Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army											Date: May 2021	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602146A *I Network C3I Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
Total Program Element	-	133.804	202.257	84.606	-	84.606	-	-	-	-	-	-
AM6: *Modular RF Communications Technology*	-	3.748	3.810	-	-	-	-	-	-	-	-	-
AM8: *Protected SATCOM Technology*	-	9.205	4.813	1.745	-	1.745	-	-	-	-	-	-
AN3: *Non Traditional Waveforms Technology*	-	3.155	-	0.492	-	0.492	-	-	-	-	-	-
AN5: *Protected SATCOM-WB Global SATCOM Inter Canc Tech*	-	0.384	-	-	-	-	-	-	-	-	-	-
AN7: *COE - Every Receiver is a Sensor Technology*	-	2.881	2.976	2.492	-	2.492	-	-	-	-	-	-
AN9: *UNT - Every Receiver is a Sensor Technology*	-	3.692	1.925	1.963	-	1.963	-	-	-	-	-	-
AO2: *Stand-In Advanced RF Effects (STARE)*	-	7.195	4.223	2.006	-	2.006	-	-	-	-	-	-
AO4: *Energy Efficient Devices Technology*	-	5.190	5.454	5.710	-	5.710	-	-	-	-	-	-
AO5: *Tag Track and Locate Small Satellites Technology*	-	4.267	3.737	-	-	-	-	-	-	-	-	-
AP4: *CEMA Camouflage Technology*	-	9.316	9.559	-	-	-	-	-	-	-	-	-
AP5: *Electronic Warfare Technology*	-	2.707	2.878	2.928	-	2.928	-	-	-	-	-	-
AP7: *Comms/Horiz Int for Army Mod Priorities Tech*	-	0.479	2.914	-	-	-	-	-	-	-	-	-
AQ2: *EW Techniques Technology*	-	-	0.482	0.494	-	0.494	-	-	-	-	-	-
AQ7: *High Tempo Data Driven Decision Tools Technology*	-	-	2.701	-	-	-	-	-	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army										Date: May 2021		
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602146A *I Network C3I Technology*							
AQ9: *Expeditionary Data to Decisions Technology*	-	1.918	2.760	-	-	-	-	-	-	-	-	-
AR1: *Robust, Resilient and Intelligent C3I Technology*	-	8.342	13.600	10.510	-	10.510	-	-	-	-	-	-
AR3: *Intelligent Environmental Battlefield Awareness*	-	-	2.897	3.059	-	3.059	-	-	-	-	-	-
AR5: *Understanding the Environment as a Threat Technolo*	-	3.872	2.246	1.956	-	1.956	-	-	-	-	-	-
AR7: *Sensing in Contested Environments Technology*	-	-	1.820	1.192	-	1.192	-	-	-	-	-	-
AR9: *Persistent Geophysical Sensing-Infrasound Tech*	-	3.898	3.035	3.414	-	3.414	-	-	-	-	-	-
AT2: *Subterranean Detection and Monitoring Technology*	-	1.534	2.791	-	-	-	-	-	-	-	-	-
AT7: *Network-Enabled GeoSpatial-GEOINT Services Tech*	-	2.869	3.855	4.635	-	4.635	-	-	-	-	-	-
AT9: *Tactical GeoSpatial Information Capabilities Techn*	-	2.657	4.085	1.776	-	1.776	-	-	-	-	-	-
AU3: *Geospatially Enabled Operational Design Technology*	-	3.166	1.413	-	-	-	-	-	-	-	-	-
AU5: *Automated Analytics for Operational Environment*	-	3.932	-	-	-	-	-	-	-	-	-	-
AV3: *Foundational S&T for Network C3I Technology*	-	-	1.927	4.657	-	4.657	-	-	-	-	-	-
AV5: *Protective Technologies*	-	6.520	7.411	7.549	-	7.549	-	-	-	-	-	-
AV6: *Airborne Engineering Support Technology*	-	0.846	0.866	-	-	-	-	-	-	-	-	-
AV7: *Atmospheric Modeling and Meterological Technology*	-	5.573	5.918	5.931	-	5.931	-	-	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army												Date: May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602146A *I Network C3I Technology*							
AV9: *Advanced PNT for GPS Independent Environments Tech*	-	6.687	6.656	10.129	-	10.129	-	-	-	-	-	-
AW1: *Autonomous Navigation Technology*	-	0.384	1.732	2.080	-	2.080	-	-	-	-	-	-
AW3: *DoD PNT M&S Collaborative Initiative (CI) Technolo*	-	1.918	1.925	-	-	-	-	-	-	-	-	-
AW5: *Modular GPS Independent Sensors Technology*	-	3.969	-	-	-	-	-	-	-	-	-	-
BP2: *Sensor and Electronic Network Initiatives (CA)*	-	23.500	90.500	-	-	-	-	-	-	-	-	-
BZ6: *Narrowband SATCOM Technology*	-	-	0.963	-	-	-	-	-	-	-	-	-
BZ8: *Aerial Teir Networking (High Altitude)*	-	-	0.385	-	-	-	-	-	-	-	-	-
CG3: *Assured PNT Communications Applied Research*	-	-	-	1.726	-	1.726	-	-	-	-	-	-
CI3: *Mobile and Survivable Command Post (MASCP) Tech*	-	-	-	6.236	-	6.236	-	-	-	-	-	-
CK1: *Assurred PNT Enabling Technologies*	-	-	-	1.926	-	1.926	-	-	-	-	-	-

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 0602143A (Soldier Lethality Technology), PE 0602145A (Next Generation Combat Vehicle Technology), PE 0602147A (Long Range Precision Fires Technology), PE 0602148A (Future Vertical Lift Technology), PE 0602150A (Air and Missile Defense Technology), PE 0603118A (Soldier Lethalty

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602146A *I Network C3I Technology*

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.

B. Program Change Summary ($ in Millions)	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total
Previous President's Budget	138.016	114.404	100.565	-	100.565
Current President's Budget	133.804	202.257	84.606	-	84.606
Total Adjustments	-4.212	87.853	-15.959	-	-15.959
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	90.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-4.212	-2.647			
• Adjustments to Budget Years	-	-	-15.959	-	-15.959

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Project: BP2: *Sensor and Electronic Network Initiatives (CA)*		
Congressional Add: *Small Satellite Technology*	3.000	-
Congressional Add: *Radioisotope Power Systems*	2.500	-
Congressional Add: *Anti-Tamper Technology Development*	10.000	-
Congressional Add: *Next Generation Synthetic Aperture*	5.500	-
Congressional Add: *Sensing Technologies for Rapid Hazard Detection*	2.500	-
Congressional Add: *Program increase - inertial navigation systems*	-	10.000
Congressional Add: *Program increase - APNT for autonomous vehicles*	-	5.000
Congressional Add: *Program increase - CHARM*	-	5.000
Congressional Add: *Program increase - energy efficient devices*	-	5.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Army	Date: May 2021
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602146A *I Network C3I Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2020	FY 2021
Congressional Add: *Program increase - integrating energy and computing networks*	-	10.000
Congressional Add: *Program increase - artificial intelligence and machine learning electronic warfare sensor technology*	-	10.000
Congressional Add: *Program increase - APNT distributed antennae*	-	20.000
Congressional Add: *Program increase: Urban subterranean mapping technology*	-	4.000
Congressional Add: *Program increase: Unmanned sensors for biological and chemical hazards*	-	2.000
Congressional Add: *Program increase: Mobile environmental contaminant sensors*	-	8.000
Congressional Add: *Program increase: Multi?UAS integrated ISR technology*	-	3.000
Congressional Add: *Program increase: Autonomous platform threat detection sensors*	-	6.000
Congressional Add: *Program increase: Intelligent electronic protection technology*	-	2.500
Congressional Add Subtotals for Project: BP2	23.500	90.500
Congressional Add Totals for all Projects	23.500	90.500

Change Summary Explanation

FY2022 funding change due to a partial administrative realignment towards Program Element 0602182A (C3I Applied Research) for better alignment to the mid- to far term priorities of the Network portfolio.

