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 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603640M *I MC Advanced Technology Demo*

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	164.992	174.809	172.847	-	172.847	168.520	171.906	175.319	178.826	Continuing	Continuing
2223: *Marine Corps ATD*	0.000	94.567	100.979	95.327	-	95.327	98.263	100.313	102.326	104.373	Continuing	Continuing
2297: *Futures Directorate*	0.000	58.354	46.830	73.046	-	73.046	65.781	67.116	68.427	69.796	Continuing	Continuing
2958: *Cyberspace Activities*	0.000	0.000	0.000	4.474	-	4.474	4.476	4.477	4.566	4.657	Continuing	Continuing
9999: *Congressional Adds*	0.000	12.071	27.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.071

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, Cost 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. This PE matures technologies emerging from PE 0602131M-Marine Corps Landing Force Technology to develop concept prototypes and initial experimentation to confirm feasibility in an environment relavent to operations.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

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B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	154.407	150.245	142.377	-	142.377
Current President's Budget	164.992	174.809	172.847	-	172.847
Total Adjustments	10.585	24.564	30.470	-	30.470
• Congressional General Reductions	-	-0.436			
• Congressional Directed Reductions	-	-2.000			
• Congressional Rescissions	-	-			
• Congressional Adds	-	27.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	4.073	0.000			
• SBIR/STTR Transfer	-3.792	0.000			
• Program Adjustments	0.000	0.000	30.470	-	30.470
• Rate/Misc Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions Adjustments	-0.296	-	-	-	-
• Congressional Directed Reductions Adjustments	-1.900	-	-	-	-
• Congressional Add Adjustments	12.500	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2018	FY 2019
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	12.071	0.000
Congressional Add: *Common Unmanned Aerial Vehicle Simulation System*	0.000	10.000
Congressional Add: *Flight Motion Simulator and Testing of UAVs*	0.000	6.000
Congressional Add: *Modular Advanced Armed Robotic System 2.0*	0.000	4.000
Congressional Add: *UAS Air-Delivered Extended Range Munitions Demo*	0.000	7.000
Congressional Add Subtotals for Project: 9999	12.071	27.000
Congressional Add Totals for all Projects	12.071	27.000

Change Summary Explanation

Major program adjustment is associated with a one-time $15M increase in FY20 in order to enhance Intelligence, Surveillance, and Reconnaissance (ISR) capabilities. Will initiate efforts to receive, transmit, and fuse joint asset specialized sensor information to communications nodes afloat and ashore via an aerial

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gateway. Additional $10M in FY20 and subsequent across the FYDP to fund Marine Corps Science and Technology in-line with Office of the Secretary of Defense (OSD) steady-state guidance. Efforts are justified in Project 2297.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy			Date: March 2019
Appropriation/Budget Activity 1319 / 3	R-1 Program Element (Number/Name) PE 0603640M / *MC Advanced Technology Demo*	Project (Number/Name) 2223 / *Marine Corps ATD*	

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
2223: *Marine Corps ATD*	0.000	94.567	100.979	95.327	-	95.327	98.263	100.313	102.326	104.373	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds technology demonstration, experimentation, and prototyping; and more technologically mature projects within the Future Naval Capability (FNC) process as means to inform, enhance, enable, and invent future concepts and capabilities with new S&T. This project is organized into ten activities, the core of which is represented by the eight Expeditionary Warfighting Capability Areas.

