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defence industry

*Profile*



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### ■ INTERVIEW WITH ITAMAR GRAFF PRINCIPAL DEPUTY DIRECTOR, SIBAT

At the end of their long visit to Israel the authors were very kindly received by Itamar Graff. The interview lasted somewhat longer than planned. The following are extracts of some of the most important points made, and answers given, by Mr Graff, particularly regarding Israel's export policy.

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### ■ AIRCRAFT AND UPGRADES

Israel's first true industrial inroads into defence aviation date back to the late 1950s with the manufacture of the Fouga Magister by Bedek. Israel is now not only a World-level expert in fighter, cargo, tanker and AEW&C adaptations, but also an airborne weapons producer that has to be reckoned with.

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### ■ AIR DEFENCE

While companies like IAI and Elta are heavily involved in Israel's air defence programmes, the latter notably for what regards its radars, Rafael remains the kingpin of the discipline with a number of programmes of international repute.

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Merkava, Galil and Uzi typically spring to mind, but many other vehicles, weapons and systems have since owed their efficiency to those who returned straight to the drawing boards from the battlefield.

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Israel's naval activities, via Israel Shipyards, originates from the 1967 embargo by France that followed the Six-Day War and affected the delivery of the last five of the 12 Saar 3-class missile boats. The lesson was well, very well, learned.

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### ■ DRONES & ROBOTICS

One can argue for hours on who made the first drones – to use their original name – but there is no question about the true, practical modern-era types: they had an Israeli origin – and that was over 40 years ago.

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### ■ ELECTRONICS

By developing its own electronics industrial capability, Israel has de facto reduced the number of systems that would be denied to the nation by foreign nations' embargoes. This explains Israel's high command of almost any sophisticated electronic system sector.

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### ■ STABILISED ELECTRO-OPTICS

This domain is largely shared between Elbit, IAI, Controp, Top I Vision and Esc Baz with numerous systems, although Rafael has its own turret known as the Toplite which has, according to the company, the unique record of being "on every ship of the US Navy".

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### ■ SPACE

As well as producing satellites, Israel now not only builds launch vehicles in the form of the Shavit series of rockets, but has also become the world's first nation to launch westwards to avoid overflying its neighbouring countries.



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# Interview With ITAMAR GRAFF

## Principal Deputy Director, Sibat

סיבט ישראל

At the end of their long visit to Israel the authors were very kindly received by Itamar Graff. The interview lasted somewhat longer than planned. The following are extracts of some of the most important points made, and answers given, by Mr Graff, particularly regarding the policy of the Israeli Ministry of Defence towards the export market.

**Origin of Sibat:** Sibat is an organisation within the MoD. It is not a company, it is a governmental organisation. It was created in the 1970s when exports amounted to a few dozens of million dollars probably {per year} and now reach \$6 to 7 billion per year. Since, things have changed dramatically. Exports of the Israel defence industry represents 70 to 75 percent of the total defence production in Israel. I don't know what the numbers are now in the US, it probably is the opposite. So in Israel we are very dependent on finding partners overseas. The role of Sibat is to coordinate all the governmental efforts, mainly of the MoD, to support the defence industries to find partners – we don't call them customers, but partners – to share new technologies {...}. So to summarise, Sibat's main focus is to find new technological co-operations, and {...} here to help find these opportunities for our companies. Because we are MoD, we have the ability to open doors {...} and we understand the needs of other countries. While until a few years ago attentions was focussed on the "Big Guys" (Mr Graff here refers to the Rafael and Elbit groups in particular), we now help the SMEs and the hundreds of smaller companies in Israel.

**Geographical markets:** We are a small organisation, with less than 100 people all together, and we have three main divisions, {...} one for North America, Canada and Europe, the other large division is for the Pacific region, mainly Australia, and then Asia, the Far East and also Africa. The {third} smaller division is for Latin America. We cannot {unlike

other countries} provide political support because there are countries that prefer work under a low profile with Israel. We are geographical Experts. We are supported by the MoD abroad and part of the Military Attachés' role is to support us. We have almost 30 people {working} abroad. The Defence sector in Israel gets huge support from the Government. There are very close relationships amongst the people and the military.

**Export risks:** Answering our questions about security and condition of sales with certain countries to avoid dissemination of post-export items, Mr. Graff explained that Israel had to be even more careful than others in that respect. We have had some bad experiences, take for example Venezuela. Venezuela was a very good ally before Chaves, and Israeli companies even had the ability to sell classified equipment. And after that things changed, and Chaves became the best friend of Ahmadinejad and {...} from intelligence the result is not good, but it's part of the risk you take. Export requires a risk management and this is a role fulfilled by Sibat, and Sibat is controlled by Parliament.

**Africa:** A few decades ago, Israel was very involved in Africa, but no longer {that much} in the last decade, but now we have a national interest to be there, to co-operate with the good regimes mainly because of the penetration of Al Qaeda. What we can see now in Africa is that many countries are asking for our support. Sibat is now looking at ways of providing consultation, not necessarily to achieve sale opportunities, but more to advise on how to cope with terrorism. We are working with a few countries in Africa that think that it is important to fight fanatic Islamism. We support them and sometimes even train them.

**Robotics:** We {Israel} are not a big platform producer. There is the Merkava, there is the Namer APC, but these are not the main items {of exportable technologies}. Our expertise is in some niches, the technologies that give the quality advantages {to our products}. I'll mention here robotics, UAVs, USVs, UGV, all that is flying or driving or cruising with nobody inside, and Israel is a world leader in that field. {...} We started with UAVs forty years ago. And today if you go with our units you'll see that no operation is carried out without anything in the sky. It's part of our doctrine to use UAVs all the time, 24/7. Mentioning other robotics for guarding pipelines and so forth, Mr Graff continued saying: it's been going on for years. So our contribution is operational experience.

**Other fortes:** Another activity is active protection. It starts with the Trophy, {now} protecting one unit of tanks, and I think it's the only operational system in the world, and it stopped an RPG two years ago or so. In terms of ballistic missile protection we already have three systems, one is the Iron Dome, again the only one {of its kind} existing in the world and it is fully operational with 86, 87 percent of success during the last activity from Gaza. Then there is the David's Sling that is under development. We already have the Arrow II, and in a few years we'll also have the Arrow III.

Towards the end of the exports aspect covered by Mr. Graff during this interview, one of his statements provides a perfect conclusion: So it is something really unique for such a small country to have such capabilities.





**The** purpose of the present survey is to provide a condensed portrait of the leading exporting Israeli companies recently visited by Armada's three senior editors specialising in air, land, sea and electronics matters who have been able to examine and discuss the most significant products they manufacture, and thereby provide a profile of their general technical capabilities. This survey should not be regarded as a register of the Israeli defence industry – for this purpose Sibat produces an excellent directory – but rather more as a bird's view of Israel's footprint in the defence world.

Eric H. Biass, Paolo Valpolini, Tom Withington

AIRBORNE  
AND UPGRADES

AIR  
DEFENCE

LAND  
SYSTEMS

NAVAL  
WARFARE

DRONES  
AND ROBOTICS

ELECTRONICS

STABILISED  
ELECTRO-OPTICS

SPACE

In its Block 60 guise, the Colombian Kfir was deemed fit enough to be invited to the 2012 Red Flag exercise during which it scored quite a few kills against more recently built aircraft. The Colombian Air Force took delivery of its last of 24 in 2011. (IAI)



# Aircraft, Upgrades, Air-launched Weapons

Israel's first true industrial inroads into defence aviation date back to the late 1950s with the manufacture of the Tzukit, the Fouga Magister built by Bedek. The first Israeli-designed and built aircraft, however, came in the mid-1960s in the form of the Arava twin tail-boom short take-off and landing transport aircraft



special missions aircraft such as electronic intelligence-gathering platforms, airborne early warning planes and tankers. Alongside its work on aircraft conversion, Bedek provides maintenance, repair and overhaul services for airframes and engines.

The only other fully Israeli designed and purely military aircraft was to have been the Lavi fighter aircraft. Under development in Israel in the 1980s, the project foiled under American pressures since it was financially supported by the United States which, at the same time was developing the F-16 and saw the Lavi as a competitor on the export market. Two of three prototypes have survived and are static displays. Lavi, incidentally, means Lion, while its predecessor, the Kfir, means Lion Cub.

**I Kfir - LAHAV**

An IAI Lahav division product, the Kfir is a heavily redesigned French Mirage 5, itself an aircraft that was originally intended for Israel but victim of a sales embargo. Cutting a long story short, the Kfir was re-engined with the more powerful General Electric J79 used in the F-4 Phantom. The Kfirs stayed in Israel Air Force inventory for slightly over 20 years, but was also exported, notably to Colombia, Ecuador and Sri Lanka – if one omits a number of examples borrowed by the US Air Force and Marine Corps to use them as for aircraft during training exercises.

Lahav has continually modernised the Kfir over the years, but has recently

*In its latest iteration, the Mach 2+ Kfir is said to be typically 1/3 cheaper to buy and operate than an F-16 and to offer a smaller radar cross-section. Amongst other amenities it comes with a smart wide-band IAI datalink and a collision avoidance system. (IAI)*

**A**t the time its manufacturer was Israel Aircraft Industries, a name that was slightly modified to Israel Aerospace Industries to reflect the company's involvement in space activities since 1988, which actually includes satellite launching from Israel. This, it is worthy of notice, involves launching over the Mediterranean, and therefore westwards, for reasons that are logical enough.

Today, the firm occupies a sprawling complex at Tel Aviv's David Ben Gurion international airport. It specialises in providing upgrades and overhauls of civilian and military aircraft. To this end, it has performed several conversions of civilian airliners into freighters, and into military





*The Kfir Block 60's cockpit, complete with multiple function display, mapping display, flight computer and modern head-up display. (IAI)*

developed a new suite of electronics and weapon kits to bring the aircraft up to current standards. According to the company, the new computer, for example, is more capable than its counterpart fitted to the F-16 Block 60. The upgrades are not only intended for its current customers but also for export to new customers, since Israel has an important stock of low flight hour aircraft that could offer a very interesting alternative to certain nations that need to equip with a reasonably capable fighter aircraft at a reasonable cost. The Kfir Advanced Multirole Fighter, for example, has been offered to Bulgaria as a response of that nation's request for proposal issued in 2011. In certain cases, however, the presence of the J79 engine might hinder its exportability.

#### **I SKIMMER - LAHAV**

The company's expertise is not only confined to fixed-wing military aircraft. IAI Lahav's Skimmer naval helicopter mission package offers a retrofit ensemble to transform 'vanilla' helicopters into maritime support platforms. Traditionally naval helicopters have not been cheap, and the Skimmer kit offers a means by which countries with an existing military helicopter fleet can transform some of their machines for this mission. The Skimmer upgrade involves the installation of a multi-mode long range maritime patrol sensor, in

this case the EL/L-2022M Maritime Patrol Radar provided by IAI subsidiary Elta Systems. Alongside the radar, the Skimmer upgrade adds self defence equipment in the form of a missile warning system, chaff and flare dispensers, plus laser and radar warning receivers. Other mission-specific equipment includes a dipping sonar, optronics, anti-ship missiles and air-launched torpedoes. All of these components can be tied together with a mission management and planning system, and the company is keen to emphasise that naval helicopter aircrew were heavily involved in the Skimmer design process to ensure its optimum configuration for the maritime support role. The work can include total airframe strip-down for marinisation.

#### **I TANKERS - BEDEK**

Mention of Bedek was made earlier in the context of the Tzukit. This subsidiary of IAI has since moved into the field of maintenance and modification of larger aircraft, civilian and military. As far as military aircraft are concerned Bedek has specialised in the conversion of airliners into air-refuelling or special mission aircraft, the latter category including types for early warning, comint, elint and sigint, and maritime patrol and antisubmarine warfare missions.

Bedek is in charge of the maintenance of

*The first Colombian Air Force B767 Multi Mission Tanker Transport here seen test feeding a Colombian Kfir, is equipped with hose and drogue underwing pods. A second aircraft is expected, equipped with a fly-by-wire air-refuelling boom. (IAI Bedek)*



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*The main contractor of the G550-based conformal (sensors) airborne early warning aircraft, known as Caew, is in fact Israel's electronics house Elta, which in any case is an IAI subsidiary. (IAI)*

all Israel Air Force transport aircraft, which encompasses Gulfstreams, Hercules and B.707 tankers. Since 1969 Bedek has turned to the next-generation tanker conversion of B.767s with one already sold to Colombia and two to Brazil. Colombia's second tanker will be equipped with an air-refuelling boom. To be more precise, these B.767s are called Multi Mission Tanker Transports to reflect the fact that they can be used for

only for air refuelling but also through a number of modules, to carry out cargo, troop, medevac and even covert CAI missions. Bedek also specialises in what it calls Small and Smart Tactical Tankers base on G550s, C5000s and B.737s.

#### **I EITAM - IAI ELTA**

IAI's latest airborne early warning aircraft is the Gulfstream G550-based Eitam, which supersedes the B.707-based Phalcon. It is also known as the CAEW, in which the C stands for conformal to reflect the design that almost completely embeds the lateral sensors as on the Phalcon. The latter originally used the Elta EL/M-2075 radars

and is no longer operated by Israel although the only officially exported system, to Chile where it is known as the Condor, is said to still be in operation.

Being based on the G550, the Eitam offers a higher degree of flexibility, a notable reduction in operating costs over its predecessor and yet offers an on-station endurance of nine hours at a range of 100 nautical miles from base. The Eitam uses Elta's active electronically scanned array EL/M-2085 radar. Five aircraft are operated by Israel, but it also has been exported (allegedly four units so far) to Singapore and Italy (two units). In Israel at least, the Eitam's maintenance is entrusted to Bedek.

# Air-to-ground weapons

**Rafael is, in Israel, almost synonymous with rocket and missile systems and has developed numerous weapons since it was founded in 1948, although Israel Military Industries whose main field of activity is focused on land systems, has also been a supplier and exporter of air-to-ground weapons.**

One of the weapons that owed much repute arguably is the Popeye, a massive, 1,360-kilo television and infrared-guided air-to-ground missile that entered into service in 1985 and is known in America as the Have Nap AGM-142. Rafael has since turned its attention to numerous new systems more tailored to today's needs.

#### **I SPICE 2000 – RAFAEL**

Rafael has developed a family of stand-off, autonomous, air-to-ground weapon system known as Spice (for Smart, Precise Impact and Cost-Effective), on the basis of a guidance kit. Once released the Spice first flies towards the designated target area using inertial/GPS



*With its wing kit the Rafael Spice 250 has a range of 100 km. Using a new quadruple launcher, an F-16 can carry 16 of these ground attack weapons. (Armada/ Paolo Valpolini)*

*As suggested by this artist impression, the 15-kilo Whip Shot laser beam rider is intended for use by light aircraft. IMI is in contact with numerous manufacturers of light aircraft, that might offer the Whip Shot as part of coin packages. (IMI)*

guidance. In the homing phase, the system locates the target using scene-matching technology using its memory-stored georeferenced imagery and relies on its tracker to hit with the pre-set attack azimuth and impact angle to ensure maximum damage.

The Spice 2000 (compatible with 2,000 pounds warheads such as MK-84, RAP2000 or BLU-109), comes in the form of a fore and an aft section, and allows the weapon to achieve a range of 60 km with a declared CEP of less than three metres. The Spice 1,000, intended for warheads such as the MK-83, RAP1000 or BLU-110, adds a deployable wing kit that further increases range to a hitherto unknown value.

The latest member of in the stable is the Spice 250 that leverages the electro-optical seeker developed for the previous members. The new ordnance is launched from the Smart Quad Rack. Each pylon thus carrying up to four weapons, a single F-16 can carry up to 16 bombs. The rack contains a data link for post-launch navigation update as well as battle damage indication, by picking the last



*Latest in the IMI portfolio is the 500-kilo Mars supersonic guided rocket. (IMI)*

image before impact. Also equipped with a wing kit, the '250 has a range of 100 km. All Spice types are in service or on order, and some have already gained a considerable operational experience.

#### **DELILAH AL - IMI**

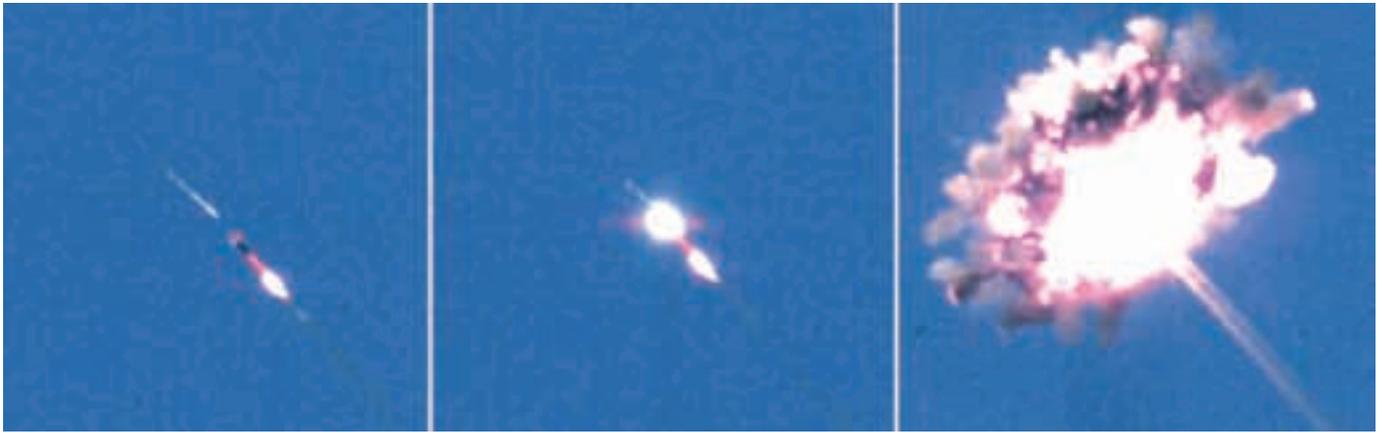
In service with the IDF, but not yet exported though, is the Delilah AL, a turbojet powered stand-off surface attack missile with a maximum range of 250 km developed by the company's Advanced Systems Division. Purposely designed to hit moving targets this missile, which is 2.71 metres long with a wingspan of 1.15 metres and a weight of 187

kg, can reach the target area, and then loiter for over 20 minutes to identify the higher value target thanks to its electro-optical seeker and hit it with utmost accuracy. The Delilah can pull-up, go-around and re-attack its target and can maintain a man-in-the-loop command until the last phase of the attack. The weapon has since been used as the base for the development of helicopter-, ship- and ground-launched versions that add a launch booster that increases its launch weight to 230 kg and length to 3.2 metres, but operational characteristics remain the same. The Delilah AL is currently in service with the Israel

Air Force's two-seater attack aircraft.

#### **MARS AND WHIPSHOT - IMI**

IMI has just finished the development of its fighter aircraft Mars (Multi-Purpose, Air-launched Rocket System) supersonic weapon, a 4.4-metre long, 100 km range, fire-and-forget system weighing 500 kg (with 120 kg accounted for by the warhead), fitted with a GPS guidance system. For light attack aircraft IMI developed the Whip Shot, a 15 kg "affordable" system guided via a wireless link from the aircraft, the electro-optical target acquisition system of which tracks the target until the guided rocket hits it. □



# Air Defence

**Although other companies like IAI and Elta are heavily involved in Israel's air defence programmes, the latter notably for what regards its radars, Rafael remains the kingpin of the discipline with a number of programmes that have gained international reach, even if only used in Israel.**

## IRON DOME - RAFAEL

The Iron Dome achieved worldwide fame in November 2012 when it was used to great effect to intercept rockets being fired towards Israel from the Gaza Strip by the Hamas militant organisation. The Iron Dome was first mooted back in the 1990s following the commencement of rocket attacks by the Lebanon-based insurgent group Hezbollah against northern Israel. Although ideas had been floated for an anti-rocket system, the capability that would eventually be called Iron Dome gained momentum in 2004 following the energies of Brigadier General Daniel Gold, the then chief of the Israeli Defence Force's Research and Development office. Gold emerged as an enthusiastic backer for a surface-to-air anti-rocket system. Two years later, the need for such a capability was given added impetus when, during the 2006 Second Lebanon War, Hezbollah fired around 4,000 rockets against northern Israel, causing the deaths of 44 Israeli citizens, and the evacuation of a further 250,000 for the duration of the conflict. However, northern Israel had not been the only area to suffer severe rocket attack. Hamas has frequently fired rockets and mortars into southern Israel from the Gaza Strip, with around 12,000 such

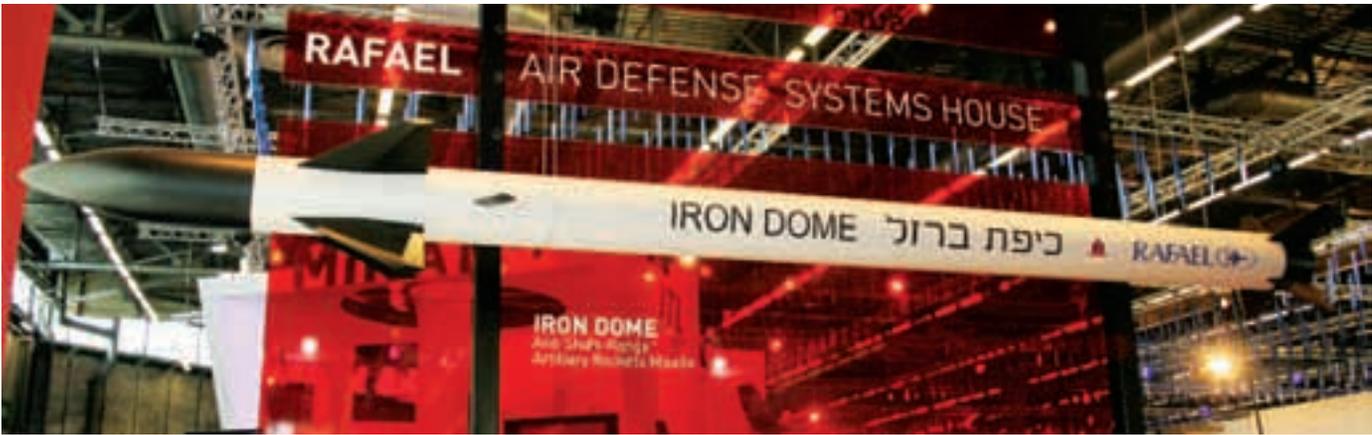
attacks conducted between 2000 and 2008. The Iron Dome was finally selected in February 2007 as the platform to engage the short-range rocket threat, and this gave the green light for Rafael's development.

*Rafael's Iron Dome came to global attention in late-2012 when it was successfully used to intercept rockets fired by Palestinian militants towards Israel from the Gaza Strip. The system undoubtedly saved many lives by intercepting these rockets. (Armada/Tom Withington)*



**Rocket intercept by an Iron Dome Tamir missile. (Armada Archive)** Iron Dome's development and procurement has been jointly funded by Israel and the United States.

Israel provided the finance for the purchase of the first two systems, with a further eight being funded by the United States. Over the years, Washington has made a number of funding pledges to support the Iron Dome. In May 2010, the House of Representatives voted in favour of a \$205 million request from President Barack Obama for the procurement of Iron Dome batteries. A further pledge of \$680 million was made by the House of Representatives in May 2012. More recently, in June 2012, the US Senate Armed Services Committee included an additional \$210 million as part of the 2013



*The Iron Dome's missile, the Tamir, as exhibited by Rafael at Eurosatory in 2008 (Armada/Eric H. Biass)*

National Defence Authorisation Act.

