Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Navy												Date: March 2019
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602131M *I Marine Corps Lndg Force Tech*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	54.526	63.212	56.604	-	56.604	50.623	51.624	52.674	53.728	Continuing	Continuing
2958: *Cyberspace Activities*	0.000	0.000	0.000	6.273	-	6.273	5.877	6.005	6.125	6.248	Continuing	Continuing
3001: *Marine Corps Landing Force Tech*	0.000	52.595	56.212	50.331	-	50.331	44.746	45.619	46.549	47.480	Continuing	Continuing
9999: *Congressional Adds*	0.000	1.931	7.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.931

A. Mission Description and Budget Item Justification

This Program Element (PE) addresses demand signals emphasized by the Commandant of the Marine Corps, the Chief of Naval Operations, and the Chief of Naval Research, as well as those pulled from dynamic engagement with stakeholders. Research efforts are carefully selected to ensure they have the potential to expand warfighting capabilities, inform operational concepts and requirements development, and advance state of the art technology and scientific knowledge. Current guidance also highlights the need to accelerate our pace of development and guide the approach to rapid experimentation, prototyping, and learning.

As reflected in the Marine Corps Operating Concept, the current strategic guidance from the Commandant, Expeditionary Forces will conduct maneuver warfare in environments characterized by complex terrain, technology proliferation, information used as a weapon, a battle of signatures, and an increasingly contested maritime domain. Additionally, an emergent operation stressor is the contested urban environment which exemplifies the characterizations listed above. The urban environment is one of the most complex terrains with physical compartmentalization and canalization, additional physical dimensions (subterranean and multi-story structures), crowded conditions and associated threat obscuration, communications challenges, informational and human aspects, and proliferation of observation and fires technologies. This environment requires capabilities addressing all the activities within this PE and while it provides many challenges, unique opportunities are also presented and can further shape technology approaches.

These future challenges and portents demand robust technologies for the Marine Corps, but the technology options are constrained. They must have a lightweight deployable character, and the ability to operate in austere conditions with little fixed infrastructure or support while retaining the agility and lethality of an integrated maneuver force. Technology must provide full spectrum capability against robust and complex peer and near-peer adversaries while meeting Size, Weight, Power, Post limitations, and information availability within Distributed, Intermittent and Limited environments.

The approach within this PE encompasses ideas that support both revolutionary and evolutionary capabilities, and in this way considers and balances both "push" and "pull" aspects of technology projects. Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Navy	Date: March 2019
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602131M *I Marine Corps Lndg Force Tech*

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	53.936	59.607	56.604	-	56.604
Current President's Budget	54.526	63.212	56.604	-	56.604
Total Adjustments	0.590	3.605	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-3.395			
• Congressional Rescissions	-	-			
• Congressional Adds	-	7.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.409	0.000			
• Program Adjustments	0.000	0.000	0.000	-	0.000
• Rate/Misc Adjustments	-0.001	0.000	0.000	-	0.000
• Congressional Add Adjustments	2.000	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	1.931	0.000
Congressional Add: *Interdisciplinary Expeditionary Cybersecurity Research*	0.000	5.000
Congressional Add: *Marine Corps Asset Life-Cycle Management*	0.000	2.000
Congressional Add Subtotals for Project: 9999	1.931	7.000
Congressional Add Totals for all Projects	1.931	7.000

Change Summary Explanation

Cyber Pure Line Item redistribution realigned $6.273M from Project 3001 into Project 2958.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy			Date: March 2019
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602131M / *Marine Corps Lndg Force Tech*	Project (Number/Name) 2958 / *Cyberspace Activities*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
2958: *Cyberspace Activities*	0.000	0.000	0.000	6.273	-	6.273	5.877	6.005	6.125	6.248	Continuing	Continuing

Note

The plans and associated programs contained in this Project are realigned from the Expeditionary CYBER Project 3001 in PE: 0602131M MARINE CORPS LNDG FORCE TECH beginning in FY 2020.

