Russian strategy to defeat US Air Power

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Since the end of the Cold War Russia's resurgent Defence industry has carved out a major niche in the global market for high technology weapon systems, catering for a diverse global clientele, most of whom see the US and its allies as actual or potential adversaries.

In a globalised and deregulated market environment, Russia's industry, freed of the Soviet-era bureaucracy, has displayed remarkable creativity in meeting the expectations of their clients. The result is the generation of new weapons designed to blunt or cripple the capabilities at the foundations of US and indeed Western military power.

The output of Russia's industry has found its largest market in Asia. Given the one a half decade of sustained purchases, it is now tilting the strategic balance in Asia away from the US and its closest regional allies, Japan and Australia. Unfortunately, this developing change in the regional and also global strategic balance has not been well understood in Washington or Canberra, unlike in Tokyo where it is at the top of the strategic planning agenda. Preoccupied with the Global War On Terror, the Bush Administration has effectively dismantled the remaining artifacts of the analytical machinery and technical intelligence and analysis capabilities, which provided the US with such an enormous advantage during the Cold War. The result is that the US is now entering territory not unlike that it occupied prior to 911 in counterterrorist intelligence and analysis, with the political and bureaucratic leadership often completely blinded to the emerging strategic problems the US faces in Asia.

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When the Cold War ended the US held the military high ground over the Warsaw Pact, as it had the technological capabilities to seize and maintain control of the air from the Soviets and their allies, and the capabilities to surveil and target ground forces in a fashion without historical precedent. As demonstrated in the 1991 Iraq air war, US capabilities were centred in stealth, Intelligence Surveillance Reconnassance (ISR) systems and precision munitions. These included cruise missiles, and allowed the US or a US led coalition force to rapidly seize control of the air, then seize control of the radio spectrum and thus the flow of

The enormous two metre band 55Zh6 Nebo UE "Tall Rack" radar was specifically built to detect stealthy aircraft and missiles.

information. With this knowledge an opponent's strategic infrastructure and ground forces could be pounded into oblivion with a deluge of precision guided munitions and cruise missiles.

Several key technologies were central to this powerful new paradigm for fighting nation state conflicts.

The first of these was US stealth technology, built around the fleet of F-117A fighters and then intended fleet of 132 B-2A 'batwing' strategic bombers, and the intended 500+ plus F-22A Raptor fighters. These assets would punch through a Soviet era Integrated Air Defence System (IADS) to knock out critical targets, shut down airfields, critical communications paths, and the IADS itself. This allowed waves of conventional fighters and bombers to bring the full weight of US precision fire power to bear.

The second key technology were US standoff ISR platforms, primarily the E-3 AWACS, RC-135V/W Rivet Joint, E-8 JSTARS and U-2, which could surveil airspace hundreds of miles beyond the Forward Edge of the Battle Area (FEBA). These assets could also surveil enemy surface movements 200-plus nautical miles beyond the FEBA to allow US air power to engage the opponent on terms most favourable to the US. The US 'ISR Constellation' provided a decisive edge in the battle for information superiority and its effect was further enhanced by the highly capable US fleet of EA-6B Prowler, EF-111A Raven and EC-130 Compass Call standoff jamming aircraft, which would cripple enemy radar and communications systems.

The third key technology possessed by the US was a large and diverse array of precision guided munitions, spanning smart bombs, standoff weapons, short-range guided missiles, the HARM anti-radiation missile, and a range of air, ship and submarine launched cruise missiles. These provided an enormous increase in destructive effect compared to the dumb munitions of the early Cold War era, resulting in significant economies of effort. Targets could be killed with one or two rounds, rather than multiple rounds, allowing smaller numbers of platforms to inflict much more damage faster than a much larger force armed with dumb munitions.

These three prongs of US military technological power have provided a decisive advantage over the last two decades against opponents lacking the required technologies to match US capabilities or to defeat them.

Russia's Industry post Cold War

When the USSR collapsed, the former Soviet defence industry was confronted with the short term crisis of surviving the loss of Soviet government orders that sustained the industry since the 1930s. This near calamitous challenge was balanced by access to a globalised market for Russian military products and the globalised market for basic technology to build weapons and systems. With prime contractors and subcontractors scattered across the Russian Federation, ByeloRussia, the Ukraine, Kazakhstan, Georgia and other republics, the stage was set for a period of turbulent changes.

