Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Defense Advanced Research Projects Agency	Date: May 2017
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	-	289.371	313.843	343.776	-	343.776	363.482	369.687	388.716	390.376	-	-
TT-03: *NAVAL WARFARE TECHNOLOGY*	-	52.948	43.024	33.544	-	33.544	41.765	34.451	23.451	41.451	-	-
TT-04: *ADVANCED LAND SYSTEMS TECHNOLOGY*	-	61.041	52.847	92.675	-	92.675	91.503	99.283	129.283	111.283	-	-
TT-06: *ADVANCED TACTICAL TECHNOLOGY*	-	10.912	6.500	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
TT-07: *AERONAUTICS TECHNOLOGY*	-	36.009	62.876	67.378	-	67.378	67.518	62.528	49.528	49.528	-	-
TT-13: *INFORMATION ANALYTICS TECHNOLOGY*	-	128.461	148.596	150.179	-	150.179	162.696	173.425	186.454	188.114	-	-

A. Mission Description and Budget Item Justification

This program element is budgeted in the Applied Research Budget Activity because it supports the advancement of concepts and technologies to enhance the next generation of tactical systems. The Tactical Technology program element funds a number of projects in the areas of Naval Warfare, Advanced Land Systems, Advanced Tactical Technology, Aeronautics Technology and Network Centric Enabling Technology.

The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. Enabling and novel technologies include concepts for expanding the envelope of operational naval capabilities such as improved situational awareness over large maritime environments, ship self-defense techniques, novel underwater propulsion modalities, high speed underwater vessels, improved techniques for underwater object detection and discrimination, long endurance unmanned surface vehicles, and high bandwidth communications.

The Advanced Land Systems Technology project is developing technologies for enhancing U.S. military effectiveness and survivability in operations ranging from traditional threats to military operations against irregular forces that can employ disruptive or catastrophic capabilities, or disrupt stabilization operations. The emphasis is on developing affordable technologies that will enhance the military's effectiveness while decreasing the exposure of U.S. or allied forces to enemy fire. This project will also explore novel design technologies for the manufacture of ground vehicles and new tools for systems assessments of emerging DARPA technologies.

The Advanced Tactical Technology project focuses on broad technology areas including compact, efficient, frequency-agile, diode-pumped, solid-state lasers for infrared countermeasures, laser radar, holographic laser sensors, communications, and high-power laser applications.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Defense Advanced Research Projects Agency	Date: May 2017
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*

Aeronautics Technology efforts will address high payoff opportunities that dramatically reduce costs associated with advanced aeronautical systems and/or provide revolutionary new system capabilities for satisfying current and projected military mission requirements. This includes advanced technology studies of revolutionary propulsion and vehicle concepts, sophisticated fabrication methods, and examination of novel materials for aeronautic system applications.

The Information Analytics Technology project develops applications for analyzing data and information arising from: 1) intelligence networks; 2) open and other external sources; 3) sensors and signal/image processors; and 4) collection platforms and weapon systems. Technical challenges include the need to process huge volumes of diverse, incomplete, and uncertain data in tactically-relevant timeframes. Efforts address problems related to conditioning of unstructured data, content analysis, behavioral modeling, pattern-of-life characterization, economic activity analysis, social network analysis, anomaly detection, and visualization. Operational benefits include deeper understanding of the evolving operational environment tailored to the needs of commanders at every echelon. Promising technologies are evaluated in the laboratory and demonstrated in the field to facilitate transition.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	302.582	313.843	381.964	-	381.964
Current President's Budget	289.371	313.843	343.776	-	343.776
Total Adjustments	-13.211	0.000	-38.188	-	-38.188
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-3.575	0.000			
• SBIR/STTR Transfer	-9.636	0.000			
• TotalOtherAdjustments	-	-	-38.188	-	-38.188

Change Summary Explanation

FY 2016: Decrease reflects reprogrammings and the SBIR/STTR transfer.
FY 2017: N/A
FY 2018: Decrease reflects rephasing of several Naval Warfare Technology and Aeronautics Technology programs.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency			Date: May 2017
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-03 / *NAVAL WARFARE TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
TT-03: *NAVAL WARFARE TECHNOLOGY*	-	52.948	43.024	33.544	-	33.544	41.765	34.451	23.451	41.451	-	-

A. Mission Description and Budget Item Justification

The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. Enabling and novel technologies include concepts for expanding the envelope of operational naval capabilities such as improved situational awareness over large maritime environments, ship self-defense techniques, novel underwater propulsion modalities, vessels for estuary and riverine operations, high speed underwater vessels, improved techniques for underwater object detection and discrimination, long endurance unmanned surface vehicles, and high bandwidth communications.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Multi-Azimuth Defense Fast Intercept Round Engagement System (MAD-FIRES)	31.845	32.024	33.544

Description: The Multi-Azimuth Defense Fast Intercept Round Engagement (MAD-FIRES) program seeks to develop a point defense system against today's most stressing threats by developing a highly maneuverable, medium caliber, guided projectile, fire sequencing and control system capable of neutralizing large threat raids of high speed, highly maneuverable targets. Leveraging recent advancements in gun hardening, miniaturization of guided munition components, and long range sensors, MAD-FIRES will advance fire control technologies, medium caliber gun technologies, and guided projectile technologies enabling the multiple, simultaneous target kinetic engagement mission at greatly reduced costs. MAD-FIRES seeks to achieve lethality overmatch through accuracy rather than size, thus expanding the role of smaller combat platforms into missions where they have been traditionally outgunned. MAD-FIRES, sized as a medium caliber system, enhances flexibility for installment as a new system and as an upgrade to existing gun systems with applications to various domain platforms across a multitude of missions to include: ship self-defense, precision air to ground combat, precision ground to ground combat, counter unmanned air vehicles (C-UAV), and counter rocket and artillery and mortar (C-RAM).

FY 2016 Accomplishments:
- Determined Point of Departure (POD) designs.
- Completed end-to-end modeling and simulation of POD designs.
- Began risk reduction tests and prototyping.
- Updated models and simulations as designs were modified.
- Conducted risk reduction subsystem tests to verify gun hardening and performance.
- Performed wind tunnel tests to validate aerodynamic models and air gun test to verify gun-launch.

