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Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Air Force **Date:** April 2022

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 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	-	37.409	163.520	176.824	0.000	176.824	182.497	216.003	125.173	84.849	0.000	986.275
651030: <i>GPS Receiver Development</i>	-	37.409	163.520	176.824	0.000	176.824	182.497	216.003	125.173	84.849	0.000	986.275
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 FY21 \$0.721M was expended for civilian pay expenses in this program element and in FY22 \$2.643M 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.

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.

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B. Program Change Summary (\$ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	38.494	167.520	0.000	0.000	0.000
Current President's Budget	37.409	163.520	176.824	0.000	176.824
Total Adjustments	-1.085	-4.000	176.824	0.000	176.824
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	-4.000			
• 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	0.000	0.000			
• Other Adjustments	-1.085	0.000	176.824	0.000	176.824

Change Summary Explanation

The FY 2022 President's Budget submittal did not reflect FY 2023 through FY 2026 funding. Therefore, an explanation of the change between the two budget positions for FY 2023 cannot be made in a relevant manner.

C. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
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Title: Embedded GPS/INS - Modernized (EGI-M)	16.940	101.139	59.324
<p>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) 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.</p> <p>EGI-M has two prime contractors: Northrop Grumman and Honeywell.</p> <p>FY 2022 Plans: Reestablish schedules following updated MGUE delivery dates and design changes. Continue production of Northrop Grumman Engineering Development Models (EDM) and conduct Test Readiness Review. Continue production of EDMs for the Honeywell design.</p> <p>FY 2023 Plans:</p>			

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
Continue development and test of Production Representative Units (PRU), from both suppliers, for delivery to Lead aircraft platforms in support of aircraft operational test. FY 2022 to FY 2023 Increase/Decrease Statement: Funding decreased due to updates in the re-baselined PRU delivery schedule.				
Title: Miniaturized Airborne GPS Receiver 2000 - Modernized (MAGR-2K-M) 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. The Air Force and the Navy are the primary users of the MAGR-2K-M system. FY 2022 Plans: Integrate Military GPS User Equipment (MGUE) software builds 6.2 and 6.3. Conduct anomaly resolution. Deliver balance of PRUs and upgrade previously delivered Production Representative Units (PRUs) to latest configuration. Initiate performance qualification testing, cyber testing, and developmental testing. FY 2023 Plans: Conduct testing and problem resolution of any issues that may arise from Lead Platform testing. Prepare artifacts to acquire Program Executive Officer (PEO) certification (Milestone C), which enables platforms to procure MAGR-2K-M units for fielding. FY 2022 to FY 2023 Increase/Decrease Statement: Funding increased due to further schedule changes in MGUE and an increased number of MGUE Software drops required to incorporate and test.		1.858	12.464	15.500
Title: PNT Resiliency, Mods, and Improvements (RMI) 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. FY 2022 Plans:		0.352	1.195	2.000

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2021	FY 2022	FY 2023
<p>Conduct studies and analysis of PNT systems and requirements. Supports the acceleration and risk reduction efforts for Secure Software Defined Receiver User Equipment. Accommodates evaluation of existing systems. Development / documentation of external & internal interface design requirements.</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 2022 to FY 2023 Increase/Decrease Statement: Funding increased due to acceleration of risk reduction efforts for Secure Software Defined Receiver User Equipment requirement.</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 2022 Plans: Complete detailed design spiral and produce the Detailed Design Prototype to allow initial integration into developmental testing labs and integration into platform labs. Build on knowledge gained through use of the Detailed Design Prototype in the final design spiral and secure long-lead parts for Production Representative Prototypes. Continue efforts to establish Government owned virtual Software Integration Lab for sustainment and follow on development of the R-EGI system.</p> <p>FY 2023 Plans: Complete Final Design Review for R-EGI development effort and produce Production Representative Prototypes. Execute Test Readiness Review, Cyber Testing, Developmental Testing, and integration into platform labs on the Production Representative Prototypes as verification of the R-EGI LRU in preparation of Qualification Testing on Lead Platform test assets. Initiate development of additional R-EGI form factor and begin early platform integration/requirement alignment of Mission Design Series (MDS) to accept new form factor. Transition to establishment of production follow-on contract.</p> <p>FY 2022 to FY 2023 Increase/Decrease Statement:</p>		18.259	48.722	51.000

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C. Accomplishments/Planned Programs (\$ in Millions)	FY 2021	FY 2022	FY 2023
Funding increased due to R-EGI additional form factor/platform on-ramping funding being approved in FY 2023.			
Title: Software Defined User Equipment	-	0.000	49.000
Description: 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. SDUE will also develop 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 REGI via open standards. SDUE is part of the larger Navigation Technology Satellite (NTS)-3 Air Force Vanguard effort. SDUE supports and is an enabler for the Secretary of the Air Force (SECAF) Operational Effectiveness Imperative (OEI) #1.			
FY 2022 Plans: N/A. Program not funded in FY22.			
FY 2023 Plans: Establish a Program Office and begin acquiring requisite manpower. Initiate a Middle Tier Acquisition program utilizing an Other Transaction Authority (OTA) and select a Design Team. Have the Design Team begin work on a preliminary design with the intent of holding a Preliminary Design Review (PDR) 9-months after contract award (i.e., early FY24). Begin development of Digital Engineering artifacts and data gathering to support PDR decision making.			
FY 2022 to FY 2023 Increase/Decrease Statement: Funding increased due to program funding starting in FY23.			
Accomplishments/Planned Programs Subtotals	37.409	163.520	176.824