$2.250 million of FY222 will be realigned to APE 622146AV3 from APE GA0750000, Abrams Upgrade Program.

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AM6: *Modular RF Communications Technology*	-	3.748	3.810	-	-	-	-	-	-	-	-	-

Note

This project is terminated in Fiscal Year (FY) 2022.

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)	FY 2020	FY 2021	FY 2022
Title: Modular Radio Frequency Communications Technology	3.748	3.810	-
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.			
FY 2021 Plans: 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			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort ends in FY21.			
Accomplishments/Planned Programs Subtotals	3.748	3.810	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army									Date: May 2021			
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AM8: *Protected SATCOM Technology*	-	9.205	4.813	1.745	-	1.745	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Protected Satellite Communication Technology	9.205	4.813	1.745
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 and technology investigation. ***FY 2021 Plans:*** 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 2022 Plans:*** Will investigate and design adaptive digital interference cancellation technology that adapts to changing contested environments for advanced fast moving waveforms, to improve satellite communications throughput. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort transitions to PE 0603463A (Network C3I Advanced Technology), Project AM9 (Protected SATCOM Advanced Technology) in FY 2022. The remaining balance supports stated FY 2022 Plans.			
Accomplishments/Planned Programs Subtotals	9.205	4.813	1.745

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AM8 / *Protected SATCOM Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AN3: *Non Traditional Waveforms Technology*	-	3.155	-	0.492	-	0.492	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, funds realigned from:
PE 0603463A Projects AM9 (Protected SATCOM Advanced Technology), and BZ8 (Aerial Tier Networking (High Altitude).

A. Mission Description and Budget Item Justification

This Project investigates non-traditional protocols and technologies to provide spectrum efficiency, high bandwidth, low latency, 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)	FY 2020	FY 2021	FY 2022
Title: Non Traditional Waveforms Technology	3.155	-	-
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.			
Title: 5G Technologies	-	-	0.492
Description: This effort investigates the use of 5G communication services and associated technologies to support high bandwidth, low latency communications for tactical environments with mobile infrastructures. ***FY 2022 Plans:*** Will investigate the use of software-defined networking and virtualization techniques for the development of a modular networks architecture using techniques, such as distributed 5G; develop methods for device-to-device communications to minimize required			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
infrastructure; and examine methods to improve low probability of intercept (LPI), low probability of detection (LPD), counter-geolocation, and anti-jam (AJ) performance of technologies, such as 5G cellular. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding in this effort was realigned from PE 0603463A Projects AM9 (Protected SATCOM Advanced Technology), and BZ8 (Aerial Tier Networking (High Altitude).			
Accomplishments/Planned Programs Subtotals	3.155	-	0.492

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AN5: *Protected SATCOM-WB Global SATCOM Inter Canc Tech*	-	0.384	-	-	-	-	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Protected Satellite Communication ? Wide Band Global Satellite Communication Interference Cancellation Technology	0.384	-	-
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.			
Accomplishments/Planned Programs Subtotals	0.384	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AN7: *COE - Every Receiver is a Sensor Technology*	-	2.881	2.976	2.492	-	2.492	-	-	-	-	-	-

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.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) \ Project AN8 (COE - Every Receiver is a Sensor Advanced Tech) and PE 0602146A (Network C3I Technology) \ Project AN9 (UNT - 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 (U.S.) Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Data Analytics for Situational Awareness	2.881	2.976	-
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. ***FY 2021 Plans:*** 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 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned conclusion lifecycle of this effort.			
Title: Intelligence Surveillance and Recognizance (ISR) Optimization for MDO Support Technology	-	-	2.492
Description: This effort investigates and designs Intelligence Surveillance and Recognizance (ISR) collection management technologies and analytics to enhance performance and optimize use of Army ISR resources during multi-domain operations (MDO). Efforts focus on developing the analytics necessary to increase situational awareness of non-organic collections across			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
all domains (Air, Land, Maritime, Space, Cyber and Electromagnetic spectrum), determine highest payoff use of tactical ISR assets, and optimize sensor selection and placement to answer unit intelligence requirements. ***FY 2022 Plans:*** Will investigate threat forecasting technologies needed to drive prioritization of ISR collections based on unit intelligence requirements and threat tactics, techniques, and procedures (TTPs); research sensor performance models necessary to predict sensor performance in real-world environments. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned initiation lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	2.881	2.976	2.492

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AN9: *UNT - Every Receiver is a Sensor Technology*	-	3.692	1.925	1.963	-	1.963	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Unified Network Technology (UNT) - Every Receiver is a Sensor Technology ***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.	1.763	-	-
Title: Multi Intelligence Modernization Components and Architecture ***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. ***FY 2021 Plans:*** 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. ***FY 2022 Plans:***	1.929	1.925	1.963

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Will investigate high altitude, long, stand-off range Electronic Warfare capabilities to bring situational awareness and understanding to the tactical edge; and conduct laboratory experiments on advanced signal processing and antenna designs for use from high altitude, long-endurance platforms. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	3.692	1.925	1.963

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AO2: *Stand-In Advanced RF Effects (STARE)*	-	7.195	4.223	2.006	-	2.006	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project investigates distributed and synchronized electronic warfare (EW) techniques and applications for future distributed Army operations in complex environments, designs algorithms for synchronization, and investigates stable radio frequency transceivers and techniques for information distribution across dynamic channels.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) Project AO3 (Stand-In Advanced RF Effects (STARE) 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 2020	FY 2021	FY 2022
Title: STAND-IN Advanced RF Effects (STARE)	1.886	1.925	2.006
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.			
FY 2021 Plans: 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 2022 Plans: Will investigate hardware limitations at extremely high frequencies; design and develop a stable transceiver architecture with optimal component technologies; research scalable synchronization techniques for phase/clock/channel alignment between RF transceivers agnostic of use case; conduct RF transceiver synchronization experiments to explore the bounds of coherent multi-aperture beam forming; and investigate reconfigurable transceiver hardware to enable a widely-applicable architecture.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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.	2.915	-	-
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 2021 Plans:*** 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 2021 to FY 2022 Increase/Decrease Statement:*** This effort ends in FY21.	2.394	2.298	-
Accomplishments/Planned Programs Subtotals	7.195	4.223	2.006

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army									Date: May 2021			
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*				Project (Number/Name) AO4 / *Energy Efficient Devices Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AO4: *Energy Efficient Devices Technology*	-	5.190	5.454	5.710	-	5.710	-	-	-	-	-	-

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.

Work in this Project complements/supports PE 0602146A (Network C3I Technology) Project AN3 (Non Traditional Waveforms Technology), PE 0602143A (Soldier Lethality Technology) Project BD8 (Soldier and Small Unit Tactical Energy Independence Technology), PE 0601102A (Defense Research Sciences) Project AA9 (Information and Networking).

