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# THE PRESENT IS GREAT WITH THE FUTURE

#### **Gottfried Wilhelm Leibniz**

he connectedness of the present and the future down to the smallest atom of our existence has increased the necessity of securing a place in the race among tech-savvy adversaries and partners. Empowering both civil and military industries and bringing them to new levels of operation is more possible today than any time before thanks to the fast pace digitalization is going at.

It was Abraham Lincoln who said that the best way to predict the future is to create it, however, the question remains: how competent can we be in taking the inherent challenges that will come along? Not only known or visible players like ministries of defense or industrial entities should be involved in the discourse about the new level of existence we have come to but non-traditional actors that might have been out of our scope before also have to participate. Our survival is not based just on our intellect and resources (because many have those), but on our ability to adapt to changes, as Darwin put it. Digitalization is an enabler of changes and at the same time it is our opportunity to adapt to a changing world. The International Military-Technical Forum Army-2020 embraces digitalization as an essential part of the process of strengthening capabilities and improving performance of the military-industrial complex. This year's Forum is a golden opportunity for those who are 'making the future' to discuss potentials of digitalization at a bigger scale and act on the results of these discussions by implementing solutions and adapting them to existing realities.

Participants and visitors of the Army-2020 Forum and the Army Games this year will get to enjoy the display and showcasing of some state-of-the-art technologies that are game changers not only in the military sphere, but also in civil and dual-use industries, thus working towards new means of diversification at its highest level and increasing information superiority and capabilities in meeting global challenges.

The 'New Defense Order. Strategy' magazine organizes a special event on the sidelines of the Army-2020 to give an opportunity for companies' experts and government officials to discuss current challenges and future projects. The round table "The Military Industrial Complex 2030. Practical Forecasting as a Tool for Modern Development of Industry, Legislation, and Management" will function as a tool of identifying priority niches in order to help us be at the forefront of technological and digital development in the coming decades.

"The future is already here – it's just not very evenly distributed" (William Gibson). ◆

**EDITOR-IN-CHIEF** Alexandra Grigorenko



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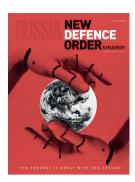
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Rostec State Corporation, PJSC United Aircraft Corporation (UAC), the Ministry of Defense of the Russian Federation, Russian Helicopters Holding Company, Rosoboronexport JSC (Part of the Rostec State Corporation), JSC SPC "Uralvagonzavod", Hindustan Shipyard Limited (HSL), the Federal Service for Military and Technical Cooperation of the Russian Federation, Mil Moscow Helicopter Plant (MHP), "Sukhoi" Design Bureau, Stockholm International Peace Research Institute (SIPRI), "Roselektronika" Holding (Part of the Rostec State Corporation), the Ministry of Foreign Affairs of the Russian Federation, Roskosmos Space Agency, Tactical Missile Weapons Corporation (KTRV), the Engineering Center (CompMechLab®), Center of Excellence in New Manufacturing Technologies of the National Technology Initiative (NTI) in Peter the Great St. Petersburg Polytechnic University (SPbPU), Zyfra Company, Raytheon/Northrop (USA), Lockheed Martin (USA), EGO Translating Company, AO Energiya JSC, JSC "Shipbuilding & Shiprepair Technology Center"

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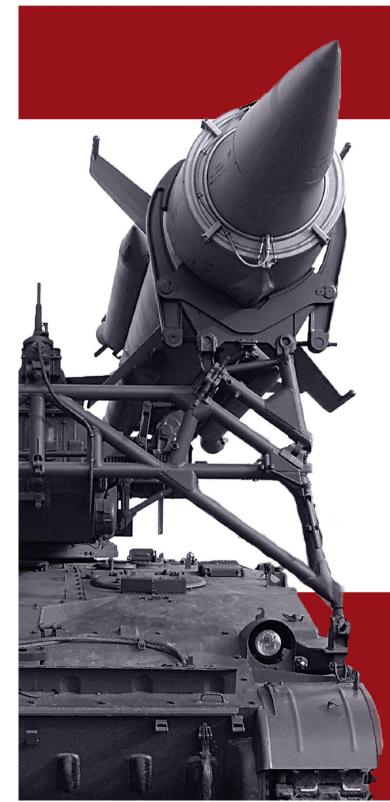
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2020

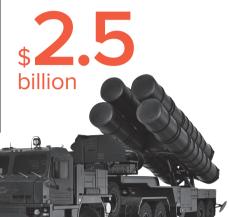
WE RISE TOGETHER

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That is the sum of the orders portfolio for Russian weapons to be exported as of July, 2020 That is the contract value for delivery of S-400 surface-to-air missile system 'Triumf' to Turkey. The obligations under the contract and delivery were fulfilled ahead of schedule. This is the first contract of such a scale for delivery to a NATO country.



SOBORONE?

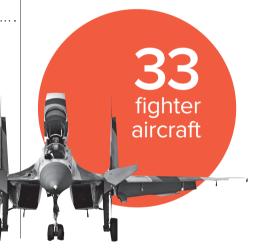
November 4, 2000, the Decree No. 1834 of the President of the Russian Federation was issued on a merger of the "Rosvooruzhenie" (FSUE) and the "Promexport" (FSUE) to establish the "Rosoboronexport" (FSUE).

......

countries buy Russian



Indian Air Force (IAF) has submitted a proposal to acquire 33 new Russian fighter aircraft. The proposal includes 21 MiG-29s and 12 Su-30MKIs, according to Indian media.



320,000 square meters

The total exhibition space of the International **Military-Technical Forum** Army-2020 has been increased by 60,000 square meters compared to 2019, to exceed 320,000 square meters.

The Army-2020 forum intends to display over 28,000 pieces of weaponry, military hardware. More than 1,500 companies are expected to participate.

#### ALEXANDER MIKHEEV, GENERAL DIRECTOR OF ROSOBORONEXPORT

Building up the export potential and modernizing the country's military-industrial complex, filling the federal budget and therefore stable development of enterprises and entire cities, largely depend on work. Therefore, it is extremely important that Rosoboronexport successfully promote domestic high-tech products to foreign markets. In recent years, we have made significant breakthroughs. Despite the sanctions, we regained the large-scale Russian presence in Africa, established cooperation with a number of NATO countries, launched a line of key products on the market, and mastered new areas of work

#### MARIA VOROBYOVA, SPOKESWOMAN FOR RUSSIA'S FEDERAL SERVICE FOR MILITARY-TECHNICAL COOPERATION

To export military products, a buyer of our weapons must present an end-user declaration to the Russian side. That is why transfer or re-export of such products to third countries is impossible without an official permit from the Russian side

# DEFENSE LOGISTICS SHARING PACT BETWEEN INDIA & RUSSIA

ECONOMIC TIMES

It has been circulated in Indian media outlets that India and Russia are getting closer to reaching a final agreement on defense logistics sharing pact, and that it is expected to be completed by the end of 2020.

"The Reciprocal Exchange of Logistics Agreement will simplify interoperability and enable support to military platforms like warships and aircraft and is of significance as Russia continues to be a leading arms supplier to India, with joint exercises number also increasing in recent years," said the Economic Times.

According to this pact, both Russian and Indian navy ships will be able to access exclusive economic zones for refuelling and getting supplies. Exercises and drills for both the naval and air forces would be much smoother for both countries, as well as deployment of troops on both sides.

India is awaiting the visit of the Russian President, Vladimir Putin, later this year after the invitation from India's prime minister, Narendra Modi. Expectations are that the pact will be signed during this visit.

India had signed such pacts with the United States, France, and Australia, and is currently in the process of finalizing a similar pact with Japan. ◆

hull. This allows the crew to ensure its safety in the event of an ammunition explosion. The crew of the tank can operate in a chemical attack or nuclear war. T-14 is hardly noticeable in the infrared, radio and magnetic ranges. In particular, this reduces the distance of anti-tank guided missiles, including Javelin, by

2.7 times. This means that the calculation of

these systems will be more vulnerable to re-

The T-14 was presented to the general public at the Victory Parade in 2015 along with other products based on Armata. At the Army-2018 forum, Deputy Prime Minister Yuri Borisov announced that 132 tanks and combat vehicles had been contracted. ◆

# RUSSIAN COUNTER-DRONE SYSTEMS FOR CENTRAL ASIA

TAS

turn fire.

Avtomatika Group has started delivery of Russian counter-drone systems to countries in Central Asia, said the Group's press office.

Russia's major news agency, TASS, reported on Monday that the press office of Avtomatika Group – part of Rostec State Corporation – said that the group has started delivering counter-drone systems to countries in Central Asia. Moreover, the press office said that negotiations are on foot with five more countries on the deliveries of these systems. According to the published statement, these negotiations include India and states in Southeast Asia, the Middle East, and Africa.

"In June 2020, acceptance trials were successfully held for the systems of detecting and countering unmanned aerial vehicles that are being supplied in the interests of a customer in one of Central Asian countries," the news agency quoted Avtomatika's press office.

The deals completed by the group included domestic market in Russia as well. The Group's press office told TASS that Avtomatika agreed on delivering these anti-drone systems to Slavneft-YANOS, a major oil refinery in Russia, and also to Tatneft. Additionally, there are now negotiations for delivery of these systems with more Russian companies, like Rosneft, Gazprom, and Unipro.

Interest in these new Russian counterdrone systems extends to airports, transport companies, various services and security agencies, including those responsible for holding mass public events, added the press office. ◆

# EGYPT'S NEW SU-35 SPOTTED IN NOVOSIBIRSK

BMPD

New Su-35 with hull numbers 9210 through 9214, the first five fighters for the Egyptian

# NEWS NEWS NEWS







# ARMATA TANK IS BEING PREPARED FOR EXPORT

GLAS JAVNOSTI

The Director of the Federal Service for Military-Technical Cooperation (FSMTC) Dmitry Shugaev has announced that Russia is preparing the Armata tank for export.

"Russian manufacturers are ready to offer potential buyers air defense systems, such as S-300 and S-400, and modern aircraft and helicopters. We are preparing for sales a light MiG-35 fighter; we are promoting the most modern T-14 Armata tank. In a word, we have something to offer," Shugaev said in an interview with the Serbian media.

Armata is the first tank in the world that implements the concept of network-centric warfare in its design plan, where T-14 is used primarily as a reconnaissance, target designation and fire adjustment system for self-propelled guns, SAM and T-90 tanks from its tactical unit.

Armata is the first tank in the world with an uninhabited tower. The crew of the vehicle is in a sealed armored capsule in front of the Air Force were spotted during a stopover at Tolmachevo airport in Novosibirsk.

Photos were taken on July 22 at Tolmachevo airport (Novosibirsk) during the stopover landing of the first five Su-35 fighters built for Egypt by the Komsomolsk-on-Amur Aviation Plant (KnAAZ) named after Yuri Gagarin (a branch of PJSC "Company "Sukhoi" (as part of PJSC UAC of the State Corporation Rostec)).

The fighters were without identification marks, but had tail numbers on the keel. They were flying from Komsomolsk-on-Amur to the European part of Russia for subsequent delivery to an Egyptian customer. Before Novosibirsk, the planes made a stopover landing in Irkutsk.

Egypt and Russia signed a contract, the details of which officially were published last May which sites Egypt, making it officially the first customer of the Su-35 in the region.

Delivery of the first aircraft is planned before the end of 2020; the contract should be fully implemented by 2023. ◆

# FOUR MI-35M DELIVERED TO KAZAKHSTAN

MINISTRY OF DEFENSE OF THE REPUBLIC OF KAZAKHSTAN

Four Mi-35M helicopters were delivered to Kazakhstan as part of the ongoing rearmament in the Kazakh Armed Forces.

"Four new multi-functional attack helicopters Mi-35M arrived at the air base of the Air Force of Kazakhstan in the west of the country as part of the ongoing rearmament in the Armed Forces," announced the Ministry of Defense of the Republic of Kazakhstan.

"It should be noted that the delivery of helicopters was carried out as part of military-technical cooperation between Kazakhstan and Russia, as well as an agreement between the Ministry of Defense of the Republic of Kazakhstan and the Rosoboronexport company," said the Ministry in its statement.

According to the Kazakh Ministry of Defense, the flight and engineering personnel have undergone both theoretical and practical retraining for these types of helicopters.

The multirole Mi-35M attack helicopter is a comprehensive modernization of Mi-24V. Mi-35M was developed by the Mil Moscow Helicopter Plant, and has been series produced at Rostvertol since 2005.

It is equipped with the latest Klimov-produced powerful VK-2500 turboshaft engines, fiber-glass main rotor blades, main rotor head with elastomeric joints, a new swashplate and X-type tail rotor. Mi-35M's fuselage boasts with shortened stub wings and fixed landing gear.

Mi-35 is operated by the Armed Forces of Russia, Venezuela, Brazil, and Azerbaijan. ◆



# NEW RUSSIAN FIGHTER AIRCRAFT FOR INDIAN AF

AN

Indian Air Force (IAF) has submitted a proposal to acquire 33 new Russian fighter aircraft. The proposal includes 21 MiG-29s and 12 Su-30MKIs, according to Indian media.

ANI news quoted a government source saying that the IAF has been considering this plan for a while, but the process has been fat-tracked. According to the same source, this proposal is estimated at approximately \$800 million.

The source added that after the IAF lost several aircraft in different accidents, there is now the need to replace them with twelve Su-30MKI fighters. As for the 33 MiG-29 aircraft to be purchased, they are slightly different from the ones that pilots of IAF are familiar with.

The proposal to buy new Russian fighter aircraft comes amidst tensions between India and China in Eastern Ladakh. The situation escalated after the Chinese forces strengthened border control measures. China's reaction came in response to the construction of defense facilities in India in the Galvan Valley region. So far, twenty Indian soldiers died in the clashes. ◆

# TOS-1A HEAVY FLAMETHROWER SYSTEM ATTRACTS FOREIGN CUSTOMERS

ROSOBORONEXPORT

Rosoboronexport together with Omsktransmash have held a demonstration for a number of foreign customers of the TOS-IA heavy flamethrower system, said the press office of Rosoboronexport today.

"The TOS-IA heavy flamethrower system is unique to the world arms market, the only deadly short-range fire support weapon in the world. Such equipment is not produced anywhere in the world except Russia, and we are proud to show it to our foreign partners. The system has repeatedly shown its impressive capabilities to destroy well-protected terrorist groups in real combat conditions in the Middle East. Owing to its unrivalled performance, the TOS-IA has held steady in the top 5 weapons supplied

by Rosoboronexport to customers' land forces," said Rosoboronexport's Director General Alexander Mikheev.

Alexander Potapov, Director General of JSC Uralvagonzavod Concern added that "the TOS-IA showed its best performance and high fire efficiency at the test site. Its effectiveness and firepower have been long recognized all over the world. It is a unique R&D product in terms of technical solutions applied and combat effectiveness."

The TOS-1A heavy flamethrower system is in service with the Russian Army, as well as in Algeria, Azerbaijan, Armenia, Iraq, Kazakhstan, Saudi Arabia, and Syria.

The press release published adds that "unlike all currently existing multiple rocket launchers (MRL), only the BM-I launch vehicle of TOS-IA system, having MBT-level armor and a minimum firing range of 600 m (maximum range of 6,000 m), can perform necessary combat missions on the forward edge of the battle area (FEBA) in a very short time frame, while remaining practically invulnerable. This is a deadly, time-tested and unrivalled flamethrower system whose high reliability has been proven more than once." •



#### DMITRY SHUGAEV, HEAD OF THE FEDERAL SERVICE FOR MILITARY-TECHNICAL COOPERATION (FSMTC)

Currently, there is a guarantee team of Russian specialists in Turkey assisting our Turkish colleagues in operating the equipment. Negotiations on the supply of the second regimental set of S-400 are in a rather advanced phase, and we are waiting for the final decision of Turkish side. In the future, we are ready to study the possibility of technological cooperation. That is, the participation of Turkish companies in the production process. It is obvious that this cooperation format presupposes a new level of interaction. This level is a more complex, trusting one, where it is important to balance our interests





# MILITARY-TECHNICAL COOPERATION OF THE RUSSIAN FEDERATION IN 2019. MAIN TRENDS

Text by Olesya Zagorskaya

The ability of the arms market participants to follow existing trends and plan their progress in this area has always been unsteady, and today it is going through the stage of high turbulence. For successful export of military products, development of new and more flexible approaches to cooperation with potential customers is required.

uch approaches are also required towards traditional partners, cooperation with which has been verified over the years and confirmed by signed contracts.

The modern arms market is characterized by a change in the relations paradigm. Thus, customer-seller relations often change into partnership under agreements on joint development and production of military products. When signing the contracts, offsetting obligations become of high importance.

The list of possible foreign trade mechanisms is expanding. According to Alexander Mikheev, Director General of Rosoboronexport, the «offset programs, loans, counter-barter deliveries tested by the Russian Federation <...> allow to be flexible and adaptable to a constantly changing world»<sup>i</sup>.

There is an increase in the market size, which can be explained by both increased tension in some regions of the world and prices growth for military products. Since 2000, the world arms market volume has grown from 28 to 85 (92, according to other sources) billion dollars a year<sup>ii</sup>.

The number of exporters is also growing, and as a result, traditional market leaders retain their positions in absolute terms, but in relative terms their indicators are decreasing. This tendency also affects Russian military-technical cooperation. It is interesting that exporting countries start to use the supply diversification process to maintain their performance indicators.

The change in the competition forms becomes an essential factor due to the increasing role of the political factor, including even methods of direct intimidation, blackmail, and sanctions. We are no longer talking about healthy market competition. In 2019, the Russian Federation had to make contacts under these conditions.

# RESULTS IN FIGURES AND FACTS

In general, the results of the year 2019 in the area of military-technical cooperation can be considered successful for the Russian Federation. By December, the total volume of deliveries reached a value of 13.7 billion dollars, more than 800 contract documents on new deliveries were signed, and the portfolio of orders amounted to about 50 billion dollars. During the year, the delivery volume trend showed a steady growth. Thus, in April, the products amounting to 4.9 billion dol-

lars<sup>iii</sup> were delivered abroad, by September this figure increased to 8.5 billion dollars<sup>iv</sup>, by November – up to 11 billion dollars<sup>v</sup>.

In the export structure, the aviation sector traditionally took more than 40%. An increase was noted in the structure of the air defence equipment export from 15 to 20%, mainly due to the deliveries of the S-400 systems to China and Turkey under previously signed contracts. Starting in 2021, deliveries of these systems to India are expected. Deliveries of S-400 systems, as well as potential deliveries of new Viking and Tor-M2E air defence systems, will allow increasing the percentage of the air defence sector in the sales structure up to 25-30%. The amount of naval armaments is traditionally low - it accounts for just over 5 billion dollarsvi, which is approximately 10%. More than 20% is the export of military equipment. Recently, indicators of the small arms segment have increased, a significant role in which was played by the contract on delivery to India of the first batch of Russian AK-200 series, the production of which was launched in 2019 at the joint Russian-Indian enterprise Indo-Russian Rifles Private Limited in Corva.

In general, for all categories of weapons and equipment, 15–20% of the orders portfolio is taken by after-sales services, which traditionally has not been a strong point of domestic exports<sup>vii</sup>. An increase in this share is expected.

Concerning the geography of deliveries, it is relatively stable. The countries of Africa (without specifying them) accounted for 35%, and in 2019 the volume of deliveries to these countries amounted to 4 billion dollars, while the orders portfolio amounted to 14 billion dollars. The countries of the Middle East accounted for approximately 15%, and it was noted that the volume of annual exports to this region is at an average level of 2 billion dollars. The same indicators of 10-15% are achieved in China. India accounts for about 30%, and the portfolio of orders of this country amounted to more than 14 billion dollars. It is worth noting a new stage in the development of military-technical cooperation with this country - from 1991 to 2019, the products amounting to 70 billion dollars were delivered to Delhi, and the amount of 15 billion dollars falls in the period of 2017-2019<sup>viii</sup>.

The military-technical cooperation with the CIS countries takes about 3–5%, and the Republic of Belarus should be marked here: the annual turnover in the militarytechnical cooperation sector with this country is 500–600 million dollars<sup>ix</sup>, and 2/3 of this amount accounts for supplies from Belarus.

## **LEGISLATION CHANGES**

In the nearest future, we are likely to be able to evaluate the results of some changes in the military-technical cooperation system implemented in 2019. We are talking here about some amendments to the Decree of the President of the Russian Federation dated September 10, 2005 No. 1062 «On Issues of military-technical cooperation of the Russian Federation with foreign states» and the development of the military-technical strategy of the Russian Federation.

On April 4, 2019, Vladimir Putin signed a document amending Decree No. 1062x. The amendments simplify the procedure for making decisions on re-export or transfer of military products to third countries. Prior to these amendments, in the re-exporting situations a third party had to provide the Federal Customs Service of the Russian Federation with the End-user Certificate (which confirms that the military products will not be transferred to other third countries without the permission of the supplier, that is, in this case the «secondary» supplier purchases armaments from this «primary» supplier). In the current situation, it will be enough to provide this document to the exporter itself, and the exporter should notify the Russian Federation that the armaments will not be transferred further on.

The aim of this legal maneuver is obvious. The explanatory note states: «The foreign states express interest in purchasing Russian military products, but in fearing to get under sanctions, refuse to purchase them.» Thus, a simplified re-export mechanism will allow to conduct deals bypassing sanctions without unnecessary bureaucratic red tape. It is known that prior to these amendments some re-export operations have also been conducted, but the amount of them was small and was carried out mainly through the Republic of Belarus.

In order to improve military-technical cooperation, a draft document of the Military-Technical Cooperation Strategy has been prepared, which describes measures of a political, diplomatic, financial, economic and technical nature. The document containing the goals and objectives of the state policy on the military-technical cooperation was approved in October 2019. In this regard, the President instructed the Government to adopt a roadmap for implementing this Strategy<sup>xi</sup>.



The President also asked to pay special attention to CSTO and CIS member countries. By the way, an active work is being conducted with these countries within the frameworks of the contracts on the development of military-technical cooperation (signed in 2009–2017). The contracts provide for special conditions, including an unlicensed supply chain, which allows enterprises to work directly with each other without participation of a state intermediate party. This corresponds to the deliveries of military products with the same characteristics as the products used by the Russian Armed Forces.

The President noted that it is worth paying attention to the after-sales service of the equipment as well. It should be mentioned that works in this direction are already being implemented – the helicopter service centers have already been opened in Egypt, China, Brazil, Peru, Vietnam, and some more will soon be opened in Mexico and Azerbaijan. The engine service center has been opened in Vietnam; the similar ones are expected to be opened in China, the UAE, and Ethiopia. The possibility of constructing a special service center for helicopters and armored vehicles in Angola, Ethiopia, Uganda, Niger, and South Africa is being discussed. It is also planned to establish service centers in the countriesoperators of the Pantsir-S1 air defence missile system.

An important area of the military-technical cooperation development is establishment of joint ventures for spare parts

production. «For this purpose, it is necessary to expand the rights of the military-technical cooperation entities and introduce amendments to the legislation base,» Vladimir Putin said, thereby announcing the next series of amendments to the military-technical cooperation system.

# WHAT ABOUT INTELLECTUAL PROPERTY?

A chronic issue is the rights on the results of intellectual activities in the course of military-technical cooperation, and unauthorized copying of Russian armaments, military and special-purpose technologies abroad. Over the past 17 years, about 500 such cases have been identified<sup>xii</sup>. And how many have not been detected yet? Traditionally, the «copy-paste» leader is China, which, in fact, has copied aircraft engines, Su aircraft, and missile defence systems.

The difficulty lies in the fact that patents on military products developed in Russia are not registered abroad, and therefore, even if Russian specialists manage to identify cases of unlicensed copying, it will not be possible to claim anything in the international court.

In 2019, the measures were taken that should solve this problem at least in part. In October, Rosoboronexport announced establishment of an advisory group on the protection of intellectual property rights in the military-technical cooperation processes. The main tasks of the group are development of a common strategy for the mil-

itary-technical cooperation participants to protect the rights on the results of intellectual activities in the Russian Federation, as well as implementation of some measures against counterfeiting and unfair competition in the military-technical cooperation area. The group includes representatives of the Ministry of Defence, the Federal Service for Military-Technical Cooperation (FSMTC), Rospatent, the Russian Academy of Intellectual Property and a number of defence industry holdings.

In addition, in 2019, as a result of the promotion of Russian small arms to foreign markets, Rosoboronexport signed an agreement with the Kalashnikov Concern on the legal protection and commercial use of the results of the intellectual activities in the military-technical cooperation process. The similar agreements were signed earlier with the United Shipbuilding Corporation, the Russian Helicopters Holding, the Concern Almaz-Antey.

There is another story connected with violation of rights. In 2019, the Russian Federation received requests from some countries to repair MiG-29 fighters modernized in Ukraine. As it turned out, Ukraine has modernized the MiG-29 fighters at its facilities without having relevant technical documentation. The MiG Corporation noted that the developer is not responsible for the operation of aircraft modernized by an enterprise not having a corresponding developer license. In this regard, in order to protect itself from possible charges and claims in advance, Rosoboronexport

in 2019 informed media about the fact of repairs of the Afghan Mi-17V-5 helicopters in Slovakia without participation of specialists from the Russian Federation, considering this incident as a violation of the Russian regulations. And these are only two cases identified last year. It is to be hoped that the measures taken in 2019 will change the situation for the better.

#### WHAT IS TO FOLLOW IN 2020

The agreement with China on the joint development of the AC332AHL heavy helicopter is still being coordinated, discussions with Malaysia on the questions concerning supply of Mi-35 under the trade-in scheme and supply of Mi-8, Mi-17 and Ka-23A11BC helicopters, and with Mexico - on supplies of Be-200 are still going. The contract on the supply of 16 Mi-171/Mi-17 helicopters to the Philippines is being discussed at the level of the technical working group, and Nepal is waiting for the conclusion of the Mi-17 deal (the technical commission is resolving the issue of payment). A deal is being discussed with Sri Lanka on the supply of Mi-17 and a patrol ship, for the purchase of which an export credit has been approved in Russia. A request was received from the UAE on the Pantsir-S1 anti-aircraft missile/gun systems, as well as on the conduction of demonstration tests of the Orion-E UAV in Russia. It is already known that there is a potential purchaser of the UAV - it is one of countries in the Middle East, but it is reported that it is too early to talk about signing a contract.

