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

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 7: Operational Systems Development</i>	R-1 Program Element (Number/Name) PE 0607865A / <i>Patriot Product Improvement</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	-	83.833	178.984	125.932	-	125.932	-	-	-	-	-	-
DV8: <i>Patriot Product Improvement</i>	-	83.833	178.984	125.932	-	125.932	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

The PATRIOT Product Improvement Program (PIP) provides for the upgrade of the PATRIOT System and the Army Integrated Air and Missile Defense (IAMD) system through individual materiel changes and upgrades to current force and IAMD-connected PATRIOT system components (interceptors, ground system equipment, launcher, and current radar) to address operational lessons-learned and other system performance improvements as well as providing enhancements to joint force interoperability, emerging technologies; and software improvements, and convergence enabling transition to IBCS and LTAMDS to provide overmatch capability against emerging threats. As software and hardware improvements are developed, there is a continuing need for system level modeling, simulation, integration and testing. Modeling and Simulation (M&S) allow for performance assessment against emerging threats in a manner that is not practical to demonstrate with live fire flight tests alone due to cost, target availability, and range constraints. Flight testing is periodically required for validation of the modeling and simulation as well as satisfying Army Test and Evaluation Command/ Director, Operational Test and Evaluation (ATEC/DOE) requirements of segment improvements.

This effort supports work with national agencies to evaluate, assess, and develop means to mitigate threat trends and specific threat developments potentially impacting system performance including effective detection, tracking, discrimination, and engagement. Specific improvements may be developed and fielded under this task if warranted. The effort maintains the Mission Tailoring Database, responding to immediate tactical concerns. Database updates are fielded between major software upgrades as necessary.

The PIP line also supports the identification, analysis, design, and test of materiel solutions to counter cyber security and electronic warfare shortcomings to all elements of the Lower Tier Battle Space.

PATRIOT is an integral part of the Integrated Air and Missile Defense (IAMD) Architecture, and enables the incremental fielding of the IBCS capability for Army Air and Missile Defense Battalions.

FY 2022 base dollars in the amount of \$125.932 million support the continuance of critical software improvements for current force PATRIOT and Army IAMD, including Software Improvement for Threat Evolution, PAC-3 Seeker Software Improvement, Advanced Electronic Counter Measures (AECM), Combat ID enhancements, Tasks 2, 6, and 7 activities, program integration, modeling and simulation, acquisition of test assets and targets, Mobile Flight Mission Simulator (MFMS), PDB-8.1 and Patriot Component Software Build (PCSB) software, convergence with the IAMD Battle Command System (IBCS), Lower Tier Air and Missile Defense Sensor (LTAMDS), and government and contractor support.

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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	87.430	187.840	161.960	-	161.960
Current President's Budget	83.833	178.984	125.932	-	125.932
Total Adjustments	-3.597	-8.856	-36.028	-	-36.028
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-2.000			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.597	-6.856			
• Adjustments to Budget Years	-	-	-36.028	-	-36.028

Change Summary Explanation

The \$36.028M decrease in funding from Previous President's Budget 2022 to Current President's Budget 2022 reflects Army decision to realign funding to support advancement of other Army priority development efforts.

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Appropriation/Budget Activity 2040 / 7					R-1 Program Element (Number/Name) PE 0607865A / <i>Patriot Product Improvement</i>				Project (Number/Name) DV8 / <i>Patriot Product Improvement</i>			
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
DV8: <i>Patriot Product Improvement</i>	-	83.833	178.984	125.932	-	125.932	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

The PATRIOT system includes a family of hardware, software, interceptors (PAC-2, Guidance Enhanced Missiles, PAC-3 and PAC-3 Missile Segment Enhancement) and Ground Support Equipment. PATRIOT system components (interceptors, launcher, and radar) are integrated with current force PATRIOT and Army Integrated Air and Missile Defense (IAMD) components, including IBCS and LTAMDS. As PATRIOT system components software and hardware improvements are developed, there is a continuing need for system level modeling, simulation, integration and testing. Modeling and Simulation (M&S) allow for performance assessment against specific threats in a manner that is not practical to demonstrate with live fire flight tests alone due to cost, target availability, and range constraints. Flight testing is periodically required for M&S validation as well as satisfying ATEC/DOE requirements of segment improvements.

