Exhibit R-2, RDT&E Budget Item Justification: PB 2014 Army											DATE: April 2013	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 2: *Applied Research*					R-1 ITEM NOMENCLATURE PE 0602709A: *NIGHT VISION TECHNOLOGY*							
COST ($ in Millions)	**All Prior Years**	**FY 2012**	**FY 2013#**	**FY 2014 Base**	**FY 2014 OCO ##**	**FY 2014 Total**	**FY 2015**	**FY 2016**	**FY 2017**	**FY 2018**	**Cost To Complete**	**Total Cost**
Total Program Element	-	54.002	53.244	43.426	-	43.426	38.199	38.550	39.733	40.257	Continuing	Continuing
H95: *Night Vision and Electro-Optic Technology*	-	54.002	53.244	43.426	-	43.426	38.199	38.550	39.733	40.257	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

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 awareness (SA). Project H95 advances infrared (IR) Focal Plane Array (FPA) technologies, assesses and evaluates sensor materials, designs advanced multi-function lasers for designation and range finding, and develops modeling and simulation for validating advanced sensor technologies. In FY11 through FY16 the Army investment in advanced IR FPA technologies is augmented to ensure a world-wide technological and competitive IR sensor advantage for the United States.

Work in this PE is fully coordinated with PE 0602120A (Sensors and Electronic Survivability), PE 0602705A (Electronics and Electronic Devices), PE 0602712A (Countermine Technology) and PE 0603710A (Night Vision Advanced Technology).

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 Army Research, Development and Engineering Command (RDECOM)/Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

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B. Program Change Summary ($ in Millions)	**FY 2012**	**FY 2013**	**FY 2014 Base**	**FY 2014 OCO**	**FY 2014 Total**
Previous President's Budget	55.116	53.244	43.426	-	43.426
Current President's Budget	54.002	53.244	43.426	-	43.426
Total Adjustments	-1.114	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.114	-			

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COST ($ in Millions)	All Prior Years	FY 2012	FY 2013#	FY 2014 Base	FY 2014 OCO ##	FY 2014 Total	FY 2015	FY 2016	FY 2017	FY 2018	Cost To Complete	Total Cost
H95: *Night Vision and Electro-Optic Technology*	-	54.002	53.244	43.426	-	43.426	38.199	38.550	39.733	40.257	Continuing	Continuing

FY 2013 Program is from the FY 2013 President's Budget, submitted February 2012

The FY 2014 OCO Request will be submitted at a later date

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 awareness (SA) at an affordable price. Component technologies include novel focal plane arrays (FPAs), processing and electronics improvements, and modeling and simulation to predict performance and to determine operational effectiveness. This research focuses on dual band infrared (IR) FPAs necessary to search, identify and track mobile targets in all day/night visibility and battlefield conditions and to improve standoff detection in ground-to-ground and air-to-ground operations. This project designs, fabricates and validates very large format IR FPAs needed for sensors to simultaneously provide wide area coverage and the high resolution for situational awareness, persistent surveillance and plume/gunflash detection. In addition this project develops multispectral and hyperspectral algorithms for on-chip hyperspectral functionality, which offer the ability to perform detection, identification and signature identification at extended ranges as well as the ability to detect targets in "deep hide". Reducing size, weight and power (SWaP) is a key research objective for all efforts. In FY11 through FY16 the Army investment in advanced IR FPA technologies is augmented to ensure a world-wide technological and competitive IR sensor advantage for the United States.

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence, Soldier, Ground and Air portfolios.

Work in this project is fully coordinated with PE 0602705A (Electronics and Electronic Devices), PE 0602712A (Countermine Technology) and PE 0603710A (Night Vision Advanced Technology).