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2020**	**FY 2021**	**FY 2022**
Title: Energy Efficient Electronic and Photonic Components	5.190	5.454	5.710
Description: This effort investigates energy efficiency improvements in support of four key areas: radio frequency (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.			
FY 2021 Plans: 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 2022 Plans: Will determine and resolve scale-up issues with fast charge anode materials; investigate tradeoffs in energy and rate capability for ultrafast charge graphite cells with high energy cathodes; explore additives and electrode coating techniques and improve power			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO4 / *Energy Efficient Devices Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
capability; design and develop batteries for fast charge systems to investigate concepts for Fast Efficient Energy Distribution; investigate coupled isotope/energy converter geometry and increased density packaging techniques to validate proof-of-principle isotope power source; explore the coupling of piezoelectric transformers with silicon integrated circuit envelope detectors and baseband electronics for wake-up receivers; design and develop two dimensional (2D) fabrication processes to reduce energy loss; investigate concepts to achieve responsivity for viable communications wavelength in the near-to-mid infrared (IR) regime in topological materials based devices; develop energy efficient electronic components based on silicon, gallium nitride, and diamond semiconductor materials. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	5.190	5.454	5.710

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AO5: *Tag Track and Locate Small Satellites Technology*	-	4.267	3.737	-	-	-	-	-	-	-	-	-

Note

In FY22, work in this Project transitions to:
Program Element (PE) 0602146A (Network C3I Technology) Projects CG3 (Assured PNT Communications Applied Research) and CK1 (Assured PNT Enabling Technologies).

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.

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 2020	FY 2021	FY 2022
Title: Tag Track and Locate Small Satellites	3.153	2.583	-
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 2021 Plans: Validates payload technologies for small spacecraft to provide tactical land component forces with space capabilities for force projection and maneuver during Multi-Domain Operations; designs and conducts experiments focused on terrestrial open air Quantum Entanglement Data Teleportation (QEDT) and space-to-ground QEDT; and qualifies and implements Quantum Key Distribution (QKD) components in order to validate satellite-to-satellite crosslink QKD.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Funds realigned to PE 0602146A Projects CG3 (Assured PNT Communications Applied Research) and CK1 (Assured PNT Enabling Technologies).			
Title: Space Components and Systems Assessment Technology ***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. ***FY 2021 Plans:*** Designs and develops payload technologies for small spacecraft to provide tactical land component forces with space capabilities for force projection and maneuver during Multi-Domain Operations. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funds realigned to PE 0602146A Projects CG3 (Assured PNT Communications Applied Research) and CK1 (Assured PNT Enabling Technologies).	1.114	1.154	-
Accomplishments/Planned Programs Subtotals	4.267	3.737	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army										Date: May 2021		
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AP4: *CEMA Camouflage Technology*	-	9.316	9.559	-	-	-	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022 this Project is realigned to:
Program Element (PE) 0602182A (C3I Applied Research) Project CM9 (Convergent CEMA Deception), and CN5 (Network Vuln/Effectiveness Assess Methods (N-VEAM))

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 2020	FY 2021	FY 2022
Title: Radio Frequency/Cyber Sensing and Deception	0.382	2.998	-
Description: This effort develops technologies to avoid geolocation of blue force 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.			
FY 2021 Plans: 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.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP4 / *CEMA Camouflage Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
This effort is realigned to Program Element (PE) 0602182A (C3I Applied Research) CM9 (Convergent CEMA Deception).			
Title: Dynamic Intelligent Networks and Cyber Camouflage and Decoy for CEMA ***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. ***FY 2021 Plans:*** 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. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is realigned to 0602182A (C3I Applied Research) CM9 (Convergent CEMA Deception).	3.349	2.398	-
Title: Understanding, Protecting, and Enabling CEMA Effects ***Description:*** This effort develops and continually improves methodology and approaches for estimating and predicting (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 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. ***FY 2021 Plans:*** Develops and extends techniques to estimate the effect of cyber and electromagnetic activities across all functional layers (i.e., physical, electromagnetic, cyber, human, and operational); matures investigations and enhances scientific understanding of cross-domain synergies building upon those previously discovered; and validates tools for understanding cross-domain synergies and determine region of applicability before the tools are passed on to vulnerability analysts. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is realigned to 0602182A (C3I Applied Research) CN5 (Network Vuln/Effectiveness Assess Methods (N-VEAM)).	3.080	2.145	-
Title: Vulnerability Analysis Methodology for CEMA Threats	2.505	2.018	-

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP4 / *CEMA Camouflage Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
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. ***FY 2021 Plans:*** Investigates 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; validates analysis techniques previously developed for novel communications modalities and techniques (e.g., ultraviolet, millimeter wave, situational adaptive controllers) and develops new experimental and analytical methodologies to assess and discover vulnerabilities; and researchs 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). ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is realigned to 0602182A (C3I Applied Research) CN5 (Network Vuln/Effectiveness Assess Methods (N-VEAM)).			
Accomplishments/Planned Programs Subtotals	9.316	9.559	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army									Date: May 2021			
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AP5: *Electronic Warfare Technology*	-	2.707	2.878	2.928	-	2.928	-	-	-	-	-	-

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 employment 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).

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AO3 (Robust Grey C3I Advanced Technology), PE 0602146A / Project AO2 (STARE), PE 0602146A/ Project AP4.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Electronic Warfare Technology Research	2.129	2.231	2.290
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 2021 Plans:*** 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. ***FY 2022 Plans:*** Will implement hardware-in-the-loop capability for multi-channel experiments with low-cost, distributed hardware; investigate spectrum analysis algorithms for Size, Weight, and Power (SwaP) constrained platforms; investigate techniques to characterize radio frequency (RF) emitter behavior; investigate implementation of cognitive radar threats in the hardware-in-the-loop laboratory environment; and develop tools to automate scenario generation in hardware-in-the-loop laboratory environment. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Electronic Warfare Assessment Technologies	0.578	0.647	0.638

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP5 / *Electronic Warfare Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
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). ***FY 2021 Plans:*** 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. ***FY 2022 Plans:*** Will converge EW and Cyber techniques into a comprehensive CEMA capability for assessment and analysis of advanced electromagnetic technologies. Apply advanced CEMA analytical capabilities to applicable network and horizontal integrated technologies and systems to assess defensive and cognitive EW in controlled environments, including hardware in the loop and linkage to operational mission simulations. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	2.707	2.878	2.928

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AP7: *Comms/Horiz Int for Army Mod Priorities Tech*	-	0.479	2.914	-	-	-	-	-	-	-	-	-

Note

In Fiscal Year 2022, Project terminates and funding is realigned to:
Program Element (PE) 0602213A (C3I Applied Cyber) Projects CY6 (Autonomous Cyber Technology) and 2CY (Information Trust Technology)
PE 0602146A (Network C3I Technology) Project AM8 (Protected SATCOM Technology)
PE 0603457A (C3I Cyber Advanced Development) Project 8CY (Information Trust Advanced Technology)
PE 0603463A (C3I Advanced Technology) Project AM9 (Protected SATCOM Advanced 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/Horiz Int for Army Mode Priorities 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 2020	FY 2021	FY 2022
Title: Communications Support to Army Modernization Priorities / Horizontal Integration Fields Technology	0.479	2.914	-
Description: This effort investigates the communication architectures of each of the Army?s modernization priorities and determines technologies and components to enable assured and resilient communications.			
FY 2021 Plans: 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 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 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
Funding realigned to the following projects in support of Field Based Risk Reduction (FBRR) experiments: PE 0602213A (C3I Applied Cyber Projects) CY6 (Autonomous Cyber Technology) Project 2CY (Information Trust Technology); PE 0602146 Project AM8 (Protected SATCOM Technology), PE 0603457A (C3I AdvancedDevelopment) Project 8CY (Information Trust Advanced Technology); and PE 0603463A (C3I Advanced Technology) Project AM9 (Protected SATCOM Advanced Technology).			
Accomplishments/Planned Programs Subtotals	0.479	2.914	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AQ2: *EW Techniques Technology*	-	-	0.482	0.494	-	0.494	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

