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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 7: Operational Systems Development					R-1 Program Element (Number/Name) PE 0607865A / Patriot Product Improvement							
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	77.391	75.288	96.430	-	96.430	102.095	81.545	97.510	96.395	Continuing	Continuing
DV8: Patriot Product Improvement	-	77.391	75.288	96.430	-	96.430	102.095	81.545	97.510	96.395	Continuing	Continuing

Note

Beginning FY17, funding specific to LTAMD-C realigned to PE 0604114A, Lower Tier Missile Defense (LTAMD) Capability.

A. Mission Description and Budget Item Justification

PATRIOT is an advanced Surface-to-Air guided missile system with a high probability of kill, capable of operation in the presence of Electronic Countermeasures (ECM) and able to conduct multiple simultaneous engagements against high performance air breathing targets and ballistic missiles likely to be encountered by U.S. Forces. The PATRIOT Product Improvement Program provides for the upgrade of the PATRIOT System through individual materiel changes and upgrades to the PATRIOT system to address operational lessons learned, enhancements to joint force interoperability, and other system performance improvements to provide overmatch capability with the emerging threat.

The hardware and software funding provides for the identification, analysis, design and test improvements to the PATRIOT system against the evolving threat. 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. 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.

Funding is also utilized to identify, analyze, design and test materiel solutions to counter cybersecurity and electronic warfare shortcomings to all elements of the Lower Tier Battle Space.

FY20 base dollars in the amount of \$96.430 million support the continuance of Software Improvement for Threat Evolution, PAC-3 Seeker Software Improvement, Advanced Electronic Counter Measures (AECM), Assured Positioning, Navigation and Timing (PNT), Combat ID enhancements, Tasks 2, 6, and 7 activities, government and contractor support.

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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army I BA 7: Operational Systems Development</i>	R-1 Program Element (Number/Name) PE 0607865A / <i>Patriot Product Improvement</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	90.217	65.369	42.803	-	42.803
Current President's Budget	77.391	75.288	96.430	-	96.430
Total Adjustments	-12.826	9.919	53.627	-	53.627
• Congressional General Reductions	-0.042	-0.081			
• Congressional Directed Reductions	-10.750	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	10.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.012	-			
• SBIR/STTR Transfer	-2.022	-			
• Adjustments to Budget Years	-	-	53.627	-	53.627

Change Summary Explanation

Adjustment to budget years increases FY 2020 funding by \$53.627 million; these funds will be used for software development to address evolving threats and countermeasures to those threats, development of Seeker software, ID enhancements, and continuation of task 2, task 6, and task 7.

FY 2019 increase of \$7.526 million will fund development of Seeker Software.

FY 2018 reduction of \$10.75 million for prior year carry-over and "restoring acquisition accountability".

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 7					R-1 Program Element (Number/Name) PE 0607865A / Patriot Product Improvement				Project (Number/Name) DV8 / Patriot Product Improvement			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
DV8: Patriot Product Improvement	-	77.391	75.288	96.430	-	96.430	102.095	81.545	97.510	96.395	Continuing	Continuing
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

Note

Beginning FY17, funding specific to LTAMDS Capability realigned to PE 0604114A, Lower Tier Missile Defense Sensor (LTAMDS) Capability.

A. Mission Description and Budget Item Justification

Software and hardware improvements for threat evolution: Performs necessary analysis and development efforts to maintain PATRIOT system effectiveness against evolving threat technologies and specific threat capabilities. This effort identifies evolving threats and threat characteristics that might present a challenge to PATRIOT's current capabilities and develops initial concepts to maintain system effectiveness relative to these threats.

Upper-Tier Debris Mitigation (UTDM): Implements algorithms to mitigate system impacts of debris from Upper Tier intercepts associated with operating in the Ballistic Missile Defense System (BMDS) environment. Debris from Upper Tier intercepts can cause significant radar loading effects and the potential for erroneous engagements and missile wastage on debris.

Radar Digital Processor (RDP) Waveform Suite: Develops a comprehensive set of waveforms in the RDP to improve PATRIOT radar capabilities against current and evolving threats, including support to Task 6 and 7 efforts (see below), and implements advanced data collection enabled by the RDP to support further system improvements. The new waveforms enabled by the RDP allow capability improvements in Discrimination, Combat ID, Electronic Protection, Search, Tracking, and other areas of need.

THAAD/PATRIOT Interoperability: Implements improvements to THAAD/PATRIOT Interoperability and addresses Joint Defense Network deficiencies that impact Tactical Ballistic Missile battle management and force/engagement operations. Efforts will be concentrated on joint, collaborative force operations (defense design and planning) and enhanced Tactical Digital Information Link - Joint interoperability.

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 affect Air and Missile Defense System effectiveness.