-PATRIOT system components software and hardware improvements for threat evolution: Performs necessary analysis and development efforts to maintain PATRIOT system (interceptors, ground support equipment, and current radar) effectiveness against evolving threat technologies, convergence with the IBCS, LTAMDS, and PATRIOT Component Software Builds (PCSB), and specific threat capabilities. This effort identifies evolving threats and threat characteristics that present a challenge to PATRIOT's current capabilities and develops initial concepts to maintain system effectiveness including detection, tracking, discrimination, and engagement relative to these threats. Additionally, evolving threat information is used to develop, integrate, and assess evolving lethality models in high-fidelity interceptor simulations supporting system level assessment of hit-to-kill and warhead interceptor performance.

-Advanced Electronic Counter Measures (AECM): This task investigates the implications of advanced technology Digital Radio Frequency Memory available on airborne platforms that enables new ECM techniques which could adversely degrade Air and Missile Defense System effectiveness. AECM efforts support PATRIOT system interceptors, ground support equipment, and current radar.

-Task 2: Implements improve ground system and interceptor capabilities (PATRIOT Advanced Capability-2/Guidance Enhanced Missiles, PATRIOT Advanced Capability-3, and Missile Segment Enhancement) to counter emerging Tactical Ballistic Missile threats.

-Task 6: Software improvements enhance ground support equipment and current radar discrimination of higher altitude Tactical Ballistic Missile Re-entry Vehicles (RVs) from associated objects to support the full engagement capabilities of the interceptor. Longer-range detection, track, and improved high-altitude discrimination are required to achieve the required lethality performance against the RV and to mitigate and reduce missile wastage against separation debris. This task leverages the signal processing capabilities of the Radar Digital Processor, and supports the high altitude engagements required by the PATRIOT Advanced Capability-3 (PAC-3) and PAC-3 Missile Segment Enhancement (MSE) missiles.

-Task 7: Performs analysis on existing and evolving TBM countermeasures to determine the effects on PATRIOT system effectiveness. Develops hardware and software concepts to address countermeasure effects to ensure the PATRIOT system maintains its effectiveness. Develops detailed system requirements to implement concepts; design/code/test software implementation leveraging Radar Digital Processor, Modernized Adjunct Processor, Enhanced Weapons Control Computer - Emulator and Flight Solution Computer-Redesign processing capabilities. Implements simulation-based concepts to define trade space and establish system requirements.

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Appropriation/Budget Activity 2040 / 7	R-1 Program Element (Number/Name) PE 0607865A / <i>Patriot Product Improvement</i>	Project (Number/Name) DV8 / <i>Patriot Product Improvement</i>
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-Combat ID Enhancements: Develop and implement improvements to the Radar Digital Processor-Capability Combat ID capabilities and additional Non-Cooperative Target Recognition techniques to further mitigate misclassification and fratricide risk, and to provide the Warfighter with improved situational awareness. This effort mitigates detection, tracking, and engagement errors on friendly targets.

-PAC-3 Seeker Software Improvements: Perform PAC-3 MSE Software improvements to address evolving and newly fielded Electronic Attack threats providing analysis, engineering, prototyping, testing, and tactical software implementation of improvements.

-Program Integration MSE LMMFC: This task support interceptor flight mission analysis, test missile preparation, flight mission interceptor integration, and range safety tasks allowing execution of required PATRIOT flight test activities.

-Mobile Flight Mission Simulator (MFMS) is a real-time system exerciser integrated with tactical ground hardware to simulate signals into the radar. The MFMS is part of the simulation and testing infrastructure required to support fielded PATRIOT.

-Post Deployment Build 8 (PDB-8) continues system testing and analysis for PATRIOT Component Software Build Developmental Test and Evaluation and Limited User Testing required to support fielded PATRIOT. MSE/PAC-3 Raytheon effort provides integration into PATRIOT and associated Raytheon/PATRIOT ground system flight test support.