The Russian Federation takes part in a number of international tenders for military products supply. India has requested information on a tender for supply of 110 fighters with an estimated amount of about 20 billion dollars. The Russian Federation competing with applicants from the USA, Sweden, and France, represents MiG-35 and Su-35 aircraft. We are just waiting for the results. Another Indian



tender is on the construction of six submarines under the 75-I project under the condition of technology transfer, and the total project cost is about 7 billion dollars. Two Indian and five foreign companies take part in the competitive selection. The Russian Federation represents the Amur-1650 submarine. Prior to the official announcement of the tender, Rosoboronexport offered India cooperation - not in the form of a tender, but as joint development and organization of production under an intergovernmental agreement on unlicensed production, which could be much faster and more useful for India in terms of technology mastering. However, the tender was announced in 2020.

Mi-I7ISh is presented for a tender in Peru, Be-200 in Turkey (an official tender announcement is expected in the nearest future), Yak-I30 in Malaysia, and in case of getting the tender on Yak-130, the Russian Federation is ready to construct a service center for combat capable trainers. It is also known about participation of MiG-29 in the Colombian and Argentinean tenders.

In 2019, Russian submarines under the Varshavyanka project 636 did not get tenders in Thailand and Indonesia – decisions were made there not in favor of the Russian proposals. According to Mikhail Petukhov, Deputy Director of the Federal Customs Service of the Russian Federation, the tender basis assumes interconnection of both objective and subjective factors, so the decisions of Thailand and Indonesia did not become a tragedy for the Russian Federation.

No matter what, we are waiting for positive decisions regarding Russian proposals and are studying the situation in the world market of military products. •

<sup>1</sup> Rosoboronexport noted the progress of the Russian Federation in the arms export market // RIA Novosti, 26.11.2019 https://ria.ru/20191126/1561592124.html

Arms trade as an instrument of political influence at the international scene, thesis by S. Goreslavskiy // Moscow State Institute of International Relations, 2019. https://mgimo.ru/upload/diss/2019/goreslavskij-dissertaciya.pdf

Rosoboronexport has signed contracts for 5.2 billion dollars since the beginning of 2019 // TASS, 7.09.2019 https://tass.ru/armiya-i-opk/6410028

MAKS-2019: export contracts regardless of sanctions // Rosoboronexport, 1.09.2019 http://roe.ru/press-centr/press-relizi/maks-2019-eksportnye-kontrakty-sanktsiyam-vopreki/

Very Rosoboronexport summed up the results of 2019 in the global market // Rosoboronexport, 1.11.2019 http://roe.ru/press-centr/press-relizi/rosoboroneksport-podvel-itogi-19-go-goda-raboty-na-mirovom-rynke/

<sup>\*\*</sup> Rosoboronexport is ready to discuss the transfer of marine technologies at IMDS-2019 // Rosoboronexport, 8.07.2019 http://roe.ru/press-centr/press-relizi/rosoboroneksport-gotov-obsuzhdat-transfer-voenno-morskikh-tekhnologiy-na-mvms-2019/

<sup>&</sup>lt;sup>vii</sup> Dmitry Shugaev, Director of the Federal Customs Service of the Russian Federation, about existing difficulties and emerging prospects of arms export, interview // Kommersant, 6.02.2019 https://www.kommersant.ru/doc/3874641

Prospects for the Russian-Indian military-technical cooperation following Defexpo India 2020, by Dmitry Bokarev // New Eastern Outlook, 25.02.2020 https://www.warandpeace.ru/ru/analysis/view/146921/

Defense partnership and export. What weapons were demonstrated by the Russian Federation and the Republic of Belarus at MILEX 2019 // TASS, 17.05.2019 https://tass.ru/armiya-i-onk/6442415

Decree of the President of the Russian Federation dated 04.04.2019 No. 146 http://publication.pravo.gov.ru/Document/View/0001201904040033?index=0&rangeSize=1

indeeting of the Commission on military-technical cooperation // Official web-site of the President of the Russian Federation, 16.12.2019 http://kremlin.ru/events/councils/by-council/1/62334

xiii Rostec told how Russian weapons are being illegally copied abroad // TASS, 13.12.2019 https://tass.ru/armiya-i-opk/7344701

# **RUSSIAN MILITARY-TECHNICAL COOPERATION IN 2019**

SUBJECT MATTER OF THE CONTRACT	NUMBER OF ITEMS	PRICES	NOTES
1. ARMENIA	шишши	ШШШШ	
ASSAULT RIFLES AK-12	About 50 in the first shipment	N/A	The first export contract for delivery of AK-12 https://www.kommersant.ru dated 24.01.2019
FIGHTERS SU-30SM	4 with an option of 8; 2 aircraft were delivered in 2019	N/A	Credit purchase at local Russian prices. The contract is partially paid by Erevan. https://www.interfax.ru dated 31.01.2019, https://www.mili- tarynews.ru dated 27.12.2019
ANTI-AIRCRAFT MISSILE AND GUN SYSTEM 'TOR-M2KM'	N/A	N/A	Nikol Pashinyan told about it on his Facebook page https://www.facebook.com/nikol.pashinyan dated 21.12.2019

# 2. BELARUS

COMPONENTS FOR RADAR	N/A	N/A	This year another shipment of radar 'Protivnik-G' is planned
'PROTIVNIK-G'			https://interfax.by dated 09.04.2019
OVERHAUL OF AIRCRAFT	N/A	N/A	Since Belorussia is a member of CSTO, the contract can be concluded
ENGINES D-30KP			directly with contractors without involving Rosoboronexport
			https://www.mil.by dated 25.06.2019, https://mkves.odkb-csto.org
			dated 06.07.2011
UPGRADING TANKS T-72B	11	N/A	Upgrading will take place in 2019–2020
TO THE LEVEL OF T-72B3			https://sputnik.by dated 25.06.2019
MAINTENANCE OF S-300 MISSILES	N/A	N/A	https://iz.ru dated 28.08.2019
SERVICE AND MAINTENANCE OF ANTI-	N/A	N/A	https://www.militarynews.ru от 28.08.2019
AIRCRAFT MISSILE AND GUN SYSTEM			
'TOR-M2K'			
ANTI-TANK MISSILE LAUNCHER 'KORNET'	N/A	N/A	To be mounted on the armored vehicle 'Vitim' designed by Belorussia
			https://tass.ru dated 16.05.2019
ANTI-TANK MISSILE LAUNCHER 'KONKURS-M'	N/A	N/A	https://tass.ru dated 16.05.2019

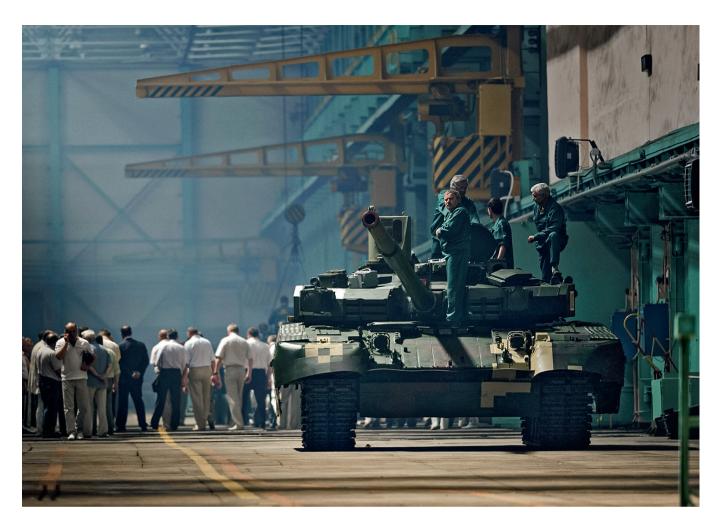
# 3. **VIETNAM**

SNIPER RIFLES ORSIS T-5000	N/A	N/A	The contract is completed. https://ria.ru dated 27.11.2019
IN-OPERATION SERVICE SUPPORT OF ENGINES TV3-117 AND VK-2500	N/A	\$5 MLN	The contract is concluded for the 10-year period https://www.uecrus.com dated 25.12.2019
COMBAT CAPABLE TRAINER YAK-130	12	OVER \$350 MLN	https://www.militarynews.ru dated 29.01.2020





SUBJECT MATTER OF THE CONTRACT	NUMBER OF ITEMS	PRICES	NOTES	
4. INDIA	пинини	пинини		
LONG-TERM LEASE OF THE NUCLEAR SUBMARINE OF PROJECT 971 'SHCHUKA-B'	1	\$3 BLN (APPR. 210 BLN RUPEES)	The intergovernmental agreement for lease of the submarine starting from 2025 for the 10-year period. The negotiations are under way considering prolongation of the lease period of nuclear submarine 'Chakra' for five more years till the tests of nuclear submarine 'Shchuka-B' are finished and it is put in service. https://tass.ru dated 07.03.2019	
REPAIR AND PARTIAL UPGRADE OF TANKERS IL-78MKI	6	\$80 MLN	https://www.kommersant.ru dated 25.03.2019	
PROLONGATION OF THE PROGRAM FOR LICENSED PRODUCTION OF MAIN BATTLE TANK T-90MS	464	\$2.8 BLN (20 THOUSANDS CRORE RUPEES)	According to some sources, India will pay to Russian defense companies in rubles. Main battle tanks will be exported as vehicle sets suitable for final assembly at HVF, Avadi. The contract is signed. https://www.janes.com	
ANTITANK GUIDED MISSILE 9M120	N/A	\$29 MLN	https://topwar.ru dated 30.06.2019	
"ATAKA" AIR-TO-AIR MISSILE R-27	300	(2 BLN RUPEES) APPROX. \$217.5 MLN	To equip Su-30MKI https://tass.ru dated 29.07.2019	
AIR-TO-AIR MISSILE R-73E AIR-TO-AIR MISSILE RVV-AE	300 400	(1500 CRORE RUPEES) \$700 MLN	hhttps://tass.ru dated 30.07.2019	
ANTI-TANK MISSILE LAUNCHER 9K113M 'KONKURS-M'	N/A	APPROX. \$110 MLN (760 CRORE RUPEES)	The release will be performed in cooperation with Russia, under a license, by BDL in Bhanur https://bmpd.livejournal.com dated 12.01.2019	
5. INDONESIA				
BMP-3F	22	\$108 MLN	The first export contract for delivery of BT-3F http://roe.ru dated 23.04.2019;	
BT-3F	21	\$67.2 MLN	https://www.kommersant.ru dated 24.04.2019	
6. <b>ITALY</b>	ШШШШШ	ШШШШ		
7 MODELS OF CIVIL SIGHTS	N/A	N/A	Models PO6x36, PO3-9x24, PO4x24, PO1x20A, PO4-12x36P, PO1/4 and PO1,5/6 with mounts are meant. https://rostec.ru dated 15.11.2019	
7. KAZAKHSTAN				
MANAGEMENT OF ASSEMBLY OF HELICOPTERS MI-8AMT/MI-171 IN KAZAKHSTAN AND DELIVERY OF THE FIRST SHIPMENT OF VEHICLE SETS	17	N/A	The contract defines general conditions of the project aiming at helicopters assembly in Kazakhstan. Under the agreement, it is also planned to generate the helicopter lifecycle support system and delivery of 45 helicopter sets by 2025 https://rostec.ru dated 18.01.2019	
8. CANADA				
GAS-TURBINE ENGINES PW207V	N/A	N/A	To equip light helicopter VRT500. Engine PW207V will be adapted to suit a single-engine helicopter, with the type certificate revised accordingly https://rostec.ru dated 18.11.2019	
9. KYRGYZSTAN	шишиш	ШШШШ		
HELICOPTER MI-8MT	2	OVER	Military equipment grant aid	
UPGRADED BRDM-2M	9	₽385 MLN	https://rg.ru dated 29.04.2019	
UPGRADING RADAR P-18-2	3			



# MILITARY-TECHNICAL COOPERATION AND MILITARYINDUSTRIAL COMPLEX IN CONCEPTUAL DOCUMENTS OF POST-SOVIET STATES

Text by Olesya Zagorskaya

The breakup of the Soviet Union placed new independent states in a position forcing them to develop their own approaches to military construction. However, even the fact of such a necessity was not apparent in the first years of their independence, not to mention that it was not a primary goal either. For this reason it was typical for the former Soviet republics not to have clear-cut goals and objectives of the military construction in the first years of their independence, with its conceptual basics being mostly borrowed from the experience of the Soviet forces.

## **KAZAKHSTAN**

The first Military Doctrine of Kazakhstan was adopted in 1993, being a classified document. The next Doctrine revision was published in 2000.

Addressing the national defense, the document provided "improvement of science and technology as well as manufacturing capabilities to enable production, repair and upgrade of armaments, military and special-purpose equipment", revision of the defense management by the state, structure re-arrangement of the industry, especially in the area of R&D management and implementation.

But, conceptually, the military-technical cooperation (MTC) was already of significant importance. Special emphasis was put on placement of mutual orders with military-industrial complex (MIC) companies, as well as on commercialization of military products (MP) manufactured by joint efforts through its sale on foreign markets. Concurrently, the high dependence on other states in terms of armaments, military and special-purpose equipment (AMSPE) was seen as a threat due to weakness of the own MIC.

The Military Doctrine 2007 announces the need of shaping the "modern general and coordinated military-technical policy of the state" that would combine activities to develop the national MIC and balance supplies of AMSPE within the cooperative framework including foreign partners. The MIC expansion on the multilateral and bilateral basis is encouraged to strengthen the collective and regional safety. Here the cooperation with foreign leaders in manufacturing of AMSPE within national MIC companies is meant.

The defense industry faces the tasks of increasing its competitive ability, among others through release of dual-use products, as well as of establishing repair, upgrade and technical support center. Special emphasis is placed on development of export capabilities – by expanding the list and amounts of exported MP and sales markets.

Also, the document mentions the funds gained "through selling the military equipment that has been released and out of use", which is likely to mean the sales of surplus obsolete AMSPE left on Kazakhstan territories after the USSR breakdown.

Speaking about MTC, the Military Doctrine 2011 of Kazakhstan repeats the highlights of the previous documents: MTC can be implemented as AMSPE supplies by foreign partners, establishment of joint companies producing, repairing and upgrading the AMSPE on the territory of Kazakhstan. The role of MTC in implementation of the defense-related export potential is noted.

Among long-term objectives there are upgrading and accelerated development of MIC companies, attraction of investments for "qualitative renewal of science and technology (S&T) and production base", as well as "finalizing the legal base regulating the military and technical cooperation".

The Kazakhstan Military Doctrine 2017 concerning the MTC and MIC can be called a revision in a sense. Here the measures for design of new military standards governing the MP production and supervisory measures of AMSPE purchase are mentioned. The Doctrine states the broad range of MIC development measures while the "improvement of the military-technical policy of the state" is referred to as one of the most promising objectives.

Alongside this, the intention to expand sales markets, to enlarge lists of exported MPs and to build up scopes of supply is still marked as MTC goals. A new supplement to this wording was the requirement of increasing production quality. A high emphasis is placed on management of mutually profitable supplies of finished products, establishment of joint manufacturing facilities producing advanced AMSPE on the territory of Kazakhstan, as well as on adapting "weapon and military equipment OEM standards along with transfer of technologies" to the conditions of own defense industry.

The common feature of all these documents was a highly detailed definition of promising areas of defense industry development with a view to the needs of national military forces. Thus, in 2000 the toppriority goals were development and retooling of communication, intelligence, electronic warfare, air defense, transport aviation units. In 2007 to these priorities replacement of "analogue communication capabilities with modern digital systems, creation of a communication network adapted to the national in-orbit force, large-scale introduction of precision weapons" were added, as well as introduction of modern electronic warfare, control and communication systems, and even "employing the space components". In 2011, special focus was on design, production, repair of automotive, air and armored vehicles, communication capabilities, automatic control systems, missile artillery weapons, munitions, among others ways – through expanding cooperation with foreign companies. Recently stake was placed on generation of AMSPE "adding to intelligence, attack, firing and transport capabilities" of forces.

Primary areas of international MTC were detailed as well. Thus, Doctrines 2000, 2007 and 2011 refer to China as one of strategic partners. Interesting enough is that the Doctrine 2017 does not offer this prospect whereas later revisions distinguish cooperative possibilities involving international organizations, among which SCO is mentioned in Doctrines 2011 and 2017.

# **UZBEKISTAN**

The Uzbekistan military doctrine was adopted in 1995. The Doctrine states that defensive power of Uzbekistan can be maintained among others through development of economic, military-technical and science capabilities, without calling specific measures, though.

The material support of conversion is encouraged – by either concessional lending or grant aid. At the same time, generation of production facilities for re-







**SHAVKAT MIRZIYOV** 

(FROM THE MESSAGE OF THE PRESIDENT OF THE REPUBLIC OF UZBEKISTAN TO THE OLIY MAJLIS (2017))

The new Defense Doctrine to be accepted will promote to the higher efficiency in military reforms.

...multifacet measures are being taken to equip the army with new armaments and the state-of-art military equipment. The State Defense Industry Committee has been established.

Advanced strengthening of the defense potential of our country, building-up of the forces combat power and capabilities are the top-priority objectives for us. We need to adopt the State Military-Industrial Complex Organization and Development Program to equip the forces with state-of-art weapons and military equipment.

lease or repair of AMSPE is offered as economics preparedness activity.

The provision stating the need of generating "agreed measures for efficient monitoring of weapon supplies and sales in the region" has indirect relation to MTC but one should add that these measures are required to prevent illegal forces from possessing weapons.

As early as by the mid 2000s, the provisions of the Doctrine 1995 were no longer relevant. The new Defense Doctrine was adopted not earlier than in 2018.

The international MTC in the Doctrine is shown as a tool for "equipping forces with the novelty and advanced AMSPE items", "allowing their upgrade, repair and disposal", "enabling cooperative projects", "attraction of foreign investments and technologies to the MIC".

The necessity of stepwise MIC development was announced. Integration of military and civil economics sectors, establishment of defense enterprises involving foreign investments and building military cooperation relations with foreign partners were the primary goals.

But at this stage the objectives set for the MIC were limited: ensuring repair and upgrade of MP while only technologies in the highest demand were to be developed and commissioned in production. Intelligence and warning systems, training automated control systems, force management automated system, electronic warfare systems, and precision weapons are amount the priority areas. Today's warfare is distinguished for the use of UAVs, network automated control systems, robotic centers.

Since, according to the Doctrine, the own MIC is hardly able to master production of these MPs, they are likely to be a subject of the MTC with foreign partners.



The first Military Doctrine of Turkmenistan was adopted in 1994 – before 1994 the Republic forces were under the joint Russian and Turkmen command. The basic concept of the Doctrine was a principle of "benevolent neutrality" envisaged a bit later at the international level by the Resolution of the UN General Assembly No. 50/80 "Permanent neutrality of Turkmenistan". The Doctrine defined the primary directions of the force development in accordance with singled-out Caspian, Afghan and Uzbek areas of enhancing the military security.

The new revision of the document – "Military Doctrine of the independent, permanently neutral Turkmenistan" – was adopted in 2009.

The Doctrine sees the MTC as a tool satisfying the needs of forces. The underlying principles of the MTC are equal rights, mutual benefit and good-neighborly relations, adherence to international stability and national security interests.

The need for improving the infrastructure "for enabling efficient operation and repair of weapons and military equipment, enhancing its technology intensiveness" was emphasized, as well as the need for generating and developing the industrial base for release, disposal and repair of AMSPE. For this purpose, the research of military technologies is planned. Since nobody's speaking about generating own industrial and S&T base for MP production, the MTC of Turkmenistan is most likely to be import-oriented.

The most recent revision of the Military Doctrine (to this date) was adopted by the President's Decree in 2016. According to the President of Turkmenistan, Gurbanguly Berdymuhamedov, the new Doctrine was revised "to enhance the defensive power". As the State Council Secretary, the Defense ex-Secretary of Turkmenistan Yaylym Berdiyev says, in line with the Military Doctrine actual steps are taken towards the stronger defense capabilities, including "upgraded material and technical base of all arms of forces".

# **KIRGHIZIA**

The first document of Kirghizia to lay the policy foundations contributing to the military security was the Military and Defense Concept of Kirghizia adopted in 1994. The Concept generated during the transition period after the "Cold War" was adopted in a hurry as an attribute of a sovereign state, for which reason its content was too generalized without hardly any certain proposals for empowering the forces and forces development priorities.

In 2002, the "Military Doctrine of the Kyrgyz Republic for the transition period till 2010" was adopted. The following is worth noting: first, the Batken events of 1999–2000 of holding attacks of armed Uzbekistan Islamic activists determined the highway direction of the force development, i.e. creation of small mobile mountain troops equipped with the state-of-art AM-SPE. Second, in spite of sparse supplies of new AMSPE



**TURKMENISTAN** 



**KYRGYZSTAN** 

from abroad, the dependence of the Republic forces on these supplies was acknowledged to be one of the security threats.

The Military Doctrine adopted in 2013 considered the MTC to be beneficial for maintaining military security and in general the way of the national defense industry development. The basic principles of implementing such a cooperation were placement of mutual orders with defense companies and promotion of the national MP production. Strengthening of bilateral and multilateral relations with CIS, CSTO, and SCO was referred as the goal of priority.

In addition to MTC, the military security was to be maintained through stepwise generation and development of the national economics industries involved in MP production. This envisages the networking of repair facilities for maintenance of weapons, armed and automotive vehicles, as well as management of replenishment and replacement of explosives and munitions. Considering these circumstances, the MTC of Kirghizia will be primarily of the import-oriented nature.

## **TADJIKISTAN**

The Tadjikistan military doctrine was adopted in 2005. The Doctrine emphasizes that it should be applied to the transition period. The military-technical aspect of the internal cooperation is not largely covered in the Doctrine, which is saying only that improving mutually beneficial MTC is among the objectives of the force military-economic support.

The importance of enhancing military cooperation "with friendly states within CIS, CSTO, SCO, and other organizations" is mentioned in the document not once, however without specifying the exact directions of such cooperation implementation.

Among other issues, defense industries are said to be in need for improvement through development of economic, technical and science capabilities as well. Enhancing the base for AMSPE production, repair and upgrade is also stated, without any details either.

#### **BELORUSSIA**

The first Military Doctrine of the Republic of Belarus was approved in 1992 and was classified. Its introduction published in the Decree of the Supreme Soviet of the Republic is open to the public. It can be derived therefrom that the size of armed forces will be reduced due to the ratification of Treaty on Conventional Armed Forces in Europe (CFE) by Belorussia and based on the "principle of reasonable adequacy for defense". Reduction in the size of forces caused "release" of AMSPE that were no longer in demand and were to be disposed of by the Belorussia government.

The new Military Doctrine was adopted 10 years later, in 2002. The document mentions the import-oriented MTC as supplies of finished MPs. However, it is noted that the purchasing policy has to combine both purchase of new commercial weapons and capabilities

of repair, upgrade and guaranteed life prolongation of existing AMSPE items available in the inventory. Besides, the Doctrine says about the "use of mutually beneficial MTC opportunities", "including export supplies of military products".

In this regard the Doctrine aims at development of the national defense industry, necessitating the accelerated import substitution of primary and double-use technologies.

The new and the last (as of this day) Military Doctrine was approved in 2016. Although it repeats the main statements concerning MTC and MIC of the previous document, these statements were expanded and added. Thus, a series of defense industry activities are said to be urgent, namely "rational use, further development and state support of S&T and production capabilities", and development of science "having direct or indirect relation to work-out of military topic and elaboration of military technologies". The most promising areas include development of multipurpose AMSPE items and those allowing numerous upgrading opportunities and employing "as many home-made component items and hardware as possible". Interestingly, this is the first time when the notion of "defense economics sector" appears in the terminological section of the document.

Another interesting novelty is a statement saying that political and economic sanctions and embargoes imposed on supplies of AMSPE to Belorussia as a tactics of putting the defense economy sector under pressure is deemed to be an external military threat, in line with risks and explosions.



**TADJIKISTAN** 



**BELARUS** 



ALEKSANDER LUKASHENKO
(FROM THE MESSAGE TO THE PEOPLE OF BELORUSSIA
AND THE NATIONAL ASSEMBLY (2016))

The most essential priority, superior to all priorities, has been and still is export, its growth and – above all – diversification. Today we have to face the fact that traditional sales markets of our products, mainly Russian and Ukrainian market, have seen the drop in the consumer demand. We cannot simply sit here and wait for it to start growing. That is why an objective of diversifying the export of Belorussia has been set. The key factor of export promotion is maintaining the package principle of sales: including the aftersales service, prompt repair, value-added services. Without it one cannot even dare to step into international markets. <...> Not that we are rattling or brandishing with our weapons. Not at all. We are totally serious and sincerely speaking about creating the state-of-art defense complex of our country.

Adopting a new revision of our Military Doctrine has become a milestone on the way towards empowering our defense capabilities. You've been dealing with it recently. It clearly defines the peaceful intentions of our foreign policy. The Military Doctrine focuses upon development of the defense industry as a high-tech economy sector aiming at not only satisfying the needs of security agencies in modern armaments and special machinery, but also at exporting our products. Whereas our products are in high demand



#### **PETRO POROSHENKO**

(FROM THE MESSAGE OF THE PRESIDENT OF UKRAINE TO THE VERKHOVNA RADA OF UKRAINE "ON DOMESTIC AND INTERNATIONAL STATUS OF UKRAINE IN 2018")

In the summer of 2014, quite a lot of time and money had to be spent on food, clothes, footwear, first aid kits, helmets. Body armors for the most of military units were even removed from the inventory – they were not planned to be purchased. The same with load bearing equipment and other necessary staff. Everything was gathered through crowdsourcing. Today we have to reach quite a different goal: new technologies, upgrading, additional armament and re-armament, transfer to NATO standards considering our unique experience in responding to attacks. Renewal of armament is guided by the import substitution strategy that enabled us to get rid of our total dependence on component supplies from the Russian Federation



**UKRAINE** 

Therefore, conceptually the MTC plays a significant role. The importance of this tool is growing, the export-oriented trends of Minsk involvement in the MTC is becoming more distinct.

# **UKRAINE**

The first Military Doctrine of Ukraine was adopted in 1993 though discussions had started two years earlier. The Doctrine 1993 mentions the MTC for the purpose of force equipment with necessary AMSPE: through purchasing from foreign suppliers as well as through development and production by joint efforts with other states. The AMSPE types adding to the fire power and mobility of forces and "successful", competitive weapon systems at the international market are referred to as being a top priority.

The national military-industrial policy is in focus too, with its objectives of maintaining the high combat effectiveness at limited costs and creating weapon systems based on preserved and elaborated modern highly efficient technologies: dual-use ones and those of which Ukraine could be a world leading provider. Among the promising force development areas there are high-precision weapons, intelligence, electronic warfare and aerospace defense capabilities, as well as advanced submarines and surface ships.

