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Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Office of the Secretary Of Defense **Date:** March 2023

Appropriation/Budget Activity 0400: <i>Research, Development, Test & Evaluation, Defense-Wide I BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602234D8Z I <i>Lincoln Laboratory</i>
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COST (\$ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
Total Program Element	-	53.522	45.844	46.858	-	46.858	47.911	48.978	50.004	51.092	Continuing	Continuing
534: <i>Lincoln Laboratory</i>	-	50.022	42.219	43.204	-	43.204	44.253	45.239	46.187	47.195	Continuing	Continuing
815: <i>Cyber Security, Science and Engineering</i>	-	3.500	3.625	3.654	-	3.654	3.658	3.739	3.817	3.897	Continuing	Continuing

Note

New Start (Y/N): No

A. Mission Description and Budget Item Justification

This program supports the Department's initiative to Build Sustainable and Long-Term Advantage.

The MIT Lincoln Laboratory (MIT LL) research project, 534, is an advanced technology research and development effort conducted through a cost reimbursable contract with the Massachusetts Institute of Technology (MIT). The MIT LL project supports innovative, multi-disciplined research that addresses critical national security problems. The project funds innovations that directly lead to the development of new system concepts, technologies, components, and materials in support of Department of Defense (DoD) missions.

As of FY 2022, the project funds eight technology areas. Of the eight areas, four are core-technology areas, three are emerging-technology initiatives and one Integrated Systems technology area. The four core-technology areas are Advanced Devices; Optical Systems and Technology; Information, Computation and Exploitation Sciences, and Radio-Frequency (RF) Systems and Technologies. The three emerging-technology areas are Advanced Materials and Processes; Quantum System Sciences; and Autonomous Systems. The one Integrated Systems technology area focuses on combining novel component-level technologies to create system-level technology solutions for important DoD problems. These technology areas provide critical capabilities that support all DoD mission areas pursued at the Laboratory. The categories are selected in consultation with the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) aligned with the DoD Communities of Interest (CoIs), and with guidance from other DoD agencies to address technology as well as system needs. The research in these categories adapts to solve emerging DoD problems as well as long-standing problems to which new technology advances can be applied. The individual efforts in each area are selected with the goal of enhancing DoD capabilities significantly, rather than incrementally. Supporting these and other priority technology and capability areas are work efforts titled Cyber Security, Science and Engineering under project code 815, which began in FY 2019. The Cyber Security, Science and Engineering research project, 815, supports innovative research that addresses critical national security problems in cyber. The project funds innovations that directly lead to the development of new system concepts, technologies, and algorithms in support of DoD missions. Funding supports high-risk, high-payoff research, which provides unique and specialized capabilities for the current and emerging needs of the Department.

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B. Program Change Summary (\$ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Previous President's Budget	55.516	46.159	47.682	-	47.682
Current President's Budget	53.522	45.844	46.858	-	46.858
Total Adjustments	-1.994	-0.315	-0.824	-	-0.824
• Congressional General Reductions	-	-0.315			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.985	-			
• Program Adjustments	-0.009	-	-0.824	-	-0.824

Change Summary Explanation

The FY 2024 reduction of \$0.824 is comprised of a realignment of \$1.038 million to support Historically Black Colleges and Universities/Minority Serving Institutions program, which is a priority of the Under Secretary of Defense for Research and Engineering (USD(R&E)), \$0.050 million to support departmental priorities and an economic assumption increase of \$0.264.

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COST (\$ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
<i>534: Lincoln Laboratory</i>	-	50.022	42.219	43.204	-	43.204	44.253	45.239	46.187	47.195	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Lincoln Laboratory (LL) research areas that comprise the overall research and development portfolio are described below.

Core-technology areas:

- Advanced Devices emphasizes the development of devices and subsystems utilizing microelectronic, photonic, biological, and chemical technologies to enable new approaches to DoD systems.

Efforts include technologies for high power Radio Frequency (RF) devices; multi-function, highly integrated lasers; fast and sensitive imagers; and mechanical microsystems for autonomous systems.

- Optical Systems and Technology focuses on developing optical technologies for visible, infrared, and wide band spectroscopic sensing as well as communications systems.