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 Army Research, Development and Engineering Command (RDECOM)/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 2012	FY 2013	FY 2014
Title: Distributed Aided Target Recognition (AiTR) Evaluation Center of Excellence	1.296	1.533	1.821
Description: This effort researches a Defense-wide virtual/distributed capability to interactively process both real and generated 3-Dimension multispectral scenes from sensor simulations. Automatic target recognition (ATR) and aided target recognition (AiTR)			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
algorithms are evaluated against realistic operational scenarios in aided or fully autonomous reconnaissance, surveillance and target acquisition (RSTA) missions to include roadside threats/explosively formed projectiles. ***FY 2012 Accomplishments:*** Investigated the Aided Target Recognition (AiTR) algorithm evaluation process for multiple sensor modalities including threat explosive detection; evaluated AiTR algorithms in order to quantify performance against established figures of merit using real data of threat explosives in urban environments to differentiate threat explosives from clutter; evaluated AiTR algorithms using real world scenario data including urban environments, threat explosive targets and hard targets in order to further populate AiTR algorithm performance databases. ***FY 2013 Plans:*** Investigate and evaluate adaptable target tracking algorithms for their ability to perform target handoff/distribution from one sensor system to another without losing a target; investigate new processing techniques for developing target detection and tracking algorithms that will allow for less processing power for smaller processors in SWaP constrained platform environments. ***FY 2014 Plans:*** Will investigate and evaluate target tracking algorithms through image based detection and confirmation processing to reduce false alarms and lost target tracks for persistent surveillance and airborne sensor systems; investigate signal processing and algorithms for threat detection and tracking that minimizes power consumption, enabling the use of smaller processors in SWaP constrained environments.			
Title: Sensor Modeling and Simulation Technology ***Description:*** This effort investigates, verifies and validates engineering models, measurement techniques and realistic simulations concurrently with the development and transition of core sensor technologies. The goals of sensor modeling and simulation technology is to improve the fidelity and adaptability of in-house simulation capabilities for the purposes of 1) Warfighter training 2) sensor system analysis 3) identifying and addressing phenomenology associated with imaging technologies and 4) perception lab-based model target task calibration of imaging technologies. ***FY 2012 Accomplishments:*** Refined and completed development and validation of complex search and persistent surveillance models and simulations incorporating the next generation cooled Infrared (IR) technology; incorporated the ability to effectively model and simulate moving targets and platforms in a spherical sensor simulation; continued development of next generation sensor simulations to support wargames and engineering tradeoff studies. ***FY 2013 Plans:***	4.984	5.242	5.228

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Incorporate, research and validate an integrated engineering sensor model that includes the capability to predict the performance of multiple imaging systems such as multi-waveband image fusion, hyperspectral sensing, polarization sensing, active-passive image fusion (including laser radar), real-time image processing and models against stationary and moving targets or platforms; refine and complete development of a capability to more accurately assess combatant/non-combatant sensor performance criteria. ***FY 2014 Plans:*** Will expand the engineering models, measurements and simulations to address new and emerging sensor capabilities, modalities and target threats; research and incorporate additions to the predictive engineering sensor performance model to include sub-pixel targets, cooperative sensors, measures of persistence and 3D target rendering; provide calibrated, IR target signatures (human, IED, vehicles) to simulations used for sensor development, training and wargaming; develop and perform perception testing procedures to refine combatant/non-combatant sensor performance related to activity and motion and to document effects of 3D target rendering and displays on human decision; design, implement and publish laboratory measurement standards for new technologies including color/false color imaging, fused imaging across EO/IR bands and 3D displays.			
Title: Advanced Multifunction Laser Technology ***Description:*** This effort investigates technology for a new class of multi-wavelength laser modules which will replace multiple laser systems and reduce the size, weight and cost of current devices such as laser designators, laser rangefinders (LRFs), pointers, markers, warning systems and illuminators. The goal is to achieve a single housing, electronics board, power supply and telescope for all applications to provide a drastic reduction in the SWaP of multi-function laser system, as well as reduction in the logistics inherent in deploying multiple systems. ***FY 2012 Accomplishments:*** Investigated laser output (pulse energies, wavelength, beam divergence) to support the laser capabilities for designation, range finding, daytime pointing and explosive detection; evaluated laser modules to perform size, weight and power trade-offs for assessment of platform transition opportunities; assembled breadboard laser modules capable of generating the required energy or power to produce three or more wavelengths in selectable modes. ***FY 2013 Plans:*** Investigate and validate novel breadboard multi-wavelength laser modules for output energy, beam divergence and boresight over MIL-SPEC temperature range; increase the laser efficiency by optimizing the laser resonator configurations and increasing the laser diode pumping efficiency; improve operation over wide operating range; design a brassboard laser with the goal of minimizing laser SWaP for applications such as designation/marking, LRF and illumination. ***FY 2014 Plans:***	3.839	3.257	4.277

