Look Not to the Skies:
The IAF vs. Surface-to-Surface Rocket Launchers

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During Operation Change of Direction in Lebanon, the Israel Air Force (IAF) recorded numerous achievements against Hizbollah's medium range and long range surface-to-surface rocket launchers. In contrast, the results against short range rocket launchers were disappointing, particularly since the air force nearly maximized its ability to deal with targets of this type. In the absence of foreseeable significant improvements in this area, the future solution to the short range rocket threat lies on the ground, not in the air.

On Friday, August 11, 2006, three barrages of medium range surface-to-surface rockets were fired towards Haifa and the northern suburbs from the vicinity of Tyre in Lebanon. In each of these cases the launcher was destroyed within minutes of the launch. In some cases secondary explosions were clearly visible, indicating that the launcher was probably attacked before it had fired all its rockets.[1] The process of locating, identifying, attacking, and destroying the three launchers was completed in record time. In approximately one hour Hizbollah lost a significant portion of what remained of its heavy rocket arsenal. However, on a day when more than 120 rockets hit northern Israel and caused dozens of casualties of varying degrees of seriousness, it is hard to be impressed with the destruction of three launchers. The air force's successful morning in terms of hunting down surface-to-surface launchers was largely irrelevant. This frustrating situation repeated itself both before that day and after.

The story of that Friday, which marked the end of the first month of the fighting in Lebanon, depicted one of the important aspects of Operation Change of Direction. The IDF managed, mainly by virtue of the air force, to record some impressive achievements against surface-to-surface rocket launchers. At the same time, the IDF reached almost the full extent of its air-based ability to deal with the problem of surface-to-surface rocket launchers and similar targets. In the foreseeable future and under similar circumstances, it is unlikely that any air-based capability will achieve better results.

The potential implications of this claim are far from simple. If the IAF reached something akin to the best result it could possibly achieve and despite this Hizbollah succeeded in firing approximately 3,970 rockets during the hostilities – an average of 120 rockets a day – Israel faces a difficult problem.[2] In other words, Operation Change of Direction has shown that anyone who thought that air power alone could remove the threat of rockets to Israel is mistaken. In fact, the lessons of the campaign underscore that at least in the coming years, that type of success for the air

1 "Attacking a Katyusha Launcher which Fired on Haifa," IDF website, August 11, 2006, http://www1.idf.il/SIP_STORAGE/DOVER/files/0/56510.wmv.

2 According to official Israeli police force figures, forty civilians and twelve soldiers were killed by rockets in the war, and about another 2,400 suffered various degrees of injury. Army figures indicate forty-two civilians killed and about 4,300 wounded.

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force is far from a viable scenario. At the same time, the war demonstrated significant progress in an air-based approach to deal with complex objectives of locating and attacking targets such as surface-to-surface rocket launchers. This progress may play a central role in dealing with similar targets of greater significance, such as surface-to-surface missile launchers.

Contending with Surface-to-Surface Rocket Launchers

Surface-to-surface rocket launchers refer to a wide range of configurations rather than a specific model of weapon, and the differences between the launchers affect the challenge in dealing with them. Surface-to-surface rocket launchers can generally be classed by two parameters: the size of the rocket, usually noted by its diameter, and the method of launching. The various sizes of surface-to-surface rockets translate into different ranges and weight of the warhead. Hizbollah, for example, has rockets with different sizes and performance levels.[3] While short range rockets can be launched from a solitary launcher, which may not be more than a barrel on a stand, the larger rockets require a more complex launching system. In general, this is a standard truck carrying a number of cylindrical containers in the back, each with a rocket inside. Long range rockets generally need a custom-built truck that carries a single rocket. In all cases, the truck acts as both carrier and launcher.

Contending with launchers can occur in two different stages: before the launch and during/after the launch.

The Pre-Launch Stage

It is best to locate and hit the launcher before it fires its load of rockets. The problem is that at this stage it is hard to distinguish the launcher from the innocuous objects around it.[4]

The most effective way to hit launchers and their rockets prior to launching is by attacking the places where they are stored. The crux is accurate intelligence, yet such intelligence does not always exist. Intelligence about the location of storage facilities, for example, does not supply air power capability with information as to what lies inside the facilities or how the facilities are used. Furthermore, the enemy will likely make every effort to keep the existence of such sites secret and will position them in places that are hard to strike, such as civilian buildings in the heart of a densely inhabited area and bunkers that are hard to penetrate. At the same time, it may be assumed that the enemy will not concentrate its assets in a few locations; rather it will prefer to spread them out so that even if some are located and successfully targeted this will not neutralize all its firing ability, or even a significant part of it.