A. Mission Description and Budget Item Justification

This Project activity provides freedom of maneuver and influence in the cyber-electronic warfare domain while simultaneously denying the same to the adversary and protecting critical command systems. Technologies are being developed using a multi-disciplinary approach that combines Radio Frequency electronics, digital signal processing, computer engineering, software engineering, machine learning and data science to support Naval Expeditionary warfighters operating with size, weight and power constrained equipment in Disrupted, Intermittent, Limited environments. Areas of applied research include distributed precision time, predictive software defined radio architectures, coordinated Cyber and Spectrum maneuver to mitigate detection and exploitation, tactical Cyber visualization, discovering and mapping networks in dense urban environments, contextual awareness and blind channel characterization.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Expeditionary Cyber	0.000	0.000	6.273	0.000	6.273
Description: This activity provides freedom of maneuver and influence in the cyber-electronic warfare domain while simultaneously denying the same to the adversary and protecting critical command systems. Technologies are being developed using a multi-disciplinary approach that combines Radio Frequency electronics, digital signal processing, computer engineering, software engineering, machine learning and data science to support Naval Expeditionary warfighters operating with size, weight and power constrained equipment in Disrupted, Intermittent, Limited environments. Areas of applied research include distributed precision time, predictive software defined radio architectures, coordinated Cyber and Spectrum maneuver to mitigate detection and exploitation, tactical Cyber visualization, discovering and mapping networks in dense urban environments, contextual awareness and blind channel characterization.					
FY 2019 Plans: N/A					
FY 2020 Base Plans: Cyber related research will be conducted to develop methodologies to securely transfer information real-time across security boundaries for tactical users. Research will expand upon general cyber health assessments for					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 2958 / *Cyberspace Activities*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
distributed systems to understand cyber resilience for systems-of-systems. Develop new algorithms and tools to demonstrate Cyber-EW capabilities for tactical engagement. Cyber-related approaches will be used to better characterize digital waveforms for better situational awareness. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The increase in FY 2020 is due to realignment of Expeditionary Cyber from the Expeditionary Cyber R-2 Activity in Project 3001 and placed into Project 2958 beginning in FY 2020.					
Accomplishments/Planned Programs Subtotals	0.000	0.000	6.273	0.000	6.273