To survive, the former Soviet industry fundamentally restructured and reoriented. Today much of the industry comprises Joint Stock Companies, and its primary market is the export market, with the Russian Armed Forces equipped mostly with legacy Soviet era weapons, and more than often less capable variants than used by export clients.

In the former USSR there are two dominant

The high mobility 9A331MK Tor M2E / SA-15D Gauntlet was specifically designed to kill smart munitions.

Like the SA-15D, the Pantsir S1 / SA-22 Greyhound is tasked with killing smart munitions, it is equipped with phased array acquisition and engagement radars.

The new S-400 Triumf / SA-21 Growler is highly mobile, and armed with short, medium and long range SAMs. It can also control legacy missile batteries.

industries: the energy industry and the defence industry, the latter being the only high technology industry for talented scientists and engineers to further their careers. The result of this concentration of engineering and scientific talent plus profit driven hothouse commercial environment, is a remarkably creative output in new weapons and systems designs since the early 1990s.

Access to the globalised market for high technology, especially computers and software tools, has contributed immensely to the technological advancement of Russian and other former Soviet designs. The new generation of products is largely digital, like US, EU and Israeli counterparts, mostly be built from the same kind of components as are Western systems. An Agat missile seeker may be mostly built around the very same Texas Instruments TMS320 processor chip as a US missile, just as a Russian cockpit or command post will use the same kind of LCD display panel and COTS computer as a US system, possibly made by the same Asian OEM. The notion that modern products from the former USSR are simple analogue or hardwired digital designs like their Soviet era predecessors is only wishful thinking.

Russia's Technological Strategy in the post Cold War Era

During the Cold War, technological strategy in Russia was dictated by the centrally planned Soviet bureaucracy, which imposed hard constraints on creativity and experimentation, and primarily focused on defeating NATO in Europe. The contemporary model could hardly be more different, as it is wholly driven by market demand and profit.

The result has been a two-pronged strategy of developing products, ones that symmetrically challenge US capabilities with like capabilities, and asymmetrically challenge US capabilities with designs intended to frustrate, cripple or wholly defeat the three pronged technological strategy that is the basis of current US military power.

In the domain of Precision Guided Munitions (PGM) and cruise missiles, the former Soviet industry has become a major global player, competing directly against the US, EU and Israeli industries. In guided bombs, the GNPP KAB-250, KAB-500 and KAB-1500 occupy the same niche as the US GBU-10/12/16/24/27 Paveway II/III, the GBU-15 and the GBU-31/32/35/38 JDAM series. The basic KAB-500/1500 bomb airframes may be supplied with penetrating, general purpose blast, thermobaric or gaseous Fuel Air Explosive warheads. These same airframes can be supplied with an Electro-Optical (EO) correlation terminal seeker modelled on the Tomahawk DSMAC, a datalink supported EO or thermal imaging seeker modelled on the GBU-15 or Walleye, a laser seeker very similar to the Paveway II, or a satellite inertial guidance package modelled on the US JDAM. The latter has 20 channels, capable of using both US GPS and Russian Glonass satellites. Another hot seller has been the 3M-54/3M-14 Club / Sizzler family of cruise missiles, now deployed by China and India on Kilo SSKs and being marketed in an air launch, ship launch and land mobile coastal defence configurations. The land attack Sizzler variant, the 3M14E/AE, best compares to the AGM-109H/L MRASM Tomahawk derivatives.

In conventional combat aircraft the new-design digital Su-35BM Flanker E+, Su-34 Fullback and MiG-35 Fulcrum aerodynamically outperform their US counterparts. These aircraft are equipped with all of the digital technological artifacts seen in the latest US designs, have radar absorbent materials applied generously, and are equipped with comprehensive sensor and electronic warfare suites which more than often match or outperform their US equivalents. The latest generation of Russian radars exemplified by the NIIP Irbis E hybrid ESA and Phazotron Zhuk AE/ASE outperform all but the top end US APG-77(V)2 AESA in the F-22A Block 20, and APG-63(V)3 AESA planned for the F-15. The Russians have a suite of BVR missiles, which mostly outrange their US equivalents. Having mastered Digital RF Memory based jammers, the Russians will soon deploy electronic warfare self-protection systems with similar capabilities to the latest generation of Western equipment.