The efforts include high energy lasers; scalable focal plane imaging technology; photonic integrated circuits; optical system prototypes; and associated phenomenology measurements.

- Information, Computation and Exploitation Sciences develops novel architectures, tools, and techniques for the processing, fusion, interpretation, computation, and exploitation of multi-sensor, multi-intelligence data.

Efforts include innovative hardware and software technologies for graph processors and cloud computing; artificial intelligence (AI) and graph algorithms for analytics, including deep learning algorithms; multi-intelligence analytics, including open-source data processing techniques; and human-machine interfacing and automation technologies to enhance warfighter effectiveness and ability to work with advanced computing systems.

- Radio Frequency (RF) Systems and Technology focuses on RF technologies to enhance warfighting capabilities in radars, electronic warfare (EW), and communications.

Efforts include development of next generation phased arrays; ultra-wideband RF systems; compact RF systems; small satellite RF payload; and advanced algorithms for jammer mitigation and EW.

Emerging-technology areas:

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- Advanced Materials and Processes emphasizes research in new materials for additive manufacturing and emerging nanoscale materials.

Efforts include research in understanding and controlling diamond chemical vapor deposition to support emerging and future applications; novel growth and transfer strategies for low-defect III-V devices; microwave circuits built with 3D printing; programmable shape change materials; and microsystems using metamaterials.

- Quantum System Sciences focuses on the development of quantum-based technologies that support sensing, communication, computation, and algorithms using quantum information.

Efforts include the demonstration of scalable computation platforms, magnetic field sensing using highly-compact, atomic-like defects in diamond, prototyping revolutionary quantum networking systems and technology, and research into advanced quantum algorithms and their applications.

- Autonomous Systems has the objective of developing mobile, autonomous, robotic platforms, as well as sensors and algorithms that support key capabilities needed for a wide range of DoD applications.

Efforts span advanced AI and processing; sensors and communications for unmanned platforms; platform designs and energy systems; human-machine interactions; and verification and validation of autonomous systems.

Systems technology area:

- Integrated Systems technology efforts use multiple new technologies to solve important national problems.

Efforts selected for funding have an applied research component focused on integrated technology capability or technologies that facilitate greater levels of integrated capability. Projects target key DoD warfare domains, including space, air, land, sea surface, and undersea.

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
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<p>Title: Advanced Devices</p> <p>Description: This project area targets the research and development of unique and innovative components, subsystems, and sensing concepts or methodologies that will enable new solutions to important DoD problems.</p> <p>Activities under this technology area include revolutionary imaging technologies, specialized silicon and compound semiconductor-based devices for radio frequency (RF), analog, mixed-signal, and digital electronics; photonics, optoelectronics and laser technologies; microsystems; components and subsystems enabling advanced computing; and novel devices and concepts for chemical, biological, and radiation sensing.</p> <p>FY 2023 Plans:</p>	5.100	4.487	5.585
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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
<p>The Advanced Devices program will continue ongoing efforts with the goal of advancing this applied research to a stage where it can be transitioned to other programs.</p> <p>In particular, it is expected that nearer-term transition opportunities will be developed for Multi-GHz Lasers for Quantum Networks, Midwave Infrared Integrated Photonics, and Enabling Technologies for Free-Space Optical Communications.</p> <p>FY 2024 Plans: The Advanced Devices program will continue ongoing efforts with the goal of advancing this applied research to a stage where it can be transitioned to other programs.</p> <p>In particular, it will further nearer-term opportunities to be developed for Multi-GHz Lasers for Quantum Networks, Midwave Infrared Integrated Photonics, and Enabling Technologies for Free-Space Optical Communications.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: The increase of \$1.098 between FY 2023 and FY 2024 will enhance the nearer-term transition opportunities.</p>				
<p>Title: Optical Systems and Technologies</p> <p>Description: The project area conducts research through the development, analysis, and demonstration of novel concepts, technology, and systems for the next-generation of optical systems for the DoD.</p> <p>This area invests in optical systems technologies that fill the critical technology gaps in emerging DoD threat areas, such as anti-access/area denial (A2/AD), counter-weapons of mass destruction (C-WMD), and asymmetric warfare, as well as to develop revolutionary technologies in the traditional DoD mission areas, such as intelligence, surveillance, and reconnaissance (ISR), space control, communications, and ballistic missile defense.</p> <p>FY 2023 Plans: The Optical Systems Technology program will continue to solicit advanced technologies in lasers, receivers, imaging systems as well as in novel optical systems and architectures for next-generation capabilities for national security challenges.</p> <p>FY 2024 Plans: The Optical Systems Technology program will continue progress in next generation passive imaging components, new laser technology, and advanced optical communications. Continue proof of concept testing for long range X ray sensing concept.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: The increase of \$0.791 between FY 2023 and FY 2024 will enhance technologies in lasers, receivers, imaging systems, novel optical systems and architectures for next-generation capabilities.</p>		5.090	4.364	5.155
<p>Title: Radio Frequency (RF) Systems and Technologies</p>		4.200	4.420	5.155