The second revision of the Military Doctrine was adopted in 2004. As compared to the previous version, the new one expanded the range of the MTC tasks and their implementation principles, stating the need for balanced export and import of the MP and dual-use goods and for lesser dependence on foreign supplies, among others due to production of basic competitive AMSPE. According to the document, ac-

cumulating surplus of obsolete AMSPE was assumed to be a security threat. Their selling in foreign markets would attenuate this threat.

The national MIC was acknowledged to experience slow conversion and poor financing. A task was set to ensure the technology and S&T, resource and information capabilities. The force development was noted to be in need for closer interoperability with forces of the NATO and UN countries, in terms of weapons as well.

Despite of the declarative nature of the Doctrine in many aspects, one can track a trend towards weaker dependence on the import-oriented MTC and an intention to manage the export-oriented MTC.

The Ukraine Military Doctrine 2012 states the necessity for maintaining the "rational balance between the international cooperation, export of weapons and State defense order" in creation of high-tech science-intensive products of military and dual purpose. Establishment of facilities manufacturing licensed and commercial AMSPE on the territory of Ukraine is a new proposed area of international cooperation. A task was set to develop the national legal base regulating the AMSPE interoperable with the relevant bases and systems of leading states. Creation of legal and institutional landscape for the MTC is an indirect indication of its growing role in the international cooperation.

The requirement for MIC reforming was emphasized once again. The state support of MIC enhancement programs and "development of the test base and firing ranges" were said to be of high importance. Among toppriority areas of AMSPE development and production the document distinguishes automatic control systems and digital communication systems, high-tech munitions, aviation equipment, air-defense capabilities, guided missile systems, and combat ships.

The most recent revision of the Ukraine Military Doctrine 2015 revises the statements of the previous versions. This revision had been largely contributed from the Ukraine crisis of 2014 and subsequent events.

An individual sector of the MIC was singled out to describe the main challenges of the industry. The major challenges include low efficiency of state policy and lack of regulation and adequate support, destruction of traditional cooperative relations, lack of closed technology chains in production of most AMSPE types, slow diversification of purchased MP and dualuse goods, critical wear of production assets and critical economic and financial condition of enterprises.

These challenges are to be solved through: "introduction of the MIC development tactic planning system"; shaping a balanced structure of MIC; maximum capacity utilization; direct purchase of MPs to satisfy needs of the State defense order; empowering the S&T capabilities; support of defense-related innovations; "introduction of emerging military technologies, generation of as closed as possible loops for design and production of the most critical AMSPE items"; as well as "extending the range and volumes of released science-intensive competitive products in the defense economics sector".

Despite the necessity of decreasing the Ukraine dependence on MP import, according to the Doctrine, the AMSPE import cannot be avoided since design and production on the territory of Ukraine are economically inadvisable or technologically infeasible. The document envisages establishment of licensed AMSPE production facilities on the territory of Ukraine and cooperative design and production in collaboration with foreign partners – the document emphasizes that the non-nuclear status of Ukraine allows claiming for international support of conventional weapons development.

The NATO and UN states are referred to as partners of top interest. The document calls for reforming the "national security system to match the level of membership in the UN and NATO", as well development of the Ukraine forces in line with Western standards and a tendency towards the interoperability with armed forces of the NATO states.

It's worth noting that in 2014 the Verkhovna Rada of Ukraine took a vote to decide on its non-aligned status determined by the Ukraine Law "About principles of foreign and domestic policies" dated July, 01, 2010. The decision was made to cancel this status.

A new revision of the Ukraine Military Doctrine is about to be adopted as soon as by summer of 2020. According to Ivan Aparshin (the Head of the Directorate of National Security and Defense in the President of Ukraine Office), it will establish the tendency of Ukraine accession to NATO membership. Last February, the preamble to the Constitution of Ukraine already rooted the "inconvertibility of the European and Euro-Atlantic course". The time will show changes in the MTC role in the new Military Doctrine revision.

#### **MOLDOVA**

The Military Doctrine of the Republic of Moldova was adopted in 1995. Considering the materiel and technical support of the forces, the document stated that the AMSPE were to be produced within Moldova in economically justified cases but mostly purchased abroad.

The military-technical issues are given significant discussion in the Military Reform Concept 2002. The document says that the MTC for the purpose of AM-SPE purchase is one of the measures for financial and economic support of the forces. Leasing deals are acceptable.

Considering the national MIC, it allows production of some AMSPE types, component items, spare parts that are "economically beneficial and affordable for the national economics" and organization of repair base. The establishment of this production shall be based on the national defense capabilities resulting from productive MTC and utilization of the dual-use technologies.

The "Provision on the procedure of selling military equipment, weapons and other military-technical assets managed by the Armed Forces of the Republic of Moldova" (hereinafter referred to as the Provision) as

revised in 2012 is also of certain interest. The Provision regulates the procedure of selling the forces' property "for the purpose of timely release of surplus, waste and non-used assets" selected on the basis of some specified criteria. The criteria include non-repairability, unprofitable operation, expensive maintenance, excess in assets. It should be noted that these assets are able to become a subject of international MTC. So, the MTC for Moldova is not only the tool for technical support of the forces, but also the way of making money from selling its excessive AMSPE.

But the changes are coming in this country too. In 2018, the Parliament approved the new National Defense Strategy that was drafted under the guidance of the NATO experts. The NATO Communication Office opened in Kishinyov a year before played a significant part. The main goal of the NATO Office in Moldova is to implement the Defense and Related Security Capacity Building (DCB) project. The project aims at design of the National Security Strategy, National Defense Strategy and Military Doctrine for Moldova with the subsequent implementation. This will engage transformation and upgrade of the armed forces, and alongside this – correction of the MTC system and goals of the Republic.

## **AZERBAIJAN**

In 2002, experts were brought together in Azerbaijan to develop the Defense Doctrine by the President's instruction. However, the draft document was not elaborated in more details in spite of being multiply included in the agenda.

Changing external situation called for drawing on new approaches, and in 2010 the Military Doctrine of the Azerbaijani Republic was adopted by the Decree of the Milli Majlis. According to the document the MTC development is among the top principles of the Azerbaijan defense policy. In addition, the "improvement of interoperability and ability to cooperate with the partners' forces in line with the multi- and bilateral cooperation" was referred to as one of the major objectives of the force in peace-time.

Establishing and expanding military technical relations aiming at purchase of advanced novelty technologies with subsequent generation of manufacturing industries on the territory of Azerbaijan is shown as the essential aid in defensive power strengthening. Such MTC will contribute to development of the national defense industry – first, for maintaining the necessary and sufficient level of defense and combat capabilities, and, second, for "ensuring the competitiveness of manufactured defense products in domestic and world markets". Also, the possibility of rendering services of MP selling and technical upgrade is under consideration. Besides, "to meet demands permanently and independently", the document announces the intention to develop local S&T, technological and production base, among others by involving business and private investments in defense industries.

It is an interesting fact that the official web-site of the Ministry of Defense of the Azerbaijani Republic has



**MOLDOVA** 





**ALEKSANDER LUKASHENKO** (FROM THE MESSAGE TO THE PEOPLE OF BELORUSSIA AND THE NATIONAL ASSEMBLY (2019))

The companies that were one step from being lost and smashed up in the early 1990s were inspired with a new life. Quite a lot remember it. Beloruskaliy, oil refineries, MAZ, BELAZ, MTZ, BMZ – this list is far from being exhaustive. Without exaggeration, their products are known in every corner of the planet. They are our national endowment nowadays.

We continue developing our production of special-purpose and combat equipment. Among achievements of Belorussian military industrial complex there are the multiple launch rocket system, new mid-range surface-to-air missile system, UAV countermeasures, which are in demand by numerous armies of the world



**ARMENIA** 

a section "Bi- and multilateral military cooperation" which lists the partner states in military, political-military and military-technical areas. China is within the first lines of the list.

#### **ARMENIA**



The Military Doctrine of the Republic of Armenia was approved in 2007. According to the document, the MTC allows strengthening military and political positions on the world stage, retaining relative parity in military and political-military alliances, and in the overall military power of the forces in the region, implementing transfer of the world advanced practices in upgrading armed forces.

In addition to the MTC, development of the domestic MIC through upgrading and "attraction of financial, materiel and intellectual potential" is also of significance. Apart from AMSPE repair and upgrading, conditions are supposed to be developed to favor design and production of MPs, with some kinds of those presented in foreign markets. The top-priority areas of the defense production include communication and intelligence aids, electronic warfare capabilities, automated control systems and response and warning systems. Besides, the Doctrine does not put it straight but the MTC is implied as a part of membership in international organizations which plays a significant role in implementation of the Armenia's defense policy.

The Doctrine was adopted for an approximate period till 2015, but a new revision of the document has not been approved so far. In July, 2018 the mass media published some information about the so-called Tonoyan Doctrine (David Tonoyan is the Minister of Defense of the Republic of Armenia) – as understand-

ing of forces' development and upgrading. According to these messages, Armenia would equip its forces with innovation weapons to achieve the force balance with Azerbaijan.

Despite the fact that Armenia will rely on military and technical capabilities of strategic allies, the focus will be placed on the MIC development to cut down military expenses and minimize the dependence on the AMSPE import.

#### **GEORGIA**

According to mass media publications, in 2005 the Ministry of Defense of Georgia made available the text of the National Defense Doctrine that is considered to be the Georgia's first ever document of the kind. The core statement of the Doctrine was the intention of accession to NATO membership, and the list of measures aimed at transformation of Georgian forces according to the Alliance samples and standards, which comprised the re-equipment program.

In 2014, the new National Military Strategy was adopted and proved to be the updated version of the 2005 document. The Doctrine reflects demands of the forces and key areas of their rearrangement. In particular, it implies development of the self-propelled artillery through the fire control system improvement, and development of air-defense, anti-tank, intelligence and data collection systems. At the management level, the document declares the need of expanding analytical capabilities of data processing and interdepartmental data exchange mechanisms.

The White Book 2013 puts special emphasis on the MIC enhancement for the purpose of satisfying demands of the forces. It mentions that the State Research and Development Center DELTA is involved not only in upgrading and technical support of already existing systems but also in searching for possibilities of producing new MPs – first of all, military aircraft, armored vehicles, fire weapons.

The White Book 2014 pays attention to development of Georgia's domestic defense industry capacity. The need of increasing its functional interoperability with the NATO is emphasized. Among others, it states that as of 2014 Georgia implements bilateral cooperation with 22 states, however the exact areas of cooperation are not disclosed in the document.

The White Book 2017–2020 mainly elaborates the provisions of the previous documents, concluding (concerning the MIC development prospects) that limited financing conditions force to select the directions of higher priority.

The strategic review of the defense for the period of 2017–2020 contains the extended list of AMSPE enhancement directions. It reflects intentions to deplete obsolete samples, to upgrade some remaining samples – the air-defense system, intelligence, artillery, and the weapons suitable for fighting armored vehicles. The depleted obsolete samples are planned to be substituted with systems interoperable with NATO

ones. The priority list of the force support areas is enhanced with an item concerning the design of UAV capacity development concepts.

The official web-site of the Ministry of Defense of Georgia, in the International cooperation section, contains the list of states the Ministry develops bilateral relations with.

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To sum up, the conceptual documents reduce the MTC role in terms of military security to mainly materiel support of the forces. This area is differently referred to by different states – "economic support of military security" (Belorussia), "technical fitting-out of forces" (Kazakhstan), "resource for military and economic support of force demands" (Turkmenistan), "satisfying material needs of forces" (Ukraine), etc. But still the same phenomenon is implied meaning that the WP import is caused by the need of the country's forces of this or that certain AMSPE kind that cannot be obtained by any other way than by purchasing.

Besides, the MTC role is to develop capacity and capabilities of the national MIC – mainly, through transfer of technologies. It is noteworthy that Turkmenistan does not accentuate it specifically while poorer countries lacking considerable defense industry capacity, such as Kirghizia and Tadjikistan, acknowledge the MTC to be exactly an opportunity for that, at the conceptual level.

The MTC largely contributes to implementation of the export capacity of national MICs. Traditionally, it is

Belorussia, Kazakhstan, Ukraine who mark this function of the MTC. It is interesting that Armenia considers this function as well. Other countries either ignore the need for developing the export capacity or distinguish the necessity for developing their national MIC oriented at satisfying domestic needs.

Apart from these three major objectives of the MTC, some others are noted. Thus, MTC is beneficial for enhancing defensive capacity (Uzbekistan), guiding the defense policy at the international level (Uzbekistan), assurance of the military security (Kirghizia), empowering the military and political stand on the world stage (Armenia), maintaining the parity of alliances (Armenia), transformation of forces in accordance with NATO standards (Georgia).

Some statements of the conceptual documents – mainly those concerning national MICs – allow making conclusions on MTC orientation: whether it is export- or import-oriented or attempts will be taken to harmonize the purchase policy. Today, the most distinct export-oriented intentions are declared by Belorussia, Kazakhstan, Ukraine (except for the last revision of the Doctrine where the top-priority goal is to satisfy needs of the national forces, however it does not diminish the role of the MP export). Some other states announce export capacity development too, but these announcements largely remain declarative. The import orientation may be indirectly perceived as a threat in case of overdependence on supplies.

Doctrines of not all states and for not all periods reflect existing actual situations and match it. Some documents only declare; this has to be taken into account and correlated with actual military and technical reality. •







The Mi-24/35 (NATO reporting name Hind) is an attack helicopter type which was once in mass use in Eastern Europe, operated in the 1990s and the early 2000s by the air arms of no less than seven countries, with a total fleet exceeding 170 aircraft.

Today the population is much smaller, with less than 50 Hinds remaining in active service in the region. There are chances, however, that this numerical strength will be maintained in the near future, as the type is set to serve for longer than originally anticipated in the Czech Republic and Poland, while Bulgaria and Hungary have also invested to extend the life of their aging machines. In contrast, four new-build Mi-35Ms – advanced gunships with much enhanced day/night capability and better guided missiles and guns were delivered to Serbia on December, 3, 2019.

The original Mi-24V Hind-E and its slightly improved derivative dubbed Mi-35 are the most numerous in service in the region, but the fleet has suffered from increasingly obsolescent systems and armament, and is lacking any usable adverse weather and night operating capability. It was originally designed in the mid-1970s as an armored attack helicopter with considerable transport capability offered by its cabin for eight troops, although this design feature is rarely used.



**BULGARIA** 

# **BULGARIA - MAINTAINING A MARGINAL CAPABILITY**

Providing Bulgaria's attack helicopter capability, a 44-strong Mi-24 fleet – including 38 Mi-24Ds (Hind-D) originally delivered between 1979 and 1985, and six more Mi-24Vs in 1986 – was cut in half in 1999. The type has suffered from a significant lack of serviceability due to the limited supply of otherwise vital and expensive spare parts, such as rotor blades, as well as expired engine and airframe time between overhauls – both TBO and total airframe time.

In 2002–2004 dozens of Mi-24Ds were sold to local arms trade companies. Six were thus delivered to the US and two went to the Ivory Coast in 2003. Then six Hind-Ds followed suite to Mali between 2007 and 2010 after having completed overhaul. Five more surplus Mi-24Ds were then sold out by the Bulgarian MoD to Metalika-AV in December 2011, and by late 2017 at least four of these had been returned to airworthy condition. In 2017–2018 three were sold out to the Ivory Coast and one went to Burkina Faso in 2018, followed by another helicopter in 2019.

During the mid-2000s, the six Mi-24Vs were the only attack helicopters remaining in operation with the Bulgarian Air Force (BuAF), with one or two of them maintained in airworthy status at any time. The fleet was finally grounded in early 2011 due to service life expiry of their airframes – originally limited to 20 years of operation. In fact, two Hind-Es continued flying for three to four more years thanks to airframe life extensions granted by the BuAF's own aviation-engineering service.

In 2004, the Bulgarian MoD moved forward with a tender covering the comprehensive upgrade and life extension of all six Mi-24Vs plus six of the newest Mi-24Ds – all of these helicopters were delivered in 1985 and 1986.

The result was the selection of Elbit Systems of Israel, which tendered in November-December 2004 a package price for upgrade, overhaul and airframe life extension of Euro 57.2 million (covering 12 Mi-24s and six Mi-17s as well). Avionics upgrade work was to comprise installation of an on-board processor, integrated with a digital map, embedded GPS/INS navigation system, and multifunctional displays in both NVG-friendly cockpits as well as a control and display unit. New observation and aiming equipment onboard the Mi-24 was to include a high-performance multi-sensor turret as well as Elbit's advanced helmet-mounted display and targeting system and also Western-standard navaids, all-new self-protection suite, new radios and weapons interfaces.



Even before the contract was finalized, sources from the Bulgarian MoD hinted that the package price of Euro 57.2 million for the sophisticated upgrade, combined with an overhaul and life extension, was a too low cost for such a comprehensive program. There were also concerns that Elbit would not be able to obtain a valid approval for the upgrades, as required by the Bulgarian MoD. Such an approval was to be issued by Mil Moscow Helicopter Plant (MHP), the design authority for the Mi-17 and Mi-24, but the Russian company had clearly stated that Elbit was ineligible for such a license, citing numerous design-right violations by the Israeli company in the past.

The Bulgarian Mi-24 upgrade program sparked further controversy as then Russian defense minister, Sergey Ivanov, publicly declared on February 10, 2005 that Russia would consider any agreements similar to the Bulgarian contract – those not supported by OEM licensing – as illegal. Following rather problematic contract details negotiations, and despite Russia's serious objections, the upgrade contract between Elbit and the Bulgarian MoD was finally signed on December 2, 2005, but very little work followed.

Eventually, on January 30, 2007, the Bulgarian Government and Elbit agreed to terminate the contract by mutual consent due to the impossibility of its performance. Bulgarian reasons behind this bitter decision also acknowledged Russia's refusal to cooperate with Elbit on the delivery of airframe life extension know-how and the supply of critical spare parts, such as rotor blades, for the Hinds and Hips. Bulgaria is known to have paid around Euro 3.5 million to Elbit for developments works and equipment supplied until contract termination.

A new tender was announced by the Bulgarian MoD in 2008. This time, the Mi-24 upgrade has been intended to be carried out in close cooperation with the Russian design authority, Mil MHP, using a technical specification broadly similar to that of the first contract. At the same time, in a bid to have a successful upgrade of helicopter's communication, navigation and identification (CNI) equipment, Electronic Warfare (EW) suite and integration of a Link 16 terminal onboard, a tailored working scheme was conceived. It called for appointment of a Bulgarian main contractor, TEREM Holding EAD company, a MoD-owned defense equipment maintenance, repair and overhaul (MRO) enterprise, which would then subcontract the upgrade and life extension works to Rosoboronexport (the Russian arms export monopolist, which will appoint Mil MHP, as OEM, to perform the actual work). The NATO-sensitive part of the avionics upgrade, in turn, was intended to be carried out by Western subcontractors, without Russian involvement.

All the upgrade and airframe refurbishment works were to be carried out by the Sofia-based TEREM-Letets facility using Russian upgrade kits and know-how, while engines and main gearboxes were to be overhauled in Russia.

In early 2009, however, the Mi-24 upgrade program was canceled before reaching an agreement with MoD, allegedly due to the excessively high price which had reportedly failed to fit into MoD's allocated budget.

This way, by 2014 the BuAF eventually decided to invest in the simple overhaul and life extension of its six Mi-24Vs in order to retain a generic attack capability. It was performed through a framework agreement with TEREM Holding EAD, where the Russian Helicopters has acted as the principal subcontractor, providing spare parts and overhaul of certain systems for the helicopters as well as a life extension know-how and final approval.

The first Hind-E covered by this agreement completed a notably protracted overhaul and life extension works at the TEREM-Letets MRO plant at Sofia Airport-North and was redelivered to the BuAF in late November 2015. The Hind-E is assigned to the helicopter squadron of the 24th Air Base at Krumovo near Plovdiv, also equipped with Mi-17s and AS532AL Cougars for tactical transport duties.

This Hind-E, originally manufactured in February 1986, was certified following the overhaul for another seven years' operation or 1,000 flight hours, whichever comes first, according to a service bulletin issued by Mil MHP, the Mi-24's design authority, and to the total of 36 years of operation.

The second overhauled and life-extended Mi-24V was returned to regular service in late 2017. Both of these Bulgaria Hind-Es are expected to remain in service until 2022–2023. Due to the lack of funds at the time, no other Mi-24Vs have been cycled through the program.

In 2018, the Bulgarian MoD launched a new tender for another framework agreement covering the overhaul and life extension of the four remaining Mi-24Vs, where TEREM-Holding EAD was the only bidder. On March 26, 2019 the Bulgarian MoD announced the results of the tender, where the unit price for the Mi-24V overhaul was set at US \$4 million.

More than 70% of the value of the works is expected to be on the account of Russian subcontractors delivering spare parts, performing engine and main gearbox overhaul and granting life-extension know-how and approval. Negotiations where successfully completed and a 4-year agreement was signed on 12 June 2019 beteen the Bulgarian Ministry of Defence and TEREM-Holding EAD. It is expected that the first Mi-24Vs could be re-delivered to the BuAF by late 2020, while the extended service life of this second-batch of life-extended Hind-Es would make them good for flying until 2027–2028.

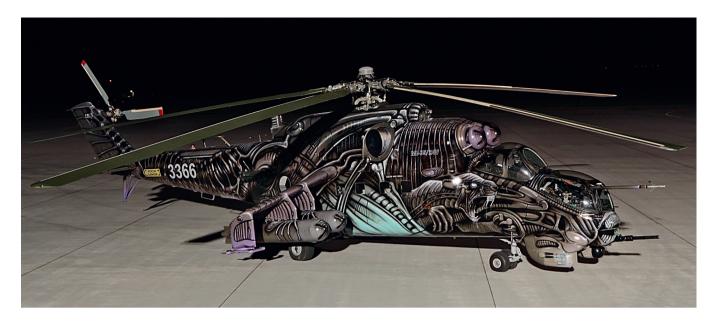
No upgrades are conceived, however, for the Bulgarian Mi-24s during the overhaul to address obsolescence in communication, navigation, and identification systems and the armored gunships are set to continue their service well into the mid-2020s with their original avionics and armament suites dating back from the late 1970s, with the only novelty being a Trimble 2021 I/O Approach GPS receiver bolted on in the front cockpit to be used by the Mi-24's co-pilot/gunner.





**HELICOPTER MI-24** (EXPORT VERSION MI-35) **DESIGNED BY THE MIL** MOSCOW HELICOPTER PLANT (MHP) AND IS ONE OF THE MOST **KNOWN HELICOPTERS** OF THIS CLASS. WORKS ON **DEVELOPMENT OF THIS HELICOPTER MI-24** STARTED IN 1968. THE PROTOTYPE MADE ITS MAIDEN FLIGHT IN 1969, WAS ACCEPTED **FOR SERVICE IN 1972** 







# **CZECH REPUBLIC**

## **CZECH REPUBLIC – SERVICE LIFE EXTENDED**

The Czech Air Force is the East European operator with the youngest Hind fleet, representing a mixture of Mi-24Vs and Mi-35s delivered in the early/mid-2000s. These machines were originally slated to serve until the end of this decade but now it seems that a significant portion of the Russian attack fleet is poised to remain for longer period although no upgrades are considered for it.

The Czech Air Force originally inherited a fleet of 16 Mi-24Ds (delivered between 1978 and 1983) and 20 Mi-24Vs (delivered between 1985 and 1989), together with one Mi-24DU trainer upon the dissolution of Czechoslovakia in 1993. All of these attack machines were retired in the mid-2000s. Six Mi-24Vs were donated following overhaul to Afghanistan in 2006 and these machines remained in active use there until the mid-2010s.

In 2003, the Czech Air Force took on strength seven newly-built Mi-24Vs in addition to ten more Mi-35s, delivered in 2005 and 2006. These new attack helicopters were received as a part of Russian arms deliveries in lieu to writing off Russian trade debt to the Czech Republic dating back to the Soviet era. The Mi-35s (in fact, the export Mi-24V version) differed from the Mi-24Vs by some minor technical features and sport external and internal lighting compatible with Night Vision Goggles (NVGs) in addition to English-language stenciling in the cockpits.

Today the Mi-24V/35 force is equipping the 221st Squadron at Namest-nad-Oslavou air base. The main tasks of the Hinds are to provide support of the land forces, close air support on the battlefield – including destruction of small-size hardened targets – plus medical evacuation, air reconnaissance, escort of other helicopters or ground convoys, and combat search and rescue operations. In addition, the fast attack helicopters can be used, on as-needed basis, for reinforcement of the national air defense system, intercepting slow-flying air targets at low and ultra-low altitude. An unusual peacetime mission for the Czech Mi-24V/35 force is the civil search and rescue performed on day-to-day basis, covering a vast area in the Eastern part of the Czech Republic.

The Czech Mi-24V/35 fleet is known as a very active one in the international arena, as the fleet is a regular participant in multi-national exercises organized in NATO area. The biggest benefit is that the international exercises enhance the tactical skills and interoperability of the aircrews when involved in NATO operations. In addition, the Czech aircrews now practice on regular basis NVG flying. It was initiated in 2005, using in the beginning Russian-made GEO-ONV-1 NVG sets, delivered together with the Mi-35s, while today, US-made AN/AVS-9 NVG sets are in use.



The Czech Mi-24V/35 fleet, although still relatively young and little-used, is now seriously considered as outdated for it lacks modern targeting avionics for night operations as well as mission planning system, secure communications and datalinks, and self-protection suite to counter heat-seeking surface-to-air missiles. Its main guided weapon – the 9M114 Shturm-V missile with semi-active command radio-guidance – is also considered to be obsolete.

There are no plans for upgrade of the Hind-E's mission avionics suite and weapons, however, as it is deemed to be a rather expensive and protracted undertaking. It would be even more difficult and risky exercise in the current political environment, with tensions between Russia (the original

manufacturer of the helicopter) and the Western world. That is why in 2011, the Czech MoD long-term plans, outlined in the so-called Defense White Paper, insisted on a gradual withdrawal from use of the Mi-24V/35 fleet, with completion of the decommissioning process originally expected by 2015–2016. By that time the helicopters of the first batch, delivered in 2003, would run out of useful life, as their time between overhaul of 1,000 flight hours and eight years will be expired in full.

In fact, at the time it was considered that instead of main overhaul at LOM Praha after 2011, the fleet would undergo a technical inspection at its home airbase in Namest to allow the airframe service life to be extended with 500 flight hours or/and 3.5 years, whichever occurred first.