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will investigate technology for a single source of multifunction, eye-safe fiber lasers operating in the Short Wave Infrared Band (SWIR, 1.5 to 2.0 microns); design a single laser for multiple applications in a compact package to perform laser range finding, day/night pointing, and 3D LIDAR imaging.			
Title: High Performance Small Pixel Uncooled Focal Plane Array (FPA) ***Description:*** This effort increases the working performance of both uncooled Longwave Infrared (LWIR) and Shortwave Infrared (SWIR) technologies. Through design and improved fabrication techniques this work increases detector resolution to high definition formats (LWIR-1920x1200 pixels, SWIR- 1280x720 pixels), improves sensitivity and image quality to increase recognition and identification ranges while reducing SWaP. ***FY 2012 Accomplishments:*** Developed pixel material processing of the LWIR FPA with associated Read Out Integrated Circuits (ROICs); developed a novel approach (increase number of pixels from 640 to 1920 pixels) to achieve High Definition (HD) to optimize wafer die size based for performance; investigated and evaluated the identification range performance of the large format LWIR/SWIR FPA electronic system; designed and developed the brass-board optics for SWIR hyperspectral imaging; researched new low noise ROIC that supports HD format clocking and timing; established multiple design lots to prove out the performance of the HD detector and ROIC; investigated camera electronics that support 60Hz HD video (>276MB/sec data rate) in order to support the testing and video analysis of the HD FPA. ***FY 2013 Plans:*** Improve the uncooled LWIR FPA design to include a second revision of the ROIC and pixel design to meet the performance goals of increased sensitivity and prevent image degradation; fabricate and evaluate multiple lots to validate performance; design, fabricate and test a brassboard camera system including support electronics to operate at higher frame rates; design a high performance uncooled hyperspectral SWIR camera with multiple bands using low noise SWIR camera electronics and a reduced pixel size. ***FY 2014 Plans:*** Will complete full performance characterization of the HD 1920 x 1080 pixel uncooled LWIR FPA camera; fabricate the final lot of HD uncooled LWIR FPA and demonstrate in a camera for long range target identification; characterize a high performance uncooled hyperspectral SWIR FPA (1280 x 720 pixel) for detection of difficult targets in high cluttered background.	6.730	7.485	3.007
Title: Advanced Structures for Cooled Infrared (IR) Sensors ***Description:*** This effort researches detector materials and substrates for infrared (IR) sensors. The emphasis is on reducing material defects and increasing the reliability by means of new ways to prepare and treat the substrates and new designs and methods of growing the structures. The goal is to develop cost effective components for high definition Army IR sensors.	3.517	3.727	4.767