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The primary objective of this Project is the development, demonstration, and assessment of technologies that represent capabilities to meet unique Marine Corps needs in conducting Expeditionary Cyber Warfare in the future. The program consists of a collection of projects categorized by critical warfighting function. Individual project metrics reflect the technical goals of each specific project. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy											Date: March 2019	
Appropriation/Budget Activity 1319 / 2					R-1 Program Element (Number/Name) PE 0602131M / *Marine Corps Lndg Force Tech*				Project (Number/Name) 3001 / *Marine Corps Landing Force Tech*			
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
3001: *Marine Corps Landing Force Tech*	0.000	52.595	56.212	50.331	-	50.331	44.746	45.619	46.549	47.480	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds applied research; technology assessment, road mapping, and concept development; and less technologically mature projects within the Future Naval Capability (FNC) process as means to inform, enhance, enable, and invent future concepts and capabilities with new Science and Technology (S&T). This project is organized into ten activities, the core of which is represented by the eight Expeditionary Warfighting Capability Areas.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4)	4.219	4.430	4.750	0.000	4.750
Description: This activity investigates robust, resilient, and secure networked communications pathways and capability that support an expeditionary force's distributed and disaggregated operations. Research supports both networked and local computation for communications that exploits the expeditionary forces close physical proximity to threats while mitigating shortfalls commiserate within Distributed, Intermittent and Limited environments. Expeditionary forces must operate in the cyber domain and in addition to defending communications networks, vehicles, and weapons systems, are reliant on electronic controllers for basic operations and as such are susceptible to cyber attacks. Technologies addressed within this activity include secure, robust, self-forming, mobile communications networks; distributed computing to support information dissemination to all echelons; improved capabilities in over-the-horizon, beyond line-of-sight, and restricted environment communications and sensors; and software and data processing to support formation of an appropriate common picture. Other efforts include power management, low detectability, conforming to Size, Weight, Power, Cost constraints, and interoperability within the joint environment. ***FY 2019 Plans:*** Understanding the lightweight, deployable character of expeditionary forces, efforts are focusing on the improving and expanding the operational capability of Command, Control, Communications and Computers which requires rethinking many of the underlying technologies. Investigations include increasing bandwidth and dynamic range in portable systems. Also included are electromagnetic signature management, countermeasure and interoperability technologies to manage control and exploitation of the electromagnetic spectrum. Focus is					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
also on developing underlying technologies to enable multifunction operations at multiple-domain cryptography and security levels. ***FY 2020 Base Plans:*** The Command, Control, Communications and Computers (C4) research focuses on operations in the challenging warfighter electromagnetic spectrum environment by making investments in the multifunction electronic warfare domains. Mission requirements include lightweight, portable, deployable systems for expeditionary forces. Investigations include increasing bandwidth and dynamic range in portable systems. Also included are electromagnetic signature management, machine learning, countermeasures and interoperability technologies to manage control and exploitation of the electromagnetic spectrum. Focus also includes developing underlying technologies to enable multifunction operations at multiple-domain cryptography and security levels. Research is closely coordinated with the Intelligence, Surveillance, and Reconnaissance and Expeditionary Cyber research to address the multifunction requirement of future systems. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no significant change from FY 2019 to FY 2020.					
Title: FIREPOWER	6.131	8.190	7.595	0.000	7.595
Description: The activity investigates a large variety of weapons to provide the warfighter with a decisive, yet surgical, tactical advantage to collectively address 21st-century combined-arms warfare against peer and near-peer states. Research efforts increase the reach, lethality and capacity, while retaining mobility and tempo beneficial to expeditionary maneuver warfare. Maintaining focus on size, weight, power, cost Size, Weight, Power, Cost and Distributed, Intermittent and Limited environments stresses the technical solutions available. Technologies being developed are intended for application on both current and future expeditionary weapons and elements of the kill chain. They include, but are not limited to, the following: fuze, fire control, launch/ propulsion, lethality, and accuracy. ***FY 2019 Plans:*** This activity will continue research of end-to-end navigation technologies suitable for flight corrections of gun launched munitions in satellite and network denied environments. Development of real-time, multi-spectral target detection and identification systems continue for individual shooters, providing anomaly and object					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
