

# Proliferation of Advanced Air Defence Systems

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Since the end of the Cold War the technology of Integrated Air Defence Systems (IADS) has evolved considerably. More importantly, many advanced technologies are now proliferating widely in a globalised market where the highest bid often determines who can procure what. The shift to commercial rather than Cold War era military strategic imperatives, especially for Russian and Chinese industry, has completely changed the proliferation dynamic in the globalised 21st Century world.



*Newa SC upgrade for the legacy SA-3 Goa SAM system.*

While Western nations remain strongly wedded to Cold War era controls on weapons exports, to ensure that problem regimes do not procure advanced weapons technology, Russian and Chinese industries and those of many former Soviet republics operate without such constraints, as long as their national governments do not object to the sale on other grounds.

The problem is multi-dimensional and presents risks to all players. When Russian forces clashed with the Georgian military over the disputed territory of South Ossetia in late 2008 the results were a surprise to all, including the Russians. Confident that Georgian air defences were an easy target, the Russian Air Force flew a large number of sorties into Georgian airspace to bomb Georgian ground forces. The result was the loss of at least three Su-25 Frogfoot close air support aircraft and one Tu-22M3 Backfire C heavy bomber, plus two Su-24 Fencers claimed. Russian Electronic Warfare Self Protection (EWSP) systems proved largely ineffective in defending the aircraft from Georgian SAMs. Unbeknown to the Russians, the Georgians contracted Ukrainian industry to perform covertly a series of technology-insertion upgrades on the Georgian inventory of Soviet-built SAM systems and supporting radars. With EWSP systems programmed to defeat baseline Russian waveforms, the systems were unable to cope.

Western nations have not confronted any modern state-of-the-art air defence equipment since the early 1970's air war in Vietnam. Saddam's extensive and dense IADS was crushed in 1991, but it comprised a mix of export variants of 1970s' and

1980s' built Soviet and French equipment. Many key systems were by then completely compromised to Western technical intelligence. In 1999, Yugoslavia's air defences were equally antiquated, further impaired by a long running embargo that denied access to spare parts, overhauls of time expired missile rounds and upgrades. While NATO forces prevailed, disproportionate numbers of defence suppression sorties needed to be flown, and most of the Serbian SA-6 Gainful force survived the air war. One F-117A stealth fighter was lost. The air campaign against the Taliban in late 2001 was effectively uncontested, as was the invasion of Iraq in 2003.

The complacency, which cost the Russians so dearly in Georgia, is even more pervasive and pronounced in the West. The ability to fly into hostile air defences without hindrance is simply assumed to be an immutable fact, into which the material reality of advanced technology proliferation never intrudes. Public statements by officialdom and manufacturers largely ignore opposing capabilities, or portray these as legacy Soviet-era or early 1990s systems. This rejection of reality is likely to persist until large numbers of Western combat aircraft are actually shot down during operations, upon which the resulting public embarrassment will produce a change in thinking and funding priorities. At present, technical intelligence collection and especially hard analysis of new IADS components is not a priority in any Western nation. Complaining about this problem is not a 'career enhancing' move for any senior air force officer in the West at this time.



*The SA-20 Gargoyle has been widely exported.*



*40V6M masts are available to extend low altitude coverage in SA-10/20 and SA-21 systems.*



SA-20 missile launch. Late build SA-20B systems share technology extensively with the later SA-21, this including almost identical 54K6E2 and 55K6E command post vehicles, and 5P85TE2 and 5P85TM towed TELs, using identical BZKT 6 x 6 high mobility tractors.



SA-21 SAM system components.



Chinese HQ-9 / FD-2000 SAM system components. Batteries are supported by modern Type 120, Type 305A and Type 305B high mobility radars on licenced Mercedes-Benz trucks. The Type 305A phased array is modelled on the new Thales Groundmaster.