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
FY 2012 Accomplishments: Validated the proof of concept of 2-color 256x256 pixel Longwave Infrared (LWIR) and 640x480 pixel Midwave Infrared/Longwave Infrared (MWIR/LWIR) performance; investigated and validated new techniques for Focal Plane Array (FPA) development of very large (2000 x 2000 pixels) FPA grown on low cost substrates with less than 0.5% pixel defects. ***FY 2013 Plans:*** Develop an advanced imprint technology to deposit small indium bumps suitable for high definition format FPAs; typify performance of emerging III-V and HgCdTe on alternate substrate FPAs; experiment with novel techniques for steep sidewalled plasma etching and passivation thus enabling megapixel III-V and II-VI FPAs. ***FY 2014 Plans:*** Will validate indium bump process for high definition format FPAs; research advanced steep sidewalled plasma etching for dual band structures for high definition FPAs, which will provide more pixels on target, increased resolution and higher quality images, thus enabling a reduction in defects.			
Title: Digital Readout Integrated Circuit (ROIC)	7.000	6.500	2.609
Description: This effort investigates and designs new Digital Readout Integrated Circuit (DROIC) technology (digital-in-pixel) enabling the affordable very large format and multiband IR FPAs. The digital-in-pixel results in increased signal storage available to collect incoming signal information from the scene, compared to traditional analog techniques. DROIC is an important component in reducing the overall IR sensor cost and SWaP by allowing much smaller FPA pitch. The increased storage improves dynamic range for targeting, situational awareness and persistent surveillance applications, contributing to the ability of the U.S. to ensure its historical night vision battlefield advantage. ***FY 2012 Accomplishments:*** Fabricated 640x480 pixel digital ROIC implementing innovative on-chip signal processing designs with reduced pitch unit cell; measured dynamic range and signal/noise performance; conducted analysis allowing correlation of digital ROIC sampling noise and parasitic capacitances to signal/noise data; conducted design of ROIC for the 640x480 pixel FPA with reduced pitch unit cell while maintaining performance. ***FY 2013 Plans:*** Fabricate and evaluate high definition, 1280x720 pixel, digital-in-pixel ROIC implementing innovative on-chip signal processing designs with 20 micron pitch unit cell; characterize performance to include dynamic range and signal/noise; conduct design review of ROIC for the 1280x720 FPA with reduced, 12 micron pitch, unit cell resulting in the reduction in overall infrared (IR) sensor cost and SWaP due to much smaller FPA pitch. ***FY 2014 Plans:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Will research and develop a high-definition, digital-in-pixel ROIC with on-chip signal processing for a 12 micron, 1280x720 pixel array; validate the DROIC performance (e.g. high dynamic range and low noise) using a well characterized 640x480, 20 micron pixel array.			
Title: Enhanced IR Detector ("nBn") Technology ***Description:*** This effort investigates and improves a new barrier detector structure that makes midwave IR FPAs easier and more affordable to manufacture and allows operation at higher temperatures resulting in much more affordable sensor systems and also significant reductions in SWaP of system optics, housings and cryogenic coolers. In addition the barrier detector approach allows for very small pixel pitch (8 micron) enabling FPAs of very large format, 5000x5000 pixel, for persistent surveillance applications that were not possible prior to emergence of this barrier FPA technology. This effort contributes to the U.S. ability to ensure its historical night vision advantage. ***FY 2012 Accomplishments:*** Fabricated 1-2 Mega pixel (Mpix) FPA implementing successes from design of experiments on dopant level, type and thickness of individual semi-conductors material layers; further investigated growth of semi-conductor material layers (nBn) on larger diameter (approximately 4-6 inches) Gallium Antimonide (GaSb) and Gallium Arsenide (GaAs) wafers to reduce defects of the FPA and determine cause of defects; designed 5Mpix FPA incorporating feedback from the results of the 1-2Mpix FPA design process. ***FY 2013 Plans:*** Fabricate 2000x2500 pixel FPA with a 10 micron pitch implementing successes from design studies of a variety of potential manufacturing methodologies; evaluate resulting FPA structure and investigate techniques to increase yield by reducing defect formation; continue investigation of growth of semi-conductor material layers (nBn) on larger diameter (approximately 4-6 inches) GaSb and GaAs wafers. ***FY 2014 Plans:*** Will research and develop 2000x2500 8 micron pitch and 4000x4000 10 micron pitch FPAs, resulting in a higher resolution, smaller size array; validate resulting FPA structures and investigate techniques to increase yield by reducing defect formation; conduct comparison studies between single very-large-format versus multiple large-format FPAs by examining FPA pitch size, FPA format, butting issues and IR system interfaces and performance relationships; begin research on very small pitch (5-6 micron) ROIC and FPA designs.	9.980	9.300	7.869
Title: Strained Layer Superlattices (SLS) Technology ***Description:*** This effort investigates and improves III-V material (materials formed by a combination of elements from group III and V of the periodic table) thin film crystal growth of IR FPAs using a very flexible Strained Layer Superlattice (SLS) structure. This will allow high performance multi band infrared FPAs to be produced at much lower costs than the existing II-VI FPAs	11.133	10.700	5.369

