullet only when the target appears in the center of the sight, thereby ensuring an accurate hit. The Ministry of Defense says that trials of the system, its use significantly increased the percentage of hits, and reduced the risk of hitting uninvolved bystanders in an urban warfare scenario.

MAFAT is also devoting a great deal of thought to air operations. It is refusing to disclose the major projects involving the next generation of UAVs that the defense industries are working on, but is unveiling programs for drones. One of these programs, funded by MAFAT, involves the use of a drone to conduct accurate sniper fire, while achieving battlefield surprise. The system will be tested in the coming year.

In addition, MAFAT is interested in a development plan by Israel Aerospace Industries Ltd. (IAI) (TASE: ARSP.B1) for building an unmanned helicopter that can bear a heavy payload for logistical purposes, while



flying at speeds of up to 150 kilometers per hour using an internal combustion engine installed on it. At the same time, Aeronautics is developing, together with MAFAT, the Yasuran drone, which has a maximum flight speed of 75 kilometers an hour. It is based on batteries and hybrid propulsion, and is capable of bearing payloads of up to 90 kilograms.

It will take years before the vast majority of these projects is ready. After passing a process of proving feasibility and successfully passing through a long series of trials, they will be increasingly integrated in IDF units.

### **"There are already successes"**

As for the tunnels threat that has been facing the IDF and the defense establishment for year, and whose monstrous scope was fully revealed three years ago during Operation Protective Edge in the Gaza Strip, Gold selects his words carefully: the strenuous activity by development teams in MAFAT and the defense companies aimed at development a fully effective solution to the threat - an Iron Dome for the tunnels - is classified, and the Ministry of Defense is providing little information about it. "The challenges and gaps in the matter are known," Gold says. "It is to both prevent digging and detect existing tunnels, and eventually to destroy them, or be able to map them and fight within them -we are investing in many spheres, and there are already successes. Israel is the first in the world to achieve technological successes in this matter."

The Ministry of Defense is currently promoting work to build an underground wall around the Gaza Strip as an answer to the threat of cross-border tunnels from the Gaza Strip. At the same time, the effort to find a technological solution is also proceeding: "We are working simultaneously on both the physical barrier and the technology. It is a chain of technologies and developments that will be integrated in the comprehensive solution. There are already

tools in place that are being tested. We have already tested over 100 different solutions. There is already technology ready, but it is not a 100% solution."

### **How much is it costing us? "The answer is complicated and classified."**

Asked about the budget available to him for the 1,500 development programs that teams are working on, Gold does not mention any figures, claiming that the answer is "too complicated, and in any case classified." Each one of the three special MAFAT administrations has a separate budget from the defense budget, in addition to MAFAT's basic annual NIS 800 million R&D budget. The three MAFAT administrations are Homa, which is responsible for air defense against rockets and missiles; the Etgar space administration, which deals with satellites; and the UAV administration. In addition to these administrations, MAFAT also has six units operating in it, two centers, including research and technological infrastructure, and R&D. In addition to the 500 officers and civilians employed in MAFAT's unit, it subsidizes the salaries of 2,000 researchers and employees in higher education and the defense industries that it classifies as "knowledge hubs." These 2,000 civilians are committed as part of their jobs to MAFAT's tasks in accordance with multi-year work plans, and the same is true of cooperative efforts with other defense companies for the sake of ventures of national importance. The defense industries pay these workers' salaries, but receive subsidies from MAFAT.

### **Leading Edge Aerospace Capabilities**

With five satellites in space launched from Israel, the country is one of only eight nations in the world with an independent space-launch capability. The country's national aeronautical corporation - Israel Aircraft Industries (IAI), which has led the country's space program,



has also developed the Arrow, the world's first-ever Anti-Tactical Ballistic Missile system. The country's aerospace capabilities also include the know-how to upgrade a broad range of aircraft and helicopters and Israeli firms are world leaders in unmanned aircraft - UAVs.

The country's aerospace industry has been able to benefit from a close relationship with the Israeli Air Force (IAF). Historically, it has been the success of the IAF and its superiority in the air, which has led the Israel Defense Forces to victory. New aerospace systems and sub-systems developed in Israel have the advantage of being immediately tested by the IAF, sometimes in real-time mission and operational conditions, providing a stream of feedback to local developers and manufacturers.

