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Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Air Force **Date:** March 2023

Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 5: System Development & Demonstration (SDD)</i>	R-1 Program Element (Number/Name) PE 0604201F / <i>PNT Resiliency, Mods, and Improvements</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	-	158.193	176.335	163.156	0.000	163.156	217.277	126.390	85.526	88.622	0.000	1,015.499
651030: <i>GPS Receiver Development</i>	-	158.193	176.335	163.156	0.000	163.156	217.277	126.390	85.526	88.622	0.000	1,015.499
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

Positioning, Navigation, and Timing (PNT) solutions are critical to defense operations, enabling delivery of precision fires, safe aerial navigation, and time coordination across multiple platforms and subsystems. PNT must be maintained in the face of emerging and continuously evolving electronic and cyber threats, requiring increased system resiliency and rapid adaptability similar to that historically required of electronic warfare systems. Evolving threats will drive upgrades such as Global Positioning System (GPS) receiver modernization, development of standard navigational system formats/interfaces, increased use of open system architecture design principles, incorporation of alternative navigation sources into navigational solutions, advanced anti-jam antennas, antenna electronics, radio frequency monitoring/locating/reporting capabilities, and precision clock improvements to maintain current and future force capabilities.

Project 651030 includes Embedded GPS/Inertial Navigation System (INS) Modernized (EGI-M), Miniaturized Airborne GPS Receiver 2000 Modernization (MAGR-2K-M), Resilient GPS (R-EGI) development, anti-jam antenna/antenna electronics development, situational awareness devices, and other advanced/non-GPS PNT solutions. Activities also include, but are not limited to, current program planning, rapid prototyping/concept development, execution, and future program planning and support to other GPS enabled systems as required. The PNT Resiliency, Mods, and Improvements (RMI) effort provides rapidly re-programmable application space for Alternate Satellite Navigation Systems User Equipment (UE), enabling agile and resilient response to GPS threat environments. Funds may be used to address emerging and short-notice Diminishing Manufacturing and Material Shortage (DMSMS) issues.

This requirement supports performance of a full financial audit as required by title 10 U.S.C. Chapter 9A, Sec 240-D.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver weapon system capability. The use of such program funds would be in addition to the civilian pay expenses budgeted in program element 0605827F, 0605828F, 0605829F, 0605831F, 0605832F, 0605833F, 0605898F, 0606398F. In FY22 \$1.609M was expended for civilian pay expenses in this program element, and in FY23 \$2.731M is forecasted for civilian pay expenses in this program element.

The total cost of the R-EGI Middle Tier of Acquisition effort is \$167.7M, including RDT&E and procurement of prototype units. The R-EGI is fully funded across the Future Years Defense Program.

The FY2024 funding request was reduced by \$16.097M to account for the availability of prior year execution balances.

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Project Positioning Navigation Timing Software Defined User Equipment (PNT SDUE), changed from Navigation, Timing, Satellite 3 (NTS-3) Software Defined User Equipment (SDUE)/Soteria.

This program is in Budget Activity 5, System Development and Demonstration (SDD) because it has passed Milestone B approval and is conducting engineering and manufacturing development tasks aimed at meeting validated requirements prior to full rate production.

B. Program Change Summary (\$ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Previous President's Budget	163.520	176.824	182.497	0.000	182.497
Current President's Budget	158.193	176.335	163.156	0.000	163.156
Total Adjustments	-5.327	-0.489	-19.341	0.000	-19.341
• Congressional General Reductions	0.000	-0.489			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-5.327	0.000			
• Other Adjustments	0.000	0.000	-19.341	0.000	-19.341

Change Summary Explanation

FY22 decreased by \$5.327M due to SBIR. FY23 \$0.489 reduction due to Federally Funded Research and Development Center mark.
 FY24 funding decrease is due to \$3.650M transfer to fund AFWERX, \$16.097M for under-execution, and \$0.478 for higher AF priorities.

