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In a European war, the allies will need every defensive asset they have – SAMs and guns as well as interceptors – to defeat a massive air assault.

Air Defense From the Ground Up

By John T. Correll, Senior Editor

The Army and the Air Force weigh their words when talking about their shared mission of air defense. The prevailing mood at the moment is one of cooperation and joint planning, but the partnership has not always been an easy one.

Ground-based defenses – surface-to-air missiles (SAMs) and antiaircraft guns – belong to the Army, which is also responsible for point defense of air bases. Air-to-air defense is an Air Force mission.

There is absolute agreement about the importance of air defense. The Army has not fought a battle without the cover of air superiority since 1942, and there are few illusions that Western Europe could be held if Soviet and Warsaw Pact attackers were able to establish control of the air. There is also agreement that existing air defenses are thin, and that neither the Army nor the Air Force can do the entire job alone.

But as with any joint responsibility, there has been friction about roles and missions. Beyond that, he two services have sometimes differed about approaches to air defense.

The Air Force is mightily concerned about the vulnerability of its air bases, particularly in Europe. The classic scenario for war begins with an all-out air assault in which the Pact attempts to knock out NATO air bases early. In the not-too-distant future, air bases will almost certainly come under threat of attack by conventionally armed tactical ballistic missiles. If western air forces cannot operate, any conventional war in Europe would be a short one.

In a 1981 funding squeeze, the Army canceled a US version of the Roland missile, which was in production to upgrade point defense of air bases and other high-value targets. The Air Force learned of the cancellation by reading the Army's budget submission. The Army says that while it failed to coordinate its decision with the Air Force, the requirement for air base defense was considered, and the conclusion was that this could be properly provided for with a combination of Improved HAWK and Chaparral missiles.

Over the objections of the Army, the Defense Department subsequently directed procurement of British Aerospace Rapier missiles, to be manned by the Royal Air Force Regiment, for defense of USAF bases in the United Kingdom. Within the Army community, this was widely perceived as the first step toward the Army's loss of its traditional air defense mission.

A similar arrangement for defense of air bases in Germany, probably with the Euromissile version of Roland, has been percolating in Washington and Bonn. Rumors vary about how well or how poorly the negotiations are going, but at this writing no decision and been announced.

The Air Force does not covet the Army's ground-bases air defense mission or the budget headaches that go with it. What the Air Force has wanted all along is for the Army to perform that mission and to give it adequate priority. That is still what it wants.

A joint Air Force-Army study of air defense requirements worldwide is in progress. If the Army cannot or will not meet the air base defense needs identified by that study, the Air Force will probably make arrangements on its own.

Blunting the Attack

Air defense in its broadest sense includes more than interceptors, SAMs, and guns. It also incorporates such passive measures as camouflage and tone-down of high-value assets, a capability to repair cratered run was rapidly to get them back into operation, and even interdiction of enemy airfields to keep penetrators from generating attack sorties in the first place.

The most demanding air defense environment is Central Europe, the focus of this article.

The NATO interceptor force is small, but it includes American F-15s, the finest air-superiority aircraft in the world today. Given enough warning time, US and allied air defense units in Europe would be reinforced by squadrons deploying from the United States before the war starts. Most analysts believe there would be some warning time, with the enemy telegraphing his punch to a degree by the preparations necessary for attack. However, a surprise assault at 5:30 a.m. some Christmas morning cannot be altogether ruled out.

Depending on the extent of warning, fighters with dual air-superiority and attack roles, such as the F-16, would probably be employed for air defense, alongside fighters dedicated to that mission, in the early part of the battle.

The task in the first few hours of war would be to blunt the assault, then to regain the initiative from the attackers, keep the airfields open, and preserve airheads on the continent for reinforcements.

Blunting of the attack will have to be done quickly. Otherwise, the enemy will throw thousands of aircraft into successive waves of assault and blowholes through the defenses. Against a ground-bases defense that is necessarily dispersed, the attackers can concentrate on selected approach corridors. Defenses would soon become saturated, would run out of missiles, and would collapse.

The scenario explains the current emphasis on mobility and extending the air battle to the enemy's side of the line, destroying some of his capability to mass and regenerate his assault waves.

A mix of aircraft, missiles, and guns for both area and point defense is required.

As defenses go, SAMs and guns are cheaper than interceptors, and they also have higher readiness rates. Historically, air defense artillery – especially the guns – has taken a punishing toll on aircraft. The problem with ground defenses is that they are fixed, or effectively so. There

is never enough air defense artillery to cover all of the airspace, and any given point on the defensive belt can be overwhelmed.

