| Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army | Date: February 2020 |
|---|---|
| **Appropriation/Budget Activity**<br>2040: *Research, Development, Test & Evaluation, Army I* BA 5: *System Development & Demonstration (SDD)* | **R-1 Program Element (Number/Name)**<br>PE 0604820A *I Radar Development* |

| 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 | - | 37.847 | 95.720 | 109.259 | - | 109.259 | 116.381 | 65.512 | 69.343 | 30.849 | 0.000 | 524.911 |
| E10: *Sentinel* | - | 37.847 | 95.720 | 109.259 | - | 109.259 | 116.381 | 65.512 | 69.343 | 30.849 | 0.000 | 524.911 |

**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 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.

| B. Program Change Summary ($ in Millions) | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total |
|---|---|---|---|---|---|
| Previous President's Budget | 39.289 | 105.243 | 103.427 | - | 103.427 |
| Current President's Budget | 37.847 | 95.720 | 109.259 | - | 109.259 |
| Total Adjustments | -1.442 | -9.523 | 5.832 | - | 5.832 |
| • Congressional General Reductions | - | - | | | |
| • Congressional Directed Reductions | - | -9.523 | | | |
| • Congressional Rescissions | - | - | | | |
| • Congressional Adds | - | - | | | |
| • Congressional Directed Transfers | - | - | | | |
| • Reprogrammings | -1.442 | - | | | |
| • SBIR/STTR Transfer | - | - | | | |
| • Adjustments to Budget Years | - | - | 5.832 | - | 5.832 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Army | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>2040 / 5 | R-1 Program Element (Number/Name)<br>PE 0604820A / *Radar Development* | Project (Number/Name)<br>E10 / *Sentinel* | |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E10: *Sentinel* | - | 37.847 | 95.720 | 109.259 | - | 109.259 | 116.381 | 65.512 | 69.343 | 30.849 | 0.000 | 524.911 |
| 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 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 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 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 FY 2050 to address evolving threat.

FY 2021 Funds address the following:

The Active Electronically Scanned Array (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 Non-Cooperative Target Recognition (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 Unmanned Aircraft Systems (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 Rocket, Artillery, and Mortar (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. The Sentinel A4 will incorporate Mode S technologies.

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Army | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 5 | **R-1 Program Element (Number/Name)**<br>PE 0604820A / *Radar Development* | **Project (Number/Name)**<br>E10 / *Sentinel* |

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.

Counter Rocket, Artillery & Mortars (C-RAM) capability increase to current Sentinel A3's effectiveness against the Low, Slow, Small (LSS), UAS, Cruise Missile, and RAM threat. This effort develops and implements advanced waveforms and processing to significantly enhance RAM capabilities. These efforts will provide fire control quality data to support LSS, UAS, CM, and RAM interceptors.

