Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602709A *I Night Vision 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	-	37.501	36.079	34.723	-	34.723	35.005	36.267	37.536	38.823	-	-
H95: *Night Vision And Electro-Optic Technology*	-	32.501	36.079	34.723	-	34.723	35.005	36.267	37.536	38.823	-	-
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	5.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts applied research and investigates core night vision and electronic sensor components and software to improve the Army's capability to operate in all battlefield conditions. Technologies pursued in this PE have the potential to provide the Army with new, or enhanced, capabilities to detect and identify targets farther on the battlefield, operate in obscured conditions, and maintain a higher degree of situational understanding (SU). Project H95 advances infrared (IR) sensor technologies, assesses and evaluates sensor materials, designs advanced multi-function lasers for marking, targeting, designation, wind-sensing, and range finding, and develops models and simulations for validating advanced sensor technologies.

Work in this PE is fully coordinated with PE 0602120A (Sensors and Electronic Survivability), PE 0602705A (Electronics and Electronic Devices), PE 0602712A (Countermine Technology), PE 0603606A (Landmine Warfare and Barrier Advanced Technology), PE 0603710A (Night Vision Advanced Technology), and PE 060708045 (End Item Industrial Preparedness Activities).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is performed by the United States (U.S.) Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602709A *I Night Vision Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	38.807	36.079	37.081	-	37.081
Current President's Budget	37.501	36.079	34.723	-	34.723
Total Adjustments	-1.306	0.000	-2.358	-	-2.358
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.306	-			
• Adjustments to Budget Years	0.000	0.000	-2.505	-	-2.505
• Civ Pay Adjustments	0.000	0.000	0.147	-	0.147

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Program Increase*	5.000	-
Congressional Add Subtotals for Project: K90	5.000	-
Congressional Add Totals for all Projects	5.000	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / *Night Vision Technology*	Project (Number/Name) H95 / *Night Vision And Electro-Optic 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
H95: *Night Vision And Electro-Optic Technology*	-	32.501	36.079	34.723	-	34.723	35.005	36.267	37.536	38.823	-	-

A. Mission Description and Budget Item Justification

This Project conducts applied research and develops component technologies that enable improved Reconnaissance, Surveillance, Target Acquisition (RSTA) and situational understanding (SU) at an affordable price. Technologies include novel focal plane arrays (FPAs), lasers, processing, and electronics. It also includes modeling and simulation to predict performance and to determine operational effectiveness of these technologies. Research focuses on infrared (IR) FPAs necessary to search, identify and track targets in all day/night visibility and battlefield conditions and to improve standoff detection in all operational environments. This Project designs, fabricates and validates large format IR FPAs for sensors to simultaneously provide wide area viewing and the high resolution imagery for situational understanding, persistent surveillance and hostile fire detection. This Project investigates and designs novel sensor electronics such as Digital Read Out Integrated Circuit (DROICs) to enable multifunction sensing. This Project also investigates and improves new semiconductor materials formed by a combination of elements from the periodic table. In addition, this Project develops algorithms for enhanced IR functionality, which provide the ability to perform detection and identification at extended ranges, as well as the ability to detect deeply buried targets. The reduction of size, weight and power (SWaP) is a key research objective for all efforts