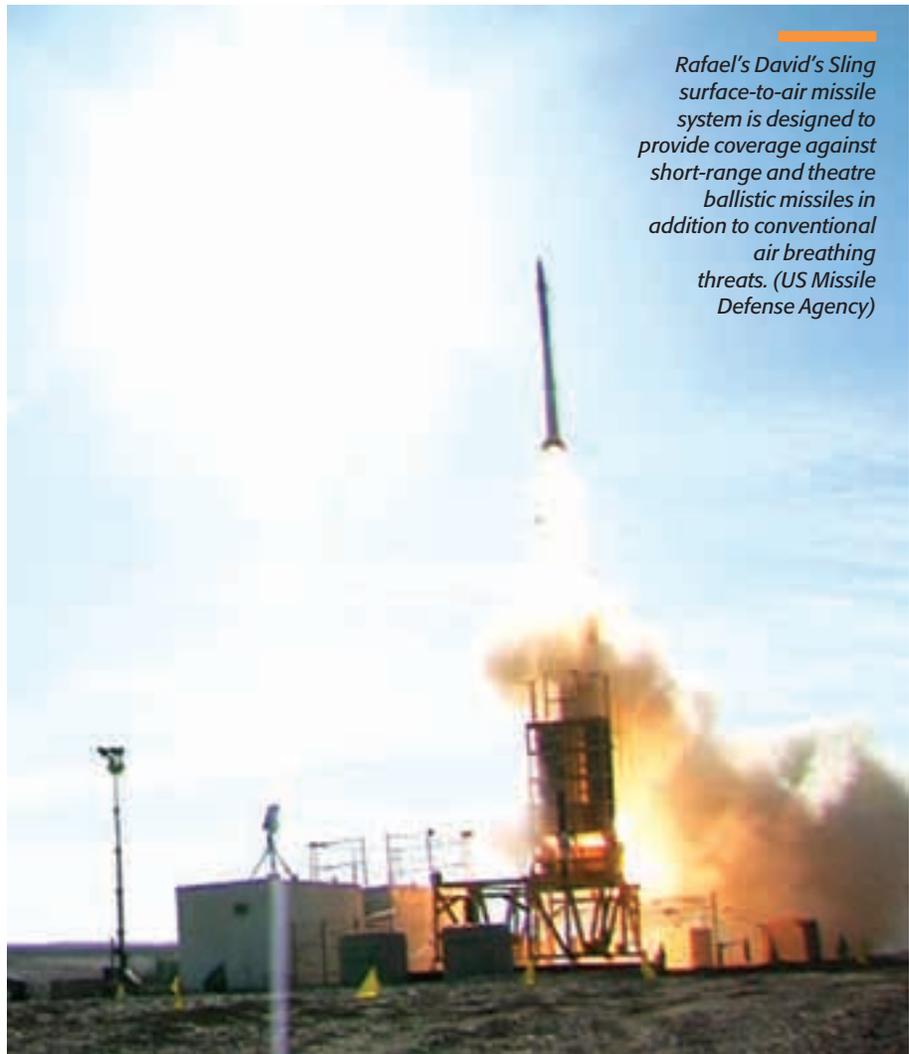
What does all of this funding buy? According to Rafael, the Iron Dome can intercept rockets at a range of up to 38nm (70km). In addition, mortars have been intercepted during tests. The success rate of Iron Dome peaked in late 2012 when the managed to shoot down three out of four rockets over Tel Aviv. Very importantly, the Iron Dome's architecture is designed to avoid intercepting rockets predicted to hit unpopulated areas, and above all is effective against both salvos of rockets and individual rounds. For example, of the 1,500 rockets fired during the November 2012 crisis, 500 were engaged, while the rest left harmlessly crashing in the desert or in the sea.

The Iron Dome architecture includes the Tamir interceptor missile, a Battle Management Centre (BMC), the missile firing unit and the fire control radar, notably the Israel Aerospace Industries Elta Systems EL/M-2084 radar (see below). One radar and one management centre can handle two missile firing units. The radar tells the Tamir interceptor where the target is and provides target updates during its flight, although the interceptor has its own radar and performs the end game autonomously.

The Israel Air Force currently has five Iron Dome batteries, and a sixth will enter service soon. Funding (a significant amount of which is provided by the United States as noted above) has been requested for an eventual total of 15 systems.

**DAVID'S SLING - RAFAEL**

As a complement to Iron Dome, Rafael's David's Sling is designed to intercept short-range ballistic missiles, theatre ballistic missiles, conventional air-breathing threats



*Rafael's David's Sling surface-to-air missile system is designed to provide coverage against short-range and theatre ballistic missiles in addition to conventional air breathing threats. (US Missile Defense Agency)*

and anything that flies in the atmosphere which is not intercepted by the Iron Dome (see above), according to a company representative. Developed with the assistance of Raytheon, David's Sling architecture includes the IAI Elta Systems EL/M-2084 radar, the Stunner interceptor and its firing units, and a battle management centre.

The Stunner is designed as a hit-to-kill

weapon which includes a bi-directional datalink for updates. The Stunner interceptor uses both radar and optronics guidance, and is said to have an effective range of between 38nm (70km) 135nm (250km). This means that the Stunner can intercept threats that fall outside the top of the Tamir interceptor's (see above) range. Rafael won the contract to develop the David's Sling in 2006 and



*Characteristic shape of the tip of the Stunner, the missile of the David's Sling system. (Armada/Eric H. Biass)*

Raytheon has reportedly provided invaluable assistance in terms of developing the missile's firing unit. While the Iron Dome has proven its mettle in engaging short-range rocket fire, the David's Sling's quarry will be longer-range and higher-altitude threats, such as ballistic missiles currently being developed as part of Iran's covert Weapons of Mass Destruction programme. According to its manufacturer, the David's Sling still has two years of development until it is deployed.

**I BARAK-8 – IAI**

As the country's work on the David's Sling and Iron Dome air defence systems illustrates, Israel has emerged as one of the world's few leading suppliers of missile technology, joining counterparts in the United States, Europe and Russia. While both of the systems discussed above are intended for ground-based air defence, maritime air defence products are available from Israeli suppliers. For example, Israel Aerospace Industries has joined forces with India's Defence Research and Development Organisation to develop the ship-borne Barak-8 air defence missile.

Development of the weapon commenced in 2007, following the signature of a joint development contract between the two countries worth \$330 million, with both countries providing equal funding. The Barak-8 can be procured as both a land- and

ship-based air defence missile. The naval variant has a range of 38nm (70km), and a ceiling of over 52,493ft (16,000m), while the land-launched missile can reach 65nm (120km). The missile can hit speeds of up to Mach-4.5 and destroys its target using a 60kg laser-fused, pre-fragmented, high-explosive warhead. In Indian service, the missile will be deployed onboard the country's navy



*Displayed at the 2005 Paris Air Show, the Spyder illustrates Rafael's involvement in shore-based systems, by using existing air-launched missiles like the Derby (left) and the Python. (Armada/Eric H. Biass)*

'Kolkata' class guided-missile destroyers where it teamed with the longer-range Barak-1 surface-to-air missile and IAI Elta EL/M-2248 MF-STAR Active Electronically Scanned Array air surveillance radar.

#### ■ ARROW-II/III – IAI

Israel's Arrow Ballistic Missile Defence (BMD) programme commenced in the 1980s to answer the ballistic missile threat presented, at that time, by Iraq. The Arrow is operational since 2000. IAI is prime contractor for the overall Arrow programme but, like several of the missile systems surveyed above, development has involved American assistance, most notably from Boeing. This involvement commenced in May 1986, when Israel and the United States signed a Memorandum of Understanding splitting the financial risk between the two countries.

The Arrow initiative has been cycled through a number of increments: the initial Arrow-1 weapon was subjected to several test launches during the 1990s and reportedly possessed a range in the region of 27nm (50km). The development efforts which underpinned Arrow-1 were then rolled into the Arrow-II. Tests of this weapon demonstrated its ability to hit a target missile at a range of 54nm (100km). This development work culminated in the first Arrow-II battery being declared operational at the start of the 21st Century. Since then, the Arrow-II has been rotated through a number of 'Blocks', including the Arrow-II Block-II which demonstrated an ability to hit targets at 33nm (60km) altitude and the Arrow-II Block-III which demonstrated in tests that it could be used as part of a distributed weapons system with disparate Arrow launchers working together to intercept a common target. Work continued on the Arrow-II Block-IV which is reportedly capable of intercepting Iran's 1,042nm (1,930km) range Shahab-3 medium-range ballistic missiles. Finally, the Arrow-II Block-V upgrade merges the capabilities of the Arrow-II and Arrow-III (see below). Currently, the Arrow architecture uses the Arrow-II interceptor which is capable of performing endo- and lower-tier exo-atmospheric missile interception. The full Arrow architecture comprises the missile launcher, the interceptor, intercept control post, battle management system and IAI Elta EL-2080 Green Pine target acquisition and fire control radar.

Since 2006, during tests, the endo-atmospheric and exo-atmospheric Arrow-II interceptor has scored a 100% hit rate against



*Israel has joined forces with India in the development of the Barak-8 naval surface-to-air missile. The weapon has a range of circa 65nm (70km) and will equip the Indian Navy's 'Kolkata' class destroyers. (Wikimedia Commons)*

representative ballistic missile targets. Development of the exo-atmospheric Arrow-III is now underway. So far, the Arrow-III interceptor has performed a single fly-out launch test which took place on 25th February 2013. Arrow-II can provide theatre-level protection but, because of its longer range, Arrow-III can provide nationwide strategic defence. The Arrow-III's concept of operations calls for it to loiter for some time in space after launch and then, once the missile is detected, the Arrow-III's hit-to-kill vehicle impacts against the target. Arrow-III can use the same launch, and command and control architecture of the Arrow-II and the missile is expected to enter service in the next five years.

#### **I RADAR - ELTA**

The country's leading radar house is Israel Aerospace Industries Elta Systems division, known as IAI Elta. The firm provides the EL/M-2084 multi-mission radar for the Iron Dome and David's Sling air defence systems. This three-dimensional radar uses an Active Electronically Scanned Array (AESA) antenna and performs either sector scanning across a 120° area, or full 360° scanning at 30 revolutions-per-minute. When operating in the air surveillance role, the radar can detect targets at a range of 256nm (474km) and at altitudes of up to 100,000 feet. When operating in a weapons-location mode, it detects targets at a range of 54nm (100km).

*An Elta ELM-2084 radar being readied at Eta's prior to delivery to an Iron Dome unit. (Armada/Eric H. Biass)*



*Although conceived in the late-1980s, the Arrow ballistic missile defence system has performed a range of successful intercept tests. IAI is currently working on the development of the Arrow-III version. (Armada Archive)*

The radar can detect and track up to 1,200 targets in its air defence mode, and 200 targets-per-minute when performing weapons location.

The Elta EL/M-2080 Green Pine air surveillance radar is a comparatively larger system than the EL/M-2084. This low frequency radar has a range of up to 269nm (500km), and uses phased-array, solid-state architecture. It is used with the Arrow family of

surface-to-air missiles and, as well as equipping Israel, it has been exported to India.

Elta, as well as producing ground-based products, provides naval surveillance radars in its MFSTAR family. These include the three-dimensional EL/M-2258 Alpha (Advanced Lightweight Phased Array Radar) which can detect low-flying missile targets at 14nm (25km), and higher altitude conventional threats at 65nm (120km). The Alpha covers

360° in azimuth and 70° in elevation, imposing a weight penalty of 700 kilos on a vessel. The Alpha is joined by Elta's EL/M-2248 fixed array naval radar as part of the MFSTAR family. Using a flat-panel aesa architecture, this radar is being installed on the 'Sa'ar' class corvettes of the Israeli Navy. Each integration of the new radar onboard the ships can be achieved in a matter of months. Low sidelobes and frequency agility help to protect these radars against electronic countermeasures.

**■ RADAR – RADA ELECTRONICS**

Although Israel is home to IAI Elta, arguably its largest radar house, the country does boast other firms producing highly capable wares.

These include Rada Electronics which offers the CHR and MHR radars. These are software-defined, multi-mission surveillance radars using AESA antennas. The radars can perform track and scan in any direction from the antenna boresight to +/-40° in azimuth. It is possible to use several radars together to provide 360° coverage. The MHR family includes the RPS-40 (hostile fire), RPS-42 (tactical air surveillance) and RHS-44 (surface and air border intrusion) variants. The CHR works with Israel Military Industries' Iron Fist hard-kill active protection system. The radar can generate streams of pulses in parallel and perform surveillance of different targets in a time-interleaved fashion; detecting mortar fire,

and then detecting drones for example, with the change taking a matter of milliseconds.

**■ THE SPARROWS - RAFAEL**

Although not air-to-ground weapons, it is worth mentioning here the Sparrow family of air-launched target missiles, as they are used not only in Israel but also abroad for testing antiballistic missile systems. The Black, Blue and Silver Sparrows represent respectively increasing short-range theatre ballistic missiles, from the Scud-B up to the Scud-C/D and to the Shibab. With a length between 4.85 and 8.39 metres and a launch weight of between 1.275 and 3,130 kg, the Sparrows have been used, for example, for the latest tests of the MBDA Aster-based Samp/T system. □



**■ CUEING V-SHORADS – IMI**

Though it does not produce any SAM effector, IMI's portfolio carries a passive system, known as Red Sky-2, that allows to considerably enhance Manpads effectiveness thanks to an IR sensor that provides surveillance and cueing functions. The scanner has a maximum detection range of over 15 km in ideal conditions, IR systems being affected by weather and targets, the sensor having a field of view is 8.3° horizontal and 11° in elevation. With a scanning rate of 36° per second the system field of regard is of 360° in azimuth and ±25° in elevation, but scanning sectors can be programmed from 30° to 180° in azimuth and of 11° and 22° in elevation. The scanner is installed on a tripod and provides target data to the tracker and launcher unit, which is equipped with a thermal camera, with instantaneous zoom taking the picture from a 24° horizontal field of view to 0.8°, and a laser rangefinder. The launcher unit is installed on a tripod, with a 360° azimuth and -10° to +70° elevation capacity, and carries two missiles. A typical layout for defending a base can see three launchers and one scanner, each launcher covering some 150°-160° thus ensuring some overlap. A single-operator control unit ensures target detection and launch, exploiting the missile's operational envelope to its maximum, and can be plugged in a higher echelon surveillance and C2 network.



The Merkava 4 is manufactured by the state arsenals; however the Israel MBT features subsystems provided by many national defence industries. (Rafael)

# Vehicles

**If typical symbols of the Israeli land military were to be found, Merkava, Galil and Uzi would be the first names to spring to mind. The need through the years to produce top tier equipment for its soldiers has led the land segment of the Israeli defence industry to develop some of the most effective equipment, designed by people who often use it on the battlefield when called on reserve duty. Many of those systems have scored successes on the export market.**

## I MERKAVA

**A**waiting to see what the new long-term development programme – launched by the Israel Defence Ministry and known as Rakiya – will bring in terms of new lighter vehicles sufficiently protected and with enough firepower to answer the challenges of both the urban and the conventional battlefield, the Israeli Defence Forces are fighting daily with some of the most protected combat vehicles which were designed to meet

national specifications, the Merkava main battle tank. This tank is definitely not banned from export, but a Mk 4 would prove very expensive. Israel's main battle tank is produced by state arsenals; however about 40% of its components are produced by Israel Military Industries (IMI) Land Systems Division. Among these components are the transmission (under Renk license), part of the suspensions, the turret bearing, the ballistic armour protection, and the main gun. IMI developed an improved version of the gun used in the Mk3, that accepts more energetic

ammunition, but the company is already looking forward and a technology demonstrator has already carried out its first shooting tests. The new RG120 gun has a weight which is half that of the Merkava Mk4, 1,800 kg compared to 3,600 kg, with 1,400 kg being accounted for by the recoil mass. Recoil stroke is 500 mm while recoil force is 350 kN. According to IMI weight reduction was obtained mainly through engineering changes and design optimisation, avoiding expensive exotic materials. The new gun is muzzle-brake compatible to further reduce recoil, and features an automatic breech. To reach the final development stage IMI is looking for a customer, the national one being of course on top of the list should a Merkava Mk5 become a reality. An RG105 is also available as a rifled 105 mm lightweight gun.

## I NAMER

IMI is also fully involved in the Namer programme, for which it provides the ballistic armour and the roof protection, as well as the transmission and part of the suspension system. The company is also active in the upgrading business, having worked on M60s, T-72s, T-55s and M113s, and having provided consultancy for the Indian Arjun tank. One of the major contracts has been that with Turkey for the M60, where IMI was active in



Derived from the Merkava MBT the Namer is one of the heaviest armoured personnel carriers in the world. For the future Israel is looking at a lighter vehicle family. (Rafael)

all domains, firepower, protection and mobility. The company is looking for further similar programmes. In the wake of programmes conducted with the Brazilian Marines for the M113 and another concerning the AM-13 in an undisclosed country, IMI recently received an upgrade contract from a Far East customer and is awaiting a major one from the same area. A kit that turns T-54/55s into Nato standard tanks is also offered and according to IMI customers should materialise soon.

#### WILDCAT

Beside its participation in the development and production of heavy vehicles and in the upgrade of armoured vehicles, Israel Military Industries developed a vehicle on its own in the late 2000s, the Wildcat. Based on a 4x4 Tatra truck chassis, it exploits that company's experience in independent swinging half-axes to provide very good off-road performances at reasonable cost. The Wildcat has a monocoque hull, its V-shape providing good resistance against mines although protection levels remain classified.

As for ballistic protection three kits are available, from 7.62 AP up to 14.5 mm AP and RPGs. The heavier the kit the lower the payload, which ranges from 1.7 to 3.7 tonnes, GVW being 18.5 tonnes. Powered by a Cummins 325 hp engine installed behind the front cabin, the Wildcat can carry a three-plus-nine crew, access being provided by a rear ramp and a second ramp on the left side of the vehicle. Proposed in numerous configurations, C4IR&S, Combat & Support, Ambulance, Recovery, Logistics and Police/Border Patrol, the Wildcat is still looking for a launch customer.

#### HURRICANE, NAVIGATOR, WOLF-HATEHOF

Remaining in the vehicles business, but turning to lighter systems, the major Israeli player here is Hatehof. Based in the Golan Heights, the company is currently putting into production its new Hurricane 4x4, which with an A-kit providing Level 2 ballistic and Level 3A/B mine protection grosses at 9.6 tonnes with a 2.1-tonne payload. Gross weight climbs to 11 tonnes though, with a Kit-B that

provides Level 3 ballistic and Level 4A/B mine protection. Powered by a Cummins 245 hp engine it can carry up to seven people. Weight saving compared to previous vehicles is due to the use of new special steel, no composites having been adopted in order to keep the price under control.

While the Xtream was developed for an specific export programme that did not materialise, its 16.5 tonnes at Level 4 ballistic and 3B/4A mine protection proved to be a niche market. According to Hatehof that did not pushed its development further, the Navigator was designed for Turkey and is the company proposal for MRAP-type vehicles. The Turkish version known as Kirpi was locally produced by BMC, but following the company financial problems



The 9.6-tonne Hurricane is currently being put in production on Hatehof assembly lines; it can transport up to seven people. (Hatehof)

production has been discontinued. Hatehof might thus look again at that market following the RfP recently launched by SMMS. At 18.5 tonnes gross, and a 15-tonne curb weight, it can reach Level 4 with B-kit and anti-RPG/IED levels with C-kit, carrying two military in the front cabin and up to 11 in the rear compartment. It is powered by a Cummins 345 hp engine.

The Wolf remains for the time being the most successful vehicle. Grossing at 8.6 tonnes (7.3 tonnes curb weight) with A kit (Level 2 ballistic, Level 1A/B mines) it can host up to nine soldiers. The project flexibility was shown when Hatehof answered a requirement for a shorter version, with a gross weight of 7 tonnes and five seats. The Wolf is also the base vehicle on which the new NBC division of Hatehof developed the command post and the sniffer

Based upon the high mobility Tatra oscillating arms 4x4 chassis, the Wildcat is an APC that can carry three crew members plus nine dismounts, at 18.5 tonnes GVW. (IMI)



vehicles. Both obviously equipped with overpressure NBC protection, the CP is equipped with a marking perimeter system, a meteorology monitoring system, GPS, two-way wireless data communication system, and advanced communications, while the sniffer is equipped in addition with a Hapsite Viper chemical identification system, an external robotic arm for soil and liquid sampling, an external probe for airborne chem-bio contamination analysis, a radiological detector, sealed storage boxes and a decontamination system for small objects. The new NBC Division also developed a truck-based decontamination vehicle currently in service with the Israeli Defence Forces.

### RAM MK. III-RAMTA

Although its name, Israel Aerospace Industries, does not suggest any involvement in land warfare, IAI Ramta division is in fact producing a light and agile vehicle known as the Ram Mk III. It is the latest iteration of the RBY platform developed in the '70s, and features a rear-mounted 189 hp Deutz air cooled engine coupled to an automatic transmission with selectable 2x4 and 4x4 drive modes, differential locking being provided on customer requirement. The RAM MkIII features a monocoque hull built of two pieces of diamond-shaped ballistic steel that provides the fully bulletproof, mine-protected cabin, to which the drive line and automotive systems are attached.

The 12.5x20 MPT tyres chosen by Ramta engineers are considerably larger than those used on most vehicles of that class delivering extremely high mobility over rough terrain without the use of heavy, complex and expensive independent suspension. The vehicle can be provided with ballistic protection at STANAG level 2 or 3; recent models received add-on ceramic armour to withstand 12.7 mm ball without exceeding the vehicle's load limit. As for mine protection the RAM MkIII meets 2A/B level, fibreglass fenders allowing to vent out the blast should a wheel hit a mine.

The RAM MkIII combat weight is of 6.5 tonnes for the basic version and grows to 7.2 with add-on armoured kit. It can host the driver and seven passengers and speed up to 100 km/h cruising speed on roads, cruising range being 800 km. The vehicle is offered with open or closed cabin and long or short versions, and has been developed in Armoured Personnel Carrier, Command Vehicle, Scout Vehicle, Weapon & Missile



Developed according to Turkish requirements, and produced in Turkey by BMC, the Navigator is the Hatehof proposal on the MRAP market. (Hatehof)



The Wolf is one of Hatehof's best sellers and has been developed both in long and short versions, to cope with customers requirements. (Hatehof)



Although specialised in aerospace matters, IAI produces an agile armoured vehicle protected up to STANAG Level 3, in service with numerous military and paramilitary forces. (IAI)

Carrier, Air Defense vehicle, Mortar Carrier, and SWAT configurations. The RAM is combat proven and is serving with over a dozen military, paramilitary and police forces in Asia, Latin America and Africa.

With the acquisition of Seymar Elbit Systems also entered the vehicle production field, inheriting the Musketeer, a light 4x4 armoured vehicle mostly aimed at border

police and patrol duties, which is still at prototype level. Elbit is currently developing a heavier vehicle. Prototypes are already running and the company has started a marketing campaign since development is planned to be completed in late 2013. The reconnaissance version will be equipped with an RCWS. No more details are currently available.



# ALL-WAYS AT THE FRONT

Technology. Performance. Partnership

The **SK Group** incorporates proven leaders in defense and Homeland Security weapons. Its synergistic companies partner with defense forces worldwide to empower them for the extreme challenges of tomorrow.

- **Israel Weapons Industries (IWI)** - where the legendary UZI and TAVOR were bred, continues to set standards for small arms.
- **Meprolight** - leads in electro-optic day and night rangefinders for armed forces and defense manufacturers worldwide.
- **Israel Shipyards (ISL)** - defense and commercial marine solutions and services, including a private port.
- **Uni-Scope** - innovative periscope products for combat equipment, including MBTs, APCs and more.
- **Camero** - where sight is might. The pioneer in tactical through-the-wall imaging for urban warfare.





*IMI developed the L-VAS as a light add-on armour to improve light vehicle protection against RPGs and IEDs. (IMI)*

# Vehicle Armour and Protection

**The need for constant upgrades in vehicles protection led Israeli companies to develop state-of-the-art technologies and solutions to cope with increasing threats. Today some of those companies are renowned around the world for their passive, reactive and active solutions.**

## I PLASAN SASA

**W**ith over 200 engineers working in order to further improve armour solutions Plasan Sasa is one of the worldwide major players in the passive armour domain and is focused in new composite armour solutions to cope with weight and cost control. Not only does the company develop new technologies to cope with increasing threats, but it also considers vehicles manufacturing aspects to minimise assembly time and costs.

Technical details on passive armour

packages, used internationally such in best-sellers as Oshkosh M-ATV, remain mostly classified. Those packages are particularly intended to defeat shaped-charge warheads, kinetic energy rounds and IED blasts.

Passive armour packages are also provided for maritime platforms as well as for airborne protection, mostly for cabin cockpits. These adopt a modular design and easy installation, while in both personnel and air solutions weight becomes a priority figure in the equation. Well known for years for those products the Galilee heights-based company adapted quickly to new realities.

With the demand for reduced armour weight, Plasan provides various composite solutions through its subsidiary Plasan US Defense Composite Structures. While no information is releasable about vehicles all-composite solutions, more is available on marine applications. Plasan US DCS composite sandwich panels offer cost and structural advantages, flammability protection, and compatibility with electrical shielding, and are ideally suited to next-generation, slab-sided low radar cross section superstructures. Composite technologies such as pultrusion are also used to manufacture structural naval components as well as missile launchers, reducing weight and price by 50%. Plasan Sasa looks even more to the future through its TorTech subsidiary, a company specialised in carbon nanotube fibres that are being used for improving the quality of composite protection armour for vehicles. The carbon nanotubes manufactured by Q-Flo can modernise the defence sector by means of a new variety of lightweight, stretchable and extremely strong protective material. TorTech is expected to manufacture a carbon nanotube-based yarn which can be woven into the most powerful man-made material.

