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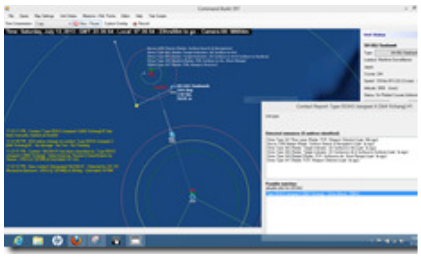

JED SPECIAL

I WILL BE YOUR ESCORT

The operational concept of escort and stand-in jamming is about to change

By **Michael Puttré**

By the accounts of developers, integrators, and customers - not to mention supporters in the US Congress who write the checks - the Improved Capability III (ICAP III) upgrade for the EA-6B Prowler is a new lease on life for the venerable electronic-attack aircraft. While action in Afghanistan has underscored the US requirement for a carrier-borne, full-spectrum, electronic-attack capability; it was the 1999 NATO campaign in Kosovo that demonstrated both the necessity and pitfalls of the Prowler and its mission.

An Increased Capability III (ICAP III) EA-6B Prowler arrived at Naval Air Station Patuxent River earlier this year for anechoic-chamber testing. Ideally, the first two aircraft will begin a series of flight trials together later this year at the Air Test and Evaluation Squadron Nine (VX-9) at China Lake, CA. With its new AN/ALQ-218 receiver and mission system, ICAP III is intended to better identify, track, and respond to modern threat emitters with the ability to hop after frequency agile radars. Other ICAP III improvements include integrating the USQ-113(V)3 communications jammer with the mission system, a provision for Link-16, geolocation targeting capability, and new displays and controls. US Navy photo

The good stuff first: Faced with a requirement of providing escort jamming for stealth strike aircraft - the F-117 and the B-2 - in addition to more conventional platforms, the US Air Force was chagrined on two counts. One, stealth is not a cloaking device. Although the more sober term "low observable" had been in the vernacular for some time, some Air Force officials clearly enjoyed the mystique of their exotic, expensive black planes. The need to escort these ultra- modern aircraft with rickety old crates making beeps and squeaks brought more than a few grins from Long Island, home of the Prowler. Two, having retired their EF-111 Ravens, peaked hat in hand, the Air Force had to approach the Navy and Marine Corps to provide indispensable escort- jamming services. Of course, this could also be spun as an example of inter-service cooperation at its finest. In any event, the Prowler escorts had full dance cards.

The bad news was the Prowler demonstrated that it was not a particularly cooperative aircraft in what was supposed to be a coalition war. In an exclusive *JED* interview, Major Thomas Emig of the German Air Force Command and a Tornado electronic-warfare officer (EWO) said that German ECR Tornados on suppression-of-enemy-air-defense (SEAD) missions in the Kosovo conflict often were unable to identify enemy radar and SAM sites due to the effects of Prowler jamming. Thus, the HARM-armed Tornados were not able to fulfill their missions. While many of the problems could be addressed with more cooperation between coalition air services during mission planning, the fact is that Prowler operations by their very nature impose limitations on who can fly other missions when and where. Currently, Prowler operators are capable of spot-jamming selective frequencies of known threat emitters. However, more mobile air-defense systems that use sophisticated, frequency-agile sensors are capable of staying ahead of operator-controlled spot jamming, leaving barrage jamming of the RF spectrum as the only viable alternative, and once again we are sharing a back seat with the frustrated Tornado EWOs of Kosovo.

Clearly, escort jamming is needed for air forces that seek to penetrate opposed airspace. Also needed is an alternative to indiscriminate, broadcast-based jamming, which, in addition to rendering many strike aircraft impotent bystanders, has the effect of telegraphing the intention and possibly even the direction of a raid. These are the sorts of issues that ICAP III is supposed to address. Escort jamming as a mission is alive and well, and it can be done better than it has been in the past.