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
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Description: This project area focuses on research, development, and evaluation of innovative RF technologies and concepts in anticipation of DoD and intelligence community requirements for radar, signals intelligence (SIGINT), communications, and electronic-warfare (EW) applications.

Key RF challenges include a rapidly expanding threat spectrum, platforms with severely constrained payloads, operations in strong clutter and interference environments, detection of difficult targets, and robustness against sophisticated electronic attack.

RF technologies of interest include antennas, filters, transmit/receive modules (high-power amplifier, low-noise amplifier, phase shifter, time domain up-sampling), beamformers (analog, digital, photonic), receivers/exciters (local oscillator, mixers, filters, analog-to-digital converter, digital-to-analog converter), and novel RF packaging concepts.

RF systems concepts that address novel analog/digital/photonic architectures and signal processing techniques for improved RF performance are also of interest.

FY 2023 Plans:
The RF Systems program will continue to focus research on advanced RF technologies in support of emerging needs for next generation phased arrays, compact RF systems, and wideband RF systems.

FY 2024 Plans:
The RF Systems program will continue progress in advanced RF signal processing, indoor RF networking, and novel front end component technologies.

FY 2023 to FY 2024 Increase/Decrease Statement:
The increase of \$0.735 between FY 2023 and FY 2024 will provide additional investment on research of innovative RF technologies.

Title: Information, Computation, and Exploitation Sciences	5.396	6.152	6.880
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Description: This project area achieves significant technical gains in data processing, computation, and exploitation.

The volume, velocity, and variety of information production and consumption in the DoD/Intelligence Community (IC) are growing at exponential rates, requiring the development of innovative ways to deal with this data deluge.

Emerging artificial intelligence (AI)/machine learning (ML)-based technologies have the potential to significantly improve military capabilities in traditional domains such as Intelligence, Surveillance, and Reconnaissance (ISR), Command and Control (C2), and Electronic Warfare (EW) in addition to new areas such as grey zone operations.