Emphasized within this project are increased efforts to actively demonstrate advanced technologies and system concepts. These demonstrations and experiments focus on the specific technologies, not necessarily their operational application, and vary based on the technical maturity of the project. This early technology exposure gives Marines a view into the future and enables them to use their imagination and innovation to envision novel employment of the technology and inform the acquisition process.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS (C4)	7.420	6.480	10.000	0.000	10.000
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 cyberattacks. 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. Further, this activity integrates and demonstrates enhanced communications and situational awareness capabilities in experimental and warfighting environments reflecting USMC operations. Advanced technology resources will be developed and applied to complement commercial, other service, and defense agency					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
investments to produce a technology base addressing identified Marine Corps technology gaps. Focus will be on developing component level prototypes and experimentation in relevant environments. ***FY 2019 Plans:*** The Command, Control, Communications and Computers (C4) research effort focuses heavily on the continued development and integration of multiple underlying technologies into subsystems and system with the purpose of demonstrating the tactical exploitation of information and the electromagnetic spectrum. To address resiliency requirements,C4 is coordinating closely with Expeditionary Cyber to address resiliency requirements by efficiently exploiting multifunction capabilities in portable and reduced Size, Weight, Power, and Cost systems. Other efforts include power management, low detectability, and interoperability within the joint environment This integrated rapid co-design, prototyping, and experimentation approach will reduce time needed to provide new capabilities to the US Marine Corps. Developed and demonstrated technologies will include signature management, interoperability, spectrum maneuver, damage assessment monitoring, and information dominance for tactical edge systems. ***FY 2020 Base Plans:*** The C4 and Electronic Warfare research effort focuses heavily on the continued development and integration of multiple underlying technologies into subsystems and system with the purpose of demonstrating the tactical exploitation of information and the electromagnetic spectrum. To address resiliency requirements of C4 this effort is closely coordinated with the Intelligence, Surveillance, and Reconnaissance and Expeditionary Cyber research portfolio also described herein so as to most efficiently exploit multifunction capabilities in portable reduced Size, Weight, Power, Cost systems. This integrated rapid co-design, prototyping, and experimentation approach will reduce time needed to provide new capabilities to the US Marine Corps. Developed and demonstrated technologies will include advanced signature management, interoperability, machine learning, spectrum maneuver, damage assessment monitoring, and information dominance for tactical edge systems. Additional emphasis of operating in the challenging warfighter electromagnetic spectrum environment is addressed in the multifunction electronic warfare domains. ***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
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
The increase from FY 2019 to FY 2020 is associated with greater emphasis on deception and signature management.					
Title: FIREPOWER	8.734	16.955	9.000	0.000	9.000
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 and Distributed, Intermittent and Limited environments stresses the technical solutions available. This activity furthers the maturity of researched technology solutions by also developing the integration required to effectively demonstrate and test emergent capabilities. Achieving a true combined arms state involves a full systems approach for both kinetic and non-kinetic capabilities all driven by a holistic targeting capability. This activity develops technology for application on current and future expeditionary weapons and elements of the kill chain. It includes, but is not limited to, the following technologies: fuze, fire control, targeting, launch/ propulsion, lethality, and accuracy. ***FY 2019 Plans:*** This activity will finalize development of direct electrical ignition for caseless small caliber ammunition for integration and testing. Development of fuzing and sensor technologies for cannon-delivered area effects munitions will continue. Systems engineering of supervised-autonomous weapon system control will continue, implementing engagement logic, to develop and demonstrate the key enabling technologies and command and control methods for weaponized unmanned ground vehicles. Efforts will include prototype weapon systems for technical evaluation. ***FY 2020 Base Plans:*** Finalize development of caseless small caliber ammunition: development of fuzing and sensor technologies for cannon-delivered area effects munitions, and development of supervised-autonomous weapon system control technologies for weaponized unmanned ground vehicles. Munitions developments will focus on low cost, extended range, precision munitions with improved lethality warhead payloads for use against stationary and moving targets on land and water, in satellite and network denied environments. ***FY 2020 OCO 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
N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The decrease from FY 2019 to FY 2020 is associated with one time increase in FY19 for the HR DPICM Replacement in the amount $8.6M.					
Title: FORCE PROTECTION ***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. ***FY 2019 Plans:*** FY 2019 Plans are focused on efforts to integrate and fuse sensor modalities while experimenting with the effectiveness of automated target recognition algorithms in high clutter environments at high speed over off-road terrains. Work will emphasize signature management of vehicle systems and integrating the knowledge of our own susceptibility, intelligence estimates of threat capabilities, and in situ data to enhance situational awareness. Focus is also on lightweight protection systems in the area of active protection that provide hemispherical coverage while reducing the threat to dismounted forces. Complete efforts associated with development of Passive Armor capabilities. Last, research is being conducted on modular, scalable, integrated stand-off Radio Frequency based explosive hazard (Improvised Explosive Devices & Mines) detection system that can be operated as a remote or autonomous system. ***FY 2020 Base Plans:***	10.422	10.794	13.415	0.000	13.415