detection and decision-aid algorithms. Materials research focuses on thin film coatings that change how munitions interact with electromagnetic waves, and on novel materials and processes to improve energetic output of explosives. Munitions efforts will focus on increasing range and precision at low cost. ***FY 2020 Base Plans:*** Resources in this activity will be used to conduct research in end-to-end navigation technologies suitable for shaping the trajectories of extended range, precision, gun-launched munitions in satellite- and network-denied environments. Conduct research into real-time, multi-spectral target detection and identification technologies for individual shooters will continue in order to improve anomaly and object detection and decision-aid algorithms. Conduct research to develop thin film coatings that will change how munitions interact with electromagnetic waves, and for novel materials and processes to improve energetic output of explosives. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no significant change from FY 2019 to FY 2020.					
Title: FORCE PROTECTION	6.579	6.670	6.500	0.000	6.500
Description: This activity investigates new ways and means to protect forces and materiel across all operational settings, from contested sea-land surface interfaces to complex urban environments. The portfolio protects against adversaries' challenges such as guided-rockets and missiles, mobile coastal artillery, threat Electronic Warfare, and counter Intelligence, Surveillance and Reconnaissance. Mines and obstacles both in the water and ashore also complicate amphibious landings. The activity invests in vehicle survivability aspects that are exacerbated due to Size, Weight, Power, Cost constraints inherent to Marine Corps operation and the harsh nature of the amphibious environment. Technologies addressed include lightweight armor for ballistic and underbody blast protection, advanced sensors for counter tactical surveillance, active protection, and signature management. This activity also considers technology for payloads, packages and sensors that are needed by amphibious vehicles (both manned and unmanned) including mine counter measures; explosive hazard defeat systems; and obstacle and threat detection systems as well as technologies for improved protection for individuals against blast, ballistic and blunt impact threats.					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2019 Plans: This activity is emphasizing developing miniaturized hardware sensing systems for the detection of threats across a variety of sensing modalities to include visual, thermal, RADAR, and Light Detecting and Ranging to take advantage of unique susceptibilities of threat systems at significant ranges. Leveraging these sensor systems, there will be development of computer vision and machine learning approaches for automated target recognition within these innovative sensing modalities. Work also continues to track technologies in the area of passive armor but there will be decreasing investments in this area until basic research in materials science provide opportunities for significant improvement in protection levels. ***FY 2020 Base Plans:*** Research will continue to focus on detecting ambush threats and surveillance of vehicles and personnel prior to reaching threat engagement range. Sensing modalities and advanced algorithms leveraging computer vision and machine learning will continue to be developed to provide counter targeting and tactical surveillance. Improve signature management and control, to include material development, will be explored. Develop improved active protection system countermeasures to expand threat set and protected area and improve robustness to operational environments and enabling technologies for countering unmanned aerial vehicles through kinetic and directed energy means. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no significant change from FY 2019 to FY 2020.					
Title: HUMAN PERFORMANCE, TRAINING AND EDUCATION ***Description:*** This activity investigates two technology investment areas, warrior resilience, and decision-making and expertise development. Warrior resilience is focused on advanced training technologies and methodologies that enhance neural, cognitive, and physical readiness. Decision making and expertise development accelerates the development and improves the retention of skills in decision making, situation awareness, and individual and team adaptability and coordination on decentralized, dynamic and dispersed battlefields. ***FY 2019 Plans:*** As efforts decrease in the areas of trauma mitigation and functional movement studies, focus will shift towards simulation-based training, operational decision tools, and physical training tools. Rapid advances in artificial	3.153	3.687	3.700	0.000	3.700

