US administration identifies Disruptive technologies, Doctrinal innovation and Nuclear modernization under Third Offset Strategy to sustain America's military dominance for the 21st century

In an Aug. 17 memorandum from Mick Mulvaney, director of the Office of Management and Budget, and Michael Kratsios, deputy assistant to the president in the Office of Science and Technology Policy, the Trump administration outlines its technology-related research and development priorities for fiscal year 2019.

It calls for Agencies to invest· in R&D that can support the military of the future, including in technologies related to the development of missile defense capabilities, a modern strategic deterrent, hypersonic weapons and defenses, autonomous and space-based systems, trusted microelectronics, and future computing capabilities.

"Agencies should invest in R&D to increase the security and resilience of the Nation's critical infrastructure from both physical threats and cyber-attacks, which have increased rapidly in number and complexity in recent years," the memo says. "Special attention should be paid to R&D that can support the safe and secure integration into society of new technologies that have the potential to contribute significantly to American economic and technological

leadership."

In November 2014, then–Secretary of Defense Chuck Hagel announced a new Defense Innovation Initiative, which included the Third Offset Strategy. Hagel said, "This new initiative is an ambitious department-wide effort to identify and invest in innovative ways to sustain and advance America's military dominance for the 21st century."

"Adversaries are devising ways to counter our technological over-match. So across the board, we see rapid developments in nuclear weapons, modernization of nuclear weapons; new anti-ship, anti-air missiles; long-range strike missiles; counter-space capabilities; cyber capabilities; electronic warfare capabilities; special operations capabilities that are operated at the lower end. All are designed to counter our traditional military strengths and our preferred way of operating," said Deputy Secretary of Defense Bob Work.

The US's first Offset strategy was recommended in the 1950's to counter Soviet conventional superiority with large increase in its nuclear weapons and their delivery systems like bombers, missiles and submarines to provide a credible deterrence even with reduced military budget. The Second Offset took shape in the 1970's when the US developed precision-guided weapons, night vision devices and stealth technology in response to the Soviet Union's nuclear parity.

Third Offset will leverage new technologies such as artificial intelligence, autonomous systems and human-machine networks to equalise advances made by the nations opponents in recent years. More than technology the third offset is about architectural innovations and massive changes in doctrine, operations, training and organization. Deputy Secretary of Defense Bob Work said "Offset is about operational and organizational constructs which are 'enabled' by new technology but not simply a matter of technology" during Air, Space & Cyber Conference.

Pentagon has dedicated $18 billion in its Future Years Defense Program (FYDP) to researching and developing third offset technologies and operational concepts in the years to come. Money allocated includes $3 billion on researching Anti-Area/Access-Denial (A2/AD) technologies, $3 billion on submarine and undersea challenges, $3 billion on human-machine collaboration and teaming, $1.7 billion on cyber and electronic warfare, $500 million on guided munitions challenges, and $500 million on wargaming and the testing of third offset operational concepts

Air Force Gen. Paul Selva, Vice Chairman of the Joint Chiefs of Staff, said his way of looking at the strategy "isn't an answer; it's a question," comparable to a journey rather than a destination. "But we have to ask the right questions" through experimentation to determine success or failure, then develop doctrine and distribute that doctrine across the joint force and share with allies, and keep refreshing it over time. An example of that would be long-range precision strike at volume across every domain from cyber to undersea, he added.

Nuclear Dimension and Russian counter strategy

President Donald Trump has added Nuclear dimension to Third offset by proposing to boost federal spending on the production of nuclear weapons by more than $1 billion in 2018. The federal spending increase by $1.4 billion for the National Nuclear Security Administration shall support refers to an existing effort to modernize three types of warheads, so they can be deployed with bombers, submarine-launched missiles, and land-based missiles, some of which will themselves be modernized in years to come.