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2020 Plans emphasize development of miniaturized hardware systems for the detection of threats across a variety of sensing modalities 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. There will be development of feature extraction of threats leveraging RF based 3D buried object detection. Signature reduction materials and sensor hardware for pre-shot detection of ambush threats and surveillance will be demonstrated on platforms to evaluate enhanced survivability. Efforts will also include tactical decision aids that provide vehicle susceptibility assessment and route planning recommendations. Additionally, technologies and systems supporting the neutralization of threat systems via kinetic and non-kinetic means, to include unmanned aerial vehicles, will be developed. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The increase from FY 2019 to FY 2020 is associated with greater emphasis on mine countermeasures and counter-unmanned aerial systems activities.					
Title: HUMAN PERFORMANCE, TRAINING & EDUCATION	6.618	6.107	5.300	0.000	5.300
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. Focus will be on developing component level prototypes for Marines to evaluate and experiment with. ***FY 2019 Plans:*** Rapid advances in wearable and human performance related technologies have provided the opportunity to demonstrate the utility of these technologies with Marine Corps populations to increase physical readiness and reduce injuries. The increased use of simulation-based training capabilities such as augmented reality offer the possibilities to demonstrate new capabilities, such as 3-Dimensional (3D) visualization, that will accelerate and increase decision making. Efforts will support hardware, software, data collection and demonstrations to support increase decision making and expertise development and warrior resilience. ***FY 2020 Base Plans:***					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Conduct research in wearable physiological monitoring, predictive algorithms, health tracking capability, and related technologies will provide the opportunity to integrate with Marine Corps' 'Force Fitness Division' programs in support of close combat formations and populations, in order to increase physical readiness and reduce potential injuries. The use of these 'Warrior Resilience' programs may be demonstrated as integral elements of larger, multipurpose exercises focused on all aspects of military tasks, or as stand-alone events where the primary purpose is to illustrate the capability to achieve improved awareness of the physical and physiological readiness of the individual. The advance of augmented reality devices and the content available for collection and display, and each of their contribution to simulation-based training (and the increased decision-making ability that this training can afford) will provide the opportunity to demonstrate 3D terrain visualization, battlefield control measures and effects, and target identification and classification. This robust and ever increasing capability will be incorporated into demonstration opportunities at ever-increasing levels of complexity and scale to demonstrate the increased decision making efficiency - in both speed and accuracy of information processing across the plan, execute, and debrief spectrum of operations. Demonstrations will include advances in hardware, software, collection and display capabilities that will support increased decision making and expertise development and warrior resilience. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The decrease from FY 2019 to FY 2020 is associated with de-emphasis on custom wearable components in force fitness.					
Title: INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)	7.868	8.460	8.400	0.000	8.400
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 development, and autonomous surveillance in support of distributed operations. Further, this activity supports the demonstration of technologies to enhance situational awareness and tactical decision making through automated analysis, fusion of data, rapid integration of information, and acquired knowledge resulting in actionable intelligence at the lower command levels. The activity includes the					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
demonstration of ISR efforts involving enhanced reconnaissance and persistent surveillance, and sensors for unmanned ground and aerial vehicles. Advanced technology demonstrations also include the collection of information [monitoring, sensing, and locating] in the 3-Dimensional urban battlespace as well as exploiting information [identifying and classifying data] as part of the intelligence preparation of the battlespace in order to facilitate operational maneuver and distributed operations. ***FY 2019 Plans:*** This activity will begin to divest investments in approximate computing for power efficiency. Research and develop prototype systems for machine question answering capabilities and in automating machine generation of complex standard military information based products. Investments are also continuing in experimentation and demonstration in artificial intelligence relevant to decision support and sensor autonomy. Increased focus will be put on investments in technology to enable all sensors, weapons, platforms to be smarter and more capable of knowing why, when and how to collaborate. ***FY 2020 Base Plans:*** Conduct assessment of the operational utility of natural language processing and computer vision. Show operational relevance of computer vision as an autonomy enabler. Increase emphasis on the production of synthetic data useful to train decision aids. Accelerate deep learning enabled data fusion. Mature algorithms capable of analyzing signatures and signature changes from graph data. Initiate development of deep learning architecture enablers including dynamic graph stores and workflow managers for models. ***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 FUTURE NAVAL CAPABILITIES	27.487	26.885	26.849	0.000	26.849
Description: This R-2 Activity addresses the advanced technology development 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 PE is to develop promising technologies emerging from the FNC technology candidates funded in PE 0602131M that have been matured to higher Technology Readiness Levels (TRLs). Investments in this activity are coordinated with similar and non-duplicative efforts in PE 0603673N. 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					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
transition commitment. Ongoing efforts were categorized as FNCs or Technology Candidates. Some efforts were terminated and others were accelerated to achieve the goals of the restructured program. Funding for FNCs, which have higher Technology Readiness Levels (TRLs of 4/5 to 6) and transition funding commitments, is being resourced in this PE. Funding for FNC technology candidates at lower TRLs (3 to 4) is being resourced in PE 0602131M. 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, FNC Program investments were selected almost two years in advance of execution. It was determined by Navy and Marine Corps leadership that this approach limits DON's ability to exploit technology advances and respond quickly to naval needs. As a result, future BA 3 investments supporting the FNC Program are now made less than one year before commencing execution. Because FNCs are now starting at higher TRLs, the typical duration of an FNC has been shortened to 3-years. The FNC Program has been fully restructured in favor of a more direct and higher level of collaboration. Individual R-2 Activities have been discontinued and investments are organized to enhance collaboration with the acquisition stakeholders and their resource sponsors. A complete accounting of the technologies being developed and a full disposition of each technology development effort will be provided separately to the Congressional oversight committees. ***FY 2019 Plans:*** The advanced technologies being developed under this R-2 Activity include, but are not limited to, those that focus on developing promising technologies emerging from the FNC Applied Research program that have been matured to a Technology Readiness Level (TRL) of 4 to 5 in the areas of asymmetric and irregular warfare, distributed operations, information dominance, maneuverability, survivability, self-defense and expeditionary warfare. ***FY 2020 Base Plans:*** The advanced technologies being developed under this R-2 Activity focus on developing promising technologies emerging from the FNC Applied Research program that have been matured to a Technology Readiness Level of 4 to 5. Technologies being developed include, but are not limited to, those that increase target prosecution speed and accuracy against enemy firing positions by compressing the kill chain timeline through sensor fusion, Command and Control integration, and automated collaboration of warfighting functions, those that will enhance mobility, propulsion, autonomy, weapons, materials, logistics, vehicle architectures, and Electronic Warfare protection for a light armored vehicle fleet, technologies associated with the development of an affordable, longer range mortar projectile, with precision delivery against stationary and moving targets during periods of full Global					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Positioning Satellite denial, technologies that optimize the balance between hardening and flexible software development for future dynamic engagements in contested environments with adversaries, and new repair techniques to include the use of solid-state technologies such as cold-spray and additive friction stir welding for structural repairs. ***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: LOGISTICS ***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 has development and demonstration of advanced technologies to anticipate and reduce maintenance demands while increasing reliability. This includes advanced technology demonstrations of advanced manufacturing methods including metal Additive Manufacturing, friction stir welding and additive friction stir welding, and cold spray for structural repair of Marine Corps equipment, creation of near net shaped parts, and advanced part demonstrations. This also includes research into the digital thread of information and cyber security required, from cradle to grave, for digital manufacturing methods, from raw materials through design, production, and qualification of parts for Marine Corps applications. This research area also includes advanced technology demonstrations that 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.	7.942	9.553	7.837	0.000	7.837

