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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 5: System Development & Demonstration (SDD)</i>	R-1 Program Element (Number/Name) PE 0604820A / <i>Radar Development</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	-	91.782	105.271	127.919	-	127.919	-	-	-	-	-	-
E10: <i>Sentinel</i>	-	91.782	105.271	127.919	-	127.919	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This system is a component of the overall Air and Missile Defense (AMD) architecture and will provide for an incrementally fielded Integrated Air and Missile Defense Fire Control System/capability for the composite Army Air and Missile Defense Brigades. The Sentinel system is a key component of the Army Integrated Air and Missile Defense (AIAMD) architecture and provides critical air surveillance of the forward areas.

Sentinel A3 consists of a radar-based sensor with its prime mover/power, Identification Friend or Foe (IFF), and Forward Area Air Defense (FAAD) Command, Control and Intelligence (C2I) interfaces. The radar is deployed in both an air defense role and a force protection role for Counter-Rocket, Artillery, and Mortar (C-RAM) missions. The sensor is an advanced three-dimensional battlefield X-Band air defense phased-array radar with an instrumented range of 75 kilometers. Sentinel is capable of operating day or night, in adverse weather conditions, in the battlefield environments of dust, smoke, aerosols and enemy countermeasures. It provides 360-degree azimuth coverage for acquisition tracking. Sentinel contributes to the digital battlefield by automatically detecting, classifying, identifying and reporting targets (cruise missiles, unmanned aircraft systems, rotary wing and fixed wing aircraft). Sentinel acquires targets sufficiently forward of the battle area to allow weapons reaction time and engagement at optimum ranges. Sentinel's integrated IFF reduces the potential for fratricide of US and Coalition aircraft.

The Sentinel A4 Active Electronically Scanned Array (AESA) is the next generation of radar technology to replace the current phase and frequency scanned array used by Sentinel today. Sentinel A4 hardware and software upgrades will extend the range for ground-based surveillance and situational awareness; will have faster and more accurate Non-Cooperative Target Recognition (NCTR) for clearing fires and preventing fratricide; will improve track accuracy, and management of larger track loads; and improve operation in severe/urban clutter. The system will provide simultaneous multi-mission capability and provides hemispherical surveillance to detect and track small targets, such as Unmanned Aircraft Systems (UAS) and Cruise Missiles, in clutter and will detect and track slow targets, such as UAS and Rotary Wing aircraft, at low altitudes in clutter. The system will detect, track, and classify Rocket, Artillery, and Mortar (RAM) threats and will support AIAMD and IFPC requirements with Fire Control quality tracks. Sentinel A4 will incorporate the upgraded AN/TPX-61 IFF with M-Code capability added by replacing the GB-Gram card with M-Code GB-Gram cards.

Sentinel program will develop nascent capability and support Army demonstration and test initiatives to increase integrated offensive and defensive capability across warfighter functions and multiple domains.

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
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B. Program Change Summary (\$ in Millions)	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2022 Base</u>	<u>FY 2022 OCO</u>	<u>FY 2022 Total</u>
Previous President's Budget	95.720	109.259	116.381	-	116.381
Current President's Budget	91.782	105.271	127.919	-	127.919
Total Adjustments	-3.938	-3.988	11.538	-	11.538
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-3.938	-3.988			
• Adjustments to Budget Years	-	-	11.538	-	11.538

Change Summary Explanation

Zero sum funding change from Fiscal Year (FY) 2022 Other Procurement Army (OPA) to FY22 Research Development Test & Evaluation (RDT&E) to fully fund the build of five User Operational Evaluation Systems to support the development and scheduling of system of system integration events and to allow soldier touchpoints prior to Low Rate Initial Production (LRIP).