Task 2: Implements improved 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 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

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performance against the RV and to mitigate 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 Tactical Ballistic Missile 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 tradespace and establish system requirements.							
Assured Positioning, Navigation, and Timing (PNT): Efforts will develop and test the military's improved Global Position M-Code with PATRIOT Major End Items (MEI) integrating the improved anti-jamming and secure access of military GPS signals. This effort meets the requirement for Assured PNT through M-Code as mandated by FY2011 National Defense Act, public law 111-383 & 913.							
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.							
Anti-Radiation Missile (ARM) Asset Defense: Provides improved capability for PATRIOT to protect other Army and Joint Services Sensors from ARM attacks. Builds on an initial capability provided in Post-Deployment Build-7 by determining remaining gaps, identifying and evaluating alternatives, and implementing further improvements.							
Tactical Telemetry Ground Station: Develops a ground-based telemetry receive station to be deployed with the tactical units and collect PAC-3 telemetry data for tactical engagements. This data will be used to assess missile and system effectiveness in tactical environments against real-world threats, and will support the development of operational improvements (Firing Doctrine and other system settings) and system software improvements to mitigate stressing threat behaviors.							
PAC-3 Seeker Software Improvements: Perform PAC-3 Missile Segment Software improvements to improve missile capability to counter Electronic Attack Threats.							
U.S. Government and contractor support for PIP efforts. Studies and support to ensure the system and its components continue to evolve to defeat threats.							
B. Accomplishments/Planned Programs (\$ in Millions)			FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: PATRIOT Product Improvement			77.391	75.288	96.430	-	96.430
Description: Patriot Product improvement line provides continuous Improvement to keep pace with and counter evolving and emerging threats.							
FY 2019 Plans:							

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Appropriation/Budget Activity 2040 / 7			R-1 Program Element (Number/Name) PE 0607865A / Patriot Product Improvement			Project (Number/Name) DV8 / Patriot Product Improvement					
B. Accomplishments/Planned Programs (\$ in Millions)							FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
-Continues Software Improvement for Threat Evolution and Advanced Electronic Countermeasures (AECM) -Continues Combat ID enhancements and Assured Positioning, Navigation, and Timing (PNT) -Continues Tasks 2, 6, and 7 activities. -Develop Seeker Software Improvement -U.S. Government and contractor support to counter emerging threat FY 2020 Base Plans: -Continues Software Improvement for Threat Evolution and Advanced Electronic Countermeasures (AECM). -Continues Combat ID enhancements and Assured Positioning, Navigation, and Timing (PNT). -Continues Tasks 2, 6, and 7 activities. -U.S. Government and contractor support to counter emerging threat. -PAC-3 Seeker Software Improvements FY 2019 to FY 2020 Increase/Decrease Statement: Adjustment to budget years increases FY20 funding by \$53.627 million; these funds will be used for software development to address evolving threats and countermeasures to those threats, development of Seeker software, ID enhancements, and continuation of task 2, task 6, and task 7.											
Accomplishments/Planned Programs Subtotals							77.391	75.288	96.430	-	96.430
C. Other Program Funding Summary (\$ in Millions)											
Line Item	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
• C50700: Patriot Mods	536.527	323.228	0.000	279.464	279.464	192.287	135.857	157.679	93.164	Continuing	Continuing
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.											
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 to address operational lessons learned, enhancements to joint force interoperability and communications, and other system performance improvements to provide overmatch capability against the emerging threat. Upgrades are implemented through individual hardware and software materiel											

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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>
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) releases.		
E. Performance Metrics N/A		

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2020 Army												Date: March 2019			
Appropriation/Budget Activity 2040 / 7						R-1 Program Element (Number/Name) PE 0607865A / Patriot Product Improvement				Project (Number/Name) DV8 / Patriot Product Improvement					
Management Services (\$ in Millions)				FY 2018		FY 2019		FY 2020 Base		FY 2020 OCO		FY 2020 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
Government Program Management	MIPR	RSA, AL : RSA, AL	6.000	2.890	Oct 2017	2.538	Oct 2018	1.634	Oct 2019	-		1.634	Continuing	Continuing	-
U.S. Contracts	Various	Multiple : Multiple	5.361	1.600	Feb 2018	1.600	Feb 2019	1.600	Feb 2020	-		1.600	Continuing	Continuing	-
Subtotal			11.361	4.490		4.138		3.234		-		3.234	Continuing	Continuing	N/A
Product Development (\$ in Millions)				FY 2018		FY 2019		FY 2020 Base		FY 2020 OCO		FY 2020 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
Software Improvement for Threat Evolution	Various	Multiple : Multiple	39.099	7.170	Jan 2018	9.018	Jan 2019	10.144	Jan 2020	-		10.144	Continuing	Continuing	-
Upper Tier Debris Mitigation (UTDM)	Various	Multiple : Multiple	1.000	2.940	Jan 2018	-		-		-		-	Continuing	Continuing	-
Radar Digital Processor (RDP) Development	Various	Raytheon : Andover, Massachusetts	49.835	-		-		-		-		-	Continuing	Continuing	-
RDP Waveform Suite	Various	Raytheon : Andover, Massachusetts	-	2.000	Jan 2018	-		-		-		-	Continuing	Continuing	-
THAAD PATRIOT Interoperability	Various	Raytheon : Andover, Massachusetts	3.200	2.200	Jan 2018	-		-		-		-	Continuing	Continuing	
Advanced Electronic Counter Measures (AECM)	Various	Multiple : Multiple	50.004	15.158	Jan 2018	18.576	Jan 2019	19.220	Jan 2020	-		19.220	Continuing	Continuing	-
Task 2 Non-Ballistic Tactical Ballistic Missile (TBM)	Various	Multiple : Multiple	30.100	8.000	Feb 2018	4.400	Feb 2019	6.200	Feb 2020	-		6.200	Continuing	Continuing	-
Task 6 Discrimination Improvements	Various	Multiple : Multiple	28.000	9.500	Feb 2018	3.700	Feb 2019	6.700	Feb 2020	-		6.700	Continuing	Continuing	-
Task 7 TBM Countermeasures / Effectors	Various	Multiple : Multiple	17.000	10.700	Feb 2018	10.000	May 2019	11.100	Feb 2020	-		11.100	Continuing	Continuing	-
Assured PNT	Various	Multiple : Multiple	7.440	3.600	Jan 2018	3.300	Jan 2019	2.800	Jan 2020	-		2.800	Continuing	Continuing	-
Combat ID Enhancements	Various	Multiple : Multiple	15.437	7.683	Feb 2018	11.537	May 2019	16.332	Feb 2020	-		16.332	Continuing	Continuing	-