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (US) Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Distributed Aided Target Recognition (AiTR) Evaluation Center of Excellence	1.725	2.486	2.586
Description: This effort investigates a virtual, distributed capability to interactively process both real and simulated three-dimensional (3D) multispectral scenes for Defense-wide applications. Automatic target recognition (ATR) and AiTR algorithms are evaluated against realistic operational scenarios, to include roadside threats/explosively formed projectiles, in aided or fully autonomous RSTA missions.			
FY 2016 Accomplishments: Investigated inclusion of airborne countermine data in algorithmic correlation approaches to improve image based detection and confirmation; explored new algorithms to improve slew-to-cue and robotic move to a way-point for multifunction display capability; applied low power techniques and look-up libraries to improve signal processing and algorithms for threat detection and tracking			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
to minimize power consumption; augmented current evaluation infrastructure and data repository used for RSTA and countermine applications to include human activity recognition. ***FY 2017 Plans:*** Will investigate holistic algorithms that address multiple targets, validate signatures and improve Probability of Detection/False Alarm Rate (Pd/FAR) rates; develop a baseline algorithms to provide a framework for cognitive image processing techniques that collect multiple types of data from networks and apply continuous learning techniques to adapt to evolving threats. ***FY 2018 Plans:*** Will investigate new algorithms for situational understanding and threat awareness in all environments through hostile fire detection and location and obstacle avoidance; validate framework for image processing techniques that ingest multiple types of data from networks to increase Pd/FAR rates on multiple targets; assess algorithm performance against realistic operational scenarios and validate correlation processing of multiple types of multispectral two-dimensional (2D) and three-dimensional (3D) data of multiple targets to increase Pd while reducing the FAR using a cognitive image processing frame work.			
Title: Sensor Modeling and Simulation Technology ***Description:*** This effort investigates, verifies and validates sensor engineering models, measurement techniques and simulations. The goal is to improve the fidelity and adaptability of modeling and simulation capabilities for Warfighter training, sensor system analysis, identification and assessment of phenomenology associated with imaging technologies, and calibration of imaging technologies. ***FY 2016 Accomplishments:*** Implemented and began verification and validation of a two dimensional version of sensor performance model and measurement techniques; extended model and measurement methodologies to incorporate non-linear processing to include image quality based metric and advanced image processing algorithms; researched modeling and simulation techniques for multi-function or multi-mission sensor systems; researched new techniques and implementation methods such as virtual prototyping to support evolution of the modeling and simulation tools development. ***FY 2017 Plans:*** Will research and develop improved imaging sensor performance metrics, using computational modeling and imaging system design and evaluation. The objectives are to extend model and measurement methodologies to assess non-linear image processing algorithms and metrics; investigate the most effective combination of computational modeling techniques, lab assessments, and field evaluations; extend confidence level calculations to non-linear systems; define verification and validation	5.021	5.246	5.110

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
methodology for sensor data collections and human performance sensors; and research methods to advance full spectral image generation and processing into augmented reality and virtual representation of new sensor modalities. ***FY 2018 Plans:*** Will research, develop, and validate Electro-optic/Infrared (EO/IR) sensor performance models and simulations for computer-aided prototyping and augmented reality applications through field data collection, lab measurements, human signature exploitation, and algorithm development; research and develop robust and comprehensive measures of target acquisition performance; validate with lab measurements; leverage commercial gaming simulation technologies and augmented reality as a means to increase situational understanding.			
Title: Advanced Multifunction Laser Technology ***Description:*** This effort investigates technology for a new class of multi-wavelength laser modules which will have the ability to replace multiple laser targeting systems and reduce the SWaP of current devices. The goal is to achieve a single housing, electronics board, power supply and telescope for all applications to provide a reduction in the SWaP of multi-function laser systems. The objective is to develop a laser with higher efficiency and lower volume than existing pulsed Mid-wave Infrared (MWIR) and Long wave Infrared (LWIR) lasers, which will be used for threat sensor detection and active imaging in degraded visual environments. ***FY 2016 Accomplishments:*** Validated and matured multifunction Shortwave Infrared (SWIR) fiber-based laser breadboard, and components for performing functions such as laser range finder (LRF), laser illumination, laser pointing, and Light Detection and Ranging (LIDAR); investigated novel laser pulsing technologies to allow for compact and lightweight, solid state lasers at reduced cost; designed a fiber-based laser operating in an extended-SWIR spectral band for active imaging for covert conditions. ***FY 2017 Plans:*** Will investigate novel techniques for improving efficiency, pulse energy and size of MWIR and LWIR solid state lasers; investigate methods to convert laser operating frequencies from operations in shorter spectral wavebands into the MWIR and LWIR spectral wavebands for use in applications such as locating and neutralizing threat sensors, 3D imaging, and landing in degraded visual environments; determine methods for optimizing laser frequency; investigate novel approaches to optimize peak output powers and reduce size, weight and power consumption. ***FY 2018 Plans:*** Will conduct investigations of various MWIR laser configurations for threat sensor detection; validate and compare performance of different laser breadboards, including bulk solid state and fiber based pump lasers for frequency conversion, compare different	5.073	4.746	5.037