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

Work in this Project complements PE 0602146A (Network C3I Technology) Project AO2 (Stand-In Advanced RF Effects (STARE)), and PE 0603463A (Network C3I Advanced Technology) Projects AO7 (EW for Maneuver Operations (EMO) Adv Tech), and AO3 (Stand-In Advanced RF Effects (STARE) 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 U.S. Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Simultaneous Counter Measures (CM) for Active Reconnaissance and Surveillance (SCARS)	-	0.482	0.494
Description: This effort will provide investments in Electronic Warfare (EW), against advancing counter-fire sensors. Research will investigate highly synchronized systems capabilities to achieve advanced effects.			
FY 2021 Plans: Conduct initial investigations and experiments against modeled or representative threats to validate technical approach feasibility for advanced EW effects.			
FY 2022 Plans: Will further investigate and experiment against modeled or representative threats to validate technical approach feasibility for EW effects against adversary counter-fire sensors and ISR.			
FY 2021 to FY 2022 Increase/Decrease Statement: Funding change reflects planned lifecycle of project.			
Accomplishments/Planned Programs Subtotals	-	0.482	0.494

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AQ2 / *EW Techniques Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AQ7: *High Tempo Data Driven Decision Tools Technology*	-	-	2.701	-	-	-	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: High Tempo Data Driven Decision Tools	-	2.701	-
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:*** 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 2021 to FY 2022 Increase/Decrease Statement:*** Effort completes in FY21. Research continues in PE 0603463A (Network C3I Advanced Technology) Project AQ8 (High Tempo Data Driven Decision Tools Advanced Technology).			
Accomplishments/Planned Programs Subtotals	-	2.701	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

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

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AQ9: *Expeditionary Data to Decisions Technology*	-	1.918	2.760	-	-	-	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022, this Project program is realigned to:
Program Element (PE) 0602146A (Network C3I Technology) Project CI3 (Mobile and Survivable Command Post 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)	FY 2020	FY 2021	FY 2022
Title: Expeditionary Data to Decisions Technology	1.918	-	-
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.			
Title: Mission Command Technologies	-	0.890	-
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.			
FY 2021 Plans: 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			

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
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. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In Fiscal Year (FY) 2022, this effort is realigned to Program Element (PE) 0602146A Project CI3 (Mobile and Survivable Command Post Tech)			
Title: Camouflage, Concealment and Decoys ***Description:*** This effort investigates 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. Designs 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. ***FY 2021 Plans:*** 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 Laser Imaging, Detection, and Ranging (LIDAR) sensor defeat approaches; and evaluate candidate deception solutions. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** This effort is realigned to Program Element (PE) 0602146A Project CI3 (Mobile and Survivable Command Post Tech)	-	1.870	-
Accomplishments/Planned Programs Subtotals	1.918	2.760	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AR1: *Robust, Resilient and Intelligent C3I Technology*	-	8.342	13.600	10.510	-	10.510	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022 partial funding realignment to:
Program Element (PE) 0602141A (Lethality Technology) Project CF7 (Solid-state Laser Concepts and Architectures).

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.

Work in this Project complements PE 0602145A (Next Generation Combat Vehicle Technology) Project BF8 (Artificial Intelligence & Machine Learning Technology), PE 0603463A (Network C3I Advanced Technology) Project AQ5 (Sensor CE - Integrated Sensor Architecture), PE 0602146A (Network C3I Technology) Project AN7 (COE-Every Receiver is a Sensor Technology), and PE 0603463A (Network C3I Advanced Technology) Project AN8 (COE - Every Receiver is a Sensor).

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 2020	FY 2021	FY 2022
Title: Intelligent Signal and Image Analytics for C3I	6.250	6.283	3.250
Description: This effort designs and characterizes technologies for multi-modal (Electro-Optical/Infra-Red (EO/IR) imaging, 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 localization, tracking, classification, and reduced false alarms. These combined sensors have unique capabilities that enable passive discrimination from deception and decoys, detection of electrical equipment operation, underground facilities, vehicles, weapons launch, gunfire, and explosions. The work includes development of learning algorithms to improve situational understanding.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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. ***FY 2022 Plans:*** Will develop artificial intelligence and machine learning (AI & ML) based analytics to process multi-modal data, both imaging based (electro-optical, infrared) and non-imaging based (acoustic, seismic, electric, and magnetic field sensing), for automated detection, classification, and tracking of targets from both ground and airborne platforms; develop synthetic data generation techniques for algorithm training to augment limited availability of real world data for robust signal and image analytics in operationally-relevant settings; understand 3-D electric and magnetic-field sensors and sensing arrays for extremely low frequency imaging and electric power grid analysis for pattern of life analysis; continue research of infrasound through audible frequency sensors, algorithmic, and hardware solutions to automate target detection, tracking, and localization; and validate advanced seismic sensing for enhanced detection and localization of ground targets. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Partial funding and work realignment in FY22 to support High Energy Laser (HEL) Enabling Technologies for Tactical Directed Energy Weapons effort in PE 0602141A (Lethality Technology) Project CF7 (Solid-state Laser Concepts and Architectures).			
Title: Smart Networks and Distributed Sensing for C3I	0.280	5.336	5.259
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. ***FY 2021 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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 2022 Plans:*** Will implement real-time scene perception based algorithms for optimal relocation of sensor assets for robust target detection, classification, and tracking; design approaches for optimally determining sensor modality, parameters, and energy requirements for carrying out scene perception tasks in resource-constrained distributed network environments; implement light-weight machine learning architectures for real-time inference at the edge on low size, weight, and power (SWaP) computing devices utilizing both centralized and distributed processing frameworks; research and validate novel adaptive real-time multimodal sensing and processing methods using low-SWaP edge processing and mobile user interfaces and controls; validate deep sensing concepts by characterizing remote employment of sensors in a strategic and tactical scenario to enable autonomous threat detection, localization, and high confidence classification. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
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 2021 Plans:*** 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 2022 Plans:*** Will investigate and conduct experiments that explore methods for intelligent information mediation and adaptive information representation; identify methods for accelerating decision support and information synthesis in SWaP and time constrained systems and adversarial environments; determine feasibility, viability, and limitations of data-driven, physics-guided information interaction and its impact on situational awareness in multi-modal, multi-perspective information representations in 2D and	1.812	1.981	2.001

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
immersive adaptive interfaces; continue to examine quantitative information recommendation and filtering approaches such as VoI/QoI for policy-based and continuously-learned multi- sensor and multi-domain battlefield information-interaction. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	8.342	13.600	10.510

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AR3: *Intelligent Environmental Battlefield Awareness*	-	-	2.897	3.059	-	3.059	-	-	-	-	-	-

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 delivery of web modules/software tools which contain crucial geo-chemical resources and advanced knowledge of geo-environmental infrastructure for mission planners.

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.