Russian sources claim the absorbent coating used in the Su-35BM Flanker will reduce engine inlet tunnel signatures thirty-fold in the X-band, making it competitive in signature performance against legacy US fighters.

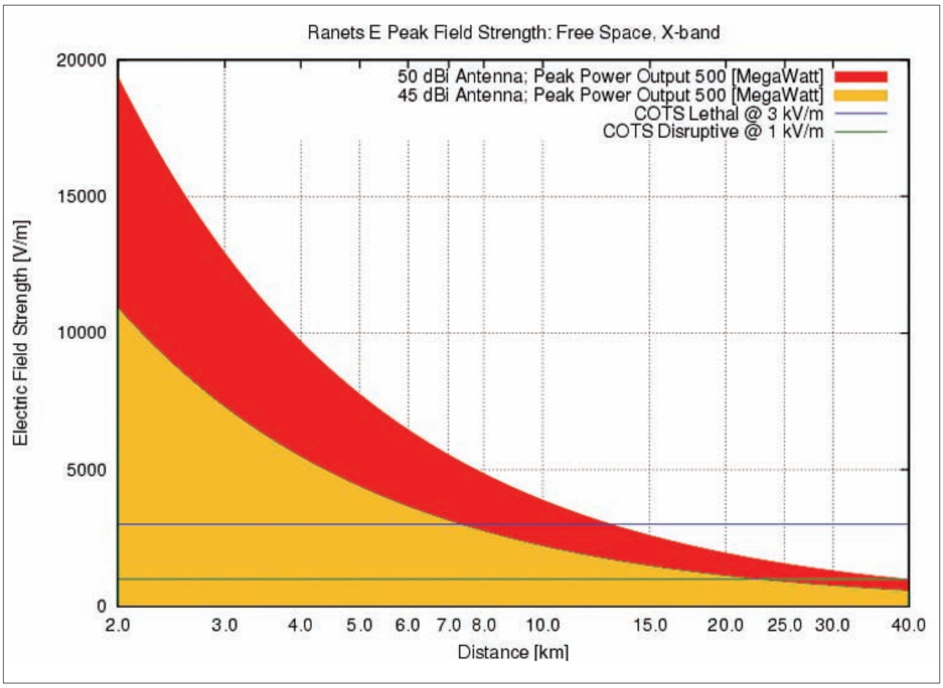
In stealthy combat aircraft, the PAK-FA in development is intended to match the aerodynamic performance of the F-22A Raptor, and provide a genuine stealth capability. The new MiG designed stealthy UCAV is remarkably similar in concept to the US X-45 and X-47 designs.

In ISR and sensor systems the Russians are now exporting a range of radars with Synthetic Aperture Radar imaging capabilities and electro-optical targeting systems like the Sapsan E pod, or the MiG-35 targeting sensor, which in many respects is similar to the JSF's EOTS system. Former Soviet contractors have reportedly contributed significantly to the development of the L-band AESA in the Chinese KJ-2000 AWACS.

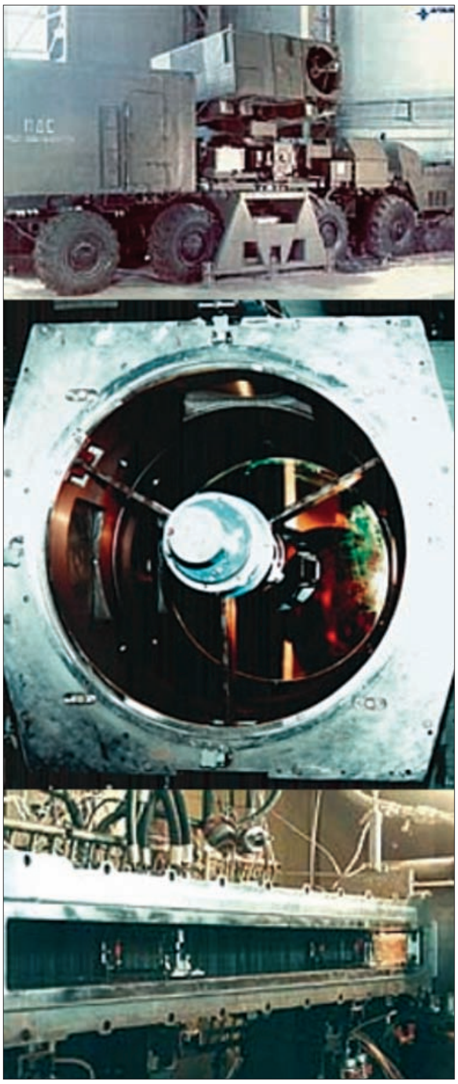
Of much greater interest are however asymmetrical capabilities specifically built to defeat the three prongs of the US technological strategy.

