

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army											Date: February 2020	
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology							
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	-	0.000	138.016	114.404	-	114.404	100.565	100.463	122.860	115.006	0.000	691.314
AM6: Modular RF Communications Technology	-	0.000	3.909	3.810	-	3.810	0.000	0.000	10.082	12.173	0.000	29.974
AM8: Protected SATCOM Technology	-	0.000	9.600	4.995	-	4.995	1.499	0.000	6.576	8.971	0.000	31.641
AN3: Non Traditional Waveforms Technology	-	0.000	3.291	0.000	-	0.000	0.000	4.691	7.804	4.683	0.000	20.469
AN5: Protected SATCOM-WB Global SATCOM Inter Canc Tech	-	0.000	0.400	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.400
AN7: COE - Every Receiver is a Sensor Technology	-	0.000	3.005	3.062	-	3.062	3.123	3.186	3.222	3.222	0.000	18.820
AN9: UNT - Every Receiver is a Sensor Technology	-	0.000	3.850	1.998	-	1.998	2.038	2.079	2.103	2.103	0.000	14.171
AO2: Stand-In Advanced RF Effects (STARE)	-	0.000	7.504	4.383	-	4.383	2.051	2.111	2.134	2.134	0.000	20.317
AO4: Energy Efficient Devices Technology	-	0.000	5.412	5.473	-	5.473	5.838	5.410	5.470	5.525	0.000	33.128
AO5: Tag Track and Locate Small Satellites Technology	-	0.000	4.406	3.834	-	3.834	3.764	3.884	3.926	3.965	0.000	23.779
AP4: CEMA Camouflage Technology	-	0.000	9.716	9.841	-	9.841	10.116	9.967	9.809	9.907	0.000	59.356
AP5: Electronic Warfare Technology	-	0.000	2.823	2.915	-	2.915	3.012	3.084	3.125	3.156	0.000	18.115
AP7: Comms/Horiz Int for Army Mod Priorities Tech	-	0.000	0.500	2.914	-	2.914	2.615	2.964	3.028	3.051	0.000	15.072
AQ2: EW Techniques Technology	-	0.000	0.000	0.500	-	0.500	0.500	0.520	0.525	0.525	0.000	2.570
AQ7: High Tempo Data Driven Decision Tools Technology	-	0.000	0.000	2.804	-	2.804	0.000	0.000	0.000	0.000	0.000	2.804

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity					R-1 Program Element (Number/Name)							
2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					PE 0602146A / Network C3I Technology							
AQ9: Expeditionary Data to Decisions Technology	-	0.000	2.000	2.805	-	2.805	4.999	3.287	3.289	0.591	0.000	16.971
AR1: Robust, Resilient and Intelligent C3I Technology	-	0.000	8.700	13.775	-	13.775	14.035	14.316	14.476	14.622	0.000	79.924
AR3: Intelligent Environmental Battlefield Awareness	-	0.000	0.000	3.007	-	3.007	3.097	3.070	2.133	0.000	0.000	11.307
AR5: Understanding the Environment as a Threat Technolo	-	0.000	3.943	2.331	-	2.331	1.980	1.284	0.980	0.990	0.000	11.508
AR7: Sensing in Contested Environments Technology	-	0.000	0.000	1.888	-	1.888	1.207	0.985	0.996	0.000	0.000	5.076
AR9: Persistent Geophysical Sensing-Infrasound Tech	-	0.000	3.963	3.150	-	3.150	3.456	2.698	2.498	2.274	0.000	18.039
AT2: Subterranean Detection and Monitoring Technology	-	0.000	1.600	2.897	-	2.897	0.000	1.956	1.636	1.485	0.000	9.574
AT4: GeoINT - OPS Merge Technology*	-	0.000	0.000	0.000	-	0.000	0.000	2.033	7.639	6.090	0.000	15.762
AT7: Network-Enabled GeoSpatial-GEOINT Services Tech	-	0.000	2.992	4.001	-	4.001	4.692	1.033	0.000	0.000	0.000	12.718
AT9: Tactical GeoSpatial Information Capabilities Techn	-	0.000	2.771	4.240	-	4.240	1.798	0.000	0.000	0.000	0.000	8.809
AU3: Geospatially Enabled Operational Design Technology	-	0.000	3.173	1.467	-	1.467	1.002	0.000	0.000	0.000	0.000	5.642
AU5: Automated Analytics for Operational Environment	-	0.000	3.950	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.950
AU7: GEOInt/Ops Integration for Multi-echelon Orders*	-	0.000	0.000	0.000	-	0.000	0.000	4.008	1.798	0.999	0.000	6.805
AV3: Foundational S&T for Network C3I Technology	-	0.000	0.000	1.927	-	1.927	1.968	2.101	2.208	2.208	0.000	10.412
AV5: Protective Technologies	-	0.000	6.800	7.692	-	7.692	7.839	6.443	6.515	6.580	0.000	41.869

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army											Date: February 2020		
Appropriation/Budget Activity					R-1 Program Element (Number/Name)								
2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					PE 0602146A / Network C3I Technology								
AV6: Airborne Engineering Support Technology	-	0.000	0.882	0.899	-	0.899	0.917	0.935	0.946	0.946	0.000	5.525	
AV7: Atmospheric Modeling and Meterological Technology	-	0.000	5.812	5.945	-	5.945	6.064	6.186	6.255	6.318	0.000	36.580	
AV9: Advanced PNT for GPS Independent Environments Tech	-	0.000	6.974	6.656	-	6.656	10.357	8.735	8.833	8.834	0.000	50.389	
AW1: Autonomous Navigation Technology	-	0.000	0.400	1.798	-	1.798	2.198	2.098	0.000	0.000	0.000	6.494	
AW3: DoD PNT M&S Collaborative Initiative (CI) Technolo	-	0.000	2.000	1.998	-	1.998	0.000	0.000	0.000	0.000	0.000	3.998	
AW5: Modular GPS Independent Sensors Technology	-	0.000	4.140	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.140	
BP2: Sensor and Electronic Network Initiatives (CA)	-	0.000	23.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.500	
BZ6: Narrowband SATCOM Technology	-	0.000	0.000	0.999	-	0.999	0.000	0.000	0.000	0.000	0.000	0.999	
BZ8: Aerial Teir Networking (High Altitude)	-	0.000	0.000	0.400	-	0.400	0.400	1.399	4.854	3.654	0.000	10.707	

*This project's R-2a exhibit has been suppressed due to funding not beginning until after FY 2021

Note

In Fiscal Year (FY) 2020 this Program Element (PE) was previously funded, with continuity of effort realigned from the following PEs:

- * PE 0602120A Sensors and Electronic Survivability
- * PE 0602270A Electronic Warfare Technology
- * PE 0602705A Electronics and Electronic Devices
- * PE 0602720A Environmental Quality Technology
- * PE 0602782A Command, Control, Communications Technology
- * PE 0602783A Computer and Software Technology
- * PE 0602784A Military Engineering Technology

UNCLASSIFIED

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

Appropriation/Budget Activity
2040: *Research, Development, Test & Evaluation, Army / BA 2: Applied Research*

R-1 Program Element (Number/Name)
PE 0602146A / *Network C3I Technology*

A. Mission Description and Budget Item Justification

This PE investigates technologies, techniques, components and tools to provide an Army tactical network and enabling infrastructure that support operations in any environment, to include where the electromagnetic spectrum is denied or degraded. This is accomplished through the design, and development of technologies and components (e.g., electronic components, software and protocols) that provide unified transport and are supportable, mobile and survivable; assured and secure positioning, navigation, and timing in all environments; converged and coordinated cyber and electronic warfare activities; resilient mission command on the move; and the collection, processing, and dissemination of information for intelligence, surveillance, and reconnaissance. Commercial technologies are continuously investigated and leveraged where possible.

Work in this PE complements PE 0602782A (Command, Control, Communications Technology), PE 0602143A (Soldier Lethality Technology), PE 0602145A (Next Generation Combat Vehicle Technology), PE 0602146A (Network C3I Technology), PE 0602147A (Long Range Precision Fires Technology), PE 0602148A (Future Vertical Lift Technology), PE 0602150A (Air and Missile Defense Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0603008A (Command Electronic Warfare Advanced Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603118A (Soldier Lethality Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0603464A (Long Range Precision Fires Advanced Technology), PE 0603465A (Future Vertical Lift Advanced Technology), PE 0603466A (Air and Missile Defense Advanced Technology), PE 0603463A Network C3I Advanced Technology.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work is performed by the United States Army Futures Command, the United States Army Space and Missile Defense Command and the Army Engineer Research and Development Center.

All FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

UNCLASSIFIED

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 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>
--	---

B. Program Change Summary (\$ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	114.516	133.431	-	133.431
Current President's Budget	0.000	138.016	114.404	-	114.404
Total Adjustments	0.000	23.500	-19.027	-	-19.027
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	23.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-19.027	-	-19.027

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: BP2: *Sensor and Electronic Network Initiatives (CA)*

- Congressional Add: *Small Satellite Technology*
- Congressional Add: *Radioisotope Power Systems*
- Congressional Add: *Anti-Tamper Technology Development*
- Congressional Add: *Next Generation Synthetic Aperture*
- Congressional Add: *Sensing Technologies for Rapid Hazard Detection*

Congressional Add Subtotals for Project: BP2

Congressional Add Totals for all Projects

	FY 2019	FY 2020
	-	3.000
	-	2.500
	-	10.000
	-	5.500
	-	2.500
Congressional Add Subtotals for Project: BP2	-	23.500
Congressional Add Totals for all Projects	-	23.500

Change Summary Explanation

FY21 funds realigned to support Army Modernization Priorities and National Defense Strategy.

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AM6 / Modular RF Communications Technology
--	--	--

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
AM6: <i>Modular RF Communications Technology</i>	-	0.000	3.909	3.810	-	3.810	0.000	0.000	10.082	12.173	0.000	29.974

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 PE 0602782A Command, Control, Communications Technology:
 * Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops techniques, methods, and standards for automation and intelligence to optimally broadcast data among available radio frequency (RF) and networking technologies. This Project adds resiliency to the network through diversity and automation techniques to make automated network decisions, (e.g., automated Primary, Alternate, Contingency, and Emergency (PACE)) for the tactical Army to maintain operation in continually changing environments.

Work in this Project complements PE 0603463A Network C3I Advanced Technology / Project AM7 (Modular RF Communications Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: Modular Radio Frequency Communications Technology	FY 2019	FY 2020	FY 2021
Description: This effort investigates and develops techniques, methods, and standards for automation and intelligence to optimally route data among available radio frequency and networking technologies. This effort adds resiliency to the network through diversity and automation techniques to make automated network decisions, (e.g., automated PACE) for the tactical Army to maintain operation in continually changing environments.	-	3.731	3.810
FY 2020 Plans: Investigate techniques and algorithms for autonomous network initialization, detection, and adaption; design and develop the architecture to enable validation of algorithms for network initialization from start-up condition; research multiple approaches to autonomous networking by providing algorithms to detect available networks and networking technologies; and develop specifications for shared interfaces between network technologies and autonomous networking algorithms.			
FY 2021 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AM6 / Modular RF Communications Technology		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Will investigate techniques based on Artificial Intelligence (AI) and Machine Learning (ML) to sense anomalies and degradation due to contested and congested Radio Frequency (RF) environments, predict the cause based on trained ML models, and coordinate across the network to recommend successful mitigation actions/procedures; research applicability of these techniques in a distributed, resource constrained tactical edge where computing resources are limited, communication pipes are narrow, connectivity is intermittent, and power is restricted due to size and weight of the battery; and determine distributed computing techniques to process, reduce, and fuse data at the tactical edge enabling local actions and reduction in load on the bandwidth constrained, intermittently connected networks.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>				
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.178	-
Accomplishments/Planned Programs Subtotals		-	3.909	3.810
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AM8 / Protected SATCOM Technology			
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
AM8: Protected SATCOM Technology	-	0.000	9.600	4.995	-	4.995	1.499	0.000	6.576	8.971	0.000	31.641

Note
 In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project investigates resiliency of Wideband Satellite Communications (SATCOM) in contested and congested electromagnetic environments. Wideband SATCOM is the primary high-bandwidth Beyond Line of Sight (BLOS) Communications used by the tactical Army. This Project designs and develops technologies and components, such as interference cancellation, to increase availability and reliability of Wideband SATCOM in spectrum-challenged environments.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / AM9 (Protected SATCOM Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
<p>Title: Protected Satellite Communication Technology</p> <p>Description: This effort designs and develops technologies and components to increase resiliency of Wideband SATCOM in contested and congested electromagnetic environments. This effort develops resiliency through science & technology investigation.</p> <p>FY 2020 Plans: Research to advance satellite communications technology in order to automatically adapt to constantly changing, congested, and contested environments; investigate emerging commercial aerial and overhead capabilities and products, to select those that may be leveraged for tactical Army use; conduct experiments to establish a baseline for future research of intelligent satellite communications (i.e., systems that automatically adapt and mitigate network problems); investigate technology to mature components that support the control of the Army satellite network in a contested environment; and research emerging</p>	-	9.164	4.995