The advantages of interceptors are that they have the flexibility, speed, and range to defend at the point of attack, wherever that may come. They are better suited to carrying out an active defense, taking it into the enemy's backyard if need be. The air-to-air war is analyzed regularly in Air Force Magazine, so the remainder of this article concentrates on the other part of air defense: ground-based systems and concepts for their employment.

Army Systems in Europe

Ground-based defenses in Europe range from a belt of large radar-controlled SAMs along the inter-German border to small systems fired from one man's shoulder. Several NATO nations contribute to the belt, which is an Alliance asset. It is "pre-chopped" to the allied air defense commander, even in peacetime, because if it has to be used there would be little time to waste on arranging for transfer of operational control.

I-HAWK. The forwardmost SAM in the belt is the Improved HAWK. It has range of forty kilometers. This is a derivative of the original Raytheon HAWK system fielded in the 1960s before low-level approaches had come to dominate tactics for penetrating aircraft. S forces have never fired HAWK in combat, but in its basic configuration the missile destroyed more than a score of high-performance aircraft in the 1973 Middle East war. In the wake of the US Roland cancellation flap, some of the I-HAWKs were redeployed for defense of air bases. The Army had planned to phase I-HAWK out of the belt by 1987 as the new Patriot system deployed, but will now keep some of the I-HAWKs in service longer.

Nike-Hercules. Back of the I-HAWKs is an inner belt of aging Nike-Hercules SAMs. They have a range of more than 140 kilometers, but can engage only one aircraft at a time and have a low rate of fire. The Western Electric Hike-Hercules' has been operational since 1958. It is characterized as "semi-mobile," and that is inadequate on the modern tactical battlefield. It will be withdrawn when Patriot is in place.

Patriot. The Raytheon Patriot is just now deploying. It uses a concept, new to the SAM world, called "track-via-missile" guidance. As the missile nears its target, it downlinks data to its radar, and a computer updates the missile onto a sure-kill path. It can engage several targets at once. Each missile is a "certified round," meaning that it can be shipped, stored, and fired without testing or maintenance in the field. Range is greater than eighty kilometers. By some estimates. Patriot is eight times better than HAWK at low altitudes. The Army is now considering the inter-netting of Patriot radars so that fire-control units can be served by more than one radar. This would provide flexibility and also a backup in case a radar is destroyed in action or neutralized by electronic countermeasures.

Chaparral. The Ford Aerospace Chaparral, with a range of ten kilometers, is the Army's current short-range SAM. It is currently a daytime, clear-weather system with infrared guidance. It fires a modified Sidewinder missile and is used around air bases as well as for forward defense. The all-weather US Roland would have replaced it for air base defense in Germany. Now, Chaparral is being upgraded with a forward-looking infrared (FLIR) night sight and will have some adverse weather and nighttime capability.

Vulcan. The General Electric Vulcan is a 20-mm Gatling gun for short-range defense. Some are deployed around air bases. Vulcan lacks range and lethality, and the Army does not think it is up to meeting the current threat in Europe, much less the future one. It is a fair-weather system

with a radar range-finder to acquire its targets. It will be replaced by DIVAD in the Army's heavy divisions and in battalions providing defense for air bases, but will be upgraded and stay in service with light divisions.

Sergeant Your/DIVAD. The Ford Aerospace Division Air Defense Gun (DIVAD), also called Sergeant York, mounts twin 40-mm Bofors guns on a modified M-48A5 tank chassis. It was designed primarily to counter Soviet Hind and Hip attack helicopters. DIVAD is an all-weather system, and its radar has high commonality with that in the F-16 fighter. At least one NATO nation is reported considering it, mounted on trailers, for air base defense, but the US Army intends to use it for protection of its field forces. The biggest problem with DIVAD may be that its funding future is shaky. It is said to be number one on the Army's cut list. The Army denies that this is so.

Stinger. The General Dynamics Stinger is an infrared, shoulder fired SAM that weighs just thirty-five pounds. It replaces Redeye, which was limited to stern shots at aircraft. Stinger can be fired from any angle to the target. It is credited with downing one Argentine aircraft in last year's Falklands War. When its regular operator fell in action, untrained comrades picked up his Stinger and later shot down an airplane with it. The US Air Force is buying Stinger for Security Police use in defense of air bases in Korea. Stinger's range is in excess of four kilometers.