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 5					R-1 Program Element (Number/Name) PE 0604820A / Radar Development				Project (Number/Name) E10 / Sentinel			
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
E10: <i>Sentinel</i>	-	91.782	105.271	127.919	-	127.919	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-		

A. Mission Description and Budget Item Justification

Mission & System Description:

This system is a component of the overall Air and Missile Defense (AMD) architecture and will provide for an incrementally fielded Integrated AMD Fire Control System/ capability for the composite Army Air and Missile Defense Brigades. The Sentinel system is a key component of the Army Integrated Air and Missile Defense (AIAMD) architecture and provides critical air surveillance of the forward areas.

Sentinel A3 consists of a radar-based sensor with its prime mover/power, Identification Friend or Foe (IFF), and Forward Area Air Defense (FAAD) Command, Control and Intelligence (C2I) interfaces. The radar is deployed in both an air defense role and a force protection role for Counter-Rocket, Artillery, and Mortar (C-RAM) missions. The sensor is an advanced three-dimensional battlefield X-Band air defense phased-array radar with an instrumented range of 75 kilometers. Sentinel is capable of operating day or night, in adverse weather conditions, in the battlefield environments of dust, smoke, aerosols and enemy countermeasures. It provides 360-degree azimuth coverage for acquisition tracking. Sentinel contributes to the digital battlefield by automatically detecting, classifying, identifying and reporting targets (cruise missiles, unmanned aircraft systems, rotary wing and fixed wing aircraft). Sentinel acquires targets sufficiently forward of the battle area to allow weapons reaction time and engagement at optimum ranges. Sentinel's integrated IFF reduces the potential for fratricide of United States and Coalition aircraft.

The Sentinel A4 Active Electronically Scanned Array (AESA) is the next generation of radar technology to replace the current phase and frequency scanned array used by Sentinel today. Sentinel A4 hardware and software upgrades will extend the range for ground-based surveillance and situational awareness; will have faster and more accurate Non-Cooperative Target Recognition (NCTR) for clearing fires and preventing fratricide; will improve track accuracy, and management of larger track loads; and improve operation in severe/urban clutter. The system will provide simultaneous multi-mission capability and provides hemispherical surveillance to detect and track small targets, such as Unmanned Aircraft Systems (UAS) and Cruise Missiles, in clutter and will detect and track slow targets, such as UAS and Rotary Wing aircraft, at low altitudes in clutter. The system will detect, track, and classify RAM threats and will support AIAMD and Indirect Fire Protection Capability (IFPC) requirements with Fire Control quality tracks. Sentinel A4 will incorporate the upgraded AN//TPX-61 IFF with M-Code capability added by replacing the GB-Gram card with M-Code GB-Gram cards.

The Research and Development funding supports Sentinel modernization/upgrades to address obsolescence issues and capabilities gaps. Sentinel A4 modernization efforts will increase detection, recognition and identification range by 100%, add RAM detection, increase electronic protect and allow for system capability growth through Fiscal Year (FY) 2050 to address evolving threat.

FY 2022 Funds address the following:

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army	Date: May 2021
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Appropriation/Budget Activity 2040 / 5	R-1 Program Element (Number/Name) PE 0604820A / <i>Radar Development</i>	Project (Number/Name) E10 / <i>Sentinel</i>
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The AESA (Sentinel A4) is the next generation of radar technology to replace the current phase and frequency scanned array used by Sentinel today. The AESA Antenna will provide increased capability including extended range for ground-based surveillance and situational awareness, faster and more accurate NCTR for clearing fires and preventing fratricide, improved Fire Control (FC) quality track accuracy, and management of larger track loads. The AESA will also provide improved operation in severe/urban clutter. The system will detect and track small targets, such as UAS and Cruise Missiles, in clutter and will detect and track slow targets, such as UAS and Rotary Wing (RW) aircraft, at low altitudes in clutter. The system will detect, track, and classify RAM threats and will support Integrated Air and Missile Defense Battle Command System (IBCS) requirements and can contribute sensor support for mitigating current and future Indirect Fire Protection Capability Increment 2 mission requirements. FY 2022 funding supports the build of five user operational evaluation systems which will allow for soldier feedback prior to Low Rate Initial Production (LRIP). These systems will also allow the AESA technology to be used to support engagements for emerging technologies. The Sentinel A4 will incorporate Mode S technologies.