IAI's space and missile achievements include the Shavit launcher, the Ofeq Imaging Satellite and Amos Communication Satellite and, in cooperation with the U.S., the Arrow missile. An agreement has been signed between IAI and Boeing for establishing a production infrastructure for manufacturing Arrow missile components.

Other Israeli firms like Elbit Systems also specialize in aerospace systems. These systems include space and airborne reconnaissance systems, UAVs, space cameras and thermal imaging systems, and the production of structural components and parts for the world's leading aerospace companies. This includes, through its subsidiary Cyclone Aviation Products, upgrading a wide range of fixed wing and rotor aircraft and helicopters including the F-4, F-5, F-15, F-16 and MiG-21 fighter aircraft, the CH-53, Super Cobra, Super Puma and V-22 helicopters and L-39 and ALX trainers. These upgrade programs have become increasingly significant in recent years as air forces worldwide are faced by ongoing budget cuts, while coming under increasing pressure to integrate the latest technological

systems into existing fleets of aircraft. Another Israeli company specializing in aircraft engine refurbishing is Bet Shemesh Engines.

Israel's budget-oriented upgrade packages are able to improve an aircraft's capabilities, while lengthening its life-cycle, and lowering a pilot's work-load. Israeli firms have undertaken these projects on a turn-key basis from conception through to implementation and subsequent maintenance for both the Israel Air Force and overseas air forces.

Israel's aerospace industry also provides a broad range of leading edge components, accessories, materials and technologies to the world's major aircraft manufacturers. Products on offer include the most advanced radar systems developed by IAI's subsidiary Elta Systems Group, satellite and other innovative communication systems, glass cockpits, electro-optical systems, advanced propulsion.

Smart weapons systems include the Python 4 and 5 and Derby missiles, developed by RAFAEL Armament Development Authority, which are considered to be the world's most advanced air-to-air missile. Other products in the Israeli arsenal include laser-guided bombs and missiles and kits converting conventional weapons and bombs into smart weapons systems. Israel is also a world leader in search and rescue systems, armament management systems, mission computers, navigation equipment, cockpit displays, electronic warfare systems, avionic suites and airborne self protection systems. RAFAEL also develops microsatellites.

IAI has also led the local aerospace industry, and the world, in developing unmanned air vehicles (UAVs). The Hermes, for example, is a long range UAV for intelligence gathering purposes, while the Harpi, is an attack UAV. The new generation of UAVs currently being developed will include Micro Air Vehicles (MAVs), just 20 centimeters in size as well as



UAVs with the capabilities of making vertical take offs and landings and improved control by using ground or airborne relay.

Israel Military Industries (IMI) specializes in rocket systems and through its subsidiary Ashot Ashkelon Industries produces long and short shafts for jet engines, products for aircraft high-lift systems, and switchboxes for the aerospace industry.

Following 9/11, IAI has developed homeland defense products including Flight Guard which when installed on aircraft offers a proven civil aviation self-protection system to combat terrorist missile attacks. Nice Systems' manufactures transceivers which send digital signals to air traffic controllers tracking planes and the company has also developed video recorders enabling pilots to inspect events in the passenger cabin.

Israel's aerospace industry also has the advantage of a highly skilled and experienced work force, many of them former senior air force personnel who continue to serve the armed forces reserves. A classic example of this relationship between the IAF and industry is BVR Systems Ltd. Founded in 1986 by two Israeli air-force pilots, BVR is a world leader in the development, manufacture and marketing of advanced computer-based training systems for pilots and other military applications. Their products include such innovations as Combat-Maneuvering-Instrumentation Systems, advanced algorithms, collision avoidance systems, advanced imagery, data-links, command and control, and man-machine interface applications.