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
(Mercury Cadmium Telluride) and can leverage commercial product research and production lines, including cell phone chips, to improve uniformity related to performance. This effort contributes to the U.S. ability to ensure its historical night vision advantage. ***FY 2012 Accomplishments:*** Fabricated 640x480 pixel, dual band, midwave infrared/longwave infrared (MWIR/LWIR) FPA utilizing results of design of experiments involving passivation material and techniques, diode architectures and lithography; designed 640x480 small pixel (15/20 micrometer) dual band MWIR/LWIR FPA on alternate substrates, incorporating feedback from the results of experiments involving passivation material and techniques, diode architectures and lithography; correlated material performance of growth on Gallium Antimonide (GaSb) versus Gallium Arsenide (GaAs); converted detector fabrication processes from 3 inches to 5 inches diameter GaSb wafer capability. ***FY 2013 Plans:*** Validate design of 1280x720 pixel with reduced pixel pitch, 12 micron, dual band MWIR/LWIR FPAs on alternate substrates; evaluate and fabricate these FPAs using analog ROICs; establish new growth processes on alternative Gallium Arsenide (GaAs) substrates to reduce defects in the SLS FPA; correlate material performance of growth on GaSb versus GaAs allowing reduction in lattice mismatch defects which increases yield and reduces FPA costs. ***FY 2014 Plans:*** Will fabricate 1280x720, 12 micron pitch, dual-band midwave/longwave infrared focal plane arrays on 4 inch GaSb and GaAs substrates; resolve the substrate flatness and detector passivation issues; begin material growth and assess the material quality on 6 inch GaSb and GaAs substrates.			
Title: Wide Field of View Displays and Processing for Head Mounted Display Systems ***Description:*** This effort investigates and designs optical filters, objective lenses and personal display viewing optics that will enable ultra-low profile, lightweight sensors and virtual displays for both individual head mounted and vehicle based, multi-user vision systems using the latest developments in holograms for small package optics that can be readily reconfigured (i.e. ultra-small/light optical zoom). Additional work in this effort investigates image processing as part of the optical design strategy and designs novel approaches for color filtering image processing for low light sensors in order to provide a color low-light imaging capability to the US Warfighter. This effort is fully coordinated with PE 0603710A/ project K86. ***FY 2012 Accomplishments:*** Investigated and evaluated techniques for the development of foveated (pitted) pixel architecture sensors and displays for ultra high resolution without trading field of view or low power. ***FY 2013 Plans:***	3.328	5.500	5.308

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2012	FY 2013	FY 2014
Investigate and design state-of-the-art technology alternatives for large format waveguide based color heads-up displays; investigate and design light weight waveguide head mounted displays; investigate and design high definition, sparse color, low light image sensor/color filter architectures and color image processing algorithms. Validate operation of low latency/power color processing algorithms on dedicated processing hardware platform; perform laboratory based proof-of-concept validation of key performance metrics with clear path for SWaP scalability. ***FY 2014 Plans:*** Will design waveguide optical components with multiple approaches including time domain switchable materials for head mounted and vehicle mounted applications; design and develop color low light solid state silicon focal plane to determine optimum color filter array spectral requirements, mature patterned interference filter coating technology for sub-10 micron pixel spacing and conduct experiments on tactical target low light color phenomenology.			
Title: Solid State Low Light Imaging ***Description:*** This effort develops true starlight and very low light sensing, solid state focal plane technology with reduced power and production cost for Soldier vision enhancement for deficient visibility conditions. The objective of this effort is an all solid state near-IR sensor for replacement of current Image Intensifier (I2) vacuum tube technology. ***FY 2012 Accomplishments:*** Researched, investigated and assessed the power, cost and low light sensitivity trade-offs for employing pixel enhanced quantum efficiency silicon material; evaluated pixel designed architecture for in-pixel gain and ultra-low noise readout circuits. ***FY 2014 Plans:*** Will investigate and develop an all solid state low light imaging architecture with sensor, processor and display in a monolithic stacked design to replace analog vacuum tube based image intensifier; develop ultra-low dark current, high quantum efficiency silicon focal plane array fabrication processes in a US micro-electronic foundry.	2.195	0.000	3.171
Accomplishments/Planned Programs Subtotals	54.002	53.244	43.426

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.