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Advanced ESM/SIGINT systems

In the last few years, it has become commonplace for “shocking” reports to crop-up in western media about some new “anti-stealth radar” being sold to a number of third world countries like Iraq, Syria or North Korea. These ambiguous reports usually refer to the sale (or sale negotiations) of advanced ESM/SIGINT systems like Tamara or Kolchuga.

The use of advanced SIGINT systems in tactical & theater anti-air operations (rather than in war-warning & strategic reconnaissance duties as is common with NATO & western branches) was a principle long sought by the Warsaw Pact since around the mid/late-60s, after the doctrinal shift of both European alliances re-emphasized conventional counter-air means & tactics instead of nuclear strikes. For the WP this meant a re-emergence of the problem of NATO’s vast superiority in tac-air capabilities and a number of methods to deal with it were considered. The experience of the Middle East conflicts as well as the US SEAD campaign in Vietnam convinced the WP that active air defences alone were insufficient to deal with NATO's air onslaught. Therefore, they would have to be reinforced with more covert means of airspace surveillance and control.

The increasing reliance of aircraft on radar for the purposes of navigation, low-level penetration and target acquisition & engagement provided an Achilles’ heel that could be exploited. If the sensor and communication emissions of NATO's aircraft could be collected, correlated and analyzed fast enough, their location could then be triangulated and estimated accurately enough to provide an initial cue for other ground-based sensors or for friendly "silent" aircraft. Interestingly, the main development effort for such systems seems to have been undertaken in Czechoslovakia and Ukraine rather than Russia.

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Deployment of a Tamara unit

The first practical products of this development endeavor were the Czech "Kopac" and "Ramona" systems, for which little hard information is available. Their service introduction timeframe must have been around the mid-to-late 1970s. The first fully operational system was the Czech "Tamara", a more capable and comprehensive system introduced in the early 1980s. It is produced by the Tesla corporation and has gathered considerable press attention in the late years. This is a fully mobile system capable of recording and analyzing all emissions from emitting aircraft such as attack & navigation radars, communication radios, terrain-following radars etc. In order to achieve sufficiently good coverage against low- flying intruders (one of the classic headaches of the WP air defenses) the system uses a cylindrical drum receiver mounted on an extensible tube-pike, which is unfolded by a cross-country truck when striking-down for deployment. The system may operate autonomously or, as is usually the case, be integrated to a larger C4I network and contribute its information to the overall air picture. According to Maj. Gen. Oldrizhikh Barak, president of Tesla, Tamara uses a so-called "chronometric hyperbolic principle" that with three units spaced “several miles apart” can track aircraft from distances of “about 12 miles”. Also JDW credits the system as being able to track 72 targets concurrently.

Similar to the Tamara but apparently more capable is the Ukrainian "Kolchuga". This system was designed and produced by Topaz (Donetsk). The company has its own design and research facilities and production facilities left over
from the former Soviet state-owned defense industry. The Kolchuga is essentially a high-precision, passive, signals- intelligence (SIGINT) system, consisting of four elements: three detection and tracking stations and a command-and-control (C2) element with powerful analysis capabilities. Normally, when the system is deployed in the field, the detection elements are separated by about 60 km from each other, which enables precision location of an air target by tracking it with two or three stations simultaneously. Each station is equipped with a set of rotating antennas, covering the 0.1- to 18-GHz frequency band. The antennas and receivers are able to detect, track, and output data for further analysis. All aircraft emissions - such as non-autonomous navigation aids (e.g., TACAN), radar altimeters and Doppler radars,

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Kolchuga

communications, fire-control radars, and IFF signals - can be intercepted and analyzed. About 40 elements of signal characteristics are analyzed, which ensures (according to the producer) a 90% probability of target identification and recognition (as a particular type of aircraft or helicopter). The system has two basic modes with two different ranges - one up to 600 km and another up to 200 km - but under ideal circumstances, it can track targets up to 1,000 km away. The system's intercept probability and ability to track multiple targets, however, is much better when operating at shorter ranges.

The system software on the C2 vehicle allows a basic assessment of the air situation, provides target prioritization, and determines the target's trajectories and modes of operation based on the target's radar mode - i.e., navigation, ground attack, air-target track etc.). The whole system is mounted on heavy cross-country tracks and is, thus, highly mobile. Each mobile element possesses its own means of autonomous secure communications for real-time data transmission and synchronization of operations with the other stations, as directed by the C2 element. The deployment and redeployment time is short, which enables the system to change positions rapidly, thereby increasing its combat survivability.

Though probably not designed specifically with VLO targets in mind, such systems can probably contribute significantly to an air-defence system's ability to cope with targets that are more likely to register on passive rather than active sensors. Hard as they are to detect on radar, VLO aircraft still have to use radar for navigation & target acquisition purposes (particularly when hunting mobile targets such as Scud launchers or mobile SAMs), in addition to regularly communicating with other assets to facilitate a flexible C4I and battle management system. For non-stealthy aircraft that are already tracked by radar, the giveaway of these emissions is not a great deal in the tactical confines (subsequent enemy analysis and eventual decoding of the emissions is a longer-term worry), but for stealthy assets the loss of the surprise factor can mean the difference between accomplishing their mission and having to abort as a result of enemy defences being pre-alerted and too dangerous to challenge (or worse, trying and dying).