C. Accomplishments/Planned Programs (\$ in Millions)	FY 2022	FY 2023	FY 2024
Title: Embedded GPS/INS - Modernized (EGI-M)	88.836	59.324	17.947
Description: EGI-M is a combined INS/GPS aircraft position, navigation, and timing system. Program upgrades EGI design to enhance resiliency against existing and emerging navigational warfare threats, incorporating design features (such as interface standardization and software modularity) to incorporate alternative navigation and timing sources, where cost effective, to reduce DoD cost and time lines to respond to newly identified threats and maintain current force capabilities. Incorporates M-Code and Automatic Dependent Surveillance-Broadcast (ADS-B) Out compliance capability into EGI receivers while addressing parts obsolescence, reducing configuration count from 260+ to a desired end-state of 16, and decreasing production and sustainment costs.			
EGI-M has two prime contractors: Northrop Grumman and Honeywell.			

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
<p>FY 2023 Plans: Continue development and testing of Engineering Development Models (EDMs), from both suppliers, for use in lead platform labs to streamline integration efforts.</p> <p>FY 2024 Plans: Continue development and testing of EDMs. Contractors will also begin building Production Representative Units (PRUs), from both suppliers, for delivery to lead aircraft platforms in support of aircraft operational test.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: Funding decreased due to anticipation of EMD completion. Follow-on efforts will be completed on the IDIQ contract.</p>				
<p>Title: Miniaturized Airborne GPS Receiver 2000 - Modernization (MAGR-2K-M)</p> <p>Description: MAGR-2K-M is an aircraft GPS receiver. Program increases MAGR-2K-Legacy resiliency against existing and emerging navigational warfare threats while reducing cost and timelines to incorporate agile capabilities to respond to newly identified threats. Incorporates M-Code capability into MAGR-2K-Legacy receivers while addressing parts obsolescence and providing a pathway to ADS-B Out implementation. Performs appropriate trade studies and incorporates additional resiliency features, such as alternate navigation inputs, where cost effective.</p> <p>FY 2023 Plans: Continue with the integration of unscheduled MGUE SW builds 6.3 and 6.3.1. Conduct testing and problem resolution of any issues that may arise from Lead Platform testing. Deliver upgraded PRUs to AF and Navy for platform integration efforts. Initiate performance qualification testing and development of artifacts to acquire Program Executive Officer (PEO) certification (Milestone C), which enables platforms to procure MAGR-2K-M units for fielding.</p> <p>FY 2024 Plans: Continue testing and problem resolution of any issues that may arise from Lead Platform and box level qualification testing (Performance, Cyber, Military Standard Order and Development Test). Prepare artifacts to acquire Program Executive Office (PEO) certification (Milestone C), which enables platforms to procure MAGR 2K-M units for fielding.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: Funding decreased due to baseline development effort completion. The remaining FY24 funds will be used for firmware updates, bug fixes, and testing efforts.</p>		14.664	15.500	7.000
Title: PNT Resiliency, Mods, and Improvements (RMI)		5.965	2.000	2.000

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
<p>Description: Conduct studies and analysis of PNT systems and requirements, develop and evaluate alternative courses of action, identify, plan and conduct PNT technology transition projects, conduct prototype and acquisition program planning, and provide recommended solutions to DoD and Air Force decision makers relative to navigation warfare threat evolution and technology emergence. This includes work for more flexible Secure Software Defined Receiver User Equipment (to include, but not limited to, developing an associated antenna electronics capability) to capture other than GPS signals like Multi-Global Navigation Satellite Systems to include Navigation Technology Satellite-III.</p> <p>FY 2023 Plans: Conduct studies and analysis of PNT systems and requirements. Supports risk reduction efforts to transition Alternative Navigation technologies into DoD PNT systems. Accommodates evaluation of existing systems. Development / documentation of external and internal interface design requirements.</p> <p>FY 2024 Plans: Continue conducting studies and analysis of PNT systems and requirements. Supports risk reduction efforts to transition Alternative Navigation technologies into DoD PNT systems. Accommodates evaluation of existing systems. Development / documentation of external and internal interface design requirements.</p> <p>FY 2023 to FY 2024 Increase/Decrease Statement: N/A</p>				
<p>Title: Resilient EGI (R-EGI)</p> <p>Description: Establishes a Government Reference Architecture (GRA) embodying open systems architecture concepts, enabling and accelerating the transition of future resilient PNT DoD systems. Enables design and development of various aircraft PNT Line Replaceable Units (LRUs) that are rapidly upgradeable to counter evolving threats. Demonstrates the GRA through prototyping of an open R-EGI LRU. Program matures, prototypes, and tests promising PNT technologies/systems and develops transition paths to flow new technologies into new and/or existing PNT systems. Provides improved PNT resiliency to counter navigational warfare threats through the design, development, test, and transition of science and technology efforts to PNT systems.</p> <p>FY 2023 Plans: Developmental Testing on the Detailed Design Prototypes and early risk reduction towards lead platform integration. Conduct Final Design Review for Production Representative Prototypes (PRP) on lead platform and initiate manufacture of PRPs. Establish development of additional R-EGI form factor and start of early platform integration/requirement alignment of Mission Design Series (MDS) to accept new form factor based on the expected completion of the Final Design Review.</p> <p>FY 2024 Plans:</p>		48.728	50.511	84.209