Air Base Defense

Unless the Army devotes more of its attention to protecting USAF bases abroad, further solutions along the lines of the Rapier arrangement in the UK may be sought. The Air Force is projecting initial operational capability for Rapier defenses in Britain by the last quarter of this year, with full system deployment by 1986.

Rapier performed well in the Falklands. The British White Paper on the campaign credits it with fourteen Argentine aircraft kills and six probables. Most of the engagements were below 100 feet, often in mist or poor light. The Argentine aircraft were flying so low that one crashed into a ship's mast. Rapier has a range of about six kilometers. The basic system has been operational since 197, and its all-weather Blindfire radar since 1978.

The leading contender fur USAF base defense in Germany the Euromissile Roland, was also in the Falklands fighting. A background paper being circulated on behalf of Roland repeats the claim that the Argentines fired eight Roland missiles against British Harriers, destroying four and damaging a fifth, and that still another Roland hit a Harrier-released bomb in midair. British spokesmen call these claims "absolute nonsense." They admit to only one loss to Roland – a Harrier flying at about 12,000 feet – and say their aircraft losses were essentially to small-arms fire.

There is little prospect for an exact "Rapier role model" solution – the US buying a short-range air defense system to be manned by the host nation – in Germany. Instead, the approach being negotiated is that the Germans will buy, man, and maintain Roland for the protection of both USAF and German bases. In return, the US would procure twenty-eight Patriot fire units on behalf of Germany, and the Germans would man them for forward defense.

German officials have made it clear that it is politically impossible for them to buy Patriot to upgrade their contribution to the belt without some form of "industrial compensation." They will not keep on purchasing American systems unless the Americans begin purchasing some systems made in Germany. The Euro-missile Roland is a joint venture by Messerschmitt-Bolkow-Blohm in Germany and Aérospatiale in France.

Roland is a highly mobile all-weather system with a range of about six kilometers. The configuration proposed for air base defense in Germany would mount Roland on an eight-wheel-drive M.A.M. truck, with the radar and all fire-control elements contained on a single chassis. Inside the vehicle, the crew is protected against chemical, biological, or radiation attack. Euromissile Roland is in service with several armies, including the German Army. A version of this system, mounted on a tank chassis, has been reported to be effective for the Iraquis in their war with Iran.

Meanwhile, the Air Force is pursuing yet another option to supplement existing base defenses and to provide some defense to bases that have none.

The project is called the Mobile Weapon System and would put together a variety of existing components into a sort of war wagon, mainly for use against light aground forces but with some capability against airborne threats. Air Force Systems Command's Armament Division at Eglin AFB, Fla., issued a Request for Proposals in late April, seeking a contractor to assemble what it has in mind for a capability demonstration.

The Mobile Weapon system will mount a Stinger missile and a lightweight 30-mm Gatling gun – the four-barrel GAU-13 in a GPU-5 pod – on the basic chassis of an eight-wheeled LAV-25 armored vehicle. The system will have a FLIR set to acquire targets at night and in bad weather, a laser rangefinder, and an optical sight.

Guns and SAMs

The last three wars in the Middle East have been instructive about the match-up of aircraft against guns and SAMs.

SAMs were developed originally to counter high-flying aircraft, and early systems were effective against that specific threat. In the Six-Day War of 1967, Egyptian SAM defenses consisted of high-altitude systems. But Israeli airmen approached from the sea and on the desert deck, sweeping in beneath radar coverage and below the range of the SAMs. They destroyed more than 400 Egyptian airplanes on the ground.

Modern defenses are designed with the expectation that penetrators will come in low and fast. By the Yom Kippur War of 1973, Arab defenses included weapons to counter the low-level threat, and that time the Israelis took heavy losses.

In last summer's Lebanon campaign, the Israelis practically conducted a tutorial on defense suppression when they took out the Syrain SAMs in the Bekaa Valley while losing none of their fighters to defense batteries. The Syrians made the job easier by doing almost everything wrong.

The Syrians did not move their SAM batteries around. Some of them had been in place for more than a year. Missiles were wasted shooting at decoy drones. Radars kept emitting, even when there was no need for them to be turned on. This attracted Israeli anti-radiation missiles (ARMs). The Syrian transmitters came up on the same frequency every time, adding to their predictability and to the danger to themselves. The Syrians did little in the way of camouflage or deception. The Israelis also managed to employ airborne jamming to good effect.