## PROLIFERATION OF NEW TECHNOLOGY THREAT SYSTEMS

When the Soviet Union and Warsaw Pact disintegrated two decades ago these entities and their Third World satellites and surrogates possessed the largest global inventory of SAM systems, SAM warstocks and supporting radars in the world. The economic crisis that ensued resulted in the collapse of state funded cashflow for manufacturing and maintenance of military systems. The result was a fire sale on the global stage of all manner of equipment and component warstocks. Nations that were previously denied access to top end Soviet equipment suddenly found themselves being offered whatever they could afford, and more.

China was a major beneficiary, and has since procured the world's largest force of advanced SAM systems, including the self-propelled Russian Almaz S-300PMU / SA-10B(C) Grumble, the Almaz S-300PMU1 / SA-20A Gargoyle, and the Almaz-Antey S-300PMU2 Favorit / SA-20B Gargoyle. The Russians also licenced the technology in the SA-10 to China's industry, enabling it to develop and manufacture the HQ-9, now being exported as the FD-2000, or equipped with anti-radiation seeker fitted SAM rounds, as the FT-2000.

These systems compare in basic technology to the US MIM-104 Patriot SAM system and its MPQ-53/65 phased array radar system. Unlike the Patriot, which has numerous design compromises in its radar to accommodate target search and acquisition, the Russian Flap Lid and Tomb Stone radar designs have a much better antenna system design, built for jam resistance. Russian SAMs have much better mobility, with a battery capable of deploying or stowing inside five minutes for 'hide, shoot and scoot' operations. As a result, this family of SAM systems is widely acknowledged to be not only the most lethal in the market but also the most survivable when subjected to attack by defence suppression aircraft. Semi-mobile variants, in which radars are equipped with the Ukrainian designed NKMZ 40V6M/MD masts are also available, providing much increased low altitude coverage against cruise missiles and aircraft. Like the Patriot, all S-300PM variant systems use radio networking to connect battery components.

China is now the largest single user of late-model S-300P SAM system variants. As of 2008, the FD-2000 and FT-2000 export configurations of the HQ-9 have been displayed and offered at international arms shows.

Until recently, former Soviet republics including Russia and two former Warsaw Pact nations, were the principal users of S-300P variants. The first export variant was exported only to

China. The more advanced S-300PMU1 / SA-20A was exported to China, but also to Cyprus, later transferred to Greece.

This variant was also sold to Iran, and after much public controversy it appears the systems are to be soon delivered to the Teheran regime, which intends to use them to protect nuclear sites.

The most successful of the variants is also the most lethal – the S-300PMU2 Favorit / SA-20B. Eight batteries of this system have been exported to China, ten to Kazakhstan, two to Vietnam, while Libya has ordered four batteries and Algeria eight. Each battery comprises a radar package and multiple four round 5P85SE/TE TEL vehicles.

The S-400 is currently used to defend Moscow, and was recently cleared for export to Belarus, providing the capability to deny use of much of Poland's airspace due to the prodigious 250 km / 400 km range of the SAM rounds when launched on ballistic midcourse trajectories. S-400 sales are currently being negotiated with Saudi Arabia, and reports suggest that Turkey, Kazakhstan and Venezuela are interested in procuring it.

The Chinese have yet to disclose interest in the FD-2000/FT-2000 system, although reports have emerged that Iran would be a likely first client if the Russian SA-20A deal collapses.

Medium range SAM systems such as the 9K317 Buk M2 / SA-17 Grizzly have been much less successful in the export market, compared to their larger and smaller siblings.

State of the art point defence SAM and SPAAGM systems have also been intensively marketed, with considerable success. Russian reports suggest that the production lines for 9K331 Tor M1/M2 / SA-15 Gauntlet, 2K22M1 Tunguska / SA-19 Grison and 96K6 Pantsir S1 / SA-22 are running to full capacity. Recent variants of all three systems have been re-engineered with digital technology and are optimized to engage and destroy cruise missiles, anti-radiation missiles like the HARM, and smart bombs during their terminal flight phase. Deployed to protect key IADS assets like SA-10/20/21 batteries or supporting radars, these redesigned systems significantly improve the survivability of a modern IADS. China, Iran and Syria are amongst users of these systems.