### IRON WALL-IMI

Israel Military Industries is providing all the ballistic package for the Merkava and the Namer. Israel has always considered reactive armour a viable solution against HEAT warheads, to the contrary of many western countries, although it constantly developed solutions aimed at reducing the danger for bystanding infantrymen. With the advent of IEDs, especially those using Explosively Formed Penetrators or Self-Formed Fragmentation IMI developed the Iron Wall, which composite-metal hybrid structure allows to save weight compared to RHA solutions. Used as an add-on, and depending on the level of protection, it weighs 200-230 kg/m<sup>2</sup> and adds between 110 and 150 mm to the original armour. A heavier hybrid passive-reactive compound is the Breakwater, designed to withstand also RPG rounds, that adds about 450 kg/m<sup>2</sup> and 350-400 mm thickness. At the other end the L-VAS is designed for light vehicles, such as wheeled APCs, to increase their protection against RPGs and IEDs; another system based on passive and energetic materials, it is fully qualified by the IDF for the M113. Capable of sustaining multiple hits from RPG-7s, 14.5 mm AP rounds or IEDs, the system ensures no sympathetic detonation between neighbouring reactive tiles, no indent on the vehicle wall and minimal effects around the vehicle.

### IRON FIST-IMI

In the active protection arena IMI developed a soft/hard kill system known as Iron Fist. The idea is to jam all jammable threats, keeping interceptors for those that cannot be jammed. Antitank missiles are dealt with an electro-optical jammer capable to disturb the missile at 1 km distance when launched from a 3 km



IMI defines the Iron Fist a second generation active protection system; it is made of a soft kill and a hard kill element. (IMI)



The Bright Arrow combines a remotely controlled weapon station and the hard kill element of the Iron Fist. (IMI)



The Iron Fist main sensor is the compact hemispherical radar RPS-10 developed by Rada. (Rada)

position. The jammer was developed by Ariel Photonics of Israel, while jamming techniques were developed by IMI. If the threat cannot be jammed, an interceptor is ejected by a trainable two-tube launcher. The intercept point is calculated thanks to the inputs of a series of sensors, bolometric camera, daylight camera and the Rada RPS-10 radar. The latter weighs 17 kg, covers 120°, three sensors being thus needed to cover 360°. The canister travels relatively fast and deflagrates breaking the round envelope. The current warhead contains some metal, that will be soon replaced by composites, further reducing potential collateral damages.

Technologies developed for the Iron Fist have been put to fruition in the development of the Bright Arrow, a system combining an RCWS and the Iron Fist Hard Kill element on a single pedestal, with radiofrequency, thermal imaging and CCD cameras as sensors, easily installable on light armoured vehicles thanks to its weight of only 250 kg. IMI is developing a static system to be used for camp protection, providing a C-RAM system.

### TROPHY-RAFAEL

Currently the only active system in service, Rafael Trophy-HV is installed on Merkava Mk.4s and has proved its worth in combat since March 1st 2011 when tank 1A, L coy, 9th Tank Battalion, 401st Armoured Brigade, defeated an incoming threat. Threat detection and tracking are entrusted to the IAI/ELTA ELM-2133 WindGuard pulse Doppler aesa radar, with four antennae located at the four corners of the vehicle to ensure 360° upper hemisphere coverage. These provide the computer with the data needed, including threat classification. Maximum accuracy is needed in order to activate the best positioned of the two launchers and launch the Multiple Explosive



A crate of RPG warheads neutralised by the Trophy; the precision with which those rounds are severed is quite impressive. (Armada/P. Valpolini)



Three IDF tank battalions deploy Merkava Mk4 equipped with Rafael Trophy. These systems have been successfully used in combat. (Rafael)

Formed Penetrators towards the incoming projectile, its EFPs being aimed at specific areas of the projectile, something for which classification by the radar is a key issue. Each effector generates “some” non aerodynamic elements, their number being very limited, that disintegrate the threat without explosion.

Visiting Rafael testing area, where a Merkava is used to carry on trials with the Trophy, it was quite impressive to see a full crate of RPG warheads that had systematically been severed in the same place, proving if it were needed the consistency of the system. Over 2,000 live tests have been carried out with RPGs in Haifa, though those involving missiles take place in southern Israel. According to Rafael over 90% of the RPGs disintegrate without initiation. This is not the case for antitank missiles, which are indeed

initiated, albeit at safer distances. Threat classification also means that if an incoming round is going to miss, the system will not take action, saving effectors and avoiding to initiate the round. The ELM-2133 radar is also used as a situational awareness tool, as it picks up the shooters position, allowing the tank to react; pushing a single button the tank commander can slave the turret and point it straight on the firing source. Rafael received a second significant order from the IDF, and since 2012 all three armour battalions of the 401st Brigade, 9th, 46th and 52nd, field Trophy-equipped Merkava Mk.4s. Since the well advertised first engagement, the Trophy went into action at least five more times, and the radar identified the shooter.

For the export market Rafael developed the Trophy-MV, that has a lesser weight



A key element of Rafael Trophy is the IAI-Elta ELM 2133 Winguard radar that provides the firing data for the effector. (Armada/P. Valpolini)

compared to the HV, 450 kg versus 850 kg, while maintaining similar performances and including also soft-kill capabilities. Weight reduction is due to miniaturisation, and the company awaits a launch customer to complete qualification, the system being at prototype stage. A third version, the Trophy-LV dedicated to light vehicles, is also marketed; based on electro-optical sensors, its effector comes in the form of modules fixed to the vehicle roof that generate a downward energetic blade at minimal distance from the vehicle armour, “cutting” the warhead. While the HV and MV are effective also against missiles and kinetic energy rounds, the 200 kg (for a Humvee) Trophy-LV is tailored for RPG-type threat. Here too Rafael is awaiting a launch customer.

#### ASPRO-RAFAEL

Rafael is also a major player in the passive and reactive armour field, its systems being used by many armies around the world, eight different add-on armour systems from the company having served in the Iraqi and Afghan theatres of operation with coalition forces. Its current two families of products are the Aspro-P and the Aspro-H, respectively passive and hybrid.

The fully passive Aspro-P system is designed to absorb energy and prevent penetration, increasing the vehicle's ballistic protection up to Stanag Levels 3, 4 or 5. Easy to install, fully modular, the system is combat tested. Although the armour package composition remains classified, it is clear that Rafael leveraged all its studies in the ceramic, metallic and other materiel fields, as well as those on the coupling and mutual effects of those sandwiches. Rafael Ordnance and Protection Division also developed an anti-



Based on a wholly different effector, the Trophy-LV is aimed at light patrol vehicles; here the system is mounted on an HMMWV. (Rafael)



mine protection with a laminated configuration to absorb the blast energy as well as a floating floor.

A lightweight Enhanced Appliqué Armor Kit was developed purposely to provide US Marine Corps AAV7s improved protection while maintaining their amphibious capabilities. Exploiting its experience in the reactive armour field, Rafael developed the tiles used on US Army Bradleys, the company gave birth to the hybrid Aspro-H that uses Insensitive Low Burning Rate energetic materials. These do not detonate or burn when hit by bullets, projectiles, or fragments, but react only when hit by the jet of a shaped-charge warhead providing full energy that disrupts the jet. The passive elements of Aspro-H ensure a Stanag Level 5 ballistic protection.

#### I ORAN SAFETY GLASS

Until now we considered opaque and active armour solutions. Turning now to transparent armour, Oran Safety Glass (OSG) is specialised in the development and production of flat and curved, laminated, tempered and armoured glass solutions for defence, security and civilian applications. Its

products are being used in over 35 countries, working together with numerous vehicle producers in the United States, France, Germany and Italy among others. Its more advanced solutions allow 30% weight savings. With threat changes, OSG developed its facilities adding blast, fragmentation, RPG, EFP, to its ballistic tests, since the company also produces blast and fragment resistant flat and curved glass. OSG also produces ceramics-based glass, allowing around 50% weight reduction from STANAG levels 1 to 4 (a typical company typical conventional STANAG 2 glass weighing 125 kg/m<sup>2</sup> while the ceramic solution lowers this to 71 kg/m<sup>2</sup>).

OSG glasses can be found on most of the American MRAPs, trucks and utility vehicles, on Renault Trucks Defense PVPs, on Daimler Zetros and Actros, on MAN trucks and on Astra trucks.

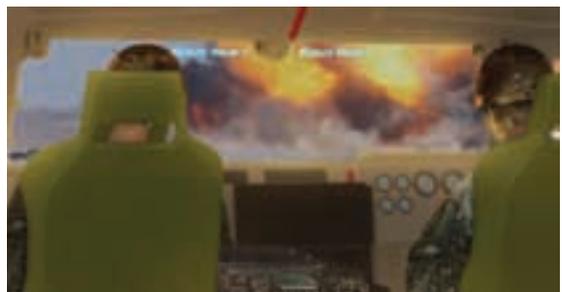
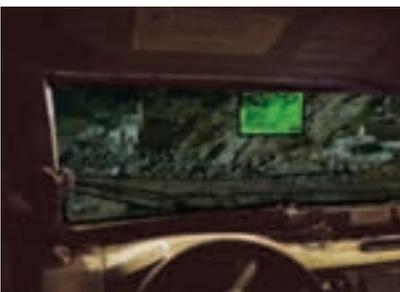
Looking for innovative solutions and well aware of the risks generated by urban warfare scenarios, OSG has developed the RockStrike, a layer that protects the ballistic transparent armour from the damages caused by rocks, even by those thrown at relatively high velocity such as slingshots. This solution reduces costs, as the armoured window needs

Rafael developed a hybrid armour, known as Aspro-H, that uses insensitive low burning rate energetic materials to disrupt shaped charge jets. (Rafael)

not be replaced if not hit by rounds. It also provides better situational awareness than metal grid solutions. A new product unveiled at DSEI is the Adi, jewel in Hebrew. This technology allows to keep a no-spall environment inside the vehicle without using the typical plastic layer attached to the safe side of the glass that causes delamination and is often damaged, reducing the armoured glass life cycle.

Speaking of situational awareness, another innovative product from OSG is the Digital Visual Window that integrates a liquid crystal display into a windshield, allowing the driver and commander to check their info while continuing to look outside. The screen can be installed in any position, and is capable of high-resolution video, text and graphics. Another OSG solution aimed at providing information on the windscreen is the Silk Light, a built-in, light-driven electronic system that displays information directly on the transparent armour. It provides pre-defined specific information such as vehicle position and turn over danger, overheating of engine or cabin crew, emergency exits and egress warnings, etc.

Another key element in vehicles safety is fuel tank protection. The Rubber Division of Magam Safety, a company belonging to the Star Defense System Group, has developed and produced the flexible self-sealing fuel tanks for the Merkava tanks. It has recently developed an external solution that allows to transform a standard tank into a self-sealing tank, weight penalty being only 14 kg/m<sup>2</sup>. Adopted by the IDF on some confidential projects, it showed during tests a leakage of only 7.7 grams of fuel following perforation by a 7.62 mm round.



The Digital Visual Window developed by Oran Safety Glass (left) integrates a digital display into the windshield, here used for night driving purposes. Map and GPS position are here (centre). A rendering (right) of the Silk Light function; a built-in system allows to project pre-programmed messages of different types. (OSG)

# Artillery

**Producing artillery fire control systems of different kinds, with the integration of Soltam, which produced the tubes, Elbit Systems is now in a position to provide turnkey integrated artillery solutions to its customers.**

## I ATMOS, ATHOS-SOLTAM

**W**ith equipment sold to over 60 countries Soltam, which is now part of Elbit Systems Land and C4I, always favoured high mobility platforms and has been a leader in truck mounted artillery. The Atmos (Autonomous Truck-Mounted Self-propelled howitzer) comes in the form of a 155 mm gun/howitzer mounted on a 6x6 or 8x8 truck chassis. A modular system, the top-tier proposal includes a 52 calibre barrel giving it a range of 41 km. Traverse is limited to  $\pm 25^\circ$  while elevation reaches  $+70^\circ$ . Power is provided by an APU which drives hydraulic and electric systems such as ammunition handling and automatic loading systems. A modular electronic suite can include tactical computers, INS navigation system, muzzle velocity radar, day and night sight, digital communication link, and target acquisition systems, depending on customers' choice. The Atmos has been considered by the IDF, based on a 6x6 truck with double armoured five-man cabin, but its acquisition is still pending. The formula was also declined in Soviet style, the Atmos D-30 being armed with the notorious 122 mm gun.

Elbit Systems Land and C4I portfolio also includes the Athos 155 mm autonomous towed howitzer system, a 52 calibre weapon that has the same performances as the Atmos (three-rounds burst in 15 seconds, 15 rounds in 3 minutes and 75 rounds within 60 minutes when equipped with the auto-loader), with an MRSI capacity of four rounds on the same target at the same time. The company also carried out upgrades of various systems, installing new guns on existing assemblies such as in the M-46S and the M-114S.



*An ATMOS 155 mm truck mounted howitzer in action; a five-man crew ensures full operational capability to the system. (Elbit Systems)*



*Elbit Systems is proposing the Cardom self-propelled recoiling mortar in 81 or 120 mm calibre. (Elbit Systems)*

## I CARDOM-SOLTAM

Besides 60 mm, 81 mm and 120 mortars, Elbit Systems Land and C4I offers two autonomous systems. The Cardom is a self-propelled recoiling mortar in 81 or 120 mm calibre, both smoothbore, with a reach of 7,000 metres and a maximum rate of fire of 16 rounds per minute. The Cardom includes a fire control system and a navigation system that allow to be ready for fire within 30 seconds from the vehicle stop. An evolution of the Cardom, the Spear is a 120 mm system which firing load has been reduced to less than 10 tonnes, allowing it to be installed on light vehicles such as a Humvee. Equipped with a computerised aiming and navigation system, it can be taken in and out of action within 60 seconds. With a 30-metres CEP, it can also be used in static position, deployed by a 2-3 crew, and has a rate of fire of 15 rounds per minute.

## I ROCKETS-IMI

Rocket artillery is the business of IMI, which LAR-160 Light Artillery Rocket System is available with a number of different ammunition. The two launch pod containers contain each thirteen 160 mm surface-to-surface rockets, the basic free-flight one having a range of 45 km. The launcher can also accept the Accular GPS-guided rocket, which has a range between 14 and 40 km with a CEP of 10 meters. An Accular pod contains 11 rockets, each having a 35 kg warhead.

Both types can also be used in the Lynx modular rocket launcher also featuring two launch pods, which is able to fire any rocket from 122 mm up; when using the 122 mm Grad each pod contains 20 such rockets. It is fully autonomous and features a state-of-the-art C4I system, the fire control system and the inertial navigation system allowing for quick reaction time. The mechanical and hydraulic system ensure a reloading time of less than 10 minutes, while on board electronics automatically identify the ammunition installed. IMI offers also other ammunition for the Lynx. One of them is the Extra, (Extended Range Artillery Rocket), a 306 mm diameter rocket provided with inertial/GPS guidance system that gives it a 10 meters CEP on a 20-150 km range, its warhead containing 120 kg explosive. Each Lynx pod can host up to four Extra, that rocket being in service with numerous customers worldwide. The bigger system that can be launched by the Lynx is the Delilah GL, the ground launched version of the air-to-ground missile, a rocket booster having been added for launch. This 250 kg precision weapon has a 180 km range while its average speed is between Mach 0.3 and 0.7, reaching a maximum of Mach 0.85 in the final dive. Its 1.15 meters wingspan, the missile diameter



The Accular GPS-guided rocket (left) has a CEP of about 10 metres and a maximum range of 40 km. Israel Military Industries Extended Range Artillery Rocket (Extra) has an inertial/GPS guidance system and a range of 250 km. (IMI)

being 0.33 meters, together with the turbojet engine, allow it to loiter over the battlefield before hitting the target with its 30 kg warhead. Exploiting its CCD or FLIR seeker that provide real-time video imagery back to base thanks to the data link, the Delilah GL features re-attack capabilities against static or moving target as well as battle damage assessment, navigation being ensured by an inertial/GPS system. A Lynx pod can accept a single Delilah.

#### AMMUNITION-IMI

The largest division within IMI, the Munition Systems Division counts 1,200 employees, 140 of whom are devoted to research and development. Three of the five directorates, artillery ammunition, tank ammunition and infantry ammunition, are directly related to land warfare, the remaining two being aerial ammunition and homeland security.

Among the 155 mm artillery projectiles, the new M454 S-HE (Super-High Explosive) is based on a pre-fragmented drogue parachuted warhead. The fuse is set before firing, and after the established time the fuse is initiated and ejects the warhead which starts its descent towards the target, detonating at the optimum height over the target itself, the pre-fragmented warhead ensuring five times more lethality than standard HE rounds when used against infantry, light vehicles and logistic targets. No duds are generated due to the built-in self destruction system, thus the round is compliant with the Oslo convention. The M454 S-HE is compatible with all Nato guns from 39 to 52 calibres and is currently under development, IMI aiming to complete qualifications in early 2014.

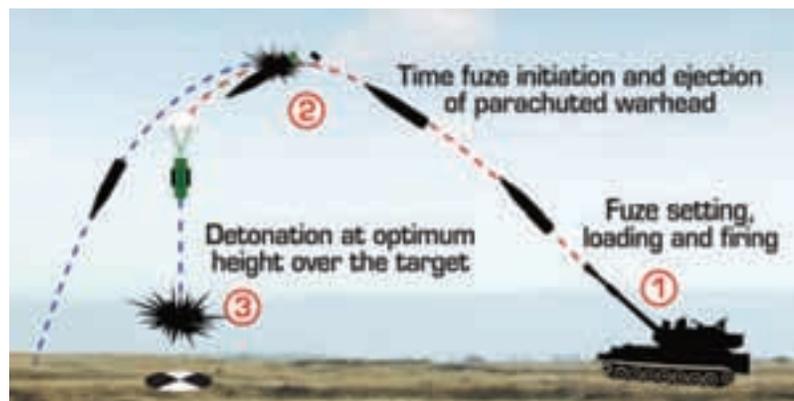
IMI also produces the M481 HE-ER, with hollow based bottom that allows ranges up to



30 km, the projectile containing 12 kg TNT, which is nearly 50% more than standard ammunition in 155 mm calibre. The IMI catalogue contains also numerous other ammunition in 155 mm, 105 mm and former Warsaw Pact calibres. As for propellant charges, the company fields a Nato standard bi-modular charge system and a uni-modular system, both providing a muzzle velocity of 940 m/s with four modules and a 52 calibre barrel and 750 m/s with 3 modules and a 39 calibre barrel.

In the tank ammunition field IMI is known to be one of the major players in the world, and is currently working on the 3rd generation of its kinetic energy round. While the 2nd generation M322 currently in use

*IMI will complete the qualification of its M454 S-HE round in 2014; this round is compliant with the Solo convention. The pre-fragmented drogue warhead of an M454 S-HE round detonates at an optimal height and is five times more lethal than standard HE rounds against soft targets. The self destruction system allows to generate no duds. (IMI)*



allowed to preserve the barrel, which could fire over 1,000 rounds before replacement (qualified by the IDF as well as by the German and Swedish authorities), the new M338 APFSDS promises further breakthrough. It adopts a low vulnerability propellant that not only increases safety but provides additional energy. The penetrator is made of a new tungsten alloy and is heavier than the M322's. Although no precise data were provided in terms of penetrator weight, ratio and muzzle velocity, IMI states that the new M338 will ensure better penetration especially against ERA and spaced armour. The new round will require the adoption of new firing tables by tank fire control systems, although it remains fully compatible with 120 mm smoothbore guns. The company finished the round development and is looking to the IDF for qualification, which is however expected shortly.

Focusing on urban warfare, a daily scenario for the IDF, one of the latest addition to IMI tank ammo portfolio is the M339 HE-MP-T, a multipurpose round that features a three-mode fuse that makes it effective against bunkers, urban structures, light armoured vehicles dismounted Infantry. The



Israel Military Industries developed the GMM120 mortar bomb, equipped with a GPS and/or a semiactive laser guidance system. (IMI)

fuse is programmable and can be set in point detonation super quick, point detonation delayed and air burst modes. The M339 can penetrate a 200mm double reinforced concrete wall, the PDD mode allowing to detonate inside the building, generating not only fragments but also a considerable overpressure. Programming is carried out using a programming coil linked to the FCS that sets the time in the front electronic device, this allowing to use it without modification to the breech. The round is already in production and the first M339s were delivered to the IDF in late 2012. Other customers have shown up, some of them looking for electronic programmable base fuse, in order to carry out the operation while loading or when the breech is closed, IMI being ready to adopt other solutions.

The other key round is the M329 APAM-MP-T, another multipurpose round that was initially designed in 105 mm caliber which fuse can be set in five different modes, the most relevant being the Ejection mode, which

ejects the six unitary warheads contained in the round in a sequence, thus saturating an area, typically a street. The fuse can also be set on point detonation super quick, point detonation delay, air burst – the whole round exploding as unitary warhead, and anti helicopters. The M329 is in use with the IDF.

IMI is also producing a full range of ammunition in the 100,105, and 125 mm calibers. While all those products come from the Munition Systems Division, another business unit, the Small Caliber Ammunition Division, is in charge of producing all small arms ammo in the 5.56, 7.62, 9, 12.7 mm and .338 Lapua Magnum calibers. IMI is the principal supplier of ammunition to the Israel Defense Forces (IDF), and has numerous undisclosed export clients, including Nato countries. Both 5.56 and 9 mm ammo are NATO qualified, and are available in Green version.

Elbit Systems, fully involved in mortar production, also manufactures 60, 81 and 120 mm calibre rounds, and is developing a new 120 ammo. IMI also developed the GMM120, a guided mortar bomb that can be fitted with a single or dual guidance system, a GPS and/or a semi-active laser seeker being those of choice. These ensure a CEP of less than 10 meters over a 9 km range, the munition featuring a canard servo and control mechanism.

# Turrets

**The need to protect the machine gunners became soon a must in Israel, whose forces are confronted with opponents in scenarios that are often of urban type. Thus three of the nation's main defence companies have remote controlled weapon stations and unmanned turrets armed with light and medium calibre weapons in their inventories.**



Elbit Systems UT30 unmanned turret; one of the last contracts is that for Brazil, where the turret equips part of Iveco's VBTP-MR Guarani 6x6 vehicles. (Elbit)

## ELBIT

Elbit Systems recently scored numerous successes in the medium calibre arena, its 30 mm UT (Unmanned Turret) being under contract in four different nations, Brazil, on the Iveco VBTP-MR Guarani, in Belgium on the Mowag Piranha IIC 8X8 vehicles, in Portugal, on the Steyr

Pandur II ordered by the Navy, and in Slovenia, on the Patria AMV 8x8 vehicles, this turret being integrated with two Spike antitank missiles. A dual-axis stabilized turret allowing fire on-the-move, it features separate gunner's and commander's sights, both dual axis stabilized each. The design allows the customer to choose among a variety of sighting subsystems. The maximum elevation of the



Elbit's Dual Remote Weapon Station can host a 12.7 mm or a 40 mm AGL in the main cradle and a 7.62 mm MG in the secondary one. (Elbit)

main gun is +60°, allowing operations in urban terrain. Protection is modular and can go up to STANAG Level 4, including ammunition, sights and electronics. To favour export Elbit Systems is ready to transfer the know-how to third parties, as in the Belgian and Brazilian contracts.

The company is also proposing a family of remotely controlled weapon stations, the first of them being a single-weapon system capable to host up to a 12.7 mm machine gun or a 40 mm AGL. Known as the 12.7 RCWS, it is dual-axis stabilized and its sensor suite includes a day camera, a thermal sight, a laser range-finder and a search light. It also features functions such as Automatic Target Tracking and manual backup operation in case of power loss, optical pod super elevation and traverse drives for ballistic compensation at the outer ranges of the weapons. The 7.62 mm RCWS is the smaller element of the family, and is also fully stabilized. Armed with

a machine gun it weighs less than 150 kg with 690 rounds, the magazine being upgradeable at 1,150 rounds. The DRWS (Dual Remote Weapon Station) can in turn carry a main weapon, a 12.7 or a 40 mm AGL, and a secondary 7.62 mm MG. Qualified for the Austrian Army it is in production for this service. Its sensors and performances are similar to the 12.7 RCWS. The DRWS can be used in the surveillance mode, decoupling the weapon from the sensor package, and disabling firing, an option useful in OOTWs. Elbit considers its unmanned turrets and RCWS portfolio complete and is looking for new customers, while no new models seems to be in the pipeline.