Meanwhile, the Czech military has initiated a program to replace in the early 2020s the entire Mi-24V/35 fleet with 12 new-build Western-made tactical transport helicopters outfitted with sighting systems and forward-firing weapons, including rockets, gun pods and guided missiles. In mid-June 2015, the Czech MoD requested information from governments and several Western manufacturers about their offering for helicopters capable of performing combat support tasks, such as troop transport and medical evacuation. The tender was announced in mid-2017, and in October that year the Czech MoD shortlisted the Bell Helicopter UH-1Y and Leonardo Helicopters AW139M, but before long the acquisition drive was put on hold. The newly-appointed defense minister Karla lechtov asked the military authorities responsible for the tender to rework the technical specifications, but the new specifications were approved only by February 2018. These were set to allow Airbus and Sikorsky to enter the tender once again, offering the H145M and an armed version of the S-70i Black Hawk.

In April 2018, the Czech MoD announced that it had planned to launch a new tender for 12 medium-class multi-role helicopters, priced at about US \$240 million. By April 2019, however, no tender has been launched yet and this provides the Mi-24V/35 fleet with fair prospects for continuing its service for at least six or seven years. On December 12, 2019, a deal for buying 12 helicopters valued at up to \$650 million was finalised at a meeting between US Defence Secretary Mark Esper and Czech Republic Defense Minister Lubomir Metnar at the Pentagon. Deliveries under this deal are expected to begin in 2023.

Latest news from Prague, dating March 16, 2019, appear to indicate that the Czech MoD looks inclined to buy US-made helicopters without a tender, by following a fast-track procurement procedure. According to Jakub Landovsky, deputy minister of defense, the choice in the new procurement procedure, with a budget two-fold increase to US \$553 million, will be made between the UH-1Y and S-70i.

Due to the expected delay in the procurement of the new helicopters, the Czech MoD and the local industry, represented by LOM Praha (the company involved in the Mi-24V/35's depot-level maintenance) agreed in 2015 that there was yet a long life in the helicopters. They initiated an overhaul program for the Hind-E fleet, priced at about \$37.5 million, covering ten helicopters. Upon the overhaul completion at LOM Praha in 2017–2020, these ten Mi-24/35s were provided with 1,000 flight hours and seven years of service life, but no avionics or armament upgrades are in the MoD plans.

# HUNGARY – SET TO SERVE SHOULDER-TO-SHOULDER WITH THE H145M AND H225M

Hungary received a fleet of 30 Mi-24Ds from the former Soviet Union between 1978 and 1985, followed by ten Mi-24Vs taken in 1987–1988.

The fleet was reinforced in 1993 by 14 second-hand Mi-24Vs and six Mi-24Ps taken from the fleet of the former German Democratic Republic Air Force, provided by Germany free of charge. Only two Mi-24Ps, however, were overhauled and re-entered service while the remaining Hinds were placed in long-term storage.

The last flying Mi-24s in Hungarian service were grounded in 2013 due to expired airframe service life but the type was not withdrawn from use. There were no funds for their overhaul and life extension over the years and only in 2017 the program was rejuvenated, with a contract with Russian Helicopters for the Mi-24's prompt return to service, inked on October 31. The contract was originally reported to have covered eight helicopters – this figure including six Mi-24Ps and two Mi-24Vs – plus four options (Mi-24Vs). As of now, all eight of the firm contract were cycled through overhaul at the 419 ARZ military MRO facility in Gorelovo near St. Petersburg and no more machines are known to have





been eventually included in the program. During their overhaul in Russia, the helicopters received some minor upgrades such as NVG compatibility and a new control panel for the navigation and communication systems.

The first four overhauled and life-extended Hinds were delivered back to Hungary in September 2018 – two Mi-24Vs and two Mi-24Ps. Hungary is known as the only nation in East Europe operating the Mi-24P Hind-F version armed with a massive and powerful twin-barrel GSh-2-30 30 mm gun, installed in a fixed position on the starboard side and provided with 470 rounds. The last four helicopters from the order, again Mi-24Ps, were delivered back to Hungary in January 2019. The life extension undertaken together with the overhaul provided the Mi-24V/Ps with 1,000 flight hours and seven years of service life.

According to Brigadier Jozsef Koller, Commanding Officer of the 86th Tactical Helicopter Wing at Szolnok, the overhauled and life-extended Hind-E/Fs are planned to remain in service for at least seven years. Their mission set will be also expanded – in addition to their purely military tasks, the helicopters will also see participation in disaster relief operations, providing assistance to the civil population.

The Mi-24 fleet will be complemented and eventually replaced by armed light and medium-size helicopters of Western origin. In June 2018, the Hungarian MoD inked an agreement with Airbus for the purchase of 20 H145M light twin-engine helicopters with a maximum take-off weight of 3.6 tons, outfitted with the HForce weapons management system, with first deliveries slated for 2020. The armament selection of the Hungarian H145Ms will include both guns and rockets in addition to guided missiles – most likely 70 mm, supplied by Thales. The targeting suite will be represented by the L-3 Wescam MX-15 electro-optical/infrared turret in the nose for day/night operations and a Thales Scorpion monocular helmet-mounted sight display for the pilots. The number of weapons kits ordered for the H145M fleet is about ten.

Then, in December 2018, another order was placed, this time for 16 H225M multi-role helicopters outfitted for tactical transport, some of which will also be equipped with the HForce system to enable the 11-ton helicopter to be used for fire support purposes.



# **POLAND**

# POLAND - UPGRADE PLANS STILL ALIVE

The Polish Army Aviation took 16 Mi-24Ds on strength between 1978 and 1985, followed by 16 Mi-24Ws (the Polish-specific designation of the Mi-24V) between 1986 and 1991.

In 1996, Poland got 18 more second-hand Mi-24Ds as a donation from Germany, formerly operated by the East German Air Force. The Polish MoD eventually decided to cycle through overhaul and reintroduce 16 of the ex-German machines into service, using the remaining two as spare parts donors.

Today, the aged Hind fleet of the Polish Army Aviation service, comprising 13 Mi-24Ws and 15 Mi-24Ds in active service, equips two squadrons assigned to the 56th Air Base Inowroc aw-Latkowo and another one with the 49th Air Base at Pruszcz Gda ski.

Flying a mix of Hind-D/E variants, one of the 56th AB's squadrons has an attack role, while the second is also equipped with eight newly-delivered PZL Swidnik W-3PL G uszec armed helicopters, and is assigned the CSAR role.

Three Mi-24Ds were damaged and subsequently written off during the combat deployment to Iraq between 2005 and 2010, while two more sustained serious damage but were repaired.

The Mi-24Ws, in turn, were involved in combat operations in Afghanistan between 2008 and 2014. Three helicopters were reported damaged beyond repair in non-combat-related accidents in Afghanistan and at least one was heavily damaged in an emergency landing following mechanical failure, but was then repaired at WZL-1 military MRO plant in d and returned to service.



The older and less capable Mi-24D version was originally slated for withdrawal from use upon expiration of its extended service life between 2016 and 2019, but now it seems that the Hind-D will continue for a while. In turn, the newer Mi-24Ws were set to serve a little longer than the Mi-24Ds, originally slated to be kept until 2020–2022, when the new-generation Kruk attack helicopter was expected to be fully introduced into Polish service. The serious delay incurred by the Kruk program, however, is going to force the Polish MoD to keep its aged Hind-D/E fleet until at least 2025, or even 2030, in case it decides to proceed forward with a comprehensive avionics and weapon systems upgrade.

A comprehensive upgrade of the Mi-24's mission avionics and weapons for day and night operations had been planned for the first time in the early 2000s, but in June 2003 Poland dropped its requirement to upgrade as many as 40 Hind-D/Es, opting instead for launching a new program set to cover only the Mi-24W fleet. Thirteen of these machines were scheduled at the time to get new NATO-interoperable avionics suites and new guided weapons, while three more were set to be upgraded for use in the combat search and rescue (CSAR) role. The upgraded Mi-24Ws were to remain in service until about 2015, while the older Mi-24Ds – considered as finally running out of airframe life – were slated for retirement in the 2005–2006 timeframe. In this event, the Polish MoD decided to shelve the ambitious and rather expensive Hind-E upgrade program as it had reportedly failed to reach working agreements with its Russian partners – arms export agency Rosoboronexport and Mil MHP.

As an alternative, a considerably less ambitious upgrade package was then conceived for the Mi-24W fleet, to be implemented by the Polish industry for delivering of a basic NATO interoperability to the Hind fleet. Completed just prior to the Hind-E's deployment to Afghanistan, the upgrade comprised all-new communication, navigation and identification friend-or-foe (CNI) equipment, NVG-compatible internal and external lighting for use with Polish-made PNL-3 NVG sets and a Ukrainian-made infrared (IR) jammer. A number of Mi-24Ds were later upgraded to the same standard, albeit without the jammer.

The Warsaw Air Force Institute of Technology (IWTL) integrated the new CNI package for production installation at state-owned Military Aviation Works No. 1 (WZL-1) at Łódź. In addition, WZL-1 overhauled the airframes to extend the airframe life.

The new communication equipment, a mixture of Polish-, German- and US-made pieces of kit (some of them built to military standard and some to civil standard), included the ZSŁ-1 integrated communication system of Radmor RRC-9500 VHF radio, Harris RF-5800H-MP-036 HF, Rhode & Schwarz MR-6000R-XM6013P UHF/VHF, Unimor RS-6106 VHF and RS06113-2 UHF/VHF radios. Navigation systems installed on the Hind-D/Es during the upgrade included a Garmin 155XL GPS receiver in addition to Bendix King KTU-709 TACAN and Bendix King KNR-634A VOR/ILS/MB (VHF omni-range/instrument landing system/marker beacon) receivers, and power cables plus a docking station for a hand-held Garmin 296 GPS receiver in the front cockpit.

Other new equipment included in the Hind-D/E upgrade package included a Radwar SC10-D2 IFF transponder and S-2-3a quick-access flight data recorder, while the Hind-Es also received the new-generation Ukrainian-made KT-01AW Adros continuously operating 'disco-light' IR jammer. Intended to defeat a wide variety of heat-seeking MANPADS, the omnidirectional Adros emitter is installed on the upper rear fuselage, replacing the original L-166B1A IR jammer.

During their overhauls at WZL-1 together with the upgrade, the entire Hind-D/E fleet is reported to have received newly-built, Ukrainian-made TV3-117VMA-SBM1V engines with improved power rate and extended time between overhauls for better hot-and-high performance.

An effort to equip the Mi-24Ws with a modern self-protection suite to complement the KT-01AW jammer and ASO-2V chaff/flare dispensers reportedly failed, despite the considerable time and money spent on it. It was to be provided by the Danish company Terma, selected in 2010 as preferred bidder in a tender to supply integrated self-defense systems to counter heat-seeking MANPADSs.

The Polish MoD requirement called for an up-to-date self-protection system for the Mi-17 and Mi-24 fleets. Terma offered a derivative of its proven, pod-mounted Modular Aircraft Survivability Equipment (MASE) system, and an US \$30 million contract was inked in August 2010. It covered supply and integration of 22 sets of aircraft equipment (including seven for the Mi-17 and 15 for the Mi-24W) — in addition to 12 more pods containing missile approach warning sensors and countermeasures dispensers.

The Mi-24W would be modified to carry the pods on its wingtip vertical endplates. The starboard pod housed three AN/ALR-60 Missile Launch Detection System sensors, and the port unit – two. The pods were also equipped with 30-round AN/ALE-47 flare dispensers. Flight tests of the system began in Poland in July 2011, but the contract with Terma was ultimately terminated by mutual consent. The reason for this was said to be an unresolved dispute concerning the interpretation of the contractual requirements on false alarms.

In 2018, the Polish MoD began to consider new upgrade plans for its aging Mi-24 fleet, due to the serious delay of the Kruk program, intended to select and purchase new-generation attack helicopters, with deputy defense minister Wojciech Skurkiewicz hinting that a limited upgrade would be pursued. As a result, on January 21, 2019, the Polish Armament Inspectorate announced the launch of the so-called technical dialogue with companies interested in the Mi-24D/W upgrade. This dialogue was held between July and September 2019, with the technical specification sent to selected interested





FIRST SUPPLIES OF MI-24
WENT FOR EXPORT UNDER
THE DESIGNATION MI-35,
AND IN THE 1990S
THE MIL MOSCOW
HELICOPTER PLANT
RELEASED MODERNIZED
SERIES UNDER THE
DESIGNATION MI-35M
AND ALSO A VERSION
MI-35PM





candidates in the form of a request for information. The upgrade was intended to cover the armament, communications, self-protection, IFF and navigation systems, with the Armament Inspectorate requesting information on the procurement cost and life-cycle costs, logistic requirements and the time for implementation of the upgrade.

In addition, the interested bidders shall prove that they possess experience in the maintenance, repair, overhaul and upgrade of the Mi-24W and Mi-24D helicopters. The number of helicopters to be cycled through the future upgrade was not declared. The ages of the current Hind fleet are ranging from 27 to 37 years.

A serious issue currently handicapping the Polish Hind fleet is the lack of ATGMs as the existing stocks of 9M114 Shturm-V and 9M17P Falanga missiles were finally depleted by 2011; so, the Polish Hind fleet currently lacks any meaningful anti-armor capabilities. The list of the new armament requirements is believed to also include 70 mm NATO-standard rockets.

The nose-mounted YakB-12.7 machine gun was also described as increasingly difficult to obtain spare parts for it. WZL-1 came with a possible replacement solution, by offering a single-barrel 12.7 mm WKM-B machine gun, produced in Poland and using NATO-standard ammunition, to be installed into the Mi-24's existing USPU turret. In turn, TDA, a subsidiary of Thales Group, in partnership with local companies, has been offering the IRS short-range laser-guided rockets, launched from the Telson 22 pod, sporting a range of up to 2.7 nautical miles (5 km).



#### ALEKSANDAR VUCIC PRESIDENT OF THE REPUBLIC OF SERBIA

This year we expect seven new helicopters. Among them there are four Mi-35, one of the best and most advanced gunships, and three Mi-17, transport helicopters with weapons

## SERBIA - NEW MI-35MS EXPECTED THIS YEAR

In 1998–1999, the then Yugoslavian Ministry of Interior used a pair of Mi-24Vs, procured earlier in the decade second-hand from Ukraine, in counter-insurgency (COIN) operations in the breakaway province of Kosovo. After the abrupt end of the Kosovo war of 1999, these Hind-Es were promptly transferred to the Yugoslavian Air Force, and were then inherited by the Serbian Air Force, established after the dissolution of the Yugoslavian state in 2006 into two independent countries – Serbia and Montenegro. In fact, the helicopters were grounded already during the early 2000s due to exhausted service life, and there were no attempts to return them into flightworthy condition.

In January 2019, it was revealed by Serbian president Aleksandar Vucic that there was an agreement in place with Russia to supply four newly-built Mi-35M attack helicopters and three Mi-17V-5 tactical helicopters, with delivery was completed by the end of 2019 ahead of schedule.

According to Vucic, this purchase, together with the expected delivery of nine Airbus Helicopters H145Ms, will seriously bolster the country's military helicopter fleet.

Serbia is the tenth export customer for the Mi-35M, a vastly improved Hind derivative, launched in production since 2007, featuring an improved armor protection, more powerful engines, more efficient main and tail rotor systems and a sophisticated digital mission avionics package for day/night operation, including deployment of the 9M120 Ataka-V anti-tank guided missiles (using radio-command guidance) at distances of up to 3.13 n.m (5.8 km) and NVG compatibility.

A total of five H145Ms are to be taken on strength by the Serbian Air Force and four more are to be delivered to the Ministry of Interior under a contract inked in December 2016. Their delivery was completed by the end of 2019 as planned.

The Serbian Air Force's H145Ms will be equipped with the HForce Generic Weapon System, which will use locally-made Serbian weapons such as gun pods with a single-barrel 12.7 mm machine gun and seven-round pods for firing 80 mm S8 rockets, also locally produced in Serbia, plus the latest Serbian-made version of the Malyutka ATGM. The first H145M was accepted by the Serbian MoD in November 2018, but its delivery to Serbia took place in June 2019.



# **SERBIA**

#### **NORTH MACEDONIA**

The Republic of North Macedonia received a fleet of a dozen of second-hand Mi-24 helicopters to meet an urgent need thanks to a military-technical cooperation agreement signed with Ukraine in March 2001. The attack helicopters were badly needed to participate in counter-insurgency operations against the ethnic Albanian militants which commenced an armed operation against the government forces in February that year.

The first pair of Mi-24Vs arrived in Macedonia a few days after signing the agreement with Ukraine and the helicopters were immediately rushed in combat, supporting the ground troops. In these combat sorties the Mi-24s were flown by Ukrainian mercenary pilots, who later on provided conversion-totype training for their Macedonian colleagues. Four more Mi-24Vs followed in April and June that year. Then two more Mi-24Vs were taken in September while December saw the arrival of two Mi-24K, the specialized battlefield reconnaissance and artillery fire correction Hind version. Thus, the Mi-24 fleet in Macedonia reached 12 aircraft, grouped in an anti-tank helicopter squadron, based at Petrovec airfield near Skopje.

A contract was signed in February 2005, covering upgrade of four Macedonian Air Force Mi-24Vs under the so-called Alexander project. It called for the integration during the first phase of the program of the ANVIS/HUD-24 system (a helmet-mounted display and sighting system), introduction of cockpit and external NVG compatibility as well as a Trimble GPS receiver.

The second upgrade phase called for integration of NATO/ICAO-standard navigation equipment (VOR/ILS/DME receivers), a moving digital map, the Elbit Systems' own CoMPASS IV highperformance multi-sensor turret (with thermal imaging camera, TV camera, auto tracker and laser rangefinder), a Rockwell Collins RT-82000 V/UHF radio and an IFF transponder. The helicopter's nose-mounted machine gun was slaved to the CoMPASS IV payload. The cockpits also received two 6x8 in multi-functional displays.

The third upgrade phase included the introduction of pilot head-cueing system for both the sensor turret and machine gun. At the same time, the upgrade removed the equipment supporting the use of the Ataka-V ATGMs and the original ballistic computer in order to save weight. This full-standard upgrade was implemented on two helicopters only.

By 2005, the Macedonian Mi-24 fleet was reduced to eight helicopters. The maintenance of the fleet proved to be a serious challenge, with all the helicopters grounded in 2015 and 2016. A contract for the overhaul of six Mi-24s at Aviakon plant in Konotop (Ukraine) was inked in June 2016. After the overhaul, combined with life extension, these machines could be expected to be good for use until the mid-2020s.

As of April 2019, there was no confirmed information for return of the first pair of Macedonian Mi-24s from overhaul in Ukraine. It could be speculated with a high probability that the serious delay has been caused by the lack of spare parts (originally produced in Russia) required to be installed during the overhaul, as the Russian government had imposed in 2014 an embargo on selling military goods to Ukraine.







#### Under the Patronage of His Royal Highness Prince SULTAN BIN SALMAN BIN ABDULAZIZ AL SAUD

Chairman of the Saudi Space Commission Founder and Chairman of Saudi Aviation Club



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The Institute for the Study of War (ISW) has published a review of Russian security cooperation agreements signed in 2014-2019. According to this publication, 90 deals have been signed with 73 countries and international organizations.

150,0 military personnel

About 150,000 military personnel, about 400 aircraft, over 26,000 weapons, military and special equipment, and more than 100 ships and support vessels were involved in the sudden check of combat readiness of the Armed Forces of the Russian Federation.



13,400 units

That is the total number of nuclear weapons at the start of 2020, owned by the United States, Russia, the United Kingdom, France, China, India, Pakistan, Israel and the Democratic People's Republic of Korea (North Korea).

The US military command decided to withdraw 12 thousand servicemen from Germany. According to the plan, 6.4 thousand soldiers will return to their homeland while 5.6 thousand will be relocated to other European countries.

2,000 troops

**13**th annual training the 13th annual training.

The military exercises of Russia and Mongolia 'Selenga-2020' are expected to be held at the Burduny training ground in the Republic of Buryatia. This will be

#### RUSSIA TO INSTALL MISSILE ATTACK WARNING SYSTEM FOR KAZAKHSTAN IN 2020 / TASS

ussia will install the Krokus warning system in Kazakhstan in 2020 to fulfil its commitments of providing the republic with information on a missile attack, Russian Space Force Commander Colonel-General Alexander Golovko said.

"Our commitments stipulate providing them [Kazakhstan] with information on a missile attack. We will carry it through this year... There is the Krokus warning system and precisely this system for Kazakhstan will be installed this year," the general said during a session of the International Affairs Committee in the upper house of Russia's parliament.

Before the summer of 2020, the Balkhash radar center in Kazakhstan functioned in the Russian missile attack warning system. It provided the radar field for missile attack warning in the southern strategic aerospace direction. The radar in Kazakhstan was withdrawn from its combat alert on June I this year. Russian Deputy Defense Minister Nikolai Pankov said on July 2I that the need for this radar had completely disappeared after four advanced radars were deployed on Russian territory.

The State Duma (the lower house of Russia's parliament) adopted a bill on terminating an agreement with Kazakhstan on the terms of the transfer and the procedure for the further use of the Balkhash station on the territory of Kazakhstan in the Russian missile attack warning system. ◆



### FRENCH-RUSSIAN CONSULTATIONS ON STRATEGIC STABILITY / MINISTRY OF DEFENSE

eputy Defense Minister of the Russian Federation Colonel-General Alexander Fomin took part in negotiations at the level of the Deputy Foreign and Defense Ministers of Russia and France, said the Russian Ministry of Defense.

On July 16, the Deputy Minister of Defense of the Russian Federation, Colonel-General Alexander Fomin, took part in the talks in the 2+2 format at the level of the Deputy Foreign and Defense Ministers of Russia and France, in Paris. The event also included a meeting with the Director General for International Relations and Strategy of the French Ministry of Defense.

"The political directors of the ministries for Europe and for Foreign Affairs and for the Armed Forces welcomed their Russian counterparts to Paris on Thursday for consultations on the subjects of strategic stability and regional crises, with a view to the forthcoming meeting in Paris of the Council of Cooperation on Security Issues, bringing together the French and Russian foreign and defense ministers," said the French Ministry of Foreign Affairs in a statement.

The last meeting of the Council of Cooperation on Security Issues took place in Moscow in September 2019.

France's Ministry of Foreign Affairs added that "this meeting provided an opportunity to take stock of the implementation of the confidence and security agenda, launched at the initiative of the President of the [French] Republic and his Russian counterpart last summer."

Various regional and international crises, both at the political and military levels, bilateral cooperation, strategic stability, as well as international security were discussed at this meeting. ◆

### NUCLEAR WARHEAD REDUCTIONS CONTINUE DESPITE GROWING TENSIONS / SIPRI

espite an overall decrease in the number of nuclear warheads in 2019, all nuclear weapon-possessing states continue to modernize their nuclear arsenals. This was the key finding of the SIPRI Yearbook 2020.

According to the Stockholm International Peace Research Institute (SIPRI), the total number of nuclear weapons at the start of 2020 was 13,400, owned by the United States, Russia, the United Kingdom, France, China, India, Pakistan, Israel, and the Democratic People's Republic of Korea (North Korea). This was a decrease of 3.4 per cent from SIPRI's estimates at the beginning of 2019. The Sweden-based institute related that decrease of 465 nuclear weapons to "the dismantlement of retired nuclear weapons by Russia and the USA – which together still possess over 90 per cent of global nuclear weapons."

"Russia and the USA have extensive and expensive programs under way to replace and modernize their nuclear warheads, missile and aircraft delivery systems, and nuclear weapon production facilities. Both countries have also given new or expanded roles to nuclear weapons in their military plans and doctrines, which marks a significant reversal of the post-cold war trend towards the gradual marginalization of nuclear weapons," says SIPRI's press release.

Although Russia and the United States possess the majority of the nuclear weapons, but other nuclear-armed states are either developing or deploying new weapon systems or have announced their intention to do so.



#### **EGYPTIAN AIR DEFENCE FORCES** TO EXERCISE IN RUSSIA IN 2021 / NATIONAL DEFENSE

n the framework of military-technical cooperation between Russia and Egypt, the Egyptian air defense forces will conduct joint exercise with Russian air defense forces on the territory of the Russian Federation in 2021.

This was confirmed by Major-General Alexander Leonov, Chief of the Air Defense Forces of the Russian Armed Forces, in an interview he gave to the National Defense journal.

This kind of cooperation between Russia and Egypt started in 2019 with the joint exercise of the air defense forces of Russia and Egypt, "Arrow of Friendship 2019".

Alexander Leonov especially noted the "complete understanding" of the numbers of combat crews at the past exercises. This is explained by the fact that a significant part of Egyptian officers was trained in Russia at the Military Academy of Air Defense Troops, as well as at the 106th and 726th training centers for air defense of the Ground Forces.

Leonov said that such events strengthen military communication between the departments of defense of both states. Moreover, their air defense specialists can exchange experience and show their skills.

During the 2019 event in Egypt, more than 100 anti-aircraft gunners of the Southern Military District from units deployed in the Volgograd Region, Krasnodar, North Ossetia and Crimea took part in the joint exercise from the Ministry of Defense of the Russian Federation.



In our contacts with the Americans, we've long been speaking in favour of making this dialogue more regular and intense, so that it is backed by work at different levels. This matches the position of the president of the Russian Federation that it is important for us to work with the US on the subject of strategic stability and strategic security

#### DR PATRICIA LEWIS.

RESEARCH DIRECTOR OF THE CHATHAM HOUSE, CONFLICT, SCIENCE & TRANSFORMATION; DIRECTOR, INTERNATIONAL SECURITY PROGRAM

The rules governing human activity in space have been in place for only a few decades, and yet they are already out of date. They need to be built on and extended to reflect the dramatic and rapid changes in the use of space

#### HYPERSONIC WEAPON AND NEW MILITARY **UNITS ON DANGEROUS VECTORS** WILL BECOME OUR RESPONSE TO RELOCATION OF THE US TROOPS TO RUSSIA BORDERS / INTERFAX NEWS AGENCY

eployment of newest weapons and additional military troops in those directions that pose threats to the national security can become a response to relocation of the US troops to the borders of the Russian Federation, Vladimir Bogatyriov, inspection officer with the Ministry of Defense of Russia, presumes.

Among the newest weapons which can be used as means to restrain a potential aggressor, the expert named in particular hypersonic aerial system "Kinzhal", mobile laser complex "Peresvet", and "Zirkon" missile. According to his words, "Russia will respond in a calm and integrated manner."

"[Russia] will strengthen its ground troops in the Western military district, will continue to modernize the forces and troops of the Baltic Fleet, equipping them with weapons capable of delivering high-power ammunition to places of possible deployment of NATO forces, including hypersonic weapons and other types of advanced weapons. We must not forget that the Russian military aviation, including the strategic one, has sufficient capabilities," Bogatyriov said.