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
frequency conversion techniques for efficient generation of MWIR; and perform trade studies of LWIR laser designs, and select best approach for implementation and further evaluation.			
Title: Advanced Structures for Cooled Infrared Sensors ***Description:*** This effort researches detector materials and substrates for IR sensors. This effort investigates and improves III-V materials (materials formed by a combination of elements from Groups III and V of the periodic table) and II-VI material (materials formed by a combination of elements from Groups II and VI of the periodic table), to provide low cost, large format, high quality imaging sensors. The emphasis is on reducing material defects and increasing reliability by developing new ways to prepare and treat the substrates, new designs, and new methods of growing the structures. The goal is to develop cost effective components for high definition Army IR sensors. ***FY 2016 Accomplishments:*** Investigated new growth methods, detector structures and pixel level wavelets for capturing photons and meta-materials into FPAs for improving the responsivity (signal to noise ratio) of SWIR through LWIR wavebands using III-V and II-VI materials; continued investigation of new techniques for etching and passivating LWIR III-V and II-VI small pixel structures; investigated small FPA pixel pitch interconnect technologies. ***FY 2017 Plans:*** Investigate in-house growth of new LWIR III-V semiconductor compound materials and device structures focusing on optimizing quantum efficiency and material lifetime; research methodologies to improve the signal-to -noise ratio and increase the sensitivity of small pixel III-V structures. Continue to investigate small-pitch pixel processing including mitigation of etch damage and novel interconnect techniques to enable larger-format focal planes with better resolution and increased range.	5.541	5.892	-
Title: Solid State Low Light Imaging ***Description:*** This effort develops true starlight and very low light sensing FPA technology, with reduced power and production cost, for Soldier vision enhancement in degraded visibility conditions. The objective of this effort is an all solid state IR sensor for replacement of current Image Intensifier (I2) vacuum tube technology that can be integrated with new 3D DROIC technology. ***FY 2016 Accomplishments:*** Leveraged complementary metal-oxide semiconductor (CMOS) and 3D DROIC design to achieve high resolution, low latency, stacked, lowlight silicon sensor and micro-display imaging components; validated design by conducting experiments of stacked wafer fabrication runs with CMOS pixel densities equivalent to the full resolution designs; investigated and designed low profile folded and switchable optics compatible with objective lens and eye piece lens functions suitable for the solid state stacked imager design.	4.781	-	-
Title: Three-Dimensional Micro-Electronics for Night Vision Sensors	5.683	5.836	6.076

