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Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army **Date:** February 2020

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>							
COST (\$ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	72.895	87.430	187.840	-	187.840	161.960	134.570	137.267	137.281	Continuing	Continuing
DV8: <i>Patriot Product Improvement</i>	-	72.895	87.430	187.840	-	187.840	161.960	134.570	137.267	137.281	Continuing	Continuing

A. Mission Description and Budget Item Justification

The PATRIOT Product Improvement Program (PIP) 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. 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 all threats that would not be possible in flight tests due to cost, target 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/DOTE) 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. 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 identification, analysis, design, and test 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 overall Air and Missile Defense (AMD) Architecture and enables the incremental fielding of the system capability for Army Air and Missile Defense Battalions.

FY 2021 base dollars in the amount of \$187,840 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, program integration, modeling and simulation, acquisition of test assets and targets, Mobile Flight Mission Simulator (MFMS), PDB-8, ARM Asset Defense, government and contractor support.

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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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B. Program Change Summary (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	75.288	96.430	102.095	-	102.095
Current President's Budget	72.895	87.430	187.840	-	187.840
Total Adjustments	-2.393	-9.000	85.745	-	85.745
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-9.000			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.393	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	85.745	-	85.745

Change Summary Explanation

Increase to Program Element (PE) 0607865A Patriot Product Improvement is a result of FY 2021 funds realigned from PE 0205456A Lower Tier Air and Missile Defense (AMD) System Project EF9 System Integration and Test.

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Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
DV8: <i>Patriot Product Improvement</i>	-	72.895	87.430	187.840	-	187.840	161.960	134.570	137.267	137.281	Continuing	Continuing
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. As software and hardware improvements are developed, there is a continuing need for system level modeling, simulation, integration and testing. Modeling and simulation allow for performance assessment against all threats that would not be possible in flight tests due to cost, target, and range constraints. Flight testing is periodically required for validation of modeling and simulation as well as satisfying ATEC/DOTE requirements of segment improvements.

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.

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 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.

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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 trade space 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 Fiscal Year (FY) 2011 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.

US 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 2019	FY 2020	FY 2021
<p>Title: PATRIOT Product Improvement</p> <p>Description: Patriot Product improvement line provides continuous Improvement to keep pace with and counter evolving and emerging threats.</p> <p>FY 2020 Plans:</p> <ul style="list-style-type: none"> -Continued Software Improvement for Threat Evolution and Advanced Electronic Countermeasures (AECM). -Continued Combat ID enhancements and Assured Positioning, Navigation, and Timing (PNT). -Continued Tasks 2, 6, and 7 activities. -U.S. Government and contractor support to counter emerging threat. 	72.895	83.460	187.840

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
-PAC-3 Seeker Software Improvements			
<i>FY 2021 Plans:</i> -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			
<i>FY 2020 to FY 2021 Increase/Decrease Statement:</i> FY 2020 to FY 2021 funding increase reflect realignment of funds from PE 0205456A Lower Tier Air and Missile Defense (AMD) System Project EF9 System Integration and Test to support program integration and test activities related to the PATRIOT system.			
<i>Title:</i> FY 2020 SBIR/STTR Transfer <i>Description:</i> Funding transferred in accordance with Title 15 USC ?638 <i>FY 2020 Plans:</i> Funding transferred in accordance with Title 15 USC ?638 <i>FY 2020 to FY 2021 Increase/Decrease Statement:</i> Funding transferred in accordance with Title 15 USC ?638	-	3.970	-
Accomplishments/Planned Programs Subtotals	72.895	87.430	187.840

C. Other Program Funding Summary (\$ in Millions)											
<u>Line Item</u>	<u>FY 2019</u>	<u>FY 2020</u>	<u>FY 2021</u> <u>Base</u>	<u>FY 2021</u> <u>OCO</u>	<u>FY 2021</u> <u>Total</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>Cost To</u> <u>Complete</u>	<u>Total Cost</u>
• C50700: <i>Patriot Mods</i>	323.228	278.716	278.050	-	278.050	223.174	232.559	168.392	178.539	Continuing	Continuing

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

<u>Line Item</u>	<u>FY 2019</u>	<u>FY 2020</u>	<u>FY 2021</u> <u>Base</u>	<u>FY 2021</u> <u>OCO</u>	<u>FY 2021</u> <u>Total</u>	<u>FY 2022</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>Cost To</u> <u>Complete</u>	<u>Total Cost</u>
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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 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. 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.

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Army **Date:** February 2020

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Management Services (\$ in Millions)				FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 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	8.890	2.538	Oct 2018	1.273	Oct 2019	5.444	Oct 2020	-		5.444	Continuing	Continuing	-
U.S. Contracts	Various	Multiple : Multiple	6.961	1.600	Feb 2019	1.239	Feb 2020	1.700	Feb 2021	-		1.700	Continuing	Continuing	-
PAC-3 Product Office	RO	Project Office : Huntsville, AL	-	-		-		1.900	Oct 2020	-		1.900	Continuing	Continuing	-
FY 2020 SBIR/STTR Transfer	TBD	Various : Various	-	-		3.970		-		-		-	0.000	3.970	-
Subtotal			15.851	4.138		6.482		9.044		-		9.044	Continuing	Continuing	N/A