The S-400's 92N2E Grave Stone engagement radar is a digital design. It is a growth derivative of the 30N6E series, equivalent to the US MPQ-65 radar.

The new S-400 Triumf / SA-21 Growler is equipped with 9M96E series interceptor missiles, specifically designed to kill smart munitions.



The proposed Ranets E microwave directed energy weapon is lethal to avionics and guidance systems at distances of the order of 7 nautical miles range.



The Almaz-Antey high energy laser weapon demonstrator uses a gasdynamic (chemical) laser. It is technologically similar to the US THEL/MTHEL weapon. While Russian industry has maintained a low profile in laser weapons, China has a large research and development program in high power chemical and free electron lasers, and adaptive optics, intended to defeat PGMs and cruise missiles.

Russian Counter-PGM Technological Strategy

Of much interest is Russian strategy for defeating PGMs and cruise missiles. These are to be shot down in flight, and this has seen a large scale reorientation of development across a range of air defence weapons. A deluge of US smart weapons will be countered with intensive missile and directed energy weapon defensive fire against these weapons. Of interest is that the US AGM-88 HARM anti-radiation missile is a cited target type for every single point defence weapon now on offer.

In 1991 the Soviets were producing the Tor / SA-15A/B Gauntlet SAM and Tunguska / SA-19 Grison SAM/SPAAG system on tracked chassis, intended to defend Red Army land manoeuvre forces against pop-up helicopter and fighter threats. Both these systems have evolved considerably since then, and their replacements are tasked primarily with defeating smart munitions while protecting long range SAM batteries, early warning radars and fixed infrastructure targets.

The new Tor M2E / SA-15D is road-mobile on a hardened 6x6 MZKT6922 vehicle, and the new Pantsir S1E / SA-22 Greyhound is carried by an 8x8 KAMAZ-6560. Both systems have digital processing and a phased array engagement radar. In the SA-22 it is directly derived from Phazotron's Zhuk-MFE originally built for the MiG-29 Fulcrum fighter. There are no direct Western equivalents to either the SA-15D or SA-22, either in capabilities or mobility.

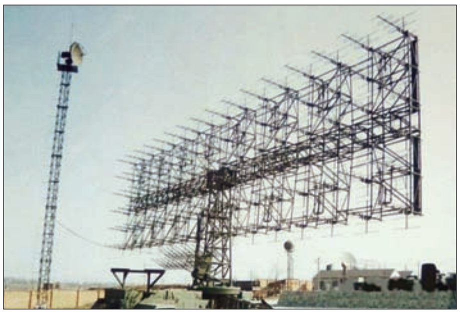
The same imperatives led to the development of the Fakel 9M96E1/E2 interceptor missiles for the Almaz-Antey S-400 Triumf / SA-21 Growler system; these weapons being equivalent to the Patriot PAC-3 ERINT interceptor. Unlike the PAC-3, these designs were built from the outset to also kill smart munitions targeting the missile battery. While the S-400 is mostly designed to provide outer layer long and medium range SAM and ABM capabilities, as demonstrated by the inclusion of counter-ISR and point defence missiles, it is much more than its predecessors, the S-300PS/PM/PMU / SA-10 Grumble and S-300PMU1/2 Favorit / SA-20 Gargoyle. The latter SAM systems have been exported to China in large numbers and form the basis of the Chinese HQ-12/15 SAM systems. The S-400 is a fully digital design and has been reintegrated on new MZKT, BAZ and KAMAZ vehicles for improved road mobility. The system's 55K6 command post is designed to also control legacy missile systems such as the 160 nautical mile range S-200 / SA-5 Gammon, exported to Iran.