The US military command decided to withdraw 12 thousand troops from Germany, the Pentagon announced. According to the plan, 6.4 thousand army men will return to their homeland, and 5.6 thousand will be relocated to other European countries. The head of the Pentagon, Mark Esper, said that part of the troops withdrawn from Germany would be transferred to the border of Russia to restrain it.

It is expected that mainly the US military will be stationed in Italy and Belgium. Also, the Pentagon said that if an agreement was reached, the American military would be sent to Poland and the Baltic countries.





#### THE US OFFER **TO SET UP COMMUNI-CATION LINE ON SPACE** PROBLEMS / KOMMERSANT

he US offered Russia to set up communication line to prevent conflict situations in outer space, said Christopher Ford, Assistant Secretary of State for International Security and Non-Proliferation.

"The communication channel should not necessarily be multilateral. It is more real to start with two-way communication. Considering the fact that Russia performs some strange and dangerous things on orbit, including the last two weeks, our operator must have a possibility to communicate with their operator in the course of arising potential problems, when some misunderstanding can take place," Mr. Ford said on the

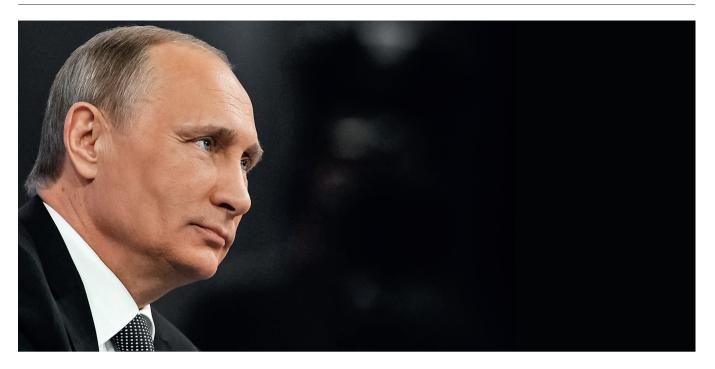
He called the negotiations in Vienna a "fair opportunity" for the US and Russia to strengthen mutual understanding of each other's policies and activities in outer space, and to advance the development of norms of responsible behavior there in order to avoid miscalculations or misperceptions that could lead to inadvertent



The Russian-American strategic relations motivated the two countries in the last 50 years to reduce both the number of nuclear weapons and the risk that they would be used. Both Washington and Moscow recognized some facts. First of all, they realized that there are never perfect environments or perfect conditions for arms control negotiations, they have to proceed even when there is tension and dispute between the two countries.

Transcribed by Reem Mohamed





oth sides recognized that their national security was well served by putting restraints for the nuclear capabilities of the other country. Both sides recognized the danger of having an unlimited number of non-strategic nuclear weapons (low-yield nuclear weapons) to use in many different conflict situations, creating a danger of escalation. All sides recognized that negotiations are not concessions, negotiations are not a sign of weakness, rather, they are means to improve national security of both countries. And finally, both sides realized the reality of mutual assured destruction. Ever since the Soviet Union's first built intercontinental missiles in the 1960s, it was unavoidable that a nuclear conflict could lead to the destruction of civilization in both countries.

People sometimes talk about mutual assured destruction (MAD) as if it is a theory or a doctrine. It is not a theory. It is not a philosophy. It is a fact, and it is one that cannot be escaped. The result of this common approach to arms reduction was significant. We have almost 85% fewer nuclear weapons in the American and Russian arsenal today than we did at the height of the Cold War. Besides reducing the number of nuclear weapons we have also seen a steady decline in the variety of the types of nuclear weapons, and in the role and function of nuclear weapons in both Russian and American doctrines.

What concerns me today is an evolution in the United States' thinking about these issues, and it is a gradual change since the end of the Cold War, that is not just about nuclear weapons, but that has implications for nuclear weapons. So, the trends that I see in the American political environment are:

- First, an increasing nationalism, particularly within the Republican Party, and nationalism meaning in this case not just pride in one's country, but a feeling of superiority towards other countries.
- Second, a changing view about treaties; there is a body of thought within the Republican Party, and



Thomas Countryman was the acting undersecretary of State for Arms Control and International Security. He served for 35 years as a member of the US Foreign Service until January 2017, achieving the rank of minister-counsellor, and was appointed in October 2016 to the position of acting undersecretary of State. He simultaneously served as assistant Secretary of State for International Security and Non-proliferation, a position he had held since September 2011.

#### INTRODUCTION

Thomas Countryman, the chairman of the Arms Control Association board of directors since 2017, gave a lecture¹ to the students of the 'Strategic and Arms Control Studies' Master's program, at the School of International Relations, Saint Petersburg State University. This is the full transcript of the lecture.

<sup>&</sup>lt;sup>1</sup> The lecture was given in November 2019. The event took place at the School of International Relations of Saint Petersburg State University (in St. Petersburg, Russia).



John Bolton – the former National Security Advisor – led the argument on this, that treaties in general are not good for the United States, that if you constrain a country that is weaker than the United States, in military or economic sense, and you put the same constraints on the United States, then the United States as the stronger power loses more than it gains from putting constraints on the other side. As a result, there is more questioning about treaties within the Republican Party and in the Congress.

– Third, there is an increasing view that arms control with rivals or adversaries is a sign of weakness, that making concessions to other countries is what arms control is all about, and you hear it in the frequent references in this administration when they say: we do not do arms control just for the sake of arms control. There is also an approach that you see in this administration that I would call 'all or nothing'. If the treaty does not solve all the related problems, then it is not a good treaty; we saw this with the Iran nuclear deal. President Trump said that because it did not solve every problem with Iran, it is not an adequate deal, and you are hearing the same approach today from the right wing of the US political spectrum with regards to arms control treaties as well.

– There is also something that I think is as much psychological as political, and it goes back to the idea of mutual assured destruction. Any human being should be bothered by the fact that in a nuclear war there is nothing that can save our two nations or our human civilization. There is a reaction within the American political thought that says that we should find ways to ensure that destruction is not automatic, that we might be able to survive and defend ourselves against the nuclear threat. This has led to an American fascination with ballistic missile defence; when ballistic missile defence was put forward under the George W. Bush administration 17 years ago, it had a certain rational argument, which was that a limited missile defence could protect the United States not against

Russia, but against the threat from other nations such as Iran or North Korea. But, since that time, the fascination with ballistic missile defence has developed into a political article of faith; it is universally popular among the Republicans in the US Congress to spend more money every year on more and more ambitious missile defence.

– The final political or psychological trend in the United States that concerns me is not so much on the political side, but on the military side. Both of our militaries have great minds and great thinkers – and I mean that sincerely, but if you let them think about too many things, they will come up with some bad ideas. One of them is a return to Cold War thinking among some in the United States military that says it is not enough to have equal capabilities to destroy each other, but we should seek some advantage, and if you cannot find an advantage in the number of warheads, you can find an advantage in some technological way, having a weapons that is more effective, or having a defence that is more effective.

All of these ideas have developed gradually since the end of the Cold War, you could say that they are part of the psychology of a power, of a country that feels itself to be a superior power; that is one explanation. I think it has more to do with the growing political trends that you see not only in the United States, but in every democratic society today; trends towards populism and nationalism. These projections of strength and of superiority appeal to those populists most. What it all adds up to is not a destruction of the arms control architecture, we are not there yet. It is also not the erosion, which is long years of decay; I prefer to call it 'crumbling of the arms control architecture'. It is gradual at first, and at some point it becomes sudden. If you have read Ernest Hemingway, one of my favourite lines is when one of his characters is asked 'how did you lose millions of dollars? How



did you go bankrupt?' and the answer is 'at first, little by little, and then all at once.'

That is the situation we are in with the arms control architecture, it has been crumbling. You can say that this began with the Bush administration's withdrawal from the ABM treaty in 2002; and President Putin had made that argument. It is not wrong, but it was not inevitable in 2002 that things would develop to this point. The more sudden moves towards the loss of these valuable arms control treaties was really put on paper in the Nuclear Posture Review presented by the Trump administration in early 2018. You can find, on the Arms Control Association website, an eight-page critique that I wrote about it. There are several things in the Nuclear Posture Review that should be concerning; it is not a radical departure from past reviews and past nuclear posture statements, 90% of it is the same as the Obama administration's Nuclear Posture Review in 2010. But even if it is not a radical change, it is a change in direction. For 50 years, for the United States, the number, the type and the role of nuclear weapons was gradually declining. What you see in the 2018 Nuclear Posture Review is this downward trend being turned back slightly, and that should concern anyone who follows these issues.

I was concerned that the Posture Review seemed to deliberately emit two very important statements that previous administrations routinely said; one "we do not seek to undermine Russia's strategic deterrence", that sentence was left out, and it is hard to find an American official who would repeat that statement today. And even if that is not intended as a signal to Moscow, I understand why it is received in Moscow as a signal of American intent. The other statement that was left out was the statement that to me is obvious as a legal matter, that the United States has a legal obligation under Article VI of the Non-proliferation Treaty to pursue arms reduction. That statement does not appear anymore; I have not yet found an American official who would make that statement in public in the last few years.

The Nuclear Posture Review also described a new reliance on non-strategic nuclear weapons, so called low-yield weapons – although I have to have a cynical chuckle every time they are called 'low-yield' as it means that they are only about half the size of the bomb that destroyed the city of Hiroshima. Finally, the Nuclear Posture Review, for the first time, said we have no proposals to make on arms control, we do not have the next goal for a new agreement between Russia and the United States. That means, for the first time in more than fifty years, we not only have no active negotiations between Moscow and Washington, we have no idea what is the logical negotiation to conduct. To me, that admission, that we have no good ideas right now, is not worthy of a country that wants to call itself a superpower or a world leader.

The Nuclear Posture Review's statement that 'Security conditions are not ripe right now for new arms control initiatives,' was motivated in part by concerns about Russia and its behaviour, but I think that an even greater factor was concern about China and the fact that China has a greater potential to expand its relatively small arsenal very rapidly. The Nuclear Posture Review, and the damage I think it has done to the arms control architecture, was exacerbated by the Missile Defence Review published earlier this year (2019). The document itself, again, is not a radical change, it still talks about defending the United States not against Russia or China, but against threats from other countries. But it does talk about developing technology that would be useful for defence against intercontinental missiles and even testing missile interceptors against intercontinental missiles. To make it worse, President Trump, when introducing the Missile Defence Review, said explicitly that the goal was to make the United States invulnerable from any adversary's attack. Again, I do not assume he knows what he's talking about, but you can understand why it was taken as a signal of an active threat in Moscow.

I do not mean to say that all the security, military, nuclear steps that have made the situation worse have



occurred in Washington. Certain Russian steps in security have contributed to the situation we are in. The first is about rhetoric; words matter. From the end of the Cold War for about 25 years, none of the major nuclear weapon states boasted about their nuclear weapons, they stopped saying 'we are great nations because we have nuclear weapons,' that is something North Korea and Pakistan sometimes do, but the US, Russia, China, France, and the UK stopped talking like that. It was unfortunately revived by president Putin to talk about the importance of nuclear weapons in the definition of the greatness of Russian power, and this was then imitated by President Trump during his campaign and since he became president. To be fair, President Putin did not talk about superiority or dominance, but stressed deterrence and mutual stability.

Second, in my mind, Russia has overreacted to ballistic missile defence efforts from the United States. As I said, I do not believe that it is physically possible to ever construct an impenetrable shield against intercontinental missiles. As one of my colleagues puts it: for every dollar that the US could spend on missile defence, Russia can spend ten cents to overwhelm that new missile defence. I understand why Russia is concerned, given history and US rhetoric, but I think that the Russian military has overreacted by designing new weapons that are intended to go around missile defence, and has introduced new categories that are not captured by past arms control treaties. President Putin said: they will listen to us now. The US is listening. But, the US is just as likely to overreact in dangerous ways as Russia has overreacted; it becomes a game not of just rhetorical brinkmanship, but of actual physical confrontation.

Third, the United States figured out long ago, and in general Russian thinkers agree, that having a variety of sizes of nuclear warheads and having them available for use in different combat situations was inherently destabilizing. NATO still has a couple of hundred low-yield gravity bombs in Europe in NATO

countries, but almost every NATO military official will tell you that these are not useful weapons in any military sense. They are primarily political weapons that demonstrate the strength of the alliance between the United States and European countries. The justification for low-yield/non-strategic weapons in Russia's doctrine of nuclear deterrence is absent, and yet Russia still possesses about 2,000 of these non-strategic nuclear weapons. That, more than any statement by Russian military officials, is what gives rise to the US suspicions about the actual nuclear doctrine of the Russian Federation.

Finally, I have to mention the violation of the Intermediate-range Forces Treaty (INF) by the Russian Federation. While I was still in government I saw the intelligence that convinced us that the 9M729 cruise missile was tested at ranges beyond 500 km, therefore a violation of the INF treaty. Of course, this has been denied by Moscow, with very little effort to get at the truth from either side. I think that it serves Russian interest to have a debate about the range of the missile because that detracts from the debate about why Russia needed new offensive weapons aimed at Germany and Romania and Poland. What stabilizing purpose does it serve for Russia to deploy new squads of missiles that are aimed at NATO territory? Of course, a Russian general will answer the same way as an American general: we have no offensive weapons, all our weapons are defensive.

From the beginning of the dispute, which was a private one, it took more than two years before it became public, I think that Moscow focused not on solving the situation but on winning the public relations battle with the United States. The Russian military has never liked the INF treaty since it was signed by Gorbachev and viewed it as a restriction on an important defence capability. The US military does not like it very much either, not because of Europe, but because of China and the fact that China possesses intermediate-range



missiles. Both sides, I think, failed to find a way to resolve the issue because neither was sincerely interested in resolving the issue in a way that stabilized the situation. Those are the security measures that have affected the US-Russian nuclear relationship.

There are a number of political issues as well that have to be discussed. When I say "political," I mean not directly related to the military or nuclear, but having an effect on the military balance in a nuclear relationship.

First, I'll give you the 60-second version of a speech I have given elsewhere. That is a general observation on the United States and Russia.

We will always be rivals. I hope we are not adversaries, but we will always be rivals because we are so similar. And these are the key points of similarity between Russia and the United States. First, both Washington and Moscow feel that they are at the very centre of God's universe. Second, both of them believe that everything other countries do is aimed at them. Third, both countries have sanitized their history, so that periods of Russian imperialism, expansion, and conquest of other peoples have been reduced to a glorious forward progress in culture and civilization. As a consequence, neither of them can understand why smaller countries feel threatened by the very large militaries of the United States and Russia. These similarities you cannot easily do away with, and there is no great desire to reverse the sanitization, mother rewriting of history; in fact, I would argue that Russia is moving in the other direction.

There is a perception in Russia of US arrogance, of a disdainful attitude towards the Russian Federation, and there is some truth to that. I have to tell you that I do not see it as different from the Russian attitude towards countries that are less powerful than Russia; Russian attitude towards Ukraine or the Baltic states reminds me very much of what Russians complain about the US attitude to Russia.

That is the political backdrop that we have been dealing with since the end of the Cold War and further back. Specific developments matter. You cannot underestimate how important the Russian military intervention in Georgia, and especially in Ukraine changed the US perceptions of Russia, Particularly, the seizure of Crimea was the first forceful seizure by a neighbour against a neighbour's territory in Europe since 1945. And I note that when that happened in 2014 (by the way, I was here in Saint Petersburg when that happened in 2014), despite that, President Obama and Secretary Kerry gave very clear instructions to me and my colleagues that said: we cannot have business with Russia as usual after that, but we must continue arms control and non-proliferation cooperation with Russia specifically in three areas. One area was the implementation of the New Start, the second was negotiations with Iran, and the third was an issue that I was leading in the US government – the elimination of Syria's chemical weapons.

So even as we cut back normal relations with Russia, cooperation in fields that were vital to both our security continues. It changed further with the Russian interference in the US elections in 2016, and that was in the perception of many within the US government and US population, a change in the perception of Russia from a rival to an adversary. Russian intelligence hacked and stole emails from many different sources in the US, but only released through Julian Assange of Wikileaks embarrassing emails that came only from the Democratic Party. This is a deviation from traditional espionage. Yes, it is absolutely true that the United States and Russia spy on each other, as usual, to understand each other better and to learn about future threats, but it is a change or a violation of the unwritten rules to use the information you gather to embarrass a particular party within the other country. It may seem like a trivial distinction to Russian intelligence, but I am telling you, it is not seen as trivial in the United States. The fact the internet research agency, which I think was here in Saint Petersburg,



hired a few hundred English-speaking Russians and mounted a massive social media campaign, is an event that could not have occurred without the approval of the Russian government.

It is not clear to me why the Russian government appears to favour Donald Trump. There are two possible explanations and they can both be true. One is sincere hope for a better relationship with the United States with Trump in the White House, there are reasons to believe that; there is the fact that Mr. Trump depended upon infusions of money from Russian Oligarchs to keep his real estate business afloat when it was in threat of bankruptcy. It is true that Mr. Putin and Mr. Trump share a similar view about the relationship of political power to the accumulation of wealth. It is true that they have a similar view that great powers have the right to dominate smaller powers. But, at the same time, the fact of Russian interference in 2016 has made it politically impossible for Mr. Trump to deliver on things that he would like to do with Russia. He cannot take any significant step forward in the areas that matter to Russia without severe political revolt, even within the Republican party, which follows him as a slave follows his master. If the goal was simply to cause chaos within the United States government, well, that has been achieved. If the thought was that a chaotic US government is automatically good for Russia, that is the situation that we are in right now.

But it remains the fact that you can have a good relationship with governments that are corrupt and chaotic, but you cannot have a stable relationship that moves forward if the United States are in a constant state of chaos. Rational, serious negotiations on arms control are not possible with the Trump administration, and they will not be possible in an equally chaotic second term, if Mr. Trump is re-elected.

That brings me to what I think is the worst-case scenario, and the most serious risk for strategic stability, and that is, if Moscow increases its bet on Trump and repeats the interference of 2016, but the Democrats win anyway, and I think that is the most likely scenario. If such an interference happened only once, in 2016, we could overcome that within a few years and get back to a normal relationship; if it happens again in 2020, it will poison the relationship between the Kremlin and the largest political party in the United States for a generation. It will convince Democratic leaders that Russia is not only a rival but an active adversary (I will conclude the same thing, by the way) and there will be retaliation in the same way. I do not expect anybody to admit or apologize for what happened in 2016, I am well used to both the Soviet and the Russian method of denial which is to say: one, we did not do it; two, you cannot prove that we did it; and three, besides, who did it first? But, if it happens again, it will be because the Kremlin took no steps to prevent it from happening and that denial will mean nothing in the United States.

So those are the security and political problems, and where does all that leave us?

It leaves 13,000 warheads between the two countries, enough not only to destroy each country but literally to end human civilization. There are many paths to a nuclear war, but broadly speaking there are two, and both of them have a more realistic chance of occurring today than at any time since the end of the Soviet Union.

The first is false alarms; we have had this very serious case under the Carter administration in 1980, and in 1995, when president Yeltsin was informed that a Norwegian rocket was actually a US submarine launch. The difference today is: would the US President and the Russian President respond as calmly and as carefully as they did in 1980 and in 1995 or would the political tension make them more ready to believe a false alarm?

The second is the risk that is also growing, in which an accident, an American and a Russian ship, or an American and a Russian plane bump into each other, an accident becomes an incident, becomes a conflict, becomes a war, and becomes a nuclear war.

So what can we do about it?

I do not think the answers will surprise you, but they are my priorities. Number one, the most urgent is to renew the New Start Treaty, to extend before it expires in February 2021. I am actually less pessimistic than many of my colleagues in Washington. I think there is better than a 50/50 chance that President Trump and President Putin will take the step in 2020. Russia strongly supports it, almost everybody in Washington supports it. There are two obstacles, and they are both within the head of Donald Trump. First, that this is an 'Obama Treaty' and the most unifying consistent principle of President's Trump administration has been to reject everything that Barack Obama did. Second, and also important, is that the president truly seems to believe that this is the right time to expand the arms control beyond the US and Russia, and involve China as well. This is a good idea for the long term, and I am glad he is thinking that way, but it is not realistic in the next year to bring China, with whom we have never negotiated in arms control, and expect that we will get to a three-way agreement within just a year.

There is a way around this. I do believe that Russia and the United States can find a way when the two presidents sign the extension. Simultaneously, to add two pages on top of it, two pages that are a political declaration, not a treaty. The political declaration can use beautiful, nearly religious language about how we will work together on further reductions and eventually we will bring China in as well; that would allow President Trump to meet the only standard he truly cares about, to be able to say: I did something better than Obama did. This depends more on Russia to make that proposal because I cannot predict how anybody could make that proposal in the very – to be polite – non-systematic policy machinery of the White House.

Second, the INF treaty is gone and getting a new treaty is not currently possible, but it does not mean that it is impossible to keep some of the benefits of the INF treaty. As I said, Russian and US militaries are both happy to get rid of the treaty, so there will not be any good ideas that come from the Kremlin or the White House, but there could be good ideas that could come from Europe, which after all is the target of the new Russian offensive missiles. None of them are perfect, none of them are easy, but to give just a couple of examples; to propose a political agreement that any missiles in Europe, whether new American missiles or the 9M729 will not carry nuclear warheads, only conventional warheads. That would be a difference from the Euromissile battle competition that we saw in the 1980s. A second would be for the NATO to say clearly: we may install new United States missiles, not next year but a few years later, but we will not install more than there are 9M729, we are not asking Russia to admit that 9M729 is in violation, but it is a new threat to us and we will match it in number. If NATO said that, it could open for negotiations that would limit the number and the geographical area of deployment of both Russian and US missiles in Europe from the Atlantic to the Urals.

Most important and most generally, what can be done is to rebuild what I call a habit of stability. There are several points to this. First is encouraging and expanding military-to-military contacts, since Russian and American military leadership appreciate better than politicians do the danger that we are in, the risk we are running. Many of these military-to-military contacts were cut back by the United States in a way that I think is dangerous. I think the US military is ready to re-establish more intensive contacts that would help defuse crises, would help prevent an incident turning into a conflict.

Second is to talk about risk reduction.

An article by Sarah Bidgood in "Arms Control Today" about ways to reduce tension and focus on risk reduction has a few really good specific ideas which I will mention briefly without explaining them. One is a parallel risk assessment where we simply have experts sit down and talk about what could go wrong from either side. Second is increased consultations on practical risk reduction measures to expand not just hotline telephones, but also agreements such as 'how to prevent accidents at sea or on the air.' Third, and very difficult thing is to write a treaty about, but something vou can write a political agreement about is to agree that we will not attack with cyber means each other's command and control because of the risk that poses to nuclear stability. Finally, to make a common statement about risk reduction between the US and Russia at the 2020 Review Conference.

The last part of the habit of stability is a regular strategic stability dialogue. We have not done this in the last few years; we have had only two meaningful strategic stability dialogues between the two governments since 2013 (in six years). It should be something we do every six months; it has to include all the topics that concern both of us, not because you can solve all the topics at once, but because you have to understand the interconnection between them in order to solve them one at a time.

So, what does all this mean for the NPT and the Review Conference coming up in the spring of 2020?

First, the US and Russia have a strong shared interest in the continued success of the Nuclear Non-Proliferation Treaty. It is in my mind the most important and most successful multilateral treaty in history, it has improved security of every country in the world, including the Nuclear Weapons States and the Nonnuclear Weapon States. Therefore, we should have a common interest ensuring that it retains its credibility and its binding nature, not just upon us but upon the rest of the world. It is important to know that much of the world views the NPT differently than Washington and Moscow do. They see Article VI as being an active binding legal measure that the United States and Russia must constantly be working on; they see that past decisions at review conferences have a legal status. It is very concerning to me that lately both the



United States and Russia have been arguing that past decisions by review conferences were good for those review conferences, but they have no permanent nature, and every review conference starts from scratch in building a new foundation.

I am not one of those who say that the only way to define success at a review conference is to have a detailed consensus document. There are other ways to measure success, there are other details, other documents that can come out that make the treaty stronger. But, it is hard right now to be optimistic about the success of the next review conference by any standard. One thing that concerns me is that the way that Moscow and Washington have been in a propaganda battle for the last few years will continue in the review conference. They will not resist the temptation to throw mud at each other, to blame each other; I have given you 25 reasons that are valid for them to blame each other, but it will not help the review conference if it is about one side scoring points on the other. Most important, at the review conference, if we extend New Start before the conference, that will be the single most positive thing that the US and Russia can do before the conference. We will still be criticised, and in fact some will accuse us of collusion, of conspiracy, of trying to change the subject and to maintain the nuclear monopoly of the five nuclear-weapon states if we do extend New Start. But if we do not extend New Start, both Moscow and Washington will be severely criticized by nearly everyone in the world, and justifiably

so. In 2010 and 2015 both Moscow and Washington could say 'we have reduced nuclear weapons by 80%, we are meeting our obligations.' With no progress in the last eight years, Russian and American diplomats in New York cannot say that with a straight face, they cannot say 'we are meeting our Article VI obligation.' That is the biggest danger to the success and continued credibility of the Non-proliferation Treaty.

I am very happy to see young people who are learning these issues, and not only learning what we did in the 20th century, but thinking about what we can do differently in the 21st century. Going into careers to the government, non-governmental world, or into academia and being ready to change, not just to move your career from one field to another, but to make sure that government, non-government and academia are talking to each other about the best ideas.

I have to be honest to you; my generation of old white men has not performed brilliantly in reducing nuclear risk, in protecting the planet from climate change, in reducing corruption, or in improving the environment. In order to really make some progress in the future on reducing nuclear risk, I am convinced we need more than Americans, more than Russians, more than politicians and generals. We need to have a much broader representation of ideas and a much greater consideration, not only of national security but of global security. •

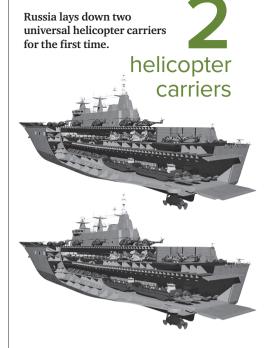




Naval version of the combat module 57 mm AU-220M cannon has a circular rotation and a firing range of up to 14.5 kilometers with a maximum fire rate of 80 rounds per minute.

The 'Strela' new light armored vehicle can develop a speed of up to 155 km/h on the road and carry eight personnel.

155 km/h



Su-57 aircraft has carried out over 3,500 test flights.

6 km

BM-I launch vehicle of the TOS-IA system has an MBT-level armor and a maximum firing range of 6 km (minimum firing range of 600 m).