A Feather in ICAP

According to Sam Abbate, ICAP III program director and integrated product team leader at Northrop Grumman (Bethpage, NY), ICAP III enables selective reactive jamming, in which the AN/ALQ-99 jammer hops around on different frequencies with the target radar. ICAP III's AN/ALQ-218 dual receiver (formerly designated the LR-700) has a broadband primary receiver that searches the entire RF spectrum and an auxiliary receiver that focuses in on specific frequencies. The ALQ-218's controller is extensively software driven, and software development is occupying most of the unfinished work in preparation for operational assessment of the first two ICAP III Prowlers later this year. In a separate activity, the ALQ-99 jammer's transmitters are being upgraded by BAE Systems (Nashua, NH). In addition, the Universal Exciter Upgrade being carried out by EDO Corp. (Deer Park, NY) is extending the frequency coverage of the ALQ-99 and incorporating advanced jamming techniques (see *"Prowler Upgrades Moving Along," JED* , December 2001).

The first ICAP III Prowler aircraft took to the air for its initial flight on November 6 at Northrop Grumman's test facility at St. Augustine, FL. The aircraft, one of two prototypes being modified by the company under a $200-million development program, was completely outfitted with all the new electronics that make up the ICAP III enhancements, along with new antennas and radomes. The first flight was used to assess concerns such as safety of flight, flight worthiness, and structural integrity. Northrop Grumman photo

Coupled with advanced threat libraries and pre-mission data-load files tailored to the threat environment, the system is expected to automatically detect and track emitters and provide the correct jamming response. If the threat emitter is frequency agile and starts hopping around, the ICAP III is designed to hop with it. "This capability allows ICAP III to attack more emitters in the environment by applying power more selectively and also be more discrete about the way it operates in that environment," Abbate said.

The ICAP III retains the Prowler's primary mission as a radar-jamming platform, covering a more current threat environment. Furthermore, ICAP III is still an escort jammer, intended to penetrate with the strike force. Nevertheless, improved capabilities are suggesting other roles. The combination of the ALQ-99 transmitter pods and the Rockwell Collins (Cedar Rapids, IA) AN/USQ-113 comm jammer - first deployed just in time for the air war over Yugoslavia - was important over Afghanistan, where Prowlers reportedly did a fair amount of communications jamming. Increased frequency coverage and long-baseline interferometry also enable the ICAP III to target emitters by geolocation, which gives it a much greater targeting capability for its own HARM anti-radar missiles and for other strike assets. Geolocation, where the aircraft is receiving target-quality data from threat emitters without broadcasting its presence, represents something of a new mission for the Prowler, although its signals-intelligence capabilities are well known, if not widely reported. "ICAP-III has a 360-degree field of regard with respect to detection, and very good fore and aft long- baseline interferometry," said John Young, Northrop Grumman's vice president and integrated product team leader for EW systems.

Mission creep is increasing the Prowler's need to communicate more closely with other assets in the theater of operations, and possibly beyond. In terms of connectivity, Northrop Grumman is implementing provisions for Link-16/MIDS [Multifunction Information Distribution System], although there is a separate contract that puts Link-16 in place. The inclusion of Link-16, although programmatically outside of ICAP III, is important because it represents a broadband datalink that will allow the aircraft to cue other assets either to perform jamming or a strike mission, if a given Prowler chooses not to let one of its HARMs go. It will also vastly expand the universe of aircraft with which the EA-6B can share data.

Inside the four-place cockpit, ICAP III is integrating a number of capabilities that currently are handled by discreet systems and crew stations. The Multimission Advanced Tactical Terminal (MATT) and an improved data modem, first installed under the ICAP II Block 89 program beginning in 2000, added provisions for satellite communications (SATCOM) that enabled the Prowler to share HARM- targeting data with similarly equipped Prowlers, Rivet Joint aircraft, and ideally with F-16CJs. But this was not an integrated function. "Right now, Prowler crews use a ruggedized laptop computer to work the SATCOM data," said Abbate. "Somebody literally sits in the back cockpit with a computer in their lap. It is not tied into the system at all. The only tie-in is the intellectual capacity of the operator. And obviously, a Prowler cockpit is not a great environment to have a loose object."

On that note, ICAP III integrates the USQ-113 communications jammer, which today also requires a separate panel as a dedicated crew station - and the laptop. Integration of the MATT, the data modem, and the USQ-113 will enable all of these systems' functions to be accessible on new 8x10" color multifunction displays in each crew station, including the pilot's. Currently, the pilot just drives the bus. "The added pilot display will enable him to take on selective roles, which have not been determined yet," Abbate said. "But the concept is once the aircraft is launched and is on station, the pilot can contribute to the EW mission."