Directed energy weapons are another capability seen by the Russians and the Chinese as critical to defeating massed attacks by US smart munitions and cruise missiles. The Russians have been marketing the 500 MegaWatt Ranets E pulsed microwave beam weapon using a mobile beam director dish on a 8x8 MZKT-7930 truck. This system will be electrically lethal to aircraft avionics and guided munition electronics at a range of 7 nautical miles or greater.The status of High Energy Laser weapons is less clear at this time. Almaz-Antey developed the Soviet 100 kiloWatt plus class carbon dioxide chemical lasers, and built a system comparable to the US THEL/MTHEL, but highly mobile on an 8 x 8 MAZ-7910 chassis.

This plethora of diverse and capable air defence weapons all share the important attributes of high mobility along with deployment and with stow times of minutes to facilitate 'shoot and scoot' operations. Defeat of highly mobile air defence weapons remains a problem as demonstrated in 1999. While 743 HARMs were fired by the US, only 12 per cent of Serbian mobile 9M9 / SA-6 Gainful SAM systems were destroyed. Networked with digital radio links and equipped with low sidelobe agile beam phased array radars, the current generation of Russian air defence weapons will be much harder to kill than the 1970s SA-6B.

Russian Counter-ISR Technological Strategy

Russian counter-ISR strategy is centred on the asymmetric development of ultra long range air-to-air and surface-to-air missiles specifically intended to destroy ISR platforms or deny their use. These include the Fakel 200 nautical mile SAM developed



The Chinese JY-27 is based on the Russian Nebo SV/SVU series. The Chinese are claimed to have experimented with the use of datalinks to relay target coordinates from VHF radars directly to SAMs in flight.

The entirely new Vostok E two metre band is claimed to acquire an F-117A at 190 nautical miles. It can stow and deploy using an elevating and telescoping mast in a mere 8 minutes. With such mobility it directly competes against current and legacy L-band, S-band and X-band SAM system radars.

Four manufacturers are offering different solid state digital upgrades for the Cold War Spoon Rest D VHF radar. There are also four unique technology insertion upgrades on offer for the legacy S-125 / SA-3 Goa SAM, and one upgrade for the S-200 / SA-5 Gammon.

for the S-400 Triumf / SA-21 Growler system and the 162 nautical mile Vympel R-37 and 200 nautical mile Novator R-172/K-100 AAMs developed to arm the Flanker family of fighter aircraft. A stated secondary role for these missiles is destroying US aerial refuelling tankers and standoff jammers such as the EC-130, EA-6B and EF-18G. By the middle of the coming decade all of these weapons will be well established in the global market, presenting interesting challenges for US forces (refer November/December 2006 issue of DefenceToday for a more detailed analysis).

Russian Counter-Stealth Technological Strategy

Russia's asymmetric counter stealth effort is now quite visible. It is centred on the use of two metre or VHF band radar technology, and the networking and integration of other sensors, including passive emitter locating systems.

Most recent Russian effort in the development of early warning and surveillance radars has been in the two metre band. All these new radars and upgrade packages for legacy Soviet era radars are digital and mostly solid state designs. Many include sophisticated adaptive processing techniques for rejection of ground clutter and jamming, a technology to date seen mostly in recent US radar designs.

The focus on the two metre radio band, used primarily for TV broadcasting, is that it largely defeats stealth airframe shaping techniques design for decimetre and centimetre band radar. The Russians are adamant that US stealthy fighter aircraft will appear as beachball sized radar targets in the VHF band, rather than marble sized targets. Raleigh scattering regime physics support the Russian view-absorbent materials made to work in the centimetre band are generally ineffective in the two metre band.

New designs include the massive 55Zh6UE Nebo UE VHF search radar now deploying to support S-400 batteries around Moscow, and offered for export, and a range of digital solid state upgrade packages. Two Russian manufacturers, one ByeloRussian and one Ukrainian manufacturer are offering unique digital solid state upgrades for the legacy P-18 Spoon Rest, of which thousands were built and exported during the Cold War. Exactly this radar upgrade was implicated in the 1999 loss of a US F-117A over Serbia.