FY 2017 Plans:
- Update models and simulations of select designs.
- Complete preliminary prototype design.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-03 / *NAVAL WARFARE TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Mature electronics packaging through design and subsystem validation. - Conduct gun launch and fire solid rocket motors to validate projectile kinematic performance. - Perform initial controlled projectile flight tests to assess projectile maneuver performance. ***FY 2018 Plans:*** - Finalize designs for major subcomponents. - Demonstrate gun survivability for all up projectile. - Conduct ballistic and controlled test vehicle flights. - Apply lessons learned from flight tests to maturing design.			
Title: Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV)	6.840	6.000	-
Description: The Anti-Submarine Warfare (ASW) Continuous Trail Unmanned Vessel (ACTUV) program has three primary goals: (1) to build and demonstrate an experimental unmanned vessel with beyond state-of-the-art platform performance based on clean sheet design for unmanned operation; (2) demonstrate the technical viability of operating autonomous unmanned craft at theater or global ranges, from forward operating bases, under a sparse remote supervisory control model; and (3) leverage unique ACTUV characteristics to transition a game changing ASW capability to the Navy. By establishing the premise that a human is never intended to step on board at any point in the operational cycle, ACTUV concepts can take advantage of an unexplored design space that eliminates or modifies conventional manned ship design constraints in order to achieve disproportionate speed, endurance, and payload fraction. The resulting unmanned naval vessels must possess sufficient situational awareness and autonomous behavior capability to operate in full compliance with the rules of the road and maritime law to support safe navigation for operational deployments spanning thousands of miles and months of time. When coupled with innovative sensor technologies, the ACTUV system provides a low cost unmanned system with a fundamentally different operational risk calculus that enables game changing capability to detect and track even the quietest diesel electric submarine threats. Key technical areas include unmanned naval vessel design methodologies, ship system reliability, high fidelity sensor fusion to provide an accurate world model for autonomous operation, novel application of sensors for ASW tracking, and holistic system integration due to unique optimization opportunities of the ACTUV system. ***FY 2016 Accomplishments:*** - Completed construction of prototype vessel. - Initiated at-sea testing to validate baseline performance of vessel, sensor systems, and autonomy. - Moved the vessel from the contractor facility to a Navy facility in San Diego for long term testing with the Office of Naval Research (ONR). - Demonstrated improved situational awareness and autonomy capabilities, incorporating advanced above water sensors. - Demonstrated the ability to successfully integrate a new mission payload, Towed Airborne Lift of Naval Systems (TALONS). ***FY 2017 Plans:***			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-03 / *NAVAL WARFARE TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Demonstrate the ability to successfully integrate new mission payloads, including a Mine Counter Measures (MCM) payload and a Mechanically Uncoupled Stereo (MUSE) camera system. - Continue vessel at-sea testing, including tactical exercises with fleet units. - Continue testing of new payloads for MCM, ASW, and other missions. - Transition custody of prototype vessel to the Navy (ONR).			
Title: Upward Falling Payloads (UFP) ***Description:*** The goal of the Upward Falling Payloads (UFP) program is to develop forward-deployed unmanned distributed systems that could provide non-lethal effects or situational awareness over large maritime environments. Building upon and complimenting concepts for maritime situational awareness and Intelligence, Surveillance and Reconnaissance (ISR) developed under the DASH program, budgeted in PE 0603766E, Project NET-02, the UFP approach centers on pre-deploying deep-ocean nodes years in advance in forward operating areas which could be commanded from standoff to launch to the surface. ***FY 2016 Accomplishments:*** - Developed and demonstrated scalable riser prototype with launch of payload surrogate from surfaced riser. - Demonstrated deep-ocean, short-duration submergence of full-scale riser prototype followed by triggered release and ascent to surface. - Demonstrated long-range acoustic communications sufficient to wake up a UFP node. - Developed and analyzed hardware interface and long range acoustic communications for triggered release of riser from existing undersea cable. ***FY 2017 Plans:*** - Complete analysis of long range underwater acoustic communications test data for triggering riser.	14.263	5.000	-
Accomplishments/Planned Programs Subtotals	52.948	43.024	33.544

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
• ACTUV: *Office of Naval Research MOA*	7.340	8.807	3.917	-	3.917	0.000	0.000	0.000	0.000	-	-

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-03 / *NAVAL WARFARE TECHNOLOGY*

E. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency			Date: May 2017
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
TT-04: *ADVANCED LAND SYSTEMS TECHNOLOGY*	-	61.041	52.847	92.675	-	92.675	91.503	99.283	129.283	111.283	-	-

A. Mission Description and Budget Item Justification

This project is developing technologies for enhancing U.S. military effectiveness and survivability in operations ranging from traditional threats to military operations against irregular forces that can employ disruptive or catastrophic capabilities, or disrupt stabilization operations. The emphasis is on developing affordable technologies that will enhance the military's effectiveness while decreasing the exposure of U.S. or allied forces to enemy fire. This project will also explore novel design technologies for the manufacture of ground vehicles and new tools for systems assessments of emerging DARPA technologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Squad X	38.600	31.410	36.675

Description: The U.S. military achieves overmatch against its adversaries in certain regimes; however, this level of overmatch is not enjoyed at the squad to individual dismounted warfighter level. The goal of the Squad X program is to leverage advances in real-time situational awareness and mission command; organic three-dimensional dismount mobility; extended range tracking, targeting, and response; and unmanned mobility and perception in order to create a squad with substantial combat overmatch. The concept of overmatch at the squad level includes increased human stand-off, a smaller force density, and adaptive sensing to allow for responses at multiple scales. Squad X will explore advanced wearable force protection, advanced organic squad level direct and indirect trajectory precision weaponry, and non-kinetic precision capabilities. The end result of the Squad X program is an individual dismount unit outfitted with sensors, weaponry, and supporting technology to achieve unit level overmatch as well as the overall integration of unmanned assets alongside the dismounts to create an advanced, dismounted small unit.