Electronic Attack/Electronic Protect (EA/EP) addresses the electronic countermeasures (ECM) gap. This effort continues through the life of the radar, addressing both changing threats and electronic counter measure gaps.

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

	FY 2020	FY 2021	FY 2022
<p>Title: Product Development</p> <p>Description: Funding is provided for the following efforts:</p> <p>FY 2021 Plans: Will complete procurement of material for Sentinel A4 Engineering and Manufacturing Development (EMD) assets and will begin integration of firmware, software and hardware for Sentinel A4 EMD assets. Will continue to perform technical assessments, concept studies, cost reduction, risk reduction, threat analysis, and required documentation for Sentinel A3.</p> <p>FY 2022 Plans: Will continue integration of firmware, software and hardware for Sentinel A4 EMD assets. Will support build and integration of five (5) Sentinel A4 User Operational Evaluation Systems (UOES) to serve as soldier touch points for feedback prior to initiating Low Rate Initial Production (LRIP). Will provide UOES assets to support test events for emerging requirements. Will continue to perform technical assessments, concept studies, cost reduction, risk reduction, threat analysis, and required documentation for Sentinel A3</p> <p>FY 2021 to FY 2022 Increase/Decrease Statement: Funding increase due to reprogramming to support full funding to build user operational evaluation systems for Sentinel A4 in FY 2022.</p>	89.771	102.259	120.737
<p>Title: Test & Evaluation</p> <p>Description: Funding is provided for the following efforts:</p> <p>FY 2021 Plans:</p>	2.011	3.012	7.182

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 5	R-1 Program Element (Number/Name) PE 0604820A / Radar Development	Project (Number/Name) E10 / Sentinel

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
Will conduct software qualification test and hardware verification testing, field testing against representative targets. Prepare logistics products and required documentation for materiel release of software and hardware upgrades for Sentinel A3.			
FY 2022 Plans: Will conduct software qualification test and hardware verification testing, field testing against representative targets. Prepare logistics products and required documentation for materiel release of software and hardware upgrades for Sentinel A3. Supports Developmental Test for Sentinel A4 EMD assets.			
FY 2021 to FY 2022 Increase/Decrease Statement: Increase due to commencement of Developmental Testing for the Sentinel A4 program.			
Accomplishments/Planned Programs Subtotals	91.782	105.271	127.919

C. Other Program Funding Summary (\$ in Millions)											
<u>Line Item</u>	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2022</u> <u>Base</u>	<u>FY 2022</u> <u>OCO</u>	<u>FY 2022</u> <u>Total</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>Cost To</u> <u>Complete</u>	<u>Total Cost</u>
• EF9: System Integration and Test	93.743	-	0.182	-	0.182	-	-	-	-	-	-
• EX2: Lower Tier Air Missile Defense (LTAMD) Capability	364.154	308.805	327.690	-	327.690	-	-	-	-	-	-
• C50016: System Integration and Test Procurement	107.157	-	-	-	-	-	-	-	-	-	-
• FM3: Future Interceptor	1.918	-	7.895	-	7.895	-	-	-	-	-	-
• C53101: MSE Missile	702.437	678.148	776.696	-	776.696	-	-	-	-	-	-
• EY7: IFPC Increment 2 - Block 1	186.369	153.362	233.512	-	233.512	-	-	-	-	-	-
• C62002: IFPC INC 2- I BLOCK 1 SYSTEM	9.337	62.461	25.253	-	25.253	-	-	-	-	-	-
• FI4: Maneuver - Short Range Air Defense (M-SHORAD)	41.690	4.813	39.376	-	39.376	-	-	-	-	-	-
• C14300: M-SHORAD - Procurement	233.300	517.287	331.575	-	331.575	-	-	-	-	-	-
• S40: Army Integrated Air and Missile Defense	211.634	206.850	157.873	-	157.873	-	-	-	-	-	-
• BZ5075: IAMD Battle Command System	29.629	198.587	301.872	-	301.872	-	-	-	-	-	-
• 0604741A: Air Defense Command, Control and Intelligence - Eng Dev	70.279	62.058	59.518	-	59.518	-	-	-	-	-	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army	Date: May 2021
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Appropriation/Budget Activity 2040 / 5	R-1 Program Element (Number/Name) PE 0604820A / Radar Development	Project (Number/Name) E10 / Sentinel
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C. Other Program Funding Summary (\$ in Millions)