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: The goal of this effort is to investigate new, microelectronics, reconfigurable optics and display technologies to interface with emerging 3D electronics processing. The ability to actively reconfigure optical elements will require investigation of new materials and lens designs to enable real time optical refocusing and extended fields of view. Micro-display technology will benefit from new integrated microelectronics by use of new and improved display materials which operate at lower powers and enable all weather, day/night visualization. ***FY 2016 Accomplishments:*** Investigated new lens designs to include radially indexed materials for enhanced beam steering, meta-materials, and improved coatings for improved transmission/reflectivity. Micro-display research will explore new organic light emitting diode (OLED) materials, which offer luminance and multi sensor input for sensor visualization with a 3D DROIC interface. ***FY 2017 Plans:*** Will perform downselect of new lens designs investigated in Fiscal Year (FY) 2016 and optimize technical approaches based on size, weight, power, performance, and cost metrics; determine feasibility of the reconfigurable and adaptive optics; characterize transmission, reflectance and absorption of materials and material coatings, and begin assessment of suitability for military environments; determine efficacy of micro-displays necessary for high brightness operation and demonstrate compatibility with multiple video source inputs. ***FY 2018 Plans:*** Will validate range performance of reconfigurable optical elements in sensor objectives and augmented reality display optics while maintaining optimized overlay of display and real scene; conduct investigation of suitability of novel optical element surface treatments for high optical throughput; mature high resolution displays for targeting and maneuver; validate optical components through bench top end-to-end testing.			
Title: Multi-Function Digital Readout Integrated Circuits for Cooled and Uncooled Focal Plane Arrays	4.677	6.645	6.334
Description: The objective of this effort is the development of advanced 2D and 3D DROICs to replace legacy 2D analog ROICs. This effort will investigate and design a digital readout architecture optimized for large format, high resolution IR FPAs through the use of modeling, analysis, and simulations. This enabling technology will bring substantial advancements to IR imaging capabilities. ***FY 2016 Accomplishments:*** Investigated and developed novel Analog to Digital (A/D) architectures for new high definition FPAs; investigated A/D architectures compatible with 2D or 3D integration by use of advanced lithographic techniques; developed small pitch vertical interconnect			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
technology such as Through-Silicon Via (TSV) technology, Isolated Deep Silicon Via Technology (iDSV), and wafer thinning and bonding processes to allow for 3D stacking of sensor display functionalities. ***FY 2017 Plans:*** Will conduct experiments to validate multi-layer ROIC functionality; explore novel material research and newly maturing technologies to increase on-chip processing capabilities; examine and quantify the ability of multi-layer ROIC technology to store large amounts of charge in very small pixel areas, while maintaining state-of-the-art noise performance; investigate the high dynamic range imaging capabilities enabled by multi-layer ROICs; begin designs of a digital ROIC circuit for uncooled sensors to enable increased performance. ***FY 2018 Plans:*** Will fabricate multi-layer ROIC to significantly increase ability to storage of charge in a very small pixel area; validate new ROICs and arrays with increased dynamic range capability over legacy cooled imaging sensors; refine designs of digital ROIC circuitry for uncooled sensors; produce initial test structures for laboratory validation of designs.			
Title: Computational Imaging ***Description:*** This effort develops component technology designed to increase battle space awareness, threat detection and target identification (ID) by using a methodology of computation algorithms and optics combined with display and vision processing . The objective is to provide extended range, multi-spectral imaging capability, with reductions to the size, weight and cost (SWaC), for the individual warfighter. This effort will leverage work accomplished under Multi-Function DROICs for Cooled and Uncooled FPAs to provide improved mounted and dismounted soldier situational understanding in urban and complex terrain under low light and visibility conditions. ***FY 2017 Plans:*** Will conduct a trade study focused of optics, sensors and processing focused on day/night helmet mounted 3D imagers; research and validate computational algorithms centered on high speed hemispherical threat detection and localization sensors and optics; explore applications of new optics concepts for multispectral weapon and handheld surveillance devices. ***FY 2018 Plans:*** Will investigate novel optics, sensors, and processing approaches for day/night visualization; conduct experiments in 3D scene visualization with compact infrared sensors; validate predicted algorithm performance for threat detection and sensor localization; begin development of new optic for performing real-time detection and localization operations	-	5.228	4.413
Title: High Sensitivity High Speed Uncooled Longwave Infrared (UCIR) Technology	-	-	5.167

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: Develop a new class of uncooled high sensitivity/high speed IR imaging sensors to enable applications such as Hostile Fire Indication (HFI), Improvised Explosive Device (IED) and disturbed earth detection, driving/pilotage, unmanned ground/air vehicles sensors, 360º situational awareness sensors, and missile seekers by leveraging commercial processes. ***FY 2018 Plans:*** Will conduct experiments on new materials and structure designs; produce initial test arrays based on the new materials; incorporate advances in DROIC designs to enable sensitivity and dynamic range increases over currently available uncooled LWIR technology.			
Accomplishments/Planned Programs Subtotals	32.501	36.079	34.723

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / *Night Vision Technology*	Project (Number/Name) K90 / *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	

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
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	5.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Night Vision Component Technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	5.000	-
FY 2016 Accomplishments: This is a Congressional Interest Item.		
Congressional Adds Subtotals	5.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A