3,500 test flights

**40** ships

to enter service with Russian Navy this year

#### RUSELECTRONICS **SUPPLIES VR-GLASSES FOR MILITARY PERSONNEL** TRAINING / ROSTEC

he Ryazan Radio Plant, which is part of the Ruselectronics holding of the Rostec State Corporation, will be supplying virtual reality glasses for training Rosguard military personnel, said Rostec.

3D glasses are designed to use VR technology in military training. They allow trainees to work in a virtual space that is created using 3D models and photorealistic circular panoramas. Working in 3D-space, a person develops skills for further work with real equipment. This equipment is used at the Perm Military Institute of the National Guard of the Russian Federation for training of communications specialists.

These VR-glasses made by Ruselectronics allows users to pair radio networks in which military personnel work at real radio stations with a radio network in the classroom. While training, one part of the trainees works in real conditions while the other do it in virtual simultaneously.

The basis of these educational and training tools is domestic software. Using the complex, trainees can visualize not only virtual reality, but also augmented and mixed reality.



## ATAKA-TROPHY MOBILE ANTI-DRONE **SYSTEM** / RUSELECTRONICS HOLDING

he Ruselectronics holding – part of the Rostec State Corporation – has developed the Ataka-Trophy mobile cross-country complex to counter civilian drones, said Ruselectronics in a statement.

The system can identify a drone under the 'friend or foe' principle without an operator's participation and automatically prevent unauthorized penetration into the secured area, the statement said.

The system is mounted on an UAZ off-road vehicle and can be deployed within five minutes, the press office specified. As part of the holding Ruselectronics, the project is being implemented by NPP Almaz (Saratov).

Attack-Trophy carries out radio frequency detection in a radius of 1 km and suppresses control channels in the frequency range that is used by UAVs for general civil use – from 2 to 6 GHz. Such drones can be used for unauthorised surveillance, transportation or dumping of compact cargo.

The mobile version allows using the complex on any territory without preliminary installation of equipment. For autonomous operation, the use of an electric generator with an external exhaust gas system, as well as any external power supply device for 220 V, is provided. The complex is managed from the passenger compartment by a driver-operator.

A special feature of the new Ataka-Trophy complex is the ability to quickly, literally "off the wheels", without preparing and installing equipment, provide protection for various objects - industrial companies, critical infrastructure, as well as crowded places during public and sports events.

The system does not interfere with the operation of surrounding communication and navigation equipment, including drones carrying out regular monitoring," said Oleg Evtushenko, Executive Director of Rostec.

#### **RUSSIAN TROOPS TO GET S-500** SYSTEMS IN THE NEAR FUTURE / KRASNAYA ZVEZDA

ommander of Missile Defence Troops of the Russian Aerospace Forces, Maj. Gen. Sergei Babakov said that it was planned to start arming the Russian army with the promising S-500 Prometei systems in the coming

"The Missile Defense Troops started receiving prospective S-350 Vityaz anti-aircraft systems. The delivery of S-500 Prometei systems is also planned," Babakov said, when asked what types of prospective weaponry the troops expected to receive in coming years.

"This gives reason to say that there are no analogues of this system," said Major General Babakov in an interview with the Krasnaya Zvezda newspaper.

The representative of the defense department explained that the S-500 air defense system makes it possible to destroy aerodynamic and ballistic targets, as well as hypersonic weapons of all modifications, including those in Near Space.

The main task that the complex will carry out is destruction of mediumrange ballistic missiles, and, if necessary, intercontinental ballistic missiles in all parts of their flight path. In addition, the S-500 is capable of destroying hypersonic aircraft, regular aircraft, and drones.



#### RUSSIAN TROOPS TO GET MEDIUM & LONG-RANGE STRIKE DRONES IN 2021

/ KRASNAYA ZVEZDA

erospace Force Commander-in-Chief Colonel-General Sergei Surovikin said today that the Russian troops will start receiving medium- and long-range reconnaissance/strike drones as from 2021.

Talking with the Defense Ministry's Krasnaya Zvezda newspaper, Surovikin said that "developing medium- and long-range reconnaissance/attack unmanned aerial vehicles is a major area of work."

He added that "the effort to outfit drone units with medium- and long-range systems is planned from 2021." In this effort, the focus is made on integrating unmanned aerial vehicles into existing and future reconnaissance/strike systems of the Russian Armed Forces and jointly employing them in aircraft combat formations, the general said.

The first serial-produced model of a medium-range unmanned aerial system was delivered after completion of its trials to a training center for preparing instructors, he said. ◆





#### **NEW WEAPONS FOR SU-57** / INTERFAX

ostec representative said that development work on new weapons for Su-57 stealth fighter has been completed, reports Interfax. "The aircraft will be able to use a large number of new weapons. Some of them have already been created, some are still being developed," said a representative of Rostec State Corporation.

Two years ago, Boris Obnosov, head of the Tactical Missile Weapons Corporation (KTRV), told Interfax that Su-57 would be put into service, including the ultra-long-range R-37M hypersonic missile. Last year, it was announced at the Army-2019 Forum that a contract for supplying Su-57 with the "project-180" medium-range missile was concluded.

Rostec's representative said that the Su-57 program implementation is going in accordance with the approved work schedule, and 76 aircraft will be delivered to Russian military on time by 2028. Three aviation regiments will be rearmed with the new fighter.

The source added that so far, the aircraft has carried out over 3,500 test flights. It is expected that serial deliveries of aircraft with new engines of supersonic cruising speed will begin in 2023.

Last week, JSC Sukhoi released its annual report for the year 2019 where it announced its plans to start the serial production of an export version of Su-57 stealth fighter and thus enter it into the combat drones market.

The company added that tests of Su-57 prototypes were conducted. In 2019, delivery of Su-57 aircraft of the installation lot was planned. However, an accident occurred during the acceptance test flight and delayed Sukoi's plans.

The fifth-generation Su-57 fighter is designated to destroy all types of air, ground and naval targets. The aircraft develops supersonic cruising speed, carries armament inside its fuselage, features stealth coating and the latest onboard equipment. ◆

#### **DOUGLAS ADAMS**

Technology is a word that describes something that doesn't work yet

#### **R. BUCKMINSTER FULLER**

Humanity is acquiring all the right technology for all the wrong reasons

#### LINUS TORVALDS, FINNISH COMPUTER EXPERT, HACKER

Being a specialist on technologies, I have always known that technologies as themselves lead nowhere. That's the society which changes technologies, not the other way round. A technology just gives us outlines of what, and how cheap, we can do

### TWO RUSSIAN LATEST NUCLEAR-POWERED SUBS TO CARRY HYPERSONIC WEAPONS / TASS

wo upgraded Project 885M 'Yasen-M' nuclear-powered submarines laid down at the Sevmash Shipyard in Russia's north-west will get hypersonic weapons, Sevmash CEO Mikhail Budnichenko said at the keel-laying ceremony.

"Today we are laying down ships with hypersonic weapons, which are the future of the Russian submarine fleet," the chief executive said. Three leading Russian shipyards simultaneously laid down six new ocean-going ships: two universal amphibious assault ships in Kerch on the Crimean Peninsula, two frigates in St. Petersburg and two nuclear-powered submarines in Severodvinsk.

Following the tradition, the universal amphibious assault ships and next-generation frigates will be named after Russian glorified military and naval commanders "who did much for strengthening the Navy," Vladimir Putin said at the keel-laying ceremony. These are helicopter carriers 'Ivan Rogov' and 'Mitrofan Moskalenko' and frigates 'Admiral Yumashev' and 'Admiral Spiridonov', he specified.

The contract for building Project 885M 'Yasen-M' multi-purpose nuclear-powered submarines was signed at the Army-2019 international arms show in the summer of 2019.

The baseline Project 885 lead nuclear-powered underwater cruiser 'Severodvinsk' entered service with Russia's Northern Fleet in 2014. The upgraded Project 885M lead sub 'Kazan' is preparing for its delivery to the Navy in 2020. Five Project 885M submarines are at various stages of their construction at the Sevmash Shipyard. Project 885/885M submarines will carry Kalibr-PL and (or) Oniks cruise missiles and also Zirkon hypersonic missiles as their basic weapons. ◆

# DIGITALIZATION IN WARFIGHTING OPENS NEW FRONTIERS

Digitization of warfighting systems has emerged as a potent force multiplier, increasing the lethality of combat weapons and management systems through increased accuracy and versatility. Inevitably, the growing reliance on digitization has opened new frontiers in warfighting such as cyber warfare.

Text By Vijainder Thakur

ligitization is a pervasive global trend. Human knowledge, past and present, is being relentlessly digitized (converted into binary code), stored on computer media, and then processed and mined for actionable information by computers using software (computer code) algorithms that mimic human way of thinking and, to some extent, human intelligence.

The greatest impetus to digitization comes from the flexibility of software based processing of data, as opposed to hardware based processing used on analogue systems of the past. Using layers of software, it becomes possible to code complex processing logic and later enhance the logic to leverage technological strides.

Development of digital processing can be traced back to the middle of the last century. Its use was initially confined to science laboratories grappling with new technologies such as aviation, space and nuclear research. The initial focus was on fast number crunching but as digital technology matured it became evident that its innate flexibility could be leveraged in many other critical areas, such as control systems. Control systems are ubiquitous in technological systems ranging from nuclear power stations, manufacturing plants,

power distribution grids, etc. Manually operated control systems are slow and error prone. The flexibility with which a computer reads and processes data makes digital automation a better choice than analogue systems based automation.

The Apollo Guidance Computer (AGC) developed in the mid sixties, which helped the Apollo command modules accurately fly to the Moon and the Apollo Lunar Modules to safely descend onto the heavily cratered lunar surface was a landmark event in flight control systems. Significantly, the AGC featured less computing horsepower than the smartphones that we use today!

#### DIGITAL PROCESSING IN DEFENSE

The advantages of digital processing inevitably started to be leveraged for more lethal warfighting. The use of digital processing in the militaries started with simple number crunching of logistics and maintenance data in the 1970s. Its use proliferated to sensor networking, simulation and combat control systems. With miniaturization, digital processing started to be deployed in weapon platforms (aircraft, ships, tanks) and subsystems, such as digital flight control, weapon guidance and management,

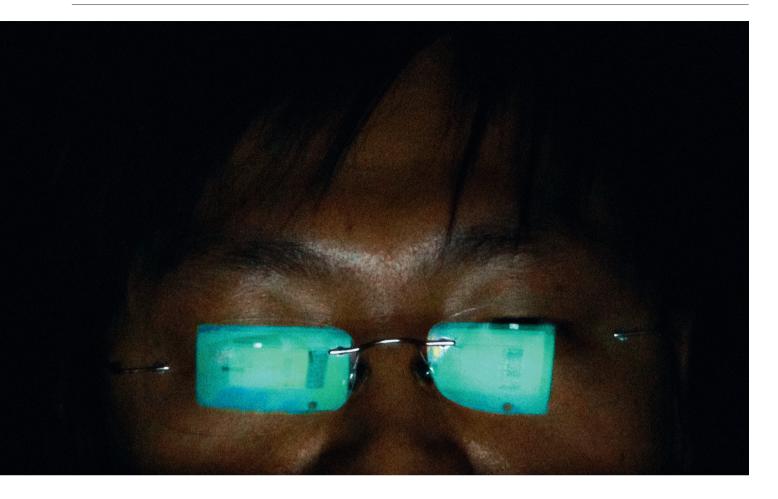
sensor management and fusion, network centric warfare, and electronic warfare.

Speed, accuracy, and flexibility of digital processing have made present day weap-on platforms more lethal and digital networking of varied systems has boosted the warfighting capability of technologically advanced nations (force multiplication).

#### ESCALATORY TREND IN DIGITAL PROCESSING REQUIREMENT

Increasing reliance on digital processing has had an escalatory effect on the requirement for digital processing in warfighting because software needs to be protected from hacking and malicious code insertions, which requires writing more software!

A few lines of malicious code surreptitiously injected into a digital subsystem by a rogue element or through oversight can completely void the capability of a platform or a network! Sensors can be spoofed or seduced. For example, DRFM (Digital Radio Frequency Memory) jamming can generate spurious radar echoes that are electronically indistinguishable from actual echoes, neutering the guidance capability of a radar. DRFM jamming can only be countered algorithmically.



Also, modern platforms and subsystems need to deploy computing horsepower and develop complex algorithms to preclude malicious code injection, data link interception and decryption.

Computer algorithms that drive digital systems have to be coded and tested painstakingly. This has resulted in cost escalation as well as dramatically increased the percentage share of software development and maintenance cost for weapon platforms and systems.

#### DIGITIZATION INCREASES CAPABILITY, COSTS

The increased capability of modern weapon systems can, to a great extent, be attributed to the use of digital systems and software in sensor and weapon subsystems. Software processing of sensor readouts facilitates precision tracking of targets and threats; and fusion of data from multiple sensors facilitates situational awareness. Computer guidance increases the lethality of shells, bombs and missiles. Computerized control systems optimize the utilization of power produced by engines and generators. They ensure safe flight or traction. Computer processors ensure safe encryption of communication, operation of ELINT and EW

systems, operation of life support systems, and much more.

Modern weapon systems need to be supported not just by state of the art electronic hardware but also thousands, and sometimes millions, of lines of well tested and flawless code. Digitization increases development costs to an extent that is not widely appreciated. Software development costs of a modern fighter aircraft, for example, are now estimated to be 60–70% of the system cost.

#### INCREASED COST OF PRODUCTION, REDUCED SHELF LIFE, LIMITED INVENTORY

Besides digitization, increase in lethality of modern weapon systems can also be attributed to the use of improved materials (alloys, composites) and improved electronic hardware (increase in computing power of processors as per Moore's law, miniaturization). Alloys, composites, electronics and software are packaged into discrete and replaceable platform subsystems which cost a lot to develop, but represent rapidly advancing technology with a short shelf life. Consequently, development costs of modern subsystems

are rarely mitigated by extended production runs.

The high initial cost of modern defense platforms and the early obsolescence of their subsystems compels the military to cut inventory size. Though, the reduced inventory is more than compensated for by increased lethality, there is a catch! Inventory reduction mandates very high serviceability levels!

To illustrate, let's assume that the accuracy, situational awareness and swing role capability of a new generation fighter makes it as capable as five older generation fighters, and a small country replaces its entire fighter fleet comprising five older generation fighters with a single new generation fighter. While the overall combat capability of the hypothetical country would not reduce, the combat capability would certainly come to a naught if the single new generation replacement fighter was grounded due to lack of spares! Which would not have been the case when flying five older generation fighters.

With earlier generation systems, high serviceability was relatively easy to achieve—all you had to do was to stock a large inventory of spares! That is not possible today because of the very high cost of



subsystems. Stocking costly subsystems prone to early obsolescence pushes up ownership and operation life cycle costs. The optimum way to beat the cost spiral is to reduce inventory to near zero using an extremely short and efficient logistics pipeline! Don't stock subsystems, just ensure that they are available as soon as they are required. Such agile provisioning is not possible without digitization.

#### MITIGATING LIFE CYCLE COSTS THROUGH DIGITIZATION

Past provisioning systems were based on depot stock levels; the imperative now is to develop provisioning systems based on residual subsystem life. Such systems require real time tracking of subsystems' usage such as a fuel pump on a fighter using networked onboard sensors! Not just usage hours, even the health of a subsystem needs to be monitored so that premature failure could be predicted and a replacement provisioned for pre-emptive replacement.

Visualize the effort and cost to develop software and supporting network and infrastructure for such agile provisioning systems. It takes money, even to cut costs!

#### DIGITIZATION CHALLENGES CONFRONTING INDIAN DEFENSE

Despite India's desire to Make-in-India, the country would need to continue relying

on import of defense platforms (aircraft, drones) and defense subsystems (engines, PGMs, sensors) in the foreseeable future. As of now, India just doesn't have the resources to develop the entire gamut of weapon platforms and subsystems that it needs within the country.

Weapon system digitization adds a lot of complexity to defense acquisitions. In the past, you could import a missile or a bomb, sling it on the pylon of an aircraft and use it to destroy a target. (Well, it has never been that simple, but it was simple enough.) Thanks to digitization, before a weapon can be used on a platform it has to be integrated with the computerized navigation and weapon management subsystems of the platform, a process that is time consuming and expensive. Also, a process that requires full cooperation of the platform vendor. Sometimes, the cooperation is not forthcoming for political reasons, and sometimes it can only be obtained at exorbitant cost.

India's problem is exacerbated by its acquisition of platforms and weapons from western countries as well as Russia. The adversarial relationship between Russia and the West often rules out platform-weapon system integrations desired by India, preventing India from optimally utilizing its defense acquisitions.

Based on past difficulties, when purchasing new platforms India is now insisting

that foreign vendors transfer the complete software code for the platform. Not all vendors are ready to do so, and those that are demand a lot of money. Without source code, India cannot integrate weapon systems that it develops within the country or acquires from other sources.

#### **THE FUTURE**

Digitization and data processing requirements permeate modern weapon system development. The imperative for digitization is set to increase over the years with the advent of concepts like loyal wingman, airborne weapon trucks, terrestrial robotic mules and autonomous weapon systems of many hues.

Leading powers of the world are starting to transition from remotely controlled platforms to first generation autonomous platforms. Human strides in Artificial Intelligence (AI) will see rapid generational changes in autonomous platforms.

With warfare increasingly dependent on digitization, cyber warfare has become a reality. The reality is stark enough for us to visualize a future where kinetic warfare, which is now so heavily dependent on digitization, will give way completely to digital warfare! Whether that would be good or bad is difficult to foresee... •

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# LEAP INTO OPPORTUNITY SPACE

Alexey I. Borovkov, Professor, Vice rector for advanced projects, Head of Engineering Center (CompMechLab®) and Center of Excellence in New Manufacturing Technologies of the National Technology Initiative (NTI) in Peter the Great St.Petersburg Polytechnic University (SPbPU).

Under his leadership, the Center has evolved into one of the most successful innovative organizations in Russia with branches nationwide, bringing together intellectual initiative of young scientists and engineers. In 2017, SPbPU spin-out hi-tech engineering company CompMechLab® was awarded the Industria National Prize of the Russian Federation.

#### Interview by Alexandra Grigorenko

In his exclusive interview to "New Defense Order. Strategy", Mr. Borovkov spoke about the trend in the field of digitization and industry digital transformation that should be developed today to enable the necessary innovative breakthrough, and what has been already done to this end by developers of the Engineering Center.

## – The Industria National Prize of the Russian Federation was first awarded in 2014. It is annually contested by hundreds of Russian innovative developments and the prize goes to the single winner firm. The competition is strong. What was the cause of CompMechLab® Engineering Center winning the prize in 2017?

— We have been awarded, speaking in modern vernacular, for creating CML-Bench™ digital platform intended for building Digital Twins. In fact, it is digitization in its most knowledge-intensive form expressed in digital transformation of business processes and business models, ensuring creation of a globally competitive and relevant product in a highly constrained environment in terms of finance, time, production capacity, technology, nature etc.

## Mentioning competitive products, do you mean software, i.e. the written platform itself, or the product that

#### has been or will be developed using this platform?

Certainly, my initial implication was the knowledge-intensive and hi-tech product.
 It can be cars, engines, aircraft, helicopters etc. We have built a cutting-edge toolbox – a computing technology, more specifically – a digital platform that brings together or integrates dozens of best-in-class global level technologies.

#### - Are you intending to export the technology?

– No, not in the near future. We are not even taking it out to the broad market so far. Why? This unique Russian development is currently unprecedented worldwide. CML-Bench™ digital platform gives us a critical edge in the process of new product development. Having this competitive advantage, who would transfer or sell it? Long story short, we are talking about a business model which would help maintain and, above all, increase the competitive edge.

#### – Do you mean that the platform gives a benefit of innovation and it would be irrational to export it?

– Yes, that's exactly what I'm saying. It is the basic critical technology. We distinguish three stages (a triad) in the technological development: technological breakthrough, technological breakaway, and technological superiority. Today we focus on solidifying our technological breakthrough through building the technological breakaway and technological superiority, and understanding the momentum of our growth that must keep pace with or somewhat exceed the global momentum. Finally, we need to make an estimation of the resources we are going to need for systematic work.

#### What stage of this marketing strategy are you presently at? And what should be done in order to create this technological edge and obtain a substantial economical result on a national scale?

– Speaking of the marketing strategy, another triad comes into play: Hi-Tech & PR & Marketing. It is a common belief that PR is a part of marketing but I make a distinction between the two. The example of Elon Musk's car launched into space perfectly illustrates how this triad works. When we discussed this case in Roscosmos, their specialists said: "Come on, he only launched it once, and we did it multiple times"! Yes, we did launch, but blocks of concrete, and without bothering to make it public. Musk launched an e-vehicle into space and the



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Technologies of the National Technology Initiative (NTI) in Peter the Great St.Petersburg Polytechnic University (SPbPU)

news reached everyone, even those who didn't have any previous knowledge about Musk or interest in space. The outcome was investors queueing to offer money and scientists/development engineers begging to cooperate. Hi-Tech & PR & Marketing in the right time and place are sometimes indispensable.

#### - Neglectful attitude to PR is quite common in our people.

- In advanced technology marketplace, and this is our case, all new products follow the Gartner Hype Cycle (Fig. 1). Our pilot project was in 2015, when we published our book Bionic Design and thereby introduced both a new term and a comprehensive technology to create products with conceptually new features. In our understanding, Bionic Design is additive technology plus optimization technology stack, e.g. multi-criterion, multi-parameter, multi-disciplinary optimization and, of course, topological and topographic optimization. A set of solutions generally termed "Bionic Design" provides an opportunity to effectively apply new or existing technology. The term "Bionic Design" instantly migrated into documents, e.g. tender documentation for engineering centers.

#### - The term's authorship belongs to you together with its "stuffing"? I mean the

#### "Digital Twins" and "Digital Shadows" that followed...

– Yes, if it is about hi-tech industry, mathematical simulation-based development, optimization technology and additive manufacturing. But for today, "Bionic Design" is past the entire Gartner Cycle. Now this complex technology develops simultaneously with the related Generative Design technology and by design, as a component, fits into the more powerful Digital Twin technology.

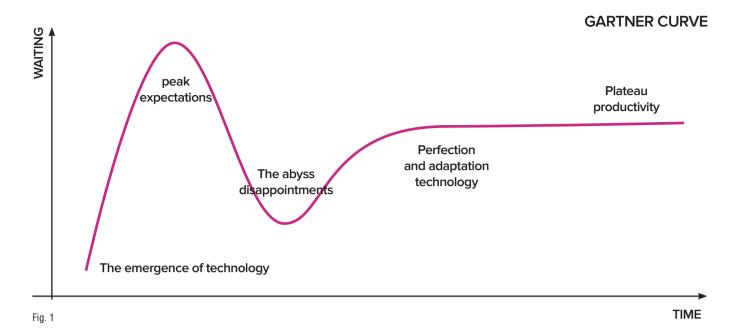
This solution is essential for development of any knowledge-intensive or hightech product for any hi-tech manufacturing area, and is therefore especially relevant for the Defense Industry.

Importantly, the Digital Twin should not be confused with the "Digital Shadow" of the production process or product in operation. Digital Shadow has long been adopted in a range of industries worldwide, usually to monitor technical condition of an object in operation, but it can do little to prevent emergency as its only function is "memory", i.e. the ability to "remember" what has already happened. Due to multiple sensors installed on (in) the physical object, it can warn about "normal wear" of units and assemblies, but will not predict an emergency condition which often results from a fateful combination of many causes.

Use of "Digital Twin" technology encircles the entire product life cycle, from design (including avant-project, research and development) through manufacturing to after-sales service / maintenance and repairs. Even more importantly, the system is trainable and represents an ever-expanding storage of data, solutions, and knowledge. It is critical and irreplaceable for the Defense Industry as it can significantly decrease the amount of expensive testbed and full-scale testing, due to the enormous number of virtual testing performed at the stage of development using mathematical simulations with a high level of approximation to real data, products, physical and mechanical processes. Tests are often performed on custom-made virtual testbeds / test ranges.

## Do you have any ready use cases?What point of the Hype Cycle is this technology in?

– Yes, we do. But people often hurry in an effort to turn the technology into a state standard, which is premature at this stage, because the critical mass of knowledgeable and trained engineers with sufficient background in physics and math and prepared to use it to develop, e.g. armaments, military and special purpose equipment, has not yet emerged.



#### - How do we bring forward this critical mass?

Only through solving real-time challenges, e.g. pilot projects that end with obtaining measurable results which were previously thought of as unachievable.

Imagine the Polytech's Engineering Center in the eyes of old-school engineers from manufacturing and Design Bureaus? "Here are the bunch of youngsters trying to teach us!" This limits our possible entry point to pilot projects where we can solve "unsolvable problems". These are the problems that were for some reason previously deemed "insurmountable". Take, for example, the renown Cortege project (with FSUE NAMI as the general contractor) implemented with deep involvement of Comp-MechLab® Engineering Center specialists. In early 2014, the automotive industry unanimously declared that the pressing deadlines (before inauguration of the new president) and with the allocated resources (around 12 billion rubles) made it impossible to achieve the result comparable to the world's best-in-class counterparts. I recall famous industrial designer Vladimir Pirozhkov saying in early 2015 that such projects were "completely adventurous" and their successful implementation was possible only at a high level of domestic automotive industry, with the budget of 120+ billion rubles instead of the available 12 billion (\$2 billion, he said).

Nevertheless, the project was successfully implemented within the budget ten times less than the amount deemed acceptable by the global automotive industry. In this project we strongly relied on the Digital Twin development technology based on the matrix of claims / target indicators and resource constraints amounting to 125 thousand. This is what advanced digital design and engi-

neering, or, more precisely, the Smart Design & Engineering, looks like...

But it is followed by another critical question: is our technology in demand with the state defense order contractors? Their usual way is to say, "Give us one billion (or multiple billions), bring forward the deadline, and we will do what you need." And here we are, saying, "No, our advanced 'Digital Twin' technology can do it cheaper and faster". We are only being rational. But in today's economical reality, we act to shrink the contractors' budgets...

This kind of a situation ("cheaper and faster development") is typical for civil hitech industry which has no other way but to navigate global markets through making competitive products in less time and for less money...

#### It is an enticing perspective to reduce time and cost from concept to implementation. Government and private business can benefit from it significantly, but state defense order contractors may lose income.

- Another very important thing. Along with many countries, Russia is currently in the technological "Death Valley". The hi-tech products become increasingly more sophisticated year by year due to the global competition and emerging new players like Elon Musk in automotive industry and rocket engineering. Boundaries between traditional industries are being erased, new markets pop up. There is less and less time to solve these more complex problems that we are facing, or we simply don't have it. We also have less and less money to solve these increasingly complex problems. Clearly, we will never have the financial opportunities of our predecessors such as Kurchatov and Khariton, Korolyov and Glushko, Tupolev and Ilyushin, Mil and Kamov, and, last but not least, Kalashnikov.