It is very interesting to note that the development of operational concepts for improved Prowlers does not appear to have kept pace with the technical developments, which, it must be said, have not been especially hurried to market. "The specific CONOPS [concept of operations] of how the Navy will function with ICAP III is still to be determined,

because they haven't really wrung it out in a wargame environment," Young said. "The three significant attributes at the core of ICAP III: passive geolocation for accurately finding a spot on the geodetic world sphere; rapid response time for jamming, firing a HARM, or handoff to another asset on the network; and connectivity to enable the handoff will be the keys to its warfighting capability. We're not sure how they are going to use it yet from a CONOPS standpoint, but those attributes will certainly be employed."

Still a topic of debate in the fleet is how many Prowlers will be retrofitted to the ICAP III configuration. The lack of a firm CONOPS is probably contributing to some of the uncertainty (see sidebar p. 44). That, and the always-mercuric attitudes about EW-program funding. Estimates are that somewhere between 50 to 120 Prowlers will eventually be ICAP IIIs, both Navy and Marine. Given the Pentagon's penchant for treading water, particularly with the *"Analysis of Alternatives (AOA)"* review of a Prowler replacement underway, the lower end of that spectrum seems likely.

Growling For Dollars

The ICAP III program also plays a significant - if not the deciding - role in determining the fortunes of the EA-18 electronic-attack variant of the F/A-18F Super Hornet being proposed by Boeing Military Aircraft (St. Louis, MO) and partner Northrop Grumman. Boeing has led the development of an EA-18 (previously dubbed the F/A-18G "Growler") demonstrator with its own money and an aircraft leased from the US Navy. The aircraft would be capable of carrying the ALQ-99 jamming pods on its centerline and under-wing stores stations and the ALQ-218 receivers on specially designed wingtip pods. The Navy is clearly interested in the concept, and Boeing is banking on spinning that interest into contracts. To increase the appeal of its horse in the AOA race, the company is stressing the high-performance capabilities of the EA-18 and the more aggressive missions these suggest.

Boeing and its partner Northrop Grumman have funded development of the EA-18 airborne electronic attack concept aircraft, which they hope will be selected as a follow on to the EA-6B Prowler. The test configuration consists of a used F/A-18F Super Hornet leased from the Navy that carried three ALQ-99 physical mockups, including one low band pod mockup under the fuselage. Wingtip ALQ-218 receiver pods are still undergoing wind tunnel testing. To support the effort, Boeing had developed an advanced EA-18 cockpit simulator to demonstrate interface and workload for the two-place crew. Photo by Michael Puttré

Late last year, Boeing completed its first flight-test program, where it got the demonstrator aircraft equipped with mock pods to 0.8 Mach and about 18,000 feet. "The data showed that we were well within the noise and vibration envelope of the ALQ-99 pods as loaded," said Paul Summers, Boeing's director of F/A-18 derivative programs. "We saw nothing to indicate that we shouldn't go further. Our plan this year is to get transonic with the pods. We'll go to about 0.9 Mach and up to 30,000 feet."

In addition, Boeing has started to do an analysis with BAE Systems that looks at whether or not the electronics would be able to operate in the aerodynamic environment under the Super Hornet. Summers reported that the analysis has shown very positive results. "So far, they don't predict a problem," he said. "As we get more data from our flight analysis, we are feeding them directly to BAE Systems so they can continue to matriculate their computer analysis."

In the conventional jamming mission, there really is no need to have transonic or supersonic capability. However, in Boeing's vision of the future, the EA-18 will have performance compatibility with the strike assets. Having an electronic- attack capability that can match the speed and endurance of the strikers is seen as essential because the escort aircraft will have to handle "pop-up" threats in time to do the strikers some good at ranges where Prowlers fear to tread. Such a capability would also be important if the Navy chooses to use this aircraft in the Wild Weasel role.

"You can envision a loadout where you will have one jamming pod on centreline -- maybe to suppress SA-6s, for example -- and weapons on all the other stations," Summers said. "We spend our weapons in the standard Wild Weasel role, and then we want to do a dash to get out of there quickly. We believe that you need transonic or Mach capability. Although this is not part of any formal CONOPS the Navy has shared with us yet, we believe that, when they get a hold of this airplane, they're going to want to use it like that."