Product Development (\$ in Millions)				FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 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	46.269	9.018	Jan 2019	7.983	Jan 2020	8.756	Jan 2021	-		8.756	Continuing	Continuing	-
Advanced Electronic Counter Measures (AECM)	Various	Multiple : Multiple	65.162	18.576	Jan 2019	17.059	Jan 2020	22.390	Jan 2021	-		22.390	Continuing	Continuing	-
Task 2 Non-Ballistic Tactical Ballistic Missile (TBM)	Various	Multiple : Multiple	38.100	4.400	Feb 2019	5.839	Feb 2020	6.300	Feb 2021	-		6.300	Continuing	Continuing	-
Task 6 Discrimination Improvements	Various	Multiple : Multiple	37.500	3.700	Feb 2019	6.339	Feb 2020	6.100	Feb 2021	-		6.100	Continuing	Continuing	-
Task 7 TBM Countermeasures / Effectors	Various	Multiple : Multiple	27.700	10.000	May 2019	8.939	Feb 2020	9.561	Feb 2021	-		9.561	Continuing	Continuing	-
Assured PNT	Various	Multiple : Multiple	11.040	3.300	Jan 2019	2.439	Jan 2020	2.800	Jan 2021	-		2.800	Continuing	Continuing	-
Combat ID Enhancements	Various	Multiple : Multiple	23.120	11.537	May 2019	14.171	Feb 2020	14.736	Feb 2021	-		14.736	Continuing	Continuing	-
Anti-Radiation Missile (ARM) Asset Defense	Various	Raytheon : Andover, Massachusetts	5.000	-		-		2.000	May 2021	-		2.000	Continuing	Continuing	-
PAC-3 Seeker SW Improvement	TBD	Multiple : Multiple	-	7.526	Feb 2019	17.840	Feb 2020	13.874	Feb 2021	-		13.874	Continuing	Continuing	-

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Army **Date:** February 2020

Appropriation/Budget Activity 2040 / 7	R-1 Program Element (Number/Name) PE 0607865A / Patriot Product Improvement	Project (Number/Name) DV8 / Patriot Product Improvement
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Product Development (\$ in Millions)				FY 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 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	-		0.800	Continuing	Continuing	-
Program Integration MSE LMMFC	Various	LMMFC : Dallas, TX	-	-		-		21.262	Feb 2021	-		21.262	Continuing	Continuing	-
MSE/PAC-3 Raytheon	Various	Raytheon : Watham, Massachusetts	-	-		-		7.900	Feb 2021	-		7.900	Continuing	Continuing	-
SETA Contracts	Various	Multiple : Multiple	-	-		-		2.800	Feb 2021	-		2.800	Continuing	Continuing	-
Subtotal			253.891	68.057		80.609		119.279		-		119.279	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 2019		FY 2020		FY 2021 Base		FY 2021 OCO		FY 2021 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	5.212	0.700	Jan 2019	0.339	Jan 2020	6.800	Jan 2021	-		6.800	Continuing	Continuing	-
Targets/Threat Simulation	MIPR	Various : Huntsville, AL	-	-		-		26.396	Jan 2021	-		26.396	Continuing	Continuing	-
Modeling and Simulation	MIPR	Various : Huntsville, AL	-	-		-		3.600	Jan 2021	-		3.600	Continuing	Continuing	-
Contractor T&E	Various	Multiple : Various	-	-		-		8.906	Feb 2021	-		8.906	Continuing	Continuing	-
Other T&E	MIPR	Various : WSMR, NM	-	-		-		4.600	Jan 2021	-		4.600	Continuing	Continuing	-
Mobile Flight Mission Simulator	SS/FPIF	Raytheon : Massachusetts	-	-		-		1.000	Feb 2021	-		1.000	Continuing	Continuing	-
PDB-8	MIPR	Various : WSMR, NM	-	-		-		8.215	Feb 2021	-		8.215	Continuing	Continuing	-
Subtotal			5.212	0.700		0.339		59.517		-		59.517	Continuing	Continuing	N/A

	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals		274.954	72.895	87.430	187.840	-	Continuing	Continuing	N/A

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Army							Date: February 2020			
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	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	Cost To Complete	Total Cost	Target Value of Contract	

Remarks

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Exhibit R-4, RDT&E Schedule Profile: PB 2021 Army		Date: February 2020
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 2019				FY 2020				FY 2021				FY 2022				FY 2023				FY 2024				FY 2025			
	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 Fielding	[Redacted]																											
PDB 8.1	[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 2021 Army		Date: February 2020
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Event Name	FY 2019				FY 2020				FY 2021				FY 2022				FY 2023				FY 2024				FY 2025			
	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	[Redacted]																											
<i>Testing, Targets, Modeling and Simulation</i>	[Redacted]																											
PDB-8 Fielding	[Redacted]																											
<i>PDB-8 Fielding</i>	[Redacted]																											
Developmental/Operational Flight Testing	[Redacted]																											
<i>Developmental/Operational Flight Testing</i>	[Redacted]																											
Follow-On Flight Testing	[Redacted]																											
<i>Follow-On Flight Testing</i>	[Redacted]																											

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Exhibit R-4A, RDT&E Schedule Details: PB 2021 Army		Date: February 2020
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Schedule Details

Events	Start		End	
	Quarter	Year	Quarter	Year
Software Build	4	2005	4	2027
Advanced Electronic Counter Measures (AECM)	1	2014	4	2027
Software Improvement for Threat Evolution	1	2014	4	2027
Combat ID Enhancements	1	2014	4	2027
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	2027
Task 6 Discrimination Improvements	1	2014	4	2027
Task 7 TBM Countermeasures / Effectors	1	2015	4	2027
Assured PNT	1	2017	4	2021
PAC-3 Seeker Software Improvements	2	2020	4	2027
PATRIOT System Testing, Integration and Evaluation	1	2016	4	2027
Program Development, Integration, and Support	1	2016	4	2027
Testing, Targets, Modeling and Simulation	1	2016	4	2027
PDB-8 Fielding	2	2018	1	2028
Developmental/Operational Flight Testing	3	2020	4	2027
Follow-On Flight Testing	4	2022	4	2027