Research in this Project complements PE 0603463A (Network C3I Advanced Technology) Project AR4 Intelligent Env Battlefield Awareness Adv Tech.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Arctic Threat	-	1.442	0.888
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:*** 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 2022 Plans:*** Will generate new input parameters for geospatial overlays that represent soil mechanics representing thaw effects based on terrain conditions and temperature extremes. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort, completing in Fiscal Year 2022.			
Title: Geo-Forensics	-	0.675	-
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.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
FY 2021 Plans: 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. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort, completing in Fiscal Year 2021.			
Title: Predictive Geographic Information System (GIS) Mapping (physical) ***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. ***FY 2021 Plans:*** Design a unified framework that will integrate several independently derived geospatial tools with streamlined data analysis and mitigation of statistical errors. ***FY 2022 Plans:*** Will consolidate geophysical data and begin parameterization for data input into unified geospatial framework. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	0.780	0.789
Title: Hydrology Mapping ***Description:*** This effort provides data tools and models to support high-fidelity battlefield overlay maps that accurately show hydrologic/soil moisture threats (soil, hydrology, and snow/ice) not captured by current terrain mapping capabilities. ***FY 2022 Plans:*** Will develop predictions of soil moisture state, infiltration, and runoff that better reflect the high degree of spatial and temporal variability in ground and surface water. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort. Funds realigned from other efforts in the Project.	-	-	1.382
Accomplishments/Planned Programs Subtotals	-	2.897	3.059

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR3 / *Intelligent Environmental Battlefield Awareness*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AR5: *Understanding the Environment as a Threat Technolo*	-	3.872	2.246	1.956	-	1.956	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This Project designs and advances mission planning software enabling the Soldier 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 in this Project complements 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)	FY 2020	FY 2021	FY 2022
Title: Environmental Threat Overlays for Operational Routing/Predictions of Lethal Environments ***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.	2.333	-	-
Title: Predictions of Lethal Environments/ Computational Prediction of Threats in the Operational Environment ***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. ***FY 2021 Plans:*** 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. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort, ending in Fiscal Year 2021.	1.539	1.156	-
Title: Subsurface Forensics	-	1.090	1.956

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
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. ***FY 2021 Plans:*** 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. ***FY 2022 Plans:*** Will consolidate candidate sensor technologies based on effectiveness and form/fit design constraints that detect and characterize hazards including water quality, explosive constituents, and non-weaponized radiological hazards. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase in FY22 will support increased focused research in sensor technologies.			
Accomplishments/Planned Programs Subtotals	3.872	2.246	1.956

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AR7: *Sensing in Contested Environments Technology*	-	-	1.820	1.192	-	1.192	-	-	-	-	-	-

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, breath-ability, and non-weaponized radiological hazards within confined environments. This effort supports the Common Operating Environment LOE.

Work is complements PE 0603463A (Network C3I Advanced Technology) Project AR8 (Sensing in Contested Environments 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 Engineer Research and Development Center and coordinated with the United States Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Non-Traditional Threat Detection in Contested Environment	-	1.820	1.192
Description: This effort identifies, examines and prioritizes commercial of the shelf (COTS) 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:*** 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 2022 Plans:*** Will consolidate candidate sensor technologies based on effectiveness and form/fit design constraints that detect and characterize hazards including water quality, explosive constituents, and non-weaponized radiological hazards. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding decrease reflects planned lifecycle progression of transitioning work to advanced technology development PE 0603463A (Network C3I Advanced Technology) Project AR8 (Sensing in Contested Environments Adv Tech).			
Accomplishments/Planned Programs Subtotals	-	1.820	1.192

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

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AR9: *Persistent Geophysical Sensing-Infrasound Tech*	-	3.898	3.035	3.414	-	3.414	-	-	-	-	-	-

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 conducted at U.S. Army Engineer Research and Development Center and coordinated with U.S. Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Remote Assessment of Infrastructure for Ensured Maneuver (RAFTER)	3.898	-	-
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.			
Title: Battlefield Intelligence by Geophysical Sensing (BIGS)	-	3.035	3.414
Description: This effort 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.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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. ***FY 2022 Plans:*** Will focus on algorithm research and development based on down-selected sources of interest as prioritized by stakeholders/ transition partners and will complete a sensor placement optimization tool to evaluate alternate array geometries/sensor configurations. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase in FY22 will support development of sensor placement optimization tool.			
Accomplishments/Planned Programs Subtotals	3.898	3.035	3.414

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AT2: *Subterranean Detection and Monitoring Technology*	-	1.534	2.791	-	-	-	-	-	-	-	-	-

Note

This project is eliminated for Fiscal Year (FY) 2022.

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 2020	FY 2021	FY 2022
Title: Subterranean Threat Assessment by Real-time Sensing	1.534	2.791	-
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 2021 Plans:*** 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 2021 to FY 2022 Increase/Decrease Statement:*** Funding decrease in FY22 is part of the planned lifecycle for this effort, ending in in FY 2021.			
Accomplishments/Planned Programs Subtotals	1.534	2.791	-

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

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*	Project (Number/Name) AT7 / *Network-Enabled GeoSpatial-GEOINT Services Tech*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AT7: *Network-Enabled GeoSpatial-GEOINT Services Tech*	-	2.869	3.855	4.635	-	4.635	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Geo-registration, Analytical Tool Development and Visualization	2.869	2.897	2.415
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 2021 Plans: 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.			
FY 2022 Plans: Will advance the investigation of automated 3D data geo-registration techniques, and advance the development co-registration software algorithms applied to multi-temporal 3D terrain data sets.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT7 / *Network-Enabled GeoSpatial-GEOINT Services Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Funding decrease reflects planned lifecycle progression of transitioning work to advanced technology development PE 0603463A Project AT8.			
Title: Geospatial Data for Tactical Visualization ***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. ***FY 2021 Plans:*** 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). ***FY 2022 Plans:*** Will develop lightweight tools consistent with the Common Operating Environment computing environments for analytics, tiling, and streaming of 3D data. Will investigate the integration of new geospatial data models that support 3D visualization, analysis and localization from a single source on tactical computing devices. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding increase will support focused development of 3D visualization, analysis and localization from a single source on tactical computing device.	-	0.958	2.220
Accomplishments/Planned Programs Subtotals	2.869	3.855	4.635

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AT9: *Tactical GeoSpatial Information Capabilities Techn*	-	2.657	4.085	1.776	-	1.776	-	-	-	-	-	-

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 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 Engineer Research and Development Center (ERDC) and coordinated with the United State Army Futures Command

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: 3D Terrain Analysis	1.275	2.654	1.776
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.			
FY 2021 Plans: 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 2022 Plans: Will develop improved collection and processing of complex 3D urban terrain increasing processing time and accuracy, leveraging evolutionary improvements to airborne, ground-level, and interior, subterranean mapping collection capabilities.			
FY 2021 to FY 2022 Increase/Decrease Statement:			

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Funding decrease reflects planned lifecycle progression in transitioning work to advanced technology development PE 0603463A Project AU1.			
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 2021 Plans:*** 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 2021 to FY 2022 Increase/Decrease Statement:*** Funding decrease reflects planned lifecycle progression of work to advanced technology development PE 0603463A Project AU1.	1.382	1.431	-
Accomplishments/Planned Programs Subtotals	2.657	4.085	1.776

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AU3: *Geospatially Enabled Operational Design Technology*	-	3.166	1.413	-	-	-	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Virtual Collaborative Operational Design (GEOD) Research	1.768	1.413	-
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 2021 Plans:*** 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. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding decrease reflects planned lifecycle progression to advanced technology development PE 0603463A Project AU4. Effort completed in FY 2021.			
Title: Tactical Data Analysis and Visualization	1.398	-	-

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
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.			
Accomplishments/Planned Programs Subtotals	3.166	1.413	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AU5: *Automated Analytics for Operational Environment*	-	3.932	-	-	-	-	-	-	-	-	-	-

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).