The air defenders in this case apparently cam about as close as possible to total failure, but the proper measure of air defense is not always the number of enemy airplanes it knocks down.

The ultimate purpose is not to win duels with penetrators, but rather to prevent the enemy success in attacking targets to advance his war aims. Blowing penetrators out of the sky is one form of prevention, but there are others.

To begin with, there is a deterrent effect. The enemy, considering the price he would have to pay n attrition, may decide not to attack a well-defended target. Further, a strong air-defense system denies options and tactics to the enemy. He cannot make long, straight runs on his targets or fly at higher altitudes where his standoff weapons might be more effective. He must also divert considerable portions of his airpower away from targets important to him in order to provide for defense suppression.

Targets and Identification

An airplane flying at 100 feet can penetrate unseen to within about thirteen miles from the average ground radar. Farther out, he is hidden behind the curvature of the earth.

A battery of air defense artillery dependent on its own radar to pick up a low-level penetrators has less than two minutes to spot the target, acquire it, and shoot. If the terrain is to the enemy's advantage, there is even less time – especially if the penetrators is an attack helicopter using pop-up tactics.

Getting the radar higher, as is the case with the E-3A Airborne Warning and Control System, enables defenders to detect low-flying aircraft earlier. So far the NATO AWACS has concentrated on the airborne early warning mission, but it can feed target information by data link to interceptors and to SAMs in the forward belt.

The target acquisition problem is compounded by inadequate IFF (Identification, Friend or Foe). Air defense gunners often have to pass up their best shots because they are not certain the target is an enemy.

The current IFF system is the Mark XII, which can identify a friendly aircraft if its IFF is on and is working properly. Non-cooperating friendlies remain unidentified, as do foes. When pulsed by an electronic query, the Mark XII transponder on the aircraft answers with the appropriate electronic countersign. This system has not always inspired great confidence among its users, and not all of the allies use it. Progress on the follow-on system, the Mark X, has been slow because of the difficulty in getting all of the allies to agree on a NATO-wide frequency.

Procedures – such as airspace lane and corridor arrangements – are used in addition to the black boxes for IFF. Various sensors and procedures, working together, build up an enhanced picture of the order of battle that is stronger than any of them could produce alone.

Still, allied airmen do not have as much freedom as they would prefer to operate in allied-controlled airspace without risk of being shot down by friendly fire. Defense sources say they do not foresee the likelihood of SAMs and interceptors being able to work the same airspace zones in the near future.

Rules of engagement for short-range air defense systems require eyeball identification of a target before gunners can shoot in most cases. The gunners understand the problem, but point out that these rules prevent their taking full advantage of new capabilities in Stinger, DIVAD, and Improved Chaparral. The say, for example, that they will probably be limited by the rules of engagement and use Stinger for tail-chase shots rather than as an all-aspect weapon.

Because IFF is so important, the search is always on for new ways of achieving it. Westinghouse, for example, claims that its independently developed W-2000 radar is good enough to "tell ours from theirs." The W-2000 yields not only data to describe an airborne target in terms of height, range, azimuth, and velocity, but also provides a high-resolution target profile that can positively identify aircraft by type. In addition, it can count closely spaced targets. Westinghouse says there is very high probability of correct identification within thirty seconds of detection. The limitation is that concentrated focus and multiple scans – perhaps ten passes – are necessary to identify a single aircraft, so it is not yet a solution to the IFF problem in Europe, where time will be short and the sky full of airplanes.

The Army's long-range doctrinal plan, Airland Battle 2000, calls for IFF systems that use "inherent air vehicle signatures" to identify airborne targets, with or without transponder cooperation from them. This system would further discriminate among types of vehicles, separating airplanes, drones, precision-guided munitions, and missiles from each other.

Survivability

Air defenders also continue to search for ways to reduce their vulnerability. Radar is the best target acquisition technology now available for most purposes, but its emissions give away the locations of the transmitters and enable anti-radiation missiles to home on them.

A principal countermeasure here is "emission discipline" – shutting down the radar except when it absolutely has to be on. Another tactic is "blinking," several radars working together, alternating on and off and pooling their information. Decoys, including dummy transmitters, can be used as well.

Under attack by an ARM, a battery must either shut down or try to shoot down the missile in flight.

As illustrated in the Bekaa Valley example, air defense assets need to be mobile and moved often. NATO still has a number of fixed radar sites. The consensus is that they would not be in operation much beyond the first minutes of the war.