FY 2016 Accomplishments:
- Completed systems architecture, technology evaluation, and experimentation trade studies.
- Completed Squad X Baseline experimentation, through live experimentation, to obtain a system performance baseline for a currently-equipped, U.S. Army rifle squad.
- Refined technology development efforts focusing on squad precision effects, non-kinetic engagement, enhanced sensor fusion and exploitation, and squad collaborative autonomy.
- Matured modeling and simulation environment to improve representation of tactics and operational realism in order to allow for an overarching iterative design process and squad system performance estimation.
- Leveraged Squad X testbed and simulation environments to iteratively assess developed technology and architecture schemes.
- Demonstrated initial individual technology capabilities in technology assessments.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Concluded Tactical Edge Standards Boards. ***FY 2017 Plans:*** - Leverage Squad X testbed and simulation environments to iteratively assess developed technology and architecture schemes. - Leverage virtual testbed to provide predictions of system performance in multiple operational conditions. - Initiate planning for system-level experimentation and evaluation in relevant conditions with operational units. - Demonstrate through live experimentation individual technology capabilities for squad precision effects, non-kinetic engagement, enhanced sensor fusion and exploitation, and squad collaborative autonomy in simulated operational environments. - Initiate technology development efforts focusing on human machine interfaces, the squad common operating picture, and the synchronization of kinetic and non-kinetic engagement capabilities. - Initiate squad-system development efforts focusing on automatic systems to increase squad performance and the integration of previously developed technologies to enhance dismounted operations. ***FY 2018 Plans:*** - Complete virtual testbed development and utilize testbed to support system-level experimentation and evaluation. - Demonstrate and complete development of individual technology capabilities for squad precision effects, non-kinetic engagement, enhanced sensor fusion and exploitation, and squad collaborative autonomy in simulated operational environments. - Continue technology development efforts focusing on human machine interfaces, the squad common operating picture, and the synchronization of kinetic and non-kinetic engagement capabilities. - Continue squad-system development efforts focusing on an automatic, augmenting system to increase squad performance and the integration of previously developed technology to enhance dismounted operations. - Conduct system-level experimentation and evaluation in relevant conditions with operational units.			
Title: Mobile Infantry (MI) ***Description:*** The Mobile Infantry (MI) program will explore the development of a system-based, mixed team of mounted/ dismounted warfighters, and semi-autonomous variants of platforms. The MI system concept will allow for a combined set of mounted and dismounted operations and for a larger area of operations over more aggressive timelines than standard infantry units. To improve operational effectiveness of the warfighter teams when dismounted, the semi-autonomous platforms, when unmanned, act as multipliers to the squad, such as extended and mobile fire support platforms and allow the MI mixed teams to perform higher risk exposure and access missions. ***FY 2016 Accomplishments:*** - Completed trades of mission/vignette-driven collaborative command and control of a MI unit composed of a warfighter team and semi-autonomous systems. - Completed trade studies and initial estimates of perception and autonomous algorithms required to match vignettes.	4.541	4.000	5.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Completed trade studies of candidate platforms and options for conversion, system integration, interfaces (electrical, mechanical, software, etc.), and define preliminary warfighter architectures to leverage. ***FY 2017 Plans:*** - Initiate technology development efforts for critical perception and autonomous algorithms to enable semi-autonomous systems to act as force multipliers for warfighter team. - Initiate technology development efforts for critical collaborative behavior algorithms to enable semi-autonomous systems to cooperatively execute missions without human interaction. - Initiate technology development efforts for critical technologies to enable effective command and control of manned and unmanned warfighter team. ***FY 2018 Plans:*** - Continue technology development efforts for critical perception and autonomous algorithms to enable semi-autonomous systems to act as force multipliers for warfighter team. - Continue technology development efforts for critical collaborative behavior algorithms to enable semi-autonomous systems to cooperatively execute missions without human interaction. - Continue technology development efforts for critical technologies to enable effective command and control of manned and unmanned warfighter team. - Evaluate integrated technologies in relevant environments with single vehicle and section-level experiments.			
Title: Mobile Force Protection (MFP) ***Description:*** *Previously Counter Unmanned Air System (C-UAS) and Force Protection (CFP) The goal of the Mobile Force Protection (MFP) program is to develop and demonstrate an integrated system capable of defeating a raid of self-guided small unmanned aircraft (sUAS) attacking a high value convoy on the move. By focusing on protecting mobile assets, the program will emphasize low footprint solutions, in terms of size, weight, power (SWaP), and manning, which will benefit other counter UAS missions and result in more affordable systems. Defending in a variety of operating environments against these sUAS threats and associated concept of operations requires several breakthroughs in affordable technology to Sense, Decide and Act on a compressed timeline while mitigating collateral damage. The program seeks to develop solutions applicable to the defense of mobile ground and naval forces that can also potentially defeat more conventional threats. The solution will be scalable and modular such that it can be deployed in multiple defense applications and does not become obsolete with evolving threat capability. ***FY 2017 Plans:*** - Define system level requirements, and conduct trade studies.	-	12.400	31.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Develop interfaces with the program mandated government owned open architecture (GOOA). - Conduct affordability and cost analysis. - Complete system conceptual designs. - Integrate early system implementation able to protect a fixed site from a small raid of multiple Radio Controlled UASs via non-kinetic neutralization techniques. ***FY 2018 Plans:*** - Conduct open air demonstration that will include realistic threats, performance models, signatures, networks, and environmental factors. - Perform modeling, simulation, and lab demonstrations to evaluate advanced algorithms and sub-systems for integration. - Modify the end-to-end system to enable rapid relocation by reducing size, weight and power. - Develop new interfaces and integrate novel algorithms in the GOOA to reduce manning, false alarm rate, and reaction time. - Update affordability and cost analysis.			
Title: Precision Light Strike Munition (PLSM) ***Description:*** The Precision Light Strike Munition (PLSM) program will seek to develop a small, lightweight, shoulder-launched, guided missile weapon for the individual warfighter. Current short-range weapons are used against a variety of target sets using different munitions and launchers without the benefit of active guidance. Current long-range weapons in support of dismounted operations are highly effective against a specific target set at range, but come with a heavy physical burden, high cost per shot/ procurement cost, and often require teams of operators (sometimes dedicated) for employment. The program goal is to improve on the existing, lightweight unguided missile systems by increasing range, accuracy, and lethality, while reducing cost. The program will also explore improvement of existing platform gun systems by leveraging advances in miniaturization, precision guidance and warheads. PLSM seeks to take advantage of commercial technologies to provide a low-cost, multi-use, and multi-function precision engagement capability. The PLSM program could significantly increase the combat power of small units with reduced physical burden, while significantly reducing cost relative to near-peer and peer adversaries. ***FY 2018 Plans:*** - Complete trade studies, evaluate concepts and performance metrics, and complete simulations for the most promising concept(s). - Initiate development efforts for high-risk and high-impact component technologies. - Initiate system-level design and development efforts.	-	-	10.000
Title: Urban Operations ***Description:*** The goal of the Urban Operations program is to generate capabilities which would allow distributed forces to operate effectively in dense urban areas (e.g. megacities). Enabling capabilities would focus on enhanced tactical situational	-	-	10.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-04 / *ADVANCED LAND SYSTEMS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
awareness, precise control of destructive and non-destructive effects, network operability and resilience, cyber- and electronic warfare robustness, freedom of movement, and agile logistic sustainment. The Urban Operations system would encompass sub-system and platform technologies supporting tactical mobility, operational endurance, precision effects, extensive command and control, and enhanced protection for ground forces across the range of conflicts in highly populated, densely built-up areas. Key operational functions and mission capabilities would make significant use of unmanned and autonomous systems. ***FY 2018 Plans:*** - Identify critical operational needs, tactical and environmental issues and key measures of effectiveness. - Conduct trade space analysis and develop overall system architecture. - Identify and begin development of foundational component technologies. - Develop system and command and control (C2) concepts of operation/employment (CONOPS/CONEMPS).			
Title: Ground Experimental Vehicle (GXV)	17.900	5.037	-
Description: The goal of the Ground Experimental Vehicle (GXV) program is to investigate ground vehicle technologies that enable crew/vehicle survivability through means other than traditional heavy passive armor solutions. This will be accomplished through research and development of novel ground combat and tactical vehicle technology solutions that demonstrate significantly advanced platform mobility, agility, and survivability. The focus of the GXV program will be on technology development across multiple areas to simultaneously improve military ground vehicle survivability and mobility. Traditionally, survivability and mobility have to be traded against each other due to the reliance on heavy armor. The GXV program seeks to break this trend. Coupled with the development of technologies, the GXV program will define concept vehicles which showcase these developmental technologies. A modeling and simulation effort will also be undertaken to understand the vehicle design trade space for the concept vehicles using the developmental technologies and to illustrate how these vehicles might be used operationally in combat scenarios. Technology development areas are likely to include increasing vehicle tactical mobility, survivability through agility, and crew augmentation, though other relevant technologies may also be pursued. ***FY 2016 Accomplishments:*** - Continued GXV technology development efforts focused on increasing mobility, survivability through agility and crew augmentation. - Matured parametric models for evaluating military utility of technologies. - Completed studies focusing on system trades relating to system power requirements, size/caliber of weapon systems, and crew size. - Initiated studies focusing on the impact of crew augmentation capabilities on the size and cognitive workload of combat vehicle crews.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Conducted survivability analysis of individual concepts. ***FY 2017 Plans:*** - Complete development of parametric models for evaluating military utility of technologies. - Complete studies focusing on the impact of crew augmentation capabilities on the size and cognitive workload of combat vehicle crews. - Complete additional survivability analyses of individual concepts. - Complete GXV technology development efforts focused on increasing mobility and survivability through agility and crew augmentation.			
Accomplishments/Planned Programs Subtotals	61.041	52.847	92.675