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
intelligence and terrain and environment collection have provided an opportunity to explore potential impacts into tactical unit-level infantry training and mission planning. Efforts will investigate means with which to document, classify, and data collect on current training programs enabling the development of tools to enhance these programs to increase effectiveness and minimize injury. Efforts will also include an increase in training tools for operation in Electronic Warfare (EW) and Cyber contested environments. ***FY 2020 Base Plans:*** Across the three technology investment areas of 'Warrior Resilience' (WR), 'Decision Making and Expertise Development' (DMED), and Operational Tools (OT) research will continue to focus on providing small unit leaders with effective training and tools to gain them the winning edge on the battlefield. These capabilities will provide information to the warfighter at the point of friction and with increased information flow ("the right information, presented the right way, at the right time") to aid cognitive reasoning about the effects of the battlefield - whether physical or physiological - and mitigation of negative aspects of combat. The WR portfolio will fund research into further understanding the necessity, and ability, to train front-line (infantry) troops for maximum performance. The DMED portfolio will research and implement state-of-the-art and science of learning-based training techniques to improve the development of small unit decision making expertise. The Operational Tools portfolio will increase the ability of the warfighter to process information and speed decision making by implementing novel data collection techniques (multi-spectral collection of signals across the electro-optical spectrum) and processing of these inputs for display - in real time, as the ultimate goal - directly to the individual who requires the information to make a timely, accurate decision. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no change from FY 2019 to FY 2020.					
Title: INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)	6.553	6.969	6.276	0.000	6.276
Description: This activity investigates enhanced situational awareness, persistent surveillance, and tactical decision making through automated analysis of data and rapid integration of information and acquired knowledge. Specific technologies in this activity effectively present actionable information to decision-makers, especially those at the lower command levels. This includes biometric monitoring for expeditionary operations, operational course of action (COA) development, and autonomous surveillance in support of distributed operations.					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2019 Plans: This activity will begin to divest investments in hardware centered approaches to low power sensing and advanced optical components for multi-spectral imagers. However, investments in smart graphs, network shaping metrics, actionable visualizations will continue. Increased focus will be on investments in context aware (smart) Artificial Intelligence (AI), automation, machine learning, deep learning, and computer vision algorithms. Additionally work will begin on research in strong artificial intelligence applied to the domain of decision support (memory neural networks) and in context adaptive pattern recognition systems (looping), as well as to leverage foundational theory for reinforced learning ***FY 2020 Base Plans:*** Conduct research in applying supervised learning and unsupervised learning algorithms to the Naval domain. Continue development of strong Artificial Intelligence as applied to both images and text. Accelerate development of algorithms that can infer patterns in common intelligence and tactical pictures useful to the development of decision support tools. Accelerate the development of planners that can learn from historical data. Develop a question answering capability that is relevant to the Naval domain. Exam network formation, growth and fracture. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no significant change from FY 2019 to FY 2020.					
Title: USMC FNC TECHNOLOGY CANDIDATES	4.630	4.799	4.800	0.000	4.800
Description: This R-2 Activity, formerly named USMC Future Naval Capabilities (FNCs), addresses the applied research associated with the Marine Corps' participation in the Department of the Navy's (DoN) Future Naval Capabilities (FNC) Program. The objective of the work in this Program Element (PE) is to develop and mature technologies needed by the Marine Corps to initiate FNCs in PE 0603640M Marine Corps Advanced Technology Development (ATD) that can be commenced at higher Technology Readiness Levels (TRLs). Investments in this activity are coordinated with similar and non-duplicative efforts in PE 0602750N Future Naval Capabilities Applied Research, where the Navy's participation in the FNC Program is funded. The FNC Program was restructured for FY19 to accelerate transition to the Fleet and Force. This restructuring involved a zero based review of all ongoing FNC projects where each effort was assessed for its technology maturity and transition commitment. Ongoing efforts were categorized as FNCs or Technology Candidates. Some					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
efforts were terminated and others were accelerated to achieve the goals of the restructured program. FNCs, which have higher Technology Readiness Levels (TRLs of 4/5 to 6) and transition funding commitments, are being resourced in PE 0603640M Marine Corps Advanced Technology Development (ATD). Funding for technology candidates at lower TRLs (3 to 4) is being resourced in this PE. ONR is working closely with the Resource Sponsors and acquisition stakeholders to develop high priority technological capabilities needed by the operational forces. Prior to FY19, the underlying FNC Program investments in this PE were aligned to specific FNC projects. In order to increase agility, exploit technology advances, and respond quickly to naval needs, future applied research investments supporting FNC technology candidates are being developed in a more flexible manner. This approach facilitates an optimum response when developing and maturing the technology options that will be developed further in PE 0603640M Marine Corps Advanced Technology