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army	Date: February 2020
--	----------------------------

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AM8 / Protected SATCOM Technology
--	--	---

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
commercial Low Earth Orbit (LEO) satellite mega-constellations to select applicable technologies to utilize and build upon for use in a mounted/dismounted environment. FY 2021 Plans: Will develop satellite communications technology that automatically adapts to constantly changing, congested, and contested environments; conduct experiments to refine the baseline for future research of intelligent and diverse satellite communications (i.e., systems that automatically adapt and mitigate network problems); and investigate technology to mature components that support the control of the Army satellite networks in a contested environment. FY 2020 to FY 2021 Increase/Decrease Statement: This effort is transitioning to Program Element 0603463A Network C3I Advanced Technology, Project AM9 - Protected SATCOM Advanced Technology.			
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638	-	0.436	-
Accomplishments/Planned Programs Subtotals	-	9.600	4.995

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AN3 / Non Traditional Waveforms Technology			
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
AN3: <i>Non Traditional Waveforms Technology</i>	-	0.000	3.291	0.000	-	0.000	0.000	4.691	7.804	4.683	0.000	20.469

Note
 In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project H92 Communications Technology

In FY21 this Project is being realigned to:
 Program Element 0603463A Network C3I Advanced Technology:
 * Project AP6 C4ISR Integrated Demonstrations Advanced Tech

A. Mission Description and Budget Item Justification

This Project investigates non-traditional protocols and technologies to provide spectrum efficiency, high bandwidth, lower spectrum footprint, or anti-jam capabilities to tactical networks. This Project develops network resiliency for the dismounted and vehicular units through science & technology investigation.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN4 (Non Traditional Waveforms Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

<p>Title: Non Traditional Waveforms Technology</p> <p>Description: This effort investigates non-traditional protocols and technologies to provide spectrum efficiency, high bandwidth, lower spectrum footprint, anti-jam capabilities to tactical networks. This effort develops network resiliency for the dismounted and vehicular units through science & technology investigation.</p> <p>FY 2020 Plans: Develop novel beam-tracking techniques and advanced directional mobile ad-hoc networking (MANET) technology to support on-the-move (OTM) millimeter wave communications; conduct study of dynamic effects of vehicle and vehicle systems on communication systems, such as the impacts to highly directive systems and/or cooperative beamforming techniques; and</p>	FY 2019	FY 2020	FY 2021
	-	3.142	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AN3 / Non Traditional Waveforms Technology		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
design adaptive power control techniques and dismounted networking for improved low probability of intercept / low probability of detection (LPI/LPD) characteristics. FY 2020 to FY 2021 Increase/Decrease Statement: Funding in this effort is being realigned to PE 0603463A Network C3I Advanced Technology / Project AP6 C4ISR Integrated Demonstrations Advanced Tech.				
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638		-	0.149	-
Accomplishments/Planned Programs Subtotals		-	3.291	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AN5 / Protected SATCOM-WB Global SATCOM Inter Canc Tech			
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
AN5: Protected SATCOM-WB Global SATCOM Inter Canc Tech	-	0.000	0.400	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.400

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project H92 Communications Technology

In FY21, this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project develops interference cancellation technologies to allow uninterrupted and resilient communications over the Wideband Global Satellite constellation when operating in proximity to enemy threats.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN6 (Prot SATCOM-WB Global SATCOM Interference Canc Adv Tech).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Protected Satellite Communication ? Wide Band Global Satellite Communication Interference Cancellation Technology	-	0.382	-
Description: This effort develops interference cancellation technologies to allow uninterrupted and resilient communications over the Wideband Global Satellite constellation when operating in proximity to enemy threats.			
FY 2020 Plans: Validate the performance of interference cancelling technology to protect satellite communications; mature predictive algorithms for satellite-based interference cancelling technology to establish expected improvement of tactical terminal operation in the presence of Electronic Warfare (EW) threats or jammers.			
FY 2020 to FY 2021 Increase/Decrease Statement: Effort completes in FY2020.			
Title: FY 2020 SBIR/STTR Transfer	-	0.018	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AN5 / <i>Protected SATCOM-WB Global SATCOM Inter Canc Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638				
Accomplishments/Planned Programs Subtotals		-	0.400	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AN7 / COE - Every Receiver is a Sensor Technology			
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
AN7: COE - Every Receiver is a Sensor Technology	-	0.000	3.005	3.062	-	3.062	3.123	3.186	3.222	3.222	0.000	18.820

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602270A Electronic Warfare Technology:
 * Project 906 Tactical Electronic Warfare Applied Research

A. Mission Description and Budget Item Justification

This Project investigates, designs, and codes advanced automated exploitation and fusion analysis tools, applications, and software services that harvest, correlate and fuse tactical receiver sources with new and emerging data sources to improve understanding of the threat picture and more efficiently support near-real time Situational Understanding of the battlefield.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States (U.S.) Army Futures Command.

Fiscal Year FY20 realignments were due to financial restructuring in support of Army Modernization Priorities.

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

Title: Data Analytics for Situational Awareness	FY 2019	FY 2020	FY 2021
Description: This effort investigates and designs spectrum sensing, electronic sensing and intelligence collection technologies and analytics to enhance overall situational understanding within a contested battlespace. Efforts focus on developing the analytics necessary to taking advantage of the expanding number of data sources available by leveraging existing tactical receivers and other tactical data feeds.	-	2.868	3.062
FY 2020 Plans: Investigate deep learning techniques to leverage tactical and national data sources identified in FY19 to improve the threat picture while reducing the analysts' burden in understanding of the Electromagnetic Operating Environment (EMOE); perform initial demonstrations with selected deep learning techniques and analytics to automatically generate an enemy Electronic Order of			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AN7 / COE - Every Receiver is a Sensor Technology		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Battle (EEOB); and demonstrate the capability to provide automated alerting and a fused picture of red cyber events to enhance the near-time Cyber Situational Understanding (SU) to support decision making. FY 2021 Plans: Will extend techniques to support fires and intelligence warfighting functions; develop target nomination mechanisms; and identify data to push forward to support the targeting process and inform Intelligence Preparation of the Battlefield and update enemy Common Operating Picture tools. FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.				
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638		-	0.137	-
Accomplishments/Planned Programs Subtotals		-	3.005	3.062
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AN9 / UNT - Every Receiver is a Sensor Technology			
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
AN9: UNT - Every Receiver is a Sensor Technology	-	0.000	3.850	1.998	-	1.998	2.038	2.079	2.103	2.103	0.000	14.171

Note
 In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project develops the algorithms to enable every communication receiver in the tactical environment to operate as a sensor while maintaining the systems' original networking capability. This Project matures standards and protocols to expand the Cyber-Electromagnetic Activity (CEMA) situational understanding.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) \ Project AO1 (UNT - Every Receiver is a Sensor Advanced Tech) and PE 0602146A (Network C3I Technology) \ Project AN7 COE - Every Receiver is a Sensor Technology.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
<p>Title: Unified Network Technology (UNT) - Every Receiver is a Sensor Technology</p> <p>Description: This effort develops software algorithms to enable commercial communications transceivers to operate in the tactical environment as Beyond Line of Sight communications while maintaining the systems' original networking capability.</p> <p>FY 2020 Plans: Investigate multiple artificial intelligence/machine learning (AI/ML) techniques that are applicable to radio frequency (RF) domain; develop and test software algorithms for dynamic spectrum sensing that incorporate identified AI/ML techniques; and design and implement method and/or interface to transmit RF sensed metadata for use in intelligence.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / AM8 (Protected SATCOM Technology) in FY21 to support higher modernization priorities.</p>	-	1.763	-
<p>Title: Multi Intelligence Modernization Components and Architecture</p>	-	1.913	1.998

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AN9 / UNT - <i>Every Receiver is a Sensor Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
<p>Description: This effort investigates underlying architectures for dynamic resource management and technology underpinnings for advanced signal processing, exploitation, and novel sensor hardening to better understand our ability to detect, intercept, identify, and geo-locate radiated radio frequency (RF) energy to command our use of the electromagnetic spectrum while denying its use to our adversaries.</p> <p>FY 2020 Plans: Investigate and develop novel Electronic Warfare (EW) hardware technologies and techniques against adversarial Communication and Intelligence Surveillance and Reconnaissance (ISR) capabilities in the Electromagnetic Spectrum while in contested operational areas; and perform research to determine the feasibility of localized, distributed, and intermittent Electronic Warfare effects to support the Commander's intent and conduct laboratory experiments utilizing developed EW techniques against high value threats to validate concepts.</p> <p>FY 2021 Plans: Will investigate dynamic resource management and technologies for advanced signal processing, conduct laboratory experiments of advanced multi-function capabilities exploiting RF emissions for adversaries; investigate high altitude, long range sensing to augment national surveillance assets bringing situational awareness and understanding to the tactical edge.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Reduction of total obligation authority.</p>			
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>	-	0.174	-
Accomplishments/Planned Programs Subtotals	-	3.850	1.998

C. Other Program Funding Summary (\$ in Millions)
N/A
Remarks

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AN9 / <i>UNT - Every Receiver is a Sensor Technology</i>

D. Acquisition Strategy
N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AO2 / Stand-In Advanced RF Effects (STARE)			
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
AO2: Stand-In Advanced RF Effects (STARE)	-	0.000	7.504	4.383	-	4.383	2.051	2.111	2.134	2.134	0.000	20.317

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602705A Electronics and Electronic Devices:
 * Project EM8 High Power and Energy Component Technology
 PE 0602782A Command, Control, Communications Technology:
 * Project H92 Communications Technology
 PE 0602270A Electronic Warfare Technology:
 * Project 906 Tactical Electronic Warfare Applied Research

A. Mission Description and Budget Item Justification

This Project investigates distributed Electronic Warfare (EW) techniques for grey-zone operations and designs algorithms for sparse detection and EW, and investigates techniques for secure transmission across network transport links and designs networking communications with low probability of detection and intercept technologies.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AO3 (Robust Grey C3I Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: STAND-IN Advanced RF Effects (STARE)	FY 2019	FY 2020	FY 2021
Description: This effort investigates emerging technologies to enable EW applications in a grey environment. The goal is to develop software and reconfigurable radio frequency (RF) hardware in a low size, weight, and power form factor for distributed EW and communications.	-	1.886	1.998
FY 2020 Plans: Investigate wideband reconfigurable transceivers, RF frontend hardware, reconfigurable filters, antenna tuners, and antennas for handheld and leave-behind EW applications; investigate techniques to counter adversarial surveillance and communications			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AO2 / Stand-In Advanced RF Effects (STARE)		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
and conduct laboratory experiments to determine effectiveness; and investigate techniques for identification and geolocation of advanced communications transceivers. FY 2021 Plans: Will investigate hardware limitations and mature component level technologies to improve stability within synchronized EW applications, this includes RF and signal processing hardware; research complex threat signal use cases with synchronized EW applications to determine additional limitations and further improvements for stability; and identify miniaturization strategies for motion-enabled reconfigurable circuits and tunable microelectromechanical systems components suitable for handheld, wide-bandwidth, adaptable EW applications. FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.				
Title: Grey C3I Communications Technology Description: This effort investigates techniques for secure transmission across network transport links and designs networking communications with low probability of detection and intercept technologies. FY 2020 Plans: Investigate enhancements to commercial off-the-shelf technologies; mature components that contribute such as cellular and/or narrowband communications, to provide dismount and mounted operators with long-range connectivity in a hostile electromagnetic spectrum environment; and design and develop enhancements to improve network resiliency and robustness, such as low probability of detection, low probability of intercept, and/or anti-jam features. FY 2020 to FY 2021 Increase/Decrease Statement: The funding in this effort was realigned to support higher priority modernization areas.		-	2.883	-
Title: Grey C3 Exploitation Technology Description: This effort investigates distributed EW techniques for grey-zone operations and designs algorithms for sparse detection and EW. FY 2020 Plans: Investigate and develop novel EW hardware technologies and techniques against adversarial Communication and Intelligence Surveillance and Reconnaissance (ISR) capabilities in the electromagnetic spectrum while in contested operational areas; and perform research to determine the feasibility of localized, distributed, and intermittent EW effects to support the Commander's intent and conduct laboratory experiments utilizing developed EW techniques against signals of interest to validate concepts. FY 2021 Plans:		-	2.394	2.385

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AO2 / Stand-In Advanced RF Effects (STARE)		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Will design and develop precise synchronization hardware technologies for EW systems to significantly improve the effectiveness of countermeasures against adversarial threats; conduct experiments in laboratory environments to validate synchronization limitations; and validate initial countermeasures on distributed sources.				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.				
Title: FY 2020 SBIR/STTR Transfer		-	0.341	-
Description: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638				
Accomplishments/Planned Programs Subtotals		-	7.504	4.383
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>				Project (Number/Name) AO4 / <i>Energy Efficient Devices Technology</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
AO4: <i>Energy Efficient Devices Technology</i>	-	0.000	5.412	5.473	-	5.473	5.838	5.410	5.470	5.525	0.000	33.128

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602705 Electronics and Electronic Devices:
 * Project H94 Elect & Electronic Dev