#### ■ RAFAEL

Rafael is another major player in the turrets and RCWS field, its Samson RCWS ranging from light to medium calibre, the lighter being the Samson Junior, aimed exclusively

at light machine guns, 5.56 or 7.62 mm. Sold to Israel and to an unknown European customer, its light weight, 60 to 75 kg without weapon and ammo, generates a minor impact to even the smaller vehicles. The in-hull commands are the same for all the three light RCWS; if weight is less a concern, then comes the Samson Mini, around 150 kg. This accepts up to 12.7 mm machine guns and 40 mm AGLs. Visiting the Rafael assembly line in Haifa it was possible to see the production for an undisclosed export customer, without stabilisation and armour, while most of the production of the 207 RCWS of that type aimed at the Israeli Namer IFV are produced in the US by Marvin Land Systems, the turrets being however assembled at Haifa. Those turrets are stabilised and can host 7.62 or 12.7 mm MGs and 40 mm AGLs, featuring the same cradle that allow quick replacement at crew level. Their actuators, front cradle and sight pod are equipped with some armour, that adds about 50 kg to the original weight. The Samson Mini has been sold in thousands to the IDF and 13 export customers. Rafael satisfied also the request from a customer that wanted a 14.5 mm KPVT machine gun, which required a new structure due to the higher recoil, length and weight of the weapon, as well as in some changing on the actuators position.

At only 260 kg without weapons and ammo the Samson Dual can host a medium calibre gun, up to 30 mm, and a secondary



A Samsom Mini on the assembly line at Rafael main plant in Haifa (left). The type has been selected by Israel for its Namer and by undisclosed export customers. One of Rafael best sellers in the turret field, the Samson Mini (right), can be armed with weapons up to 12.7 mm machine guns or 40 mm AGLs. (Armada/P. Valpolini)



The new pod containing two Spike antitank missiles that can be retracted when not in use. It is aimed at the Samson MkI and MkII turrets. (Armada/P. Valpolini)

weapon in the form of a machine gun up to 12.7 mm. Based on a completely new structure, the Dual allows reloading from inside the vehicle and can easily be installed on a light 4x4 vehicle. One of the weapons can be removed and replaced by a twin-ATGM launcher.

The Samson Mk I, of which some 100 were sold to the Czech Republic, has evolved into two Mk II prototypes, with reloading from under armour. Following the conclusion of the testing phase in June 2013 it is now ready for production. A new system allows to carry two Spike ATGMs that are retracted in a protected position when not in use, the pod being able to host the MR, LR and ER versions of that Rafael missile.

#### IMI

Fully involved in heavy and medium turrets upgrades, Israel Military Industries is nonetheless also present in the light RCWS business. Its portfolio currently features the Wave brand, all of them fully stabilised. The Wave 100 can host a 7.62 or a 12.7 mm machine gun, the turret weight without weapon and ammo being 160 kg. With only a 10 kg penalty, the Wave 200 gives the customer the option of mounting also a 40 mm H&K automatic grenade launcher, elevation remaining  $-20^{\circ}/+60^{\circ}$  while the sensor suite is still made by a daylight continuous zoom camera, a thermal sight and a laser rangefinder. While maintaining similar performances, the Wave 300 differs considerably as its architecture has been developed to accept former Warsaw Pact weapons such as the 7.62 mm PKT and the 12.7 mm NSVT machine guns.



The Spike NLOS can reach a target at a range of 25 km and can also be mounted on ship. (Rafael)

# Anti-armour missiles and rocket launchers

The Spike family of missiles developed by Rafael covers an extremely wide area of missions, going from a medium range artillery role to short range engagements in urban areas. Leveraging its experience in electro-optics the Haifa-based company aimed at providing the infantry with pinpoint accuracy systems, some of them being used not only in the ground to ground roles but also in air-to-ground, on board of combat helicopters, and in naval systems.

Going by decreasing range, the champion is the Spike NLOS, a missile featuring a wireless data link keeping the man in the loop and a day/night seeker, thus allowing to hit non-line of sight targets and to shift from one target to another one at the very last minute. Equipped with cruciform wings, it has an effective range of 25 km, weighs 71 kg in his canister and can be equipped with different types of warheads, HEAT, fragmentation, Pressure-Blast-Fragmentation. It can be launched by ground vehicles, helicopters or light vessels.

The other member of the family that goes beyond the ground use is the Spike ER, for Extended Range, with its 8 km range. The link between the operator and the missile is



A Rafael Spike ER on a Cobra attack helicopter. This missile has also been integrated in the Eurocopter Tiger and in the AgustaWestland A129 Mangusta. (Rafael)

provided by a fibre-optic that allows to launch it in a lock-on-after-launch mode or in a more conventional LOBL mode, keeping a fire-observe-update capacity. The seeker allows however also a fire-and-forget launch mode. The typical ER application is on attack helicopters, Spain and Italy have chosen it respectively for the Tiger and the Mangusta, although it is also used in other roles, such as in coastal defence mounted on a tripod. The Long Range and Medium Range versions are those mostly used by infantry, Spike LR and Spike MR are both missiles that can be fired from enclosure while differing of course by range, 4 km and 2.5 km respectively, the LR being the only one among the two that can be used in the fire-observe-update, the MR being a full fire-and-forget weapon, guidance being provided by the CCD/IR seeker. A two-man team can deploy with one launcher and two missiles. The MR, LR and ER versions are also produced by Eurospike, a joint venture between Rafael, Diehl BGT Defence and Rheinmetall Defence Electronics.

The two newcomers of the family are the Spike-SR, for short range, and the Mini-Spike, both in development. Equipped with a PBF warhead the Mini-Spike has a radio link to the launcher that allows to update after launch using the missile electro-optic seeker. Operating range is up to 1,500 meters, the 4.5 kg missile being able to carry out high angle attacks. Provided with a lightweight launch unit, it can be used also from MR/LR launchers. The Mini-Spike should reach production status in 2017. The Spike-SR is a fire-and-forget disposable weapon weighing 9 kg with a 1 km range, guided by an IR uncooled seeker. The original warhead is



The Mini Spike features a radio link to the launch unit. It can be launched either from its launch unit or from the standard Spike infantry launchers. (Rafael)



Urban targets, fortified positions and light armoured vehicles are the raison d'être of Rafael's Matador AS. (Rafael)

aimed at destroying tanks, but other types of warheads might be provided in the future. Production should start in 2016.

### STREET FIGHTING

When range and target do not require the use of a missile, rocket launchers come into play. Rafael acquired the German company Dynabit Nobel Defence, the R&D assets of both companies having thus developed a series of products, many of which aimed at urban warfare. Known in Germany with the acronym RGW-90 and in Israel as Matador, the 90 mm rocket launcher is in production with many warheads, the Rafael catalogue featuring the anti-structure (AS) and the wall breaching (WB) munitions. All the Matador systems are 1 meter long and are based on the Davis gun principle, thus allow to fire from enclosure.

The Matador-AS has a range of 400 meters and a weight of 10 kg, and has a tandem warhead equipped with a multimode fuse that allows it to defeat fortified positions, timber bunker, urban structures and light armoured vehicles. The heavier Matador-WB, 13 kg, features an Explosively Formed Ring warhead which diameter is larger than that of the launch tube; it is specifically designed to open breaches into walls to allow the passage of an infantryman. Its maximum range being of 120 meters a simple flex sight is installed. A Matador-MP, equipped with a multipurpose warhead is also available.

Israel Military Industries developed the Shipon, also based on the Davis principle and thus usable from enclosures. Its multipurpose munition can be used in the follow-through-grenade mode, in the air-burst mode, or in normal mode, against triple wall bricks or reinforced concrete. At 6.8 kg, the maximum range of the Shipon is of 300 metres.

The focus on urban warfare is further highlighted by the Simon door breaching rifle grenade, developed by Rafael. Launched from a rifle, using a standard live 5.56 mm ball round, it is designed to breach steel or



Developed by Israel Military Industries, the Shipon warhead is based on the follow-through-grenade concept. (Armada/P. Valpolini)



A light system for ramming doors open, the Simon rifle grenade developed by Rafael is one of the numerous breaching systems born out of the IDF experience. (Rafael)

wooden at ranges of 15 to 30 meters. It weighs only 680 grams and is made of a plastic housing containing the charge, a standoff rod, the stabilizing tail, the safety and arming mechanism and the impact detonator.

IMI Wall Buster is another system dedicated to urban fighters; this remotely-activated pyrotechnic breaching device is designed to create a passageway in a wall. It can be put in position using a telescoping pole, magnetic tape or double-sided tape. Available in various grain sizes it includes an initiator, that can be replaced with IMI Matchbox electronic time initiator, flexible transfer cord and detonator.

# Electro-optics in the Field

Israel industrial capacity in the night vision and targeting field is considerable, the need to dominate the battlefield at night and to pinpoint targets in complex scenarios being the daily business of the national customer. Other applications of electro-optic system have also been developed



The Mini-Coral, previously known as Mars, is the uncooled member of the Coral family and is normally issued at platoon level. (Elbit)

Elbit Systems provides night vision systems for MBTs and AIFVs, its systems being installed into the Merkava, T-72, Leopard and Arjun, as well as in Namers and BMP-2s. These range from commanders' and gunners' sights, to drivers' sensors, to situational awareness systems. In the tactical field its Coral family of handheld binocular thermal imagers can answer the requirements of the various unit levels, from squad up. The 1.7 kg uncooled Mini Coral can carry out man recognition at 1 km and is typically provided at platoon level, the bigger Coral-Z, equipped with an optical and a digital zoom, doubling that figure. Other Coral systems are available, those thermal systems based on the proven 3-5 $\mu$ m FPA InSb detector technology; they are in service in 25 countries among which Israel, the US and several NATO nations. For longer

ranges the Long View CR is available, containing a TI channel with a x18 continuous zoom as well as wide and narrow field of view day CCD cameras, capable of recognising a man at over 7 km.



The Rattler-G (left) is one of the lightest laser marker/designators available; originally issued only to very specialised personnel, such as JTACS, this type of system is now issued to a wider audience. Very light, easy to use thanks to its shape, the Rattler H can designate a target for third parties up to a range of 3 km. (Elbit)



Elbit's Long View CR allows one to recognise a man at 7 km distance, thanks to its x18 zoom. (Elbit)

Target designation is the other side of Elbit Systems electro-optical business. Numerous systems are available to cover different ranges. For shorter ranges the Rattler H and Rattler G are optimal solutions for troops in contact and JTACS. The pistol-like H weighs only 1.3 kg and can designate a Nato target at 3 km, while the 1.7 kg Rattler G can mark a target at 10 km and designate it at 5 km. Packed together with the Coral CR and the micro Atlas lightweight tripod with integral gyro-compass it allows precise targeting in day and night conditions. The PLDR II with its built-in GPS, electronic compass and tactical computer weighs 6.7 kg and can designate a tank-size target at 6 km and a large target at 10 km. Night vision can be added in the form of a Coral LS, that features a Long-range 1.06 $\mu$ m "See-Spot" capability. Two portable long range systems are available, the Serpent, with designation ranges of 8 km against a tank and 11 km against a large target, and with a weight of only 4.63 kg, and the 8 kg PLLDS with continuous designation at over 10 km. Elbit Systems designators are also widely used in western armies, their weight-to-range performances having always been among the best.





For the protection of infantry positions Rafael has developed a tripod-mounted version of its SpotLite gunshot detection. (Rafael)

While providing night vision solutions for antitank missile systems such as the A-TIM, Elbit Systems electro-optics activity also extend to the protection against that same threat, the VIRCIM (Vehicle-Mounted IR Counter Measure) being able to jam IR guided antitank missiles, that is many 2nd generation SACLOS missiles.

Protection of vehicles and troops against direct fire threats is also provided by Rafael with its SpotLite family of systems. The SpotLite P (for portable) is a portable electro-optic system with a 48° field of view that can detect and locate small arms fire. The system can be carried by two soldiers and is installed in static position on a tripod. The sensor head includes a CCD, a laser rangefinder, a laser marker and a GPS; once verified that the small arms fire source is not a friendly one, the system extracts the grids and possibly marks the target with its laser. Grids are provided to effectors, that can go from snipers to armoured vehicles to air assets. The SpotLite M (for mobile) is designed to be installed on vehicles and enables the detection and location of small arms, RPGs, ATGMs, and tank shells being fired towards the vehicle, even on the move, covering 360°. The vehicle can then react with passive or active measures, or can forward the fire source location through the command chain.



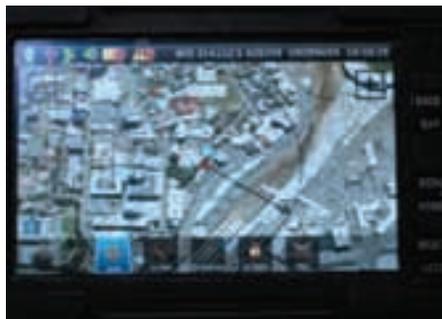
Elbit eyepiece is the main human-machine interface during fighting for soldiers equipped with the Dominator or the Dominator LD. (Elbit)

# An Integrated Soldier Approach

**Looking at worldwide soldiers modernisation programmes and at the IDF requirement Elbit Systems developed the Dominator, a soldier system that exploits the company know-how in many fields, from C4I to optronics to communications, making every soldier both a node and a sensor of the distributed system.**

The main HMI is the Personal Digital Unit (PDU), a ruggedized tactical computer with an integrated GPS that runs the Integrated Infantry Combat System C2 application as well as the Tactical Intranet Geographic Dissemination in Real-time (Tiger), the latter providing the relevant information at the right time as well as optimising message transfer. The TORC<sup>2</sup>H, a

battlefield management system tailored for mounted/dismounted operations, can also be installed, allowing coordinated battle teams to perform their tasks with optimum precision. The TORC<sup>2</sup>H also provides commanders and crew with simplified operational interface, enhanced situational awareness and data communication capabilities.



The Dominator LD 4.3-inch display (left) and Raptor terminal linked to the soldier radio. The system developed for dismounted soldiers weighs only 1.3 kg. (Armada/P. Valpolini)



In the IWI briefing room it is possible to see the first Uzi, something quite different from the current Uzi Pro seen here (left) equipped with a Meproflight reflex sight. The X95, here in the Flattop version, is the latest development of the Tavor, and can be quickly converted from 5.56 mm to 9 mm. (Armada/Paolo Valpolini)



The X95 in 9 mm calibre guise equipped with a silencer. The X95 is available with standard and short barrels. The Negev is one of the few machine guns to also feature a semi-auto mode. The IWI machine gun has very low recoil and is easy to control. (Armada/P. Valpolini)

Other HMI assets are part of the system, such as the Eyepiece, which display shows the C4I picture as well as live video; it can be mounted on the helmet, on the vest, or become part of the weapon FCS. Hand-held displays of various types are also available. Radio agnostic, Elbit Systems proposes its communications solutions from its Tadiran subsidiary, such as the PNR-1000A or the PNR-500 personal network radios. Adds-on such as specialised C4I packages, target acquisition systems, unmanned air and ground vehicles, can be integrated into the Dominator in order to expand its reach. Elements of the dominator are part of the IDF Integrated Infantry Combat System and have also been adopted by the Australian Army, by the Finnish Army, and by some armies in Latin America and Europe.

In 2012 Elbit Systems introduced the Dominator-LD, for Light Dismounted, a lightweight version of the previous system aimed at special forces and dismounted

soldiers. The core element is the Raptor computing unit running on Linux, with its 4.3" screen and cell-phone like interface. The TORC2H-D, the dismounted version of the BMS, is installed, communications being provided by the Tadiran PNR-1000A. The Raptor is installed into a docking station, and can be easily taken off i.e. for planning. For a comprehensive situational awareness picture on-the-move the JS Eyepiece handheld display unit is available. The whole system weighs less than 1.3 kg, and the system can be configured at customer choice.

#### **I SMALL ARMS**

Once part of Israel Military Industries, Israel Weapon Industries (IWI) was privatised in 2005 and is now part of the SK Group that also acquired Meproflight and Pulse Inteco System, bringing under the same hat weapons, sights, electro-optical systems, lasers and night vision systems, which allows

to exploit synergies when developing new products from scratch.

Two historical names are part of IWI portfolio, the Uzi and the Galil, although the company has deeply updated the two designs. The new 9x19 mm Uzi Pro makes extensive use of polymer components to save weight, while the new adjustable stock with cheek rest considerably improves ergonomics, together with the new front grip. The barrel is 152 mm long and the weapon fires from closed bolt, a quick fitting suppressor being available.

The Galil, for its part, is now available in 5.56 mm guise for the Assault Rifle, Short Assault Rifle and Micro Galil versions. An upgrade kit known as the Galil Ultra is available for all three versions and includes an ergonomical hand grip for Picatinny rails, telescopic butt and ergonomic pistol grip. The Galil Sniper is the 7.62 mm version in semiauto, with full ergonomic adaptations in terms of buttstock, pistolgrip plate and bipod. The Galil mechanism is also the base of the

ACE family of assault rifles, available in 5.56x45, 7.62x39 and 7.62x51 mm calibres.

The upgrades to the existing weapons come from lessons learned on the field by the numerous young officers, many of them from special forces, that work at IWI and that twice a year go back to service. This hands-on experience obviously has a deep impact also on new projects, and beside the link to the IDF in terms of requirements the company can leverage the operational know-how of its proper personnel. In recent years the Tavor bullpup assault rifle has become the workhorse of the IDF. Chambered in 5.56x45 mm it works in auto and semi-auto mode thanks to a gas on piston head mechanism and a rotating bolt locking. It is available with two different barrel lengths, the 460 mm being used for the standard, sniper and grenadier versions, the compact having a 380 mm barrel. A follow-on is the X95, a lighter weapon with shorter barrel, 330 mm that becomes 380 mm in the long version, aimed mostly at special forces. The same weapon can be quickly converted from 5.56 mm calibre to 9x19 mm, the latter being based on a blowback system firing from close bolt position. Both the Tavor and the X95 are now also available in flattop configuration, which enables the attachment of all types of day and night optics and additional accessories. The IWI catalogue also features a light machine gun in 5.56 mm, the Negev, available in the standard version with a 460 mm long barrel, and in the special forces version with a 330 mm barrel. The 7.62 NG-7 version is the latest addition, the drum feed being from the side and not from the bottom to speed up ammunition replacement. As with the other Negev the NG7 fires in semi-auto mode. IWI is also active in the handgun arena with its Jerico pistols.

A number of new projects will come to fruition in the short or mid term future. Among these the 40 mm underbarrel grenade launcher has undergone the last testing with low velocity rounds and should soon enter production. IWI has now its own line of silencers, and all those new production needs brought to the construction of a new building that will host the company in 2-3 years time, manpower having constantly increased, doubling in the last eight years, and looking in perspective to a further 50% increase. Other new projects are already in the computers of IWI engineers, most of them remaining under wraps. At least one was unveiled in general terms, a sniper bolt action rifle the R&D work of which has been carried



The ACQ1 sight (left) developed by MSE, a company founded by Lt. Mikey Hartman, former commander of the IDF Marksmanship and Sharpshooting school. MSE sights, here an ACQ2, have considerably larger windows, allowing unlimited view with both eyes open. (MSE)



out with the IDF. Some of the key features will be a quick barrel change and a rough bipod. Meprolight is currently starting to work on the sighting system that will combine a telescope and a clip-on thermal sight.

In the small arms field Israel Military Industries just finished developing the Multi-Purpose Rifle System (MPRS), centred on a Fire Control System that can be used to accurately deliver either a 40 mm grenade or a 5.56 mm round. A built-in computer containing multiple ballistic tables makes the system pretty flexible, however the system is fully exploited when using IMI 40 mm Air Burst munitions. These feature a multimode fuse that can be used in time delay, point detonation or airburst modes, with an integrated self destruct capability. Fuse programming is done by magnetic induction, coils being present in both the grenade launcher and the grenades. The communication protocol adopted for the FCS allows, however, to use it also on weapons adopting different types of airburst grenades.

The FCS weighs around 700 grams, the first systems having been delivered to the IDF for evaluation in late 2012.

#### DAY AND NIGHT RIFLE SIGHT

Numerous companies in Israel are active in the sight production, from daylight CQB sights to snipers telescopes, to image intensification sights up to thermal imagers. It is thus impossible to depict the whole offer coming from those companies, a selection of the latest entries and of the most peculiar systems being the most appropriate way to depict the whole panorama.

The above mentioned Meprolight being part of the same group of IWI, its sights are often offered together with the Israeli-made small arms. The Mepro M5 red dot sight, which recently obtained a major contract in Latin America, is a x1 system that gives a 160° field of view with both eyes open thanks to its 33 x 22 mm window. Originally the red dot covered 2 MOA and had four brightness settings; the most recent version of the M5



features two dots, a 0.8 MOA for long range shooting and a 1.8 MOA for short range /CQB. The M5 is compatible with Gen II and Gen III NVGs and with magnifying scopes, as the company MX3. With the integral Picatinny attachment and without battery, power is provided by a single AA battery that ensures 8,000 hours continuous operation, the M5 weighs less than 300 grams. The Mepro 4X fixed 4 magnification sight features an 8° field of view that is wider than most of its direct competitors. Meprolight is developing new reticles for different ammunition and ranges on customers request, five illumination settings being available. The sight, which weighs 320 grams with the single CR2023 battery that ensures over 250 hours of operation, is in the last stages of evolution and has already bagged some orders.

The Mepro 4X can be coupled to the NOA XT4 clip-on thermal sight, that exploits the same technology of the NOA Nyx family, and is powered by four AA or CR123 batteries, or by only two CR123s. Its configuration is being frozen and it will soon enter production, some orders having already been signed in Asia and Latin America. The well known NOA NYX uncooled thermal sight family has a new member, the NOA NYX 3x dedicated to marksmen. This sight, featuring a 2.7 magnification optic, can withstand the recoil of 5.56, 7.62 and 338 Cal. rifles, a shock absorber is available as optional for using it on 12.7 mm rifles, while a new attachment is also available that maintains zeroing. A x2 – x4 digital zoom is available, while reticles have been modified keeping into consideration longer ranges and different ammunition, such as 5.56x45, 7.62x39, 7.62x51 mm and .338. A remote control is available. Powered by four AA batteries providing 8 hours continuous operation, it has a weight of less than 1 kg. A Picatinny rail on top allows to install an olographic sight for CQB. This sight adds to



*Meprolight M5 red dot sight is often provided with IWI assault rifles, the two companies being part of the same industrial group.*



*The OR night sight is a low-cost solution provided by MSE using a low-level light camera. It is mounted before the sight. (MSE)*



*Meprolight developed a series of uncooled thermal sights known as NOA NYX tailored for riflemen as well as for marksmen and snipers. (Meprolight)*

*Israel Military Industries has developed a weapon system that includes 40 mm grenades with programmable fuse and a fire control system, allowing to use various modes including the airbursts one. (IMI)*

the Meprolight thermal sights family that includes 2x, 3x, and 7x magnification for a variety of operational and tactical needs. For snipers Meprolight developed the MESLAS, a 10x40 riflescope with an integrated 1.54 μm laser rangefinder with 2,000 meters range. The range data is fed into the fire-control computer that automatically calculates the elevation angle. The computer hosts up to 10 different ballistic tables for 7.62 mm, .338 LM, 12.7 mm and possibly .300 WM. Meprolight is starting to produce the Meslas, for which it has obtained a couple of orders. The Meprolight catalogue includes numerous other sights such as the Mepro MOR reflex sight with laser pointers, the Mepro 21 self-illuminated day-night sight, and the Hunter and Mini Hunter image intensification night sights.

Within the Star Defense Systems group are two companies active in the sighting business, MSE (Marksmanship, Sniper, Excellence) that produces electro-optic day sights, and New Noga Light, active in the electro-optic day and night vision systems. MSE is headed by Lt. Mikey Hartman, founder and former commander of the Marksmanship and Sharpshooting school of the IDF for the last two decades, the man who wrote the marksmanship doctrine of the IDF. His experience is key in developing sights that are as much fighter-friendly as possible. The development of the sights currently available started in late 2011, thus all the portfolio is brand new.