-US Government and contractor support for PIP efforts supporting system interceptors, ground support equipment, and current radar provide studies and support to ensure the system and its components continue to evolve to defeat emerging threats.

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

	FY 2020	FY 2021	FY 2022
<p>Title: PATRIOT Product Improvement</p> <p>Description: Patriot Product improvement line provides continuous improvement to current force PATRIOT and Army IAMD to keep pace with and counter evolving and emerging threats.</p> <p>FY 2021 Plans:</p> <ul style="list-style-type: none"> -Continue Software Improvement for Threat Evolution and AECM -Continue Combat ID enhancements, ARM Asset Defense, and Assured PNT -Continue Tasks 2, 6, and 7 activities -Continue program development through system level modeling, simulation, integration and test support -Continue test program to include utilization of targets/threat simulators, flight simulator and modeling efforts -Continue test activities to support the TEMP -Continue Ballistic Missile Defense System (BMDS) Integration Testing -Continue PATRIOT program M&S laboratory infrastructure maintenance as well as the conduct of M&S for hardware/software capability improvements -U.S. Government and contractor support to counter emerging threat -Continue PAC-3 Seeker Software Improvements <p>FY 2022 Plans:</p> <ul style="list-style-type: none"> -Continue Software Improvement for Threat Evolution and AECM to address emerging threats and convergence with IBCS and LTAMDS 	79.436	178.984	125.932

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
-Continue Combat ID enhancements -Continue Tasks 2, 6, and 7 activities to develop hardware and software to maintain PATRIOT system effectiveness in the field -Continue program development through system level modeling, simulation, integration and test support to address emerging threats and convergence with IBCS and LTAMDS -Continue test program to include utilization of targets/threat simulators, flight simulator and modeling efforts to maintain system effectiveness -Continue test activities to support the TEMP -Continue Ballistic Missile Defense System (BMDS) Integration Testing -Continue PATRIOT program M&S laboratory infrastructure maintenance as well as the conduct of M&S for hardware/software capability improvements -U.S. Government and contractor support to ensure force effectiveness is maintained to keep pace with evolving and emerging threats -Continue IBCS convergence and PCSB effort (IBCS convergence and PCSB efforts begin in FY21) , and begin LTAMDS integration -Continue PAC-3 Seeker Software Improvements to counter Electronic Attack Threats -Continue interceptor design reviews, system integration activities, test and analysis, and threat analysis and modeling -Continue MSS-2 laboratory support for high fidelity seeker data collection, modeling and analysis FY 2021 to FY 2022 Increase/Decrease Statement: The \$36.028M decrease in funding from Previous President's Budget to Current President's Budget reflects Army decision to realign funding to support advancement of other Army priority development efforts.			
Title: FY 2020 Army Withhold for Pending ATR Description: Pending ATR	4.397	-	-
Accomplishments/Planned Programs Subtotals	83.833	178.984	125.932

C. Other Program Funding Summary (\$ in Millions)											
Line Item	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
• C50700: Patriot Mods	278.716	278.050	205.469	-	205.469	-	-	-	-	-	-
Remarks	The improvements/enhancements developed through the PATRIOT Product Improvement Program (PIP) are interrelated with the hardware kits that are procured and installed under the Missile Procurement, Army (MIPA) appropriation's PATRIOT Mods program and maximizes PAC-3 MSE capabilities.										

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D. Acquisition Strategy

The design objective of the PATRIOT system was to provide a baseline system capable of modification to cope with continuing threat evolution. This program minimizes technological risks and provides a means of enhancing system capability through planned upgrades of deployed systems. The PATRIOT Product Improvement Program upgrades the PATRIOT system and the Army IAMD system to address operational lessons learned, enhancements to joint force interoperability and communications, and other system performance improvements including detection, tracking, discrimination, and engagement to provide overmatch capability against the emerging threat. Upgrades are implemented through individual hardware and software materiel changes and fielded incrementally. This program encompasses several changes which will require the use of a variety of acquisition methods to develop, test, procure and field. Future hardware and software capabilities will be incorporated into future Post Deployment Build (PDB) and Patriot Component Software Build (PCSB) releases, and convergence efforts with IBCS and LTAMDS. Developing, fabricating, and testing hit to kill surface to air missile and associated ground support equipment provides essential increases in battle space, accuracy, lethality and firepower to counter and destroy evolving air defense threats. These state-of-the-art capabilities and enhancements require ongoing demonstration through a series of flight tests and modeling and simulation activities to add survivability and resiliency in a denied environment.