US has developed super-fuze device that has resulted in vastly increase in nuclear targeting capability of the US submarine

force against hardened targets such as Russian ICBM silos. A decade ago, only about 20 percent of US submarine warheads had hard-target kill capability; today they all do. Russian planners will almost surely see the advance in fuzing capability as empowering an increasingly feasible US preemptive nuclear strike capability—a capability that would require Russia to undertake countermeasures that would further increase the already dangerously high readiness of Russian nuclear forces.

"Russian responses to counter these initiatives consist of two major elements: The first one is 'countering the Third Offset Strategy with the First Offset Strategy', which means prioritising the development of a wide array of both strategic and tactical nuclear weapons systems," wrote Michael Raska, a professor at IDSS, and Vasily Kashin, a senior research fellow in the Institute of Far Eastern Studies in the Russian Academy of Sciences.

The second element of the response strategy is more ambitious, and carries greater technological risks. Russia began to counter many U.S. technological initiatives via similar indigenous programs, although more narrowly focused and smaller in scale. In October 2012, Russia established the Advanced Research Foundation (ARF) – a counterpart to the U.S. DARPA. The ARF focuses on similar areas such as the Third Offset Strategy, including hypersonic vehicles, artificial intelligence, additive technologies, unmanned underwater vehicles, cognitive technologies, directed energy weapons, and others.

Third U.S. offset strategy

Deputy Secretary of Defense Bob Work said, "We don't face a single monolithic or implacable adversary like we did in the Cold War. We face multiple potential competitors, from small

regional states like North Korea and Iran, to large advanced states like Russia and China, to non-state adversaries and actors with advanced capabilities. Each of these are probably going to require a different approach and a different strategy, which is why we actually say “offset strategies.”

This offset strategy that we pursue in the Pacific is focused primarily on overcoming anti-access and area of denial network. As applied to Europe, for example, we’re probably going to have to have a high technology component as well as an innovative whole-of-government concept to counter the ambiguous hybrid threats we saw in Crimea and we continue to see in Ukraine today.

U.S. develops “super-fuze” under its Nuclear Force modernization

Under its Nuclear modernization program US has developed a “super-fuze” device that by making small adjustment to the height of warhead explosion results in revolutionary increase in lethality of U.S. submarine–launched ballistic missiles, according to the report in the 1 March issue of the Bulletin of the Atomic Scientists (BAS). The targeting change is part of the nuclear stockpile stewardship plan that began a decade ago and is aimed at maintaining the U.S. nuclear deterrent without the need to develop and test new weapons.

“Shortly before a warhead arrives at its target, the superfuze uses radar to gauge the distance remaining on the ballistic path, taking into account any drift off track. The old technology set the detonation at a fixed height at or near the ground; course errors could shift the center of the blast away from the target (see diagram). But the new system adjusts the detonation altitude so that the blast is triggered at a higher point to keep it in the target’s so-called “lethal volume.” Within this zone, the authors say, a 100-kiloton warhead will

destroy a hardened structure with 86% certainty". The public has "completely missed [the superfuze's] revolutionary impact on military capabilities," reports Eliot Marshall, a science journalist in Washington, D.C.

The BAS authors calculate that by the end of 2016, U.S. weapon facilities had already produced roughly 1200 of a planned 1600 W76s armed with the superfuze. Of these, they say, "about 506" are now deployed on ballistic missile submarines. They estimate that potentially 272 such warheads, with two sent against each target, could eliminate "all 136 Russian silo-based ICBMs [intercontinental ballistic missiles]." US submarine-based missiles can carry multiple warheads, so hundreds of others, now in storage, could be added to the submarine-based missile force, making it all the more lethal.

The increased capability of the US submarine force will likely be seen as even more threatening because Russia does not have a functioning space-based infrared early warning system but relies primarily on ground-based early warning radars to detect a US missile attack, writes Hans M. Kristensen director of the Nuclear Information Project with the Federation of American Scientists (FAS) in Washington, DC. Since these radars cannot see over the horizon, Russia has less than half as much early-warning time as the United States. (The United States has about 30 minutes, Russia 15 minutes or less.)