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Attacking sites suspected of serving as storage depots for launchers and rockets can be complemented by operating in places suspected of being launch sites. First, certain operations can make it difficult to use the area. For example, mines can be dispersed in advance from the air, the territory can be exposed in various ways, and continuous obtrusive air presences can be maintained in the hope that this will deter the enemy from using the location. Second, one can define loose criteria of incrimination so that any vehicle moving in a suspicious area that meets a certain description relating to its dimensions will be attacked even if it is not possible to ascertain that it is a launcher.

The chance that these steps will lead to a significant reduction in the enemy's launch potential, except for successful destruction of the rocketry while it is still in storage, is doubtful. These approaches mainly make it difficult for the enemy to operate and as

3 For details of Hizbollah's rocket arsenal, see the table in Yiftah Shapir, "Artillery Rockets: Should Means of Interception be Developed?" *Strategic Assessment* 9, no 2 (2006): 8.

4 Operation of the launcher is not preceded by identifying activity prior to the launch. The launcher does not need to transmit, and its heat radiation is no different from that of a regular truck. This means that devices used to locate targets, such as thermal imaging systems, radar, and signal intelligence devices (SIGINT) find it hard to locate and identify launchers of this type.

a result may reduce the volume of the rocket fire and, in particular, have an adverse effect on the accuracy of the rocket fire. However, as long as the rockets fired into northern Israel are the type that lack accurate precision, if the rockets hit land and not the sea it is likely that something will be damaged.

The Launch/Post-Launch Stage

The chances of locating and identifying a launcher change at the moment when the launcher goes into action and starts to fire rockets. In general, all the launcher has to do is to reach a launch location (which may or may not be predetermined), straighten the rocket containers to a vertical position, launch the rockets, and then vanish back into the surrounding area. All this takes little time.[5]

Several segments of the launch brand the launcher's signature. First, the actual launch immediately differentiates the launcher from other trucks. Second, the launcher can be located according to the amount of heat it gives off, the smoke trail of the rockets, and the movement of the rockets through the sky. Most of these changes can be discerned regardless of the time of day.

What Did the Air Force Achieve in Lebanon?

Israel scored much success in contending with launchers at the pre-launch stage, particularly vis-à-vis medium and long range launchers. An Israeli defense source was quoted as saying that in the first two days of Operation Change of Direction the air force destroyed around 80 percent of Hizbollah's medium and long range rocket capability.[6] This success can be attributed to the intelligence community more than to the air force.

The air force's ability to contend with short range launchers was limited and did not materially affect Hizbollah rocket capability.

In order to identify a launcher during or after the launch, surveillance devices or sensors are needed over the enemy's territory on an ongoing basis. They must identify the launch and its source, and guide attack systems or "shooters" that strike the launcher. This process, which is called "closing the loop," must occur within minutes of the event. If it takes too long the launcher is liable to relocate. Moreover, the enemy generally fires off a heavy barrage from a large number of launchers, which means that several launch positions have to be dealt with simultaneously. If there are sufficient solid intelligence means in place, all the targets can be dealt with at the same time. Without this ability, however, a decision must be made as to which launch sites to target.

As was expected, the greatest challenge was in contending with the launchers that were not destroyed in the opening stages of the campaign. Estimates indicate that overall the IDF and particularly the air force destroyed over 125 surface-to-surface rocket launchers,[7] and hit more than 250 targets suspected of being launchers and hundreds of sites where launches were carried out. Without an exact figure for the scale of the

5 The type of rocket and launcher determines how difficult it is to contend with the launcher. The smaller the rocket, the less need there is for a special launcher, and a single barrel, which can hardly be identified in advance, is all that is required. On the other hand, the larger the rocket, the larger the launcher required and, in the case of particularly heavy rockets, a special vehicle is needed that is different from a civilian truck. In other words, the launcher signature is greater the larger the rocket, but also greater the number of rocket containers. Similarly, the larger the weapon, the longer the launcher appears in the open. A barrage of rockets fired from a number of containers lasts appreciably longer than the launch of a single rocket. In the case of medium range rockets and even more so in long range rockets, the launching operation is longer. However, here too the whole operation takes no more than a few minutes.

6 Steven Erlanger, "Israel Committed to Block Arms and Kill Nasrallah," *The New York Times*, August 20, 2006. According to another report, in the first thirty-nine minutes of the war fifty-four long range surface-to-surface rocket launchers were destroyed, Ben Caspit, "Amateurism," *Maariv*, August 18, 2006.

7 Yossi Yehoshua, "The Military Action," *Yediot Ahronot*, August 15, 2006.

Hizbollah rocket arsenal prior to the fighting as well as a breakdown of the various types of launchers, including those that were destroyed, it is hard to assess the air force's success. But two main points can be highlighted.

