Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Office of the Secretary Of Defense	Date: May 2017
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*

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	-	46.750	42.206	49.226	-	49.226	53.060	53.662	54.770	55.895	Continuing	Continuing
P227: *Applied Research for the Advancement of S&T Priorities*	-	46.750	42.206	49.226	-	49.226	53.060	53.662	54.770	55.895	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Applied Research for the Advancement of Science and Technology (S&T) Priorities program element (PE) enables the early launch of S&T applied research projects to shape Components' investments. The PE focuses on the design, development, and improvement of prototypes and new processes to achieve general mission requirements and to decipher promising research solutions for military needs. Additionally, this PE enables concept exploration efforts and studies of alternative concepts. The research projects are part of the Department of Defense (DoD) S&T priorities and designated focus areas that will include non-system specific technology efforts and feasibility assessments and are formulated and managed by teams of subject matter experts drawn from the Office of the Secretary of Defense, the Military Services, and the Defense Agencies. The PE also provides support to the S&T Communities of Interest (CoI).

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	48.131	42.206	49.271	-	49.271
Current President's Budget	46.750	42.206	49.226	-	49.226
Total Adjustments	-1.381	0.000	-0.045	-	-0.045
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.381	-			
• Other Adjustments	-	-	-0.045	-	-0.045

Exhibit R-2A, RDT&E Project Justification: FY 2018 Office of the Secretary Of Defense			Date: May 2017
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602251D8Z / *Applied Research for the Advancement of S&T Priorities*	**Project (Number/Name)** P227 / *Applied Research for the Advancement of S&T Priorities*	

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
P227: *Applied Research for the Advancement of S&T Priorities*	-	46.750	42.206	49.226	-	49.226	53.060	53.662	54.770	55.895	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Applied Research for the Advancement of Science and Technology (S&T) Priorities program element (PE) enables the early launch of S&T applied research projects to shape Components' investments. The PE is oriented toward the design, development, and improvement of prototypes and new processes to meet general mission area requirements and to translate promising research into solutions for military needs. Efforts are situated within the DoD S&T priorities and focus areas and will include feasibility evaluations and non-system specific technology efforts. Investigations conducted in this PE facilitate concept exploration efforts and studies of alternative concepts. Efforts are formulated and managed by teams of subject matter experts drawn from the Office of the Secretary of Defense, the Military Services, and the Defense Agencies. The PE also provides support to the S&T Communities of Interest (CoI).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Applied Research for the Advancement of S&T Priorities	29.831	30.000	42.000

Description: The Applied Research for the Advancement of S&T Priorities PE focuses on fostering Joint-Service research areas of common elements of cross-cutting S&T efforts. This enables the early launch of applied research projects to shape Components' investments and facilitates concept exploration efforts and studies of alternative concepts. The cross-cutting S&T efforts include the DoD S&T Priorities, such as Electronic Warfare, Human Systems, Autonomy, and Cyber, as well other focus areas, such as Advanced Materials, Biomedical, Weapons, Quantum, and Command, Control, Communications, Computers and Intelligence.

FY 2016 Accomplishments:
Continued concept exploration efforts that focus on the S&T priority areas. The accomplishments include:

Autonomy ($15.500 million):
– Enabling superior tactical-level cooperation between warfighters and machines
– Translating military goals into specific plans for using human and machine assets
– Scaling how information is handled to ensure fast, accurate top-level decisions
– Scaling to manage very large numbers of assets, without overloading humans
– Complex planning and re-planning of human and machine assets under duress
– Rapid insertion of support capabilities into disaster areas
– Rapid recovery of basic infrastructure in disaster areas
– Increasing robustness to enable broader use of autonomy