AFMC proposes Third Offset strategic plan for USAF

The Air Force Materiel Command (AFMC) has a devised a strategic plan to help carry the US Air Force (USAF) to Third Offset by developing the next-generation of operational

capabilities.

The strategic plan aims at increasing agility of AFMC support to the Air Force enterprise, driving cost-effectiveness into the capabilities. AFMC commander general Ellen Pawlikowski said. “The expertise in our centres and laboratories puts us in the perfect position to deliver Third Offset capabilities and this strategic plan is the bedrock of our road ahead.”

Army Acquisition Chief: Ground Combat Technology a Key Piece of Third Offset Strategy

Acting Assistant Secretary of the Army for Acquisition, Logistics and Technology Katrina McFarland, argued that the Army has a piece of this movement (third offset strategy). The categories in the strategy include: Autonomy, human systems and cognition, big data, quantum sciences and hypersonics. The Army community fits into each of those five categories, she said at the National Defense Industrial Association’s Chemical, Biological, Radiological and Nuclear Defense Conference.

“There has to be boots on the ground. So not matter what approach you take to a conflict, at some point you have to have a presence” and these five categories must be partnered with ground forces, she added. “We are looking at how autonomous systems can provide an extension to a soldier so that they can gather information on the battlefield without putting themselves in harm’s way,” she said. The Army wants to use big data to make effective decisions, she added. The amount of data coming at soldiers can be overwhelming and human cognition can help them sort it all out and make decisions faster. These categories address the need for speed on the battlefield, she said.

For the Army to be maneuverable and mobile, the logistics trail for equipment is a dynamic that must be taken into account, she said. “From the pack that the soldiers wears to the gear that the soldier operates, that equipment must be designed with this in mind.”

Often times called the “tooth to tail ratio,” it’s not just about money, she said. “In fact, I would probably pay more if I could be faster, more maneuverable, carry less and have a more effective outcome,” she added.

Work Outlines Key Steps in Third Offset Tech Development

Deputy Secretary of Defense Bob Work gave greater insight into five key points he is looking into over the next year:

Deep-Learning Systems

Autonomous “deep learning” machines and systems, which the Pentagon wants to use to improve early warning of events in cyber defense, electronic warfare attacks and large-density missile raids when human reactions just aren’t fast enough. As an example, Work pointed to the influx of “little green men” from Russia into Ukraine as simply a big data problem that could be crunched to predict what was about to happen. A deep-learning system might be able to analyze 90,000 Facebook post made by ISIL in one day, crunch that data and find patterns from it, pulling out what might be of use.

The Defense Advanced Research Projects Agency is also working on two programs, Adaptive Radar Countermeasures and Behavioral Learning for Adaptive Electronic Warfare. The aim is to enable U.S. airborne EW systems to automatically generate effective countermeasures against new, unknown and adaptive radars in

real-time in the field.

Human-machine collaboration

Human-machine collaboration, specifically the ways machines can help humans with decision-making. This teams up human insight with the tactical acuity of computers by allowing machines to help humans make better, faster decisions. Pairing the two will combine the ability of humans to think on the fly with the quick problem-solving methods of artificial intelligence. Work pointed to the advanced helmet on the F-35 joint strike fighter, which fuses data from multiple systems into one layout for the pilot.

Assisted-human operations

Assisted-human operations, or ways machines can make the human operate more effectively – think park assist on a car, or the experimental "Iron Man" exoskeleton suit DARPA has been experimenting with. At the Air Force Research Lab, they're perfecting skin biosensors that look and feel like a Bandaid, except they're equipped to read all sorts of data, like your heart rate, hydration and other vital signs. Work was careful here to differentiate between this point and what he called "enhanced human operations," for which he did not offer an example, but warned "our adversaries are pursuing [enhanced human operations] and it scares the crap out of us, frankly."