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

Remarks

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

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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 2023 Air Force **Date:** April 2022

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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Product Development (\$ in Millions)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 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 #1 EMD	C/CPAF	Honeywell : Clearwater, FL	-	4.663	Sep 2021	37.809	Apr 2022	18.938	Nov 2022	-		18.938	Continuing	Continuing	-
EGI-M #2 EMD	SS/CPFF	Northrop Grumman : Woodland Hills, CA	-	10.139	Sep 2021	51.744	Apr 2022	32.719	Nov 2022	-		32.719	Continuing	Continuing	-
MAGR-2K-M	SS/CPFF	Raytheon : El Segundo, CA	-	4.858	Mar 2021	11.214	Apr 2022	12.600	Oct 2022	-		12.600	Continuing	Continuing	-
PNT RMI	SS/CPFF	Collins Aerospace : Des Moines, IA	-	-		1.200	May 2022	4.800	Mar 2023	-		4.800	Continuing	Continuing	-
R-EGI	C/CPFF	IS4S : Huntsville, AL	-	12.635	Apr 2021	42.463	Apr 2022	3.750	Jan 2023	-		3.750	Continuing	Continuing	-
R-EGI Modernization & Additional Platforms	C/CPFF	TBD : TBD	-	-		-		37.900	Mar 2023	-		37.900	Continuing	Continuing	-
SDUE	TBD	Not specified. : TBD	-	-		2.000	Jun 2022	35.890	May 2023	-		35.890	Continuing	Continuing	-
Subtotal			-	32.295		146.430		146.597		-		146.597	Continuing	Continuing	N/A

Support (\$ in Millions)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 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 FFRDC	Various	MITRE Corp. : Bedford, MA	-	-		1.300	Nov 2021	0.263	Nov 2022	-		0.263	Continuing	Continuing	-
R-EGI FFRDC	Various	MITRE Corp. : Bedford, MA	-	1.851	Mar 2021	0.624	Nov 2021	1.750	Nov 2022	-		1.750	Continuing	Continuing	-
SDUE FFRDC	Various	MITRE Corp : Bedford, MA	-	0.381	Apr 2021	-		6.150	May 2023	-		6.150	Continuing	Continuing	-
DCA Civ Pay	Allot	Allotment : Robins AFB, GA	-	-		2.643	Apr 2022	2.731	Jan 2023	-		2.731	Continuing	Continuing	-
Subtotal			-	2.232		4.567		10.894		-		10.894	Continuing	Continuing	N/A

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2023 Air Force **Date:** April 2022

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 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 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	-		0.500	Continuing	Continuing	-
MAGR-2K-M	PO	Various : TBD	-	-		1.250	Jun 2022	0.900	Jun 2023	-		0.900	Continuing	Continuing	-
R-EGI	PO	Various : TBD	-	0.270	Mar 2021	0.750	Apr 2022	1.000	Dec 2022	-		1.000	Continuing	Continuing	-
R-EGI Modernization & Additional Platforms	Various	Various : TBD	-	-		-		1.000	Mar 2023	-		1.000	Continuing	Continuing	-
SDUE	TBD	Not specified. : TBD	-	-		-		-		-		-	Continuing	Continuing	-
Subtotal			-	0.270		2.500		3.400		-		3.400	Continuing	Continuing	N/A

Management Services (\$ in Millions)				FY 2021		FY 2022		FY 2023 Base		FY 2023 OCO		FY 2023 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/Various	Whitney, Bradley & Brown : Robins AFB, GA	-	2.612	Oct 2020	10.023	Oct 2021	15.933	Oct 2022	-		15.933	Continuing	Continuing	-
Subtotal			-	2.612		10.023		15.933		-		15.933	Continuing	Continuing	N/A

Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	37.409	163.520	176.824	-	176.824	Continuing	Continuing	N/A

Remarks

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Exhibit R-4, RDT&E Schedule Profile: PB 2023 Air Force		Date: April 2022
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	FY 2021				FY 2022				FY 2023				FY 2024				FY 2025				FY 2026				FY 2027			
	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 (NGC)																												
EGI-M #2 EMD (HI)																												
MAGR-2K-M EMD																												
MAGR-2K-M Testing																												
R-EGI Prototyping																												
R-EGI Modernization & Additional Platforms																												
SDUE																												

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Exhibit R-4A, RDT&E Schedule Details: PB 2023 Air Force		Date: April 2022
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Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
<i>PNT</i>				
EGI-M #1 EMD (NGC)	1	2021	1	2026
EGI-M #2 EMD (HI)	1	2021	1	2026
MAGR-2K-M EMD	1	2021	4	2024
MAGR-2K-M Testing	3	2021	4	2026
R-EGI Prototyping	4	2021	4	2023
R-EGI Modernization & Additional Platforms	2	2023	4	2027
SDUE	3	2023	4	2027