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total |
|---|---|---|---|---|---|
| ***Title:*** Product Development | 33.112 | 89.698 | 105.268 | - | 105.268 |
| ***Description:*** Funding is provided for the following efforts:<br><br>***FY 2020 Plans:***<br>Will integrate firmware, software and hardware. Design and build prototype subsystems/components for testing. Complete software code coding and modification of the system search and track logic, clutter mapping, and waveforms for Counter Rocket, Artillery, & Mortar (C-RAM) and Counter Unmanned Aircraft System (C-UAS) missions as well as the Resiliency and Software Assurance Modification (RSAM) upgrade effort. Characterize performance, design & replace firmware, software and hardware. Perform technical assessments, concept studies, cost reduction, risk reduction, threat analysis, and required documentation. Continue development of Active Electronically Scanned Array (AESA) technology, conduct design reviews for Sentinel AESA (Sentinel A4), begin procurement of material for Engineering and Manufacturing Development (EMD) assets.<br><br>***FY 2021 Base Plans:***<br>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.<br><br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>Overall product development funding increases due to the integration efforts for the Engineering and Manufacturing Development (EMD) prototype production for the Sentinel A4 program. | | | | | |
| ***Title:*** Test & Evaluation | 4.735 | 1.675 | 3.991 | - | 3.991 |
| ***Description:*** Funding is provided for the following efforts:<br><br>***FY 2020 Plans:*** | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Army | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 5 | **R-1 Program Element (Number/Name)**<br>PE 0604820A / *Radar Development* | **Project (Number/Name)**<br>E10 / *Sentinel* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2019 | FY 2020 | FY 2021 Base | FY 2021 OCO | FY 2021 Total |
|---|---|---|---|---|---|
| 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.<br>***FY 2021 Base Plans:***<br>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.<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>FY 2020 to FY 2021 funding has a increase to support planned test events for Sentinel A3. | | | | | |
| ***Title:*** FY 2020 SBIR/STTR Transfer<br>***Description:*** Funding transferred in accordance with Title 15 USC ?638<br>***FY 2020 Plans:***<br>Funding transferred in accordance with Title 15 USC ?638<br>***FY 2020 to FY 2021 Increase/Decrease Statement:***<br>Funding transferred in accordance with Title 15 USC ?638 | - | 4.347 | - | - | - |
| **Accomplishments/Planned Programs Subtotals** | 37.847 | 95.720 | 109.259 | - | 109.259 |

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

| Line Item | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| • EF9: *System Integration and Test* | 74.295 | 97.746 | 0.166 | - | 0.166 | 0.169 | - | - | - | 0.000 | 172.376 |
| • EX2: *Lower Tier Air Missile Defense (LTAMD) Capability* | 84.981 | 379.772 | 376.373 | - | 376.373 | 332.007 | 241.235 | 87.419 | 88.298 | 0.000 | 1,590.085 |
| • C50016: *System Integration and Test Procurement* | 105.395 | 107.157 | 0.000 | - | 0.000 | - | - | - | - | Continuing | Continuing |
| • FM3: *Future Interceptor* | - | 2.000 | 7.992 | - | 7.992 | 7.993 | 7.993 | 7.993 | 7.993 | 0.000 | 41.964 |
| • C53101: *MSE Missile* | 1,131.276 | 702.437 | 603.188 | 176.585 | 779.773 | 765.887 | 1,008.835 | 908.799 | 804.295 | Continuing | Continuing |
| • DU3: *IFPC2* | 10.324 | - | 0.000 | - | 0.000 | - | - | - | - | 0.000 | 10.324 |
| • EY7: *IFPC Increment 2 - Block 1* | 92.674 | 194.366 | 235.770 | - | 235.770 | 341.077 | 181.830 | 98.210 | 13.639 | 0.000 | 1,157.566 |
| • C62001: *IFPC Inc 2-I Block 1 Missile 1* | 166.536 | - | 0.000 | - | 0.000 | - | - | - | - | 0.000 | 166.536 |

| Exhibit R-2A, RDT&E Project Justification: PB 2021 Army | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 5 | **R-1 Program Element (Number/Name)**<br>PE 0604820A / *Radar Development* | **Project (Number/Name)**<br>E10 / *Sentinel* |

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

| Line Item | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| • C62002: *IFPC INC 2-I BLOCK 1 SYSTEM* | 31.286 | 9.337 | 106.261 | - | 106.261 | 237.803 | 392.134 | 368.447 | 274.566 | 0.000 | 1,419.834 |
| • FI4: *Maneuver - Short Range Air Defense (M-SHORAD)* | 75.711 | 42.900 | 4.995 | - | 4.995 | 39.863 | 271.946 | 308.415 | 446.026 | 0.000 | 1,189.856 |
| • C14300: *M-SHORAD - Procurement* | - | 233.300 | 378.654 | 158.300 | 536.954 | 330.738 | 80.412 | 436.129 | 728.215 | Continuing | Continuing |
| • S40: *Army Integrated Air and Missile Defense* | 318.850 | 208.638 | 193.929 | - | 193.929 | 63.678 | 33.162 | 94.758 | 74.936 | 0.000 | 987.951 |
| • BZ5075: *IAMD Battle Command System* | - | 29.629 | 201.587 | - | 201.587 | 353.561 | 416.995 | 413.356 | 417.415 | Continuing | Continuing |
| • 0604741A: *Air Defense Command, Control and Intelligence - Eng Dev* | 208.965 | 33.502 | 43.651 | 27.000 | 70.651 | 49.051 | 39.720 | 24.397 | 16.692 | 0.000 | 442.978 |
| • AD5070: *AIR & MSL Defense Planning & Control Sys* | 29.913 | 39.061 | 47.374 | 15.143 | 62.517 | 68.778 | 102.399 | - | - | 0.000 | 302.668 |