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency			Date: May 2017
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-06 / *ADVANCED TACTICAL TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
TT-06: *ADVANCED TACTICAL TECHNOLOGY*	-	10.912	6.500	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This project focuses on broad technology areas including compact, efficient, frequency-agile, diode-pumped, solid-state lasers for a variety of applications including infrared countermeasures, laser radar, holographic laser sensors, chemical sensing, communications, and high-power laser applications.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Laser Ultraviolet Sources for Tactical Efficient Raman (LUSTER)	8.000	6.500	-
Description: The Laser Ultraviolet Sources for Tactical Efficient Raman (LUSTER) program is developing a compact laser suitable for a wide array of DoD applications, such as sensing the presence of chemical agents. The program aims to develop a semiconductor laser that emits deep ultraviolet (UV) radiation with high efficiency, high laser purity, and an output power over one watt. This would represent a significant advance over the state of the art, since existing deep UV lasers are bulky, highly inefficient, and expensive. Semiconductor lasers, on the other hand, benefit from low-costs, established manufacturing processes, compact size, and unique electro-optical performance capabilities. ***FY 2016 Accomplishments:*** - Optimized laser epitaxial material, electron-beam source, and frequency multiplying nonlinear crystals for higher efficiency and high power operation. - Developed compact low power electronics for driving and controlling photonic and mechanical components. - Demonstrated first electrically injected UV light-emitting diode (LED) at 237nm. - Demonstrated record UV emission of 213mW from an electron-beam pumped semiconductor chip. - Demonstrated record output power of >2W from a Gallium Nitride based tapered amplifier blue laser. ***FY 2017 Plans:*** - Demonstrate bench top deep UV laser system that meets final metrics of > 100 mW output power, >4% efficiency, and line width <0.1 nm. - Demonstrate a path to meeting the Phase 2 metrics of > 1 W output power, 10% total system efficiency, line width less than 0.01 nm and size < 2 in^3.			
Title: Endurance	2.912	-	-
Description: The Endurance program developed laser technology to protect airborne platforms from emerging and legacy electro-optical/infrared (EO/IR) guided surface-to-air missiles. The Endurance system planned to have an open architecture, granting the flexibility to integrate different subsystems with varying capabilities. Endurance is an early application of technology			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-06 / *ADVANCED TACTICAL TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
developed through DARPA's Excalibur program and plans to transition to the Services. The applied research portion of the program focused on miniaturizing the component laser technologies, developing high-precision target identification and tracking, and making a lightweight, agile beam control system to engage high speed targets within the short times needed for aircraft self-defense. The program also focused on the phenomenology of laser-target interactions and associated threat vulnerabilities. An advanced technology component of this program, which focused on developing and testing various Endurance subsystems, is budgeted in PE 0603739E, Project MT-15. ***FY 2016 Accomplishments:*** - Conducted effects testing on an available surrogate of the key optical assembly of a seeker of a larger class of threat EO/IR guided surface-to-air missile and verified estimated lethality criteria to anchor lethality models. - Completed a live-fire test plan in conjunction with all the stakeholders (Government test team, performer, target logistics, range support, range safety and environmental offices, laser clearing house, etc.). - Completed missile trajectory simulations for each threat class from many possible launch locations and pod test locations to support risk reduction for the advanced technology component testing. - Partially-packaged high-power laser for pod-integration testing.			
Accomplishments/Planned Programs Subtotals	10.912	6.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency			Date: May 2017
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-07 / *AERONAUTICS TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
TT-07: *AERONAUTICS TECHNOLOGY*	-	36.009	62.876	67.378	-	67.378	67.518	62.528	49.528	49.528	-	-