A. Mission Description and Budget Item Justification

This Project addresses sustainment operations by unburdening the Soldier and reducing logistics requirements (e.g., fewer batteries) for communications, computing, and sensing. The objective is to improve the underlying energy efficiency of supply and demand for Soldier-portable and distributed sensor electronics to enable the dismounted Soldier to maintain communications, freedom of movement, and increase mission duration. The majority of the electronics power used by the dismounted Soldier and by distributed electronics is attributable to radio frequency (RF) communications. In addition, freedom of movement and action during sustained and high tempo operations requires seamless battery recharging. To address these challenges, energy efficient electronics research includes RF and optoelectronic circuits, devices, materials and wireless power (and data) transfer.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: Energy Efficient Electronic and Photonic Components	FY 2019	FY 2020	FY 2021
Description: This effort investigates energy efficiency improvements in support of four key areas: RF component devices, optoelectronic devices for alternative communications modes, long-lived and high efficiency power sources, and efficient wireless power and data transfer technologies. These components enable energy-efficient communications and networked energy, specifically leading to increased soldier mission duration and long-lived networked electronics.	-	5.166	5.473
FY 2020 Plans: Research and develop RF component technologies such as advanced silicon accelerators to improve squad level communication efficiency; develop zero-power sensors for wake-up radio applications; explore the development of optoelectronic devices for alternative communications; develop technologies for long-lived efficient power sources; develop efficient wireless power and data			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AO4 / <i>Energy Efficient Devices Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
technologies with >10% efficiency enabling squad-level power and data transfer; and explore methods to support higher rate and energy density wireless battery recharging. FY 2021 Plans: Will investigate and optimize the interplay between insulator materials to determine if transistor action provides significant power savings as theoretically predicted; investigate radiation tolerance of wide-band-gap semiconductors and compare to material dependent displacement energy, atomic number, bond strength, and lattice constant; develop optimized energy conversion semiconductor structures delivering 1mW power; understand and develop new materials for fast charge anodes with the objective to develop a material that can be scaled; explore chemistries to support fast charge batteries and investigate new electrolytes and additives to stabilize lithium plated on graphite; and study and develop RF component technologies, such as high efficiency materials, circuits, and neural network hardware for improved squad level communication efficiency. FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638	-	0.246	-
Accomplishments/Planned Programs Subtotals	-	5.412	5.473

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AO5 / Tag Track and Locate Small Satellites Technology			
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
AO5: <i>Tag Track and Locate Small Satellites Technology</i>	-	0.000	4.406	3.834	-	3.834	3.764	3.884	3.926	3.965	0.000	23.779

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602120A Sensors and Electronic Survivability:
 * Project TS1 Tactical Space Research

A. Mission Description and Budget Item Justification

Tag, Track, and Locate Small Satellites Technology develops and adapts technologies for space-based and high altitude applications for Army tactical ground forces. Efforts include the design and development of sensors and electronic components for communications, signal and information processing, target acquisition, position/navigation, and threat warning within space and high altitude environments. Evaluations conducted leverage other Department of Defense (DoD) space science and technology applications to support Army space force enhancement and cooperative satellite payload development. Funds research in quantum sciences based communications, sensing, and data teleportation to mature current technologies for small spacecraft applications.

Work complements PE 0603463A (Network C3I Advanced Technology) / AO6 (Tag Track and Locate Small Satellites Adv Tech).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Space and Missile Defense Command (USASMDC) in Huntsville, AL.

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

	FY 2019	FY 2020	FY 2021
Title: Tag Track and Locate Small Satellites	-	3.179	2.663
Description: This effort will design, develop, and adapt space-based technologies, components, and tools that lead to smaller, lighter, more responsive payloads and applications. These technologies allow for the rapid integration and development of tactical payloads in support of responsive space environments.			
FY 2020 Plans: Research and validate software, hardware, and algorithms used to enable space-based capabilities in support of the Army's Modernization Priorities; investigate the maturity and feasibility of commercial advances and opportunities in small satellite constellation and payload management for application to future Army concepts.			
FY 2021 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AO5 / <i>Tag Track and Locate Small Satellites Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Will validate payload technologies for small spacecraft to provide tactical land component forces with space capabilities for force projection and maneuver during Multi-Domain Operations; design and conduct experiments focused on terrestrial open air Quantum Entanglement Data Teleportation (QEDT) and space-to-ground QEDT; and qualify and implement Quantum Key Distribution (QKD) components in order to validate satellite-to-satellite crosslink QKD.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>				
<p>Title: Space Components and Systems Assessment Technology</p> <p>Description: This effort supports experimentation and validation of hardware and software components and models to further anchor laboratory capabilities enabling small spacecraft and payload design and development.</p> <p>FY 2020 Plans: Design and conduct experiments for space-based technologies; and validate hardware and software components and models, to further anchor laboratory capabilities enabling small spacecraft and payload design and development.</p> <p>FY 2021 Plans: Will design and develop payload technologies for small spacecraft to provide tactical land component forces with space capabilities for force projection and maneuver during Multi-Domain Operations.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>		-	1.073	1.171
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.154	-
Accomplishments/Planned Programs Subtotals		-	4.406	3.834
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AO5 / <i>Tag Track and Locate Small Satellites Technology</i>

D. Acquisition Strategy
N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AP4 / CEMA Camouflage Technology			
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
AP4: CEMA Camouflage Technology	-	0.000	9.716	9.841	-	9.841	10.116	9.967	9.809	9.907	0.000	59.356

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602705A Electronics and Electronic Devices Project:
 * Project EM8 High Power and Energy Component Technology

A. Mission Description and Budget Item Justification

This Project develops and characterizes hardware and software to enable electronic spoofing and cyber deception along with inconspicuous Cyber Electromagnetic Activity (CEMA) and network operations of Army platforms and dismounts, while maintaining freedom to maneuver, communicate, and sense. This research is critical to counter near-peer ability to geo-locate our troops and put indirect fires onto our positions. This effort develops a holistic cross-domain analysis and assessment methodology for network and communication technologies faced with advanced CEMA. These investigations are critical to identifying vulnerabilities of United States systems and technologies so that network and network-enabled systems can be hardened as early in development as possible.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
<p>Title: RF/Cyber Sensing and Deception</p> <p>Description: This effort develops technologies to avoid geolocation of blue force Radio Frequency (RF) emissions by peer/near-peer adversaries. Research will focus on developing low probability of detection (LPD) communications and decoys to increase freedom of maneuver while maintaining effective communications.</p> <p>FY 2020 Plans: Investigate compact antennas utilizing novel additive manufactured techniques to demonstrate wide bandwidth spectrum tuning for enabling low probability of detection communications in non-military bands; conduct experiments on passive optical-phased array (OPA) communication link based on chip-level, photonic integrated circuits; mature components for development of an active OPA for communication link studies; and investigate wideband reconfigurable transceivers, radio frequency frontend hardware, and antennas for decoy development.</p> <p>FY 2021 Plans:</p>	-	0.382	3.159

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP4 / <i>CEMA Camouflage Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Will develop hardware for RF decoys, including compact antennas, wideband reconfigurable transceivers, and radio frequency frontend hardware; model performance of coherent beam-forming from dispersed emitters for RF decoys; investigate techniques for decoy emission waveforms and antennas for decoy development; investigate materials, device designs, and components for non-RF communication techniques; demonstrate initial chip-level active optical-phased array (OPA) for communication link using co-packaged external laser; conduct experimentation on native photonic integrated circuit (PIC) laser and co-packaging control electronics.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funds realigned from other efforts within this Project to support increased focus on RF/Cyber Sensing and Deception.</p>				
<p>Title: Dynamic Intelligent Networks and Cyber Camouflage and Decoy for CEMA</p> <p>Description: This effort investigates techniques and develops methods for combining the physical (RF) and network (cyber) layers for enhanced effects when coupled with electromagnetic camouflage and decoy methods.</p> <p>FY 2020 Plans: Design and develop flexible and adaptive methods for automated/semi-automated active tactical cyber defense that use machine learning techniques to anticipate future activities and select the most effective response; design adaptive networking methods that leverage unconventional communication channels (e.g., lower-radio-frequencies and ultraviolet frequencies) and dynamic spectrum sensing to provide for enhancement, adaptation, and/or balancing of energy usage, probability of detection, jamming resistance, and security; implement networking protocols in simulation and/or hardware; and conduct experiments to develop and characterize the performance of such active cyber defense methods.</p> <p>FY 2021 Plans: Will implement and experimentally validate the use of unconventional spectrum, directional networking, and novel modulations to enhance the low-probability-of-detection features of the network; develop and characterize protocols for adapting networks to optimize performance under low-probability-of-detection constraints; and research adaptive cyber deception methodologies to provide defensive advantage by hiding mission critical assets (camouflage), misrepresenting a system (obfuscation), and luring the enemy to expend resources on fake nodes (decoys), while real systems remain safe and continue to execute mission critical tasks.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funds decreased to support increased focus on RF/Cyber Sensing and Deception.</p>		-	3.308	2.398
<p>Title: Understanding, Protecting, and Enabling CEMA Effects</p> <p>Description: This effort develops and continually improves methodology and approaches for estimating and predicting Cyber Electromagnetic Activity (CEMA) effects on networks and network-enabled systems during complex multi-domain operations when significant cross-domain effects can be expected. Methods include drawing upon past research concerning the interaction of cyber</p>		-	3.080	2.207

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP4 / <i>CEMA Camouflage Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>and electromagnetic threats on operational networks; anechoic chamber, laboratory, and field measurements; and first principles Modeling and Simulation (M&S) and engineering analysis. Abstracting, generalizing, and automating multi-domain CEMA operations will enable the development of analysis and assessment capabilities to anticipate the impact of future threats. Live, virtual, and simulated environments will be developed to estimate the potential operational impact of threat CEMA technologies on friendly systems.</p> <p>FY 2020 Plans: Develop techniques to estimate the effect of cyber and electromagnetic activities across functional layers (i.e., physical, electromagnetic, cyber, human, and operational); and study intelligent protocol learning and adaptation, automated vulnerability assessment techniques, physical-layer cyber assessment methodologies, and modeling and simulation representation of CEMA-enabled tactical scenarios.</p> <p>FY 2021 Plans: Will develop and extend techniques to estimate the effect of cyber and electromagnetic activities across all functional layers (i.e., physical, electromagnetic, cyber, human, and operational); mature investigations and enhance scientific understanding of cross-domain synergies building upon those previously discovered; and validate tools for understanding cross-domain synergies and determine region of applicability before the tools are passed on to vulnerability analysts.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funds decreased to support increased focus on RF/Cyber Sensing and Deception.</p>				
<p>Title: Vulnerability Analysis Methodology for CEMA Threats</p> <p>Description: This effort investigates threat/target interactions to develop experimental and analytical methodology for separate and cross-domain cyber and electromagnetic threat attack so that assessed vulnerabilities in a multi-domain complex environment can be reduced or eliminated before fielding new networks and network-enabled systems. Experimental and analysis methodology will be developed to investigate vulnerabilities of specific configurations of complex future networks with multiple communications modalities, advanced decoy techniques in the cyber and electromagnetic areas, and advanced Positioning, Navigation, and Timing (PNT) systems.</p> <p>FY 2020 Plans: Study multi-domain impact analysis and experimental techniques that encompass cyber, electronic warfare, and other electromagnetic activities; investigate novel communications modalities and techniques (e.g., ultraviolet, millimeter wave, situational adaptive controllers) to develop experimental and analytical methodologies to assess and discover vulnerabilities; and research new vulnerability assessment methodology and techniques for new, non-Global Positioning System (GPS) PNT technologies (e.g., inertial navigation technology, chip-scale atomic clocks, optical time transfer, and video-based technologies).</p> <p>FY 2021 Plans:</p>		-	2.505	2.077

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP4 / <i>CEMA Camouflage Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Will investigate cross-domain vulnerability analysis with both simulation and experimental techniques that encompass cyber, electronic warfare, and other electromagnetic activities; cross-domain experiments will include hacking communications equipment at all relevant levels of hacker sophistication while that equipment is under Electronic Warfare (EW) attack in controlled (i.e. anechoic chamber) environment for tactically plausible waveforms, power levels, switching algorithms, etc; validate analysis techniques previously developed for novel communications modalities and techniques (e.g., ultraviolet, millimeter wave, situational adaptive controllers) and develop new experimental and analytical methodologies to assess and discover vulnerabilities; and research new vulnerability assessment methodology and techniques for new, non-Global Positioning System (GPS) PNT technologies (e.g., inertial navigation technology, chip-scale atomic clocks, optical time transfer, and video-based technologies).</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funds decreased to support increased focus on RF/Cyber Sensing and Deception.</p>				
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.441	-
Accomplishments/Planned Programs Subtotals		-	9.716	9.841
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AP5 / Electronic Warfare Technology			
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
AP5: <i>Electronic Warfare Technology</i>	-	0.000	2.823	2.915	-	2.915	3.012	3.084	3.125	3.156	0.000	18.115

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602120A Sensors and Electronic Survivability:
 * Project H16 S3I Technology
 PE 0602705A Electronics and Electronic Devices
 * Project EM8 High Power and Energy Component Technology:

A. Mission Description and Budget Item Justification

This Project investigates emerging technologies related to electronic warfare (EW) applications, non-kinetic survivability/lethality, and emerging concepts of operation in the increasingly contested and congested electromagnetic environment, with the goal of enhancing the survivability/lethality of Army platforms through electronic attack (EA), electronic warfare support (ES), and electronic protection (EP).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Electronic Warfare Technology Research	-	2.116	2.260
Description: This effort investigates emerging technologies related to EW applications, non-kinetic survivability/lethality, and emerging concepts of operation in the increasingly contested and congested electromagnetic environment, with the goal of enhancing the survivability/lethality of Army platforms through EA, ES, and EP.			
FY 2020 Plans: Investigate algorithms for emitter geolocation and classification from distributed radio frequency (RF) receivers; research, design and develop spectrum sensing and channel prediction signal processing techniques to anticipate adversarial operations in congested and contested electromagnetic environments; develop EA and EP techniques in an advanced hardware-in-the-loop complex electromagnetic environment to investigate deception and degradation of realistic threat capabilities; investigate methods to detect and identify threat emitters without a priori characterizations; and investigate techniques to determine target susceptibility to EA using feedback from ES sensors.			
FY 2021 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP5 / <i>Electronic Warfare Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Will investigate signal processing techniques for detection, classification, and emitter geolocation from distributed radio frequency (RF) receivers; develop electronic attack and electronic protection techniques in an advanced hardware-in-the-loop electromagnetic environment by adding situational awareness sensor input into the cognitive RF algorithm to investigate deception and degradation of realistic threat capabilities; investigate techniques to identify and classify RF emitters based on generalized attributes and characteristics; develop hardware-in-the-loop resource manager to expand RF channel emulation; study cognitive EW integration into the hardware-in-the-loop laboratory environment; and develop approaches for radar and communications networks to co-exist in congested and contested electromagnetic environments.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>				
<p>Title: Electronic Warfare Assessment Technologies</p> <p>Description: This research investigates emerging technologies related to EW applications (e.g., digital RF memory, software defined radios, cognitive radars) and electromagnetic-enabled cyberspace operations in the increasingly contested and congested environment. Research is focused on near-peer and future threats to enhance survivability/lethality, and discover critical vulnerabilities, of Army technologies and systems through cyber and electromagnetic activities (CEMA).</p> <p>FY 2020 Plans: Study novel electronic warfare approaches using unmanned aerial systems, software defined radios, and digital RF memory, and cyber techniques. These multi-domain technologies will be studied in advanced CEMA laboratories and anechoic chambers to develop approaches and methodology to assess technologies and systems. RF to digital signal conversion methodologies will be studied along with traffic-based modeling to reverse engineer protocols and automated digital vulnerability techniques.</p> <p>FY 2021 Plans: Will continue to investigate novel EW approaches using unmanned aerial systems, software defined radios, digital RF memory, and cyber injection techniques; continue to investigate multi-domain technologies in advanced CEMA laboratories, anechoic chambers, field experiments, and with modeling and simulation so as to develop approaches and methodologies to assess friendly and enemy technologies and systems.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>		-	0.578	0.655
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans:</p>		-	0.129	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army	Date: February 2020
--	----------------------------

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP5 / <i>Electronic Warfare Technology</i>
--	---	--

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
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			
Accomplishments/Planned Programs Subtotals	-	2.823	2.915

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AP7 / Comms/Horiz Int for Army Mod Priorities Tech			
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
AP7: Comms/Horiz Int for Army Mod Priorities Tech	-	0.000	0.500	2.914	-	2.914	2.615	2.964	3.028	3.051	0.000	15.072

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project investigates the communication architectures of each of the Army's modernization priorities and determines technologies and components to enable assured and resilient communications and horizontal integration.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AP8 (Comms Supp to CSA/Horizontal Int Fields Adv Tech)

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Communications Support to Army Modernization Priorities / Horizontal Integration Fields Technology	-	0.477	2.914
Description: This project investigates the communication architectures of each of the Army's modernization priorities and determines technologies and components to enable assured and resilient communications.			
FY 2020 Plans: Design and develop network requirements for Long Range Precision Fires (LRPF), Next Generation Combat Vehicle (NGCV), Future Vertical Lift (FVL), Air & Missile Defense (AMD), and Soldier Lethality (SL) Cross-Functional Teams (CFTs) based upon extended or new operational capabilities, and future science & technology insertions.			
FY 2021 Plans: Will develop lab-based integration of the many varied technologies participating in the NGCV-themed NetModX21 and an Integrated Visual Augmentation System capstone investigation as risk reduction activities; and conduct end-to-end system of			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AP7 / Comms/Horiz Int for Army Mod Priorities Tech

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
systems modeling and simulation of varied technologies that are planned to participate in the Integrated Tactical Network-themed NetModX22 as early risk reduction activities. FY 2020 to FY 2021 Increase/Decrease Statement: Funding increased to support NetModX21 activities.			
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638	-	0.023	-
Accomplishments/Planned Programs Subtotals	-	0.500	2.914

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

Remarks

D. Acquisition Strategy
N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AQ2 / EW Techniques Technology			
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
AQ2: EW Techniques Technology	-	0.000	0.000	0.500	-	0.500	0.500	0.520	0.525	0.525	0.000	2.570

Note

This is a new start in FY2021.

This Project is a New Start for Fiscal Year 2021 (FY21).

A. Mission Description and Budget Item Justification

This Project develops countermeasures against adversarial counter-fire systems that obscure and create distractive blue force locations

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the U.S. Army Futures Command (AFC).

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

	FY 2019	FY 2020	FY 2021
Title: Simultaneous CM for Active Reconnaissance and Surveillance (SCARS)	-	-	0.500
Description: This effort will provide investments in Electronic Warfare (EW), against advancing counter-fire sensors. Research will be performed to investigate highly synchronized systems capabilities to achieve advanced effects.			
FY 2021 Plans: Will conduct initial investigations and experiments against modeled or representative threats to validate technical approach feasibility for advanced EW effects.			
FY 2020 to FY 2021 Increase/Decrease Statement: New Project to investigate applied research of Electronic Warfare Techniques.			
Accomplishments/Planned Programs Subtotals	-	-	0.500

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AQ7 / High Tempo Data Driven Decision Tools Technology
--	--	--

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
AQ7: High Tempo Data Driven Decision Tools Technology	-	0.000	0.000	2.804	-	2.804	0.000	0.000	0.000	0.000	0.000	2.804

Note

This Project is a New Start for Fiscal Year 2021 (FY21).

A. Mission Description and Budget Item Justification

This Project investigates and develops data driven decision tools that help develop cyber Situational Understanding (SU) for commanders and staff that will enable them to more quickly and accurately assess and integrate cyber impacts with all of the domains in Multi-Domain Operations (MDO) and to thereby enhance mission effectiveness by improving decision cycles.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AQ8 (High Tempo Data Driven Decision Tools Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: High Tempo Data Driven Decision Tools	-	-	2.804
Description: Develops data driven decision tools that help develop cyber Situational Understanding (SU) for commanders and staff that will enable them to more quickly and accurately assess and integrate cyber impacts with all of the domains in Multi-Domain Operations (MDO) and to thereby enhance mission effectiveness by improving decision cycles.			
FY 2021 Plans: Will investigate methods for improving Common Operating Picture (COP) decision time and quality; design visualizations for the exploration and understanding of the impact of the cyber domain on the current mission in order to improve the decision cycles.			
FY 2020 to FY 2021 Increase/Decrease Statement: This is a New Start Project for FY21.			
Accomplishments/Planned Programs Subtotals	-	-	2.804

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

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AQ7 / <i>High Tempo Data Driven Decision Tools Technology</i>

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

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AQ9 / Expeditionary Data to Decisions Technology
--	--	--

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
AQ9: Expeditionary Data to Decisions Technology	-	0.000	2.000	2.805	-	2.805	4.999	3.287	3.289	0.591	0.000	16.971

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602782A Command, Control and Communications Technology:
 * Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project investigates, codes and designs software, and algorithms that improve Mission Command by increasing situational understanding, via the intelligent sharing of data in degraded networks during high op-tempo missions or while under cyber-attack. This Project includes researching artificial intelligence techniques to improve decision making capacity across the battlefield by using software knowledge representation to model the mission, automate staff tasks, correlate and analyze information, and provide recommendations. These capabilities allow forces to maximize op-tempo and maintain strategic advantage.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: Expeditionary Data to Decisions Technology	FY 2019	FY 2020	FY 2021
Description: This effort investigates algorithms and software that dynamically identify and arrange the most accurate, useful, and timely information from across the warfighting network to optimize commander and staff decision cycles and enable Mission Command from anywhere on the battlefield. It matures artificial intelligence techniques that provide the most relevant and available data to support time-sensitive and critical decisions, and present information in context and in alignment with complex cognitive needs.	-	1.909	-
FY 2020 Plans: Will identify a set of critical, time-constrained decisions that require data and information collection and analysis, map battlespace data and information to a set of important tactical decisions and identify the appropriate models for those decisions; and develop a set of initial requirements to enable the development a concept demonstrator upon effort completion.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AQ9 / <i>Expeditionary Data to Decisions Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Planned program decrease to support other efforts in this Project.				
<p>Title: Mission Command Technologies</p> <p>Description: This effort investigates and designs components and technologies for agile, survivable, modular, non-traditional Command Post platforms to enable decentralized and distributed mission command operations in the future operating environment.</p> <p>FY 2021 Plans: Will identify a set of critical, time-constrained decisions that require data and information collection and analysis, map battlespace data and information to a set of important tactical decisions and identify the appropriate models for those decisions; and develop a set of initial requirements for a concept demonstrator; conduct experiments on Command Post components for secure communications within a decentralized environment to validate component performance; and provide knowledge products that support development of future requirements.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Realigned from PE 0602143A Soldier Lethality Technology / Project BE1 Support Technology for Mission Command.</p>		-	-	0.905
<p>Title: Camouflage, Concealment and Decoys</p> <p>Description: This effort matures innovative camouflage, concealment and deception technologies for expeditionary high-value assets to defeat advanced current and emerging adversary Intelligence, Surveillance and Reconnaissance (ISR) threats, and to reduce the probability of detection in multi-domain operations. Matures physics-based models for material and system performance that support probability of detection metrics in the multi-domain operational environment, assisting in closing the capability gap between current camouflage, concealment and deception technologies and defeating enemy sensorial capabilities in future operating environments.</p> <p>FY 2021 Plans: Will research performance of camouflage materials to identify promising solutions for Command Post survivability; research and evaluate performance effects of new materials against emerging threats; research hyperspectral and LIDAR sensor defeat approaches; and evaluate candidate deception solutions.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Realigned from PE 0602143A Soldier Lethality Technology / Project AZ9 Soldier Protection Adv Tech Detectability.</p>		-	-	1.900
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.091	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AQ9 / <i>Expeditionary Data to Decisions Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
<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			
Accomplishments/Planned Programs Subtotals	-	2.000	2.805

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR1 / Robust, Resilient and Intelligent C3I Technology
--	--	--

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
AR1: <i>Robust, Resilient and Intelligent C3I Technology</i>	-	0.000	8.700	13.775	-	13.775	14.035	14.316	14.476	14.622	0.000	79.924

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602120A Sensors and Electronic Survivability:
 * Project H16 S3I Technology
 PE 0602783A Computer and Software Technology:
 * Project Y10 Computer/Info Sci Tech