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2020 Army												Date: March 2019			
Appropriation/Budget Activity 2040 / 7						R-1 Program Element (Number/Name) PE 0607865A / Patriot Product Improvement				Project (Number/Name) DV8 / Patriot Product Improvement					
Product Development (\$ in Millions)				FY 2018		FY 2019		FY 2020 Base		FY 2020 OCO		FY 2020 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
Flat Panel Array Concept Development	Various	Multiple : Multiple	3.300	-		-		-		-		-	Continuing	Continuing	-
Anti-Radiation Missile (ARM) Asset Defense	Various	Raytheon : Andover, Massachusetts	2.000	3.000	Jan 2018	-		-		-		-	Continuing	Continuing	-
Tactical Telemetry Ground Station	Various	Multiple : Multiple	-	0.250	Jan 2018	-		-		-		-	Continuing	Continuing	-
PAC-3 Seeker SW Improvement	TBD	Multiple : Multiple	-	-		7.526	Feb 2019	20.000	Feb 2020	-		20.000	Continuing	Continuing	-
SBIR/STTR	TBD	TBD : TBD	-	-		2.393		-		-		-	0.000	2.393	-
Subtotal			246.415	72.201		70.450		92.496		-		92.496	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 2018		FY 2019		FY 2020 Base		FY 2020 OCO		FY 2020 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
RDEC and Other Govt Agencies	MIPR	RDEC and OGA'S : RSA, AL	4.512	0.700	Jan 2018	0.700	Jan 2019	0.700	Jan 2020	-		0.700	Continuing	Continuing	-
Subtotal			4.512	0.700		0.700		0.700		-		0.700	Continuing	Continuing	N/A
			Prior Years	FY 2018		FY 2019		FY 2020 Base		FY 2020 OCO		FY 2020 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals			262.288	77.391		75.288		96.430		-		96.430	Continuing	Continuing	N/A
Remarks															

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Exhibit R-4, RDT&E Schedule Profile: PB 2020 Army			Date: March 2019		
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>	

Event Name	FY 2018				FY 2019				FY 2020				FY 2021				FY 2022				FY 2023				FY 2024			
	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																												
Software Build																												
Advanced Electronic Counter Measures (AECM)																												
AECM																												
Software Improvement for Threat Evolution																												
Software Threat																												
Combat ID Enhancements																												
Combat ID Enhancements																												
PDB 8 IOC																												
PDB 8 Fielding																												
PDB 8.1																												
Task 2 Non-Ballistic Tactical Ballistic Missile (TBM)																												
Task 2 Non-Ballistic TBM																												
Task 6 Discrimination Improvements																												
Task 6 Discrimination Improvements																												
Task 7 TBM Countermeasures / Effectors																												
Task 7 TBM Countermeasures																												
Assured PNT																												
Assured PNT																												
Tactical Telemetry Ground Station																												
Tactical Telemetry Ground Station																												
PAC-3 Seeker Software Improvements																												
PAC-3 Seeker Software Improvements																												

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Exhibit R-4A, RDT&E Schedule Details: PB 2020 Army			Date: March 2019
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>	

Schedule Details

Events	Start		End	
	Quarter	Year	Quarter	Year
Software Build	4	2005	4	2024
Advanced Electronic Counter Measures (AECM)	1	2014	4	2024
Software Improvement for Threat Evolution	1	2014	4	2024
Combat ID Enhancements	1	2014	4	2024
PDB 8 IOC	4	2018	4	2018
PDB 8 Fielding	2	2018	4	2022
PDB 8.1	3	2022	3	2022
Task 2 Non-Ballistic Tactical Ballistic Missile (TBM)	1	2015	4	2024
Task 6 Discrimination Improvements	1	2014	4	2024
Task 7 TBM Countermeasures / Effectors	1	2015	4	2024
Assured PNT	1	2017	4	2021
Tactical Telemetry Ground Station	2	2018	4	2023
PAC-3 Seeker Software Improvements	2	2020	4	2024