A. Mission Description and Budget Item Justification

Aeronautics Technology efforts will address high payoff opportunities that dramatically reduce costs associated with advanced aeronautical systems and/or provide revolutionary new system capabilities for satisfying current and projected military mission requirements. This includes advanced technology studies of revolutionary propulsion and vehicle concepts, sophisticated fabrication methods, and examination of novel materials for aeronautic system applications.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Aircrew Labor In-cockpit Automation System (ALIAS)	13.213	22.876	19.378

Description: The Aircrew Labor In-cockpit Automation System (ALIAS) program will design, develop, and demonstrate a kit enabling affordable, rapid automation of selected aircrew functions across a broad range of aircraft. ALIAS intends to enable reduction of aircrew workload and/or the number of onboard aircrew to improve performance. The program will develop hardware and software to automate select aircrew functions and will employ novel, low impact approaches to interface with existing aircraft monitoring and control systems. The program will also develop tractable approaches to rapidly capture crew-station specific skills and aircraft unique behaviors. To accomplish this, ALIAS will leverage recent advances in perception, manipulation, machine learning, reusable software architectures, autonomous systems architecture, and verification and validation. ALIAS will culminate in a demonstration of the ability to rapidly adapt a single system to multiple aircraft and execute simple missions. This reliability enhancement capability will enable new operational concepts for reuse of existing air assets and allow a reduction in the number of aircrew required.

FY 2016 Accomplishments:
- Performed ground demonstration of ALIAS system mission functionality and contingency management.
- Conducted flight demonstration of perception and actuation subsystems and new command interface.
- Demonstrated portability to new aircraft type.
- Continued risk reduction activities.

FY 2017 Plans:
- Conduct flight demonstration of integrated capabilities.
- Perform ground demonstration of portability timeline into other aircraft.
- Initiate airworthiness evaluation for integrated flight demonstration on operational aircraft.
- Initiate commercial certification process of ALIAS.

FY 2018 Plans:
- Demonstrate knowledge acquisition timeline and kit installation/removal on other aircraft.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-07 / *AERONAUTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Refine system human interface. - Conduct integrated system flight demonstration on an operational aircraft to include contingency management. - Continue system refinement and demonstration on multiple aircraft. - Initiate the transition of select knowledge acquisition, perception, and interface technologies to operational aircraft.			
Title: Gremlins ***Description:*** The goal of the Gremlins program is to develop platform technologies that enable a new class of distributed warfare. The Gremlins concept envisions small air-launched unmanned systems that can be responsively dispatched in volley quantity from commodity platforms, fly into contested airspace, conduct a moderate duration mission, and ultimately be recovered. Key enabling technologies for the concept include smaller developmental payloads that benefit from multiple collaborating host platforms. The Gremlins program will conduct risk reduction and development of the host platform launch and recovery capability and develop and demonstrate a recoverable UAV platform concept. Enabling platform technologies will include precision relative navigation, advanced computational modeling, variable geometry stores, compact propulsion systems, and high speed digital flight control. The program will leverage these technologies, perform analytic trade studies, conduct incremental development, and ultimately demonstrate the potential for an integrated air-launched Gremlins unmanned platform. ***FY 2016 Accomplishments:*** - Conducted exploratory trade studies to establish feasibility of technical approaches. - Initiated studies on integration with existing Service systems and systems architectures. - Conducted system concept design tradeoff analyses. ***FY 2017 Plans:*** - Conduct conceptual design and system requirements review of demonstration system. - Initiate engineering design of integrated demonstration concepts. - Conduct system and subsystem risk reduction test planning. - Develop objective system concepts and mission capability projections. ***FY 2018 Plans:*** - Conduct demonstration system Preliminary Design Review. - Initiate detailed design of integrated demonstration system. - Fabricate and ground test demonstration system or subsystem mock-ups. - Perform wind tunnel or flight test of demonstration system components.	17.996	36.000	36.000
Title: Advanced Aeronautics Technologies ***Description:*** The Advanced Aeronautics Technologies program will examine and evaluate aeronautical technologies and concepts through applied research. These may include feasibility studies of novel or emergent materials, devices and tactics	4.800	4.000	2.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-07 / *AERONAUTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
for both fixed and rotary wing air vehicle applications, as well as manufacturing and implementation approaches. The areas of interest range from propulsion to control techniques to solutions for aeronautic mission requirements. The result of these studies may lead to the design, development, and improvement of prototypes. ***FY 2016 Accomplishments:*** - Performed modeling of concepts and architectures. - Conducted trade studies of emerging concepts. - Conducted study with military Service Academies (USNA, USAFA, USMA) utilizing a live-fly competition to examine swarm versus swarm unmanned aerial system (UAS) technologies and tactics. ***FY 2017 Plans:*** - Perform testing of enabling technology components. - Investigate tactically relevant concepts for swarm versus swarm unmanned aerial system (UAS) technologies. - Initiate conceptual system designs. ***FY 2018 Plans:*** - Conduct proof-of-concept technology demonstrations. - Investigate emerging technologies and conduct initial studies.			
Title: OFFensive Swarm-Enabled Tactics (OFFSET) ***Description:*** The OFFSET program will design, develop, and demonstrate a swarm system architecture to advance the innovation, interaction, and integration of novel swarm tactics. The program will examine enabling technologies for advanced mobility, distributed perception, distributed decision-making, and collaborative autonomy for large teams of unmanned systems, including unmanned ground, air, and/or maritime capabilities through the use of both virtual, game-based and physical, live-fly testbeds. Key research thrusts include the development of new platforms, sensors, and algorithms; advances in communication, networking, and autonomy; improvement of swarm logistics and concepts of employment; and development of human-swarm teaming interface technologies. These combined enhancements will enable employment of these collective systems to address current needs and defeat future threats. The program will consider technologies supporting U.S. ground, air, and maritime operations requiring organic and/or tactical swarm capabilities, leveraging low-cost, rapidly deployable, autonomous system technologies. ***FY 2018 Plans:*** - Perform initial trade studies of platform requirements to include range, payload, mobility, communications, and autonomy requirements - Assess technology maturity and predict technology trends to identify research and development needs and gaps. - Identify key technology advances required for swarm tactics concepts of deployment and employment.	-	-	10.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-07 / *AERONAUTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Initiate research and development for integration of advanced sensors, mobility, communication, and command & control technologies.			
Accomplishments/Planned Programs Subtotals	36.009	62.876	67.378