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Army **Date:** May 2021

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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			
Government Program Management	MIPR	RSA, AL : RSA, AL	11.428	1.600	Oct 2019	5.444	Oct 2020	5.474	Oct 2021	-		5.474	Continuing	Continuing	-
U.S. Contracts	Various	Multiple : Multiple	8.561	1.239	Feb 2020	1.700	Feb 2021	1.770	Feb 2022	-		1.770	Continuing	Continuing	-
PAC-3 Product Office	RO	Project Office : Huntsville, AL	-	-		1.900	Oct 2020	-		-		-	Continuing	Continuing	-
FY 2020 Army Withhold Pending ATR	TBD	Various : Various	-	4.397		-		-		-		-	0.000	4.397	-
Subtotal			19.989	7.236		9.044		7.244		-		7.244	Continuing	Continuing	N/A

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			
Software Improvement for Threat Evolution	Various	Multiple : Multiple	55.287	7.983	Jan 2020	8.756	Jan 2021	6.486	Jan 2022	-		6.486	Continuing	Continuing	-
Advanced Electronic Counter Measures (AECM)	Various	Multiple : Multiple	83.738	17.059	Jan 2020	16.390	Jan 2021	7.736	Jan 2022	-		7.736	Continuing	Continuing	-
Task 2 Non-Ballistic Tactical Ballistic Missile (TBM)	Various	Multiple : Multiple	42.500	5.839	Feb 2020	6.300	Feb 2021	6.648	Feb 2022	-		6.648	Continuing	Continuing	-
Task 6 Discrimination Improvements	Various	Multiple : Multiple	41.200	6.339	Feb 2020	6.100	Feb 2021	5.074	Feb 2022	-		5.074	Continuing	Continuing	-
Task 7 TBM Countermeasures / Effectors	Various	Multiple : Multiple	37.700	8.939	Feb 2020	9.561	Feb 2021	8.787	Feb 2022	-		8.787	Continuing	Continuing	-
Assured PNT	Various	Multiple : Multiple	14.340	2.439	Jan 2020	1.900	Jan 2021	-		-		-	Continuing	Continuing	-
Combat ID Enhancements	Various	Multiple : Multiple	34.657	14.171	Feb 2020	14.736	Feb 2021	2.912	Feb 2022	-		2.912	Continuing	Continuing	-
Anti-Radiation Missile (ARM) Asset Defense	Various	Raytheon : Andover, Massachusetts	5.000	-		1.200	May 2021	-		-		-	Continuing	Continuing	-
PAC-3 Seeker SW Improvement	TBD	Multiple : Multiple	7.526	13.489	Nov 2020	13.874	Feb 2021	2.649	Feb 2022	-		2.649	Continuing	Continuing	-

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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			
CDC and OGAs	MIPR	RSA : RSA	-	-		0.800	Oct 2020	0.836	Oct 2021	-		0.836	Continuing	Continuing	-
Program Integration MSE LMMFC	Various	LMMFC : Dallas, TX	-	-		21.262	Feb 2021	13.308	Feb 2022	-		13.308	Continuing	Continuing	-
MSE/PAC-3 Raytheon	Various	Raytheon : Watham, Massachusetts	-	-		7.900	Feb 2021	5.100	Feb 2022	-		5.100	Continuing	Continuing	-
SETA Contracts	Various	Multiple : Multiple	-	-		2.800	Feb 2021	2.900	Feb 2022	-		2.900	Continuing	Continuing	-
Subtotal			321.948	76.258		111.579		62.436		-		62.436	Continuing	Continuing	N/A

Remarks
The contract method type Sole Source/Various is Fixed Price Level of Effort which includes Cost Plus Fixed Fee for material, ODC, and travel.