Other companies in Israel's private aerospace sector include CONTROP Precision Technologies Ltd., which specializes in the development and production of electro-optical and precision motion control systems for helicopters, UAVs and light aircraft. Elisra Electronic Systems has developed EW systems

which are installed in over 30 types of fixed and rotary winged aircraft, while its sister company, Tadiran Spectralink, also part of Elisra Group, produces advanced wireless communication systems for a variety of airborne platforms and Blades Technology International (BTI), which manufactures high quality jet engine fan, compressor and turbine blades. Techjet Aerofoils Ltd. is a world leader in the development and manufacture of compressor aerofoils. The company's products are based on state-of-the-art technology and automation, ensuring ultimate quality through controlled processes. T.A.T. Technologies develops and manufactures a range of aerospace products including heat management and cooling systems.

RADA Electronic Industries develops and manufactures core avionic systems, ground information management and debriefing systems and automatic test equipment and Orlite Industries has developed advanced composite products for aerospace and military applications.

The 20th century saw the decisive battle front move from land and sea to the air. This process will be certain to intensify during the 21st century with an even more pressing need for technological systems, which are smarter, more efficient and cost effective. Systems, which Israeli firms, are well placed to provide.

### Why Israel has the most technologically advanced military on Earth

Israel is one of the world's top weapons exporters with \$6.5 billion in annual arms sales.

In 1950, just two years after the state of Israel was founded, the country's first commercial delegation set off for South America.

Israel desperately needed trading partners. Unlike its Arab adversaries, Israel did not have



natural resources to fund its economy. There was no oil or minerals. Nothing.

The delegation held a couple of meetings but was mostly met with laughs. The Israelis were trying to sell oranges, kerosene stove tops and fake teeth. For countries like Argentina, which grew its own oranges and was connected to the electrical grid, the products were pretty useless.

It's hard to imagine this is what Israeli exports looked like a mere 67 years ago. Today, Israel is a high-tech superpower and one of the world's top weapons exporters with approximately \$6.5 billion in annual arms sales. Since 1985, for example, Israel is the world's largest exporter of drones, responsible for about 60 percent of the global market, trailed by the US, whose market share is under 25 percent. Its customers are everywhere - Russia, South Korea, Australia, France, Germany and Brazil.

In 2010, for example, five NATO countries were flying Israeli drones in Afghanistan. How did this happen? How did Israel, a country not yet even 70 years old, become a superpower with one of the most technologically advanced militaries in the world that is changing the way modern wars are fought?

The answer, I believe, is a combination of a number of national characteristics unique to Israel.

First, despite Israel's small size, about 4.5 percent of its GDP is spent on research and development, almost twice the Organization for Economic Cooperation and Development average. Of that amount, about 30 percent goes to products of a military nature. By comparison, only 2 percent of German R&D and 17 percent of US R&D is for the military.

Another major contribution is the culture of innovation and creativity in Israel. Israelis are

more willing to take risks than other nations. They get this from their compulsory military service during which they are tasked, at a young age, to carry out missions often with deadly consequences.

While Israeli 19-year-olds embark on operations behind enemy lines, their Western counterparts can be found in the safety of their college dormitories.

Lastly, Israel has been in a perpetual state of conflict since its inception, fighting a war almost every decade. This reality, of having your back against the wall, sharpens the mind. It forces Israelis to be creative and come up with innovative ways and weapons to survive.

This is the Israel story ...

### Robotic border patrols

The Guardium is a part of a new category of robotic weapons known as Unmanned Ground Vehicles or UGVs. Israel is the first country in the world using these robots to replace soldiers on missions like border patrols.

Already, Guardium UGVs are deployed along Israel's border with Syria in the north and the Gaza Strip in the south.

The Guardium is based on a Tomcar dune-buggy-like vehicle and equipped with a range of sensors, cameras and weapons. It can be driven by a soldier sitting in a command center miles away or receive a pre-designated route for its patrol, making it completely autonomous.

The increasing use of robots by the Israel Defense Forces is part of a larger strategy to minimize risk to soldiers when possible. In addition, soldiers require breaks, food and water. All a Guardium needs is a full tank of gas. Other UGVs in use by the IDF include the Segev, which is based on a Ford F-350 pickup truck.



Facing terrorists who use tunnels to infiltrate into Israel from places like the Gaza Strip, Israel is also relying on UGVs like robotic snakes to slither into underground passageways and enemy headquarters. The robots will then map out the structures, giving soldiers an accurate picture of a battle area before the place is stormed.