The AQC-1 (Accurate Quick “Chot”) family of sights follows Lt. Hartman idea for which a narrow field of view brings the shooter to close one eye, losing situational awareness; thus the window size is 25 x 34 mm with an unlimited field of view with both eyes open. This x1 magnification sight has three selectable reticles, quick shooting, accurate shooting and red dot, the central dot covering 1.7 MOA. Three buttons on the rear allow to switch on and off the sight, to select the reticle and to select the brightness (four day and four NVG settings are available), a PTT cable enabling the same operations without moving hands from the shooting position. A motion sensor automatically reactivates the sight when this goes into sleep



*Meprolight Meslas includes a computer and a laser rangefinder, the sight thus providing the firing equation to the shooter. (Armada/P. Valpolini)*

mode for battery saving, a low battery indicator providing a warning when replacement of the CR123 is needed. The AQC-1 sights are available in three different models, B and C, and the AQC-1W with an even bigger window, 30x35 mm, their weight being between 297 and 375 grams. The AQC-2 family is derived from the AQC-1W but integrates a laser designator, the AQC-2 an IR 850 nm laser with a 200 meters range at night, the AQC-2C a visible 639 nm laser with a range of 25 meters in daytime and 300 meters at night, and the AQC-2D both IR and visible lasers.

MSE also developed the OR-Sight, a low cost add-on system with x1.5 magnification based on an ultrasensitive camera and is equipped with an interchangeable laser module, either 830 or 980 nm. When mounted in front of an AQC-1 it uses the front sight's reticle features, zeroing and ballistics trajectory, but it can also be used as a stand-alone observation device, the range being of 200 meters in pitch black using the IR laser illuminator. Powered by two 3.7 V rechargeable batteries, it has an operation time of eight hours and weighs 540 grams with batteries. MSE products are currently

being tested by the IDF, the company having already obtained some successes in the US.

Turning to New Noga Light, this company is specialised in night vision sights, both intensification and thermal. The Matisse series comprises two uncooled thermal sight, the Matisse M75, a x3.6 magnification for sharpshooters, and the Matisse SD, a dual field of view with x1.7-x5 magnification sight for snipers, weighing respectively 1.1 and 1.8 kg. They both feature a x2-x12 continuous or discrete digital zoom and are powered by six CR123 3V batteries or by a rechargeable battery pack. Beside thermal sights we find the Li-Or series of image intensification sights for long range shooting, the family including three members, M4F, M4FS and M7F, the number showing the magnification. The M4s are dedicated to sharpshooters, the FS being the submersible version for naval commandos, while the M7 is aimed at snipers. Li-Or sights can be equipped with Gen II or Gen III tubes and are powered by a single AA battery. A remote PTT allows to operate the sight while keeping the hands on the rifle. An open cross reticle or a mil-dot reticle are available, with five brightness settings. The sights weigh respectively 1.1, 1.2 and 1.8 kg.



*New Noga Light catalogue features two uncooled thermal sights known as Matisse M75 and SD, dedicated respectively to sharpshooters and snipers. (New Noga Light)*



*The Li-Or image intensification sight family by New Noga Light, here the M4F, includes also a submersible version for naval special forces. (New Noga Light)*

New Noga Light is looking closely at the evolutions in the II-TI fusion domain, and might move in that field but only when true digital fusion will be available, although cost will be a key issue in a future decision.

Elbit, the biggest electro-optics house outside the United States, is mostly oriented on long range optronic systems, its Elop subsidiary being the player in that field. However with the acquisition of ITL Elbit Systems added its portfolio of day and night rifle sights increasing its offer in this field. Looking at the Elbit ITL portfolio, this includes the Mars (Multi Aiming Reflex Sight) family that is based on a x1 reflex sight available with various types of reticle, such as red reflex pattern, red dot or others, which incorporates a laser pointer. The latter can be of the IR or visible-red type, although both can also be available in the same sight. The Mars has an automatic brightness control that automatically adjusts the reticle brightness to the outside scene. Both the sight and the laser functions are boresighted using a single control, the Mars being also operated from an external PTT connected by cable to the unit. Using the Trisight unit in combination allows to obtain a x3 magnification, the Trisight being also usable as a stand-alone sight. The Elbit-ITL line of products also comprises a family of uncooled thermal sights, known as Coyote, designed for uses that range from special forces operators, to snipers, to machine gunners. The smallest is the Coyote 20 mm, that through a Picatinny adaptor can be mounted on a weapon, the same solution being used also for the Coyote 45/75 mm and the Coyote 100 Sniper. The Coyote 100 HMG is purposely designed for machine gun use and is the only such system developed specifically for maritime use. It has been proven in combat on many weapons, from 40 mm guns to 7.62 mm machine guns.

The Elop portfolio includes many surveillance systems, the family dedicated to the sighting role being the Lily, which is available in three versions, S (short range), M (medium) and L (long). The S and M models weight is less than 1 kg, including batteries that provide 8 hours operation. They are both based on Elop's 3rd generation micro-bolometer. The Lily-L is a cooled TI clip-on device working in the 3-5 μm band,



The Elbit Elop catalogue includes the Lily family of uncooled thermal sights, available in shot, medium and long versions. (Elbit)

with two fields of view, 2.5° and 10°, with a weight of 3.1 kg. Equipped with a remote PTT it allows a man detection at 5 km and recognition at 2 km.

### PERSONAL PROTECTION

Due to its security situation Israeli security and military forces needs for personnel protection systems led the way to a strong industrial base in this specific field. Numerous companies are thus manufacturing personal armour systems, that found a successful output also on the export market.

Israel Military Industries has a huge portfolio of personal body armour both for military and police/security purposes. Among those aimed at the military market ASA03 plates, a Level III NIJ solution with 250 x 300 mm plates weighing 1.35 kg if uses an add-on in a body armour, or 1.5 kg as stand-alone solution. The ASA75 is a hard plate for antiterror duties, providing Level III+ protection, with high multihit performances; capable of stopping 7.62x39 mm AP rounds and NATO ball rounds in 5.56 and 7.62 mm calibres, this 0.12m<sup>2</sup> plate weighs approximately 3.5 kg. The ASA44A plate has the same size of the ASA03 but increases protection to Level IV, weight being 3.1 kg as add-on and 3.3 kg as stand-alone.

Rafael is active in the production of boron carbide ballistic components, that are used for platform protection as well as for body armour. The company patented the pressureless sintering technology that ensures lower costs compared to hot press technology offering high performances, lightweight and flexibility in shape. Most personnel protection systems are produced in multi-curve shape, and reach MIJ Level IV protection. Backed with polyethylene



Rafael developed a sintering technology that allows to produce cheaper and more effective ballistic ceramic elements. (Rafael)

Rafael plates provide protection against SS109 5.56x45 mm round at 24 kg/m<sup>2</sup> density, 7.62x39 AP at 28 kg/m<sup>2</sup>, and 30-06 APM2 at 33 kg/m<sup>2</sup>.

Plasan Sasa, a specialist in armour protection, developed a product line tailored to military and security requirements, the company providing both the plate carrier as well as the ballistic package. The company has nearly 30 years experience in this field, and is constantly developing new solution based on state of the art raw materiel available on the market such as aramid fibres, high density polyethylene (UHMWPE), and ceramic plates and tiles produced with various materiel like alumina, glass ceramics, silicon carbide and boron carbide. Its body armour reach NIJ Level III, IV and IV+ protection. Among its load carriage systems is the ATLAS (Advanced Tactical Load-carriage Armor System) that provides a 0.56 m<sup>2</sup> coverage area at 2.65 kg and can be equipped



A multi-curve plate produced by Rafael. The company markets a full range of personal protection solutions. (Rafael)



Magam Safety, part of the SDS Group, has established a cooperation with DSM Dyneema and is working on new technologies for next generation body armour. (Magam Safety)

with a series of optional protections, and the MPAC (Modular Protection Armor Carrier), a lighter solution weighing less than 1.2 kg.

Magam Safety, part of the SDS Group, is another player in this field, and is currently marketing its MS-OTV modular ballistic protective vest wit inserts ensuring Level IIIA – III – IV according to customers requirements. The company established a cooperation agreement on R&D with DSM Dyneema, and is currently concentrating on the future generation body armour, developing new processing technologies and a new matrix for Dyneema. Magam Safety is also working with partners on new technologies for hard ballistic materiel. It has recently put on the market a Level III solution against AK-47 mild steel core ammunition at 15 kg/m<sup>2</sup> density, the aim being to reach 12 kg/m<sup>2</sup>. A 700 grams helmet shell with a V50 of 800 m/s against 1.1 gr fragments has also been developed. While the company is currently concentrating on new Level III solutions, it already started to cooperate with some German partners on Level IV.

### SENSORS FOR ALL USES

Originating from the technical unit of the ID Intelligence Corps, Serafim Optronics is active in the persistent covert surveillance field. Its Mugi (Mini Unattended Ground Imager) has been sold in numbers to the IDF as well as to North American and European customers. The Mugi consists of an IR imager and a CCS camera (visual and near-IR, with zoom) installed on a moving platform that allows ±39° pan and ±10° tilt, without any external movement nor reflection that might give away the system position. It allows recognition of a human being on the move at 3,500 meters in day and 1,600 meters at night.

The sensor unit is 367 mm high, has a diameter of 197 mm and weighs 5.5 kg. The operation time depends on the power system adopted; the BPU-10 rechargeable battery package brings the total weight to 19 kg and ensures 9-12 days of operation, while the non-rechargeable BPU-60 pack is heavier, total weight going up to 36 kg, but ensures 50-80 days autonomy. Typically the Mugi is dug into the soil, only the small periscope unit containing the sensors protruding 110 mm from the ground making it practically invisible, the system having been purposely developed to be camouflaged. A built-in encrypted data wi-fi allows to send images, full motion video or single frames, up to 20 km distance, these being received on the operator unit that comes in three different variants, mobile, a 13 kg rugged case, rugged tablet, a 5 kg unit, and rugged handheld, at 3 kg weight. Radio, sitcom or 3G links can also be used. The Mugi is equipped with a video motion detection system that automatically warns the operator, and can be easily integrated in a net of unattended ground sensors that can be used to "wake-up" the MUGI, thus providing considerable power saving. The C2 software allows to connect up to 32 systems and to operate four systems simultaneously, battery status and communications status of each system being displayed on the console.

Integrating the Mugi with the IAI Elta ELM 2112(V1) surveillance radar gives birth to the UGF (Unattended Gap Filler). A C-band low consumption radar weighing only 6 kg, it detects a moving person or rubber boat at 1,000 meters and a vehicle at 2,000 meters with a range accuracy of less than 10 meters and an azimuth accuracy of less than 2°. The radar covers a 90° sector, four such units ensuring 360° coverage i.e. for protecting a FOB, each unit having a consumption of 12 W. While the MUGI is designed for being deployed in the field, Seraphim Optronics Chameleon is intended for covert urban reconnaissance, the system being capable of recognising a human target at 2 km and to identify it at 120 meters. It employs an internal CCD camera (VIS & NIR) or an uncooled IR imager with pan, tilt and zoom capability of  $\pm 25^\circ$  and  $\pm 5^\circ$  with no external movement and no light reflection from the system. As the MUGI, also the Chameleon is proposed in a configuration with a low power consumption radar. The Seraphim portfolio also includes a Smart Relay Unit (SRU), an all-in-one video router and transmitter that extends the range of the company systems, as well as a



*The UGF (Unattended Gap Filler) is composed of Seraphim Optronics Mini Unattended Ground Imager integrated with IAI Elta's ELM 2112(V1) surveillance radar gives (Seraphim Optronics).*



*Seraphim Optronics' Chameleon 2 optronic surveillance system was developed for urban operations and can be integrated with other sensors, such as a radar. (Seraphim Optronics)*



*Camero's Xaver 400 is the mid-size see-through-the-wall radar developed by the company and is intended both for military and paramilitary use. (Camero)*



*A view of the latest version of the Xaver 100 sporting a screen that displays the symbols of human beings and their distance from the wall. (Armada/P. Valpolini)*

ruggedized hand-held control unit.

Camero, part of the SK group, is specialised in see through the wall radars, the Xaver family now including three members, all working in the 3-10GHz frequency range. The Xaver 800 is mostly devoted to security forces due to its dimensions and weight, 14.5 kg, however this 3-D sensor allows not only to verify the presence of life in the room but also to establish the number of people and their location, to track target movement patterns, to establish target height and orientation and to pick up the room general layout, including dimensions and major infrastructure elements. Much more compact and light, only 3.2 kg, the Xaver 400 can be used at tactical level and provides information in 2-D, thus lacking the height and orientation mode. Both systems can penetrate cement, plaster, brick, concrete, reinforced concrete, adobe, stucco, drywall and other standard building materials with detection ranges of 4, 8 and 20 metres, with a range resolution better than 3 cm and a cross range of 30 cm at 8 meters distance.

The most recent addition to the Camero portfolio is the Xaver 100, incorporating improvements following lessons learned in the field, with a better handle and HMI. At less than 700 grams the Xaver 100 can tell the operator if a target is present in the room and its movement direction and distance with a resolution better than 15 cm.. In late 2012 and early 2013 Camero received numerous orders for its products from European, Central Asia and Latin America customers, the details of those contracts remaining undisclosed. □



An artist impression of the SAAR S72 fast attack vessel showing the missile weaponry, the helicopter landing pad and the 76 mm gun. (Israel Shipyards)

# Naval Activities

**Israel's naval activities, via Israel Shipyards, originates from the 1967 embargo by France that followed the Six-Day War and affected the delivery of the last five of the 12 Saar 3-class missile boats (the famous Boats of Cherbourg). Israel decided that it had to build an autonomous shipyard capability, which in 1971 led to the launch of the first Saar 4 and to that of the first Saar 4.5 in 1980. However, as seen below, IAI is also involved in shipbuilding activities.**

## ISRAEL SHIPYARDS

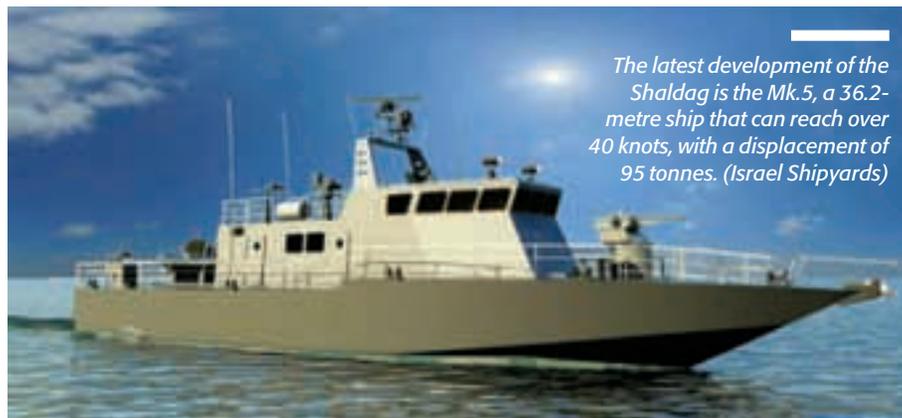
An FMS plan in the early '90s led to the construction of part of the Saar 5 in the United States, which in turn led to the privatisation of the company, the working force being reduced from 1,200 to 300 employees. Privatisation – Israel Shipyards is currently a member of the SK Group – sparked off a greater interest from the export market. In addition to orders from the IDF, eight Saar 4.5 were ordered as of 2002 plus five Shaldag Mk.III fast patrol boats in 2008. In 2004 the company secured an order for its OPV 58 from the Hellenic Coast Guard in view of Athens Olympic games. This vessel is based on the Saar 4 hull, with a smaller CIC on the bridge, the same architecture being adopted for the OPV 62 which was launched in March 2011.

Looking at the age of the IDF fleet, the latest vessels are 12 years old while the older units are over 35 and, considering the discovery of offshore gas fields, Israel Shipyards thought of a multirole vessel to allow Israel to use its reduced budgets in a most possible clever way. The new model, known as Saar 72, was developed on company funds and is based on commercial standards in order to reduce cost. The work took two and a half years, the shipyards benefiting of some

help from the Israeli government, and its hull is common to two different models, the above-mentioned fast attack vessel and the OPV 72 offshore patrol vessel.

With an overall length of 72 metres and a beam of 10.25 metres, the Saar 72 has a displacement of about 800 tonnes and is powered by two MTU 16V1163M94 diesel engines providing a maximum speed of over 30 knots, a sustained speed of 28 knots and a cruise speed of 18 knots. At this speed the range is of over 3,000 nautical miles or 21 days. The crew consists 50 sailors, though 20 more special forces men can also be carried on board. The Saar 72 features a 10 x 15.3-metre flight deck that can operate a medium-size helicopter. The ship can host surface-to-air and surface-to-surface missiles, a naval gun up to 76 mm calibre and other systems and weaponry at customers choice. Israel Shipyards is waiting for a launch customer, since the Israeli Navy is still looking for a budget to launch a new corvette class. Major interest appears to be coming from Asia, mostly for the OPV configuration, although another undisclosed potential customer is interested in the corvette.

In the early '90s Israel Shipyards launched a new aluminium-built fast patrol boat, the



The latest development of the Shaldag is the Mk.5, a 36.2-metre ship that can reach over 40 knots, with a displacement of 95 tonnes. (Israel Shipyards)



*The Super Dvora Mk.III is offered with a choice of high-speed surface drives or waterjets. (Ramta)*



*IAI Ramta is now developing the 20-metre Mini-Dvora. Crewed by only four against 12 to the Dvora, it has a range of 300 nm at 30 knots. (Ramta)*

Shaldag Mk II in which all systems were as light as possible in order to reach over 45 knots. A larger derivative, the Mk III, is in service in southern Israel, while the Mk IV with the same hull but more accommodation was sold to the Romanian Border Police in 2010 to enforce the Schengen Treaty.

Shaldags have also been exported to Cyprus, Equatorial Guinea, Nigeria and Sri Lanka. However some nations needed a bigger vessel, which led Israel Shipyards to develop the Shaldag Mk V. The new Shaldag is 32.65 metres long, has a 6.2-metre beam, a displacement of 95 tonnes, and its MTU or Caterpillar engines coupled to waterjets from MJP Kamewa or Rolls Royce can speed her up at over 40 knots, with a range of 650 nm at 32 knots and 1,000 nm at 12 knots, which means a six-day endurance. The crew consist of 10 to 12, while armament is to customers choice, the maximum calibre for the gun being of 30 mm, though surface-to-surface missiles are also among the options. Israel



*The Wizard geometrical shape decoy developed by Rafael is launched by the standard 115 mm launcher. (Rafael)*

Shipyards already secured a first order for six Mk V from an undisclosed customer a few months after its unveiling. The first should be launched before year end. The same nation also acquired six OPV 62.

#### IAI RAMTA

Despite the company's name, it may surprise some readers to learn that IAI is in the business of supplying naval vessels, albeit through its Ramta division. In fact its 'Dvora' family of light attack craft have sold well around the world. They equip Israel's navy and the naval forces of Gambia, Paraguay, Taiwan and Sri Lanka. The improved Super Dvora Mk.II is used by Eritrea, India, Israel, Sri Lanka and Slovenia. The Dvora class displaces 45 tonnes, can reach speeds of 37 knots, and carries both a 20mm cannon and 12.7mm machine gun. The latest Super Dvora Mk.III, however, can achieve speeds of 50 knots, and dashes of up to 52 knots. These craft have a range of up to 1,500 nautical miles, and displace 70 to 75 tonnes fully loaded. In terms of armament, the Super Dvora Mk.III carry one stabilized 25mm or 30mm gun mount and two 12.7mm machine guns.

#### DECOYS-RAFAEL

Although better known for other lines of products, Rafael is pretty active also in the naval domain, having decoys, electronic warfare systems and turrets in its portfolio.

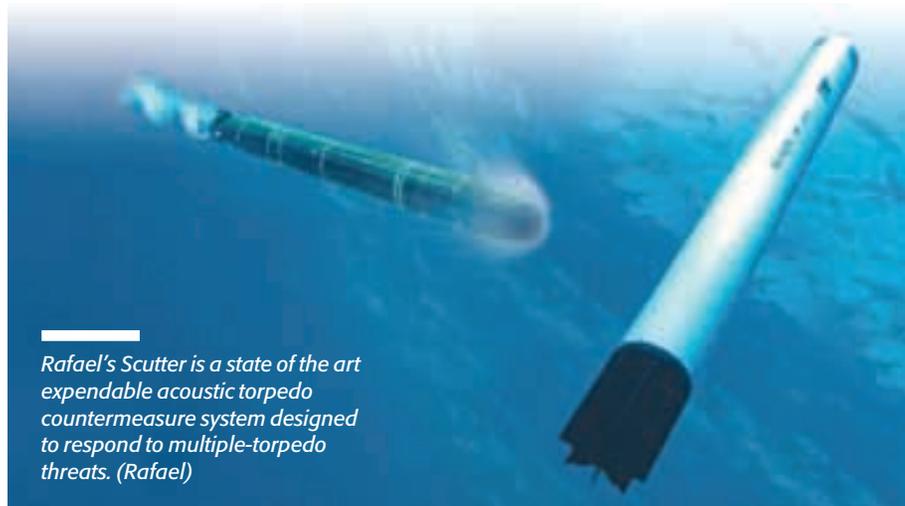
In the decoy field Rafael developed the



Rafael's Wizard decoy was designed with an optimised geometrical shape that allows to simulate not only the radar cross section but also scintillation and glint. (Rafael)

Wizard, a new generation system which geometrical shape, a corner reflector, allows to better simulate the target. As the latest missiles are equipped with decoy discrimination algorithms, that take not only radar cross section into consideration, but also scintillation and glint, the Wizard ensures such characteristics providing distraction defence, before the enemy missiles has locked-on the actual ship, at medium ranges and seduction defence, switching the missile towards the decoy after it had locked-on the ship, at short ranges. This decoy can be launched from standard 115 mm tubes, the same that are used for the other Rafael 115 mm decoys such as the IR Heatrap flare decoy, the LRCR, MRCR and BT-4 long, medium and short-range chaff decoys, and the Leacut acoustic decoy used against homing torpedoes.

Underwater decoys are also part of Rafael portfolio. The Scutter reactive expendable



Rafael's Scutter is a state of the art expendable acoustic torpedo countermeasure system designed to respond to multiple-torpedo threats. (Rafael)

acoustic torpedo countermeasure is a self-propelled third-generation system designed to respond simultaneously to more than one torpedo, also of different types, such as active, passive or passive-active. Based on its threat library the Scutter generates customised deception signals to lure the torpedo that re-attacks the countermeasure multiple times until it runs out of power. While the Scutter is mostly dedicated to ship and helicopters use, the Subscut is submarine-launched and adopts evolved algorithms to generate the right signals to lure active sonar guided torpedoes or generate generic noise for passive homing torpedoes.

Turning to the fourth-generation decoy, the Torbuster combines the "brain" of the Scutter, attracting the enemy torpedo and,

when this is at its closest point comes the final "punch": the decoy's warhead generates enough damage to the torpedo to oblige it to abort its attack.

#### BARRELS-RAFAEL

Rafael produces two series of naval stabilised remote control weapon stations. The junior member is the Mini-Typhoon. This can either be operated as a stand-alone system with its own sensors that include CCD camera and thermal imager, or integrated in the ship architecture, exploiting the naval unit sensor suite. Lead angle and super-elevation are provided by the computer that takes ship and the target motion data into account. The Mini Typhoon weight varies between 140 and 170 kg depending on the



A fourth generation underwater decoy, the Torbuster attracts the enemy torpedo and then detonates its warhead to damage it. (Rafael)



A Rafael Mini Typhoon remotely controlled gun mount armed with a 12.7 mm machine gun. It has a maximum weight of 170 kg. (Rafael)



*The Typhoon accommodates weapons up to 30 mm. This example is installed on a US Navy ship and is equipped with a top optronic sight. (Rafael)*

weapon mounted. Four types of system are possible: 7.62 mm or 12.7 mm machine guns, GAU-17 7.62 mm Gatling gun and MK19 40 mm automatic grenade launcher.

Missiles can be integrated to further enhance lethality, Spyke-NLOS and Spyke-ER being proposed also as naval solutions. Elevation goes from  $-20^{\circ}$  to  $+60^{\circ}$ , stabilisation accuracy being 0.5 mrad. The senior member of the family, the Typhoon, is armed with a gun up to 30 mm calibre, weighing less than one tonne fully loaded. Its traverse is limited to  $\pm 160^{\circ}$  while elevation is between  $-20^{\circ}$  and  $+45^{\circ}$ . Its sensor suite includes a CCD camera, a thermal imager and a laser rangefinder.

Both stations have been selected among others by the US Navy. Among sensors Rafael proposes its Toplite electro-optical system, that can also be mounted on the Typhoon, as well as its Sea Spotter, and an infrared staring and tracking system that allows passive operations against surface and airborne targets. Rafael also developed a full series of electronic warfare systems for naval use and is active in the training and simulation business.