**Remarks**

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

**D. Acquisition Strategy**

Sentinel was 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.

Sentinel System of Systems (Sentinel A3): The Sentinel Product Office will contract with Raytheon for risk reduction efforts in the development of the software package to support the identification and engagement of Low Slow Small target sets. The Sentinel Product Office will work with Other Government Agencies to finalize integration and test of the IAMD B Kit on board the Sentinel platform and to add simulation capability to allow a high fidelity representation of Sentinel to IAMD.

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

| Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Army | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>2040 / 5 | R-1 Program Element (Number/Name)<br>PE 0604820A / *Radar Development* | Project (Number/Name)<br>E10 / *Sentinel* | |

**Management Services ($ in Millions)**

| Cost Category Item | Contract Method & Type | Performing Activity & Location | Prior Years | FY 2019 Cost | FY 2019 Award Date | FY 2020 Cost | FY 2020 Award Date | FY 2021 Base Cost | FY 2021 Base Award Date | FY 2021 OCO Cost | FY 2021 OCO Award Date | FY 2021 Total Cost | Cost To Complete | Total Cost | Target Value of Contract |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Management Support | Various | Various : Multiple | 5.651 | 2.843 | Nov 2018 | 3.580 | Nov 2019 | 4.592 | Nov 2020 | - | | 4.592 | Continuing | Continuing | Continuing |
| FY 2020 SBIR/STTR Transfer | TBD | Various : Various | - | - | | 4.347 | | - | | - | | - | 0.000 | 4.347 | - |
| | | **Subtotal** | 5.651 | 2.843 | | 7.927 | | 4.592 | | - | | 4.592 | Continuing | Continuing | N/A |

**Product Development ($ in Millions)**

| Cost Category Item | Contract Method & Type | Performing Activity & Location | Prior Years | FY 2019 Cost | FY 2019 Award Date | FY 2020 Cost | FY 2020 Award Date | FY 2021 Base Cost | FY 2021 Base Award Date | FY 2021 OCO Cost | FY 2021 OCO Award Date | FY 2021 Total 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 | 15.316 | 6.186 | Jan 2019 | 4.924 | Jan 2020 | 5.313 | Jan 2021 | - | | 5.313 | Continuing | Continuing | - |
| Active Electronically Scanned Array (A4) | C/FPIF | Lockheed Martin & Cruise Missile Defense Systems : Syracuse, NY and Huntsville, AL | 18.804 | 20.213 | Sep 2019 | 75.228 | May 2020 | 95.160 | Jan 2021 | - | | 95.160 | Continuing | Continuing | - |
| Mode S | Various | Raytheon & Various : Fullerton, CA / Various | 1.838 | 5.134 | Jan 2019 | 0.452 | Jan 2020 | - | | - | | - | 0.000 | 7.424 | - |
| Resiliency and Software Assurance Modification (RSAM) upgrade | Various | Raytheon & Various : Fullerton, CA / Various | - | - | | 1.774 | Jan 2020 | - | | - | | - | 0.000 | 1.774 | - |
| Counter Rocket Artillery and Mortars | Various | Raytheon & Various : Fullerton, CA / Various | - | - | | 3.306 | Jan 2020 | 1.195 | Jan 2021 | - | | 1.195 | Continuing | Continuing | - |
| | | **Subtotal** | 47.394 | 31.533 | | 85.684 | | 101.668 | | - | | 101.668 | Continuing | Continuing | N/A |

| Exhibit R-3, RDT&E Project Cost Analysis: PB 2021 Army | | | Date: February 2020 |
|---|---|---|---|
| Appropriation/Budget Activity<br>2040 / 5 | R-1 Program Element (Number/Name)<br>PE 0604820A / *Radar Development* | Project (Number/Name)<br>E10 / *Sentinel* | |