Development (ATD). The FNC Program has been fully restructured in favor of a more direct and higher level of collaboration. Investments are organized to enhance collaboration with the acquisition stakeholders and their resource sponsors. A complete accounting of the technologies being developed in this PE will be provided separately to the Congressional oversight committees. ***FY 2019 Plans:*** The technologies being pursued under this activity include, but are not limited to, investments that focus on developing and maturing new capabilities for asymmetric and irregular warfare, distributed operations, information dominance, maneuverability, survivability, self-defense and expeditionary warfare. ***FY 2020 Base Plans:*** Future Naval Capability Technology Candidate development in FY20 will continue to focus on a broad range of technologies including, but are not limited to, investments that focus on developing and maturing new capabilities for asymmetric and irregular warfare, distributed operations, information dominance, maneuverability, survivability, self-defense and expeditionary warfare. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
There is no significant change from FY 2019 to FY 2020.					
Title: LOGISTICS	5.589	5.784	6.254	0.000	6.254
Description: This activity investigates the practical discipline and real world application of the deployment, sustainment, reconstitution, and re-deployment of forces engaged in expeditionary operations. Logistics replaces mass with assured knowledge and speed, is equally capable ashore or afloat in austere environments, and is fully scalable to meet uncertain requirements. This includes efficient and responsive force sustainment, planning and directing logistics operations, logistics demand reduction, fleet maintenance, and expeditionary energy. Expeditionary Energy enhances combat capability of expeditionary warfighters by increasing the efficiency and effectiveness of energy production, storage, distribution and use. Beyond traditional energy efforts, this portfolio also looks at other issues, including energy-efficient behaviors and hybridization of energy sources. These pillars are thoroughly integrated and perpetually related in execution. ***FY 2019 Plans:*** This activity includes developing technologies to anticipate and reduce maintenance demands while increasing reliability. This includes applied research and evaluation of advanced manufacturing methods including metal additive manufacturing (AM), friction stir welding and additive friction stir welding, and cold spray for structural repair of Marine Corps equipment. Additional focus will be on developing a thorough understanding of material Process-Structure-Properties-Performance for high hard steel repair and other structural materials. This research area also includes applied research to predict vehicle health and prognostics of remaining useful life for military ground vehicles and equipment in support of Condition Based Maintenance (CBM) goals, while seeking to automate CBM practices through automatic data retrieval and algorithm development. The focus of this investment area includes enhancing combat capability by increasing energy production, storage, distribution, and curbing energy consumption of the individual Marine and other tactical assets. Activities involve applied research into new, rugged, low cost, and high specific power solar cell technologies that are compatible with military use on flexible substrates, while overcoming current limitations including short-lived cell stability and small area cell growth. Additionally, investigations will take place for developing more energy efficient components for the Marine warfighter and high energy and power density technologies to simultaneously curb exponential power use trends, reduce combat load, and enhance mission duration and combat performance. ***FY 2020 Base Plans:***					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Logistics development in FY20 will focus on the broad range of technologies noted in the FY19 plans section above. Research into friction stir welding, additive friction stir welding, and cold spray for structural repair of Marine Corps equipment will complete. Research will be initiated in artificial intelligence tools to support logistics planning, execution, and combat support. Develop enhancing autonomous logistics aerial/ground asset teaming. Develop cyberphysical security of Digital Manufacturing methods, including Additive Manufacturing. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no significant change from FY 2019 to FY 2020.					
Title: MANEUVER	7.696	10.516	9.022	0.000	9.022
Description: This activity investigates new ways and means to land forces and material through contested sea-land surface interfaces and then conduct maneuver warfare. In order to enable future Amphibious Operations, research efforts will support autonomous operations across the sea-surf-ground environment, improved fuel efficiency and speed of amphibious vehicles, amphibious vehicle technologies, water performance, and amphibious payloads to change the dynamics of a surface amphibious assault. This includes the emergence manned-unmanned teaming and autonomous vehicle collaboration. The technologies included in this work address areas of mobility, materials, propulsion, signature reduction, modularity, and unmanned systems. ***FY 2019 Plans:*** Efforts will research advanced mobility technologies and concepts for tactical and combat ground and amphibious vehicles to extend the operational reach and range, enable higher operational tempo over rough terrain, and to provide protection against cyber threats. This activity will emphasize efforts on providing an autonomous capability to the amphibious fleet for maneuver from ship to shore in a contested landing environment. Also planned for development is autonomous perception, path planning, and vehicle controls for amphibious vehicles from small low cost craft, traditional amphibious combat and assault vehicles, and landing craft. Research will develop knowledge and models for characterizing the surf zone impacts on amphibious craft to allow for physics based simulation of unmanned amphibious craft transition from sea to land environments. Also to be explored are vision based perception systems capable of robust object recognition and complex					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