#### **I ELBIT AND ELISRA**

Elbit Systems Elisra also provide naval electronic warfare systems, such as its Acqua Marine integrated naval Radar Electronic Support Measure, Counter Electronic Support Measure, Laser Warning System and Electronic Counter Measure suite, its Natacs



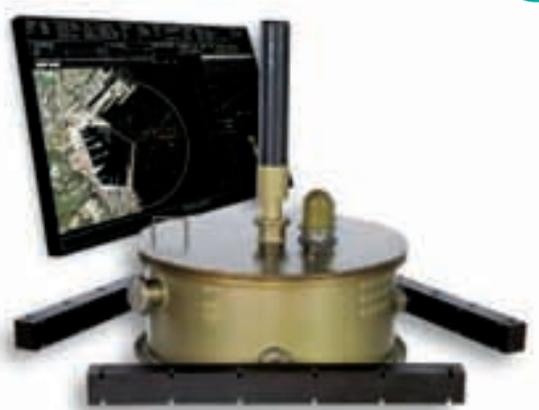
*Elbit's Compass stabilised optronic turret seen here, and Mini-Compass are also often used on naval gun mounts. (Elbit Systems)*

2000 tactical comint/direction finding system, and its Timnex II ESM/elint system. Physical decoys come in the form of the Deseaver Mk II system, a single launcher being able to host up to 12 six-decoy modules; fully integrated in the ship the system ensures optimal deployment of the

decoys. Active defence can be provided by the Mini-Orca (Overhead Remotely Controlled Armament) armed with a 7.62 machine gun. Sighting for this system can be made through one of Elbit Elop stabilized, multi-sensor electro-optical payloads, the Compass or the smaller 8-inch Mini-Compass (see the Stabilised Electro-optical Systems section). Ship integration is one of Elbit Systems most important businesses in the naval field, the company also providing combat management systems such as the ENTCS 2010 based on open architecture.

A most powerful system is the Aquashield diver detection sonar which results from the firm's 15-year experience in the development of specific diver detection algorithms. According to DSIT, the Aquashield currently is the longest range diver detector. First deliveries took place in 2006. It is used in Asia and Europe, by the Israeli Navy of course, but also in the Gdansk harbour where it constitutes its first civilian application.

DSIT also offers a comprehensive system Port View, a harbour surveillance command and control system that integrates the above-mentioned Aqua Shield, search radars and day and thermal cameras.



*The Aqua Shield has the ability to detect a diver equipped with a closed circuit breathing system at a range of 700 metres. It is fully automatic and can simultaneously handle up to 1,000 targets. In order to sharpen its effectiveness the coverage angle can be selected (DSIT)*

#### **I DSIT**

Eighty-employee stron DSIT specialises in both sonars and acoustic sensors for the protection of sites (harbours and oil rigs for example) and harbours. The company's main market is Asia, followed by South America, Europe and finally North America. □

# Drones & Robotics

**One can argue for hours on who made the first drones – to use their original name – but there is no question about the true, practical modern-era types: they definitely have an Israeli origin. Even one of the earlier and most popular American drones, the Northrop Grumman RQ-5 Hunter was based on the eponymous IAI aircraft.**

**I**ronically, even America's current larger drone manufacturer General Atomics sees the background of its Gnat drone written in the Leading Systems Amber designed by Abraham Karem – a former Israel Air Force engineer who had designed his first drone in the early 1970s. As a matter of fact, operations conducted by the United States in Afghanistan and in other areas like Yemen, where the hunt for terrorists is on, have had a tendency to blur the fact that the leading exporter of drones today actually is Israel.

The Israeli drone world is largely divided between Israel Aerospace Industry and Elbit Systems, at least as far as the larger types are concerned. For the smaller, so-called tactical, types, they are followed in the military field by Aeronautics, Top-I and Steadicopter. Rafael had made attempts to cut its slice of the drone cake, particularly with niche urban warfare types, but withdrew from that scene a few years ago to concentrate on land and naval robotics. We shall not attempt to cover all Israeli drones here, Armada has an excellent worldwide yearly survey covering the subject in the form of the Drone Compendium, but rather provide some of the latest examples that best illustrate the those companies' capabilities.

## **I MALES**

The queen category is the Medium Altitude Long Endurance type, which is better known as male. There are very few players in this category worldwide, but Israel alone has two – IAI Malat and Elbit. The definition of a male drone is vague and arguable, but refers to a drone able to fly at a minimum altitude of around 10,000ft (which for many is lower than "medium") over a period of time of 24 to 48 hours.

## **I HERON-IAI**

The current veteran here is the IAI Heron which took to the air in 1994. Capable of an endurance of 52 hours and of an operational ceiling of 35,000ft, the 1,150kg Heron has been ordered by at least 14 nations



*Taking off at 5,650kilos and powered by a 1,200 hp turboprop, the IAI Eitan is the largest drone produced by Israel.*



*Typically the Heron can carry an ELM/2020U maritime radar, or an ELM/2055 synthetic aperture radar, an Elk-1891 satcom system and a variety of gimballed electro-optical systems. Some, like the example featured here sport electronic warfare sensors, while others operated by Israel are seen literally covered in elint and comint aerials. (Armada/Eric H. Biass)*

worldwide, the most notable customers being India, Germany, Brazil, Turkey and France, although the latter had it modified with mixed results by Cassidian under the name of Harfang. The Heron has a retractable gear, carries four simultaneously operable sensors, uses a dual automatic take-off and landing system and a satcom set can be carried for long range missions.



*The now 550-kilo Hermes 450 has a payload capacity of around 180 kilos. Its ceiling is 18,000 feet and it offers an endurance of 17 hours. This artist impression shows it carrying electronic warfare gear in its underwing pods. (Elbit)*

## **I HERMES 450-ELBIT**

Second on the list is the Elbit Hermes 450, which had its maiden flight in 1998. In service with the Israel Defence Forces for over 13 years, it also proved quite successful on the export market, having been sold to a good dozen nations including Singapore and other unexpected countries such as Azerbaijan, Botswana and Georgia, to name but a few. It is



The evolution of the Hermes 450 never seems to stop as exemplified by this "guinea pig" photographed at the Pik airfield workshop in the Golan Heights, fitted with a new rotary piston engine, a three-blade propeller and an experimental radar gondola housing a Selex Gabbiano T20 maritime radar. (Armada/Eric H. Biass)

also used by Britain in Afghanistan under Elbit operation as an interim solution until the Thales version known as the Watchkeeper becomes operational.

The '450 is generally fitted with an Elbit Compass gimbed electro-optical chin-mounted turret, but can also be fitted with a synthetic aperture radar, a maritime patrol radar as well as with elint, comint and communications jamming suites. A fit that appears to have been popular is the fitting of the Italian Selex Gabbiano T-20 (20-watt output) maritime and coastal surveillance radar. The Hermes 450 also takes-off and lands automatically and can use semi-prepared airfields. The drone can also carry the marginally larger, but more powerful T200.



Photographed by the author at the Pik airfield in the Golan Heights, the 15-metre span Hermes 900s display their ample bays enabling them to carry an impressive array of sensors, including a maritime surveillance radar. (Armada/Eric H. Biass)

#### ■ EITAN-IAI

Initially known as the Heron TP, this is more than a turboprop-powered version of the Heron. In spite of similar twin-boom configuration, it is dramatically larger and heavier. The Eitan (which means Steadfast) had its maiden flight in 2004, has a take-off weight of 4,650 kilos which is more virtually four times that of the Heron. Its 1,200-hp PT6A affords it a ceiling of 45,000 feet and an endurance in excess of 70 hours. It is in operation in Israel since 2009, but is not known to have scored any export orders so far.

#### ■ HERMES 900-ELBIT

With a take-off weight of 1,180 kilos, a payload capacity of 350 kilos a ceiling of 30,000 feet and a 36-hour endurance, the Hermes 900 aims at expanding the gap between the Hermes 450 and far heavier drone models. One of the major advances of



A definite boon for operators that already operate the Hermes 450 and who wish to either upgrade to Hermes 900 or operate both is that all ground control, datalink and C4I equipment remain the same. As can be seen here, it employs "glass cockpit" and hotas controls. (Armada/Eric H. Biass)

the '900 is its large electronics bays which enables it to internally accommodate a wide choice of systems. This is a huge advantage over external fits or mounts that require tampering with the airframe, in that the configurations do not need to be aerodynamically approved. It is interesting to note in this context that the radar is the only out-of-house component used in the Hermes 450 if one accepts that electronics supplier Elisra is a subsidiary of Elbit. The datalink, for example is from Elisra and provides a line-of-sight range of 250 km.

One of the important features, in regards to the number of electronic systems the '900 can carry thanks to its ample payload bays, is its payload plug-and-play architecture. In spite of the ample internal capacity, the Hermes 900 has four external hardpoints.

Possible payloads include the Dcompass electro-optical turret, Lasso scanner (a relatively new development that creates near real-time updated multi-spectral aerial



The Eitan is alleged to have a weapon carrying capability, as suggested by this real-size mock-up presented with Lahat missiles. Teamed with Rheinmetall, IAI is offering the aircraft to Germany as part of the Saateg requirement. (Armada/Eric H. Biass)

## I IT WAS BOUND TO HAPPEN



With drones becoming more sophisticated – and therefore expensive – their protection has been an issue of growing concern in recent years, especially that enemy forces hitherto regarded as primitively equipped in terms of air defence assets are beginning to gear up.

Elisra, Elbit's electronic warfare specialist subsidiary, has thus unveiled a new electronic warfare self-protection system suite for drones (here photographed by the authors) based on the normal aircraft Spectrolite suite, but with power consumption reduced to 300 Watts. Although the system was officially announced at the 2103 Paris Air Show, it had already been ordered by the Israeli Air force. The system is also described in the "Electronics" section of this Profile.

photography and provides automatic exploitation and mapping of very large areas), elint gear (typically Elisra's AES-210), comint and direction-finding suite, Elisra Skyfix and Skyjam units (which listen and record Cell-phone conversations and SMSs, locate the unit to then transmit the gathered intelligence information where needed on the ground, and eventually jam the 'phone), Elisra's Skeye (a high-resolution wide area airborne persistent video surveillance system which is capable of permanently monitoring wide areas, intercept events, thence support access to a video archive for comparison). The '900 is also available with a TCAS and avoidance evasive manoeuvre system, a panoramic 200° electro-optical sensor. Soon to come is a radar source avoidance system being developed by Elisra.

The Hermes 900, which had its maiden flight in December 2009, was ordered by the Israeli Air Force as soon as 2010, and besides having been tested by Switzerland, has already been ordered by Chile, Colombia and Mexico (for police duties).

## I LIGHTER DRONES

Leaving the male drone world for the lighter category of aerial explorers, but that still require to take-off and land traditionally, Israel has a couple of players in this range that typically weigh 100 to 25 kilos, and offer an endurance of up to 12 hours or more. One of the older models in this context must be the IAI Searcher which entered service in the very early 1990s and is still in production in Mk II guise. Given the high numbers exported, the type is still being overhauled and maintained by IAI Malat's facilities.

Newer contenders come in the form of the Aerostar from Aeronautics and Elbit's Hermes 90.



*The size and performance of aircraft like the Aerostar now tends to seduce paramilitary and homeland security forces around the world. (Aerostar)*

## I AEROSTAR-AERONAUTICS

Aeronautics' star product is the Aerostar which made its début in the early 2000s. It is powered by a 38 horsepower flat-twin engine developed by Italian engineer Guido Zanzottera. Bearing this name, the company which is based near Lugano and manufactures a whole range of engines, was bought up by Aeronautics.

Although it is twice as lighter, the Aerostar roughly fits into the shoes of the IAI Searcher mentioned above in terms of size, payload capacity and endurance. Indeed, not only does the shoulder winged and twin tail boom Aerostar have a span of 8.7 metres, it has a maximum payload capacity of 50 kilos, an endurance of over 12 hours and a datalink range of 250 km.

## I HERMES 90-ELBIT

The lightest, at 115 kg take-off weight in this category, is the Hermes 90 unveiled at the Paris Air Show in 2009. One of the peculiarities of the Hermes 90 airframe is that it can be fitted with a traditional fixed landing gear, or with a landing sled when no smooth airfield is available, in which case the aircraft has to be catapult-launched. Elbit sees the Hermes 90 as a high-end tactical drone system that can perform typical observation and surveillance missions through its Microcompass stabilised electro-optical chin-mounted turret, but also comint and direction-finding missions using the Elisra Skyfix. It can however be fitted with a synthetic aperture radar.

## I ORBITERS-AERONAUTICS

Lighter still, but also launched by a lightweight catapult are the Orbiter I, II and III developed by Aeronautics. They come with wing spans of 2, 3 and 4.2 metres offering endurances of 3, 4, and 7 hours. Their take-off weights range from 7 to 28 kilos. While all are tail-less designs, the I and II have a conventional tubular fuselage with a highly swept wing fitted with upward pointing winglets. The Orbiter III, on the other hand, has a downward-pointing winglet-equipped wing that blends into the fuselage, but it also carries a small wing (not a canard) mounted above the nose. All three are pusher-prop configured (brushless motor powered) and



*The Orbiter III was unveiled at the 2011 Paris Air Show. Its T-Stamp stabilised electro-optical package affords it a target designation capability. (Aeronautics)*



*The Hermes 90 has a wingspan of five metres and, taking off at 115 kilos maximum, can carry a 25-kilo payload at an operational ceiling of 15,000 feet for a duration of 15 hours. (Elbit)*



*The electrically powered Skylark 1 LE weighs 7.7 Kilos, has an endurance of about three hours and lands by prancing into a deep stall at an adequate height above the ground and deploying a belly landing airbag. (Elbit)*

land with a combination of parachute and airbag. Their nose tip-mounted payloads typically are from Controp, the D- or U- (day ccd or night infrared) Stamp for the Orbiter I, the Orbiter II adds a stabilised zoom Z-Stamp capability, while the Orbiter III can also carry the T-Stamp that packs day, night, laser and stabilised zoom.

#### **I BIRDEYE SERIES-IAI**

IAI Malat has produced quite a number of 90-minute endurance Birdeye 400s, but the type has been replaced around 2010 by the twice as heavy (at 11 kilos) Birdeye 650, which uses a three-metre span high-sweep, downward-point winglet wing that blends into a relatively stout, but obviously lift-generating fuselage. The catapult launched, it flips over it back and deploys a parachute for landing. The aircraft has no vertical tail surface and is electrically powered by a pusher prop aircraft located at the end of a short tail boom. It has an endurance of three hours (although this would be increased to seven hours with the use of a fuel cell). It can use a Tamam Micro-pop or a Controp electro-optical payload.

#### **I SKYLARK-ELBIT**

The much lighter, hand-launched category is largely occupied by Elbit's Skylark (retroactively designated Skylark-1) for years now, and has been ordered by a good dozen countries.

The type was then superseded by the Skylark 1 LE (bringing user nation numbers to 20 on the scoreboard) that offers a longer endurance. The 7.5-kilo Skylark 1-LE offers an endurance of three hours and typically employs a Controp D- or U-Stamp nose-mounted camera system at ranges of up to 20 or 40 kilometres depending on terrain configuration. The Skylark I LE has been extensively used by the coalition forces in Afghanistan. The Skylark, its tracking aerial

and operating station can be carried by two men and put into operation within minutes. It will operate even in GPS-denied areas.

#### **I CASPER SERIES-TOP I VISION**

Lighter still is the series of featherweight, hand-launched Casper drones produced by Top I Vision, a company that also specialises in surveillance aerostats and stabilised payloads, mainly for homeland security operations. It also has developed a "smart" robotised jet ski. Its 5.5-kilo Casper 250 drone has a wingspan of 2.5 metres, and endurance of 90 minutes and offers a datalink range of more than 10 kilometres depending on terrain configuration. Its payload options include the firm's own Lev 2 day or uncooled infrared stabilised electro-optical packs (Lev means heart). Top I Vision is also working on other types of drones, notably a tail-less design called Whisper. Top I Vision, it is worthy of notice, exports 90% of its production and has even established a production line in India.

#### **I VERTILIFTS**

Vertical take-off and landing drones is a relatively new field for the Israeli defence industry, although some industrial developments have been conducted here and



*The electrically powered Top I Vision Casper 250 comes in a neat compact package that includes aircraft, datalink aerial and control station. (Top I Vision)*



*Here seen presented at the Paris Air Show in 2011 by IAI, the treble rotor Panther constitutes an innovative approach to convertible vertical-horizontal flight. It flies at an astonishing height of 5,000 feet above ground level. (Armada/Eric H. Biass)*

there, including by Israel Aerospace Industry who put together a uninhabited system based on the Alouette III helicopter.

#### **I PANTHER-IAI**

With the Panther, IAI has moved into a somewhat innovative concept of tiltrotor aircraft in that it includes three electric motors: two on the wing and one in the rear of the fuselage pod, between the tail booms. While the wing-mounted rotor axes tilt from vertical for take-off and landing to horizontal for high speed level flight, the tail rotor axis remains vertical to provide pitch stability (through varying rpm) but can swivel slightly left or right with respect to the aircraft's longitudinal axis to produce yaw control.

The secondary relevant feature of the Panther is its relatively quiet operation. The Panther takes off at 65 kilos maximum, carries an 8.5-kilo payload (typically a stabilised ccd/infrared Mini-Pop) and its four-hour endurance affords it an operational range of 60 kilometres. A typical mission station would include three aircraft, an integrated communications suite and two operator consoles. IAI is now working on hybrid power generation system for the Panther.



*The Black Eagle 50's data link is from Elbit while typical payloads come from Controp, in this instance a D Stamp. (Steadicopter)*

#### **I BLACK EAGLE-STEADICOPTER**

Of a radically more conventional design, the Black Eagle 50 has been under development by Steadicopter since 2008 for Tsahal and is now undergoing certification. The Army requirement stipulates that a system should include two aircraft and one ground station. The 35-kilo aircraft is now also being offered to the Israeli navy. Powered by a two-stroke water-cooled 120cc engine, it has an endurance of three hours.

Steadicopter is currently working on a larger machine called the Black Eagle 300 based on a single seater light helicopter of Canadian origin.



The original Guardium on surveillance duty at Ben Gurion airport (G-nius)

# Surface Robotics

**Land features undoubtedly constitute the toughest challenge for robotic vehicles. Their flying counterparts (the drones) only have one major obstacle, and it is called Earth (their other obstacles being other, and comparatively sparse, aircraft). Their swimming mates have much larger and reasonably flat expanses on which to move about and can generally be kept within eye shot range.**

**O**n land, a wheeled or tracked vehicle can run into many sorts of trouble. Some of these can be unforeseen like a pool of water resulting from a heavy storm, for example, which requires some form of artificial intelligence to be detected unlike a felled tree which only requires an obstacle sensor, like those nowadays fitted in the bumpers of our automobiles.

While a number of challenges are being organised around the world, Israel is, to our knowledge the first nation to have put an autonomous system into service, even if it patrols on a known terrain and that its weapon function has a man-in-the-loop channel.

## GUARDIUM — G-NIUS

G-Nius, a company formed in equal parts by Elbit and IAI has been working on the Guardium (retroactively designated Guardium Mk.I) for a number of years, ending up with an operational vehicle that went into service in 2007 to carry out border patrol missions and route proofing against roadside bombs. Some ten vehicles have been built.

Then came the Guardium Mk.II based on a better and stronger platform capable of carrying an extra 500 kg of payload, with a full day and night capability. Given its extra payload capability, the MkII could in addition have been employed as a mule.

The new trend now is to use production vehicles as indeed, and against all odds, their readily integrated electronics greatly facilitates the injection of external commands: since all commands on steering, throttle and gearbox are readily sent via electronic signals (accelerator, power assisted steering and gearbox are now devoid of any physical mechanical link) tapping into the electronic circuits renders the installation of costly and cumbersome servos totally redundant. Hence the Ford-based Mk.III, which has been ordered by the Israeli Defence Forces to replace the Mk I. G-nius is employing all the systems and sensors used (all being of Israeli origin, by the way) on the Mk.I and II on an M-113 and testing it as a possible hybrid convoy lead vehicle.



The projected G-nius Guardium Mk.III robotic vehicle would be based on a Ford truck and would carry a Rafael turret. (G-nius)



A four-wheel drive, four independent wheel suspension, four-steered wheel vehicle, the Lahav Rex is 160 cm long, 80 cm wide and 75 cm tall, and drives at a speed of 12km/hour. (Eric H. Biass)



Three prototypes of the 250-kilo capable Rex carrier have been built so far and demonstrated to potential customers. (Eric H. Biass)

#### REX - LAHAV

Lahav has very recently come up with the Rex, which is a robotic logistic carrier. The prime intention behind the Rex is to offer a powered slave platform, a mechanical porter, or sherpa, or coolie, in other words, able to carry the increasingly heavy paraphernalia soldiers to carry out their missions. Other missions can be more logistically orientated, such as the delivery of power supplies, notably fresh batteries, or even recce missions in which case all manner of sensors can be fitted to its flatbed platform.

The Rex thus has a "follow me" function by which its high off-road capabilities enables it to follow a small commando and carry its supply of missiles, for example. Another mode is active remote control, where a Rex equipped with a powerful stabilised electro-optical package could be driven just shy of the crest of a hill to observe the terrain "beyond behind", so to speak.

The three Rex demonstrator prototypes are currently powered by a diesel engine, but a hybrid diesel-electric powerplant is now being studied to provide quiet operation when required.



The IRIS, Individual Reconnaissance and Intelligence System developed by Roboteam pictured in a culvert. (Roboteam)

# Smaller, Remote Controlled or Throwable

#### EYEBALL-ODF

Acquired in May 2013 by the Mistral Group, ODF Optronics is active in omni-directional imaging solutions for military and law enforcement use. Its first success was the EyeBall R1 audio/visual surveillance sensor, a self righting ball capable to rotate at 4 rpm providing a 360° panoramic imaging. Weighing only 580 grams and with an 85 mm diameter, the ball includes a colour or black and white camera, infrared and white light diode illumination, and a microphone. Once thrown or rolled into a room, the system starts to send its images, its endurance depending very much if illumination is used or not. An EyeBall kit includes a portable display unit with screen and three R1 balls. To ensure more mobility to the sensors, ODF developed the EyeDrive, a 3.8 kg throwable wheeled/tracked robot equipped with four cameras that provide 360° situational awareness. A fifth camera, with a  $\pm 45^\circ$  tilt capability is used for investigation while a microphone provides acoustic awareness. The EyeDrive can speed up at 4 km/h, and while it has a payload capacity of 3.5 kg to accommodate other cameras or manipulators, this limits its throwability.

To improve command and control ODF developed the OWLink: in the multicamera version this bidirectional COFDM data link allows to operate eight standard definition

cameras or four standard and one high definition cameras. Inside buildings its range reaches 50 metres, stretching to 200 meters in the open. The OWLink, a light and low power consumption item, can be integrated into existing robots.

#### IRIS-ROBOTEAM

Another company active in the mini-UGV field is Roboteam, born out of the experience in the military of its two co-founders. The first product developed by Roboteam was the Iris, for Individual Reconnaissance and Intelligence System, a one-kilo robot powered by two AA batteries that can be thrown at over 60 metres using the David sling technique, or dropped from a height of 10 metres. The Iris has no up or down and can thus move as it lands. All made of composites, its sensor package includes a front day/night



ODF Optronics throwable robots; in the foreground the EyeBall R1 and in the background the EyeDrive. (Armada/P. Valpolini)

camera with a  $\pm 90^\circ$  tilt mechanism, a near-IR and visible laser pointer and a microphone. To improve mobility its front nylon wheels are bigger than rear ones, but all equipped with a six-arm spider that increases grip. The Iris dimensions are 175 x 205 x 95 mm, allowing a soldier to carry it in his side pocket. It was the first miniature throwable robot delivered to the IDF.

Also made of composite materials, powered by a standard BB-2557 US military battery, the MTGR for Micro Tactical Ground Robot is the second product developed by Roboteam. At 5.9 kilos it is tracked and exploits its extremely long arms to obtain maximum manoeuvrability, with a top speed of 6.4 km/h. The MTGR carries six cameras providing full 360° coverage day and night, as well as a microphone for situational awareness. The MTGR can be equipped with a tactical manipulator, a top-view camera, or a

*The ROCU 7 is the Roboteam's remote control unit featuring an NVG-compatible 7-inch screen. (Roboteam)*



Picatinny rail to allow easy attachment of multiple military tools and accessories.