In mid-April, at press time, Boeing was scheduled to hang a F/A-18E in the anechoic chamber at Patuxent River with ALQ-99 pods radiating on the airplane to do electromagnetic systems-compatibility testing. Summers said that Boeing is looking at ways to use the self-protection suite with the jamming suite, exploring techniques such as blanking. Such a capability would be essential in the aggressive posture that is the Growler's raison d'etre. "Although we don't anticipate flight testing that kind of demonstration on our own funding, as that's going to be a fairly substantial effort and would have to be done under contract during system development and demonstration," Summers said. "What we are doing is an analysis on a position that would support the use of those assets together."

Back Off

Of course, the United States today is just about the only country that can afford scores of dedicated electronic- attack aircraft and the cast of thousands of highly trained experts who support them. "The US has specialized EW aircraft that cover an area and so take some of the burden off the strike aircraft in terms of self- protection." said Dov Granot, business development manager for the Elisra Group (Bene Beraq, Israel). The Israeli Air Force favors a system where select aircraft in a strike package are equipped with escort- jamming pods. "Israel's philosophy is that an aircraft needs to be able to protect itself from start to finish, from take-off through landing."

Jean-Philippe Gourion, deputy director of strategic planning for Thales Airborne Systems (Paris, France), said Thales is working on an escort-jamming concept in which dedicated platforms and crews would be replaced by a combination of integrated systems featuring a solid-state, phased-array jammer with very high transmitted power and real-time multi-beam steering. This would be fitted in an automatic pod carried by a multirole fighter for the stand-in/escort jamming mission. Since 1993, Thales has been developing its Carbone offensive jammer demonstrator under contract to the French military procurement agency. According to Gourion, the Carbone is significantly more powerful than existing or upgraded offensive-jamming pods. Carbone also draws on Thales' digital receivers and real-time geolocation algorithms, such as those implemented in the Spectra EW system for the Rafale aircraft.

The Carbone demonstrator has been mounted on a Mystere 20 testbed aircraft and has flown extensively since 1998, including during the NATO MACE X field trials in August 2000. A preliminary study for a pod installation has been through cost-assessment and risk- reduction studies. "Operational trials have demonstrated Carbone's effectiveness, and particularly its capability to jam through scattered lobes." Gourion said. "This is a big change in the strategy of the use of such equipment."

A fighter aircraft carrying a pod-mounted phased-array jammer would have the ability to loiter at the periphery of the threat area, but not necessarily in line with the flight path of the strikers. Once the strike package is about to enter the threat area the electronic attack aircraft is alerted by datalink to commence jamming through the secondary or scattered lobes of the threat emitters. Thus, the enemy would remain unaware of the direction of the strike package's arrival. Gourion pointed out that there would be some burden during the mission-planning phase to ensure that timing, waypoints, and jamming duration are synchronized. "In fact, if your mission planning is excellent, then you are not obliged to use a datalink or otherwise transmit between the strikers and jammer aircraft," he said.

Another benefit of this approach to stand-in/escort jamming is that the electronic-attack aircraft does not have the same demands on its self-protection jammers, thus eliminating the potential for interference. In fact, Gourion questioned the wisdom of even attempting to operate electronic-attack and self- protection systems on the same aircraft at the same time. "Frankly speaking, I don't think that it would be a very good idea to use stand-in jamming tactics other than those that attack side or scattered lobes at some distance," he said. "If the electronic-attack aircraft is loitering at very low altitude somewhere in a relatively safe place quite close to the danger zone, then you can decide at a given instant to pop up and begin your jamming job."

But if you have to stay in the high-threat area, Gourion continued, it would be much more preferable to use a UAV as a stand-in platform, loitering at very high altitude -- say, over 50,000 feet. The very same selective-reactive technologies that automatically detect, track, and provide the correct jamming response to threats in ICAP III conceivably also make it possible for the EWO to be snug in a command shelter hundreds of miles away, monitoring the proceedings via SATCOM with a cup of coffee. Try that in a cockpit.

SUPPORT JAMMING AND FORCE STRUCTURES

By **Carlo Kopp**

In December 2001 the DoD released the Joint Airborne Electronic Attack Analysis of Alternatives (AEA AoA) document, which distills the findings of a team comprising more than 180 specialists across the armed services, DoD and industry. The unclassified summary document (*see "AEA AOA Charts Future Direction for Airborne Electronic Attack," JED, March 2002, p. 26 or go to www.jedonline.com for the full document*) underscores the difficulty in reconciling the EA role against a complex multi-service force structure.