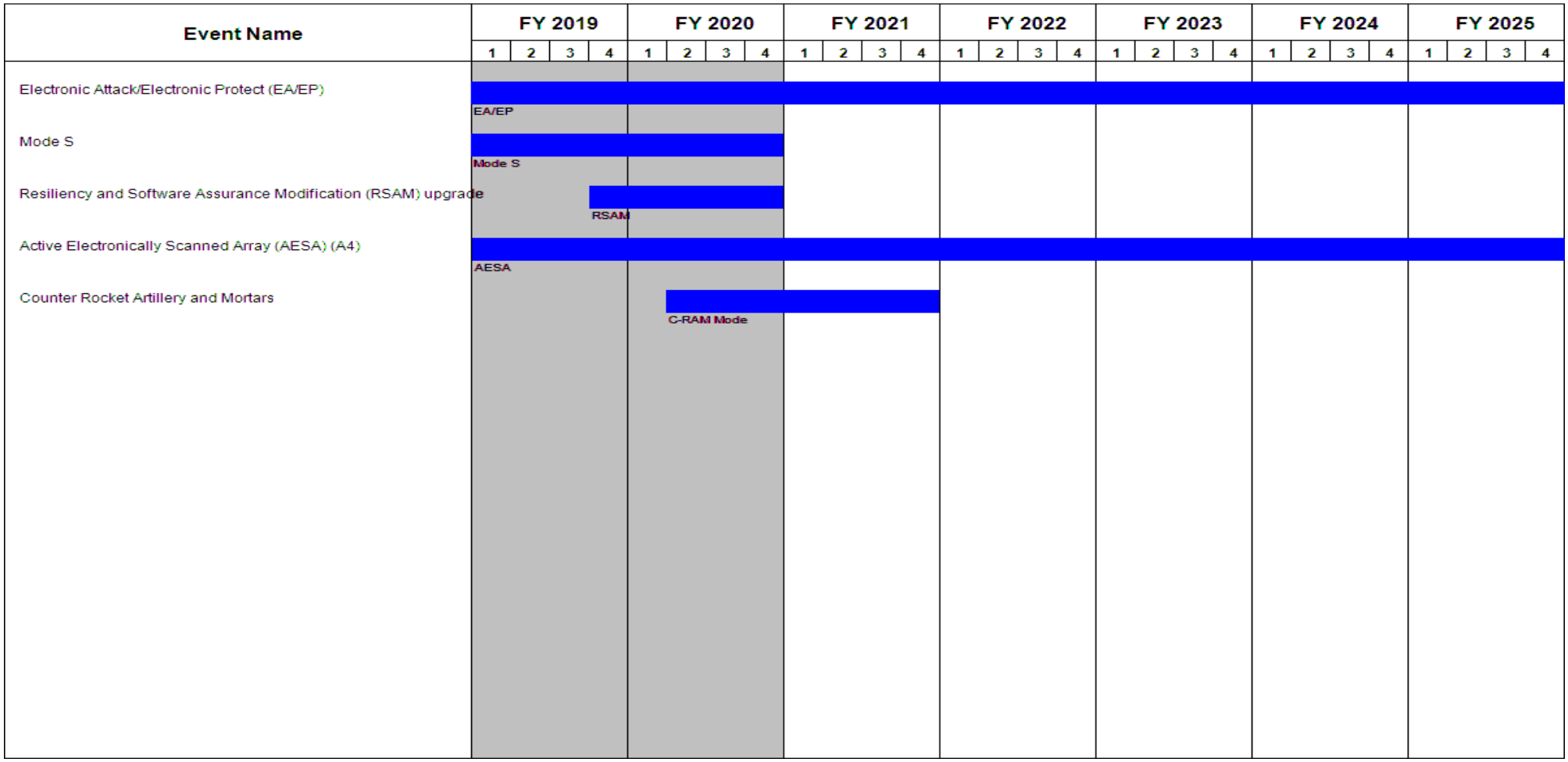
**Test and Evaluation ($ in Millions)**

| Cost Category Item | Contract Method & Type | Performing Activity & Location | Prior Years | FY 2019 Cost | FY 2019 Award Date | FY 2020 Cost | FY 2020 Award Date | FY 2021 Base Cost | FY 2021 Base Award Date | FY 2021 OCO Cost | FY 2021 OCO Award Date | FY 2021 Total Cost | Cost To Complete | Total Cost | Target Value of Contract |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 2.458 | 1.501 | Jan 2019 | 0.330 | Jan 2020 | 1.803 | Jan 2021 | - | | 1.803 | Continuing | Continuing | - |
| Mode S | Various | Raytheon & Various : Fullerton, CA / Various | 0.516 | 1.970 | Jan 2019 | 0.829 | Jan 2020 | - | | - | | - | Continuing | Continuing | - |
| Resiliency and Software Assurance Modification (RSAM) upgrade | Various | Raytheon & Various : Fullerton, CA / Various | - | - | | 0.065 | Jan 2020 | - | | - | | - | 0.000 | 0.065 | - |
| Counter Rocket Artillery and Mortars | Various | Raytheon & Various : Fullerton, CA / Various | - | - | | 0.885 | Jan 2020 | 1.196 | Jan 2021 | - | | 1.196 | Continuing | Continuing | - |
| | | **Subtotal** | 6.414 | 3.471 | | 2.109 | | 2.999 | | - | | 2.999 | 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** | 59.459 | 37.847 | | 95.720 | | 109.259 | | - | | 109.259 | Continuing | Continuing | N/A |