The senior member of the Roboteam family, which is also the latest development, is the Probot – a 120 kg platform able to carry a 230 kg payload at a maximum speed of 35 km/h on wheels. When high mobility is needed each of the four wheels has a tracked flipper that comes into action, allowing the Probot to climb stairs and overcome difficult obstacles. It can operate at a range of 500 metres in urban environment, and features tracing and imaging sensors allowing semi-autonomous operations, shifting the operators focus from platform control to mission control. Equipped with a 360° video, a tilt camera with a x10 zoom, a laser pointer and an illumination module, it is powered by standard US military batteries that ensure 4-6 hours of operation.

Roboteam proposes two control units for its Iris and MTGR, the ROCU-5 with a 5” touch screen, a one-thumb stick and two push-buttons, and the ROCU-7 with a 7” NVG compatible touch screen.

# The Liquid Element

**With its drone and electro-optical know-how feathers in its cap, Elbit Systems is unsurprisingly active in Neptune's kingdom. But Elbit also has good company there with the likes of Rafael and IAI, not to mention Top I Vision.**



*Elbit System's Silver Marlin is over 10 meters long and can be armed with a 12.7 mm RCWS for offensive operations. (Elbit Systems)*

## STINGRAY AND MARLIN-ELBIT

Elbit's solutions employ mission control suites akin top those of its drones, which naturally open the door to combined sea surface and drone missions. Currently, the company is proposing two unmanned vessels. The junior element is the Stingray, a 3.2-metre boat with a 250 kg payload. It can reach up to 45 knots with an endurance of eight hours and has a stabilising system that prevents it from capsizing. Mostly used for reconnaissance and ISR missions, the Stingray is equipped with a stabilised electro-optic payload, from Elbit needless to say.

The Silver Marlin is much larger at 10.6 metres, powered as it is by two 315 hp diesel engines driving two propellers, allowing it to reach the speed of the smaller craft, but with a 24 to 36 hour or 500 nm endurance. Displacing 6.5 tonnes, the payload is ten times that of the Stingray, which allows to carry not only extra optronic sensors but also weaponry, a remotely controlled weapon station armed with a 12.7 mm machine gun for example. Due to its range, the Silver Marlin can be equipped with a satcom system to remain linked to the operator ashore, though direct line-of-sight comms are possible over shorter ranges. The craft is equipped with an autonomous obstacle avoidance system.



The Stingray USV by Elbit Systems is mostly devoted to reconnaissance and intelligence missions, equipped with an electro-optic sensor suite. (Elbit Systems)



The new Rafael Protector 11, here photographed at the 2012 Euronaval exhibition in Paris, is impressive and comes, from left to right, with a Spike twin launcher canister attached to a Typhoon gun turret, loudspeakers, a Toplite electro-optical turret, two multiple 180° camera systems (the second unit looking rearwards), a detection radar, and finally a powerful water cannon mounted on the rear platform. (Armada/Eric H. Biass)

#### PROTECTOR-RAFAEL

As said above, the Silver Marlin has good company with the Rafael Protector which, according to its builder, is the only system of its kind to be in service in several countries around the world. The boat is available in two versions – 9 and 11 metres. It is now available with a monumental 80-metre throw water

cannon. The craft carries 8 cameras that provide a full 360° view, can be armed with a Typhoon remote control turret and has been demonstrated firing the Spike missile. The nine-tonne Protector 11 is based on a deep V hull designed for high seas and is equipped with two powerful Caterpillar C7 diesels driving Hamilton/Kamewa waterjets systems



The ski-jet based Barracuda being developed by Top I Vision is able to hide low in reed marshes for a week. (Top I Vision)

that affords it a maximum speed of 38 knots.

The Protector, it goes without saying is equipped with a laser rangefinder, a search radar and an electro-optical director for automatic or manual day-and-night detection, identification, tracking and targeting operations. By the very nature of the equipment carried that Protector is de facto a C4I component.

#### BARRACUDA-TOP I VISION

Another item that will soon join the fray is the smaller, but smart device Top I Vision is coming up with. A jet-ski based system particularly designed for the surveillance of river coasts where smuggling and illegal penetration are easy, the Barracuda is equipped with a stabilised day and night ball (from Top I Vision, of course) and can hide in reed marsh or a mangrove. It can stay “dormant”, in other words engine cut-off, for one week and be woken up as soon as its sensors detect trouble.” □

The Lockheed Martin F-16I has been a staple of the Israel Air Force for several years, yet the activities of Israeli firms such as IAI, Rafael and Elbit have made Israel's Vipers arguably some of the most advanced around. (Rafael)



# Electronics

**By developing its own electronics industrial capability, Israel has de facto reduced the number of systems that would be denied to the nation by foreign nations' embargoes. This explains why Israel has a finger in almost every electronics pie (air defence radars though are covered in the air defence section of this Profile).**

**T**he key players in this field are undoubtedly Elbit, Elisra and Elta, although, as we shall see below, Rafael has its say in the radios department. Smaller companies seen below also have come up with interesting systems. Reviewing the latest achievements from these companies, this section is divided into subsections, namely radios, electronic warfare, battlefield management and C2, and jammers.

## RADIOS

### PNR1000 – ELBIT

Command and control (see below) is arguably nothing without communications and Elbit Systems' PNR-1000 Personal Net Radio offers a small, lightweight, full duplex UHF product. There is no limit as to the number of listeners accommodated on a PNR-1000 network, which can host three talkers at any one time. The radio can handle voice and data transmissions; the latter at a rate of 320kbps. The radio can be loaded with either Elbit's proprietary waveforms, or those used by the customer and the radio performs its own network management. Elbit says that the range of the PNR-1000 is around double that of its legacy CNR-9000.

This translates into a range of up to two kilometres in open space, 700 metres to one kilometre in urban environments and up to

500 metres in jungle. Elbit's Military-IP Radio (MIPR) is a VHF vehicular/manpack transceiver which has a data rate of up to four megabits-per-second. Typically used as a backbone transceiver, the MIPR can be utilized at the brigade level. The radio hosts Elbit proprietary or customer-specific waveforms. Finally, the firm's THF-8000HF radio offers a data rate of 92kbps. It can be used for manpack, vehicular or fixed-station applications. The manpack weighs under four kilograms and has an output of 25W, although this increases to 125W for the vehicular version.

### TAC-4G LTE – ELBIT

Other innovative communications capabilities pioneered by Elbit include the TAC-4G LTE Cellular Network which is built around an encrypted cellular network which is managed from a ground vehicle. This can give a deployed military force a common cellular communications network which can be used regular cellphones, but in a secure fashion. These cellphones can then be utilised for viewing pictures and video, transmitting data and for conventional voice communications. By deploying several ground vehicles to manage the network, a degree of redundancy is built in by which the network can continue functioning should one of the vehicles cease operation.

### MP-DF-100 – ELISRA

Elbit Systems is the parent of the Elisra Group which provides a number of specialized electronic platforms. For example, its MP-DF-100 is a tactical, man-portable communications intelligence system. Covering the 25-3000 megahertz band, the MP-DF-100 can be used on the move or at the halt. This comint product allows soldiers to classify and locate the position of emitters. When used in a stationary fashion, the MP-DF-100 can build up a tactical map of local emitters and their frequencies. Elisra is currently working on the MP-DF-200 which it expects to be available by the middle of 2014. This will have a smaller receiver and hot-swap batteries. Both the MP-DF-100/-200 can transmit their comint data across any tactical radio or satcom network.

### RAVNET-300 – RAFAEL

Although it has earned a solid reputation as a missile house, Israel's Rafael Advanced Defense systems also specializes in military communications. Notably, it produces airborne radios in the form of the dual-band Very High Frequency (VHF)/Ultra High Frequency (UHF) Ravnet-300 which is currently in service with the Israeli Air Force and Israeli Navy; the latter of which only uses it for ship-to-air communications. The Ravnet-300's data throughput is in the region of up to 300 kilobits-per-second (kbps) and provides high-quality, low-delay voice services including full duplex communications at a range of up to 180nm (333km). Moreover, compatibility with the Mil-Std-1553 protocol allows the Ravnet-300 to equip a diverse array of air platforms which accommodate this data bus.

Despite only entering service four years ago, the Ravnet-300 will be replaced in the coming years with a new airborne radio produced by Rafael called NetCore (a.k.a BNET-AR). In its pilot stage of development,

the NetCore provides three-channel communications in the form of VHF/UHF and satellite communication. NetCore has a small form factor which is below that of the Ravnet-300. The company says that it can import Nato-compatible waveforms into the radio for use with Link-16, which are compatible with the waveforms developed for the United States Joint Tactical Radio System (JTRS) programme. Notably, NetCore eclipses Ravnet-300 in terms of data rates, offering speeds of 1.5 megabits-per-second. Spare space is included within the radio for future software upgrades, and the radio has an ad-hoc networking capability which can manage, as well as use, the network.

At the command and control level, NetCore carries Rafael's GlobalLink airborne command and control network. GlobalLink can carry voice, video and data traffic between aircraft, and between aircraft and the ground. The network can perform video sharing, situational awareness, such as blue force tracking and collision avoidance. Although not its primary task the company says that GlobalLink does have a residual mission planning capability, particularly for helicopter missions. NetCore is expected to enter service with the Israeli Air Force in the coming two years, and will eventually be rolled-out across all of its airborne platforms. As NetCore enters service, there will be a parallel introduction of GlobalLink into the IAF.

#### ■ BNET – RAFAEL

BNET is in fact of family of radios which include the airborne BNET-AR, discussed above and the vehicular BNET-V and handheld BNET-HH broadband software-defined radios. The BNET-HH provides a data transmission rate of two megabits per second (mbps) across a single 1.25MHz channel, with the BNET-V offering up to 10mbps across noncontiguous 1.25MHz independent channels.. Although primarily designed to handle data, the radio can carry voice-over-IP traffic and runs both airborne and ground communications channels. The company refers to the BNET-V/HH as the 'Israeli version of JTRS', and stresses that it can import Nato-standard waveforms into the radio to this end. Rafael is on course to deliver both radios to the Israeli Defence Force by the end of next year. The firm is also in discussion with two non-disclosed European non-Nato countries regarding further acquisitions. Ergonomically, the BNET-HH does not impose too much of a physical burden, weighing a mere 1.2kg (2.6lb) including its

battery. The BNET-V is not much heavier, tipping the scales at 7kg (15.4lb). It is noteworthy that the BNET-V can also be used in an airborne configuration. Both of these radios are compliant with the Software Communications Architecture which has been developed as part of the erstwhile United States Joint Tactical Radio System (JTRS) programme to define specific standards to increase waveform portability in software-defined radios. The BNET-V has a frequency coverage of 20-2000MHz and this can be extended upwards into the S-band of



*Elbit Systems' PRC-710HH, marketed under its Tadiran banner, is a lightweight VHF handheld radio. An add-on amplifier provides it with up to 20 watts of power. The company claims that it is the lightest frequency-hopping hand-held radio on the market. (Elbit)*

2000-4000MHz. Likewise, the BNET-HH can be extended upwards into the L-band (1,000-2,000MHz) and S-band if desired by the customer. The output power for the radios is five watts (BNET-HH) and 50W (BNET-V).

#### ■ SOURCE OF SOUND

Silence maybe golden; but not on the battlefield. Source of Sound has sold its in-ear noise reduction systems around the world. Soldiers need to hear, and need to be aware of the environment, but at the same time need to be protected from the loud noises which provide the soundtrack to battle. To put the financial cost of the noise of battle into proportion, the company says that each year the US government pays over \$1.2 billion in compensation for hearing loss damage.

Source of Sound is offering the Mini Black Box. It has been undergoing tests and trials for the last twelve months. The IDF has already ordered a few hundred and they are currently being delivered. Each earplug combines a small microphone to pick up the ambient noise, and the earphone itself. These link to a control box with two push-to-talk buttons for two radios, or two channels, and a volume control for the ambient noise and for the communications feed. The earphones fit into standard earplugs, of which the company offers five different sizes. The Mini Black Box constantly monitors the level of ambient noise, and if there is a sudden bang, the earphones automatically cancel out the loud noise to protect the wearer's ears. Mini Black Box can be powered for around 45 hours using batteries, although it can also draw its power from a soldier's radio.

#### ■ MAXTECH NETWORKS

Much has been made of the growing software and computing industry in Israel. The expertise which is being developed for the civilian sector owes its ancestry to the investment which the country has poured into defence technology since its foundation in 1948. Companies such as MaxTech Networks provides both tactical radio and waveform technology. In terms of the latter, it provides software to firms such as Selex and Thales where it is embedded into these company's transceivers. The company will soon unveil its MaxTech SDR UHF radio which is already in trials with one of the customers. The radio has an analogue-like FM waveform which can link into civilian radio networks used by emergency services first responders for example, while offering narrowband and wideband networking. MaxTech will commence deliveries in six months. To provide an illustration of how the company's products can mesh with existing communications networks, MaxTech says that it is working on a project in the Far East which involves remote police stations located in isolated border regions. The police will use MaxTech's radios, and their transmissions will go through an internet protocol gateway which will link the radios to satcom and existing cell phone networks to enable them to communicate with command centres at the local and national levels.

#### ■ UTC

Communication underwater is never easy. Although sound travels faster in water, humans have not learnt the ability to speak

beneath the waves and be understood, and are unlikely to for the next few millennia. UTC's Underwater Digital Interface (UDI) gets around this problem by providing an acoustic modem for underwater text messaging by divers. Using ultrasonic waves it enables full digital communications, transmitting and receiving using the same antenna. Each device can transmit 14 pre-set messages and these can be added to the device using a USB cable via a laptop computer. When messages are transmitted to other receivers, the sender gets a confirmation that the message has arrived. To help divers in distress the UDI, which takes the form of a wrist-worn display, has an SOS button. Once this is pressed it transmits the position of the diver and their depth. Each wrist display has a range of up to one kilometre and ten hours of battery power during continuous use. The product has also been tested at depths of up to 100m. Up to 14 divers can be accommodated on each Acoustic Modem network.

## ELECTRONIC WARFARE

### SEWS-DV

Given the company's expertise in the field of defence electronics, it will come as little surprise to readers to learn that Rafael offers products in the electronic warfare domain. For example, Rafael's SEWS-DV maritime electronic warfare system covers the 0.2-40Ghz radar section of the electromagnetic spectrum. SEWS-DV equips the Israeli Navy. It can furnish submarines, surface vessels and also maritime patrol aircraft. Although not providing specific details, the firm says that the SEWS-DV has an expansive threat library, although this is empty when sold and it is up to the customer to populate this as they utilise the SEWS-DV in service.

The frequency spread of the SEWS-DV makes an important contribution to the protection of a ship. Anti-ship missiles routinely use millimetre-wave guidance radars in the Ka-band. The flight profile of such weapons means that they tend to skim the surface to avoid detection, which is further aided by their comparatively small physical size. Therefore, an electronic support measure such as the SEWS-DV can detect the missile's tell-tale emissions comparatively early, enabling the ship to take evasive action through aggressive maneuvering, the use of countermeasures or kinetic attack.

### SPS-65(V)

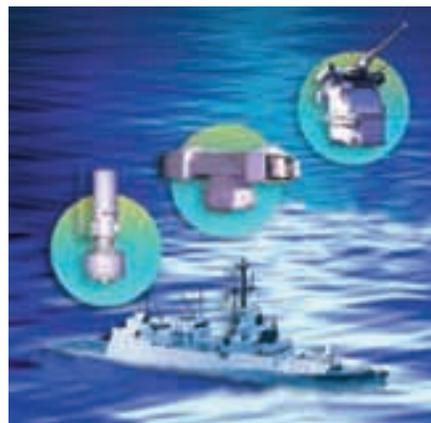
In the EW domain, Elbit Systems announced new products at this year's Paris Air Show in



*Rafael's RAVNET-300 airborne radio is currently in service with the Israeli Air Force and Israeli Navy. It has a data throughput of up to 300kbps and, although having only recently entered service, it will soon be replaced by the company's NetCore product. (Rafael)*

the form of the SPS-65(V)5 Electronic Intelligence and jamming platform. According to the company, the SPS-65(V) offers a wide spectrum of capabilities and has competitive size, weight and power characteristics. The frequencies covered by the SPS-65(V)5 range from low-band frequencies up to 18Ghz. In terms of signals, the product can detect conventional pulse, continuous wave and high-pulse repetition frequencies. In addition, the SPS-65(V)5 performs a laser warning function for multi-band laser frequency coverage, single or multiple pulse lasers. A number of airframes, including UAVs, can accommodate the SPS-65(V)5 given that it has compatibility with the MIL-STD-1553 databus, and also the RS422 and RS232LAN technical standards. Elbit Systems have produced the SPS-65 in several versions including the (V)1,(V)2,(V)3 and (V)5. The key differences between these versions is the steady reduction of the quantity of black boxes. For example, the 'brains' of the SPS-65 is all housed in one Line Replacement Unit which in turn links to up

*Rafael's SEWS-DV is a digital shipborne electronic warfare system. It covers the 0.5-40Ghz frequency range, allowing it to detect the millimetre-wave radars of anti-ship missiles, while also being able to perform electronic countermeasure functions.*



to eight laser and radar sensors located about the airframe, providing 360° coverage. In the medium term Elbit is developing a 40Ghz extension which will be available soon, although this will require the aircraft to accommodate more antennas. Elbit Systems has several customers for the SPS-65(V)5 to equip manned platforms, and the company hopes to secure an order for drone-mounted SPS-65(V)5 payloads from the Israeli Defence Force shortly.

### SKYFIX

The SPS-65(V) joins the SkyFix product which is a UAV-mounted system electronic warfare payload. SkyFix consists of a family of products including SkyFix Comint-DF, SkyFix-G, which can jam tactical networks and SkyFix-Cellular for mobile phone jamming. All of the SkyFix products can search across the target spectrum; monitor and classify selected frequencies and perform jamming. SkyFix has been deployed on the Hermes-450 drone, and may yet equip the larger Hermes-900.

## BATTLEFIELD MANAGEMENT AND C2

### DAP - ELBIT SYSTEMS

Elbit Systems has carved out a niche as a leading supplier of defence electronics since its formation in 1967 in the northern Israeli city of Haifa. Currently, the company is leading the Israeli Army's Digital Army Programme (DAP) battle management software which is carried by the Tiger/Torch communications backbone. The DAP, which entered service in the 2008/9 timeframe, provides a Battle Management System for all branches including armour, artillery, engineers, infantry, reconnaissance and logistics. It connects all echelons of command from the Corps level down to the individual soldier.

The DAP is built around a core suite of software which is adapted to the echelon of command and the branch of the army which it equips. Over the long term, Elbit is working on algorithms that can 'clean up' the quantity of information which is being delivered from sensors to various levels of command to ensure that users are not deluged with data. This will be implemented in DAP via a software upgrade and should be rolled out across the Israeli Defence Force in the next five years.

### C2 - MPREST

Software is also a speciality of MPrest which provides Command and Control (C2) software, and has been heavily involved in the

development of the C2 architecture for the Iron Dome. The company's strength is that it develops a generic infrastructure for a C2 system which can then be sold to customers and tailored to their requirements. The Israeli Air Force has also adopted the infrastructure and MPreSt says that it can establish a C2 system in less than 24 hours using its generic building blocks. At the civilian level MPreSt is developing a C2 system for Israeli electrical companies. This will connect up to 300 sites, some of them manned and some of them unmanned. MPreSt's C2 software is Windows-based and has been used for a wide range of applications, from drone ground control stations to border security systems.

## JAMMERS

### PHANTOM TECHNOLOGIES

Israel knows all too well the death and destruction which can be wrought by car bombs and explosives. Little surprise then that Israeli firms such as Phantom Technologies are producing analogue and digital cell phone jammers and other counter-roadside bomb equipment. These products can take the form of manpack and mobile tactical jammers, power amplifiers, but also



*Elbit Systems is leading the Israeli Army's Digital Army Programme (DAP) which provides battle management software across the Tiger/Torch communications backbone for all branches of the force.*

large compound jamming solutions to cover a wide area such as a prison to prevent cell phone use by inmates. For security on-the-move Phantom Technologies provide convoy jammers in the form of vehicle-based systems, and covert vehicle-borne jammers.

### SKYFIX - ELBIT

The SkyFix is a drone-mounted system electronic warfare payload, and is mentioned in that section (it has been deployed on the Hermes-450 drone, and may yet equip the larger Hermes-900). It in fact consists of a family of products that includes the SkyFix Comint-DF SkyFix-G, which can jam tactical networks and SkyFix-Cellular for mobile phone jamming. All of the SkyFix sets can search across the target spectrum, monitor and classify

selected frequencies and perform jamming.

### ATALD - IMI

In the survivability and protection field an IMI export success is the Atald decoy. Adopted by the US Navy, it can be configured with different payloads, RF, IR or IR & RF, simulating advanced targets in order to saturate the defences of the enemy vessel. The Atald can generate multiple false targets, can be set for RCS and speed, and can be programmed for a certain flight behaviour. The carrier is 2.34 metres long, has a 1.55 meters wingspan, and weighs 170 kg, and can reach a speed of up to 260 m/s powered by a 77 kg thrust turbo engine. When operating at low altitude, up to 20,000 feet, it has an endurance of 18 minutes, which increase to 35 minutes when operating at high altitude, up to 30,000 feet. □

## The Ultimate Threat Management Solution



# The WARFIGHTERS TACTICAL RADARS

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- Hostile fire detection - indirect (C-RAM), direct, irregular
- Aerial surveillance - C-UAS, manned aircraft
- Ground surveillance - GMTI
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- Hemispheric coverage, software defined, AESA

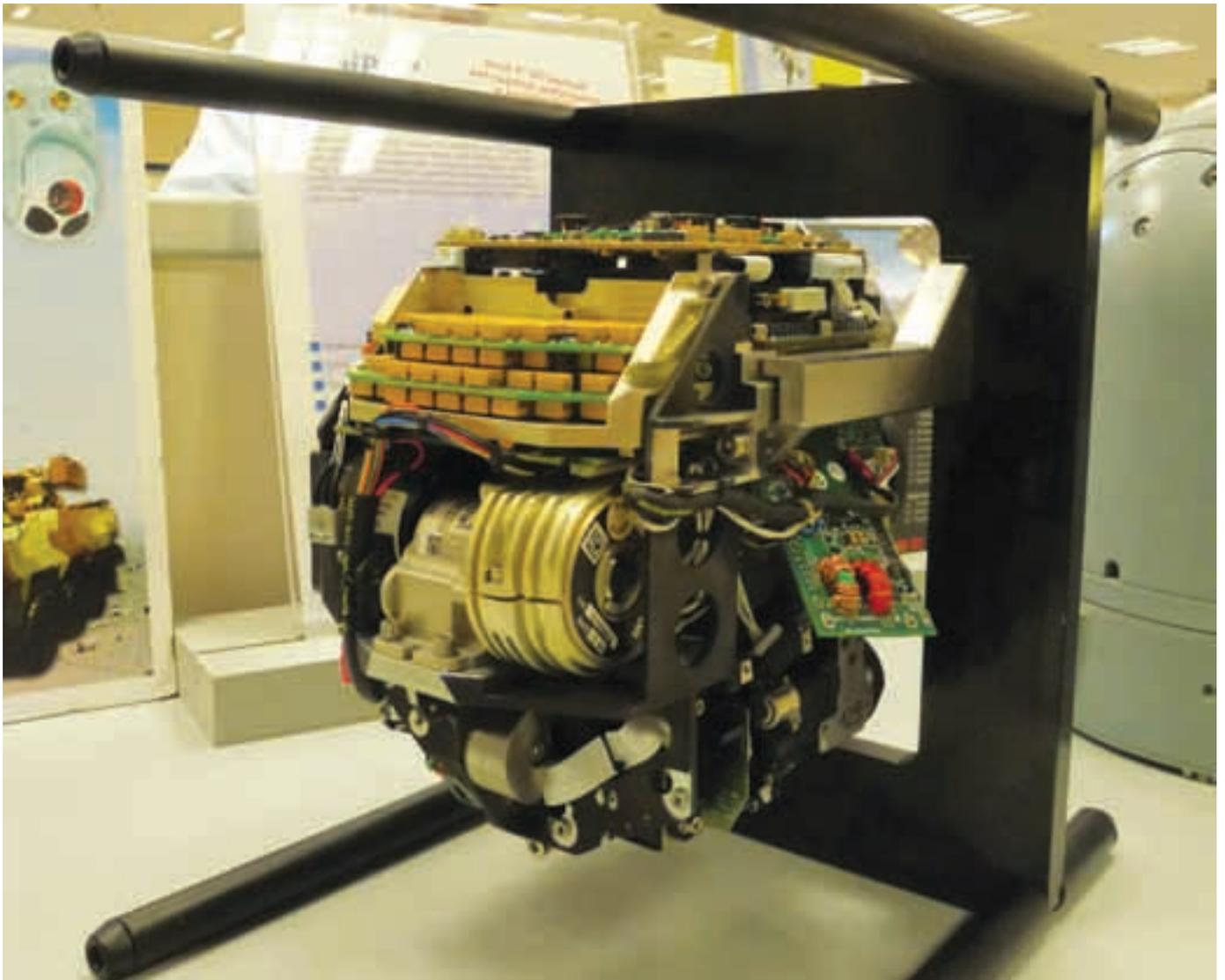


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# Stabilised Electro-Optics

This domain is largely shared between Elbit, IAI, Controp, Top I Vision and Esc Baz with numerous systems, although Rafael has its own turret known as the Toplite which has, according to the company, the unique record of being “on every ship of the US Navy”.



