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Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force **Date:** May 2021

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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	-	202.354	38.494	167.520	0.000	167.520	-	-	-	-	-	-
651030: <i>GPS Receiver Development</i>	-	202.354	38.494	167.520	0.000	167.520	-	-	-	-	-	-
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 programs funds would be in addition to the civilian pay expenses budgeted in program element 0605831F. In FY20 \$1.662M was expended for civilian pay expenses in this program element, and in FY21 \$1.231M is forecasted for civilian pay expenses in this program element.

BY funding totals include 134.622M requested for the Pacific Deterrence Initiative.

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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	142.782	38.564	50.923	0.000	50.923
Current President's Budget	202.354	38.494	167.520	0.000	167.520
Total Adjustments	59.572	-0.070	116.597	0.000	116.597
• Congressional General Reductions	0.000	-0.070			
• 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	59.572	0.000			
• SBIR/STTR Transfer	0.000	0.000			
• Other Adjustments	0.000	0.000	116.597	0.000	116.597

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 651030: *GPS Receiver Development*

Congressional Add: *Program Increase - Embedded GPS/INS - Modernized (EGI-M)*

Congressional Add Subtotals for Project: 651030

Congressional Add Totals for all Projects

	FY 2020	FY 2021
	75.000	-
	75.000	-
	75.000	-

Change Summary Explanation

FY20 funding increased by 59.572M via reprogramming in order to cover FY21 funding movement due to higher Air Force priorities.

FY21 funding decreased by 0.07M due to general Congressional mark against RDT&E funds.

FY22 funding increased by 116.597M to fund M-Code receiver development in accordance with Department priorities.

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

	FY 2020	FY 2021	FY 2022
Title: Embedded GPS/INS - Modernized (EGI-M)	72.054	0.000	89.420
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			

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>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 2021 Plans: N/A</p> <p>FY 2022 Plans: Finalize production of Northrop Grumman Engineering Development Models (EDM) and conduct TRR on the Honeywell hardware design.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: Funding increased in conjunction with planned receiver development activities for the EGI-M effort.</p>				
<p>Title: Miniaturized Airborne GPS Receiver 2000 - Modernized (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 time lines 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.</p> <p>FY 2021 Plans: N/A</p> <p>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.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: Funding increased in conjunction with planned receiver development activities for the MAGR-2K-M effort.</p>		3.800	0.000	25.200
<p>Title: PNT Resiliency, Mods, and Improvements (RMI)</p> <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</p>		0.500	0.000	2.000

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C. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>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 capture other than GPS signals like Multi-Global Navigation Satellite Systems to include Navigation Technology Satellite-III.</p> <p>FY 2021 Plans: N/A</p> <p>FY 2022 Plans: Conduct studies and analysis of PNT systems and requirements.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: Funding increased in conjunction with planned development activities for prototype efforts.</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 2021 Plans: Converge Phase I R-EGI LRU prototypes into Phase II R-EGI LRU "Best of Breed" prototypes while refining fabrication, testing, and design on functional demonstration prototypes. Continue development of hardware standards and software navigation protocols, aircraft data/communication networking protocols and advanced receiver designs. Continue to mature resilient hardware and software technologies into new and/or existing 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 produce the Production Representative Prototypes. Initiate Developmental Testing and Cyber Testing on the Production Representative Prototypes which starts the verification of the R-EGI LRU.</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement:</p>		51.000	38.494	50.900

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C. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
Funding increased due to refinement of R-EGI LRU Production Representative Prototype design and prototype deliveries supporting Developmental and Operational Test.			
Accomplishments/Planned Programs Subtotals	127.354	38.494	167.520

	FY 2020	FY 2021
Congressional Add: Program Increase - Embedded GPS/INS - Modernized (EGI-M)	75.000	-
FY 2020 Accomplishments: EGI-M development, testing, and production engineering development models (EDM).		
Congressional Adds Subtotals	75.000	-

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 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 2022 Air Force **Date:** May 2021

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 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 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	-	34.976	Jul 2020	-		59.420	Oct 2021	-		59.420	-	-	-
EGI-M #2 EMD	SS/CPFF	Northrop Grumman : Woodland Hills, CA	-	95.504	Oct 2019	-		30.000	Oct 2021	-		30.000	-	-	-
MAGR-2K-M	SS/CPFF	Raytheon : El Segundo, CA	-	3.800	Oct 2019	-		25.200	Oct 2021	-		25.200	-	-	-
PNT RMI	SS/CPFF	Collins Aerospace : Des Moines, IA	-	0.500	Oct 2019	-		0.500	Oct 2021	-		0.500	-	-	-
R-EGI	C/CPFF	IS4S : Huntsville, AL	-	51.000	Feb 2020	35.383	Oct 2020	41.500	Oct 2021	-		41.500	-	-	-
Subtotal			-	185.780		35.383		156.620		-		156.620	-	-	N/A

Support (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 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	-	0.263	Sep 2020	-		-		-		-	-	-	-
R-EGI FFRDC	Various	MITRE Corp. : Bedford, MA	-	1.663	Sep 2020	1.925	Oct 2020	0.720	Oct 2021	-		0.720	-	-	-
Subtotal			-	1.926		1.925		0.720		-		0.720	-	-	N/A

Test and Evaluation (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 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	Oct 2019	-		-		-		-	-	-	-
MAGR-2K-M	PO	Various : TBD	-	0.400	Oct 2019	-		-		-		-	-	-	-
R-EGI	PO	Various : TBD	-	0.030	Nov 2019	0.500	Oct 2020	0.500	Oct 2021	-		0.500	-	-	-
Subtotal			-	0.930		0.500		0.500		-		0.500	-	-	N/A

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Management Services (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 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	-	13.718	Oct 2019	0.686	Oct 2020	9.680	Oct 2021	-		9.680	-	-	-
Subtotal			-	13.718		0.686		9.680		-		9.680	-	-	N/A
Project Cost Totals			-	202.354		38.494		167.520		-		167.520	-	-	N/A

Remarks
Funding increased in FY 2022 because of planned receiver development activities and to recover from the lack of funding in FY 2021.

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Exhibit R-4, RDT&E Schedule Profile: PB 2022 Air Force		Date: May 2021
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FY 2020				FY 2021				FY 2022				FY 2023				FY 2024				FY 2025				FY 2026			
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	

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Exhibit R-4A, RDT&E Schedule Details: PB 2022 Air Force		Date: May 2021
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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	2020	1	2026
EGI-M #2 EMD (HI)	2	2020	1	2026
MAGR-2K-M EMD	1	2020	4	2023
MAGR-2K-M Testing	1	2020	4	2026
R-EGI Prototyping	1	2020	4	2023