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)	FY 2020	FY 2021	FY 2022
Title: Simultaneous Multi-Domain Data Representation ***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.	1.838	-	-
Title: Automated Analysis of Multi-Domain Data ***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.	2.094	-	-
Accomplishments/Planned Programs Subtotals	3.932	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AV3: *Foundational S&T for Network C3I Technology*	-	-	1.927	4.657	-	4.657	-	-	-	-	-	-

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), Project AV4 (Foundational S&T for Network C3I Advanced Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Development of Foundational technologies for holistic network integration	-	1.927	-
Description: This effort develops underlying technologies applicable to next generation networks and integration of the same.			
FY 2021 Plans: Investigates and researches foundational technologies focusing on autonomy, Artificial intelligence/Machine Learning as applicable to, but not limited to, holistic network integration. Investigates 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 2021 to FY 2022 Increase/Decrease Statement: This effort ends in Fiscal Year 2021. Funding is partially realigned towards Development of Disruptive, Innovative Research for Emerging (DIRE) Applied Network Capabilities within this same project.			
Title: Development of Disruptive, Innovative Research for Emerging (DIRE) Applied Network Capabilities	-	-	4.657
Description: This effort develops innovative network capabilities using a rapid and agile methodology to examine feasibility of incorporation into Army network problem sets.			
FY 2022 Plans:			

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Will investigate and research innovative emerging technologies focusing on network resiliency, artificial intelligence, and autonomy enabled machine learning technologies that will be integrated into a holistic network in support an MDO enabled environment. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY22, funding for this effort increases to support the rapidly changing need for innovative network solutions to an all domain battlefield. Funding was realigned from Abrams Recapitalization, APE GA0750000, Abrams Upgrade Program.			
Accomplishments/Planned Programs Subtotals	-	1.927	4.657

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army									Date: May 2021			
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AV5: *Protective Technologies*	-	6.520	7.411	7.549	-	7.549	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Protective Technologies	6.520	7.411	7.549
Description: This effort develops tools, devices, and techniques to protect acquisition program systems and (CPI) from adversarial threats. ***FY 2021 Plans:*** 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. ***FY 2022 Plans:*** Will develop additional technologies focused on the latest adversarial threats being faced by Army programs. Evaluate the technology protection requirements of Army and DoD programs; and develop technologies to assist those programs in maintaining their technological overmatch capabilities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	6.520	7.411	7.549

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AV6: *Airborne Engineering Support Technology*	-	0.846	0.866	-	-	-	-	-	-	-	-	-

Note

Project terminated in Fiscal Year (FY) 2022 and funding is realigned to:
Program Element (PE) 0602463A (Network C3I Adv Technology) Project C17 (Mobile and Survivable Command Post (MASCP) Adv 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 2020	FY 2021	FY 2022
Title: Airborne Engineering Support Technology	0.846	0.866	-
Description: This effort supports the experimentation of new and emerging C3ISR technologies. This venue performs technology assessments by evaluating candidate technologies in support of the Army Modernization Priorities. Events are determined by the maturity of the tech base programs across the Army?s Science and Technology (S&T) C3ISR portfolio. ***FY 2021 Plans:*** Evaluate performance of S&T technologies developed to provide robust and adaptive intelligence, electronic support, and electronic warfare capabilities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Effort terminates in FY21, and funding is realigned to Program Element (PE) 0603463A (Network C3I Advanced Technology) Project CI7 Mobile and Survivable Command Post (MASCP) Adv Tech).			
Accomplishments/Planned Programs Subtotals	0.846	0.866	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV6 / *Airborne Engineering Support Technology*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*	Project (Number/Name) AV7 / *Atmospheric Modeling and Meterological Technology*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AV7: *Atmospheric Modeling and Meterological Technology*	-	5.573	5.918	5.931	-	5.931	-	-	-	-	-	-

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)	FY 2020	FY 2021	FY 2022
Title: Atmospheric Characterization, Modeling, and Impacts	5.573	5.918	5.931
Description: This effort develops environmental situational understanding enabled though coupled sensing, modeling, and decision support technologies for data-sparse, computationally-limited, and network-constrained domains. ***FY 2021 Plans:*** 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 Perdig?o, Portugal field experiment; establish			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV7 / *Atmospheric Modeling and Meterological Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
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. ***FY 2022 Plans:*** Will conduct validation study of Atmospheric Boundary Layer Environment Lattice-Boltzmann Method (ABLE-LBM) in urban domains and mature LiDAR and radar assimilation methods building from initial Perdigo, Portugal field experiment data; develop and implement improved atmospheric acoustic propagation model with range dependence; investigate applicability of machine learning modeling based on heterogeneous sensor input to inform situational awareness; investigate machine algorithms to characterize and assess aerosols; experiment with the use of surrogate models to quantify uncertainty of impactful environmental conditions for autonomous flight of unmanned aerial systems (UASs); and investigate assimilation of multi-UAS sensing as constraints in simplified-physics or other surrogate models designed for low-resource platforms. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	5.573	5.918	5.931

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AV9: *Advanced PNT for GPS Independent Environments Tech*	-	6.687	6.656	10.129	-	10.129	-	-	-	-	-	-

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 radio frequency (RF) signals.

This research also addresses the PNT Scenario 1 (GPS operations that start well and have degraded GPS signals throughout the mission duration) through Scenario 3 (GPS operations that 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 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 (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: Precision Measurement Technology for Contested Environments	2.898	3.054	3.084
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 assessment 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.			
FY 2021 Plans: 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			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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. ***FY 2022 Plans:*** Will iterate designs, fabricate, and validate performance of novel MEMS IMUs using advanced MEMS materials and micro-structures to develop path to low cost navigation grade MEMS IMUs accuracy and improved drift correction techniques in representative operational environments (temperature and vibration); study performance of chip-scale, low-noise stabilized frequency sources and integrated electro-optic frequency combs for low SWAP-C atomic clock designs to assess improved clock stability over relevant operating environments; develop algorithms to implement RF sources of opportunity and multi-sensor/multi-waveband vision-based geo-localization and validate their performance on the PNT testbed; perform laboratory and relevant environment performance validation of low SWAP multi-node, anti-jam reception/operations of both GPS and 5G operations. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Quantum Effects for Assured PNT in Zero-GPS Environments ***Description:*** This effort will conduct research on size, weight, power, and cost (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. ***FY 2021 Plans:*** Refines quantum based timing designs with modeled performance and representative operational environments, targeting improved performance for a chip-scale atomic clock; develops and assesses materials growth to enable blue laser required for quantum based timing design; integrates 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 integrates and assesses a multi-modal, inertial navigation capability to validate the multi-sensor fusion engine and perform continuous INS calibration in a relevant environments. ***FY 2022 Plans:*** Will assess high performance and reasonable SWAP atomic clock for platform and increased performance network applications and iterate design to increase hardening and manufacturability; will validate initial designs of low cost (<$300 per unit) SWAP Chip-Scale Atomic Clock 2.0 (CSAC 2.0) for Soldier and small platform and munition applications; will iterate design, fabricate, and validate performance of first low cost SWAP CSAC 2.0; will investigate transition of government gyro designs (sub-component of high performance IMUs) to commercial partners to accelerate maturity of advanced government gyro capability; will validate a	3.789	3.602	7.045

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
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 2020	FY 2021	FY 2022
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; will validate multi-sensor fusion engine and perform continuous INS calibration in a relevant environment using the additional capability of the high performance and reasonable SWAP atomic clock to assess potential performance improvements of PNT calculations during GPS contested events. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Planned increase in funding to develop hardened and, manufacturable atomic clock technologies.			
Accomplishments/Planned Programs Subtotals	6.687	6.656	10.129

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*	Project (Number/Name) AW1 / *Autonomous Navigation Technology*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AW1: *Autonomous Navigation Technology*	-	0.384	1.732	2.080	-	2.080	-	-	-	-	-	-