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Quantum Science and Engineering Program (QSEP) ($13.300 million): − Established solid state lab for studying entanglement and optical control of spins in Silicon Carbide (SiC)-based quantum bits and memories − Established ion trap clean room facility and bake-out station for ultra-high vacuum preparation and ion trap installation; established basic trapped-ion lab infrastructure − Developed fiber-based entanglement distribution testbed and characterized entanglement swapping − Integrated single quantum dots (QDs) into mechanical resonators; measured the sensitivity of optical and spin transitions to motion-induced strain, finding the hole spin to have a higher sensitivity than electron spins − Produced optical lattice in an atomic cloud − Completed initial test for Aluminum Nitride (AlN) devices and demonstrated high power handling in infrared Synthetic Biology for Military Environments (SBME) ($1.000 million): − Launched a tri-Service effort to expand and integrate existing capabilities in synthetic biology − Outlined plans for building a comprehensive DoD pipeline wherein synthetic biology-based innovation can be supported from conception to testing in a relevant environment; targeted capabilities include gene network modeling and simulation, genome editing, and circuit optimization and characterization			
FY 2017 Plans: Continue concept exploration efforts that focus on the S&T priority areas. The challenge areas within the priorities include: Quantum Science and Engineering Program (QSEP) ($15.000 million): − Plan to entangle electron and nuclear spin ensembles and setup Silicon Carbide chemical vapor deposition reactor to grow low-strain, high purity samples for use as quantum memories − Plan to demo e-beam pumped lasing in Ultraviolet (UV) for Vertical External Cavity Surface Emitting Laser (VECSEL) structure − Plan to finalize cavity design with integrated thermal management − Plan to fabricate photonic cavities with integrated defect qubits; measure the spin and optical properties, including enhancement of photon emission − Plan to measure memory time, readout efficiency, and second order correlation in optical lattice − Establish trapped ion capability and prepare ultra-high vacuum chambers for quantum node tests; trap ions in two independent ultra-high vacuum chamber for remote entanglement demo − Optimize Aluminum Nitride devices for singlemode operation; design/simulate experiment for out-coupling of Ytterbium (Yb) ion − Conduct Initial quantum frequency conversion (QFC) experiments; demonstrate initial coupling; conduct loss measurements/ characterization/testing			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Synthetic Biology for Military Environments (SBME) ($14.000 million): - Continue efforts to establish a biological open system architecture and "chassis" relevant to military environments and to create a cell-free system for gene network optimization - Plan to develop Genetic manipulation tools for the nine chassis candidates, and the Genetic parts will be identified computationally and validated experimentally; the final selections will be made using potential applications and the maturity of genetic and characterization tools Initiation of new Applied Research for the Advancement of S&T Priority Project ($1.000 million) ***FY 2018 Plans:*** Continue concept exploration efforts that focus on the S&T priority areas. The challenge areas within the priorities include: Quantum Science and Engineering Program (QSEP) ($15.000 million): − Demonstrate spin-photon entanglement and grow isotopically purified Silicon Carbide quantum memories with enhanced performance − Demonstrate breadboard UV VECSEL laser and entanglement teleportation over telecom fiber − Continue efforts on scalable, integrated quantum memory nodes with emphasis on photons at telecom wavelengths; demonstrate quantum repeater with four memory system − Improve quantum dots material properties to enhance indistinguishably of photons; improve sensitivity using a system of coupled quantum dots for enhanced strain coupling − Plan to analyze ion-photon interface to swap entanglement for long-distance communication; demonstrate remote entanglement − Conduct experiment for out-coupling − Conduct single and dual stage quantum frequency conversion; conduct quantum frequency conversion experiments for photon-based entangled state creation and manipulation Synthetic Biology for Military Environments (SBME) ($15.000 million): − Continue efforts to establish a biological open system architecture and "chassis" relevant to military environments and to create a cell-free system for gene network optimization − Develop transcriptomic, proteomic and metabolomic tools; the tools will be applied to identify chassis network architectures, measure compensatory changes, and determine circuit yields − Design complex circuit, and initiate the synthesis, incorporation, and testing of the circuit − Initiate the validation and optimization of the circuits in both cell-based and cell-free platforms − Explore ruggedization of the cell-free platform to improve stability for storage and field use			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
− Continue iterations of in silico predictions, test bed optimization and in vivo validation; these testing scenarios will be used to establish “calibration transfer” between systems − Complete baseline measurements of the simple circuits in chassis organisms and extend the circuit designs to produce modulating output Continuation of FY 2017 Applied Research for the Advancement of S&T Priority Project ($12.000 million)			
Title: S&T Communities of Interest	16.919	12.206	7.226
Description: The S&T Communities of Interest effort facilitates cooperation and collaboration among Components; it optimizes the development of critical S&T efforts across the DoD enterprise. The efforts include the development of technology roadmaps and the integration of technology planning. The Communities of Interest select/examine critical technology areas to address gaps or opportunities. ***FY 2016 Accomplishments:*** Continued to provide technical support to the Communities of Interest. Concluded projects initiated in FY 2015, and initiated a new set of projects to address gaps identified by the Communities of Interest. The completed projects include: – Adaptive Technologies for Language Training – Foundations for Context-Aware Info Retrieval for Proactive Decision Support – Biomarkers & Acute Radiation Sickness – DoD-wide Cloud-Based Collaborative Silicon Microelectronics Design – Hypersonic Flight Experiments – Smoke Screen in Cyberspace – Unmanned Air Vehicle Countermeasures (SQUAD) The new projects include: − Development of a Prototype Cryogenic Optical Interconnect Demonstrator − Electromagnetic Battle Management in Heterogonous Disconnected Electromagnetic Environment − Joint-Service Universal Materials Data Fusion and Visualization Structures ***FY 2017 Plans:*** Continued to provide technical support to the Communities of Interest. Conclude projects initiated in FY 2016, and select a new set of projects to address gaps identified by the Communities of Interest.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
The completed projects include: − Development of a Prototype Cryogenic Optical Interconnect Demonstrator − Electromagnetic Battle Management in Heterogonous Disconnected Electromagnetic Environment − Joint-Service Universal Materials Data Fusion and Visualization Structures The Communities of Interest will select a set of new two-year projects in FY 2017. ***FY 2018 Plans:*** Continue to provide technical support to Communities of Interest. Conclude projects initiated in FY 2017, and select a new set of projects to address gaps identified by the Communities of Interest.			
Accomplishments/Planned Programs Subtotals	46.750	42.206	49.226

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Project performance metrics specific to each effort are identified in the project plans established by the program leads and the Communities of Interest. Individual project success will be monitored through these metrics.