To sum up, the problems are becoming more complex, and there is less time and money to solve them. This is our common reality, or, metaphorically speaking, the "Death Valley".

One may conclude that obviously, traditional approaches will not work for crossing the Death Valley, being more time- and money-consuming when applied to solving more complex problems. Therefore, the solution will only come from using new, advanced, best-in-class global level technology. The technological breakthrough that the president has been mentioning, without properly being heard should be built systematically and purposefully. In our development we have reached a certain stage which is challenged by a problem requiring a way more advanced level; we are facing a leap in complexity. Overcoming it with less time and money would require the matching kind of leap - a technological breakthrough.

#### – Can Digital Twins provide this opportunity?

– Yes. Take Figure 2. We are looking at a hypothetical but highly realistic situation. Our level of development is described by value RL(t) (Russian Level), t – time, and our development pace is, for the sake of simplicity, shown as angle A. Worldwide development level is WL(t) (World Level), and its development pace is represented by angle B. From comparison of curves in Fig. 2 we can see that WL(t) > RL(t) at any t, as B > A, with breakaway WL(t) – RL(t) > o, moreover, for any t2 > t1 we have WL(t2) – RL(t3) > WL(t4) – RL(t5).

What does this mean? It means that "whatever we do, our disadvantage increases day after day", despite our development

#### CML-Bench™

CML-Bench™ is a digital platform for development of Digital Twins, design and computer engineering management system (Smart Design & Engineering), which greatly simplifies processing of data arrays (Smart Big Data) regardless of industry, and automates the virtual testing process, employing, inter alia, custom-designed virtual testbeds and test ranges.

CML-Bench™ system is intended for automation of engineering design, collection, processing, cataloguing of simulations and design options, generation of make files, processing and display of engineering design outputs. It helps structure all design simulations and options, simplifies work with databases, and improves comparison of various design projects.

CML-Bench™ is a client-server web application consisting of user interface, back-end part, DB management system and solving service. CML-Bench™ is the only system of its kind with a flexible project hierarchy enabling its use in a variety of industries.

#### **Russian Federation Digital Economy**

National program is the platform creating a new model for interaction between business, authority, expert and academic communities to improve Russia's global competitive edge.

with "A" pace that we keep proudly reporting to our seniors (without mentioning, of course, the "B" pace of our opponents).

So again, we are facing our hereditary "catch up and outdo" objective. How, in solving this kind of a complex task, we can draw on the Digital Twins technology? Let us assume that global level  $WL(t_o = 0) = WL_o$  is a Benchmark, and take it as a landmark that we need to outreach. We are at a level RL  $(t_0 = 0) = RL_0$ , meaning that we only have a short time  $(t^* - t_0)$  (preferably months, not years!) to "jump up" to the World Level  $DT(t^*) = DT^* \sim WL(t^*) = WL^*$ and it is only possible using the DT (Digital Twin) technology. Next we will have to set the pace for DT\* development according to angle D - this kind of improvement will be ensured by rational balancing of increasing numbers of characteristics in the matrix of claims / target indicators and resource constraints, as well as use of optimization and advanced manufacturing technology.

Since D > B > A, by the time  $t^{**}$  we will "catch up with" the World Level DT( $t^{**}$ ) = DT\*\* = WL( $t^{**}$ ) = WL\*\*, however at times  $t > t^{**}$  we will have: DT(t) > WL(t),  $t > t^{**}$ , i.e. a family of Digital Twins surpassing the global level: DT( $t^{**}$ ) < DT ( $t_3$ ) < DT ( $t_4$ ) < DT ( $t_5$ ) < ...,  $t^{**}$  <  $t_3$  <  $t_4$  <  $t_5$  < .... The product we take to the market will be at the level of Digital Twin DT( $t_3$ ), which is, notably, above the World Level. DT( $t_4$ ), DT( $t_5$ ), ... are Digital Twins "in an ambush" that can be released to the market at any time, whenever the global marketplace requires it.

Experts raised by Klaus Martin Schwab, pioneer of the Fourth Industrial Revolution, termed our approach Double Leap Frogging. In fact, this figure shows the technological breakthrough ( $t < t^{**}$ ), technological breakaway ( $t > t^{**}$ ), and technological breakaway ( $t > t^{**}$ ).

nological superiority ( $t >> t^{**}$ ). Evidence that proves it might have already happened. The Cortege project, for instance.

#### - Could you explain how this technology works and describe the advantages of its implementation, including cost impact?

 It is important to understand that a "Digital Twin" is not a digital copy of a real object; that would be too simplified an idea. Come to think of it, it is the real object that is a "copy" of a full-on Digital Twin. General Electric has taken its digital copies (replicas) of real objects earliest and farthest along the way. In 2017 they declared, "By year end we will have a million of Digital Twins." That said, they termed "Digital Twins" the part we refer to as "Digital Shadow". They only studied the construct's behavior in operation through "stuffing" it with sensors and capturing huge data arrays. Clearly, this approach only works well if the process follows the standard pattern or has minor deviations that unfold relatively slowly.

A "Digital Shadow" cannot predict an emergency situation because "nobody taught it" to do so, and it can be trained only on real cases. Conversely, a "Digital Twin" can simulate probable critical situations suggested by experts, feed them into his "digital brain" and perform multiple virtual tests.

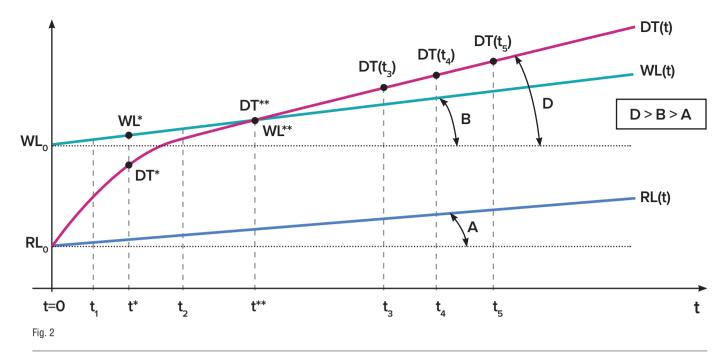
Basically, it is important to realize that the "Digital Shadow" only has its memory function and is not designed to predict emergencies, whereas the "Digital Twin" possesses a unique predictive potential.

#### - You mean that the Digital Twin can "anticipate", "imagine" and simulate a situation? How?

 Yes, it is capable of predicting, and that's the main thing. Consider an example. Assume that at a development stage of a complex object there is a chief designer who has, say, five senior designers, each of them responsible for designing a certain plant unit. Imagine that each of the senior designers can "hold in sight" up to one hundred target indicators: five multiplied by one hundred is five hundred, meaning that the design encompasses five hundred target indicators.

In fact, a real object in all modes of operation can be described by about five thousand target indicators and characteristics. The next step in development and elaboration is fifty thousand, since a Digital Twin keeps adding target indicators, parameters and characteristics, in the process of both development and operation. Once the addition reaches an order of magnitude, its effect becomes obvious as the improvement in design quality is also substantial. This is the proverbial technological breakthrough...

For information: In project Cortege for development of a single modular platform the tests concurrently took into consideration one hundred and twenty five thousand target indicators and constraints this is what was implemented on the basis of CML-Bench™ digital platform and got us the Industria National Prize of the Russian Federation in 2017. It was a world record back then. Notably, one year before, in June 2016, Aurus (a sedan from project Cortege at that time) got the top grade in the first attempt during tests at an independent test range in Berlin for passive safety in a frontal crash test. Never before the indigenous automotive industry got a top grade; in its previous days it "got nothing". I gave you an example of successful implementation of the Double Leap Frogging strategy in a particular project.



From the cost perspective, the leap effect is reached through reducing the amount of testbed and full-scale tests, in some instances – by an order of magnitude or more. However, don't forget that the amount of virtual tests, including those performed on custom-made virtual testbeds/test ranges, grows by two or more orders of magnitude. Looking at the marginality curve of any product of global leading manufacturers, you can see that the most marginal stages are design and aftersales service/maintenance and repair. Manufacturing is not marginal any more; global leaders have long made it lean, in many instances digital, and are now making it intelligent, "smart".

Thus the Digital Twins of a product, manufacturing steps and modes of operation, in combination with the Digital Shadows of the products in operation, help considerably decrease costs at all life cycle stages of an innovative product's development and maintenance, first of all, at the stage of design.

#### Does the successful experience with Aurus from Cortege project mean that the breakthrough technology already exists and it can and should be upscaled?

– Yes. And this is how it looks. The design process generates the so-called Type I Digital Twin of a product, while the manufacturing stage brings forth Type 2 Digital Twin of the production process operations. Once the product and manufacturing process Digital Twins merge together, the resultant Digital Twin becomes a Smart Digital Twin which possesses with a "genetic memory" about how and in what sequence it was manufactured. Next, the Smart Digital Twin informs us of critical zones and characteristics at the

stage of operation, answering critical questions of Where and What to measure. This, in turn, helps build the Smart Digital Shadow and substantially reduce the amount of "garbage data" generated at the stage of operation. On the one hand, the Smart Digital Shadow makes our Twin smarter with each operation stage; on the other hand, it enables three important kinds of feedback – about the stages of operation, manufacturing and, most importantly, design and creation of new, more competitive products in the shortest timespan.

#### – Ok, but what's next? How do you factor in external influences and foresee changes in the operational environment?

– Exposure of a material to aggressive environments can result in degradation of its properties. Nuclear power industry leads the research in this area. Speaking about other hi-tech industries, their learnings, one should mention cross-industry technology transfer performed under the umbrella of the trans-disciplinary approach. We simultaneously cooperate with ten hi-tech industries, and each of these industries faces its own challenges and addresses them, "outrunning" the other industries in this respect. As a result, superiority and learnings in development of Digital Twins in one of the industries can be extended to another.

## Do you mean that soon the Digital Twin development technology is going to become a blueprint for all design work in a variety of industries?

– Yes, but implementation can be challenging. People that never had such opportunities are "suddenly" given "unlimited opportunities" and of course they struggle

to believe it. They are used to not having a tool to ensure quick results; in their experience, no matter what design path they opt for, there is an inevitable risk of missing the deadline. They also tend to choose just one path, one design trajectory, which they deem the most correct.

On the other hand, in our experience, the design process is inherently non-stationary and non-linear, with many bifurcation points; which means that we launch 10, 20 or 30 design trajectories without knowing which will lead us to success. Imagine that designers are sitting together brainstorming and generating ideas, one of them saying "I would do it this way" and another, "And I suggest this thing." Traditionally, the chief designer would respond, "Stop that. Cease talking. This is what we are going to do". And this cuts off all other options.

Certainly, some of these neglected options were better, but it couldn't be verified at that point; conversely, the advanced design methods suggest "design beyond chief designer's experience and intuition", and also design tools fundamentally different from what the industry employs today.

#### – Does it mean that the Digital Twin development process expands the opportunity space?

– Yes, this is exactly what happens, and it is a critical change. We can launch several design trajectories. Afterwards, in a while, we can bring the experts together again to review the intermediate results and see which idea, hypothesis, or concept had worked, controlling enormous amounts of target indicators and limitations along the way. In fact, we reinvent the process of design to include "continuous quality gate".

In the opportunity space, there is no limit... ◆





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## INDUSTRY 4.0

Digitalization is not just one of the global modern trends. Today it is already a necessity, a tool not only for development, but and survival. About his international experience in introducing digital technologies to the magazine "New Defence Order. Strategy", said Igor Bogachev, General Director of Zyfra.

Interviewed by Reem Mohamed



#### First of all, please explain to the readers what does "digitalization of production" mean in plain terms.

– Digital Transformation is implementation of modern technologies in business processes of a company. If we look at stages of digital transformation, at preparative level we see sensors, diagnostic systems, we get already approximate results, and in some specific cases – diagnostics of technological systems. Gradually, this passes into system monitoring of equipment which improves performance. Top level is robotic systems, i.e. "unmanned technologies".

"Industry 4.0" begins from data collection and real-time intellectual planning and continues with every-day control and additional adjustment. The aim here is traditional enough for any business: to produce more for less money. So far, digital solutions existing in Russian production facilities, as a rule, are connected with detection but not solution of a problem. Whereas, for successful competition, companies need digitalization at all stages of production process, and preferably, of a product life cycle also – in order to increase staff productivity and service profitability.

Digitalization of enterprises, the use of elements of artificial intelligence in production process are resources for increasing workforce productivity. Before starting any programs to upgrade process equipment, which might require billions rubles in investments, it is logical to deploy it first in full. It is best to get the most out of your existing equipment stock first by reducing its downtime and increasing productivity via digital monitoring. When you do digitalization, you don't change equipment. This is the case with Uber: running the same vehicles with the same drivers, a new model is created to manage and use the same service. The same can be done in industry at large – changing production structure with the same equipment, processes, and workers.

We work with customers from several key industries: mining, metallurgy, oil-and-gas production and refining, chemistry and mechanical engineering. Functionally, the approaches in each industrial sector differ, but there are three basic elements everywhere. The

first level – interconnection of industrial equipment, its monitoring for analysis of capacity utilization, causes of downtime and availability of free resources for further optimization. The second level consists of digital management of production using the first-level data. The third level adds machine learning technologies to optimize production processes on the real-time basis and creates "autopilots" that assist people in making right decisions.

#### – What are the opportunities that production digitalization brings to industries in general and to the defense industry in particular?

– Today, Russian industrial sector requires new management models and technologies rather than only substantial material resources for modification. Existing infrastructure can work faster and more effective. This is a global challenge of today in response to which we should undertake efforts towards digitalization and not wait for appearance of industry standards and ready-to-use typical solutions proven by industry leaders. It's important to take into account that digital economy is not a thing in itself, and there is no sense in perceiving it just as fashionable trend fed by close attention of state and business. This is backed by real economic effects.

Previously the question of how to make general transfer from manual to machine operations at mechanical level has been addressed, but now actual agenda aims towards enhancement of equipment operation and technological processes efficiency, delegation of routine and hazardous operations to robots or artificial intelligence. New process management model based on digital transformation should be quick, precise and eco-friendly in the broad sense of the word.

Primary conditions of sustainable development of any industrial facility include real-time automatic control of productive assets, predictability of systems' operation, as well as reducing transaction costs. Meeting these requirements in contemporary reality is provided with the use of data-based management. Data collection as such is still a weak point of the industry. In

**Igor Bogachev,** General Director of Zyfra





particular, in Russia and in the most part of the world, 90% of industrial equipment is not being monitored, parameters of its operation are not accounted and analyzed. Thereby, country mean utilization of machine pool accounts to 30% in average. Therefore, a path to digital production starts from connecting to Industrial Internet of Things (IIoT).

Today's systems provide real-time monitoring of production equipment, anytime and anywhere, and support connection to Computer numerical control (CNC) machines, industrial robots and production lines. You can evaluate the state of your machines by dashboards, a timeline, or on an interactive shop floor layout using a traditional Windows application or a modern Web client.

Monitoring of most modern CNC machines is simple – all you need is just connect the network cable to an appropriate port on the machine controls (a list of supported CNC controls is available on the website and from authorized dealers) and configure it to transmit data. In this case, you automatically receive not only information about the state of a machine (its cycle, downtime, alarm conditions), but also a large amount of data regarding the process: numerical control (NC) program number, coordinates, speed, feed, tool number, etc.; and many system variables: temperature, spindle load, alarm number, etc.

To connect to any other piece of equipment, you can use a wide range of hardware products (including a proprietary TVV monitoring terminal and various sensors) as well as third-party products (Android tablet computers and MOXA network equipment).

TVV terminals and tablet computers help an operator to work more efficiently – they are used to specify reasons for downtime (i.e. setup, no tools, no task, no work pieces, etc.), which are used to notify (by SMS and E-mail) respective specialists and production departments. The terminal displays information that is useful for completing a job: order number, documentation (setup sheets and drawings), machine status, number of machined parts; an NC program is selected for transfer to the machine. Optionally, a barcode scanner can be connected to register the operator and technological operations, specifying reasons of downtime.

Data from each machine is transmitted (24/7) and stored in a server. Many tools are available for users to get a full view of production efficiency and its bottlenecks. You can choose from more than 100 predefined reports (OEE, KPI, reasons for downtime, machined parts, alarms, defects, etc.), including tabular data and diagrams, or use the report generator, which generates analytics in accordance to selected criteria.

Main functions available are monitoring the load, state and operating modes of equipment; identification and classification of downtime reasons; assisting operators in performing production tasks; notifying specialists and production departments regarding accidents and unplanned downtime; compiling analytical reports on the equipment operation and production efficiency.

Currently, there are more than 50 large industrial holdings which use our MDC-plus Industrial Machine Monitoring and Manufacturing Data Collection System, including the United Aircraft Corporation (Russia), Russian Helicopters (Russia), the Rosatom State Atomic Energy Corporation (Russia), the Godrej Group (India), Indian Railways (India), and many others. We

see the potential to work in this direction with our European and Indian colleagues from companies in the aerospace sector. MDC-plus is the first Russian system that uses not only the technology of the Industrial Internet of Things, but also artificial intelligence. With the help of predictive analytics, the system can predict equipment breakdown and control tool use.

Recently, Zyfra and the United Engine Corporation have deployed MDC-plus real-time machine monitoring and manufacturing data collection system in various manufacturing facilities across the country. MDC-plus is designed to track machine operation, personal productivity and parts manufacturing progress. Its tailored reports and charts can be used to eliminate unreasonable downtime, evaluate overall equipment efficiency (OEE) and reduce production costs. On average, equipment monitoring increases production efficiency by 15%.

#### - What are the challenges that come along with this digitalization of production?

– Lack of data is one of the main problems hindering development of such digital models for Russian companies and enterprises. In my experience, at least six months' load of data on the operation of the target facility are needed in order to build such a model. The company should have its data stored in digital format, not a hardcopy, and be easily retrievable. It's difficult to retrieve undigitized information and use it. According to Zyfra, three quarters of Russia's total pool of 800 thousand machines are not equipped with numerical control, and this complicates connecting them to industrial monitoring systems.

Other barriers to digitalization are conservatism of some enterprises, plus resistance of management: sometimes, managers don't want the plant's processes to become more transparent so that their abuses or deficiencies would become apparent.

Lack of general knowledge about capabilities of digital technologies in production is slacking up the process as well.

Some manufacturers say: "Let's try digital technologies for some secondary process, and then we can go from there." But it is impossible to note a significant effect with a small production and minimum economy.

The first and most important rule for business is to implement new technologies. The second is to change management by integrating new technologies in it. In addition to implementation of new technologies, it is necessary to transform the management system by making it more flexible and able to respond faster to changing conditions.

#### - How would you evaluate digitalization in the defense sector in Russia and in other countries where you operate?

– If we talk about modern equipment, modern production management systems, then, of course, defense enterprises are equipped better than civil ones. There had been various systems before the time when everybody began speaking about digitalization. Enterprises are equipped with more or less up-to-date machines.

Equipment connectivity is important. Basis of production optimization lies in physical possibility to get structured information about equipment operation. Baseline requirement consists of availability of numerically controlled (NC) machines. If a machine has no wire in it, and Wi-Fi can't be provided, then miracles do not occur: you will not have any data from this machine.

By our estimates, about 14% of factories in Russia are already at high stage of readiness for digital transformation: more than 50% of their machine pool are NC machines. Additionally, according to results of our survey, approximately 20% of enterprises are actively increasing machine pool – equipment amount gain in these companies for the last three years has exceeded 20%; almost 80% of respondent enterprises are going to purchase machines in the nearest three years.

More advanced industry sectors include aircraft industry, automotive industry, and machine-tool building. Share of NC machines in aircraft engineering amounted to 30%, and within the last three years almost 40% of additionally purchased machines were indeed with CNC. In automobile factories, about 60% of new equipment contain already CNC modules, gross share of automated equipment did not exceed 7% here. In machine-tool building, 41% of new equipment is automated, current percent is just above 10%.

As for comparison with other countries, I would divide this question into two parts. The first is workforce productivity. Notwithstanding positive first outcomes of implementation of "Workforce productivity and employment support" national project which aims to accelerate the pace of increase in productivity in medium and large enterprises of key non-raw-material industry sectors by 5% minimum per year to 2024, workforce productivity in Russia (GDP per hour of hours worked) is approximately half as high as similar indicator for another countries' companies. Figuratively speaking, in the same term, in Russia one house is constructed, and in America and EU – three houses are.

This lagging of Russia can be eliminated using end-to-end digitalization of all real sectors. Technologies of Industrial Internet of Things and artificial intelligence allow to increase equipment and personnel productiveness by 10% in average, and finished products output – up to 15%.

Second, there is the level of digitalization. Global technical market does not differ greatly from Russian market. We work in various countries and see the same situation. Everywhere people try to implement in production process technologies of Industry Internet and artificial intelligence. Everywhere pilot projects run, but this is far form saying that some countries are much ahead. In other words, we have a chance to build new economy and be among the first to get results, as Russian industry is known for not only being large but also for the fact that people working in the country are well educated, not afraid of taking risks and can manage changes.

#### - How does the rise of digital platforms benefit the military sector?

- In some production facilities where, for instance, engines (not necessarily for military-oriented purposes)

are manufactured exclusive quality standards are applied. For military products, these standards are even higher, including those for parts traceability. This is one of the current tasks for us now – to trace a path from raw metal to finished part. This is called a "product digital certificate."

In civil industry, it is not of great importance, for instance, who made a part for a vacuum cleaner; this part can be replaced and everything will work fine. And in the defense industry it is very important. If a missile has not taken off, this is not equal to broken vacuum cleaner. It is important to know everything, including which enterprise has delivered metal. A part blank has passed through 20 machines and 30 hands but, in the end, something happened to it, and it can't be determined who is to blame. May be, it was the company that supplied raw metal.

It is also important to understand technological modes in part manufacturing process. For each product it is possible to review all its transitions, all manufacturing operations which have been made, and who executed them and how they have been performed. Also, manufacture technological parameters are to be recorded. This is complicated task but we are approaching its solution. This is also becoming interesting for civil enterprises, but everything depends on product cost and manufacturer's liabilities to client.

As for the rest, digital technologies benefits are similar for civil and military enterprises. I can give specific example. In 2018, we connected 45 CNC machines at a subsidiary of Magnitogorsk Iron and Steel Works (MMK) to our monitoring system for industrial equipment and personnel. The system monitored basic modes of the machines: "production," "idle," "no data" and others.

The system showed that the machines stayed in their off mode for 33% of their working time. Causeless downtime was 22%. There was a huge reserve for optimization, and the decisions taken based on the results of that survey of the situation made it possible to almost double equipment workload. Monitoring power consumption revealed more reserves in the use of equipment, as a result of which the technological cycle of part processing was shortened. Thanks to the transparency of production processes, it became possible to improve operators' labor discipline.

A machine-time reserve of 3,300 machine hours of downtime per month was revealed. Each hour of downtime per one machine cost the company almost \$20. Using the system made it possible to increase the workload of equipment by 31%. This led to an increase in output by more than \$110 thousand a month. The whole project paid off in 7.5 months.

- The digital transformation is bringing forward so many new players to the market who try to provide new relevant services. How would you evaluate relevance of those services to the current needs of the market?

– Practice shows that such solutions pay off in six months. And we set for ourselves the goal: to ensure that all of our projects feature a payback period of six months, maximum. And that's our competitive advantage, in fact.





In addition, these systems are not intended for super-professionals: they are systems that will make it possible to raise production to a new level, while at the same time attracting staff with little work experience that can produce high results in a short time. All of this ultimately affects workforce productivity and job attractiveness for young professionals. A college or technical school graduate should generally be eager to go into production. A graduate with a smartphone in his hands is not interested in going to work in a workshop that is stuck in the last century.

#### - How fierce is the competition in the market of production digitalization?

– You often hear startup owners asserting that they have no direct competitors. But this is actually an illusion.

When we were in the process of entering Indian market with our product in the field of Industrial Internet of Things (IIoT), we "got acquainted" with our competitors in a tender. They didn't even have a website, but they worked on a system similar to ours, which was known to a narrow circle of users in the local market.

Competitors will always be there, especially if you plan to start selling your product in developed countries.

Even if your product or technology has no comparable products today, no one can guarantee that tomorrow a company won't appear capable of implementing your idea faster or cheaper. Therefore, it's necessary to look for potential competitors and assess their capabilities in the country where you plan to operate.

There are simultaneously many and few competitors. Moreover, sometimes there are competitors inside companies themselves. The point is that in Russia it is very fashionably to create a company's own IT-divisions, this is such a purely Russian "trick". Probably, we have too much programmers who need to be placed somewhere.

Therefore, there is competition with people who is working inside companies, but the difference is in that they do almost the same but on limited scale and with limited experience. We, on the other hand, are working with hundreds of companies and can transfer the best practices from one to another.

#### – Zyfra has international partnerships. Can you tell us briefly about that?

– The revenue of the Zyfra Group amounted to 2.4 billion rubles in 2019, which is a 37% increase on the previous year. The export revenue reached 400 million rubles, having increased by 21%.

The main points of business growth and revenue for Zyfra are new products based on artificial intelligence technology and robotics. In Kazakhstan, the new Safety product has been launched in AK Altynalmas for managing safety and work orders for all types of work.

Regarding industrial perspective, most of the revenue (68%) was provided by projects in the mining industry and metallurgy. Ten more mines began using Zyfra's products, and their total number has reached 81. Two new foreign projects have been launched. In India,

Intelligent Mine is being implemented by the largest Indian coal mine operator Thriveni Earthmovers at the coal Pakri Barvadi mine (one of the largest mines of NTPC, the leading energy corporation in India). Peruvian mining company Cosapi Mineria has implemented the OpenMine mining management system at the Shougang Hierro Peru open-pit mine. Investments in the project amounted to 750 thousand US dollars.

We have connected 10,000 CNC machines to our MDC-plus real-time machine monitoring and manufacturing data collection system. The projects have been implemented in Bulgaria, China, Finland, France, India, Romania, Turkey, and Singapore. By 2021, we are looking forward to more than 15,000 MDC-plus installations across the globe.

#### - How can a company like Zyfra help industrial companies during the Covid-19 pandemic to improve production?

- In the days of "Industry 4.0", it is already quite allowable to ask the question how digitalization will help to overcome crisis. Industrialists are not all ready yet to change over to full automation of production. Economic effect of introduction of modern controllers or appearance of robotic installation in a shop can, in the beginning, amount to only fractions of per cent, therefore it is easier to rely on old proven machines and workers. Under conditions of pandemic of dangerous virus, the picture appears to be quite different. Robots cannot be ill and do not infect people, therefore quarantine on the shop floor can become an impetus for implementation of robotics. Industrial Internet of Things (IIoT) technologies are becoming current, due to which various equipment can interact with each other without people participating in this.