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
The activity also will demonstrate the military utility of enhancing combat capability by increasing energy production, storage, distribution, and curbing energy consumption of the individual Marine and other tactical assets. This includes advanced system research into the scaled use of high specific power solar cell for Marine Corps applications ranging from the individual warfighter to augmenting the power and combat endurance unmanned robotic vehicles. Additionally investigated, system level research and demonstration of enhanced power and energy technologies to support the Marine warfighter as a system, to include enhanced power and energy storage technology, more energy efficient equipment, and enhanced power networks that enhance mission duration, decrease combat load, and enhance combat performance. ***FY 2020 Base Plans:*** Logistics development will focus on the broad range of technologies to demonstrate the military utility of enhancing combat capability by increasing energy production, storage, distribution, and curbing energy consumption of the individual Marine and other tactical assets. This includes advanced system research into the scaled use of high specific power solar cell for Marine Corps applications ranging from the individual warfighter to augmenting the power and combat endurance unmanned robotic vehicles. Additionally investigate, system level research and demonstration of enhanced power and energy technologies to support the Marine warfighter as a system, to include enhanced power and energy storage technology, more energy efficient equipment, and enhanced power networks that enhance mission duration, decrease combat load, and enhance combat performance. Research into friction stir welding and additive friction stir welding, and cold spray for structural repair of Marine Corps equipment will be completed. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The decrease from FY 2019 to FY 2020 is associated with completion of research into friction stir welding, additive friction stir welding, and cold spray for structural repair of Marine Corps equipment.					
Title: MANEUVER ***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.	13.896	13.270	14.526	0.000	14.526