A. Mission Description and Budget Item Justification

This Project develops and characterizes machine learning and artificial intelligence methods for processing, analysis and provisioning control of smart, distributed, networked sensors and devices. It provides situational understanding and decision support to enable fast, adaptive and interoperable C3I network-integrated applications, resilient to adversarial activity in contested and complex environments. Effective use of distributed networked sensors, autonomous agents and automated decision support tools is critical to address threats posed by peer competitors and more capable asymmetric forces, particularly in complex environments where traditional sensors provide an incomplete understanding of the tactical situation due to adversarial activity, occluded sightlines and small fields of regard.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: Intelligent Signal and Image Analytics for C3I	FY 2019	FY 2020	FY 2021
Description: This effort designs and characterizes technologies for multi-modal (acoustic, seismic, infrasound, electric and magnetic (E/H) field, and passive radio frequency (RF), low-cost networked sensors to enhance persistent sensing capabilities for increased probability of target detection and reduced false alarms. These combined sensors have unique capabilities that enable detection of electrical equipment operation, underground facilities, vehicles, weapons launch, gunfire, and explosions. The work includes development of artificial intelligence (AI) and machine learning (ML) for analytics to improve situational understanding.	-	6.213	6.460
FY 2020 Plans: Develop very low-frequency electric- and magnetic-field sensors and arrays for electromagnetic imaging, and for power anomalies; improve hardware and software reliability for novel low-size, weight, power and cost (SWAP-C) unattended sensor applications; develop multi-functional algorithms with acoustic and seismic fusion and robust noise mitigation to detect and			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR1 / <i>Robust, Resilient and Intelligent C3I Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>track diverse targets in complex environments; enhance elevation localization accuracy for Counter-Unmanned Aerial Vehicle (C-UAV) and counter-sniper applications; develop AI-enabled analytics for situational understanding, improved performance characterization, data enrichment, and domain adaptation; create synthetic data for training and algorithm development purposes; evaluate deep learning algorithms against adversarial attacks; assess and compare performance and confidence using curated multi-modal data and tools; and compare domain adaptation methods using automatically curated re-training data with off-ramp to fielded capabilities.</p> <p>FY 2021 Plans: Will assess improved 3-D electric and magnetic-field sensors for electromagnetic imaging, target characterization, electric power analysis for fault detection, resilient supervisory control and data acquisition, and anomaly detection; improve ?processing at the edge? hardware and software reliability for novel low-size, weight, power and cost (SWaP-C) unattended sensor applications and assured Position, Navigation, and Time (PNT) applications; develop multi-functional algorithms to encompass multimodal sensors to detect targets in complex tactical scenarios; investigate the use of electric and magnetic field sensing arrays and inversion methods for new classes of extremely low frequency imager development; develop infrasound through audible frequency sensors, algorithmic and hardware solutions to automate the detection, tracking, and localization of transient and continuous-wave targets; incorporate advanced seismic sensing for enhanced detection and localization of ground targets; exploit coupled acoustic and seismic sensing to automatically differentiate and track ground and airborne targets.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Increase in funding to support sensor assessments that directly impact the Network/C3I modernization priority goals.</p>				
<p>Title: Smart Networks and Distributed Sensing for C3I</p> <p>Description: This effort will develop and assess a concept to link physical sensors and information sources to Soldiers and small units. Specifically, the research focuses on (1) multi-modal sensor fusion for detection and classification of human activities and infrastructures such as personnel, vehicles, machinery, RF emissions, chemicals, and computers in hidden and confined spaces, (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision-making, and (4) approaches for fusing results of processed outputs of multi-modal sensors, such as visible, infrared (IR), and hyperspectral imagers, and acoustic, magnetic, and electric field sensors.</p> <p>FY 2020 Plans: Develop the framework for a reconfigurable network of fixed and relocatable sensors for accurate detection and tracking of hostile forces and in support of reconnaissance activities.</p> <p>FY 2021 Plans:</p>		-	0.280	5.337

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR1 / Robust, Resilient and Intelligent C3I Technology		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Develop the framework for a reconfigurable network of fixed and re-locatable sensors for accurate detection and tracking of hostile forces and in support of reconnaissance activities. FY 2020 to FY 2021 Increase/Decrease Statement: Planned program increase to fund higher priority improvements for a reconfigurable network of sensors.				
Title: Information Processing and Analysis Description: This effort investigates techniques that integrate local and external information sources and applies machine learning and artificial reasoning approaches to support automated intelligence analysis, command/control, and decision making. The goal is to enable tactical users to cooperatively interact with relevant and timely tactical information supported by methods that are network-aware/adaptive and deliver transparent and uniform transport. FY 2020 Plans: Develop and evaluate methods for multi-modal, network-aware, ensemble machine learning and computational reasoning that enable tactical human and autonomous decision-making where there may be few or no guarantees of convergence and are amenable to adaptive learning and optimization; and develop algorithms and approaches for self (e.g., self-organizing, self-managing, self-adapting, self-maintaining/self-protecting, etc.) behaviors in heterogeneous, command and control complex-systems that facilitate interoperability, just-in-time human interactions, and that implement resilient mission command network and decision making functionality. FY 2021 Plans: Will investigate and develop resilient information mediation and accelerated tactical and intelligence decision making tools through the use of virtualization and machine learning-augmented autonomous algorithms; develop intelligent Information Mediation and Immersive Common Operating Picture (COP) by applying resilient network protocols for adaptive information mediation; develop and assess prototype contextual policy-based and continuously learned information recommendation integrating Value-of-Information (VoI)/Quality-of-Information (QoI) network sensitivity; and integrate real-time multi-sensor and multi-domain battlefield information for accelerated exploration and decision making in an immersive COP that is tailorable and learns Soldier preferences. FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.		-	1.812	1.978
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans:		-	0.395	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR1 / <i>Robust, Resilient and Intelligent C3I Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638				
FY 2020 to FY 2021 Increase/Decrease Statement:				
Funding transferred in accordance with Title 15 USC ?638				
Accomplishments/Planned Programs Subtotals		-	8.700	13.775
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AR3 / Intelligent Environmental Battlefield Awareness			
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
AR3: <i>Intelligent Environmental Battlefield Awareness</i>	-	0.000	0.000	3.007	-	3.007	3.097	3.070	2.133	0.000	0.000	11.307

Note

In Fiscal Year 2021 (FY21), this Project is a Restructure.

This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A:

- * Project 835 Mil Med Environ Crit
- * Project 896 Base Fac Environ Qual.

A. Mission Description and Budget Item Justification

This Project investigates, develops, and designs technologies to allow Soldiers to maneuver faster in dynamic environments as informed by physical, geological, and biological constraints. This Project enhances visualization tools for mission planning through delivering web modules/software tools which contain crucial geo-chemical resources and advanced knowledge of geo-environmental infrastructure for mission planners. This Project supports the Common Operating Environment LOE. Research in this Project will transition to PE 0603463A (Network C3I Advanced Technology) / Project AR4 Intelligent Env Battlefield Awareness Adv Tech.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project is performed by the United States Army Engineer Research and Development Center and coordinated with the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Arctic Threat	-	-	1.497
Description: This effort delivers a geospatial decision aid to United States Army units conducting expeditionary operations to anticipate threats, hazards and dependencies posed by terrain and weather extremes in cold regions.			
FY 2021 Plans: Will fund research to ensure high fidelity understanding of terrain conditions for improved threat (e.g., thaw vulnerability and ground state instability) and hazard (e.g., chem/bio fate and effects and pathogenicity) prediction to aid in preventing risks to operational effectiveness and efficiency in cold regions.			
FY 2020 to FY 2021 Increase/Decrease Statement: This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A, Project 835 Mil Med Environ Crit and Project 896 Base Fac Environ Qual.			
Title: Geo-Forensics	-	-	0.700

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR3 / Intelligent Environmental Battlefield Awareness

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
<p>Description: This effort generates data to develop the data mining framework and software tools to generate geo-referenced predictive map layers to inform mission planning and operational assessments for area denied sites.</p> <p>FY 2021 Plans: Will develop preliminary framework by coalescing existing geo-forensic methodologies into a geochemical forensics tool that represent a high resolution geo-referenced soil type map layer of a specified Outside Continental United States (OCONUS) areas of interest, powered by soil-matching algorithms.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A, Project 835 Mil Med Environ Crit and Project 896 Base Fac Environ Qual.</p>			
<p>Title: Predictive Geographic Information System (GIS) Mapping (physical)</p> <p>Description: This effort develops a comprehensive GIS tool that integrates predictive models of soil, vegetation, hydrology, and permafrost conditions in OCONUS dark sites from the statistical analysis of known datasets and the application of geophysical principles.</p> <p>FY 2021 Plans: Will design a unified framework that will integrate several independently derived geospatial tools with streamlined data analysis and mitigation of statistical errors.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A, Project 835 Mil Med Environ Crit and Project 896 Base Fac Environ Qual.</p>	-	-	0.810
Accomplishments/Planned Programs Subtotals	-	-	3.007

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR5 / Understanding the Environment as a Threat Technolo
--	--	--

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
<i>AR5: Understanding the Environment as a Threat Technolo</i>	-	0.000	3.943	2.331	-	2.331	1.980	1.284	0.980	0.990	0.000	11.508

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602720A Environmental Quality Technology
 * Project 835 Mil Med Environ Crit
 * Project 896 Base Fac Environ Qual

A. Mission Description and Budget Item Justification

This Project designs and advances mission planning software enabling the Solider to identify, track, and plan for industrial or commercial chemical/environmental threats. Software modules will increase capability of mission based planning technologies providing new operational routing options for mission execution with environmental threat overlays. Work supports the Common Operating Environment research effort. Research in this Project will transition to PE 0603463A (Network C3I Advanced Technology) / Project AR6 Understanding the Environment as a Threat Adv Tech.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Engineer Research and Development Center and coordinated with the United State Army Futures Command.

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

Title: Environmental Threat Overlays for Operational Routing/Predictions of Lethal Environments	FY 2019	FY 2020	FY 2021
Description: This effort develops tools enhancing operational route planning technologies. It will deliver a new capability informing the Solider of the risks associated with physical landscape, chemical exposure, and biological threats lethal to personnel and disruptive to equipment. Tools will support route planning and soldier mobility within a complex urban environment.	-	2.327	-
FY 2020 Plans: Develop models and algorithms needed for software to define potential hazards and the affects to Solider mobility. Software will model chemical and biological threats associated with Outside Continental United States (OCONUS) soil and landscape behavior within an urbanized operational environment. Relevant urban chemical and biological risk information will inform models.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR5 / <i>Understanding the Environment as a Threat Technolo</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Effort completes in FY 2020.				
<p>Title: Predictions of Lethal Environments/ Computational Prediction of Threats in the Operational Environment</p> <p>Description: This effort develops tools and models for the Soldier providing critical information of the operational environment allowing the Soldier to operate in, avoid, or prepare for contaminated battlefields.</p> <p>FY 2020 Plans: Conduct research to provide new computational predictions that inform the Soldier on how materials interact with, move, and change in the operational environment and how to respond to contaminated battlefields.</p> <p>FY 2021 Plans: Will conduct research to design software modules that support mission based planning technologies for improved operational maneuver routing (e.g., deep maneuver) using a threat overlay design.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>		-	1.537	1.200
<p>Title: Subsurface Forensics</p> <p>Description: Develops effective and covert methods to collect data and transmit telemetric signal through solid media to advance chemical and biological sensing to prepare Soldiers for the risks of deliberate or accidental release of toxic industrial chemicals and materials.</p> <p>FY 2021 Plans: Will investigate and assess chemical and biological sensing and sampling technologies to develop methods that identify risks of deliberate or accidental release of toxic industrial chemicals and materials in subterranean waste disposal networks.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funds realigned from other efforts in the Project.</p>		-	-	1.131
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement:</p>		-	0.079	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR5 / <i>Understanding the Environment as a Threat Technolo</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	3.943	2.331

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AR7 / Sensing in Contested Environments Technology			
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
AR7: Sensing in Contested Environments Technology	-	0.000	0.000	1.888	-	1.888	1.207	0.985	0.996	0.000	0.000	5.076

Note

In Fiscal Year 2021 (FY21), this Project is a Restructure.

This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0603728A Environmental Quality Technology Demo:
* 03E Environmental Restoration Technology

A. Mission Description and Budget Item Justification

This Project characterizes through direct or inferential methods the identification of non-weaponized biological hazards posed to Soldiers in operational environments by advancing sensor technologies. Sensor technologies and software modules will detect and characterize hazards including water quality, heavy metals in soils, breathability, and non-weaponized radiological hazards within confined environments. This effort supports the Common Operating Environment LOE. Research is transitioned to PE 0603463A (Network C3I Advanced Technology) / Project AR8 Sensing in Contested Environments Adv Tech.

All FY20 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the Engineer Research and Development Center and coordinated with the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Non-Traditional Threat Detection in Contested Environment	-	-	1.888
Description: This effort identifies, examines and prioritizes commercial of the shelf capabilities from multiple sources that can accurately detect biological hazards relevant to operations in subterranean environments from point of ingress/egress to evaluate exposure potential and affects.			
FY 2021 Plans: Will assess candidate sensor technologies for maturity and effectiveness and design demonstration scenarios to detect and characterize hazards including water quality, heavy metals in soils, breath-ability, and non-weaponized radiological hazards to provide immediate warning of natural, man-made, and biological hazards that impact operations.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR7 / <i>Sensing in Contested Environments Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program 0603728A Environmental Quality Technology Demo, Project 03E Environmental Restoration Technology			
Accomplishments/Planned Programs Subtotals	-	-	1.888

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR9 / Persistent Geophysical Sensing-Infrasound Tech
--	--	--

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
AR9: <i>Persistent Geophysical Sensing-Infrasound Tech</i>	-	0.000	3.963	3.150	-	3.150	3.456	2.698	2.498	2.274	0.000	18.039

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602784A Military Engineering Technology:
 * Project T40 Mob/Wpns Eff Tech

A. Mission Description and Budget Item Justification

This Project designs and develops algorithms, software, and hardware components to enable near-real-time battlespace awareness to persistently monitor (through non-line-of-sight sensing including infrasound) critical infrastructure conditions and threat activities in dynamic battlefields. These technologies provide near real time data collection, processing, and alerts of infrastructure go/no-go condition required for maneuver planning. This project also designs and develops methodologies to assign maneuver relevant engineering attributes to geospatial feature data such as bridge load classification, road condition, and bathymetry.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) /Project AS9 (Persistent Geophysical Sensing-Infrasound Tech Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Engineer Research and Development Center.