One of our European customers, a lifting and transporting equipment manufacturer, has managed to reduce the negative effect of the COVID-19 pandemic with the help of a monitoring system to complete strategically important orders in time. The company has managed to set priorities and redistribute its orders depending on their urgency while also keeping some machines in off mode. It helped to move 25% workers to remote working without sacrificing total output of production.

Of course, there is always possibility to stop a plant or a factory operation. But in metallurgy industry such a decision is equal to close off. Blast furnace, because of steelmaking process peculiarities, is working continuously throughout its service life – from construction stage to overhaul or closing. Therefore, projects of construction of autonomous factories or mines where participation of people in production process is minimized, unmanned vehicles run about factory or openpit mine, and technical equipment operators can reside in several dozens or hundreds kilometers from the enterprise now seem not so fantastic.

Time of crisis is always characterized by lack of proven information, therefore, it is becoming vitally necessary to have exact vision of current situation in your own company. Today, data on production volumes, equipment condition, forced downtime are already successfully collected by automated technological and production process management systems based



**Igor Bogachev,** General Director of Zyfra

on artificial intelligence technologies. Afterwards, Big Data processing technologies help to analyze the information collected and make necessary management decisions while being anywhere. Equipment digital monitoring is simply rising the company's production capacity. Meanwhile, product output can be controlled precisely taking into consideration external conditions, which fact is also of significance.

#### How will the current global crisis shape the future of digitalization of industries, military industry in particular?

– The coronavirus epidemic will accelerate development of digital technologies, inspire their more active employment in ordinary life. Many technologies which have been planned to be implemented in practice within 10 years, now will be put in motion within 3–5 years. This will concern defense enterprises, among others.

Furthermore, we suppose that transition to "limited manning production" will be accelerated. Equipment and personnel monitoring system actually performs tasks of remote people communication with each other. If we run through all tasks we will see this. Let's take for example a machine operator. Now he has got digital place. He can call any service, get shift task, account for shift task. To do this, a foreman does not need anymore to gather all operators personally around himself and give everybody written or oral task as before.

A foreman does not need to walk around machines and supervise everybody. Now, he does not need to run, he sits at his working place and watches how each worker is working, and whether a worker fulfills a plan or not. A foreman is able to contact with a worker. The same relates to shop manager, to administrative body and to a general director. Thanks to digitalization, it can be easily seen who, how and where is working.

We analyzed why there has been no really deep implementation of the systems so far. This is because life did not force us yet! Of course, for a shop manager it is easier and more comfortable to gather fellow-workers, whom he has not seen for the whole day, at a kick-off meeting and to talk for two hours about life, instead of examining circular or linear chart. But today it's impossible as he has already got a tool which can be used without collecting anybody at all. And eventually, even while staying at home. We have already got it.

The same can be said about services: technological and energetic ones. Of course, it is impossible to repair a machine while being at home, but the same manager or technician can already see what happened with the machine while sitting at his working place. He does not need to communicate with an operator, asking for details, and what there was and what there is now. He can see "remotely", so he can take everything that is necessary, and go and do the repair. For example, management staff of a shop manager level can avoid practically any contacts with workers. •



ARRW Launch

## MILITARY HYPERSONIC TECHNOLOGY IN THE US

No doubt that the word "hypersonic" has become a buzzword in the military realm. After a public presentation of Russian programs on March 1, 2018, the US defense industry and military doubled down on obtaining funding for development of own hypersonic weapons, resulting in a number of parallel programs one can easily become confused in. The "New Defense Order. Strategy" prepared a brief guide for readers on this matter.

Author Aleksandr Ermakov

The foreword suggests a general talk about the present-day hypersonic weapons, their potential and types, as well as whether the excitement about them is justified and what reasons there are for it; however, these are subjects for other articles. We will only speak about American developments, and the goal of this review is to provide the reader with information about subjects of future news about testing of new US defense products.

We will briefly note that, for the purpose of this review, hypersonic weapons only mean those capable of actively maneuvering in the atmosphere at high speeds (more than 5 M), both powered and unpowered.

The latter are more widely known by the word "glider", since the term "guided hypersonic gliding head" used in Russia is a bit awkward. We should also clarify that all the systems mentioned below are only being developed in non-nuclear versions, at least at the current stage (which does not prevent from retrofitting them with nuclear charges or developing nuclear carriers on their basis).

#### **US AERIAL MISSILE PROGRAMS**

**Air-Launched Rapid Response Weapon (ARRW).** It's a program for a glider-equipped aerial missile officially developed by Lockheed Martin according to a \$480 million contract awarded to the US Air Force on August 13, 2018. Later on, the amount of the missile development contract was increased to almost \$1 billion. It is probably based on the company's earlier developments conducted together with DARPA (Defense Advanced Research Projects Agency). This explains the extremely tight project deadline: it is planned to reach the initial combat deployment stage as soon as in 2022.

It is one of the few weapon systems mentioned in the article that has official images, both weight and size mockup photos taken in June 2019 and some concept art showing the missile in flight with the nose

cone ejected and demonstrating the glider, published at the end of February 2020 when the missile design was reviewed. At this time, the ARRW can be called the priority hypersonic weapon program at least for the US Air Force and potentially for the Pentagon. This is described, for instance, by the telling fact that only this missile has a publicly disclosed military index AGM-183A. The program name acronym was transformed into the unofficial missile name Arrow.

The AGM-183A is a fairly light missile (it has a starting weight of about 3–3.5 tons) with a maximum launch range of 1000 km, according to unofficial assessment. It looks like a missile with conventional proportions, but the "body" is, in fact, a solid booster that is jettisoned in flight, and the flat glider that kills the target is hidden under the nose cone. The glider dimensions are apparently very small and do not allow for a very powerful head. It is possible, the missile does not have a head at all, with only the kinetic effect of a high-speed impact used for killing the target, but this would set extremely high requirements to accuracy and limit the list of targets that could be killed.

The strategic bombers B-52H Stratofortress will probably be used as the carrier for the AGM-183A missiles at the initial stage, however, other aircraft are planned to be used for this purpose in the future, including at least the B-21 Raider bombers and even the F-15E/EX Strike Eagle fighters – if the weight and dimensions can be kept moderate, one missile could be suspended under the fighter fuselage.

Hypersonic Conventional Strike Weapon (HCSW). Until lately, the ARRW had a parallel "sister", an also gliding guided high-precision head using a solid booster. The main difference would be the head type: the missile would utilize a "common" type-independent glider Common-Hypersonic Glide Body (C-HGB), which has a conical shape and noticeably larger dimensions. There are several photos of C-HGB concepts and mockups. It is probably based on the glider developed according to the common US Army and DARPA program Advanced Hypersonic Weapon (AHW), which included a successful test launch for a range of about в 3,700 km in 2011.

The potential dimensions of the resulting HCSW including the booster could only be guessed, but they would apparently be much larger than the AGM-I83A dimensions. It is perhaps for this missile that the development of wing pylons for the B-52H bombers with a possibility to suspend mul-

tiple weapons with a maximum weight of 9 tons each started in 2018.

It would probably have larger range than the ARRW, and a definitely larger list of targets that could be killed, both thanks to its higher weight and due to a possibility to install a more advanced guiding system within the volume. The missile got the unofficial name Hacksaw. In 2018, Lockheed Martin was awarded a contract for its development, approximately amounting to \$928 m. Similar to the ARRW case, it was planned to deliver the missile for service within the minimum time possible. However, at the beginning of 2020, a decision was made to abandon the program after a formal project review, which would be utilized to accumulate useful experience, and to redistribute the funds for the ARRW program.

Why did the "common" glider that was touted by the Pentagon as a very important unification not save the HCSW program? It is probably the matter of the dimensions: the US Air Force decided to concentrate on more compact ARRW, which would be used from tactical aircraft or in large numbers from bombers. Perhaps, the problem was not even the final price but a less definite tactical niche – if the question is killing an extremely important target, the Army and Navy would have the C-HGB carriers within a few thousand kilometers, and the B-52H would be unnecessary.

Tactical Boost Glide (TBG). Besides programs that would result in the development of a new weapon system, a large number of other projects aimed at technical solution testing and experience accumulation are underway in the US. These include, for instance, the X-6oA, a mutual NASA and US Air Force program for the development of a booster that could be launched from the Gulfstream III business jet and could accelerate various payloads to hypersonic speeds.

Even more characteristic example would be the TBG program mutually conducted by DARPA and the US Air Force with a goal to design a glider for refining technical solutions that would be used in the AGM-183A. The program was commenced in 2015 and includes competing projects developed by Raytheon and Lockheed Martin. Flight testing was slated for the end of 2019 but later delayed into 2020.

Hypersonic Air-breathing Weapon Concept (HAWC). It is another mutual research program by the US Air Force and DARPA, which has an important difference from those mentioned in this review.



DONALD TRUMP, US PRESIDENT

Our missiles are big, powerful, accurate, lethal, and fast. Many new hypersonic missiles are being built. However, the fact that we have such a great army and equipment does not mean that we must use all this. We don't want this to happen



THOMAS MODLY, US SECRETARY OF THE NAVY

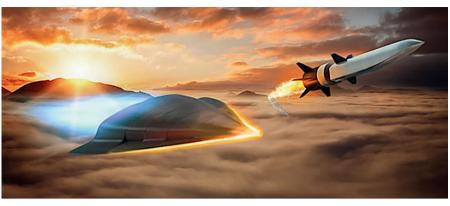
Potential areas of hypersonic technology application have already changed the nature of combat, same as the nuclear technology did in the past century. For this reason, when we talk about hypersonic weapons, we must take the full-on approach

The HAWC is aimed at the development of a missile demonstrator with a hypersonic steady-flow ramjet engine (Scramjet), rather than another glider. Potentially, it is this area of research that should result in a "true" hypersonic technology with breakthrough capabilities, wider than those of a simply maneuvering ballistic missile heads. At present, the US has relatively successful programs of flying labs in this area, the X-43 reaching a speed of almost 9.7 M at a 33 km altitude and the X-51 with a 3.5-minute flight time record with the scramjet engine on (the X-43 was mostly accelerated using a solid booster, the hydrogen fuel reserve for its own engine was



### LIEUTENANT GENERAL NEIL THURGOOD

Our potential enemy has created area denial locations. To guide our forces there, we must establish penetration strips. Hypersound is a strategic weapon that will provide us with this possibility



TBG & HAWC



M. LEWIS, DIRECTOR OF MILITARY ANALYSIS INSTITUTE

In the Pentagon, you will not be able to pass ten feet without hearing the word "hypersonic"





Composition of the LRHW complex

Flying laboratory X-51



about I kilogram, which is sufficient for approximately 10 seconds of operation).

As part of the HAWC program being implemented since 2016, it is planned to design a more advanced aircraft with a scramjet engine, with dimensions and capabilities close to fully functional weapons. The contenders are a Raytheon/Northrop team and the omnipresent Lockheed Martin. It was reported that ground testing of missile systems had been conducted, with flight testing slated for 2020. It is planned that the HAWC would be able to evolve into a light missile in the near future. Lockheed Martin demonstrated F-35 concepts with a pair of missiles (probably anti-ship ones) under the wing, while bombers would be able to carry up to 15-20 light scramjet missiles. The American military have a conservative view of deployment of longrange guided missiles with hypersonic engines and speeds of 5+ Mach - this would be in the next decade.

#### US ARMY GROUND MISSILE SYSTEMS

Long Range Hypersonic Weapon (LRHW).

Along with the aerial ARRW, this is the highest priority military hypersonic program in the US. As part of this program, it is planned to design a new mobile system with an intermediate-range guided missile, practically a new Pershing II, but with a non-nuclear high-precision glider as the payload, the "common" C-HGB mentioned above. It would not be a great exaggeration to say that the US left the Intermediate-Range Nuclear Forces (INF) Treaty in 2019 to be able to create such a weapon system.

In its current state, the program was probably started in the second half of 2018. The LRHW efforts are spread among a number

of individual contracts; the total development stage costs could be estimated at approximately one and a half billion dollars. Again, Lockheed Martin takes on the main designer's role, gliders are being developed by Dynetics operating according to a contract for the production of a test lot including twenty C-HGB for the Army and Navy. The deadline is extremely ambitious: the first battery would be deployed for testing and combat duty as soon as in 2023.

Although the LRHW system is not ready yet, a lot is known about it as a weapon system. The missile battery would include four launchers and a command post vehicle. The launcher is a M870 semi-trailer (similar to that used for the Patriot AA missile system) with two transportation and launch containers that are about 10 m long and the four-axle all-wheel drive tractor Oshkosh M983A4. Each container has a two-stage missile with a diameter of about 0.88 m and a C-HGB glider under the nose cone. The LRHW range is anyone's guess at the moment, but it would at least be 2,000 km (potentially, up to 4,000 km).

The deployment of the new missile system would provide the US Army with an instrument for independent killing of targets deep in the enemy territory, which was lost with the signing of the INF Treaty. This time, the instrument would be non-nuclear, that is in a more applicable version. The priority targets for the LRHW should be intermediate-range missile systems and anti-access and area denial (A2/AD) equipment: AA systems and coastal missile systems with anti-ship missiles, while the range would allow to have entire regions in sights.

**Operational Fires (OpFires).** The Army and DARPA's mutual program that is likely

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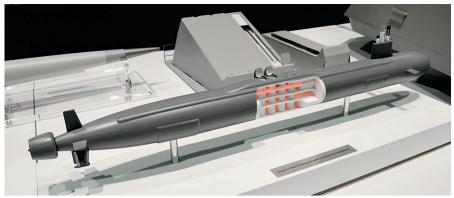




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Model submarine type "Virginia" with VPM missile compartment

to be in the same position to the LRHW as the TBG is to the ARRW: this is a simplified demonstrator (probably with smaller dimensions, in this case) of technology for refining ground system and glider solutions.

The main contractor of the third program stage that is underway at the moment, as part of which flight testing is planned in 2022, is Lockheed Martin. The two previous phases concentrated on the development and ground testing of compact solid missile engines and included such participants as Aerojet Rocketdyne, Dynetics, Exquadrum and Sierra Nevada.

#### Strategic Long Range Cannon (SLRC).

The most exotic system in this review would probably be the "thousand-mile cannon" developed for the US Army, with a planned firing range of up to 1,800 km. It is evident that there is no conventional weapon, let alone with reasonable dimensions, capable of sending shells to such a distance. In fact, the system in question is an exotic launcher that would provide initial acceleration to a small missile shell, which, in turn, would be equipped with a power plant (with possible versions ranging from a solid booster to a compact ramjet engine). Besides that, it is apparent that the missile shell must be guided.

Although we are not clear about exact solutions that would enable such a firing range at the moment, the general system design is unknown: the weapon would be transported using the standard tank-towing tractor Oshkosh M1070, and must be suitable to be carried by aircraft; the crew of a single weapon includes eight persons, the battery would consist of four weapons (and, apparently, charging and command vehicles). The intended timeframe for full-scale prototype testing is 2023, while

a full battery would be deployed two years after that. If the shot price is acceptable, the "thousand-mile gun" should be a natural complement to the LRHW with its extremely expensive missiles. Besides that, compact and multiple missile shells would be capable of overloading the enemy's AA system.

Apparently, saying that the SLRC is hypersonic weapon would be a stretch because it is unknown to what extent the missile shells would have gliding and maneuvering performance, if any. It is possible that they will only be guided in the sense that it would be possible to control deviation from the target due to firing errors and the atmosphere effect.

However, it would be difficult to not include such an exotic-looking project that is actually being implemented. Besides that, while different from the other projects from the technical point of view, their tactical performance allows us to classify them as short- and intermediate-range missile systems.

#### **US NAVY PROGRAM**

Intermediate Range Conventional Prompt Strike (IRCPS). Details are only known about a single hypersonic program by the Navy, aimed at the development of an intermediate-range missile with the C-HGB glider. The current program was probably launched in the middle of the present decade, while its roots go back to the Navy part of intertype research on the Prompt Global Strike (PGS) subject popular at the turn of the century. While such proposals as developing non-nuclear ICBM modifications, widely discussed at that time, did not gain any traction, works on an initially non-nuclear intermediate-range ballistic submarine missile that is smaller than the Trident II have never stopped. Thus, in October 2017, the first missile test including a launch for a distance "exceeding 3,700 km" was conducted as part of these works. The next test launch is slated for 2020.

By current estimations, the IRCPS and LRHW missiles will be virtually identical. In this case, synergy between the Navy and the Army is evident, with the former providing a booster that has been in development for many years and the latter making available the glider, also in development for quite a long time. The costs would be split in this case, with the Navy, probably, bearing the most part: more than \$1 billion has been requested for FY 2021 alone. The Army would deploy the system earlier and would be capable to accumulate operating experience and help eliminate initial-phase drawbacks. The Navy is only planning to deploy the IRCPS starting in 2028, which can be explained by the need to obtain and learn to operate the carriers. the multipurpose Virginia series 5 submarines with an extra missile compartment, the so-called Virginia Payload Module (VPM). Initially, four VPM silos should be able to house 28 Tomahawk missiles designed for installation in the future IRCPS. Surface ships, in particular, Zumwalt destroyers, are regarded as potential carriers of the new missiles.

Obtaining a high-speed and high-precision means for killing targets deep within the continent would allow the Navy to keep its position as a force that could be lost if it were behind the Army and Air Force actively seeking to deploy hypersonic weapons. •

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#### **EXPERIENCE**

- ▶ Energiya JSC was established in 1941.
- On September 15, 1941, the plant was launched into operation.
- On October 8, 1941, the first batch of electrochemical cells (wafer-type anode batteries with resin insulation) was produced. This date is celebrated by the plant workers as the plant's foundation day.



▶ Over 75 years, Energiya JSC has been maintaining its edge as one of the leading manufacturers of electrochemical generators across Russia and CIS countries.

#### **TECHNOLOGY**

▶ Since 2007, the plant started to produce super-capacitors with high specific characteristics and long service life. These products are widely used both in civil industry (in hybrid vehicles, railway rolling stock, quality energy systems) and for Ministry of Defense needs, including latest advanced military equipment.

- ▶ Since 2013, the company has been series producing home-designed Li-Ion batteries in response to the demand from the MoD. The company has also mastered production of a wide range of LI-based batteries and battery banks. In this area, Energiya JSC takes a leading place among the manufacturers of these products.
- ▶ In 2015, in the framework of the import substitution program, we offer innovative solutions for a wide general market: sources of current ensuring reliable operation in a wide temperature range, with a high discharge rate and long storage life (up to 10 years), matching the performance of foreign counterparts:
- FR14G505 and FR10G445 elements, AA and AAA standard sizes, lithium iron disulfide electrochemical system;
- CR34615 element, D standard size, lithium – manganese disulfide electrochemical system;



▶ In 2017, the FR14G505 element was issued a quality declaration under the program "Russia's Top 100 Goods."

Energiya JSC operates in the following key markets: Russia, Belarus, Kazakhstan, Uzbekistan, Armenia, Azerbaijan, Lithuania.

#### **FUTURE**

In 2020, the plant launched production of LIP-72, LIC-3 batteries of 18650 standard size for use in such areas as e-transport, UAVs, energy storage systems for household, office, healthcare institutions etc., as well as uninterruptible power supplies.

We replace lead-acid batteries in cellular providers' UPS. The plant successfully tested and piloted the use of LI cylindrical batteries ICR 14/51 (14500 standard size) in wearable technical rehabilitation equipment such as prosthetics.

Over the recent years, the company's management has its focus on import substitution of materials and on supplies of Russian-manufactured products.

The plant's core area of operation is design and manufacturing of autonomous power sources for domestic, general industry and special-purpose equipment used in aviation; in river and sea fleet; in emergency communication and signaling on water, in air and on the ground; fire extinguishing systems and other various purpose appliances; and also for radio equipment, household electric and electronic appliances, medical devices, toys and games. •



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# Integrated Solutions and Production Potential of JSC "Shipbuilding & Shiprepair Technology Center" in the Area of Valves and Fittings Production

For more than 80 years JSC "Shipbuilding & Shiprepair Technology Center" (JSC SSTC) successfully resolves issues related to setting-up infrastructure, development of technologies and design of equipment for the Russian Navy and civil fleet, as well as for foreign customers. JSC SSTC is a leading Russian center for development of shipbuilding and ship repair technologies as well as for design and organization of serial production of shipboard valves and fittings, including sophisticated ones.

Produced valves and fittings are purposed for operation as part of shipboard systems and propulsion plants with a wide range of mediums, pressures, and temperatures. Design Bureau Armas (DB Armas), which is a subdivision of JSC SSTC, has already developed, completely tested and released for serial production more than 20,000 types of various valves and fittings. Pipe fittings – stop valves, control valves, safety valves, reducing valves, throttles, filters, valve assemblies, distributing units – developed by DB Armas are installed on all Russian and many foreign ships and vessels.

DB Armas offers integrated solutions for development, design, and support of valves and fittings through all stages of life cycle: design, engineering analysis, manufacture, testing, certification, training, supervision, after-sales service and repair.

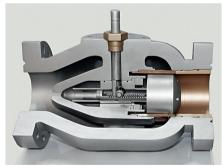
Our specialists design valves and fittings using virtual environment, based on digital twins technology and purposed for the development and optimization of valves and fittings. This environment includes development of 3D models, kinematic and dynamic analysis, structure analysis, simulation modeling, numerical modeling of liquid and gas flow, prediction of noise and vibration levels, and optimization of design. Main areas of researches and new developments include improv-

ing operational performance, noise and vibration levels reduction, expanding of adjustments range and accuracy, improving performance parameters (pressure, temperature and consumption), application of new materials (including composites) and technologies (additive manufacture, virtual stands).

The quality of valves and fittings manufacturing is also guaranteed by the use of our own production facilities. Advanced multifunctional machining centers and NC machines enable processing of shipboard valves and fittings of all configurations and complexity. As a part of technological preparation of production facility, the following procedures, ensuring readiness for manufacture of new products, are carried out: checking manufacturability of article, estimation of justified material and labor norms, checking availability of required production equipment and areas, implementation of technological procedures and managing the same. Carrying out the above procedures results in manufacturing of any type of high-quality valves and fittings in minimum time period.

The production procedure includes incoming inspection of materials and semi-finished products, metal cutting, thermal processing, determination of physical and mechanical, chemical properties of materials, mechanical process-





Ship borne valves designed by DB Armas, JSC SSTC

ing, pressing and clamping of gaskets, welding (welding and cladding), fitting and assembly works, and finally the inspection of finished articles.

Testing valves and fittings on test benches constitutes an essential part of the



Test bench HPA-400 for ship borne valves and fittings



Ship valve produced by DB Armas, JSC SSTC

production procedure. Each article undergoes a series of tests and trials to check its conformity with set specifications: tightness, operability, hydraulic, aerodynamic parameters, resistance to vibration, shock resistance, and resistance to external impacts. Quantitative and qualitative parameters, calculations correctness, justification of applied materials and components are also checked. All test benches comply with certain safety requirements, i.e. safety requirements of production facilities, equipment and working stations arrangements, equipment installation and operation, personnel safety requirements, requirements for trials preparation and conduction, safety requirements for maintenance and repair, and protective devices requirements. Unique research and development complex of DB Armas is properly approved and certified to conduct the following trials:

- Leakage test and test for operation with various working mediums: air, water, HPA, paraffin-glycerin-water liquid;
- Determination of vibroacoustic and metering characteristic for various working mediums: air, water, paraffin-glycerin-water liquid;
- Vibration and shock resistance tests, climatic tests.

In order to ensure the effective operation of valves and fittings, DB Armas conducts trainings, develops regulatory documents and norms, provides supervision and technical assistance, conducts technical and after-sales service, as well as repair of supplied products.

When cooperating with Russian and foreign customers, DB Armas resolves various technical issues, focused on development of industrial potential and innovation in valves and fittings production:

- Development of valves and fittings in accordance with the requirements of a customer;
- Manufacturing and testing valves and fittings of all types;
- Rendering services related to technical support, warranty and post-warranty maintenance, repair of valves and fittings;
- Training on the basis of design, production and trials of valves and fittings;
- Development and implementation of digital twins;
- Development of state-of-the-art advanced production facilities for production and testing of valves and fittings;
- Rendering technical assistance in equipping production facilities, purposed for production and testing of valves and fittings;
- Development of regulatory documents, norms, guidances, procedural and technological documents for development, production and testing of valves and fittings.

The production and scientific experience gathered by DB Armas and JSC SSTC, the high quality standards of designed and manufactured articles, as well as the availability of our own test and production facilities ensure reliable and long-term operation of manufactured valves and fittings on ships, vessels and in other industrial facilities. •

#### **HISTORY OF DB ARMAS:**

**1939** – Foundation of DB Armas, design of valves and fittings for heat power plants;

**1953** – Design of pipe valves and fittings for diesel electric submarines and surface ships;

**1966** – Design of pipe valves and fittings for nuclear-powered submarines and surface ships;

**1976** – Design of pipelines fittings for icebreakers, tankers and fishing vessels;

**1988** – Development of test procedures and design of test benches for inspection of valves and fittings;

**1991** – Development and design of new generation of pipelines fittings for the Navy and civil fleet;

**2010** – Development of projects for setting-up and modernization of specialized facilities for valves and fittings manufacturing;

**2019** – Development and design of axial control valves for civil marine equipment and oil industry;

**2020** – Development of projects for creation of digital twins of pipeline fittings and virtual test benches for inspection of the same.

#### **DB ARMAS TODAY:**

- 80 years of experience in development, design and manufacture
   of pipelines valves and fittings;
- 160 highly skilled employees;
- More than 20,000 developed types of valves and fittings;
- More than **70** developed standards;
- **4,800** m<sup>2</sup> of production facilities;
- More than **80** production machines;
- More than **10** test benches;
- Annual production rate of valves and fittings exceeds **2,500** pc.



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SIMBF 2020	Sevastopol, Crimea	October 6–7, 2020
INTERPOLITEX 2020	Moscow, VDNHExpo	October 20–23, 2020
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NAVITEKH	Russia, Moscow, Expocentre	November 2–6, 2020
SFITEX 2020	Saint-Petersburg, ExpoForum	November 10–12, 2020
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EDEX 2020	Egypt, Cairo	December 7–10, 2020
SAUDI INTERNATIONAL AIRSHOW	Riyadh, Kingdom of Saudi Arabia	February 16–18, 2021
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