Another important technology now being aggressively marketed are VHF band radars, designed for 'counter-stealth' applications. Five designs have been offered for export. The self propelled Nebo SVU is a solid state digital AESA with many capabilities comparable to the SPY-1 Aegis radar. The self-propelled Vostok D/E is a digital solid state radar, which can stow/deploy in less than six minutes. Both are highly jam resistant and use sophisticated digital signal and data processing techniques, hosted on COTS computing platforms.



SA-15B Gauntlet exported to China.



Late model SA-15D Gauntlet on hardened MZKT-6922 chassis. The SA-15D is intended primarily for defeat of the HARM/AARGM, JASSM and smart bombs during terminal flight.

Advanced self-propelled VHF radars are potent additions to SAM batteries, as they can deny surprise and cue fire control radars into very small acquisition boxes, putting an exceptionally high premium on top end stealth capabilities and fighter speed/altitude performance.

Export sales of the Nebo SVU have yet to be disclosed, but it is known that at least one export client has procured the Vostok E radar.

Modern digital AESA radars operating in the decimetric L-band are also now on offer. Another advanced technology now appearing in the export market are sensor track fusion systems, akin to the recently deployed US Navy CEC (Cooperative Engagement Capability) system. This technology has been offered in the Salyut Poima system, and is part of the new NNIIRT Nebo-M multi-band counter-stealth radar system.

The marketing of new generation SAMs, SPAAGMs and radars has been paralleled by a very active market for active radar seduction decoys, and for integrated EWSP packages for radars and SAM batteries. These products are designed to degrade the accuracy of Western emitter locating systems, but also to frustrate the terminal guidance of smart weapons. This in turn drives up the number of smart munitions needed to kill the radar or SAM battery to economically unsustainable levels in combat.



SA-22 system exported to the UAE. Like the SA-15D, it is intended primarily for defeat of the HARM/AARGM, JASSM and smart bombs during terminal flight.

### THE BOOMING LEGACY SYSTEM UPGRADE MARKET

While sales of new technology systems have been robust they have not matched the level of activity in technology insertion upgrades into Soviet-era radars and SAMs. These were exported in vast numbers during the Cold War, and remain widely used. Many operators bolstered their inventories during the 1990s, as former Warsaw Pact nations and Soviet republics dumped inventory onto the global marketplace.

Typical insertion upgrades involve replacement of most and sometimes all Soviet era electronics in the system. New solid-state digital hardware, usually based on COTS technology, is retrofitted. The upgrades are more than often enhancements, as the new radars tend to be jam resistant automatic frequency hopping designs, and control laws for missile guidance are usually replaced, resulting in missile range and accuracy/lethality improvements.

Upgraded Soviet-era systems will typically have greater missile kinematic engagement ranges, expanding the lethal footprint of the system, but are also much more difficult to jam, which is a major problem given that most Western combat aircraft are fitted with legacy EWSP systems, or evolutions of late Cold War EWSP systems. Many such EWSP systems lack sophisticated DRFM exciter technology and are no match for new technology frequency agile radars. Newer DRFM jammers will still be challenged by more powerful frequency agile threats, and their effective footprint will be strongly reduced.

The S-125 / SA-3 Goa has been a popular target for upgrades, with packages on offer by Almaz-Antey in Russia, the joint Russian-Belarus Defence Systems corporation, and Belarus based Tetraedr. Poland's Cenrex are also offering a full digital package, but have encountered active Russian government interference in marketing the product. Decoys and EWSP packages are typically supplied with the upgrade.

Importantly, most of these upgrades include rehosting of the legacy semi-mobile hardware on vehicles, transforming the systems into self-propelled or mobile designs, making the system much more difficult to kill in combat. Egypt is a reported customer for the Defense Systems upgrade.