Initially more orientated on airborne applications, stabilised “balls”, as they often are referred to, now see applications extended to remote-controlled and robotic land and marine applications. In land applications they have become extremely appreciated to provide high-quality, long range pictures from the tip of a telescopic mast, for example. In the marine field, they are an absolute sine qua

non mount on robotic speedboats.

## ELBIT

Elbit's range comprises four main products, the Amps, the Compass, the Dcompass and the Microcompass.

The heaviest at 85 kilos, the Amps is designed for longer range maritime surveillance from larger aircraft, whether inhabited (typically Beech special mission

*A stabilised electro-optical ball (here a Minipop) is a challengingly tight combination of electronics and watchmaking precision mechanics. (Armada/Eric H. Biass)*

aircraft and helicopters) or not, like Elbit's own Hermes 900. The sensors it carries are largely configured to customer requirements but would typically include CCD camera, an infrared camera and an ICCD sensor. Image

Elbits range of gimballed electro-optical sensor essentially revolves around the Amps, the 15" Compass and 8.2" Microcompass turrets. (Elbit)



interpretation is greatly facilitated by the unit's own GPS and inertial navigation system that allow for accurate geo-pointing and image geo-referencing.

The 38-kilo 15" diameter Compass is more destined for maritime platforms. Its high definition day channel uses a large

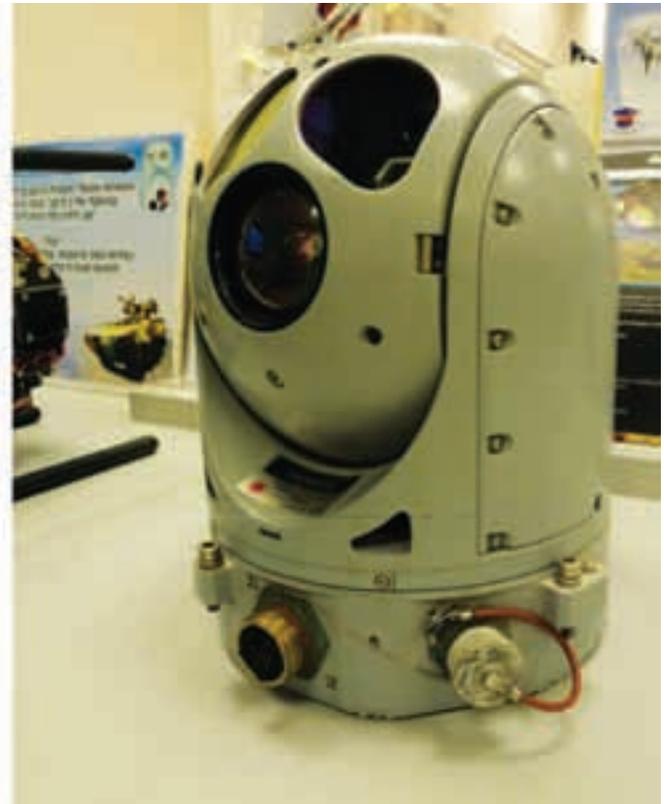
format CCD colour camera with three fields of view, namely 0-6° x 0.45°, 21.25° x 16° and 25° x 19°. The infrared camera is a cooled 3<sup>rd</sup> generation sensor based on a 640 x 512 pixel matrix. Laser sensors include two channels, one for rangefinding with an 154 µm eyesafe beam, the other for target designation using

1.064 µm beam although a 830 nm night vision-compatible emitter can be used.

The airborne Dcompass, also a 15-inch unit, is largely the same, but adds a 1394 x 1040 pixel CCD day sensor and geo-location through the use of inertial measurement unit. Its weight varies between 33 and 38 kilos.

The Microcompass is an 8.2-inch turret that tips the scales at nine kilos providing a 360° coverage and an elevation capability of

The Micropop (left) and Minipop are typical members of the wide range of stabilised electro-optical sensor produced by the Tamam division of IAI (Armada/Eric H. Biass)



STABILISED  
ELECTRO-OPTICS



*The Recce-U's sales already hover above the 60 unit mark, and given its capabilities, could eventually near the Reccelite's 1,300-unit scoreboard. (Rafael)*

gimbal assembly designed for a number of airborne, land and naval applications. The higher performance unit is actually called Toplite III and comes with a 640x480-pixel 3-5  $\mu\text{m}$  infrared sensor offering 1° x 0.77°, 4.4° x 3.3° and 24° x 18° fields of view. Tipping the scales at 59 kilos, it also houses a day camera (a variety of choices), a 1.54  $\mu\text{m}$  laser rangefinder and a dual-band 1.06/1.57  $\mu\text{m}$  laser designator-rangefinder.

In the context of sensors that are often used by drones, mention must be made here of the Recce-U from Rafael. A podded system, it in fact is a smaller and lighter version of the now well established Reccelite used by fighter aircraft or larger aircraft assigned on a deep reconnaissance mission, the Reccelite being itself a descendant of the Litening.

Unveiled at the Paris Air Show in 2009 the Recce-U can be carried by male drones such as



+30° to -90°. It houses a zoomed CCD camera, a 2nd generation 640 x 512 pixel array, 3-5  $\mu\text{m}$  infrared sensor with 2.5° x 2° and 17.5° x 14° fields of view, a 830  $\mu\text{m}$ , 10 km-range night vision goggle compatible target illuminator and an optional 1.54  $\mu\text{m}$  eyesafe 4 km-range rangefinder. This will typically find applications in drones or surface robots.

#### **I IAI**

Tamam's division of IAI specialises in all manner of electronic intelligence gathering and navigation systems, and it comes as no surprise that it should have developed a whole of range gyrostabilised electro-optical sensors, from the simpler Pop 200, through the Mosp series, to the latest and most sophisticated Pop300D-HD of which over 1000 have been sold world-wide.

The 20-kilo Pop 300D-HD is a 10.4-inch device which, as its suffix suggest, houses a high- definition 1280x1024 pixel, 3-5  $\mu\text{m}$  indium antimonide infrared sensor. The Day channel has nothing to envy either, being based on a 1920x1080 pixel Cmos sensor. Other channels include a dual 1.06  $\mu\text{m}$  and 1.54  $\mu\text{m}$  eyesafe laser rangefinder, an 830 nm laser pointer, and an automatic video tracker .



*Controp's flagship is the 22.5kg, 3-5  $\mu\text{m}$  infrared and day four-gimbal gyrostabilised turret, which is used, inter alia, by naval helicopters and drones. Controp is the first company to have developed a thermal camera equipped with a constant zoom. (Controp)*

*The ubiquitous Toplite is used on helicopters, fixed wing aircraft, ships, land vehicle telescopic surveillance masts. (Rafael)*

#### **I RAFAEL**

Rafael's Toplite is a sturdy 16-inch four axis



the Heron and upwards, and has been ordered inter alia by Spain, the Netherlands, Germany and Italy and has been used in Afghanistan. The system works in conjunction with a stationary or mobile ground station via a 250-km range SDV-53 datalink, simultaneously gathers high-resolution infrared and digital “visual” images and can fuse and patch pictures in real time, although specific frames can be blown up if needed. The patching is stitchless because is performed at pixel level.

With such performances, the Recce-U gets particularly useful in the search for roadside bombs (it can spot powerlines from a height of 15,000 feet) because of the perfect image

These small (pen provides a scale) and lightweight stabilised electro-optical sensors are representative of the Stamp series produced by Controp. The D-Stamp in the centre for example houses a x10 zoom CCD camera with inertial tracking mode with optional hold coordinate mode. The U-Stamp on the left carries an uncooled dual field-of-view sensor, while the TR-Stamp on the right packs a cooled 3-5  $\mu\text{m}$  sensor, plus a CCD camera with zoom and a laser rangefinder. (Controp)

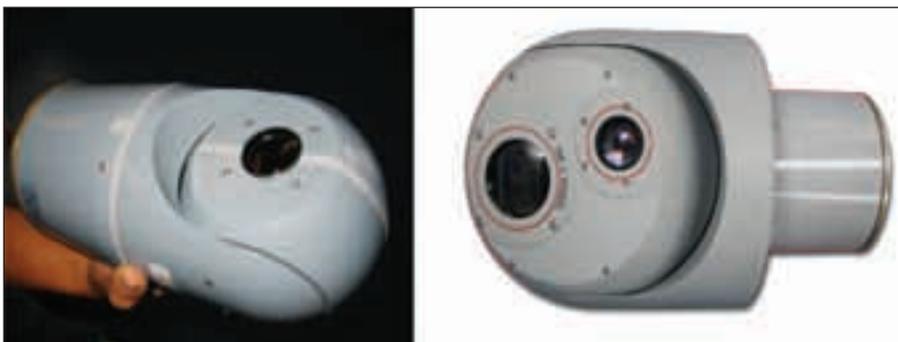
overlap it does and thus facilitates change detection. The system was put through its paces in a test where 144 items had been hidden. The Recce-U found 126 in one hour and thirty minutes.

**CONTROP**

Downsize, Controp is particularly renown as the supplier of small stabilised electro-

optical payloads for smaller and lighter drones to the extent that even numerous foreign lighter drones are seen equipped with one or the other of the company’s Stamp series.

However, the 210-employee company also produces larger and more powerful stabilised systems for helicopters (like the DSP-1), maritime platforms and all manner of vehicles, as well as powerful thermal imaging cameras (including the 15-km range Spider stabilised system for aerostats), automatic intruder detection systems and stabilised aerial pedestals. Its 3<sup>rd</sup>-generation 320x256 focal plane array Fox thermal camera, which is fitted to a number of unsuspected systems (including Tamam’s Mops and Controp’s own DSP-1), features an automatic gain control and imaging enhancement. Currently, exports account for 84% of Controp’s business, a figure that stood a 3% only fourteen years ago.



Amongst the lightweight stabilised sensors for light drones produced by Top I Vision are the 950-gram day camera Lev 2 and the 1.5-kilo Lev 6 that adds an uncooled camera channel. (Top I Vision)

**TOP I VISION**

Drone producer Top I Vision already

STABILISED  
ELECTRO-OPTICS



*The AVIV-LR is amongst the latest products from Esc Baz. Based on the Layla uncooled thermal camera, its dual-channel digital signal processing allows the addition of a CCD day camera. The AVIV-LR is also equipped with a 25-225 mm optical zoom. (Esc Baz)*

mentioned elsewhere in this survey, also produces its own range of stabilised payloads for light, hand-launched drones. These are the two-gimbal Lev 2 series that weigh one kilo maximum. The company also makes the Lev 4 Series, which at about 3.5 kilos carries a x40 zoom CCD camera, the Lev 6 Dual which packs a day camera and an uncooled thermal sensor for a total weight of 1.5 kilos.

#### **I ESC BAZ**

Esc Baz specialises in wired, wireless and man-portable observation systems, as well as tactical communication systems for HMS and military applications. Its surveillance and observation product line includes turn-key

solutions for perimeter defense, armored vehicle protection, and quick-deployment mobile systems.

The most tactical systems of the Esc Baz catalogue are those of the man-portable surveillance category, such as the AMI man-portable modular, scalable, remote control surveillance system, designed for combat multi-tasking at short, medium and long ranges. The Rooster is another remote operation observation system featuring a motorised pan-tilt head that can integrate hand-held thermal binoculars or other electro-optic sensors allowing soldiers to carry out a better surveillance while seeking protection from snipers. These systems are remotely controlled by Esc Baz Max and Max II multi-functional command and control systems.

The company portfolio includes a series of short and long range surveillance systems. Currently Esc Baz is mostly focusing on new long range uncooled thermal imaging systems able to detect a man at 6 km range. One of these is the AVIV-LR, designed for

military and paramilitary surveillance and observation missions, based on an accurate pan and tilt unit and a day/night sensor. The latter is the company Layla uncooled thermal camera, designed with integrated dual-channel digital signal processing video processing; the camera offers a built-in second video input for an additional CCD day camera enabling enhanced day time color vision. The system is equipped with a 25-225 mm optical continuous zoom and includes two built-in video processors and video image stabilization, ensuring night-vision video of the highest quality. With the addition of a laser rangefinder, a GPS and a gyrocompass the AVIV-LR can become a targeting asset, the system being also open to be integrated with other sensors such as radars, fence systems or unattended ground sensors. If fitted with a 25µm 384x288 pixels array the AVIV-LR allows to detect a man at 4,100 metres and to recognise him at 1,300 metres, while the 17µm 640x480 pixels array increases those figures respectively to 6,100 and 1,900 metres. □



# Space

**As well as producing satellites (above the Amos-5), IAI builds launch vehicles in the form of the Shavit series of rockets. Performing its first launch in September 1988, these rockets can be sent into space from the Israeli Air Force's Palmachim air force base on the country's southern Mediterranean coast, launching westwards to avoid the rockets overflying Israel's neighbours.**

**T**he maintenance of Israel's terrestrial airpower is a major priority for IAI, although the company is also heavily involved in supporting efforts in the 'final frontier'. Initiatives which IAI is currently working on in this domain include the Amos-4 satellite, the latest in the series of Amos communications satellites. This satellite is expected to weigh in the region of



4,000 kilograms and will produce 4,100 watts of power. Amos-4 will be placed in a geosynchronous orbit and will provide coverage of Southeast Asia. IAI's Amos-5 satellite is now operational, having been launched in December 2011 providing communications services over Africa, Europe and the Middle East. Looking towards the future, Amos-6 should be launched in circa-

*Since its maiden launch, several Shavit launches have been performed from the Palmachim complex. The rockets can lift up to 800kg into space. (IAI)*

2016. It will weigh around 4,500kg and be equipped with 40 transponders. This satellite is expected to replace the legacy Amos-2 bird launched in December 2003. This provides communications services in the Middle East, Europe and across the East Coast of North America, handling television, radio and internet communications. It is possible that Amos-6 could eventually be followed by Amos-7, although this satellite has not yet entered development.

Alongside the Amos family of communications spacecraft, IAI has developed the OptSat-3000 new generation observation satellite. With a weight of 400kg and a projected life span of circa six years, the OptSat-3000 will produce both panoramic and multi-spectral, high-resolution imagery. It is expected to be launched

in the next two-to-three years. For radar-based observation, IAI produces the TecSAR day and night synthetic aperture radar satellite which offers wide coverage using mosaic, spot and fine resolution. It was launched in 2008 and is expected to have a lifespan of up to six years. Imagery gathered by the TecSAR is transmitted to earth using an X-band datalink. □

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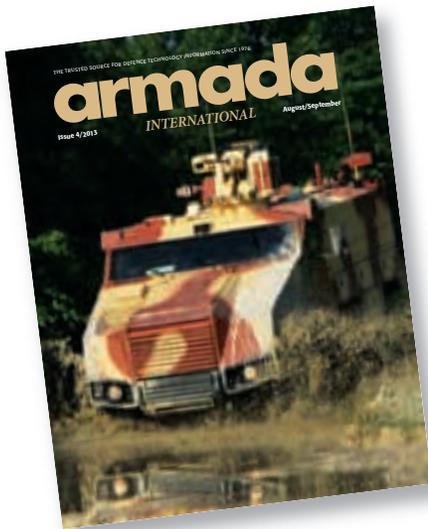
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<b>IAI</b> Israel Aerospace Industries, Ben-Gurion Int'l Airport, 70100, Israel www.iai.co.il	7, 8, 15, 41, 44, 46, 47, 49, 57, 58, 59, 61	Aircraft, Upgrades, Air-launched Weapons, Drones and Robotics, Stabilised Electro-Optics, Air Defence, Smaller, Remote Controlled or Throwable
<b>Elta Systems</b> IAI Elta Systems, PO Box 330, Ashdod 7710202, Israel www.elta.co.il	8, 10	Aircraft, Upgrades, Air-launched Weapons
<b>BEDEK</b> Ben-Gurion Int'l Airport, 70100, Israel www.iai.co.il	8, 10	Aircraft, Upgrades, Air-launched Weapons
<b>RAFAEL</b> Advance defence systems Ltd P.O Box 2250, Haifa 3102102, Israel www.rafael.co.il	10, 11, 12, 13, 17, 18, 19, 22, 23, 24, 25, 29, 30, 31, 32, 38, 41, 42, 43, 44, 48, 51, 52, 53, 54, 56, 57	Air-to-ground weapons, Air Defence, Vehicles, Vehicle Armour and Protection, Turrets, Anti-armour missiles and rocket launchers, Electro-optics in the Field, An Integrated Soldier approach, Naval Activities, Drones & Robotics, Surface Robotics, The Liquid Element, Electronics, Stabilised Electro-Optics
<b>IMI</b> Israel Military Industries Ltd., PO Box 1044, 64 Bialik Blvd, Ramat Hasharon, 4711001, Israel www.imi-israel.com	11	Air-to-ground weapons
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<b>Ariel Photonics</b> 4 Ha'Ma'ayan St, Lobby Fl, LIGAD Center 2 Bldg, Modiin 71700, Israel www.arielgroupinc.com	23	Vehicle Armour and Protection
<b>Camero</b> Intergama Building Level 3 Grand Netter Industrial Zone P.O Box 3521, Kfar Netter 40593, Israel www.camero-tech.com	39	An Integrated Soldier Approach
<b>Controp</b> P.O. BOX 511, Hod Hasharon, 45105, Israel www.controp.com	47, 57, 58	Drones and Robotics, Stabilised Electro-Optics
<b>DSIT</b> 2 Rechavam Zeevi St., Givat Shmuel, 5401777, Israel www.dsit.co.il	43	Naval Activities
<b>Elbit</b> Adv.Tech Center, P.O.Box 539, Haifa, 31053, Israel www.elbitsystems.com	44, 45, 46, 47, 50, 51, 52, 56, 54, 55	Drones and Robotics, The Liquid Element, Electronics, Radios, Electronic Warfare, Jammers, Battlefield Management systems and C2

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<b>Elisra</b> 48, Mivtza Kadash St., Bene Beraw, 512503, Israel www.elisra.com	43,46, 52	Naval Activities, Drones & Robotics, Electronics
<b>Elop</b> Advanced Technology Park, P.O.B. 1165, Rehovot 76111, Israel. www.elbitsystems.com/elop	43,37,38	Naval Activities, An Integrated Soldier Approach
<b>Elta</b> 100 Yitzchak Hanasi Blvd., P.O.BOX 330, Ashdod, 77102, Israel. www.elta.co.il	8,16,17	Aircraft, Upgrades, Air-launched Weapons, Air Defence
<b>Esc Baz</b> P.O. Box 173 Kibbutz Einat 48805, Israel www.escbaz.com	58	Stabilised Electro-Optics
<b>G-Nius</b> P.O.Box 4018, Nes-Ziona, 74140, Israel www.g-nius.co.il	48	Surface Robotics
<b>Hatehof</b> P.O Box 639, Ind. Zone Ziporit, Nazareth Elite 17001, Israel www.hatehof.co.il	19,20	Vehicles
<b>Plasan Sasa</b>	22, 38	Vehicle Armour and Protection, Personal Protection
<b>Roboteam</b> HaAhim MiSlavuta 14. Tel Aviv, Israel 67010 www.robo-team.com	49,50	Smaller, Remote Controlled or Throwable
<b>Seraphim Optronics</b> 2 Hayetzira St.P.O.Box 621 Yokne'am, 20692 Israel www.seraphim.co.il	38,39	An Integrated Soldier Approach
<b>Top I Vision</b> 25, Hathiya St., Holon, 58402 Israel www.topivision.com	47,51,58	Drones & Robotics, The Liquid Element, Stabilised Electro-Optics,
<b>Star Defence System group</b> 11 Granite st., P.O.Box 3034 Kiryat Arie, Petach Tikva, 4951410, Israel www.star-ds.com	25	Vehicle Armour and Protection
<b>Source of Sound</b> 19 Yad Harutzim St.P.O.Box 8628 Netanya, 42505, Israel www.s-o-s.co.il	53	Electronics
<b>Saymar Elbit Systems</b> 11 Granit St., P.O Box 3158, Petach-Tikva 49002, Israel www.saymar.co.il	20	Vehicles

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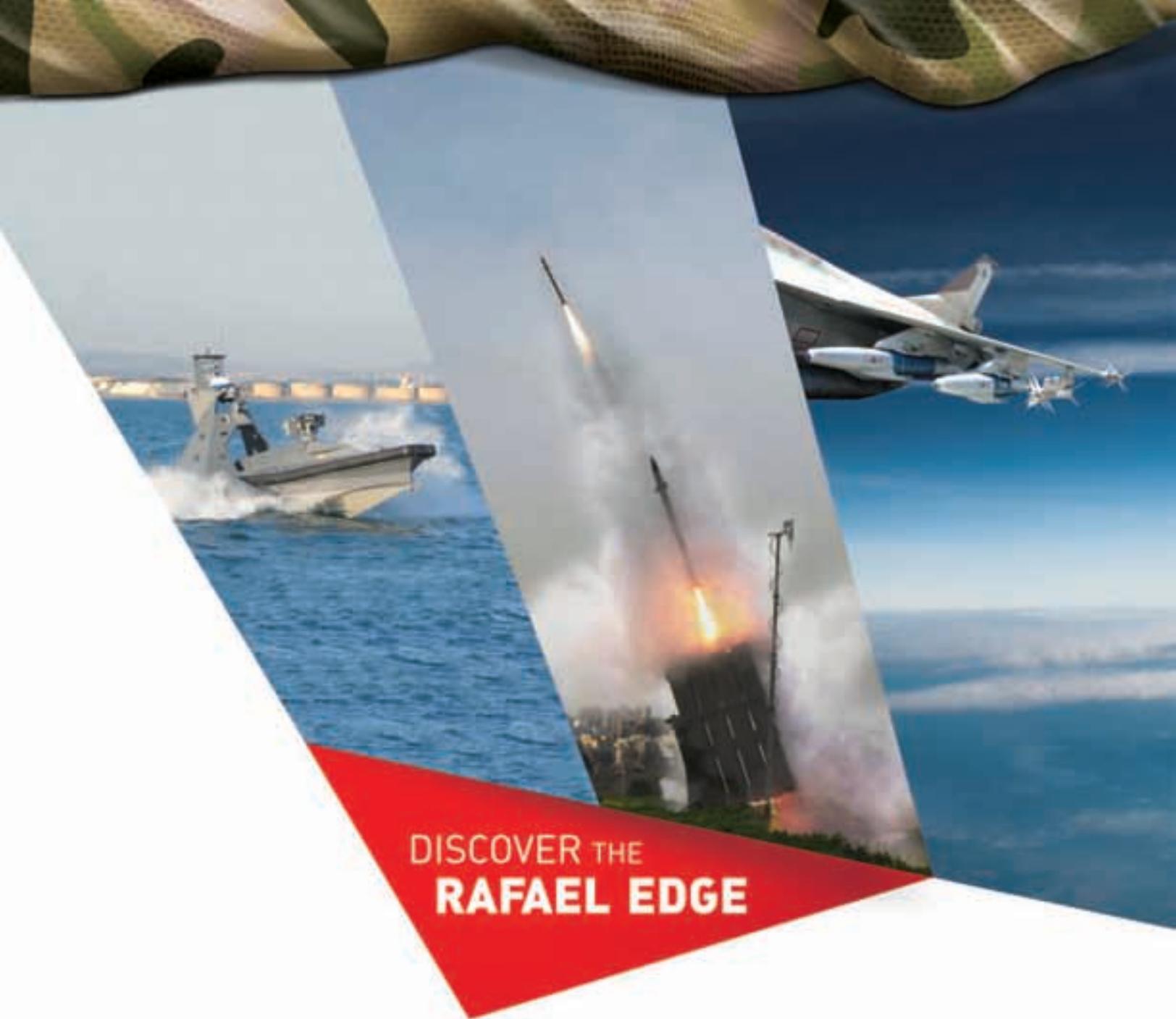
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