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

Title: Remote Assessment of Infrastructure for Ensured Maneuver (RAFTER)	FY 2019	FY 2020	FY 2021
Description: This effort develops parameters for a suite of geophysical and geosensing technologies to persistently assess infrastructure capability and condition for large areas including urban terrain; develops complex terrain, topography, and meteorological models related to acoustic propagation detected by the sensor suite, as well as signal processing algorithms for detection and classification of transportation infrastructure.	-	3.891	-
FY 2020 Plans: Develop and refine algorithms associated with infrasound data processing for infrastructure monitoring as well as the urban, terrain, topographical, and meteorological models that feed into the analysis.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR9 / Persistent Geophysical Sensing- Infrasound Tech		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
This research effort completes in FY2020.				
<p>Title: Battlefield Intelligence by Geophysical Sensing (BIGS)</p> <p>Description: This effort investigates and develops a suite of geophysical and geo-sensing technologies to persistently assess battlefield elements to include infrastructure and additional sources of interest such as explosive and fires events and various air platforms; refines terrain, topography, and meteorological models related to acoustic propagation detected by the employed sensor suite as well as detection and classification signal processing algorithms for a broader range of sources and/or threats.</p> <p>FY 2021 Plans: Will design and develop algorithms associated with non-traditional sensing methods (including infrasound) for detecting, classifying, and monitoring additional sources of interest (explosive events, air platforms, etc.) as well as refinement of the terrain, topographical, and meteorological models that feed into the analysis.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Increase to initiate funding for the BIGS effort.</p>		-	-	3.150
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.072	-
Accomplishments/Planned Programs Subtotals		-	3.963	3.150
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AT2 / Subterranean Detection and Monitoring Technology			
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
AT2: Subterranean Detection and Monitoring Technology	-	0.000	1.600	2.897	-	2.897	0.000	1.956	1.636	1.485	0.000	9.574

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602784A Military Engineering Technology:
 * Project T40 Mob/Wpns Eff Tech

A. Mission Description and Budget Item Justification

This Project designs and develops an integrated suite of tunnel detection, subterranean monitoring solutions, and vulnerability assessment technologies to detect, identify, and monitor subterranean threat activities in urban environments through advanced sensing and rapid analysis capabilities. This Project also develops and investigates enhanced technologies to detect tunnels and tunneling activity in complex and varied environments.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology / Project AT3 (Subterranean Detection and Monitoring Adv Tech).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus area and the Army Modernization Strategy.

Work in this Project is conducted at the United States Army Engineer Research and Development Center and coordinated with the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Subterranean Threat Assessment by Real-time Sensing	-	1.527	2.897
Description: This effort designs and develops an integrated suite of tunnel detection and persistent surveillance technologies to detect, track, and identify subsurface activities; expedient underground municipal infrastructure detection system; urban source characterization and modeling algorithms; expedient void detection systems in urban areas, and vulnerability assessment tools for the urban subterranean domain.			
FY 2020 Plans: Design and develop a rapidly deployable passive seismic sensor system to detect subterranean activities of interest; mature electromagnetic induction transmitter component designs; and continue to investigate and conduct experiments on sensor coupling.			
FY 2021 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AT2 / Subterranean Detection and Monitoring Technology		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Will design and develop ground-penetrating radar and seismic hardware for detection of underground municipal infrastructure; and develop sensing classifiers based on simulated urban source signatures. FY 2020 to FY 2021 Increase/Decrease Statement: Increased funding for further development and experimentation of ground-penetrating radar.				
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638		-	0.073	-
Accomplishments/Planned Programs Subtotals		-	1.600	2.897
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>				Project (Number/Name) AT7 / <i>Network-Enabled GeoSpatial-GEOINT Services Tech</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
<i>AT7: Network-Enabled GeoSpatial-GEOINT Services Tech</i>	-	0.000	2.992	4.001	-	4.001	4.692	1.033	0.000	0.000	0.000	12.718

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602784A Military Engineering Technology:
 * Project 855 Topographical, Image Intel & Space
 * Project T42 Terrestrial Science Applied Research

A. Mission Description and Budget Item Justification

This Project investigates and develops a revolutionary, integrated capability to rapidly share mission critical 3-dimensional (3D) information that supports planning and execution at the Soldier level. This will be achieved through the maturation of next-generation geospatial analytical models for 3D complex urban environment data, delivering enriched understanding of dynamic Operational Environments and distributed to a tactical Common Operating Environment. This Project will result in improved situational awareness and autonomy at low echelons, contributing to increased maneuver and mobility during manned and unmanned teaming operations.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AT8 (Network-Enabled GeoSpatial and GEOINT Services AdvTech).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Engineer Research and Development Center (ERDC) and coordinated with the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Geo-registration, Analytical Tool Development and Visualization	-	2.856	3.007
Description: This effort investigates the design and formulation of new urban terrain data models, frameworks and processes to automate the geo-registration of 3D and 2-dimensional (2D) source data (e.g. light detection and ranging (LiDAR), imagery, Open Street Maps, and full motion video derived data) to new model constructs for rapid alerting to changes in the Operational Environment of interest.			
FY 2020 Plans: Investigate and compare software for accurately aligning 3D and 2D sources together, then adapt and/or develop new software to fully automate the alignment of these geospatial sources to maximize their utility for automated extractions and change detection			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AT7 / <i>Network-Enabled GeoSpatial-GEOINT Services Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>alerting within the Operational Environment; and initiate the design of an advanced 3D data processing framework meeting criteria for transformation of point cloud data to compact feature data models, 3D-data indexing and transmission algorithms.</p> <p>FY 2021 Plans: Will complete research and design of an advanced 3D data processing framework and algorithms for co-registration of disparate sources of time sensitive, tactical unit generated 3D geospatial data for incorporating into the unit's tactical foundation terrain dataset.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>				
<p>Title: Geospatial Data for Tactical Visualization</p> <p>Description: This effort develops new open source software, data models and processes to generate a vision-based geospatial foundation layer to enable end-users systems to visualize real-time mission critical geospatial content at the required level-of-detail (LOD) and enable position-navigation self-localization capability applicable to end-user devices at required accuracies optimized for the device, application, and mission.</p> <p>FY 2021 Plans: Will investigate new geospatial data models for 3D urban terrain supporting the generation of a vision-based foundation layer enabling end-user's systems to visualize real-time mission critical geospatial content at the required level-of-detail (LOD).</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: In FY2021, includes realignment from PE 0603463A Network C3I Advanced Technology / Project AU6 Automated Analytics for Operational Environments AT.</p>		-	-	0.994
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.136	-
Accomplishments/Planned Programs Subtotals		-	2.992	4.001
C. Other Program Funding Summary (\$ in Millions)				
N/A				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AT7 / <i>Network-Enabled GeoSpatial-GEOINT Services Tech</i>

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

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AT9 / Tactical GeoSpatial Information Capabilities Techn			
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
AT9: Tactical GeoSpatial Information Capabilities Techn	-	0.000	2.771	4.240	-	4.240	1.798	0.000	0.000	0.000	0.000	8.809

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
 Program Element (PE) 0602784A Military Engineering Technology:
 * Project 855 Topographical, Image Intel & Space

A. Mission Description and Budget Item Justification

This Project investigates and develops next generation geospatial analytical tools for 3-dimensional complex environments for low echelon and tactical edge exploitation. Research focuses on improving geospatial and Geospatial Intelligence (GEOINT) aspects of situational awareness at the tactical edge in the complex environment by exploiting new data sources, automating analytical tasks, and testing new collection technologies, including interiors of infrastructure. Research develops capabilities to enhance/update provisioned (baseline) standard, sharable, geospatial foundation (SSGF) data through automated analytics on multi-sourced spatial data resulting in streamlined, enhanced high fidelity terrain analysis products. Reducing data gaps and processing timelines will greatly increase Soldier situational awareness and support faster decision making in complex terrain.

Work in this Project complements PE 0603463A Network C3I Advanced Technology / Project AU1 (Tactical GeoSpatial Information Capabilities ATech).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Engineer Research and Development Center (ERDC) and coordinated with the United State Army Futures Command

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

Title: 3D Terrain Analysis	FY 2019	FY 2020	FY 2021
Description: This effort investigates and develops software models and workflows provisioned on the geospatial and GEOINT workstations for improved capabilities to generate, process and exploit terrain products enabling situational awareness and rapid decision making at the tactical edge.	-	1.267	2.755
FY 2020 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AT9 / <i>Tactical GeoSpatial Information Capabilities Techn</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Investigate and build Distributed Common Ground System - Army (DCGS-A) compatible workflows that provision remotely sensed tactical data exploitation and conflation for geospatial and GEOINT workstations, enabling enhanced situational awareness and rapid decision making. FY 2021 Plans: Will research enhanced terrain processing algorithms to rapidly process higher resolution data (spatial and temporal), generating time sensitive geospatial products supporting tactical maneuver and protection in complex terrain. FY 2020 to FY 2021 Increase/Decrease Statement: Funding increase to support enhanced terrain processing algorithms.				
Title: Airborne Light Detection and Ranging (LiDAR) Description: This effort investigates and develops enhanced Geiger-mode LiDAR hardware/software, for advanced testing of protocols, equipment, and products for improved high-altitude/wide area terrain data collection, to support tactical operations. FY 2020 Plans: Investigate new Geiger-mode LiDAR sensor payload components, for increasing performance and speed of collection and processing, for more realistic portrayal of multi-domain environments. FY 2021 Plans: Will research airborne LIDAR signal processing algorithms and calibration model frameworks, tailored for higher resolution 3D data collections over large areas, providing for extended collection stand-off and enhanced surface feature classification accuracies. FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.		-	1.379	1.485
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638		-	0.125	-
Accomplishments/Planned Programs Subtotals		-	2.771	4.240

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AT9 / <i>Tactical GeoSpatial Information Capabilities Techn</i>
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AU3 / Geospatially Enabled Operational Design Technology			
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
AU3: <i>Geospatially Enabled Operational Design Technology</i>	-	0.000	3.173	1.467	-	1.467	1.002	0.000	0.000	0.000	0.000	5.642

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602784A Military Engineering Technology:
 * Project 855 Topographical, Image Intel & Space

A. Mission Description and Budget Item Justification

This Project investigates, advances and develops a geospatially enabled collaborative planning environment, accessible across echelons, with capabilities that support Army Design Methodology (ADM) by providing the ability to perform conceptual planning and problem framing, supporting a greater understanding and visualization of the dynamic operational environment, a shared understanding of the operations purpose across echelons, and enhanced products to drive detailed planning (Military Decision Making Process - (MDMP) and the operational assessment process, enhancing the collaborative interaction between commanders, staffs, and unified action partners.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) /Project AU4 (Geospatially Enabled Operational Design Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Engineer Research and Development Center (ERDC).

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

	FY 2019	FY 2020	FY 2021
Title: Virtual Collaborative Operational Design (GEOD) Research	-	1.770	1.467
Description: This effort investigates automation technologies to digitally visualize, create and assess critical elements of the Operational Environment required to inform the Operational Design functions, including collaborative conceptual framing of the problem by examining the differences between the current state of an operational environment and the desired end state.			
FY 2020 Plans: Research methodologies and tools to support ADM using digital collaboration tools to frame the problem and visualize the desired end state in a geospatial context.			
FY 2021 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AU3 / <i>Geospatially Enabled Operational Design Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Will examine model approaches for visualizing differences between the natural tendency of an operational environment (OE) and desired future states of relevant actors with the desired end state (military objective) to include tensions (frictions, conflicts, and competitions) between relevant actors including geographic, demographic, economic, religious, and resource consumption trends.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>				
<p>Title: Tactical Data Analysis and Visualization</p> <p>Description: This effort develops a suite of data aggregation analysis and visualization capabilities allowing commanders and staffs the capability to bridge conceptual planning to deliberate planning of the Military Decision Making Process (MDMP) at echelons down to battalion.</p> <p>FY 2020 Plans: Develop capabilities to geospatially enable strategic guidance inputs to operational design, in a digital, integrated, collaborative planning environment.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Realigned to accelerate GEOD in support of Modernization Priorities.</p>		-	1.396	-
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.007	-
Accomplishments/Planned Programs Subtotals		-	3.173	1.467
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AU5 / Automated Analytics for Operational Environment			
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
AU5: Automated Analytics for Operational Environment	-	0.000	3.950	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.950

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602784A Military Engineering Technology:
 * Project 855 Topographical, Image Intel & Space

In FY21 this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project investigates, advances and develops algorithms for automated extraction of relationships between the population and the operational environment. Linking the data points across multiple domains to include patterns of life will result a greater understanding of the operational environment enabling the Mission Analysis phase of detailed planning (Military Decision Making Process). Work supports the Common Operating Environment research effort. Research is transitioned to PE 0603463A (Network C3I Advanced Technology) Project AU6 (Automated Analytics for Operational Environment) Advanced Technology.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the Army Engineer Research and Development Center and coordinated with the United States Army Futures Command.