The same is happening at sea. Israeli defense contractor Rafael has developed an unmanned patrol ship called Protector which is being used by Israel to protect its strategic ports and patrol the country's long Mediterranean coastline.

### The Arrow anti-missile program

In 2000, the Israeli air force received its first operational Arrow missile battery, making Israel the first country in the world with an operational system that could shoot down incoming enemy missiles.

The idea to create the Arrow was born in the mid-1980s after US President Ronald Reagan floated his Star Wars plan and asked America's allies to partner in developing systems that could protect the country from Soviet nuclear missiles.

The Arrow was a revolutionary idea. Due to Israel's small size and lack of territory, all ballistic missiles deployed in the region - by Syria, Iraq and Iran - can reach anywhere within the country and pose a strategic and possibly even existential threat. Israel, the developers argued, needed a system that could shoot down enemy missiles over neighboring countries and provide overall protection for the tiny Jewish state.

The program had its ups and downs but got a huge boost in funding after the First Gulf War in 1991, when Saddam Hussein fired 39 Scud missiles into Israel, paralyzing the country and forcing millions of Israelis into bomb shelters with their gas masks.

The Arrow was just the beginning. Today, Israel has the Arrow, which is partially funded by the United States, to intercept long-range ballistic missiles, David's Sling to intercept medium-range rockets and cruise missiles as well as the combat-proven Iron Dome, which has intercepted hundreds of Katyusha rockets fired from the Gaza Strip in recent years.

Israel is the only country in the world that has used missile defense systems in times of war. These systems do more than just save lives. They also give the country's leadership "diplomatic maneuverability," the opportunity to think and strategize before retaliating against rocket attacks.

While other countries have also invested in missile defense, none has created a multi-tier architecture like Israel.

### Mini spy satellites

In 1988, Israel launched its first spy satellite into space, gaining membership in the exclusive club of just eight nations with independent satellite-launching capabilities.

From the beginning, there were those who doubted Israel was capable of developing, building and launching its own satellite, but in the nearly 30 years since that day, it has grown into a satellite superpower, now operating eight different spy satellites in space. This is a critical capability considering the threats Israel faces from countries like Iran, which it still suspects is planning one day to build a nuclear weapon.

Israel has shied away from building big satellites and instead designs what are known as "mini satellites," which weigh about 300 kilograms (661 pounds) in comparison to America's 25-ton satellites.

Most of Israel's satellites come with advanced high-resolution cameras like the Ofek-9, launched in 2010, which can discern objects as



small as 50 centimeters (20 inches) from hundreds of miles away.

Israel's other category of satellites are known as the TecSar. These satellites use a synthetic aperture sensor, basically a radar system that can create high-resolution images at almost the same quality as a regular camera.

The advantage this technology provides Israel is tremendous. A camera cannot see through clouds or fog, but radars can work in all weather conditions and can even see through camouflage nets. What this means is that Israel has the ability to track its enemies and gather intelligence on them at all times of the day and through rain, fog or clouds.

Israel's success in developing state-of-the-art satellites has caught the world's attention. In 2005, the French entered a strategic partnership with an Israeli company to develop a satellite, and in 2012, Italy ordered a reconnaissance satellite, paying \$182 million. Singapore and India have also reportedly purchased Israeli satellites over the years.

### Drones

It is referred to in Israel as the "drone that can reach Iran." The Heron TP is Israel's largest unmanned aerial vehicle with an 85-foot wingspan, the same as a Boeing 737 airliner. It can stay airborne for 24 hours and carry a 1-ton payload.

While Israel doesn't openly admit it, the Heron TP is believed to also be capable of launching air-to-surface missiles.

Israel was the first country in the world to operate drones in combat operations. Its first use of drones was in 1969, when the Israel Defense Forces flew toy airplanes with cameras glued to their bellies along the Suez Canal to spy on Egypt. In 1982, it flew its first combat drone, called Scout, in Lebanon, where they

played a key role in locating and neutralizing Syrian anti-aircraft missile systems.

That operation caught the world's attention, and in 1986, Israel supplied the US Navy with its first drone, known as the Pioneer. A few years later, one Pioneer made history when it flew over a group of Iraqi soldiers during the First Gulf War. The soldiers saw the aircraft, took off their white undershirts and waved them in the air. It was the first time in history that a military unit had surrendered to a robot.