A key recent development is the emergence of new technology VHF designs built for high mobility to support mobile SAM batteries. The NNIIRT 1L119 Nebo SVU is the first ever VHF band Active Electronically Steered Array (AESA) and is accurate enough to provide midcourse guidance for a missile. Russian thinking on counter-stealth technique is to fly the missile close enough for its seeker to lock on despite the stealthiness of the target, using datalinking from a stealth-defeating sensor. This radar can be deployed and stowed in 45 minutes, a fraction of the time required for its predecessors. The Chinese have already attempted to reverse engineer the Nebo SVU, with the JY-27 design.

The new ByeloRussian KBR Vostok E has even greater mobility, with a mere eight-minute deploy and stow time, using a hydraulically folded and elevated antenna. This is very close to the five minutes typical of the most mobile Russian radars, including the 30N6, 64N6, 96L6 and 92N2 series. This new VHF radar is also fully digital, solid state, and employs an innovative 'Kharchenko' square ring antenna element design. Defeat of US stealth is a primary claim by its designers, who state the ability to track an F-117A at 190 nautical mile range.

The effort in VHF radar is paralleled by developments in Emitter Locating Systems, specifically the networked 85V6 Orion/Vega and Topaz Kolchuga systems. Users of the earlier Tamara / Trash Can system, claimed the ability to track the position of US aircraft with emitting JTIDS/Link-16 terminals (Refer NCW101 April). Other counter-stealth technology includes a VHF band multi-static radar being developed by NNIIRT.

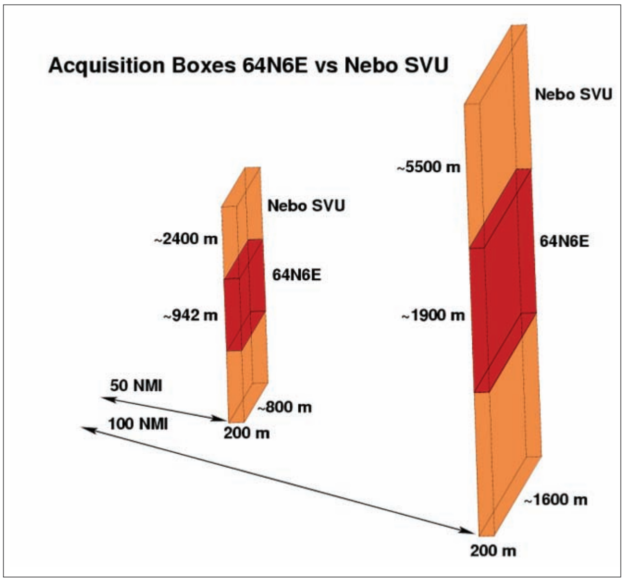
Conclusions

Advanced Russian technology exports present a major strategic risk for the US, whether operated by China or smaller players like Iran or Venezuela. These systems will deny access to most US ISR and combat aircraft, with only the B-2A, the planned '2018 bomber' and the F-22A designed to penetrate such defences. With its compromised and X-band optimised stealth, the F-35 JSF will simply not be survivable in this environment. Legacy designs like the F-15E and US Navy's F/A-18E/F are simply unusable.

The fallback position of standoff bombardment with cruise missiles is also not viable. Only a fraction will reach their targets through such defences. The economics of trading \$500k cruise missiles for \$100k interceptors, or hundreds of dollars of laser propellant favour the defender. Time of missile flight is also problematic given the high mobility of air defence targets, and targeting the cruise missiles no less problematic given denial of ISR coverage.

Unless the US effects deep and major changes to USAF force structure it will lose in a few years the capability to prevail decisively and quickly in any non-nuclear air war in Asia. For Australia this has profound strategic implications.

The Nebo SVU is the first ever VHF band AESA. Its agile electronic beamsteering provides it with similar tracking capabilities to the US SPY-1 Aegis series, but operating in the two metre rather than S-band.



The Nebo SVU was designed as a battery acquisition radar for the SA-20 and SA-21. Its azimuthal tracking error is identical to the SA-20's S-band 64N6E2 Big Bird phased array.