scene understanding in dynamic environments. In addition efforts will address technologies that can lead to next generation manned ground vehicles. ***FY 2020 Base Plans:*** Research will focus on intelligent mobility technologies to enable greater capability in harsh off road and littoral environments. Efforts will include better understanding of the ground interface through terrain characterization and researching enhanced platform effectors that allow the system to adapt to varying terrain approaching real time thereby increasing operational tempo. Efforts also include the development of forward-operating autonomous unmanned systems, in communication limited and Global Positioning System denied environments, with a focus on sense-making from local-sensors at the edge. Research will continue to improve the impacts of the surf zone and other land-sea interfaces on vehicle dynamics. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The decrease from FY 2019 to FY 2020 is due to the completion of Modernization Enhanced Experimentation efforts.					
Title: EXPEDITIONARY CYBER ***Description:*** This activity provides freedom of maneuver and influence in the cyber-electronic warfare domain while simultaneously denying the same to the adversary and protecting critical command systems. Technologies are being developed using a multi-disciplinary approach that combines Radio Frequency electronics, digital signal processing, computer engineering, software engineering, machine learning and data science to support Naval Expeditionary warfighters operating with size, weight and power constrained equipment in Disrupted, Intermittent, Limited environments. Areas of applied research include distributed precision time, predictive software defined radio architectures, coordinated Cyber and Spectrum maneuver to mitigate detection and exploitation, tactical Cyber visualization, discovering and mapping networks in dense urban environments, contextual awareness and blind channel characterization. ***FY 2019 Plans:*** Cyber related encryption and multiple-domain processing tools are developed to enable a new class of portable devices that can securely transfer information across multiple tactical user platforms. Research is performed on the phenomenology of cyber battle damage on a class of systems, and results are used to develop hardware and algorithms for assessing cyber system health. Develop and test a new class of component technologies,	6.690	3.574	0.000	0.000	0.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
architectures, and embedded algorithms that demonstrate improved cyber Electronic Warfare resilience. Technologies are developed to perform autonomic monitoring and self-healing of EW-cyber, Command, Control, Communications and Computers and information exchange systems. Cyber behavior research will also be performed on a class of autonomous systems to demonstrate optimized stability, efficiency and resiliency. ***FY 2020 Base Plans:*** N/A ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The FY 2019 to FY 2020 decrease is due realignment of Expeditionary Cyber from this Project and Activity to Project 2958 Cyberspace Activities for FY 2020.					
Title: FUTURE CONCEPTS, TECHNOLOGY ASSESSMENT, AND ROADMAPPING	1.355	1.593	1.434	0.000	1.434
Description: This activity supports the planning and integration of technology development efforts across the entire Program Element (PE). In conjunction with the Concepts Based Capabilities System and the Marine Corps Warfighting Laboratory, unique and novel concepts for advanced warfighting are developed and validated. Effectiveness analyses are conducted to identify the synergistic effects that can be achieved through the integration of emerging technology with innovative tactics, doctrine, and techniques. Technology assessments are conducted to determine the supporting technologies that have the highest impact across the warfare areas, and warrant further investment within this PE. Technology Roadmapping is conducted to help identify opportunities to leverage technology development within the Department of the Navy and the Department of Defense, as well as, with the commercial sector and university communities. The resultant technology investment strategy is developed and used to guide out-year technology development efforts. ***FY 2019 Plans:*** Assess technologies that best address warfare environments and drivers described in the Marine Corps Operating Concept (MOC) and the Navy's A Design for Maintaining Maritime Superiority. This includes technologies within expeditionary design constraints that exploit scientific opportunities, and develop technology concepts to enable the execution of maneuver warfare in environments characterized by complex terrain including dense urban, technology proliferation, information used as a weapon, battles of signatures, and an increasingly contested maritime domain. Focus on and assess strategies that develop and field more flexible and adaptive technology quicker and with unit costs that win battlefield economics. Create roadmaps and concepts					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 3001 / *Marine Corps Landing Force Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
that enhance expeditionary capabilities against peer and near-peer adversaries whose technologies rival our own. Explore science and technology approaches that can speed up assessment, exploitation, and delivery of capability to expeditionary warfighters. ***FY 2020 Base Plans:*** Assess systems of technologies that best address warfare environments and drivers described in the MOC and the Navy's A Design for Maintaining Maritime Superiority. Identify and integrate numerous technology options within expeditionary design constraints to develop technology counterparts to Operational Concepts. Create technology roadmaps, concepts, and holistic systems of systems approaches that fulfil the needs identified in Operational Concepts such as the Marine Corps' Expeditionary Advanced Based Operations Concept and Littoral Operations in a Contested Environment Concept and enhance expeditionary capabilities against peer and near-peer adversaries. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** There is no significant change from FY 2019 to FY 2020.					
Accomplishments/Planned Programs Subtotals	52.595	56.212	50.331	0.000	50.331