Advanced human-machine teaming

Advanced human-machine teaming, where a human is working with an unmanned system. This is already going on with the Army's Apache helicopter and Gray Eagle Unmanned Aerial Vehicle, and the Navy's P-8 aircraft and Triton UAV.

There are also swarming UAV's like the Perdix mini-drone, which has a 3D-printed airframe and electronics made from cellphones. Only about a foot long, the Perdix can be launched from an unmanned aircraft and fly in close proximity to several identical drones, communicating with them to complete a mission. "We're actively looking at a large number of very, very advanced things," Work said, including swarms of unmanned systems. While the above collaboration helps humans make better decisions, human-machine combat teaming actually works with the unmanned systems to perform operations.

Semi-autonomous weapons

Semi-autonomous weapons that are hardened to operate in an electronic warfare environment. Work has been raising the alarm for the past year about weapons needing to be hardened against such attacks, for example, the DoD is modifying existing systems, like the small-diameter bomb, to operate completely without GPS if an enemy is somehow able to deny it service.

The deputy also was up front about why he, and others at the Pentagon, have been talking openly about the technologies it is looking at, citing it as part of the conventional deterrence strategy against near-peer competitors. "We will reveal to deter and conceal for war-fighting advantage. I want our competitors to wonder what's behind the black curtain," Work said.

DARPA and Third offset strategy

"Fundamentally, what's behind the push of the Third Offset Strategy is this idea that the department needs to reinvigorate our ability to develop these advanced technologies," Prabhakar said. "If we do that at the same old

pace in the same old way, there's a strong recognition that we're just not going to get there." Instead of such custom-tailored, tightly integrated systems, you want a modular and open architecture where you can easily replace a component – hardware or software – without disrupting the rest of the system.

Instead of a relatively small number of pricey manned platforms, you want a "heterogeneous" mix of manned and unmanned vehicles of all kinds, from 130-foot robotic ships to disposable handheld drones. Instead of architectures designed for a specific kind and size of force, you want systems that can scale up and down as the force changes.

And instead of brittle networks dependent on a few means of transmission and a few central nodes, you want a highly distributed network that stays up despite physical attack, jamming, and hacking. A project called HACMS – High Assurance Cyber Military Systems – applies a class of mathematics called "formal methods" to finding and closing cyber vulnerabilities. DARPA's also applying new methods to the old problem of electronic warfare. To keep up with these ever-mutating signals, "cognitive electronic warfare" aims to use artificial intelligence to detect, catalog, and counter transmissions in real time.

"There's this powerful new wave that's happening today in AI," she continued, and the Pentagon needs to exploit it. DARPA already has some programs tackling this problem, Prabhakar said, but "you'll see more, I think, in that area as we start developing this next foundation for AI."

DARPA seeks ideas and disruptive technologies

A recent announcement by the Defense Advanced Research

Projects Agency seeks ideas and disruptive technologies related to Battle Management, Command and Control (BMC2), Communications and Networks, Electronic Warfare, Intelligence, Surveillance, and Reconnaissance (ISR), Position, Navigation, and Timing (PNT), Maritime, and Foundational Strategic Technologies and Systems.

The subject areas are ones that fit within the department's third offset strategy, which is aimed at maintaining the United States' military technological superiority.

Battle Management, Command and Control (BMC2)

Warfare is increasingly conducted by networks of platforms, weapons, sensors, and EW systems. The BMC2 of such networks poses complex algorithmic and software challenges, particularly with intermittent connectivity, limited data rates, and robustness against network disruption from electronic and physical attack.

Of particular interest are BMC2 technologies and systems for mixtures of manned and unmanned systems. Efforts in this area should develop and incorporate realistic assumptions concerning allocation of functions between human operators and automated systems.

Communications and Networks

The success of military operations depends on assured, secure, communications at every military echelon, from the continental U.S. to the forward-deployed warfighter. DARPA seeks system concepts and enabling technologies that will provide assured high-capacity mobile communication capabilities in space, air, ground, sea surface, and underwater environments.