<u>Line Item</u>	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2022</u> <u>Base</u>	<u>FY 2022</u> <u>OCO</u>	<u>FY 2022</u> <u>Total</u>	<u>FY 2023</u>	<u>FY 2024</u>	<u>FY 2025</u>	<u>FY 2026</u>	<u>Cost To</u> <u>Complete</u>	<u>Total Cost</u>
• AD5070: AIR & MSL Defense Planning & Control Sys	39.061	62.517	67.193	-	67.193	-	-	-	-	-	-

Remarks

These programs are an integral part of the Army Integrated Air and Missile Defense (IAMD) architecture.

D. Acquisition Strategy

Sentinel A3 and its predecessors were procured from Raytheon as a non-developmental item. Raytheon owns the Technical Data Package (TDP) for the Sentinel A3 and its predecessors and therefore no other contractor has the technical ability to modify the Sentinel radar or Sentinel software. The modifications planned for the Sentinel that fall into this category are: Electronic Attack/Electronic Protect; Signal Data Processor; North Finding Module; Medium Bandwidth; Resiliency and Software Assurance Modification (RSAM); Counter Rocket Artillery and Mortar (C-RAM), Low Slow Small, Unmanned Aircraft Systems, Cruise Missiles; and Mode S.

For the Sentinel A4 modification, Lockheed Martin was competitively awarded a Fixed Price Incentive Firm (FPIF) contract to develop a modified Sentinel with a new Active Electronically Scanned Array (AESA) antenna.

UNCLASSIFIED

Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Army												Date: May 2021			
Appropriation/Budget Activity				R-1 Program Element (Number/Name)				Project (Number/Name)							
2040 / 5				PE 0604820A / Radar Development				E10 / Sentinel							
Management Services (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 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
Management Support	Various	Various : Multiple	8.494	4.015	Nov 2019	4.592	Nov 2020	4.679	Nov 2021	-		4.679	Continuing	Continuing	Continuing
Subtotal			8.494	4.015		4.592		4.679		-		4.679	Continuing	Continuing	N/A
Product Development (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 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
Sentinel A3 Modifications	Various	Raytheon & Various : Fullerton, CA / Various	11.436	-		-		-		-		-	0.000	11.436	-
Electronic Attack/ Electronic Protect	Various	Raytheon & Various : Fullerton, CA / Various	21.502	4.357	Jan 2020	5.313	Jan 2021	5.327	Jan 2022	-		5.327	Continuing	Continuing	-
Active Electronically Scanned Array (A4)	C/FPIF	Lockheed Martin & Search, Track, Acquire, Radiate, Eliminate (PM STARE) : Syracuse, NY and Huntsville, AL	39.017	74.662	May 2020	91.160	Jan 2021	110.731	Jan 2022	-		110.731	Continuing	Continuing	-
Mode S	Various	Raytheon & Various : Fullerton, CA / Various	6.972	0.851	Jan 2020	-		-		-		-	0.000	7.823	-
Resiliency and Software Assurance Modification (RSAM) upgrade	Various	Raytheon & Various : Fullerton, CA / Various	-	2.209	Jan 2020	-		-		-		-	0.000	2.209	-
Counter Rocket Artillery and Mortars	Various	Raytheon & Various : Fullerton, CA / Various	-	3.677	Jan 2020	1.194	Jan 2021	-		-		-	0.000	4.871	-
Subtotal			78.927	85.756		97.667		116.058		-		116.058	Continuing	Continuing	N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 5	R-1 Program Element (Number/Name) PE 0604820A / Radar Development	Project (Number/Name) E10 / Sentinel
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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			
Sentinel A3 Modifications	Various	Raytheon & Various : Fullerton, CA / Various	3.440	-		-		-		-		-	0.000	3.440	-
Electronic Attack/ Electronic Protect	Various	Raytheon & Various : Fullerton, CA / Various	3.959	0.765	Jan 2020	1.816	Jan 2021	0.840	Jan 2022	-		0.840	Continuing	Continuing	-
Mode S	Various	Raytheon & Various : Fullerton, CA / Various	2.486	0.526	Jan 2020	-		-		-		-	0.000	3.012	-
Resiliency and Software Assurance Modification (RSAM) upgrade	Various	Raytheon & Various : Fullerton, CA / Various	-	0.500	Jan 2020	-		-		-		-	0.000	0.500	-
Counter Rocket Artillery and Mortars	Various	Raytheon & Various : Fullerton, CA / Various	-	0.220	Jan 2020	1.196	Jan 2021	-		-		-	0.000	1.416	-
Active Electronically Scanned Array (A4)	C/FPIF	Lockheed Martin & Search, Track, Acquire, Radiate, Eliminate (PM STARE : Syracuse, NY and Huntsville, AL	-	-		-		6.342	Jan 2022	-		6.342	Continuing	Continuing	-
Subtotal			9.885	2.011		3.012		7.182		-		7.182	Continuing	Continuing	N/A