First, monitoring the IDF's reports during the fighting indicates that on many occasions when medium range rockets were launched – i.e., 220 mm and 302 mm rockets[8] – particularly towards the Haifa region, the air force succeeded in destroying the launchers within a short time of the launch. The figure of between 45 seconds and one minute as the time that elapsed between locating the launchers and attacking them sounds overly short,[9] but what is important is that almost all such launchers were identified and attacked, sometimes before they had completed firing all the rockets they carried. There was no report of how many such launchers Hizbollah had prior to the war, but it appears it was a small number ranging from isolated launchers to several dozen, so that any strike on such launchers was significant. There were days on which a number of such launchers were destroyed, for example, on August 11, when the three launchers were destroyed, and two days later, on the last day of the fighting, when seven were destroyed.

Second, it seems that the IAF achieved a shorter time span for closing the loop, shorter than the entire rocket launch process. No less important is the fact that the air force demonstrated this ability day after day for over a month of fighting: the ability to maintain continuity in intelligence gathering and attacks over a wide area of enemy territory with ongoing command and control alongside other air force activities, such as attacking infrastructure targets, providing close air support for the ground forces with assistance, and gathering other intelligence. In addition, Hizbollah's launch records indicate there were days when no medium range rockets were launched, despite the ongoing short range surface-to-surface rocket fire. It is hard to determine if the lack of launches stemmed from a conscious decision due to political considerations, or was based on a wish to maintain the launch ability for later stages of the hostilities – or a future confrontation – and not to continue it as a one-time device.[10]

In contrast with this success, the air force's ability to contend with short range launchers was far more limited and was not reflected by changes to Hizbollah rocket capability. During the fighting Hizbollah fired close to 4,000 rockets, whereby the rate of firing not only did not decrease but peaked at over 200 rockets a day in the last days of the fighting. It is also hard, based on data currently available, to identify substantial damage inflicted on the accuracy of Hizbollah fire.

The Recurring Picture

The primary achievement of the air force's success in Operation Change of Direction lay in proof of its ability to focus on low-signature time sensitive targets. A combination of advanced technological means in the area of intelligence gathering and attack, partly the result of innovative advances by the Israeli defense industries, allowed the air force to close the attack loop in an amount of time that until Change of Direction was considered far-fetched. It is highly possible that had the fighting continued much longer Hizbollah would have had difficulty in continuing to launch medium range rockets, even without the presence of ground forces in the launching areas. Moreover, it is reasonable to assume that the relatively small number of barrages fired at Haifa was a direct result of the air force's achievements.[11]

8 The 320 mm rockets were dubbed by Hizbollah Haiber 1. According to IDF figures, sixty-four 220 mm rockets and twenty-eight 302 mm rockets hit Israel. An unknown quantity of these types landed in the sea. Amir Buhbut, "Hizbollah United, We Less So," *NRG*, September 18, 2006.

9 Erlanger, "Israel Committed to Block Arms."

10 It is also difficult to determine if long range rockets were not launched during the fighting, despite threats made by the Hizbollah leader, because most of the capability was destroyed at the start of the fighting, because of other operations carried out by the air force, or due to a political decision not to use this weapon in the current confrontation.

11 Based on Israeli police figures, ninety-two rockets landed in Haifa (thirty-two in inhabited areas), seven in Afula, six in Beit Shean, two in Tirat HaCarmel, two near Hadera, and one near Zikhron Yaakov. Two rockets landed in Judea and Samaria. By way of com-

In the absence of precise figures it is hard to determine whether the attack loop can be narrowed further or the air force's performance improved. However, the impression is that the air force realized close to its full potential. The main improvement that can be anticipated is more intelligence gathering means with an eye to greater coverage, although without further information it is hard to determine whether this would have allowed narrowing the attack loop and the destruction of additional launchers.

The air force did not succeed in contending with short range surface-to-surface rockets because of any failure or error in judgment. It is simply not capable of doing this well.

Despite all the justified praise heaped on the air force, the bottom line cannot be erased. The air force did not succeed in stopping the short term rocket attacks on northern Israel. Even if the air force did hit launchers and launch units, the damage was insufficient. The air force's actions may have reduced the number of launches somewhat; however, it does not really matter whether Hizbollah fired only 200 rockets a day and not, say, 300, which it could have launched without the air force.

Why did the air force not succeed? Each surface-to-surface rocket launcher was a difficult target, but even more complicated is that most of the rockets were launched from single launchers dispersed across the terrain.[12] These targets pose a formidable challenge to the air force. Indeed, the IDF, including the air force, has encountered similar difficulties in recent years in contending with Palestinian Qassam rockets, despite the fact that the launching areas are more limited and the launches are relatively fewer.