Israel's drones have revolutionized the modern battlefield. They cost a fraction of a manned fighter jet - some as little as a few million dollars - and participate today in every single operation conducted by the IDF.

Drones give soldiers the ability to make calculated decisions before invading territory or storming enemy compounds.

Before Israel bombs a building in the Gaza Strip, for example, it always has a drone in the air to ensure that civilians are not inside. They also reportedly fly almost daily over Lebanon, tracking fighters for Hezbollah, which is believed to have about 130,000 missiles capable of striking Israel.

### The top-secret tank

To this day, the Merkava tank is one of Israel's most top-secret projects. It is said to be one of the most lethal and protected tanks in the world, and its construction started out of pure necessity — the United Kingdom and other countries refused to sell Israel tanks. So in the 1970s, it started to build its own.

The newest model - known as the Merkava Mk-4 - is the most impressive. It can reach speeds of 40 mph and comes with a new modular armor kit, meaning that the tank can be fitted with the armor it needs based on the specific mission it is heading into.



An area, for example, known to be full of anti-tank missile squads requires heavy armor, while an operation without the threat of anti-tank missiles means less. This also allows tank crews to replace damaged pieces of armor on the battlefield without having to bring the full tank back to a repair shop inside Israel.

In 2012, the Merkava underwent its biggest change yet when a new system - called Trophy - was installed on the tank. Trophy is an active-protection system, basically a personal missile defense system for an individual tank.

Trophy uses a miniature radar to detect incoming anti-tank missiles and then fires a cloud of countermeasures - basically metal pellets - to intercept them. The radar also interfaces with the tank's battle management system. This means that once a missile launch is detected, the coordinates of the enemy squad that fired the missile are immediately obtained, allowing the tank to retaliate quickly and accurately.

### IAF holds successful David's Sling missile defense system test

The Israeli Air Force successfully tested the David's Sling missile defense system and destroyed several "enemy" missiles fired over the ocean. David's Sling, which is expected to become fully operational within a few weeks, is designed to intercept medium- to long-range rockets and cruise missiles fired from ranges of 40 kilometers (25 miles) to 300 kilometers (186 miles) away. According to the Defense Ministry's Homa Directorate, which oversees the development of Israel's missile defenses, the test simulated the missile threats Israel faces.

Held at the Palmachim Airbase in central Israel, the test included a series of interception scenarios during which the system's radar and command and control abilities were put into action. IAF personnel assigned to the future

David's Sling Unit participated in the test as part of their training.

Homa Director Moshe Patel said the test was "a complete success." "This successful test is an important milestone in Israel's operational defense capabilities," the Defense Ministry said in a statement. The system was developed by Rafael Advanced Defense Systems, along with the U.S. Missile Defense Agency, Israel Aerospace Industries' subsidiary Elta, Elbit Systems, and American defense contractor Raytheon. A Rafael official said that "the targets intercepted in this test fire were the most advanced [threats] the defense system can take on. The targets were intercepted at very high altitude." He said David's Sling would allow Israelis "to lead a normal life even when faced with the threat of precision and unconventional missiles."

David's Sling is part of Israel's four-tiered air defense, which also includes the Iron Dome system designed to intercept and destroy short-range rockets and artillery shells, the Arrow 2 short- and medium-range ballistic missile interceptor, and the Arrow 3 long-range missile interceptor, which is in the last leg of its development. In the future, the Air Defense Forces plan to use David's Sling to intercept enemy drones, an IAF official said. Israel is one of the world's top weapons exporters with \$6.5 billion in annual arms sales. IDF In 1950, just two years after the State of Israel was founded, the country's first commercial delegation set off for South America.

Israel desperately needed trading partners. Unlike its Arab adversaries, Israel did not have natural resources to fund its economy. There was no oil or minerals. Nothing. The delegation held a couple of meetings but was mostly met with laughs. The Israelis were trying to sell oranges, kerosene stove tops and fake teeth. For countries like Argentina, which grew its own oranges and was connected to the electrical grid, the products were pretty



useless. It's hard to imagine this is what Israeli exports looked like a mere 67 years ago. Today, Israel is a high-tech superpower and one of the world's top weapons exporters with approximately \$6.5 billion in annual arms sales.