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

Title: Simultaneous Multi-Domain Data Representation	FY 2019	FY 2020	FY 2021
Description: This effort investigates and develops advanced capabilities to provide commanders and staff with the ability to understand and operate in multiple domains simultaneously, by proposing and validating new data models and encoding for threat actors and actions, and operational environment characterization optimized across multiple domains in the battlespace, and represented geospatially.	-	1.833	-
FY 2020 Plans: Investigate spatio-temporally coherent multi-domain data representations that capture explicit and implicit relationships between threat actors distilled from raw text content data; and develop a flexible suite of geospatial methods and algorithms for processing and correlating heterogeneous data streams generated from multiple domains using feature signatures.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AU5 / Automated Analytics for Operational Environment

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
This research effort concludes in FY20.			
<p>Title: Automated Analysis of Multi-Domain Data</p> <p>Description: This effort investigates and develops data models to support automated understanding and analysis and advanced relevancy ranking approaches to identify and prioritize knowledge gaps and contextualized results.</p> <p>FY 2020 Plans: Investigate algorithms for automated threat pattern and non-threat categorization, and changes to the operational environment that may be revealed across multiple diverse data sources.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: This research effort concludes in FY20.</p>	-	2.096	-
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>	-	0.021	-
Accomplishments/Planned Programs Subtotals	-	3.950	-

<p>C. Other Program Funding Summary (\$ in Millions) N/A</p> <p>Remarks</p>
<p>D. Acquisition Strategy N/A</p>

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV3 / Foundational S&T for Network C3I Technology
--	--	---

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
<i>AV3: Foundational S&T for Network C3I Technology</i>	-	0.000	0.000	1.927	-	1.927	1.968	2.101	2.208	2.208	0.000	10.412

Note

In Fiscal Year 2021 (FY21), this Project is a Restructure.

This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element (PE) 0602270A Electronic Warfare Technology.

A. Mission Description and Budget Item Justification

This Project develops underlying technologies applicable to artificial intelligent agents and holistic network integration as applied to, but not limited to autonomous manned-unmanned teaming for ground and air platforms. This Project also matures emerging research leading to potential technology development in areas of strategic importance to the Army in network technologies, by bringing competitively selected Universities with research teams into Technical Alliances.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command (AFC).

This work is done in coordination with PE 0603463A (Network C3I Advanced Technology).

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

	FY 2019	FY 2020	FY 2021
Title: Development of Foundational technologies for holistic network integration	-	-	1.927
Description: This Project develops underlying technologies applicable to next generation networks and integration of the same.			
FY 2021 Plans: Will investigate and research foundational technologies focusing on autonomy, Artificial intelligence/Machine Learning as applicable to, but not limited to, holistic network integration. Will investigate autonomy-related machine learning technologies, advanced teaming, and navigation/routing necessary for the Ground and Air platforms in support of the Army Modernization Priorities			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding increase due to realignment from PE 0602270A / Electronic Warfare Technology after a Skip Year in FY20.			
Accomplishments/Planned Programs Subtotals	-	-	1.927

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AV3 / <i>Foundational S&T for Network C3I Technology</i>

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

Remarks

D. Acquisition Strategy
N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AV5 / Protective Technologies			
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
AV5: Protective Technologies	-	0.000	6.800	7.692	-	7.692	7.839	6.443	6.515	6.580	0.000	41.869

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602705A Electronics and Electronic Devices:
 * Project H94 Elect & Electronic Devices

A. Mission Description and Budget Item Justification

This Project develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
<p>Title: Protective Technologies</p> <p>Description: This effort develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats.</p> <p>FY 2020 Plans: Integrate threat-based sensors and enhance secure processor intellectual property (IP) for enhanced Rigor 1b second engineering model; develop full Rigor 1a engineering models; perform laboratory characterization of Rigor 1a module; and develop the designs for Rigor 1c and Rigor 1d modules.</p> <p>FY 2021 Plans: Will develop Rigor 1b second engineering model for laboratory characterization and application part qualification activities; develop initial designs for additional Rigor modules; evaluate commercial and other Government agency security solutions for AT enhancement; and develop next generation Systems Engineering Development tailored for DoD Rapid Acquisition systems.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Planned program increase.</p>	-	6.491	7.692
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p>	-	0.309	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army	Date: February 2020
--	----------------------------

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AV5 / <i>Protective Technologies</i>
--	---	--

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
<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			
Accomplishments/Planned Programs Subtotals	-	6.800	7.692

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV6 / Airborne Engineering Support Technology
--	--	---

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
AV6: Airborne Engineering Support Technology	-	0.000	0.882	0.899	-	0.899	0.917	0.935	0.946	0.946	0.000	5.525

Note
 In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project supports advanced Command, Control, Communications, Intelligence, Surveillance and Reconnaissance (C3ISR) research and development technologies for airborne, and air-to-ground based testing of emerging Radio Frequency (RF) technologies.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
<p>Title: Airborne Engineering Support Technology</p> <p>Description: This effort supports the demonstration of new and emerging C3ISR technologies. This venue performs technology assessments by evaluating candidate technologies in support of the Army Modernization Priorities. Demonstration events are determined by the maturity of the tech base programs across the Army's Science and Technology (S&T) C3ISR portfolio.</p> <p>FY 2020 Plans: Investigate and provide early performance feedback to S&T efforts that are developing technologies to provide robust and adaptive intelligence, electronic support, and electronic warfare capabilities.</p> <p>FY 2021 Plans: Will evaluate performance of S&T technologies developed to provide robust and adaptive intelligence, electronic support, and electronic warfare capabilities.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Planned program increase.</p>	-	0.842	0.899
<p>Title: FY 2020 SBIR/STTR Transfer</p>	-	0.040	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AV6 / <i>Airborne Engineering Support Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638				
Accomplishments/Planned Programs Subtotals		-	0.882	0.899
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AV7 / Atmospheric Modeling and Meteorological Technology			
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
<i>AV7: Atmospheric Modeling and Meteorological Technology</i>	-	0.000	5.812	5.945	-	5.945	6.064	6.186	6.255	6.318	0.000	36.580

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602784 Military Engineering Technology:
 * Project H71 Meteorological Research for Battle Command

A. Mission Description and Budget Item Justification

This Project develops tactical atmospheric sensing, modeling, and decision support technologies. New atmospheric sensing technologies are developed that enable near-real-time, high-resolution measurements of atmospheric parameters via light-weight systems that can be employed in tactical domains. Efforts include high-resolution local assessments and forecasts of meteorological conditions that can accommodate the effects of dense urban and complex, mountainous terrain. Both physics-based and rule-based decision support systems are developed for assessing the impacts of weather/atmosphere across a spectrum of friendly and threat weapons systems, sensors, platforms, and operations. It provides detailed model applications for various effects of the atmosphere on electro-optical and acoustic target detection, location, and identification. Information can be applied to mission planning and execution; battlefield visualization; reconnaissance, surveillance, and target acquisition, route planning to maximize stealth and efficiency, web-enabled tactical decision aids, long-range precision fires; and modeling of environmental impacts for combat simulations and war games

This work provides technologies for evaluation by and/or transitions to the Department of Defense weather and operations community including: Program Executive Office (PEO) Ammunition-PM Combat Ammunition Systems (CAS) and Marine Corps Systems Command (MCSC) for meteorological message input to field artillery targeting systems; Project Manager, Distributed Common Ground System-Army (DCGS-A); the US Air Force 557th Weather Wing and the Air Force Life Cycle Management Center (AFLCMC) to improve their operational weather support to the Army.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: Atmospheric Characterization, Modeling, and Impacts	FY 2019	FY 2020	FY 2021
Description: This effort develops environmental situational understanding enabled through coupled sensing, modeling, and decision support technologies for data-sparse, computationally-limited, and network-constrained domains.	-	5.548	5.945
FY 2020 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV7 / Atmospheric Modeling and Meteorological Technology		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Apply stochastic collocation methods to Weather Running Estimate ? Nowcast (WRE-N) and Atmospheric Boundary Layer Environment (ABLE) model simulations over the Meteorological Sensor Array (MSA) region in and adjacent to White Sands Missile Range, NM, to compute quantitative forecast uncertainty metrics, improve risk understanding (or management), and increase decisiveness; examine model uncertainty and optimize WRE-N physics configurations over diverse geographic settings; update model algorithms to enable efficient operations on mobile computing architectures supporting decide-faster scenarios; demonstrate upgraded model operation in complex terrain domains for improved targeting for long range fires; enhance atmospheric impacts decision aids for ground and air maneuver including strategic-level solutions (e.g. climatology data inputs), route optimization (i.e., including environmental variables and urban area buildings), assessing autonomous systems at the Dense Urban Environment (DUE) MSA testbed, implementing fuel consumption computations along a mission route, characterizing atmospheric hazards for airfields; and develop techniques to implement environmental inputs into a next-generation acoustic propagation decision support tool to support threat detection.</p> <p>FY 2021 Plans: Will implement and assess machine learning techniques applied to path optimization (air and surface) through atmospheric hazards including strategic-level solutions (e.g. climatological time-scales) and obstacles; implement and assess machine learning techniques applied to environmental effects on directed energy propagation, including strategic-level solutions (e.g. climatological time-scales); conduct validation study of Atmospheric Boundary Layer Environment Lattice-Boltzmann Method (ABLE-LBM) forecast model over forested, complex terrain using observational data from the Perdigo, Portugal field experiment; establish robust radar and satellite data assimilation capabilities for use with numerical weather prediction models such as Weather Running Estimate - Nowcast (WRE-N); utilizing database of sub-km WRE-N model simulations over the Meteorological Sensor Array (MSA) and Design of Experiments expertise, quantify the primary sources of model uncertainty and loss of predictability in sub-km numerical weather prediction; optimize Doppler Light Detection and Ranging (LiDAR) wind retrieval algorithms for low-power and low-computer architectures/platforms; implement viable range-dependent environmental input techniques into a next-generation acoustic propagation decision support tool to augment threat detection; and employ surrogate models for physical self-awareness for autonomous flight of unmanned aerial vehicles (UAVs) to incorporate differing, static weather conditions; adapt surrogate models for use on resource-constrained usage on computer hardware on UAVs.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Planned program increase.</p>				
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans:</p>		-	0.264	-

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AV7 / <i>Atmospheric Modeling and Meteorological Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638				
FY 2020 to FY 2021 Increase/Decrease Statement:				
Funding transferred in accordance with Title 15 USC ?638				
Accomplishments/Planned Programs Subtotals		-	5.812	5.945
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV9 / Advanced PNT for GPS Independent Environments Tech
--	--	--

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
<i>AV9: Advanced PNT for GPS Independent Environments Tech</i>	-	0.000	6.974	6.656	-	6.656	10.357	8.735	8.833	8.834	0.000	50.389

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602705 Electronics and Electronic Devices:
 * Project H94 Elect & Electronic Dev

A. Mission Description and Budget Item Justification

This Project develops technologies that will enable precise and assured Positioning, Navigation and Timing (PNT) in Global Positioning System (GPS)-denied environments. This Project develops technologies addressing the PNT's toughest Scenario - Scenario 4 (no available GPS signal during the mission duration) with a goal of enabling Soldier missions of up to seven days in a GPS denied environment. This is achieved with research addressing advanced quantum timing circuits, advanced inertial measurement unit (IMU) components, multi-sensor modalities, perception techniques, geo-location data, vision aided navigation sensors, and available RF signals.

This research also addresses the PNT Scenarios 1 (GPS operations that start good and have degraded GPS signals throughout the mission duration) through Scenario 3 (GPS operations have 'bad' or limited availability of GPS signals throughout the entire mission). This is achieved with research addressing the ability to transmit jam-resistant, precision timing synchronized signals using optical fibers, free-space using lasers, and in the radio frequency (RF) domain using innovative RF antenna concepts to extend the reach of Soldier compatible capabilities in heavily contested GPS environments.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: Precision Measurement Technology for Contested Environments	FY 2019	FY 2020	FY 2021
Description: This effort will develop technologies that will enable precise and assured PNT in GPS-denied environments for up to 1 hour. This research will improve the accuracy while also focusing on size, weight, power, cost (SWAP-C) of current IMUs through the design, fabrication, and testing of novel micro-electromechanical system (MEMS) sensor designs and materials and the integration of multiple sensor modalities with the IMUs using sensor fusion and perception techniques to reduce drift and increase positional accuracy. Research will also include the ability to transmit jam-resistant precision position, navigation, and timing signals via electro-optical and/or RF transmission methods.	-	2.898	3.054

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV9 / Advanced PNT for GPS Independent Environments Tech