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency			Date: May 2017
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602702E / *TACTICAL TECHNOLOGY*	Project (Number/Name) TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
TT-13: *INFORMATION ANALYTICS TECHNOLOGY*	-	128.461	148.596	150.179	-	150.179	162.696	173.425	186.454	188.114	-	-

A. Mission Description and Budget Item Justification

The Information Analytics Technology project develops technology for analyzing data and information arising from: 1) intelligence networks; 2) open and other external sources; 3) sensors and signal/image processors; and 4) collection platforms and weapon systems. Technical challenges include the need to process huge volumes of diverse, incomplete, and uncertain data in tactically-relevant timeframes. Efforts address problems related to conditioning of unstructured data, content analysis, behavioral modeling, pattern-of-life characterization, economic activity analysis, social network analysis, anomaly detection, and visualization. Operational benefits include deeper understanding of the evolving operational environment tailored to the needs of commanders at every echelon. Promising technologies are evaluated in the laboratory and demonstrated in the field to facilitate transition.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Media Forensics (MediFor)	17.000	22.500	28.879

Description: The Media Forensics (MediFor) program is creating technologies for analyzing diverse types of media content to determine their trustworthiness for military and intelligence purposes. Current approaches to media forensics are labor intensive, requiring analysts and investigators to undertake painstaking analyses to establish context and provenance. The program will develop, integrate, and extend image and video analytics to provide forensic information that can be used by analysts and automated systems to quickly determine the trustworthiness of open source and captured images and video. Technologies will transition to operational commands and the intelligence community.

FY 2016 Accomplishments:
- Defined processes and practices for the scientific grounding of integrity of visual media, including detection of pixel level manipulations and inconsistencies in shadows/illumination and motion/trajectories.
- Collected images and videos for evaluation and training of algorithms.
- Designed evaluation paradigms for integrity assessment appropriate for adversary insertion/deletion actions.

FY 2017 Plans:
- Develop advanced techniques for media fingerprinting and for searching large repositories for content produced by the same device.
- Develop cross media representations of semantic content in image and video sources and techniques to indicate where the sources reinforce or contradict each other.
- Develop approaches for detecting commonly occurring media manipulations.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Create an integrated baseline platform for high performance forensic components. ***FY 2018 Plans:*** - Develop approaches to counter evolving media-editing technologies and to detect manipulation in noisy, degraded and highly compressed media. - Develop methods to fuse knowledge from multiple forensic engines to determine whether a manipulation renders media unsuitable for an intended application. - Develop a large scale integrated platform with graphical user interfaces (GUIs) for operator communication, and evaluate the platform independently and with selected government users.			
Title: Distributed Battle Management (DBM) ***Description:*** The Distributed Battle Management (DBM) program will develop mission-driven architectures, protocols, and algorithms for battle management (BM) in contested environments. The military is turning to networked weapons and sensors on-board a heterogeneous mix of multi-purpose manned and unmanned systems. In contested environments, it is a challenge for BM networks to communicate with subordinate platforms due to extensive adversarial cyber and electronic warfare operations, anti-satellite attacks, and the need for emissions control in the face of a formidable integrated air defense system. The Distributed Battle Management program will seek to develop a distributed command architecture with decentralized control of mission-focused asset teams. The architecture will enable rapid reaction to ephemeral engagement opportunities and maintain a reliable BM structure, despite limited communications and platform attrition in continuously evolving threat environments. The program will incorporate highly automated decision making capability while maintaining vital human-on-the-loop operator approval. ***FY 2016 Accomplishments:*** - Identified and further researched the most promising planning concepts, situation understanding concepts, and systems integrator. - Completed design of the overall DBM system, to include architecture, software components, CONOPS, and integration strategy for expected host platforms. - Implemented initial version of the integrated DBM system architecture, algorithms, and software. - Demonstrated initial version's capabilities in a simulated battle environment with impaired communications and loss of critical resources. ***FY 2017 Plans:*** - Update DBM algorithms and architecture based on experimentation to support complex contested environments. - Continue development of the DBM human-machine interface for battle management platforms and tactical platforms. - Demonstrate integrated DBM capabilities in live, virtual, and constructive simulations.	14.709	17.000	21.250

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Conduct software flexibility tests to demonstrate the ability to insert software upgrades without disrupting the BM structure. ***FY 2018 Plans:*** - Conduct a virtual, constructive-based simulation of the air portion of an Air-to-Ground battle using DBM software components. - Use DBM components in a simulation event for the System of Systems Integration Technology and Experimentation (SoSite) program (budgeted in PE 0603766E, Project NET-01). - Conduct a live-fly experiment with a virtual, constructive-based simulation of the air portion of an Air-to-Ground battle using DBM software components. - Use DBM components in a live-fly event for the SoSite program.			
Title: Memex ***Description:*** The Memex program is developing search technologies to revolutionize the discovery, organization, and presentation of domain-specific content. Current search technologies have limitations in search query format, retrieved content organization, and infrastructure support. These current technologies impose an iterative search process that is time-consuming and inefficient, typically producing only a fraction of the available information. Memex is creating a new domain-specific search paradigm to discover relevant content and organize it in ways that are more immediately useful to specific missions and tasks. In addition, Memex domain-specific search engines will extend the reach of current search capabilities to the deep web and non-traditional content. Memex technologies will enable the military, government, and commercial enterprises to find and organize mission-critical information on the Internet and in large intelligence repositories. Anticipated mission areas include counter-terrorism, counter-drug, anti-money-laundering, and anti-human-trafficking, with transition partners from DoD and other U.S. Government activities. ***FY 2016 Accomplishments:*** - Developed specialized search techniques for information discovery in networks of illicit activity. - Developed advanced content discovery, deep crawling, information extraction, and information relevance algorithms to support domain specific search. - Integrated and evaluated multiple end-to-end operational prototypes with automated and user-guided methods for web content analysis. - Conducted system evaluation with feedback from operational partners. - Transitioned capabilities for use in counter-human-trafficking operations and deep-web investigations. ***FY 2017 Plans:*** - Develop advanced domain search techniques and methods across the data pipeline (domain specification, crawlers, extractors, indexing, search, analytics, and visualization) that are domain agnostic, highly adaptable, and rapidly deployed.	22.492	17.920	9.460