### **8th in the world in supply of defense systems**

Sales by Israel's four largest defense companies, led by Elbit Systems, topped \$8.6 billion in 2016.

Israel was rated in eighth place among the world's leading sellers of weapons systems last year. In 2016, Israel's four leading defense companies - Elbit Systems Ltd. (Nasdaq: ESLT; TASE: ESLT), Israel Aerospace Industries Ltd. (IAI) (TASE: ARSP.B1), Rafael Advanced Defense Systems Ltd., and Israel Military Industries Ltd. (IMI) - had \$8.6 billion in sales to the defense market.

The ranking is based on figures from US weekly "Defense News." The rating of the world's 100 leading defense companies is solely according to their sales to the defense markets, and does not include civilian market sales and revenue.

Elbit Systems was the leading Israeli defense company in defense sales in 2016, although when civilian sales are included, IAI had larger sales. Elbit Systems was ranked 27th in the world in defense sales, while IAI was ranked in 33rd place. According to Baker Tilly, Elbit Systems' defense sales totaled \$3.1 billion in 2016, compared with \$2.6 billion for IAI. Rafael rose from 41st place in international rankings for 2015 to 37th place for 2016 with \$2.3 billion in sales, up 17%, compared with the preceding year, making it one of the world's fastest growing defense companies.

In contrast to most of the defense companies, Rafael's business is all in the defense industry.

IMI is further down the list in 92nd place with \$496 million in sales in 2016, compared with 90th place in 2015. .

Rafael was in 28th place in 2010, IAI in 36th place, Rafael in 47th place, and IMI in 97th place.

IAI's ranking is expected to improve in the current year, following a series of major weapons deals signed in India in recent months, including the sale of Barak 8 missiles. IAI's sales of these systems in India total \$2.5 billion. The world leader in defense sales is US company Lockheed Martin, with \$43.4 billion in sales in 2016.

### **Israel's defense industries**

Israel produces a wide range of products from ammunition, small arms and artillery pieces to sophisticated electronic systems and the world's most advanced tank. From the days of the French arms embargo in 1987 Israel developed a powerful arms and defense industry. Today it is among the ten largest exporter of defense products. The weapons are also offered on the basis of being battle tested. The range of weapons manufactured include planes, drones, tanks and small weapons.

Having to fight five major wars in its first four decades, Israel built a comprehensive standing army - the Israel Defense Forces (IDF) - and furnished it with an arsenal of highly advanced military hardware. The government, which owns three major defense firms, also encouraged the formation of private companies to equip the IDF. The development of a sophisticated defense industry inevitably led to exports, which today account for a majority of its revenues and allows the country's defense industry to compete against some of the largest companies in the world for foreign contracts, in addition to producing many of the arms needed for Israel's own defense.



Faced with a shrinking market for military hardware over the last decade and a half, Israeli defense concerns have made a concerted effort to employ their research and development teams in devising products for non-military markets and, more frequently, in adapting defense technology for civilian applications. Indeed, many of the most innovative products developed by Israel's civilian high tech industry, especially in the field of telecommunications, trace their origins to military technology.

The modern defense industry in Israel was set in motion in the early 1920s. Faced by an increasingly hostile Arab population, the Jewish community began to manufacture homemade hand grenades and explosives. In the early 1930s, members of the Haganah (the pre-state Jewish underground defense organization) set up clandestine small arms factories, which became the Israel Military Industries (IMI) in 1948. In the first two decades after independence, IMI produced many of the basic weapons used by the IDF, including the Uzi sub-machine gun. The more costly aircraft and other advanced weapons were procured from foreign suppliers, principally France.