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Far from simply providing the friendly integrated air-defence system (IADS) an ambiguous heads-up or the general location of possible targets, modern systems can actually perform a substantial part of the detect-classify-track-engage loop in complete electronic silence. This was amply demonstrated during the state acceptance trials of the advanced S-400 SAM system on the Kapustin Yar test range on September 2003. One of the test-firings involved using the S-400's ability for "late lock", the Russian equivalent term for lock-on-after-launch capability. A Kolchuga system fed the S-400 initial targeting information and the missile launch was performed in total EMCON. When the missile reached the target area, the radar was switched from stand-by to normal operating mode, and the engagement was successfully completed.

The series production of the Kolchuga system started in 1987, and since that time, system manufacturer Donetz has produced 76 systems. Through January 1, 1992, under a Soviet order, 46 systems had been produced and introduced into Soviet service. Of these, 14 were deployed in Ukraine and were subsequently taken over by the Ukrainian armed forces, when the former Soviet republic became an independent state. After the collapse of the Soviet Union, Ukraine produced 30 more systems (both the Kolchuga and the improved Kolchuga-M), of which 18 were delivered to Russia, eight to Ukraine, and four to China. The systems in Ukrainian service have been replaced by newly produced Kolchuga-M.

Aside from these, an unspecified number of the systems produced under the aforementioned Soviet order were left in Ukraine after the collapse of the USSR, modernized, and sold to Ethiopia. An idea as to the number of the systems exported to Ethiopia can be deduced from the Ukrainian government's statement that the country currently has 19 Kolchuga sets, which might suggest that three were exported. (It is often misinterpreted that a "set" means a single Kolchuga station, but a set, or system, actually consists of four such stations – 3 snoopers and a central C2 node). Delivery of these systems to a country in the developing world, such as Ethiopia, makes it unlikely that their further fate can be traced with any great certainty, and it is technically possible that some of them could have been re-acquired by other interested customers.

The Ramona and later the Tamara systems were common in Warsaw Pact dedicated air- defense SIGINT regiments (usually one per country, except for the Soviet Union, which had numerous sets, both Czechoslovakian and domestically produced). Presently, Russia operates large numbers of Kolchugas (not to be confused with the more modern Kolchuga- M, presently offered by Ukraine). Another system, VERA-E is produced by ERA (a kind of "daughter company" of Tesla) and is being negotiated for sale to China, and the BORAP system is manufactured by Tesla itself. India is interested in purchasing BORAP systems, and talks are underway.

p.s. It is reasonable to assume that, against a maneuvering target, the S-400 battery would have to partially break EMCON in order to uplink course corrections and target updates to the missile(s). However, these emissions would probably be significantly harder to sniff than the very strong signal of the main phased array radar. Furthermore, the uplink signal, while a strong indication that missiles are in the air, does not provide a clear clue (to enemy RWR or ELINT systems) of just who is being targeted and should take defensive action. Therefore, a significant degree of tactical surprise is still maintained even in this case.

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Typical workstation consoles for the VERA-E system

Ukraine was recently accused by US authorities to have sold four Kolchuga-M systems to Iraq through Jordan just prior to PGW-III, but since a single Kolchuga system consists of four elements, this could be a misunderstanding. It is not known whether the sale was of four full systems or four elements of a single system. However, the value of the transaction - $100 million - indicates the latter. According to some reports, the system might had helped Saddam Hussein evade the "decapitation strike" from a US Air Force F-117A early in the air operation. Reportedly, the system was capable of detecting an approaching F-117A some five to seven minutes before the aircraft reached its target, enabling Hussein to evacuate the target zone just in time, before the attack was executed. This is technically possible and explains some early "misses," but the story is not fully confirmed.

If Iraq had indeed purchased a passive detection system like the Kolchuga, it need not have come from Ukraine. Many countries have worked extensively on such systems - four Eastern European countries among them. The Czech Republic, with its long-established experience (e.g., its Kopac, Ramona, and Tamara systems) currently offers no less than three: SDD, VERA-E, and BORAP. Poland has just developed and fielded on a limited scale its MUR-20 system, and Ukraine and Russia have their own such systems: Kolchuga and VEGA, respectively. All these systems are production rather than prototype hardware, and all have been fielded.

Interest in such systems has recently increased, as a result of their effectiveness in the management of air-defense systems in a heavy jamming (i.e. radar-eroding) environment. It has been reported (without any solid confirmation) that the use of such passive detection systems helped Serbian forces in shooting down a USAF F-117A over Yugoslavia in 1999, as well as badly shooting-up another one. Until recently, western tactical-level SIGINT systems (including the abortive and highly sophisticated PLSS) focused more on tracking ground forces (particularly HQ units and mobile SAM elements) than directly contributing to the immediate air picture. However, as part of the renowned interest in non-emitting airspace control techniques, western interest in this technological sector is likely to increase in the near future.

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