Airland Battle 2000 notes that air defense systems today depend primarily on active radar for target acquisition, but proposes future systems with "multimode, quiet, passive sensors and the capability to engage threats completely by remote cuing."

The plan does not specify what technology might be used to achieve that. Other than radar, the main target acquisition sensors now in use are either infrared or electro-optical, which are limited by such natural factors as night and bad weather. Radar can be "quietened down" somewhat by such design features as reducing the beam side lobes to present a smaller target.

As Warsaw Pact aircraft become more technologically complex and electronics-dependent, they also become more susceptible to a receiver tracking them by their radar emissions.

Free-wheeling speculation about passive target acquisition systems of the future might include acoustic and scent-sensitive sensors, both of which were used in the Vietnam War, but their adaptability for air defense purposes requires a substantial leap in imagination.

The Future

Air defense is an area of intense activity, both for military planners and for the aerospace industry. The systems previously described here are only a sampling of those in being or in prospect.

Near-term options include other SAM systems already available. Thomson-CSF, for example, thinks the Air Force should take another look at its Crotale SICA for defense of air bases abroad. Proponents point out that SICA was designed specifically for air base defense. It has an eleven-kilometer range, as opposed to six for Roland. Its greater reach and more lethal warhead give greater defense against attacking aircraft before they can release standoff weapons. Reliable sources predict that Thomson-CSF will submit an unsolicited proposal, offering SICA for defense of air bases in Germany, Advocates claim their system would be “at least as German as Roland” with sixty percent of the project going to Siemens, the German partner in the endeavor. The strong indication, however, is that the German government prefers to go with Roland as its part of the air defense upgrade.

Another set of options would adapt existing aerial weapons for ground use. One such proposal is to try the Hughes Advanced Medium-Range Air-to-Air Missile, called AMRAAM, in a SAM configuration dubbed “SAMRAAM.”

Looking further ahead, Airland Battle 2000 sees a whole new generation of systems and capabilities for air defense. It postulates “smart” air defense weapons and directed energy devices – lasers, high-energy microwaves, and particle beams. A concept for aerial mines, barriers, and other obstacles is left vague, but the plan says anti-air mines would “thicken low-altitude defenses” and “deny landing zones and nap-of-the-earth routes” to enemy air assault forces.

The Airland Battle 2000 forecast of hypervelocity “rail” guns is especially intriguing. Basically, these weapons use electronic energy instead of powder for propellant, sending a charge from a generator down a rail to launch the bullet. Westinghouse, which is working on a system for the Army, reports having fired a projectile weighing 317 grams – about eleven ounces – at a velocity of 13,780 feet per second.

Rail guns give better range, accuracy, and penetration than present weapons do. So far, however, these guns are huge, and the problem is getting them down to a practical size.

The Air Force is interested in rail guns, too, and has begun some exploratory development work, looking generally at the technology for a broad range of possible applications. An electromagnetic gun would pack a devastating wallop. As one Air Force developer pus it, rail guns have “real nasty terminal effects.”

Command and control has always been a problem in air defense, especially where the short-range systems are concerned. Some networking is possible and improvements are being made, but fire units now depend mainly on their own sensors. AirLand Battle 2000 speculates that while centralized control would be attempted under the present arrangement, “autonomous operation” would be more likely in actual practice.

The solution foreseen in the plan lies in the vastly improved IFF of the future. The C^2 problem is taken care of largely by eliminating the requirement for so much of it: “As identification and discrimination capabilities approach the near perfect, using active and passive means, the need for centralized control is greatly diminished.”

But even air defense technology and concepts advance, so do the capabilities of the offensive forces they defend against.

The emerging threat to air bases and other high-value targets is from tactical ballistic missiles. This approach has the potential to neutralize air bases as early as possible in the fighting, and lessens the need to send manned aircraft into high-risk areas.

Among other things, an antimissile defense requires fast reaction, good targeting information in a hurry, and excellent accuracy. By and large, air defense planners say that target acquisition is more of a problem than actual intercept of the incoming missiles. The big part of the intercept problem is devising a weapon that can destroy the attacking missile without a direct hit – and without a nuclear warhead. Passive measures, and perhaps more dispersal bases for aircraft, will be necessary as well.

The air defense task is formidable, both in scope and in complexity. In wartime, the combined assets of the services – defenses in the air and from the ground up – would be hard pressed to meet the requirement. – End