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Develop integrated applications from Memex components demonstrating reduced time and increased flexibility of standing up new domain specific search capabilities with highly effective user experience. - Transition software components and integrated systems, and demonstrate enhanced support for partner missions. - Formulate approaches for optimizing big data analytics algorithms on reconfigurable hardware and create initial design for a combined software-hardware compiler (i.e., a software-hardware co-compiler). ***FY 2018 Plans:*** - Develop optimized components and integrated applications that address new domain specific search requirements arising from the national security and intelligence communities, and transition these to operational partners. - Establish and develop software and user communities around open source components and applications to ensure tool sustainment, software evolution, and long-term operational use. - Engineer runtime reconfigurable hardware and adaptive software that enables performance approaching that of custom hardware for data-intensive algorithms without need for redesign for specific algorithms and without sacrificing programmability.			
Title: Network Defense	28.874	17.500	6.750
Description: The Network Defense program is developing technologies to detect network attacks using network summary data. U.S. computer networks are continually under attack, and these attacks are typically handled by individual organizations as they occur. Analyzing network summary data across a wide array of networks will make it possible to identify trends and patterns visible only when the data is viewed as a whole. Network Defense is developing novel algorithms and analysis tools that enable a big picture approach for identifying illicit behavior in networks. This analysis and subsequent feedback to system administrators, security engineers, and decision makers will enhance information security in both the government and commercial sectors. ***FY 2016 Accomplishments:*** - Developed algorithms that use scanning events to provide indications and warning of coordinated adversary activities. - Enhanced the persistent threat detection techniques and worked with potential users to identify threats particular to individual organizations/networks and/or shared by multiple organizations/networks. - Explored mathematical approaches for using summary information about an attack on one network to automatically detect similar attacks on other networks. - Demonstrated the feasibility of anticipating specific attack formats on one network based on attacks observed on other similar networks. ***FY 2017 Plans:*** - Optimize algorithms that detect anomalous behaviors and coordinated adversary activities, and test these through exercises, summary data and on-site evaluations.			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Perform comprehensive test and evaluation of the multiple detection algorithms developed to produce quantitative understanding of probabilities of detection and false alarm and receiver operating characteristic curves for important classes of attacks. - Transition capabilities to U.S. government, defense industrial base organizations/networks, and other U.S. commercial companies. ***FY 2018 Plans:*** - Develop distributed versions of the most effective algorithms to permit deployment on a decentralized global infrastructure. - Extend comprehensive test and evaluation of the most promising techniques to adversarial use cases, for example, where the attacker has varying degrees of insider knowledge. - Transition evolved capabilities to U.S. government, defense industrial base organizations and networks, and other U.S. commercial companies.			
Title: Causal Exploration of Complex Operational Environments* ***Description:*** *Formerly Predicting Complex Operational Environments The Causal Exploration of Complex Operational Environments program will develop advanced modeling, analysis, simulation, and visualization tools to enable command staffs to rapidly and effectively design, plan and manage missions in complex, hybrid operational environments. The U.S. military increasingly operates in remote and unstable parts of the world where mission success depends heavily on cooperation with and among a wide variety of stakeholder groups. These groups typically include host nation government organizations, local civilian groups, and non-governmental organizations each of which has priorities, sensitivities and concerns that may differ significantly. Current mission design and planning technologies do not adequately model the range of options or the inherent uncertainties. The program will develop tools to create causal, computational models that represent the most significant relationships, dynamics, interactions, and uncertainties of the operational environment including political, military, economic, and social factors. These will enable command staffs to design and quantitatively assess potential courses of action in complex operational environments. ***FY 2017 Plans:*** - Introduce and initiate development of an Intelligence, Surveillance, and Reconnaissance (ISR) collaboration environment that facilitates analyst assessments by enabling information discovery and workflow process sharing/reuse. - Develop information integration and scenario simulation frameworks to support mission design and planning for complex hybrid environments. - Develop appropriate schema for knowledge bases of entities typically encountered in an operational environment and their relationships.	-	19.050	25.600

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Develop dynamical systems models for projecting and predicting the interactions between diverse stakeholder groups that may have differing priorities, sensitivities and concerns. - Develop metrics for quantitative assessment of models including correctness and completeness of causal structure, ability to predict and explain known behavior, and quality and precision of model outputs. ***FY 2018 Plans:*** - Develop knowledge bases for the entities and their relationships in selected operational environments. - Develop displays for rapidly visualizing and evaluating likely outcomes of alternative U.S. mission designs. - Implement models and run simulations that are required to support the design of representative hybrid missions. - Integrate techniques in an initial prototype system and, in collaboration with operational and transition partners, initiate qualitative assessment of models for selected complex operational environments.			
Title: Data-Driven Discovery of Models (D3M) ***Description:*** The Data-Driven Discovery of Models (D3M) program, expanding on technical opportunities emerging from the XDATA program, is developing automated model discovery techniques and tools that enable non-expert users to create empirical models of real, complex processes and phenomena. The ability to understand the battlespace is driven increasingly by analysis of sensor and open source data, and the construction of empirical models that enable decision makers to predict behaviors and anticipate contingencies during tactical and strategic planning. The DoD and the Intelligence Community (IC) are fundamentally limited in this regard by a shortage of expert data scientists. D3M will address this need by creating technologies that automate the construction of complex empirical models. D3M technologies will include a library of data modeling primitives that is automatically selectable, given data and an outcome; automated approaches for composition of complex models from modeling primitives; and intuitive mechanisms for human-model interaction that enable curation of models by non-experts. D3M technical development will focus on the types of empirical modeling problems commonly encountered by the DoD and IC. ***FY 2017 Plans:*** - Formulate automated approaches for hypothesizing relevant models/model components for a given outcome of interest and set of input data and for determining when apparent correlations are spurious. - Propose approaches for assessing alternative models by identifying which model(s) are most likely to generalize well in the presence of new data. - Design visualizations of data to help users understand the data underlying learned models and to make informed selections between alternative models. - Develop initial implementations of mechanisms for users to interact with models by mixing and matching model components. ***FY 2018 Plans:***	-	20.247	26.840