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
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<p>The project area is structured around a canonical AI-based decision support architecture that addresses the end-to-end processing chain, which includes data conditioning, algorithms, and human-machine teaming to determine courses of action, as well as the advanced heterogeneous computing required to convert raw data into insight.</p> <p>Furthermore, the program addresses specific DoD/IC challenges, such as limited training data and decision process explainability.</p> <p>FY 2023 Plans: The Information, Computation, and Exploitation Sciences program will continue applied research and development along several key technical thrusts, including predictive and prescriptive analytics, automated Processing, Exploitation and Dissemination (PED), advanced computing technologies, and human-machine teaming, all within the context of the AI oriented decision support architecture.</p> <p>FY 2024 Plans: The Information, Computation, and Exploitation Sciences program will continue applied research and development along several key technical thrusts, including predictive and prescriptive analytics, automated Processing, Exploitation and Dissemination (PED), advanced computing technologies, and human-machine teaming, all within the context of the AI oriented decision support architecture.</p> <p>Continue progress in AI and exploitation algorithms for DoD missions. Continue to develop computational architectures for AI and big data applications. Apply advanced AI algorithms within select mission applications areas (material discovery, cyber, etc.).</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: The increase of \$0.728 between FY 2023 and FY 2024 will provide additional investment towards research on the key technical thrust areas.</p>			
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<p>Title: Autonomous Systems</p> <p>Description: This project area performs applied research in autonomous robotics to address current and anticipated national security needs.</p> <p>One project area goal is to enable unmanned systems to perform useful tasks in uncertain environments as trusted, capable agents without continuous human operator control.</p> <p>Project elements include the development of autonomy algorithms and technologies, and of infrastructure to quickly develop autonomous systems.</p>	4.055	4.280	4.400
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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
<p>Lincoln Laboratory also collaborates with research universities to transfer promising autonomy concepts from academia into prototype systems.</p> <p>Technology areas include perception and world modeling, planning, human-robot interaction, manipulation, learning and adaptation, and robotic platforms.</p> <p>Efforts range in scope from simulation-based seedlings to prototype efforts demonstrating autonomous system capabilities in relevant environments.</p> <p>FY 2023 Plans: The focus of decision-making and teaming in complex environments will continue; research will continue related to AI for autonomy, multi-agent systems, and trust and resilience.</p> <p>FY 2024 Plans: Continue progress in AI for robotics, platform technology, multi agent systems, and trusted and resilient autonomy. Continue to develop multi agent autonomous space technology for mission planning and satellite coordination.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: The increase of \$0.120 between FY 2023 and FY 2024 is an adjustment for economic assumptions.</p>				
<p>Title: Quantum System Sciences</p> <p>Description: This project area develops methods for sensing, communicating, and processing information using quantum mechanical manipulation not possible with classical computing techniques.</p> <p>Collaborating with major universities, quantum system science efforts are establishing a robust scientific foundation.</p> <p>On this foundation, application-oriented developments important for national security are being fostered.</p> <p>FY 2023 Plans: The Quantum System Sciences program will focus on other applied research topics in quantum sensing, quantum communications, and quantum computing.</p> <p>FY 2024 Plans: Future work in the program will focus on the underlying scientific and engineering issues of quantum system science.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement:</p>		5.079	4.834	5.486

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
They increase of \$0.652 million between FY 2023 and FY 2024 will provide additional investment on research of other applied research topics in quantum sensing, quantum.				
<p>Title: Advanced Materials and Processes</p> <p>Description: This project area develops materials and processes that make a transformative impact on enduring national challenges.</p> <p>Areas of strategic focus are material property customization and material enablers for highly-integrated, miniature platform.</p> <p>FY 2023 Plans: The Advanced Materials and Process program will continue to conduct research on all forms of data-enhanced, computationally accelerated materials development, alongside a focus on advanced materials technologies that underpin small platforms.</p> <p>Focus on the following areas: beyond CMOS electronics, materials for advanced sensors, integrated microstructures, and other advanced structures.</p> <p>FY 2024 Plans: The Advanced Materials and Process program will continue to conduct research on all forms of data-enhanced, computationally accelerated materials development, alongside a focus on advanced materials technologies that underpin small platforms.</p> <p>Continue focus on the following areas: beyond CMOS electronics, materials for advanced sensors, integrated microstructures, and other advanced structures.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: The increase of \$1.181 million between FY 2023 and FY 2024 will reflect enhanced focus on the following areas: beyond CMOS electronics, materials for advanced sensors, integrated microstructures, and other advanced structures.</p>		3.216	3.119	4.300
<p>Title: Integrated Systems</p> <p>Description: This project area combines multiple new technologies to solve important national needs.</p> <p>Projects selected for funding have an applied research component focused on integrated technology capability or technologies that facilitate greater levels of integrated capability.</p> <p>Projects target key DoD warfare domains, including space, air, land, sea surface, and undersea.</p> <p>The intent is to support early work on systems that cut across the conventional categories.</p>		5.236	6.571	6.243