Another popular upgrade target has been the 2K12E Kvadrat, the export variant of the SA-6 Gainful ramjet area defence SAM. Russian industry is offering two basic digital technology insertion upgrades for the 1S91 Straight Flush radar system and 2P25 launchers. Czech and Hungarian contractors developed unique upgrades, which are also on offer, but only to NATO friendly clients.

Much more interesting are the advanced upgrades on offer for the SA-6. These include the second stage Tikhomirov NIIP upgrade which replaces the legacy 2P25 TELs with the 9M310-M1-2 TELAR from the late model 9K37M1-2 Buk M1-2 / SA-11 Gadfly system and the 3M9 series SAM with the 9M317 / SA-17 Grizzly SAM. The result is a defacto hybrid between the SA-6, SA-11 and SA-17 SAM systems, with the jam resistant seeker and agile airframe of the 9M317 / SA-17 Grizzly missile round. Egypt is a reported customer.



Rezonsans NE VHF counter-stealth radar.



Nebo SVU VHF counter-stealth AESA radar.



Vostok E VHF counter-stealth radar.



*Tetraedr Osa 1T / SA-8 Gecko upgrade on MZKT-6922.*



*Upgrades are available for the widely proliferated 250 km range SA-5 Gammon.*



*The Chinese H-200 radar is likely used in a hybridization upgrade of the SA-2 Guideline.*

Agat, designers of the active radar missile seeker for the R-77 / RVV-AE/SD 'AMRAAM-ski' are also offering an enlarged digital variant of this seeker, the 9B-1103M-350 as a replacement retrofit seeker for legacy semi-active homing 1SB4M seekers in the 3M9/9M9 (SA-6) missile and 9E47M/9E50/9E420 in the 9M38 (SA-11/17) missiles. Such a retrofit significantly increases the lethality of missile and its jam resistance.

The 9K33 Osa/Romb / SA-8 Gecko and 9K35 / SA-13 Gopher short range SAMs have also been popular targets for modern upgrades. While these mostly involve comprehensive electronics replacement and addition of thermal imaging passive trackers, two upgrades go further. Tetraedr in Belarus are also rehosting the SA-8 system on the new build high mobility hardened 6 x 6 MZKT-6922 chassis, developed for the Tor M2E system. As of early 2009 Tetraedr had 80 orders for SA-8 rebuilds, mostly including the new MZKT-6922 vehicle. The other interesting item is the 9K35A Gyurza 9A34M3/9A35M3 SA-13 TELAR upgrade, which adds a dorsal Azov L-136 MAK-F hemispherical infrared search / track sensor for passive detection of aircraft.

Both Tetraedr and Almaz-Antey are offering digital rebuilds of the massive 250 km range S-200VE Vega / SA-5 Gammon SAM system, primarily involving the 5N62 Square Pair fire control radar and 5G24 missile seeker. A hybridisation upgrade, which slaves the Square Pair to an SA-20A/B Tomb Stone engagement radar is also on offer.

A hybridisation upgrade of the Chinese HQ-2E/F / SA-2 Guideline SAM may also be available, using the new H-200 phased array radar developed for the KS-1A/HQ-12 SAM. To accommodate the SA-2 missile round the system merely needs to generate compatible command link waveforms, and be equipped with suitable software for missile guidance.

In conclusion, the proliferation of advanced IADS technology is a direct consequence of the commercially oriented focus of non-Western defence industries and a globalised market for advanced weapons. Over the coming decade this will completely transform the air defence landscape Western aircraft must penetrate. The 'permissive' legacy Soviet-era systems, around which all contemporary fighters other than the US F-22A Raptor have been designed, will largely vanish from existence, leaving Western nations with potentially non-viable combat fleets.



*Pechora 2M SA-3 Goa upgrade.*



# Defence

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