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. This project investigates and develops techniques and algorithms to provide assured access to PNT in degraded electromagnetic (jamming), space, or cyber environments and notifiy Soldiers, Systems, and Platforms when PNT cannot be trusted for mission duration

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AV8 (Navigation Warfare 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 2020	FY 2021	FY 2022
Title: Autonomous Navigation Technology ***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.	0.384	-	-
Title: Intelligent Electronic Protect (IEP) ***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. ***FY 2021 Plans:*** 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. ***FY 2022 Plans:***	-	1.732	2.080

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW1 / *Autonomous Navigation Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Will continue to investigate assured access to PNT in contested electromagnetic environments; and validate unhindered access to military Global Positioning System (GPS) level of accuracy. Will develop techniques to detect and identify radio frequency (RF) signals on a PNT system with minimal additional hardware. Will begin algorithm development to enhance integrity and graceful degradation in challenged environments. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding change reflects planned life cycle of this effort to begin algorithm development in challenged environments.			
Accomplishments/Planned Programs Subtotals	0.384	1.732	2.080

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army												Date: May 2021
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*				Project (Number/Name) AW3 / *DoD PNT M&S Collaborative Initiative (CI) Technolo*			
COST ($ in Millions)	**Prior Years**	**FY 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
AW3: *DoD PNT M&S Collaborative Initiative (CI) Technolo*	-	1.918	1.925	-	-	-	-	-	-	-	-	-

Note

This project efforts has concluded in Fiscal Year (FY) 2021 so there will be no funding request for FY 2022.

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)	FY 2020	FY 2021	FY 2022
Title: DoD PNT M&S Collaborative Initiative (CI)	1.918	1.925	-
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.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW3 / *DoD PNT M&S Collaborative Initiative (CI) Technolo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
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 2021 to FY 2022 Increase/Decrease Statement:*** This effort completes in FY21.			
Accomplishments/Planned Programs Subtotals	1.918	1.925	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
AW5: *Modular GPS Independent Sensors Technology*	-	3.969	-	-	-	-	-	-	-	-	-	-

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 2020	FY 2021	FY 2022
Title: Modular GPS Independent Sensors	3.969	-	-
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.			
Accomplishments/Planned Programs Subtotals	3.969	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BP2: *Sensor and Electronic Network Initiatives (CA)*	-	23.500	90.500	-	-	-	-	-	-	-	-	-

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 2020	FY 2021
Congressional Add: Small Satellite Technology ***FY 2020 Accomplishments:*** Program Increased to support applied research on Small Satellite Technology. Work executed under the direction of the Army Futures Command.	3.000	-
Congressional Add: Radioisotope Power Systems ***FY 2020 Accomplishments:*** Program Increased to support applied research on Radioisotope Power Systems. Work executed under the direction of the Army Futures Command.	2.500	-
Congressional Add: Anti-Tamper Technology Development ***FY 2020 Accomplishments:*** Program Increased to support applied research on Anti-Tamper Technology Development. Work executed under the direction of the Army Futures Command.	10.000	-
Congressional Add: Next Generation Synthetic Aperture ***FY 2020 Accomplishments:*** Program Increased to support applied research on Next Generation Synthetic Aperture.	5.500	-

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
Work executed under the direction of the Army Futures Command.		
Congressional Add: Sensing Technologies for Rapid Hazard Detection ***FY 2020 Accomplishments:*** Program Increased to support applied research on Sensing Technologies for Rapid Hazard Detection. Work executed under the direction of the Army Futures Command.	2.500	-
Congressional Add: Program increase - inertial navigation systems ***FY 2021 Plans:*** Conduct applied research in Inertial Navigation Systems. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program increase - APNT for autonomous vehicles ***FY 2021 Plans:*** Conduct applied research in APNT for Autonomous Vehicles. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - CHARM ***FY 2021 Plans:*** Conduct applied research in CHARM. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - energy efficient devices ***FY 2021 Plans:*** Conduct applied research in Energy Efficient Devices. Work executed by Army Futures Command.	-	5.000
Congressional Add: Program increase - integrating energy and computing networks ***FY 2021 Plans:*** Conduct applied research in Integrating Energy and Computing Networks. Work executed by Army Futures Command.	-	10.000
Congressional Add: Program increase - artificial intelligence and machine learning electronic warfare sensor technology	-	10.000

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2021 Plans: Conduct applied research in Artificial Intelligence and Machine Learning Electronic Warfare Sensor Technology. Work executed by Army Futures Command.		
Congressional Add: Program increase - APNT distributed antennae ***FY 2021 Plans:*** Conduct applied research in APNT Distributed Antennae. Work executed by Army Futures Command.	-	20.000
Congressional Add: Program increase: Urban subterranean mapping technology ***FY 2021 Plans:*** Conduct applied research in Urban Subterranean Mapping Technology. Work executed by Army Futures Command.	-	4.000
Congressional Add: Program increase: Unmanned sensors for biological and chemical hazards ***FY 2021 Plans:*** Conduct applied research in Unmanned Sensors for Biological and Chemical Hazards. Work executed by Army Futures Command.	-	2.000
Congressional Add: Program increase: Mobile environmental contaminant sensors ***FY 2021 Plans:*** Conduct applied research in Mobile Environmental Contaminant Sensors. Work executed by Army Futures Command.	-	8.000
Congressional Add: Program increase: Multi?UAS integrated ISR technology ***FY 2021 Plans:*** Conduct applied research in Multi-UAS Integrated ISR Technology. Work executed by Army Futures Command.	-	3.000
Congressional Add: Program increase: Autonomous platform threat detection sensors ***FY 2021 Plans:*** Conduct applied research in Autonomous Platform Threat Detection Sensors. Work executed by Army Futures Command.	-	6.000
Congressional Add: Program increase: Intelligent electronic protection technology	-	2.500

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021
FY 2021 Plans: Conduct applied research in Intelligent Electronic Protection Technology. Work executed by Army Futures Command.		
Congressional Adds Subtotals	23.500	90.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army											Date: May 2021	
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 2020**	**FY 2021**	**FY 2022 Base**	**FY 2022 OCO**	**FY 2022 Total**	**FY 2023**	**FY 2024**	**FY 2025**	**FY 2026**	**Cost To Complete**	**Total Cost**
BZ6: *Narrowband SATCOM Technology*	-	-	0.963	-	-	-	-	-	-	-	-	-

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.

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 2020	FY 2021	FY 2022
Title: Narrowband Satellite Communication Technology	-	0.963	-
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:*** 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 2021 to FY 2022 Increase/Decrease Statement:*** This effort completes in Fiscal Year (FY) 2021			
Accomplishments/Planned Programs Subtotals	-	0.963	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
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 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
BZ8: *Aerial Teir Networking (High Altitude)*	-	-	0.385	-	-	-	-	-	-	-	-	-

Note

Project terminates in Fiscal 2022, and funding is realigned to:
Program Element (PE) 0602146A (Network C3I Technology)
* Project AN3 (Non Traditional Waveforms)

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).

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 2020	FY 2021	FY 2022
Title: Aerial Tier Networking (High Altitude)	-	0.385	-
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:*** Investigate the capability, performance parameters and operational requirements which can be achieved without changing existing SATCOM terminals and modems. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In FY22 funding realigned from PE 062146A Network C3I Technology Project AN3 (Non Traditional Waveforms Technology) for 5G Technologies research.			
Accomplishments/Planned Programs Subtotals	-	0.385	-

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

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*	Project (Number/Name) CG3 / *Assured PNT Communications Applied Research*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
CG3: *Assured PNT Communications Applied Research*	-	-	-	1.726	-	1.726	-	-	-	-	-	-

Note

In Fiscal Year 2022, this project is realigned from PE0602146A Project AO5 (Tag, Track, and Locate Small Satellites Technology).