This will include systems with and without access to

infrastructure. The goal is delivering relevant and timely information to the warfighter anytime and anywhere while denying the same capabilities to our adversaries. Approaches to this goal include developing new system concepts and technologies that: improve network availability; increase network capacity and scaling; enable tolerance to network degradation; mitigate extremely high levels of man-made and natural electromagnetic interference; defeat network and RF exploitation techniques; and counter denial of service techniques.

Approaches that can potentially mitigate emerging threats exploiting commercially-leveraged technologies are also desired. DARPA is interested in approaches that leverage commercial infrastructure when it is available as well as and those that leverage the capabilities and cost efficiencies of commercial devices, components, processes and applications. These commercial leveraging approaches will need to consider the reliability, robustness, and security of commercial infrastructure, devices, and applications in a military environment. Also of interest are approaches and technologies for preventing or disrupting the adversary’s capability for assured communications.

Of special interest are: approaches for greater spectrum efficiency in complex RF environments; new spectrum use technologies such as dynamic use of space/time, as well as access to new modalities, such as high frequency Radio Frequency (RF) and optical polarization; intra- and cross-modality (radar, communications, and sensing) spectrum access techniques; spatial reuse through higher frequency operations; interference avoidance and tolerance; and large-scale testing of complex RF environments.

Electronic Warfare

The proliferation of highly capable RF technology has created a new emphasis on positive control of the electromagnetic (EM) spectrum. Many adversaries are increasing their reliance on RF sensing and communications in order to provide significant improvements to their offensive and defensive systems. This includes short-range tactical communications, long-range C2 communications networks, networked defensive systems, and RF seekers.

DARPA is looking for system approaches for active and passive EW techniques in order to counter these advanced networked and agile systems using technologies such as distributed systems, coherent systems, disposable systems providing asymmetric capabilities, and close-in remote sensing coupled with advanced jamming and spoofing.

Strategic Technologies

The EW capabilities that the U.S. military will encounter are also becoming much more sophisticated. Many advanced capabilities that were only available for use by the U.S. military are now available to be used against U.S. military systems. The commercial investments in RF materials, components, and subsystems are immense and the cost threshold to deploy high power, agile systems continues to drop.

DARPA is seeking systems concepts and advanced technologies that provide the US military fundamental asymmetries to address these new capabilities. These can include concepts using physical and network solutions, distributed systems, as well as exploitation of precise spectral, time, and position information.

Intelligence, Surveillance, and Reconnaissance (ISR)

The U.S. military has become accustomed to collecting large quantities of ISR data in permissive environments, such as recent operations in Iraq and Afghanistan, and in processing and exploiting this information with ground-based exploitation and C2 centers. However, in contested environments, new approaches are needed to provide survivable, standoff sensing that is difficult for adversaries to detect, exploit and counter.

DARPA is seeking new, innovative methods for finding difficult targets in contested environments that could include combining existing or new sensor modalities, novel in-sensor Automatic Target Recognition (ATR) techniques, new algorithms, and new system concepts and processing techniques.

DARPA is also interested in new approaches for the design of low-cost, adaptable sensors that leverage commercial technologies and processes to reduce development time and cost, and increase adaptability and technology refresh rate of sensor systems. As other nations develop and acquire increasingly sophisticated ISR and counter ISR capabilities, new approaches and technology will be required to protect and preserve a superior U.S. ISR capability in all strategic environments. DARPA is interested in innovative technology and approaches that can potentially provide U.S. warfighters with superior ISR and situational awareness while denying the same capability to our adversaries.

Position, Navigation, and Timing (PNT)

The U.S. military has become increasingly dependent on the Global Positioning System (GPS) for accurate and precise position, navigation, and timing in a wide variety of operational environments. However, as U.S. military operations are increasingly being carried out in areas where GPS is denied, unreliable, or not accessible, military use of GPS has

evolved from strategic advantage to vulnerability. GPS access can now be readily blocked by jamming or environmental conditions.