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
<p>FY 2020 Plans: Refine modeling designs for novel MEMS IMU using advanced MEMS materials, cavity designs, and micro-structures; develop and evaluate micro-structures demonstrating improved MEMS IMU accuracy; refine algorithms enabling vision-based geolocalization, and demonstrate impact of drift correction techniques on the performance of MEMS IMU operations in representative operational environments (temperature and vibration); and fabricate and evaluate core components, techniques, and methods for chip-scale fiber combs.</p> <p>FY 2021 Plans: Will implement refined designs based on prior modeling for novel MEMS IMUs using advanced MEMS materials and micro-structures; develop and assess advanced micro-structures demonstrating improved MEMS IMU accuracy; validate algorithms enabling vision-based geo-localization, and improve drift correction techniques on the performance of MEMS IMU operations in representative operational environments (temperature and vibration); develop chip-scale, low-noise stabilized frequency source based on integrated electro-optic frequency combs for SWaP-C constrained timing methods; and develop system models for multi-node, anti-jam performance in the 600 MHz to 6 GHz and 24-86 GHz bands.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.</p>			
<p>Title: Quantum Effects for Assured PNT in Zero-GPS Environments</p> <p>Description: This effort will conduct research on SWAP-C quantum based timing sub-systems, incorporating advanced sensors, RF signals (beyond GPS), navigation databases, and advanced algorithms. This effort incorporates advanced quantum timing circuits, advanced IMU components, multi-sensor modalities, perception techniques, geolocation data, vision aided navigation sensors, and available RF signals in order to increase precise and assured PNT operations in a GPS ? denied environments for up to 7 days.</p> <p>FY 2020 Plans: Refine quantum based timing designs (e.g., materials, cavity, integrated optical coupling) with modeled performance and representative operational environments (temperature and vibration); develop and evaluate a laboratory quantum based timing design compatible blue laser (blue laser required for full functionality of the quantum timing operations); develop designs and methods for chip-scale, integrated opto-electronic controls for SWaP-C constrained quantum based timing methods; develop an embedded hybrid multi-sensor fusion engine with continuous Inertial Navigation System (INS) calibration; and develop an integrated, multi-modal, inertial navigation capability to evaluate the multi-sensor fusion engine and perform continuous INS calibration.</p> <p>FY 2021 Plans:</p>	-	3.759	3.602

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV9 / Advanced PNT for GPS Independent Environments Tech		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
<p>Will refine quantum based timing designs with modeled performance and representative operational environments, targeting improved performance for a chip-scale atomic clock; develop and assess materials growth to enable blue laser required for quantum based timing design; integrate a minimum of three heterogeneous sensor modalities into an embedded hybrid multi-sensor fusion engine with continuous Inertial Navigation System (INS) calibration capable of interfacing with the Department of Defense PNT Open Architecture standards; and integrate and assess a multi-modal, inertial navigation capability to validate the multi-sensor fusion engine and perform continuous INS calibration in a relevant environments.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Planned program decrease.</p>				
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>		-	0.317	-
Accomplishments/Planned Programs Subtotals		-	6.974	6.656
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>				Project (Number/Name) AW1 / <i>Autonomous Navigation Technology</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
AW1: <i>Autonomous Navigation Technology</i>	-	0.000	0.400	1.798	-	1.798	2.198	2.098	0.000	0.000	0.000	6.494

Note
 In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project investigates use of sensors on the platform and available navigation signals to the localization and decision making of Robotic/Autonomous Systems. Additionally, it examines the use of machine learning algorithms for cooperative navigation to aid in a Positioning, Navigation and Timing (PNT) solution. This will enable the user to achieve operational overmatch in a Global Positioning System (GPS) impeded environment as well as enhanced navigation (reducing dependence on GPS) through challenging terrains.

Work in this Project complements PE060343A (Network C3I Advanced Technology) / Project AW2 (Autonomous Navigation Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: Autonomous Navigation Technology	FY 2019	FY 2020	FY 2021
Description: This effort leverages Assured PNT efforts that improve localization and decision making of Robotic/Autonomous Systems by optimizing use of sensors on the platform and taking advantage of all available navigation signals. It examines the use of machine learning algorithms for cooperative navigation to aid in a PNT solution.	-	0.382	-
FY 2020 Plans: Develop and evaluate a ground vehicle navigation algorithm based on unmanned aerial vehicle (UAV) imagery data for the localization and heading estimation of unmanned ground vehicles (UGVs); develop and investigate alternative methods of UAV-based ground vehicle identification utilizing fiducial markers and deep learning algorithms; and investigate and validate methodologies to combine UGV localization and identification algorithms through simulation.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army	Date: February 2020
--	----------------------------

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AW1 / <i>Autonomous Navigation Technology</i>
--	---	---

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
This effort ended after FY20.			
<p>Title: Intelligent Electronic Protect (IEP)</p> <p>Description: This effort provides assured access to PNT in degraded electromagnetic (jamming), space, or cyber environments; notifies Soldiers, Systems, and Platforms when PNT cannot be trusted for mission duration; provides Soldiers, Systems, and Platforms a reduction in the likelihood of being spoofed for mission duration; provides unhindered access to military Global Positioning System (GPS) level of accuracy when access to military GPS is unavailable; and facilitates graceful degradation of PNT systems when military GPS is denied or degraded.</p> <p>FY 2021 Plans: Will investigate assured access to PNT in degraded electromagnetic (jamming), space, or cyber environments; validate unhindered access to military Global Positioning System (GPS) level of accuracy when access to military GPS is unavailable.</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Realigned from PE 0603463A Network C3I Advanced Technology, Project AV8 Navigation Warfare (NAVWAR) Advanced Technology in support of Modernization Priorities.</p>	-	-	1.798
<p>Title: FY 2020 SBIR/STTR Transfer</p> <p>Description: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638</p> <p>FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638</p>	-	0.018	-
Accomplishments/Planned Programs Subtotals	-	0.400	1.798

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AW3 / <i>DoD PNT M&S Collaborative Initiative (CI) Technolo</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
AW3: <i>DoD PNT M&S Collaborative Initiative (CI) Technolo</i>	-	0.000	2.000	1.998	-	1.998	0.000	0.000	0.000	0.000	0.000	3.998

Note
 In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project designs and develops Positioning, Navigation and Timing (PNT) modeling and simulation (M&S) frameworks and tools to provide Department of Defense (DoD) with the capability to conduct analysis and create quantifiable data on the impact of PNT technologies on warfighters and missions operating in a denied or degraded Global Positioning System (GPS) environment. Additionally, it provides senior leadership with the information required to understand the value of PNT investment versus the improvement in mission performance and operational effectiveness. This Project also assess the effectiveness and maturity of complementary PNT systems/sensors.

Work in this Project complements PE 0603463 (Network C3I Advanced Technology) / Project AW4 (DoD PNT M&S Collaborative Initiative Adv Tech).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

Title: DoD PNT M&S Collaborative Initiative (CI)	FY 2019	FY 2020	FY 2021
Description: This effort designs and develops PNT M&S frameworks and tools to provide DoD with the capability to conduct analysis and create quantifiable data on the impact of PNT technologies on warfighters and missions operating in a denied or degraded GPS environment. Additionally, it provides Senior leadership with the information required to understand the value of PNT investment versus the improvement in mission performance and operational effectiveness. This effort also assess the effectiveness and maturity of complementary PNT systems/sensors. Work accomplished under PE 0603463A/Project AW4 (DoD PNT M&S Collaborative Initiative Advanced Technology) complements this effort.	-	1.909	1.998
FY 2020 Plans:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AW3 / <i>DoD PNT M&S Collaborative Initiative (CI) Technolo</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Design and develop an architecture, framework, catalogue, repository and models for complementary PNT technologies. FY 2021 Plans: Will complete the design and development of an architecture, framework, catalogue, repository and models for complementary PNT technologies; and produce final technical reports documenting the federated Tri-service M&S capability. Completed M&S capability will be integrated into Army, Navy, and Air Force M&S environments. FY 2020 to FY 2021 Increase/Decrease Statement: Funding change reflects planned lifecycle of this effort.				
Title: FY 2020 SBIR/STTR Transfer Description: Funding transferred in accordance with Title 15 USC ?638 FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638		-	0.091	-
Accomplishments/Planned Programs Subtotals		-	2.000	1.998
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AW5 / Modular GPS Independent Sensors Technology
--	--	--

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
AW5: Modular GPS Independent Sensors Technology	-	0.000	4.140	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.140

Note
 In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology:
 * Project 779 Command, Control and Platform Electronics Tech

In FY21 this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project performs research and development of modular Global Positioning System (GPS)-independent sensors and an open architecture sensor fusion core enabling simple, plug-and-play sensor modules that can be tailored for any platform based on mission needs and requirements.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AW6 (Modular GPS Independent Sensors Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Modular GPS Independent Sensors	-	3.952	-
Description: This effort performs research and development of modular GPS-independent sensors and an open architecture sensor fusion core enabling simple, plug-and-play sensor modules that can be tailored for any platform based on mission needs and requirements.			
FY 2020 Plans: Continue to develop Quad Mass Gyro Inertial Measurement Units and investigate Infrared Vision Sensors for use in positioning, navigation, and timing (PNT) solutions; develop a PNT sensor fusion core and sensor fusion modules; Will develop algorithms for PNT integrity; design a PNT Software Defined Receiver; and investigate other existing sensors to be used in a PNT solution.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AW5 / <i>Modular GPS Independent Sensors Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2019	FY 2020	FY 2021
Research effort concludes in FY20.				
Title: FY 2020 SBIR/STTR Transfer		-	0.188	-
Description: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638				
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638				
Accomplishments/Planned Programs Subtotals		-	4.140	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) BP2 / Sensor and Electronic Network Initiatives (CA)
--	--	--

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
BP2: <i>Sensor and Electronic Network Initiatives (CA)</i>	-	0.000	23.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.500

Note
Congressional Interest Item funding provided for Sensor and Electronic Network Initiatives.

A. Mission Description and Budget Item Justification
Congressional Interest Item funding provided for Sensor and Electronic Network Initiatives.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020
Congressional Add: Small Satellite Technology	-	3.000
FY 2020 Plans: Small Satellite Technology		
Congressional Add: Radioisotope Power Systems	-	2.500
FY 2020 Plans: Radioisotope Power Systems		
Congressional Add: Anti-Tamper Technology Development	-	10.000
FY 2020 Plans: Anti-Tamper Technology Development		
Congressional Add: Next Generation Synthetic Aperture	-	5.500
FY 2020 Plans: Next Generation Synthetic Aperture		
Congressional Add: Sensing Technologies for Rapid Hazard Detection	-	2.500
FY 2020 Plans: Sensing Technologies for Rapid Hazard Detection		
Congressional Adds Subtotals	-	23.500

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

Remarks

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) BP2 / <i>Sensor and Electronic Network Initiatives (CA)</i>

D. Acquisition Strategy

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army										Date: February 2020		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) BZ6 / Narrowband SATCOM Technology			
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
BZ6: <i>Narrowband SATCOM Technology</i>	-	0.000	0.000	0.999	-	0.999	0.000	0.000	0.000	0.000	0.000	0.999

Note

Fiscal Year 2021 (FY21) funding is realigned from:
 Program Element (PE) 0602143A Soldier Lethality:
 * Project AN1 Narrowband SATCOM Technology

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to enable Army Narrowband Satellite Communications (SATCOM) networks to control traditional military tactical SATCOM along with non-traditional networks, such as commercial networks, to enable adaptability of the narrowband SATCOM network in a contested environment.

FY20 realignments are due to financial restructuring in support of Army Modernization Priorities.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN2 (Narrowband SATCOM Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

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

	FY 2019	FY 2020	FY 2021
Title: Narrowband Satellite Communication Technology	-	-	0.999
Description: This project designs and develops technologies to enable Army Narrowband Satellite Communications (SATCOM) networks to control traditional military tactical SATCOM along with non-traditional networks, such as commercial networks, to enable adaptability of the narrowband SATCOM network in a contested environment.			
FY 2021 Plans: Will develop emulator configuration and develop an agile, network-defined architecture that enables gateway communications across Narrowband SATCOM networks; and develop system engineering documentation and user documentation for the architecture.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army	Date: February 2020
--	----------------------------

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) BZ6 / <i>Narrowband SATCOM Technology</i>
--	---	---

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2019	FY 2020	FY 2021
Realigned from PE 0602143A Soldier Lethality Technology, Project AN1 Narrowband SATCOM Technology in support of Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	0.999

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

N/A

Remarks

D. Acquisition Strategy

N/A

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) BZ8 / Aerial Teir Networking (High Altitude)			
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
BZ8: Aerial Teir Networking (High Altitude)	-	0.000	0.000	0.400	-	0.400	0.400	1.399	4.854	3.654	0.000	10.707

Note

In Fiscal Year 2021 (FY21) this Project was realigned from:
 Program Element (PE) 0602146A Network C3I Technology:
 * Project AO2 Stand-In Advanced RF Effects (STARE)

A. Mission Description and Budget Item Justification

This Project designs and develops technologies for aerial networking to establish line of sight and beyond line of sight communications.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this

Project is performed by the United States Army Futures Command (AFC).

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

	FY 2019	FY 2020	FY 2021
Title: Aerial Tier Networking (High Altitude)	-	-	0.400
Description: Develop a Wideband Global Satellite Communications (WGS) surrogate payload for usage on a High Altitude Platform (HAP) with seamless transition to existing ground terminals by modifying existing solutions to support Network Modernization Capability Sets (CS) beginning with CS23 - Capacity & Resiliency.			
FY 2021 Plans: Will investigate the capability, performance parameters and operational requirements which can be achieved without changing existing SATCOM terminals and modems.			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding realigned from PE 062146A Network C3I Technology, Project AO2 Stand-In Advanced RF Effects (STARE).			
Accomplishments/Planned Programs Subtotals	-	-	0.400

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

N/A

Remarks

UNCLASSIFIED

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

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) BZ8 / <i>Aerial Teir Networking (High Altitude)</i>
--	---	---

D. Acquisition Strategy
N/A