The major catalyst for Israel's metamorphosis from a small-arms manufacturer to a producer of sophisticated military systems came after the 1967 Six-Day War. During the war, France imposed an embargo on arms sales to Israel, including the Mirage planes already on order from the Dassault aircraft factory. When the United States became the primary supplier of combat aircraft, Israel began to develop its own production capability. The government-owned Israel Aircraft Industries (IAI), founded as a maintenance facility in 1953, soon began developing and assembling a variety of its own aircraft, including the Kfir - a replacement for the Mirage - as well as the Arava and Nesher planes. At the same time, IAI's contacts with US suppliers advanced from subcontracting jobs to joint ventures with Boeing and

Lockheed-Martin. As a result, employment at IAI grew rapidly from 4,000 to a peak of 14,000 in the late 1980s.

The growing sophistication of Israel's defense industry gave it the confidence to develop an all-Israeli military aircraft, the Lavi. Over the first half of the 1980s, IAI developed avionics, electronics and weapons systems for the aircraft, and by 1986 the first prototype had taken to the air. However, the government concluded that it was unable to finance such an ambitious undertaking, and the project was canceled a year later. Shorn of the Lavi, IAI began to develop a variety of products in the military and civilian spheres - such as advanced radar systems, precision weapon systems, unmanned air vehicles (UAVs) and commercial and military aircraft conversion - many of which were based on the technology developed during the Lavi project.

There are approximately 150 defense firms in Israel, with combined revenues of an estimated \$5.5 billion. The three largest entities are the government-owned IAI, IMI and the Rafael Arms Development Authority, all of which produce a wide range of conventional arms and advanced defense electronics. The medium-sized privately owned companies include Elbit Systems and the Tadiran Group, which focus mainly on defense electronics. The smaller firms produce a narrower range of products. In all, the industry employs close to 50,000 people, all of whom share a commitment to high levels of research and development and the ability to make use of the IDF's combat experience.

Israel's defense exports are coordinated and regulated through SIBAT - the Foreign Defense Assistance and Defense Export Organization - which is run by the Ministry of Defense. SIBAT's tasks include licensing all defense exports as well as marketing products developed for the IDF, from electronic components to missile boats and tanks.



Each year, SIBAT publishes a defense sales directory, an authoritative guide to what the industry has to offer. Despite their far-reaching client base, even the biggest local firms are relatively small players in the global defense market. With increasing competition from the major world aerospace players, Israeli companies tend to specialize in niche markets, or have sought to combine forces through mergers or joint marketing efforts. In addition, declining global defense spending has provided them with new opportunities as foreign governments seek to upgrade their existing arsenal rather than buy new equipment. This policy is typified by the Phantom 2000, a sweeping modernization of the F-4 aircraft that Israel acquired from the US in the early 1970s.

In the wake of the Lavi's cancellation, IAI diversified and expanded with funding from the United States, developing the Amos and Ofeq satellites and the world's first operational anti-missile missile system, the Arrow. IAI's unmanned air vehicles (UAV or pilotless aircraft) systems, including the Hunter, have now become standard for military establishments in many countries around world. The company is also engaged in the repair and maintenance of aircraft and helicopters, and in upgrading aircraft with state-of-the-art avionics. It also designs, develops and manufactures naval and ground systems, electronic warfare and radar equipment and missiles. Company sales in 2000 amounted to \$2.18 billion, of which exports accounted for \$1.7 billion. In the same year, IAI signed some 1,600 new contracts worth approximately \$2.6 billion.

Israel Military Industries (IMI) was founded in 1933, as a secret small-arms plant. After the establishment of the State in 1948, it was operated by the Ministry of Defense, developing and manufacturing assault weapons - from the classic Uzi sub-machine gun to the Tavor assault rifle - heavy ammunition, aircraft and rocket systems,

armored vehicles like the Merkava tank, and integrated security systems. In 1990, IMI was converted into a government-owned company. Altogether IMI manufactures some 350 products and employs over 4,000 people.

In addition to Israel and the US, IMI has distributors in a number of countries, including Norway, Belgium, the Philippines and Greece. Some 60% of its revenues, worth approximately \$550 million, come from exports.

The third government-owned defense firm, the Rafael Arms Development Authority, developed and now manufactures Python and Popeye "smart" airborne missiles, both of which have co-production agreements with major US aerospace companies. In addition, its products include such varied categories as passive armor, naval decoys, observation balloon systems, acoustic torpedo countermeasures, ceramic armor, air-breathing propulsion, and air-to-air, air-to-surface and surface-to-surface missiles.