A. Mission Description and Budget Item Justification

Tactical Land Component Forces require access to Space and High Altitude capabilities to enable force projection and maneuver during Multi-Domain Operations. Space and High Altitude sensors provide resilient communications, assured PNT and deep sensing capabilities required in the targeting process to enable rapid and responsive sensor-to-shooter applications to engage and defeat Anti-Access/Area Denial (A2/AD) forces.

Assured Positioning Navigation and Timing (APNT) Applied Research PE designs and develops technologies for Space-Based and High Altitude applications to support 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. Investigations conducted leverage other Department of Defense (DoD) space science and technology applications to support Army space force enhancement and cooperative satellite payload development.

Work complements PE 0603463A (Network C3I Advanced Technology) Project CJ8 (Assured PNT Communications Advanced 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 2020	FY 2021	FY 2022
Title: Assured PNT Communications Applied Research	-	-	1.726
Description: This effort will design, develop, and validate Space and High Altitude technologies, components, and tools that lead to smaller, lighter, more responsive payloads and applications. These technologies will allow for the rapid integration and development of tactical payloads in support of responsive Space or High Altitude environments.			
FY 2022 Plans: Validate payload technologies in the lab to provide tactical land component forces with Space and High Altitude capabilities for force projection and maneuver during Multi-Domain Operations.			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** CG3 / *Assured PNT Communications Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Maturation of quantum science-based crosslink communications, sensing, and data teleportation. Conduct a series of progressive tests assessing and verifying photonic information components for Space/HA sensor or Deep Sensing capabilities. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** In Fiscal Year 2022, this project is realigned from PE 0602146A Project AO5 (Tag, Track, and Locate Small Satellites Technology).			
Accomplishments/Planned Programs Subtotals	-	-	1.726

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*	Project (Number/Name) CI3 / *Mobile and Survivable Command Post (MASCP) Tech*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
CI3: *Mobile and Survivable Command Post (MASCP) Tech*	-	-	-	6.236	-	6.236	-	-	-	-	-	-

Note

In Fiscal Year (FY) 2022 this Project is realigned from:
Program Element (PE) 0602146A (Network C3I Technology) Project AQ9 (Expeditionary Data to Decisions Technology)
Program Element (PE) 0602213A (C3I Applied Cyber) Project CY8 (Cyber Security App Research and Exper Partner Tech)

A. Mission Description and Budget Item Justification

This Project develops and investigates emerging communications, tactical cloud, distributed computing, power management and storage, and shielding materials necessary to improve Command Post (CP) survivability and effectiveness for near-peer Multi-Domain Operations (MDO) engagements.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology), Project CI7 (Mobile and Survivable Command Post (MASCP) Adv Tech).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Title: CP Modularity and Dispersion Technology	-	-	4.146
Description: Funds research to enable CP?s to reconfigure and reconstitute at speeds consistent with a near-peer MDO engagement. Investigates emerging low probability of interception (LPI)/low probability of detection (LPD) radio technologies, distributed computing, tactical data and security architectures, and distributed collaboration methods. Initiates analysis to develop mobile, and integrated power systems that enable CP?s to disperse geographically and create extended at-the-halt and on-the-move command and control.			
FY 2022 Plans: Will conduct gap and threat analysis of peer competitors; initiate market survey?s across the technology sectors applicable to CP survivability (e.g., resilient communications, adaptable computing infrastructure, advanced energy sources and smart distribution).			
FY 2021 to FY 2022 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** CI3 / *Mobile and Survivable Command Post (MASCP) Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
Funding in this effort was realigned from Program Element (PE) 0602146A (Network C3I Technology) Project AQ9 (Expeditionary Data to Decisions Technology).			
Title: Signature Management and Reduction Technology ***Description:*** Develops electromagnetic spectrum (EMS) management tools to model CP signatures and optimize the employment of CP nodes and communication assets. ***FY 2022 Plans:*** Will validate threat capability and develop electromagnetic spectrum models of threat and friendly emissions. Implement a software model that visualizes CP emissions and conduct user design workshops that inform EMS signature management options. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding in this effort is realigned from Program Element (PE) 0602213A (C3I Applied Cyber) Project CY8 (Cyber Security App Research and Exper Partner Tech).	-	-	1.392
Title: Technology Supporting Camouflage, Concealment, and Deception ***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. ***FY 2022 Plans:*** Will investigate the use of natural fibers for use in camouflage materials; investigate the use of various materials for use in the physical assets to achieve more accurate signatures; conduct a feasibility study of active sensor identification systems; and investigate improvements to current CP infrastructure through the development of material solutions that will enable rapid set-up/ tear down times, allow for longer loiter times and provide greater protection of command post structures and enclosures. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** Funding in this effort was realigned from Program Element (PE) 0602146A Project AQ9 Expeditionary Data to Decisions Technology.	-	-	0.698
Accomplishments/Planned Programs Subtotals	-	-	6.236

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** CI3 / *Mobile and Survivable Command Post (MASCP) Tech*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army			Date: May 2021
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*	Project (Number/Name) CK1 / *Assured PNT Enabling Technologies*	

COST ($ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
CK1: *Assured PNT Enabling Technologies*	-	-	-	1.926	-	1.926	-	-	-	-	-	-

Note

Project is realigned from PE0602146A AO5 (Tag, Track, and Locate Small Satellites Technology).

A. Mission Description and Budget Item Justification

Tactical Land Component Forces require access to Space and High Altitude capabilities to enable force projection and maneuver during Multi-Domain Operations. Space and High Altitude sensors provide resilient communications, assured PNT and deep sensing capabilities required in the targeting process to enable rapid and responsive sensor-to-shooter applications to engage and defeat Anti-Access/Area Denial (A2/AD) forces.

Assured Positioning Navigation and Timing (APNT) Enabling Technologies PE investigates and matures technologies for Space-Based and High Altitude applications for Army tactical ground forces. Efforts include the 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. Investigations conducted leverage other Department of Defense (DoD) space science and technology applications to support Army space force enhancement and cooperative satellite payload development. Efforts include research to mature current technologies in quantum sciences based communications, sensing, and data teleportation for small spacecraft applications.

Work complements PE 0603463A (Network C3I Advanced Technology) Project CJ8 (Assured PNT Communications Advanced 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 2020	FY 2021	FY 2022
Title: Assured PNT Enabling Technologies	-	-	1.926
Description: This effort supports validation of hardware and software components and models to further anchor laboratory capabilities enabling Space/HA sensor or Deep Sensing capabilities, payload design and development.			
FY 2022 Plans: Will design and develop an advanced laboratory testbed with the Mult-Axis Simulator (MAS) system that will be utilized to mature payloads for APNT, and optical/quantum secure communications on multiple simulated platforms simultaneously with hardware and software in the loop. Flight hardware will be designed to support delivery in early 2024 and for launch in 2025 to conduct			

Exhibit R-2A, RDT&E Project Justification: PB 2022 Army		Date: May 2021
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** CK1 / *Assurred PNT Enabling Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2020	FY 2021	FY 2022
experiments of the first US Army quantum entanglement transmission of data across free space for satellite-to-satellite and/or satellite-to-ground communications. ***FY 2021 to FY 2022 Increase/Decrease Statement:*** New start in FY22. In Fiscal Year 2022, this project is realigned from PE0602146A AO5 (Tag, Track, and Locate Small Satellites Technology).			
Accomplishments/Planned Programs Subtotals	-	-	1.926

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A