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2022	FY 2023	FY 2024
Complete deliveries of the Production Representative Prototypes (PRP), Test Readiness Review, Cyber Testing, Developmental Testing, and PRP integration into lead platform. The FY24 milestones and efforts will serve as verification of the R-EGI Line Replaceable Unit (LRU) in preparation of Qualification Testing on Lead Platform test assets, which is also planned to finalize in FY25.				
FY 2023 to FY 2024 Increase/Decrease Statement: Funding increased due to development work shifting in FY24 to accommodate program impacts and R-EGI form factor.				
Title: Positioning Navigation Timing Software Defined User Equipment (PNT SDUE)		0.000	49.000	52.000
Description: PNT SDUE will develop a Software Defined Receiver (SDR) hosted on a Commercial Off-the-Shelf (COTS) Field Programmable Gate Array (FPGA) delivering an M-Code GNSS receiver prototype with agile reprogramming capability to provide robust, resilient PNT against navigational warfare (NAVWAR) and cyber threats with a government owned technical baseline. The program will also develop Software Defined Antenna Electronics (SDAE), an associated antenna electronics capability utilizing COTS FPGA equipment to support the ingest of new satellite signals/capabilities and assist in handling these signals in a software reprogrammable environment. The Global Navigation Satellite System (GNSS) receiver and antenna electronics will interface directly with R-EGI via open standards. This program will transition and field advanced User Equipment capabilities from the Navigation Technology Satellite (NTS)-3 Air Force Vanguard effort.				
FY 2023 Plans: Establish a Program Office and begin acquiring requisite manpower. Initiate a Major Capability Acquisition program utilizing an Other Transaction Authority (OTA) and select a Design Agent. Have the Design Agent begin work on a preliminary design with the intent of holding an Initial Design Review (IDR) 6-9-months after contract award (i.e., early FY24). Begin development of Digital Engineering (DE) artifacts and data gathering to support IDR decision making.				
FY 2024 Plans: Hold the IDR and validate Design Agent initial direction. Begin preparation for the Detailed Design Review (DDR) 18-months after contract award (i.e., early FY25) using requisite design products. DDR will review all developed DE artifacts, and have the ability to meet system size, weight, and power (SWaP) requirements based on DE modeling, system architecture documentation (focus on an open system approach with government owned baseline), and initial design specifications.				
FY 2023 to FY 2024 Increase/Decrease Statement: Funding increased due to ramp up of PNT SDUE developmental efforts.				
Accomplishments/Planned Programs Subtotals		158.193	176.335	163.156

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Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Air Force Date: March 2023

Appropriation/Budget Activity
3600: *Research, Development, Test & Evaluation, Air Force I BA 5: System Development & Demonstration (SDD)*

R-1 Program Element (Number/Name)
PE 0604201F / *PNT Resiliency, Mods, and Improvements*

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

N/A

Remarks

Navigation, Timing, Satellite 3 (NTS-3) Software Defined User Equipment (SDUE)/Soteria has been renamed to Positioning Navigation Timing Software Defined User Equipment (PNT SDUE) beginning FY23 per signed Acquisition Decision Memorandum.