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
The technologies included in this work address areas of mobility, materials, propulsion, signature reduction, modularity, and unmanned systems. ***FY 2019 Plans:*** FY 2019 Plans include development and evaluation of mobility technologies and future concepts for the ground and amphibious fleet to improve maneuverability across a range of challenging terrain environments. Work will emphasize experimentation with autonomy approaches through both simulation and live events for amphibious vehicles from small low cost craft, traditional amphibious combat and assault vehicles, and landing craft. Additional focus will be on integrating real time precepts with learned information, a priori knowledge, and contextual understanding to facilitate informed autonomous decision making. There will be demonstration and experimentation with systems that enable intelligent planning, reasoning, learning, and control to affect tactically appropriate autonomous behaviors in littoral and urban environments. In addition efforts will be pursued in component technology and prototypes for future advanced manned expeditionary ground vehicles and amphibians. ***FY 2020 Base Plans:*** FY 2020 Plans include research and evaluation of advanced technologies for full combat systems. Demonstrator platforms will be developed that integrate novel propulsion, mobility, and autonomous technologies to enable enhanced land operations and seamless transition between land and water environments. The automation and autonomy systems developed will concentrate on the surf-zone and beach operations and include work to include development of unmanned swarming amphibious assault craft. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The increase from FY 2019 to FY 2020 is associated with development of new maneuver technologies to enhance the mobility, agility, signature, and warfighting capabilities of advanced combat vehicles, including unmanned swarming amphibious assault craft.					
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	4.180	2.475	0.000	0.000	0.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total

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:
The Expeditionary Cyber portfolio focuses heavily on the development and integration of multiple underlying technologies into subsystems and system demonstrations supporting experimentation. The Expeditionary Cyber portfolio is also closely coordinated with the Command, Control, Communications and Computers research portfolio also described herein to efficiently exploit co-design opportunities and shorten development times needed to keep pace in an environment rapidly driven by Moore's Law. Battle damage assessment technologies are integrated into system sensor technologies to prove efficacy in an increased Technology Readiness Levels application in cyber experimentation. Cyber experimentation will be performed on an autonomous system operating in a test range. Novel resilient cyber components and architectures integrated into a multi-function cyber Electronic Warfare system will be demonstrated in a realistic Electro-Magnetic environment measuring performance.

FY 2020 Base Plans:
N/A

FY 2020 OCO Plans:
N/A

FY 2019 to FY 2020 Increase/Decrease Statement:
The plans and associated programs contained in this activity and Project 2958 are realigned from the Marine Corps ATD Project 2223 in PE 0603640M Marine Corps Advanced Technology Demonstrations beginning in FY 2020. The FY 2020 increase will initiate a concerted research effort to develop a rapid testing tool of major C2 and weapon systems addressed in NDAA 1647. Adversaries are finding vulnerabilities in our systems faster than our acquisition cycle can patch them. This effort is to provide acquisition sponsors and operational planners a method to identify and project vulnerabilities and impacts within computing systems and networks as well as an

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
operational assessment measure to determine how to proactively address these issues and maximize projection power.					
Accomplishments/Planned Programs Subtotals	94.567	100.979	95.327	0.000	95.327

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. 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 / 3					R-1 Program Element (Number/Name) PE 0603640M / *MC Advanced Technology Demo*				Project (Number/Name) 2297 / *Futures Directorate*			
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**
2297: *Futures Directorate*	0.000	58.354	46.830	73.046	-	73.046	65.781	67.116	68.427	69.796	Continuing	Continuing

A. Mission Description and Budget Item Justification

As a subordinate organization under the Deputy Commandant, Combat Development and Integration (DC, CD&I), the mission of the Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) is to identify future challenges and opportunities, develop warfighting concepts, and comprehensively explore options in order to inform the combat development process to meet the challenges of the future operating environment. DC, CD&I is designated as the United States Marine Corps (USMC) Advocate for Science and Technology (S&T). MCWL's Commanding General (CG) is the DC, CD&I designated Proponent of USMC S&T and serves as the USMC Executive Agent for Marine Corps S&T. The MCWL/FD also serves as the Marine Corps' liaison to the Joint Staff for Joint Concept Development and Experimentation; thereby facilitating service-specific experiments as well as participation in joint service experimentation.