**Remarks**

| Exhibit R-4, RDT&E Schedule Profile: PB 2021 Army | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 5 | **R-1 Program Element (Number/Name)**<br>PE 0604820A / *Radar Development* | **Project (Number/Name)**<br>E10 / *Sentinel* |



| Exhibit R-4A, RDT&E Schedule Details: PB 2021 Army | | Date: February 2020 |
|---|---|---|
| **Appropriation/Budget Activity**<br>2040 / 5 | **R-1 Program Element (Number/Name)**<br>PE 0604820A / *Radar Development* | **Project (Number/Name)**<br>E10 / *Sentinel* |

## Schedule Details

| | Start | | End | |
|---|---|---|---|---|
| **Events** | **Quarter** | **Year** | **Quarter** | **Year** |
| Battle Space Improvement | 4 | 2012 | 4 | 2015 |
| Stop, Stare and Track (SS&T) | 4 | 2012 | 4 | 2015 |
| Cross Domain Solution (CDS) Network Interface / Cyber Security | 2 | 2015 | 4 | 2016 |
| Electronic Attack/Electronic Protect (EA/EP) | 2 | 2015 | 4 | 2033 |
| Signal Data Processor (SDP) / North Finding Module (NFM) | 2 | 2015 | 4 | 2017 |
| Medium Bandwidth | 2 | 2016 | 4 | 2018 |
| System of Systems | 2 | 2018 | 4 | 2018 |
| Mode S | 2 | 2018 | 4 | 2020 |
| Resiliency and Software Assurance Modification (RSAM) upgrade | 4 | 2019 | 4 | 2020 |
| Active Electronically Scanned Array (AESA) (A4) | 1 | 2017 | 4 | 2033 |
| Counter Rocket Artillery and Mortars | 2 | 2020 | 4 | 2021 |