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Develop an initial library of modeling primitives that transform, structure, reduce, infer, augment, and model data, and a capability to compose modeling primitives into complex models. - Develop a collection of data science and empirical science problems with data and annotated code to enable automated learning. - Initiate development of an end-to-end, integrated virtual data scientist to generate and propose models that are relevant to a given problem. - Address problems of overfitting, spurious correlation, and biased training data by creating curation aids that explain model limitations and data dependencies to non-expert users.			
Title: Modeling Adversarial Activity (MAA)	-	10.000	16.400
Description: The Modeling Adversarial Activity (MAA) program will extend and apply techniques introduced in the Memex program to develop technologies for generating high confidence indications and warnings for weapons of mass terror (WMT) activities. WMT pathways consist of networks or links among individuals, groups, organizations, and other entities that promote or enable the development, procurement, possession, transport, and/or proliferation of WMTs and related capabilities. Monitoring and controlling WMT pathways is essential in denying access to WMT technology, knowledge, materials, expertise, and weapons. MAA will create graph models reflecting prototypical WMT pathways, develop methods for creating merged activity graphs by aligning entities across multiple intelligence modalities, develop algorithms to match empirical graph activity patterns with pathway models, and create synthetic data sets at scale to support development and testing of WMT pathway detection techniques. MAA research will be informed by interactions with the Defense Threat Reduction Agency (DTRA). ***FY 2017 Plans:*** - Formulate graph models for WMT pathway activity sequences designed by subject matter experts. - Explore computationally feasible approaches for aligning entities across multiple intelligence modalities and for approximate graph matching. - Collaborate with DTRA and additional potential transition partners on methods for generating synthetic activity data with realism adequate for testing WMT pathway recognition techniques. ***FY 2018 Plans:*** - Implement graph alignment techniques and assess strengths and weaknesses of alternative approaches on synthetic data. - Implement techniques for approximate matching of activity graphs and demonstrate pathway detection on synthetic data. - Create an initial prototype pathway recognizer and demonstrate the capability to detect modeled WMT activity sequences in synthetic data.			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Collaborate with DTRA and additional potential transition partners to implement techniques in their environments and to optimize techniques for efficient and timely execution on their computational infrastructure.			
Title: Warfighter Analytics using Smartphones for Health (WASH) ***Description:*** The Warfighter Analytics using Smartphones for Health (WASH) program will pioneer analytic techniques for continuous and real-time assessment of warfighter physiological health and cognitive state based on the multiple sensor data streams generated by modern smartphones. Recent research in the area of smartphone biometrics has shown the feasibility of measuring user physiological and behavioral parameters for purposes of user authentication. WASH will explore extending these smartphone biometrics to provide the capability to reliably measure additional user physiological and behavioral parameters relevant to health assessment and the diagnosis of disease. If successful, WASH will produce a mobile application that continuously and reliably assesses warfighter health and combat/mission readiness. WASH will be closely coordinated with the Naval Health Research Center and the Armed Forces Health Surveillance Branch. ***FY 2018 Plans:*** - Propose, develop, and implement a privacy framework and privacy processes for smartphone-based physiological health and cognitive state assessment. - Design and initiate development of secure cloud-based data ingest and storage technologies for collecting, organizing, and associating user smartphone, physiological health, and behavioral data. - Propose, explore, and initiate evaluation of empirical and machine learning-based techniques for using smartphone sensor data to assess warfighter physiological health and cognitive state.	-	-	15.000
Title: Quantitative Crisis Response (QCR) ***Description:*** The Quantitative Crisis Response (QCR) program is developing digital tools that can help operational partners better understand how information is being used by adversaries, and predict and assess the effects of adversary information campaigns and of countermeasures quantitatively, in real time, and at scale. The anticipated tools will be able to assess population-scale radicalization and other potential effects of the information being traded through social media and other communications channels. QCR is coordinated with multiple national security agencies, Combatant Commands, and the Department of State. ***FY 2016 Accomplishments:*** - Refined algorithms for content discovery, deep crawling, information extraction, and information relevance to support search, analysis and visualization of collected information. - Developed dynamic, interactive, and collaborative user interface capabilities to support user needs. - Transitioned initial QCR tools to operators for assessment and feedback. ***FY 2017 Plans:***	20.929	13.750	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
- Evaluate semi-automated methods for web content analysis and visualization. - Integrate algorithms, analytic models, processes and methods into operational prototypes. - Conduct system evaluation with operational partners, refine prototype tools, and add advanced functionality in response to operator feedback. - Effect transitions to U.S. government agencies and Combatant Commands.			
Title: XDATA ***Description:*** The XDATA program is developing computational techniques and software tools for analyzing large volumes of data, both semi-structured (e.g., tabular, relational, categorical, metadata, spreadsheets) and unstructured (e.g., text documents, message traffic). Central challenges addressed include; a) development of scalable algorithms for processing imperfect data in distributed data stores; and b) creation of effective human-computer interaction tools for facilitating rapidly customizable visual reasoning for diverse missions. The program has developed open source software toolkits that enable flexible software development to support users processing large volumes of data in timelines commensurate with mission workflows of targeted defense applications. An XDATA framework supports minimization of design-to-deployment time of new analytic and visualization technologies on diverse distributed computing platforms, and also accommodates changing problem spaces and collaborative environments. ***FY 2016 Accomplishments:*** - Developed methods and software for interactive, iterative, distributed analysis of diverse data enabling transition, integration and implementation on heterogeneous platforms. - Developed new analytics for distributed data and systems through machine learning and algorithmically scalable methods. - Developed a scalable, robust framework for user-defined, adaptable visualizations. - Developed, tested and benchmarked a library of user interfaces that provide a consistent user experience independent of scale or processor heterogeneity. - Developed integrated applications from components and interface libraries demonstrating flexible adaptation to emergent user requirements and ad-hoc tasking. ***FY 2017 Plans:*** - Optimize software components and integrated applications to allow seamless integration into a user enterprise or mission environment. - Transition end-to-end systems, components, platforms and operating environments to identified user communities.	24.457	10.629	-
Accomplishments/Planned Programs Subtotals	128.461	148.596	150.179

Exhibit R-2A, RDT&E Project Justification: FY 2018 Defense Advanced Research Projects Agency		Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602702E / *TACTICAL TECHNOLOGY*	**Project (Number/Name)** TT-13 / *INFORMATION ANALYTICS TECHNOLOGY*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Specific programmatic performance metrics are listed above in the program accomplishments and plans section.