Many environments in which our military operates (under heavy foliage, underground, underwater, in buildings, and in cities) have limited or even no access to GPS. In addition, evolving mission requirements for EW, communications, and cooperative effects are challenging the limits of state-of-the-art clocks used in military systems. Current system solutions for providing accurate and precise position, navigation and timing in GPS denied environments are costly, inflexible, and often need an external fix that requires intermittent access to GPS. DARPA is seeking new technology and systems solutions to provide the U.S. military with accurate and precise PNT independent of GPS

Strategic Technologies communications, and cooperative effects.

Technologies of interest include architectures for ad hoc PNT networks of disparate nodes; sensors and signal processing to enable PNT in adverse environments; and new architectures that enable other domains, such as communications, EW, and ISR systems, to inherently support PNT systems. In addition, technologies that enable affordable, compact, and flexible system solutions that can quickly and easily be reconfigured to meet the PNT needs for a broad range of military missions and platforms continue to be of interest.

Maritime

DARPA is interested in innovative ideas for maritime networked operations in contested environments. Maritime networked systems must provide cost leverage and a high degree of

adaptability to address new threats or missions. Ubiquitous, survivable communications and networking concepts that are extendable throughout the subsurface, surface and air domains are of interest. Innovative ideas in ubiquitous communications and networking for the undersea domain are especially important to the integration of operations.

DARPA is interested in developing system-of-systems methodologies to help maintain and enhance U.S. maritime superiority using distributed and disaggregated systems as force multipliers for scarce capital assets. This includes simulation tools to assess feasibility and conduct system trades in a mission context. Feasibility and affordability of these systems requires efficient and survivable delivery methods for off-board assets – network elements, sensors and effects packages – and novel delivery approaches are of interest. DARPA is interested in the use of autonomy at the end nodes and management tools at the network level to reduce the operator burden for these systems.

Foundational Strategic Technologies and Systems

DARPA is seeking innovative ideas for systems and systems-of-systems incorporating disruptive technologies that offer significant potential capability improvement across multiple Strategic Technology Office focus areas as described above. This could include technologies that would enable dramatic reduction in size, weight, power, or cost of systems, technologies that allow for adaptability and/or rapid refresh, technologies that offer the potential for significant advances in system level performance, and approaches to demonstrating the military utility of these systems and technologies.

This can include aperture, components, hardware, firmware, software or power mechanisms to reduce size, weight, power, cost, enable multiple modes, simplify porting of signal

processing waveforms and capabilities amongst multiple platforms with varying constraints, means to manage and control modes of operation, and or means to collect performance information from multiple networks

The articles sources also include:

- http://www.nationaldefensemagazine.org/blog/Lists/Posts/Post.aspx?ID=2265
- http://www.dodlive.mil/index.php/2016/03/3rd-offset-strategy-101-what-it-is-what-the-tech-focuses-are/
- https://news.usni.org/2016/10/28/officials-third-offset-strategy-key-maintaining-u-s-military-technology-dominance
- https://www.usnews.com/opinion/world-report/articles/2017-02-27/key-to-defense-departments-third-offense-is-use-of-military-technology
- http://www.rsis.edu.sg/rsis-publication/idss/countering-the-u-s-third-offset-strategy-russian-perspectives-responses-and-challenges/#.WM5cLfmGM2z
- http://www.rsis.edu.sg/rsis-publication/idss/countering-the-u-s-third-offset-strategy-russian-perspectives-responses-and-challenges/#.WM5hSPmGM2z
- http://www.sciencemag.org/news/2017/03/more-precise-us-nukes-could-raise-tensions-russia
- http://thebulletin.org/how-us-nuclear-force-modernization-undermining-strategic-stability-burst-height-compensating-super10578
- https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2017/m-17-30.pdf