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			
CCDC and Other Govt Agencies	MIPR	RDEC and OGA'S : RSA, AL	5.912	0.339	Jan 2020	6.800	Jan 2021	7.000	Jan 2022	-		7.000	Continuing	Continuing	-
Targets/Threat Simulation	MIPR	Various : Huntsville, AL	-	-		26.396	Jan 2021	23.650	Jan 2022	-		23.650	Continuing	Continuing	-
Modeling and Simulation	MIPR	Various : Huntsville, AL	-	-		3.022	Jan 2021	3.700	Jan 2022	-		3.700	Continuing	Continuing	-
Contractor T&E	Various	Multiple : Various	-	-		8.328	Feb 2021	6.012	Feb 2022	-		6.012	Continuing	Continuing	-
Other T&E	MIPR	Various : WSMR, NM	-	-		4.600	Jan 2021	4.600	Jan 2022	-		4.600	Continuing	Continuing	-
Mobile Flight Mission Simulator	SS/FPIF	Raytheon : Massachusetts	-	-		1.000	Feb 2021	1.175	Feb 2022	-		1.175	Continuing	Continuing	-
PDB-8	MIPR	Various : WSMR, NM	-	-		8.215	Feb 2021	10.115	Feb 2022	-		10.115	Continuing	Continuing	-
Subtotal			5.912	0.339		58.361		56.252		-		56.252	Continuing	Continuing	N/A

Project Cost Totals	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
	347.849	83.833	178.984	125.932	-	125.932	Continuing	Continuing	N/A

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Army							Date: May 2021			
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	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract	

Remarks

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Exhibit R-4, RDT&E Schedule Profile: PB 2022 Army		Date: May 2021
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Event Name	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
Software Build	[Redacted]																											
Advanced Electronic Counter Measures (AECM)	[Redacted]																											
Software Improvement for Threat Evolution	[Redacted]																											
Combat ID Enhancements	[Redacted]																											
PDB 8.1	[Redacted]																											
PDB 8.1 Material Release	[Redacted]																											
Task 2 Non-Ballistic Tactical Ballistic Missile (TBM)	[Redacted]																											
Task 6 Discrimination Improvements	[Redacted]																											
Task 7 TBM Countermeasures / Effectors	[Redacted]																											
Assured PNT	[Redacted]																											
PAC-3 Seeker Software Improvements	[Redacted]																											
PATRIOT System Testing, Integration and Evaluation	[Redacted]																											
Program Development, Integration, and Support	[Redacted]																											

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Exhibit R-4, RDT&E Schedule Profile: PB 2022 Army		Date: May 2021
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Event Name	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
Testing, Targets, Modeling and Simulation																												
Testing, Targets, Modeling and Simulation																												
Developmental/Operational Flight Testing																												
Developmental/Operational Flight Testing																												
Follow-On Flight Testing																												
Follow-On Flight Testing																												

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Exhibit R-4A, RDT&E Schedule Details: PB 2022 Army		Date: May 2021
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Schedule Details

Events	Start		End	
	Quarter	Year	Quarter	Year
Software Build	4	2005	4	2028
Advanced Electronic Counter Measures (AECM)	1	2014	4	2028
Software Improvement for Threat Evolution	1	2014	4	2028
Combat ID Enhancements	1	2014	4	2028
PDB 8.1	2	2023	1	2029
PDB 8.1 Material Release	2	2023	2	2023
Task 2 Non-Ballistic Tactical Ballistic Missile (TBM)	1	2015	4	2028
Task 6 Discrimination Improvements	1	2014	4	2028
Task 7 TBM Countermeasures / Effectors	1	2015	4	2028
Assured PNT	1	2017	4	2023
PAC-3 Seeker Software Improvements	2	2020	4	2028
PATRIOT System Testing, Integration and Evaluation	1	2016	4	2028
Program Development, Integration, and Support	1	2016	4	2028
Testing, Targets, Modeling and Simulation	1	2016	4	2028
Developmental/Operational Flight Testing	3	2020	4	2028
Follow-On Flight Testing	4	2022	4	2028