Even in those cases when the launcher was identified after the launch, in itself a complicated operation – particularly when dozens of such launchers operate simultaneously in a large area – the question arises whether there was any point in attacking. A launcher of this sort is largely a one-time device. Hizbollah has a limitless supply of these launchers and in contrast with larger launchers stationed on a truck, they are relatively easy to improvise, even in the middle of a war. Was it right to invest resources and effort in attacking a barrel that had already launched its load, and was unlikely to be used again by the enemy? The answer is no.

Did the air force, before the war, promise it would stop the threat of surface-to-surface rockets entirely, including short range surface-to-surface rockets? It is highly likely that the answer to this question will surface in one of the commissions of inquiry called on to investigate the war. On the other hand, it is questionable whether someone who understands the abilities and limitations of an air-based force can make such a promise. The air force did not succeed in contending with short range surface-to-surface rockets – when not carrying out a preventive strike when the rockets were still in storage – because of any failure or error in judgment. It is simply not capable of doing this well.[13] However, the impression during and after the war is that many in the political and defense echelons (and as a result, many members of the public) expected the air force to be able, almost single-handedly, to bring about a significant reduction and possibly even a cessation of rocket fire on northern Israel, including short range rockets. Since this goal was not

parison, the Kiryat Shmona area was hit by 1,102 rockets, Nahariya – 808, Maalot – 642, and Tzfat – 471 rockets.

12 The air force succeeded in hitting a large number of multi-barrel launchers of short range surface-to-surface rockets installed on trucks.

13 It is hard to determine the accuracy of a report according to which Intelligence was in possession of information that, if it had been passed on to the air force, could have helped the air force contend with short range surface-to-surface rockets: information that would have facilitated attacks on launchers prior to launching. In any case, however, this would not entail an improvement of the air force's ability to deal with surface-to-surface rockets but its accurate guidance by Intelligence. See Ze'ev Schiff, "How We Missed Destroying the Short Range Rockets," *Haaretz*, September 3, 2006.

achieved, and particularly following the significant increase in Hizbollah fire in the last days of the war, the dominant impression was that the air force failed in its mission. For many, the air force's performance against the surface-to-surface rocket launchers is one of the most striking failures of Operation Change of Direction. The fact that these targets were not achievable became irrelevant.

There are a number of questions that merit a cautious attempt at an answer. If fighting recurs in the north, would the air force achieve better results in contending with surface-to-surface rockets? Similarly, what can be learned from confronting surface-to-surface rockets in the Lebanese arena apropos surface-to-surface rockets and surface-to-surface missiles, for example, in Syria?

Based on experience acquired in Operation Change of Direction and information on the means under development to confront a threat such as surface-to-surface rockets, no significant improvement in the air force's ability to deal with surface-to-surface rockets is expected, at least in the coming years. In absence of new detection technology that will allow early location of launchers, the air force will – in the future too – have to deal with launchers mainly after they have started firing rockets. In this context, advances may occur on two main levels: simultaneous handling of a larger number of launchers, and striking at launchers at an earlier stage of the launch process, so that they will be able to launch fewer rockets before being destroyed.

This is true particularly vis-à-vis medium range and long range launchers. The encouraging point here is that the capabilities that were demonstrated in Lebanon indicate that the air force has good – and to an extent unparalleled – abilities in dealing with other targets such as surface-to-surface missile launchers, particularly in the Syrian arena. It is safe to assume that this message has been received by the other side. On the other hand, in Operation Change of Direction, the air force operated in almost optimum conditions. The aircraft operated without being exposed to airborne threats, and there were relatively few land-based threats. The weather in the fighting arena was good and the distance between the air bases and the area of operation was short, what allowed the continuous presence of aircraft over the fighting arena round the clock.

It is unclear whether in fighting scenarios with different basic parameters the air force would be able to repeat its achievements in Lebanon, particularly during the early stages of the fighting. Potential enemies will also learn from the current hostilities and will try to use their rockets in new ways and provide a solution for the air force's operations. With regard to short range launchers, and particularly those based on nothing more than a barrel, the solution will not be provided by the air force. At this stage it is hard to think of a technological means or a fighting technique that will allow substantial and serious improvement of the aerial ability to deal with this threat.

In view of the fact that Israel continues to live under an extensive threat of surface-to-surface rockets – from the Lebanese arena, from Gaza, and possibly from the West Bank – a solution is necessary to counter the threat of short range surface-to-surface rockets. In addition to possible means of intercepting the rockets in flight, which have not been addressed by this paper, the air force's ability to deal with the launchers must be enhanced. However, the air force cannot be the sole or even main actor in this effort. The struggle to deal with the threat of short range surface-to-surface rockets requires significant use of land-based means, including special forces and artillery. Despite the desire to avoid using land forces, due to the high cost they incur, politicians and military personnel would do well to remember that as long as the threat of surface-to-surface rockets remains substantial – and the last war in Lebanon proved this even to skeptics – this cannot be avoided. As far as short range rocket launchers are concerned, the sky is not the limit.