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
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<p><i>FY 2023 Plans:</i> The Integrated Systems program will continue to support projects that innovate at the system level through architecture, design, and/or introduction of new technologies from other line research areas.</p> <p>The projects will be those of strategic interest to the DoD and aligned with Lincoln Laboratory mission areas.</p> <p><i>FY 2024 Plans:</i> The Integrated Systems program will continue to support projects that will be those of strategic interest to the DoD and aligned with Lincoln Laboratory mission areas.</p> <p><i>FY 2023 to FY 2024 Increase/Decrease Statement:</i> The decrease of \$0.328 between FY 2023 and FY 2024 reflects minor deviations in budget priorities.</p>			
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<p><i>Title:</i> Emerging Artificial Intelligence Capabilities</p> <p><i>Description:</i> This project area funds the emerging Artificial Intelligence (AI) needs of the DoD in addressing critical operational and research areas.</p> <p>The AI approach addresses both the immediate operational issues as well as the long-term research requirements of the Department.</p> <p>However, significant gaps exist both in the ability to understand and apply AI at the tactical edge, democratized AI development across the Department, and use new AI approaches to improve the innovation ecosystem.</p> <p><i>FY 2023 Plans:</i> This project will continue to explore engineering and training requirements for deploying and retraining machine learning tools at the tactical edge and demonstrating such capabilities in operationally relevant environments, as well as continuing to fund projects from FY 2022.</p> <p><i>FY 2023 to FY 2024 Increase/Decrease Statement:</i> The decrease of \$3.992 between FY 2023 and FY 2024 is the result of the Emerging Artificial Intelligence Capabilities project being completed in FY 2023.</p>	12.650	3.992	-
Accomplishments/Planned Programs Subtotals	50.022	42.219	43.204

C. Other Program Funding Summary (\$ in Millions) N/A

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C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

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COST (\$ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
815: Cyber Security, Science and Engineering	-	3.500	3.625	3.654	-	3.654	3.658	3.739	3.817	3.897	Continuing	Continuing

A. Mission Description and Budget Item Justification

The Cyber Security, Science and Engineering research project focuses on the development of technologies and new techniques for the protection of systems against cyber- attack and exploitation.

Efforts include research into technologies for cyber situational awareness, command and control; technology to improve resilience of systems to cyber-attack; and technologies for system exploitation research.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2022	FY 2023	FY 2024
<p>Title: Cyber Security, Science and Engineering</p> <p>Description: This project conducts research and development, including design, analysis, evaluation, and deployment, of prototype systems to improve the security of computer hardware, software, and networks.</p> <p>Its goal is to assure the resilience of Department of Defense (DoD) missions against cyber-attack and cyber-exploitation, with particular emphasis on the overlap between traditional Laboratory mission areas and the cyber domain.</p> <p>Ongoing efforts and areas of concentration include: foundational approaches for integrating traditional and cyber domains, tools and methods to compute threat-based cyber metrics, artificial intelligence (AI) and machine learning-based capabilities supporting cyber analysis and decision making, building trustworthy and resilient mission systems even with untrustworthy components, new cryptographic systems and prototypes, side-channel prevention and exploitation techniques in cyber and cyber-physical systems, and techniques for exploit repurposing.</p> <p>Integral to these efforts are demonstrations of the impact of cyber effects on traditional kinetic systems, the quantitative and repeatable evaluation of prototypes, and deployment of prototype technology to national-level exercises.</p> <p>The cyber security mission area uses line funding to research new cyber security techniques in anticipation of DoD and Intelligence Community (IC) needs and requirements.</p> <p>FY 2023 Plans: The Cyber Security, Science and Engineering program will continue to develop far-reaching cyber improvements that will significantly improve our interactions with the cyber world.</p>	3.500	3.625	3.654

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
<p>The program will continue to extend cyber applied research along the following strategic areas: cyber physical systems, cyber operations, resilient systems, and system exploitation.</p> <p>FY 2024 Plans: The Cyber Security, Science and Engineering program will continue to develop far-reaching cyber improvements that will significantly improve our interactions with the cyber world.</p> <p>The program will continue to extend cyber applied research along the following strategic areas: cyber physical systems, cyber operations, resilient systems, and system exploitation.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: The increase of \$0.029 between FY 2023 and FY 2024 is the result of economic assumptions.</p>			
Accomplishments/Planned Programs Subtotals	3.500	3.625	3.654

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A