Elbit Systems, based in Haifa, develops, manufactures and integrates advanced, high-performance defense electronics systems, focusing on upgrade programs for aircraft and armored vehicles. The company also manufactures command, control and communication (C3) systems, and upgrades in weapons platforms and electronic systems and products for both Western and former Eastern bloc countries. In 2000, Elbit Systems merged with another major private-sector defense concern, El-Op Electro-Optics Industries Ltd, and combined sales reached \$591 million, up from \$436 million the previous year.

The second major private sector defense firm is the Tadiran-Elisra Group, whose subsidiaries specialize in defense electronics. The group's Elisra Electronics offers a range of electronic warfare systems for the military, including radar warning systems, active countermeasure



systems, comprehensive self-protection systems, ESM and ELINT systems, and sophisticated communication links complemented by extremely lightweight components and super components. It employs a staff of over 800, two thirds of whom are engineers. Tadiran Electronic Systems designs and produces a wide range of military applications, including intelligence, reconnaissance and electronic warfare and specialized naval communication systems, all tailored to customer specifications. Tadiran Spectralink specializes in pilot-rescue electronic equipment while BVR Systems develops innovative flight simulators for fighter pilots. The group, which is controlled by Koor Industries, announced sales of \$284 million in 2000.

In addition to Elbit and Tadiran-Elisra, there are scores of smaller, more specialized defense firms in the private sector, including: Cyclone Aviation, which upgrades helicopters and makes aircraft components; Urdan Industries, which through its Associated Steel Foundries makes many of the components of the Merkava tank; Magal Security Systems, whose products include sensors for security perimeter fences and explosive-detection devices for airports and other public facilities; BVR Technologies, which produces airborne collision-avoidance security systems, trainers for pilots and for the use of "smart" weapons, and a variety of simulators for combat training and pilot debriefing; the Elul Group, a complex of companies which specialize in development and coordination of defense business for Israeli firms abroad, and for international firms in Israel; RSL Electronics, which produces both airborne electronics systems for airplanes and helicopters and muzzle-velocity radar for field artillery; and Soltam, which makes both mortars and heavy artillery pieces as well as Israel's most popular line of stainless steel kitchen equipment.

Since the end of the Cold War, the global

defense industry, including the IDF, has had to cope with declining military spending. In response, many private companies have either merged or reduced staff, or diversified into civilian markets, with some companies fully spinning off their civilian activities into separate businesses. Many of the high technology products designed by Israeli companies for such areas as the Internet, medical electronics and robotics, are based on technology originally developed by the IDF or the defense industries. Friendly Robotics is one notable high-tech start-up that traces its origins to the army. Its top executives worked in army technology units and the company's robot lawn mowers are based on advanced missile guidance technology, providing accurate positioning and navigation functions to perform its tasks. Among the few private sector defense firms with civilian activities, Elisra designs, develops and produces electronic and microwave applications for the commercial market.

In 1968, IAI acquired the rights to manufacture the Jet Commander executive aircraft from the US company Rockwell, which eventually evolved into the IAI's Astra. In the 1990s, IAI began producing the Galaxy executive jet in partnership with the Pritzker family of Chicago. In April 2001, the international aerospace firm General Dynamics contracted to purchase the Galaxy firm for approximately \$600 million. In addition, in the late 1970s Bedek, a division of IAI specializing in aircraft maintenance, began overhauling and refitting Boeing 707 airliners, and today the upgrade of commercial aircraft has become a major business for IAI. The civilian content of the new contracts signed in 2000 was worth \$1.1 billion, or 42% of total new contracts. IMI has fewer civilian businesses but has developed technology for electronic wallets and computerized payment systems.

Rafael develops military technologies for civilian use through its Rafael Development



Corp., a joint venture with the private sector Discount Investment Group. One of these projects used miniaturization and guidance techniques to produce a transmitter and camera the size of a vitamin capsule. The capsule is swallowed by a patient and

pictures of the gastrointestinal tract are then taken by the camera for use by diagnosticians, substituting for invasive diagnostic procedures. The system, which was developed by Given Imaging, was the brainchild of a missile guidance expert.



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