Until the 1998 retirement of the USAF's EF-111A Raven fleet, support jamming was a specialized capability in the land-based USAF and carrier- based Navy/USMC force structure. While the core Tactical Jamming System (TJS), the AN/ALQ-99, was substantially common, its mode of deployment into combat was unique to its respective users, with the Navy operating its dedicated EA-6B Prowler fleet. How the two services came to operate variants of one TJS on very different platforms is a reflection of the trend well established by the 1970s, of taking the core theater strike asset then in use and adapting it to carry the jamming payload. The USAF's EB-66 and Navy operated EKA-3 support jammers were land and carrier-based variants of one airframe. By the early 1970s the last vestiges of commonality in

platforms vanished as the Navy deployed the EA-6A and then the substantially re-engineered four-seat EA-6B, while the USAF rebuilt over 40 F-111A bombers into the superlative EF-111A Raven.

The parallel model of EA capabilities was a good fit to the environment of the latter Cold War period. The EA-6B was well matched in performance to the A-6E, the Navy's core strike asset, while the EF-111A fit very closely with the USAF's F-111E/F wings based in the UK and very much the backbone of the NATO strike force. This fit worked well both in logistical terms due to substantial commonalities in support infrastructure, but also in tactical terms as closely matched climb, cruise, and penetration performance and capabilities facilitated escort jamming as well as standoff jamming. Economies of scale implicit in the operation of jammer variants of the mainstream tactical bomb truck alleviated the total cost of operating the respective jammer fleets.

This model began to unravel over the last decade, with the massive force-structure downsizing following the collapse of the Soviet Bear. The Navy's increasingly less survivable A-6E was phased out as the A-12 foundered and died, leaving the service without a medium bomber type. The USAF, threatened with repeated F-22 cancellations and the concurrent pressure to accept new-build F-15Es and F-16Cs to keep the industrial base alive, progressively retired all four F-111 strike variants -- even though the F-111's other user, Australia, plans to operate them to 2020 or beyond.

The retirement of the A-6E and F-111A/D/E/F changed the whole context of the EA capability in the evolving force-structure model. Neither the USAF nor the USN/USMC now operates a medium bomber type - the role having been subsumed with varying degrees of success by multirole fighters, i.e. the F-15E "Beagles," F-16C "Lawn Darts", F/A-18C/D "Bugs", and F-14B/D "Bombcats." The EF-111A and the EA-6B became specialized platforms without the economic advantages of a large base of bombers using common basic airframes, bomb- navigation systems, propulsion, electrical, hydraulics, and defensive EW equipment.

The disappearance of the medium-bomber class is significant, since this category of aircraft carried sufficient internal fuel to provide very good in-theater loiter performance, vital for persistent suppression of hostile emitters, yet was also survivable enough to operate at the boundaries or indeed inside a hostile integrated air-defense system (IADS). The inverse square law of the jammer-to-signal (J/S) equation is operative here, since the closer a jammer of a given power rating is to the target emitter, the better the J/S ratio.

An EA platform carrying a TJS package should be highly survivable in contested air space, since the value of such an asset in monetary and tactical terms is very high: it is a priority target for any air-defense operator. The challenge of providing an EA capability after the retirement of the EA-6B fleet remains daunting. Fighter airframes are not optimised for persistent loiter in the manner of an EA-6B or EF-111A, with high aspect ratio 26-27 degree swept wing. This is an important design optimisation for an aircraft intended to loiter with many thousand pounds of jamming payload.

The need for good loiter performance in an EA platform has not diminished with time, the opposite has occurred. With the EA-6B tasked in Afghanistan with the jamming of hostile battlefield communications using modified ALQ-99 pods, the demise of an opposing integrated air-defense system only sees the EA asset swung into another vital information-superiority role.

If we are to draw long-term conclusions about the EA role and its importance, one conclusion is that the evolution into a more generic EA role is already in progress (the term "information attack" would better describe this role, but it has already been usurped by the cyberwar community!), while another is that we can expect to see Moore's Law enabling an increasing effort by opponents to fuse data - especially from low-band radars or networked emitters in an attempt to counter evolving stealth capabilities. Therefore, the ability to carry a powerful programmable jamming package into contested airspace will remain important, if not critical, for many combat scenarios.