E. Acquisition Strategy

Modify and modernize existing legacy PNT systems to incorporate major enhancements such as GPS M-Code, ADS-B Out, and alternative PNT solutions to GPS while reducing lifecycle costs through common sustainment practices and economies of scale. Design, development, and testing efforts, to include the development of government owned reference architectures for rapid capability insertion, share a common PE to allow flexibility in funding and planning. Integration and operational testing of completed PNT solutions are accomplished by individual platforms and weapons systems. This approach uses a combination of cost-plus and fixed-price contract types based on acquisition phase and risk with a mix between competition and sole-source strategies. Modifications to legacy receivers are acquired via Engineering Change Proposals (ECP)/Task Orders on existing contracts. Other Transaction Authorities (OTA) and industry consortiums are used to support prototyping and open standards development for new PNT solutions.

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2024 Air Force												Date: March 2023			
Appropriation/Budget Activity				R-1 Program Element (Number/Name)				Project (Number/Name)							
3600 / 5				PE 0604201F / PNT Resiliency, Mods, and Improvements				651030 / GPS Receiver Development							
Product Development (\$ in Millions)				FY 2022		FY 2023		FY 2024 Base		FY 2024 OCO		FY 2024 Total			
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Cost To Complete	Total Cost	Target Value of Contract
EGI-M #1 EMD	C/CPFF	Honeywell : Clearwater, FL	-	37.809	Apr 2022	18.938	Nov 2022	3.390	Nov 2023	-		3.390	Continuing	Continuing	-
EGI-M #2 EMD	SS/CPFF	Northrop Grumman : Woodland Hills, CA	-	46.417	Apr 2022	32.719	Nov 2022	4.898	Nov 2023	-		4.898	Continuing	Continuing	-
MAGR-2K-M	SS/CPFF	Raytheon : El Segundo, CA	-	11.214	Apr 2022	12.600	Oct 2022	7.000	Dec 2023	-		7.000	Continuing	Continuing	-
PNT RMI	SS/CPFF	Collins Aerospace : Des Moines, IA	-	1.200	May 2022	4.800	Mar 2023	2.000	Mar 2024	-		2.000	Continuing	Continuing	-
R-EGI	C/CPFF	IS4S : Huntsville, AL	-	42.463	Apr 2022	3.750	Jan 2023	-		-		-	Continuing	Continuing	-
R-EGI Modernization & Additional Platforms	C/CPFF	TBD : TBD	-	-		37.900	Mar 2023	75.419	Jan 2024	-		75.419	Continuing	Continuing	-
PNT SDUE	TBD	Not specified. : TBD	-	2.000	Jun 2022	35.890	May 2023	50.000	Nov 2023	-		50.000	Continuing	Continuing	-
Subtotal			-	141.103		146.597		142.707		-		142.707	Continuing	Continuing	N/A
Support (\$ in Millions)				FY 2022		FY 2023		FY 2024 Base		FY 2024 OCO		FY 2024 Total			
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Cost To Complete	Total Cost	Target Value of Contract
EGI-M FFRDC	Various	MITRE Corp. : Bedford, MA	-	1.300	Nov 2021	0.263	Nov 2022	0.263	Dec 2023	-		0.263	Continuing	Continuing	-
R-EGI FFRDC	Various	MITRE Corp. : Bedford, MA	-	0.624	Nov 2021	1.261	Nov 2022	4.000	Dec 2023	-		4.000	Continuing	Continuing	-
PNT SDUE FFRDC	Various	MITRE Corp : Bedford, MA	-	-		6.150	May 2023	2.000	Dec 2023	-		2.000	Continuing	Continuing	-
DCA Civ Pay	Allot	Allotment : Robins AFB, GA	-	1.631	Apr 2022	2.731	Jan 2023	2.847	Jan 2024	-		2.847	Continuing	Continuing	-
Subtotal			-	3.555		10.405		9.110		-		9.110	Continuing	Continuing	N/A

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2024 Air Force **Date:** March 2023