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The primary objective of this PE is the development of technologies to meet unique Marine Corps needs in conducting Expeditionary Maneuver Warfare and Combating Terrorism. The program consists of a collection of projects categorized by critical warfighting function. Individual project metrics reflect the technical goals of each specific project. Typical metrics include the advancement of related Technology Readiness Levels, the degree to which project investments are leveraged with other performers, reduction in life cycle cost upon application of the technology, and the identification of opportunities to transition technology to higher categories of development.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy											Date: March 2019	
Appropriation/Budget Activity 1319 / 2					R-1 Program Element (Number/Name) PE 0602131M / *Marine Corps Lndg Force Tech*				Project (Number/Name) 9999 / *Congressional Adds*			
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
9999: *Congressional Adds*	0.000	1.931	7.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.931

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019
Congressional Add: Program Increase	1.931	0.000
FY 2018 Accomplishments: Conduct Applied Research associated with two major thrust areas supporting Marine Corps warfighting capabilities. Cyber-Development of active cyber defense techniques - Conduct Cyber-Development of active cyber defense techniques on relevant tactical vehicles. Demonstrate these active defense techniques in a lab environment. Construct attacks for INL benchmark model to determine if Cyber Physical model can detect intrusion via metrics. Cyber technique development against UAS threat. Development of local time and frequency event scenarios associated with low level transient system dynamics needed to measure and control transient responses. Asset Lifecycle Management - Conduct research for new sensors and integrated vehicle health management systems for emerging vehicle programs and prototypes, such as the Armored Reconnaissance Vehicle, in order to enhance overall asset lifecycle management. While existing and prior research has been targeted to supporting the large legacy fleets through leverage of existing vehicle sensors and controller area networks, this research will investigate new asset health data sensing systems to support more advanced diagnostics and prognostics asset management capabilities.		
FY 2019 Plans: N/A		
Congressional Add: Interdisciplinary Expeditionary Cybersecurity Research	0.000	5.000
FY 2018 Accomplishments: N/A		
FY 2019 Plans: This program will fund the following research efforts in FY19:		

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602131M / *Marine Corps Lndg Force Tech*	**Project (Number/Name)** 9999 / *Congressional Adds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019
- Identification of system vulnerabilities within blue and gray cyberspace that affect Expeditionary Cyber operations - Develop proof of vulnerabilities, where applicable - Propose defensive technologies and methodologies for target platforms		
Congressional Add: Marine Corps Asset Life-Cycle Management ***FY 2018 Accomplishments:*** N/A ***FY 2019 Plans:*** Conduct research for new sensors and integrated vehicle health management systems for emerging vehicle programs and prototypes, such as the Armored Reconnaissance Vehicle, in order to enhance overall asset lifecycle management.	0.000	2.000
Congressional Adds Subtotals	1.931	7.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

Congressional Interest Items not included in other Projects.