The decline of the medium bomber in US usage has led to something of a crisis in manned electronic attack platforms in that there are no longer any cost-effective strike aircraft with long endurance times to base a future EA configuration on. This has caused the US to consider heavy bombers, commercial aircraft, business jets, tactical aircraft, and even UAVs as candidates for replacing the retired EF-111 Raven (shown here flying by Gibraltar) and the increasingly overworked EA6-Bs, whose airframes are nearing the end of their useful lives. US

How should this be reconciled against the planned future force structures? The AEA AOA analysis explores a wide range of alternatives including UAVs, bizjets, EA-6B, F-15E, F/A-18F, JSF, F-22, B-737, B-767, B-1B, and B-52H derivatives. Yet the public and not-so-public debate following the release of this analysis does not show highly decisive preferences. The most likely successor to the Navy's EA-6B will probably be the EA-18, simply because it will be the standard carrier-based fighter asset, at least until the JSF arrives on a carrier deck. This aircraft will not provide the kind of survivable deep-penetration capability we will see in the F-22, but is likely to be adequate for the littoral combat environment central to Navy air operations.

From a land-based air-power perspective, the EA-18 is not particularly competitive against the USAF F-22, which has the ability to go deep, perform the mission repeatedly, and survive no matter how good the IADS might be; stealth and supersonic cruise in combination are hard to beat. While a JSF-based solution might be viable in terms of subsonic persistence, it will not have the survivability of a F-22 airframe. If the intent is to carry an expensive jamming package deep into heavily defended airspace, then a F-22-based solution may be the only viable choice, especially since the aircraft's kinematics and observable performance makes it a difficult target for the best S-300/400 series SAMs, even if cued to the jammer emissions.

The alternative of stand-off jamming using a large airframe or high- flying UAV runs into two key obstacles: the inverse square law pushes up the size, weight and cost of the jamming package, while the limited survivability of the platforms constrains their effective footprint to less than the radio/radar horizon. Mobile S-300/400- style long-range SAMs could push the operating orbits of such EA platforms well back from the forward edge of the battle area, further exacerbating the inverse-square-law constraints.

The Global Strike Task Force (GSTF) model envisages the use of a combined force of F-22As and B-2As penetrating deep inside hostile airspace, with the F-22 elements sanitizing airspace to permit 24-hour operations by the B-2A element. The GSTF is the centrepiece of USAF strategic planning and could become in the long term the force-structure paradigm for an air expeditionary force, should the USAF acquire additional F-22 and B-2C aircraft. In this context, an F-22-derived EA capability is a good force-structure fit, even if it does represent a more expensive basic platform.

The difficulty with any F-22 derived solution will be persistence. Experience in Afghanistan with loitering bombardment by B-52H and B-1B heavy bombers clearly illustrates that the engagement of dispersed and highly mobile ground targets, such as ballistic missile launchers and SAM systems, will require the ability to loiter in contested airspace. This is an easy task for a B-2 to perform, but will be challenging even for the large F-22 which is optimised for super cruise and agility - and arguably puts the smaller JSF out of the game altogether.

An F-22 derivative with more internal fuel and a variable cycle engine would fit this role better than the baseline design does, as it would better fit the GSTF strike roles. However, such a derivative will incur development costs, which in turn exacerbates the existing political arguments over the aircraft. If the USAF were to acquire the 750 or so F-22s originally planned, this argument might be wholly academic. In such a build volume, the incremental costs of modest design alternations would not be decisive.

The force-structure issues implicit in providing a credible and survivable EA capability with the longevity that makes for a good investment of taxpayer's funding are not trivial problems. The very limited range of production types in the post 2010 period complicate this problem very significantly. The genuine risk is that by adopting expedient -- or indeed "affordable" -- solutions the US will find itself with a large investment in assets with poor survivability and thus limited operational flexibility in the long term, forcing in turn yet another replacement cycle. The intellectual effort expended in the AEA AOA study illustrates that this is a problem that is not easily or cheaply solved.

The central question is that of what value should be placed upon the EA capability over the longer term. With dominance in the information domain becoming an increasingly central feature of the global warfighting paradigm, the argument that multirole electronic-attack capabilities will progressively increase in value has much merit. Gazing into the strategic crystal ball is never easy, but this is one prediction that is unlikely to fail. The challenge will lie in articulating this reality in terms understood by parties other than the EW/IW community.