Appropriation/Budget Activity 3600 / 5	R-1 Program Element (Number/Name) PE 0604201F / PNT Resiliency, Mods, and Improvements	Project (Number/Name) 651030 / GPS Receiver Development
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Test and Evaluation (\$ in Millions)				FY 2022		FY 2023		FY 2024 Base		FY 2024 OCO		FY 2024 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
EGI-M	PO	Various : TBD	-	0.500	Apr 2022	0.500	Nov 2022	0.300	Nov 2023	-		0.300	Continuing	Continuing	-
MAGR-2K-M	PO	Various : TBD	-	1.250	Jun 2022	0.900	Jun 2023	-		-		-	Continuing	Continuing	-
R-EGI	PO	Various : TBD	-	0.750	Apr 2022	1.000	Dec 2022	0.750	Dec 2023	-		0.750	Continuing	Continuing	-
R-EGI Modernization & Additional Platforms	Various	Various : TBD	-	-		1.000	Mar 2023	-		-		-	Continuing	Continuing	-
PNT SDUE	TBD	Not specified. : TBD	-	-		-		-		-		-	Continuing	Continuing	-
Subtotal			-	2.500		3.400		1.050		-		1.050	Continuing	Continuing	N/A

Management Services (\$ in Millions)				FY 2022		FY 2023		FY 2024 Base		FY 2024 OCO		FY 2024 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Strategic Planning/PMA	C/Variou	SERCO : Robins AFB, GA	-	11.035	Oct 2021	15.933	Oct 2022	10.289	Oct 2023	-		10.289	Continuing	Continuing	-
Subtotal			-	11.035		15.933		10.289		-		10.289	Continuing	Continuing	N/A

Project Cost Totals	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	Cost To Complete	Total Cost	Target Value of Contract
-	-	158.193	176.335	163.156	-	163.156	Continuing	Continuing	N/A

Remarks

EGI-M funding for EMD #1 and EMD #2 decreased significantly from FY 23 to FY 24 due to expected EMD completion/Engineering Development Model (EDM) delivery in 2nd Quarter (#2) and 3rd Quarter (#1) FY 24. Follow-on efforts will be accomplished on the production & sustainment IDIQ contract.

R-EGI Modernization & Additional Platforms increase is due to the approval of development of additional R-EGI Form Factor 3.

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Exhibit R-4, RDT&E Schedule Profile: PB 2024 Air Force		Date: March 2023
Appropriation/Budget Activity 3600 / 5	R-1 Program Element (Number/Name) PE 0604201F / PNT Resiliency, Mods, and Improvements	Project (Number/Name) 651030 / GPS Receiver Development

FY 2022				FY 2023				FY 2024				FY 2025				FY 2026				FY 2027				FY 2028			
1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

PNT	
EGI-M #1 EMD (Honeywell)	[Redacted]
EGI-M #1 Modernization & Additional Platforms	[Redacted]
EGI-M #2 EMD (NGC)	[Redacted]
EGI-M #2 Modernization & Additional Platforms	[Redacted]
MAGR-2K-M EMD	[Redacted]
MAGR-2K-M Testing	[Redacted]
R-EGI Prototyping	[Redacted]
R-EGI Modernization & Additional Platforms	[Redacted]
PNT SDUE	[Redacted]

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Exhibit R-4A, RDT&E Schedule Details: PB 2024 Air Force		Date: March 2023
Appropriation/Budget Activity 3600 / 5	R-1 Program Element (Number/Name) PE 0604201F / <i>PNT Resiliency, Mods, and Improvements</i>	Project (Number/Name) 651030 / <i>GPS Receiver Development</i>

Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
<i>PNT</i>				
EGI-M #1 EMD (Honeywell)	1	2022	3	2026
EGI-M #1 Modernization & Additional Platforms	2	2024	4	2028
EGI-M #2 EMD (NGC)	1	2022	3	2026
EGI-M #2 Modernization & Additional Platforms	2	2024	4	2028
MAGR-2K-M EMD	1	2022	4	2024
MAGR-2K-M Testing	3	2022	4	2026
R-EGI Prototyping	4	2022	4	2024
R-EGI Modernization & Additional Platforms	2	2023	4	2028
PNT SDUE	3	2023	3	2028

Note

Position Navigation and Timing (PNT) schedules updated to reflect current developmental timelines and reflect development for additional aircraft which will be utilizing modernized PNT receiver technology.