	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Project Cost Totals	97.306	91.782	105.271	127.919	-	127.919	Continuing	Continuing	N/A

Remarks

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 5	R-1 Program Element (Number/Name) PE 0604820A / Radar Development	Project (Number/Name) E10 / Sentinel
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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				
Sentinel A3																																
Electronic Attack/Electronic Protect (EA/EP)																																
EA/EP																																
Mode S																																
Mode S																																
Resiliency and Software Assurance Modification (RSAM) upg																																
RSAM																																
Counter Rocket Artillery and Mortars																																
C-RAM Mode																																
Active Electronically Scanned Array (AESA) (A4)																																
Engineering Manufacturing and Development Prototype Build and																																
EMD Prototype Build and Integration																																
Preliminary Design Review																																
1 PDR																																
Critical Design Review																																
2 CDR																																
Contractor Verification Testing																																
CVT																																
Developmental Test																																
Developmental Test																																
Limited User Testing																																
LUT																																
User Operational Evaluation System Build and Integration																																
UOES Build and Integration																																

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 5	R-1 Program Element (Number/Name) PE 0604820A / <i>Radar Development</i>	Project (Number/Name) E10 / <i>Sentinel</i>
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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
Initial Operational Test and Evaluation System Build and Integration																												
Initial Operational Test and Evaluation (IOT&E)																												

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

Appropriation/Budget Activity 2040 / 5	R-1 Program Element (Number/Name) PE 0604820A / <i>Radar Development</i>	Project (Number/Name) E10 / <i>Sentinel</i>
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Schedule Details

Events	Start		End	
	Quarter	Year	Quarter	Year
Sentinel A3	2	2019	4	2030
Electronic Attack/Electronic Protect (EA/EP)	2	2015	4	2030
Mode S	2	2018	4	2020
Resiliency and Software Assurance Modification (RSAM) upgrade	4	2019	4	2020
Counter Rocket Artillery and Mortars	2	2020	4	2021
Active Electronically Scanned Array (AESA) (A4)	4	2019	4	2033
Milestone B	4	2019	4	2019
Engineering Manufacturing and Development Prototype Build and Integration	2	2020	2	2022
Preliminary Design Review	2	2020	2	2020
Critical Design Review	2	2021	2	2021
Contractor Verification Testing	4	2021	2	2022
Developmental Test	2	2022	3	2023
Limited User Testing	4	2023	4	2023
User Operational Evaluation System Build and Integration	2	2022	3	2023
Initial Operational Test and Evaluation System Build and Integration	3	2023	4	2024
Initial Operational Test and Evaluation (IOT&E)	4	2024	2	2025