The current MCWL/FD Campaign Plan addresses how the Naval Services must reshape their capabilities in order to meet the concepts and Concepts of Operations (CONOPS) called for in the Secretary of the Navy's "Cooperative Strategy 21" and the Marine Corps' capstone Marine Operating Concept (MOC), according to the objectives of the Commandant of the Marine Corps' guidance to develop the future Marine Corps Force 2025. Execution of the MCWL/FD Campaign Plan results in recommendations to Marine Corps advocates and proponents so that they may more cohesively and logically structure the future Navy and Marine Corps team. In support of the Marine Corps' role to provide an ever-ready quick strike force to protect US interests, MCWL/FD pursues concepts and new capabilities focused on the Marine Air-Ground Task Force (MAGTF). The MAGTF is the Marine Corps' doctrinal, task organized, force deployment package. It consists of four elements: the Command Element that provides overarching Command and Control of the entire force; the Ground Combat Element normally built around a core infantry unit with supporting armor, artillery, and other ground units; the Aviation Combat Element which provides aircraft, air defense, and other aviation functions; and the Logistics Combat Element which consists of Combat Service Support elements including medical, supply, and transportation. Marine Corps Force 2025 also seeks to maximize the employment of electronic, information, and cyber warfare, as well as manned/unmanned teaming, within each element of the MAGTF. MCWL/FD also examines future enhancements in training, organization, and equipment. MCWL/FD accomplishes its mission through five subordinate Divisions:

Futures Assessment Division's mission is to: research, examine, and describe plausible future security environments 15 to 30 years into the future. Knowledge of these future security environments will provide an estimate of possible future threats, challenges, and opportunities, to include: the rise of possible partners and adversaries, emerging disruptive technologies, and likely sources of conflict. This work is largely accomplished through research, seminar participation, and coordination with various experts in academia, the intelligence community, and think tanks.

The mission of Concepts and Plans Division is to: examine select future security environments, emerging warfighting opportunities and challenges, and Naval warfare and joint/coalition integration and capabilities, in order to develop Marine Corps Service concepts and CONOPS to promote development of the emergent Marine Corps force. CAP is responsible for the production of formally published concepts, CONOPS, and options for future force organization and posture that describe how the Marine Corps will operate and fight.

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Wargaming Division conducts formal wargames to frame emerging warfighting concepts, establish the Joint context for the Marine Corps Force Development System, and identify opportunities for development of experimental and non-experimental capabilities.

Experiment Division conducts live force concept-based experimentation to facilitate exploration of prototype and surrogate technologies, as well as Tactics, Techniques, and Procedures (TTPs), in order to better refine equipment requirements and to identify Doctrine, Organization, Training, Materiel, Leadership, Personnel, and Facilities (DOTMLPF) initiatives needed to produce future capabilities.

Science and Technology (S&T) Division conducts investigations and assessments to identify, modify where appropriate, and evaluate technological capabilities that support advanced warfighting concepts, and to explore the military utility of promising new commercial or government technologies in support of urgent and compelling needs. MCWL/FD investigates the relevance to MOC-prescribed capabilities and gaps of advanced technologies according to the following Thrust Areas: Command, Control, Communications, and Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR); Autonomy and Robotics; MAGTF Fires; Maneuver; Expeditionary Logistics (to include Expeditionary Energy); Expeditionary Medicine; Cyber and Electronic Warfare (EW); and Force Protection.

This project is organized into 6 activities, the core of which are represented by the Warfighting Capability Areas of the MAGTF. The project emphasizes development and demonstration of advanced technology capability concepts, and the examination of their operational application and military utility in the context of live-force field experimentation with Marines. This operational experimentation directly supports Marine Corps combat development to inform future capability requirements and optimize the acquisition process.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: COMBAT SERVICE SUPPORT (CSS) AND FORCE PROTECTION	18.206	8.142	9.447	0.000	9.447
Description: This activity includes Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) Combat Service Support and force protection experimentation efforts including assessment of equipment, new Tactics, Techniques, and Procedures, training programs, and proposed organizational changes associated with enhanced capabilities. This area provides seabasing, expeditionary logistics, urban combat, and expeditionary medicine experimentation support. Although this category covers a few small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity may be conducted under the Thrust Areas of Expeditionary Logistics, Expeditionary Medicine, Force Protection, or Autonomy and Robotics.					
FY 2019 Plans: Continue to develop prototypes and experiment with logistics enablers in support of dismounted operations and the Expeditionary Force-21 concept. This includes completing assessment and experimentation to understand the relevance of autonomy to ship to shore surface connectors to focus on development and experimentation with afloat and forward-deployed metal adaptive manufacturing. Continue to explore technologies and					

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
methodologies that reduce resource consumption and enhance sustainability of the distributed units. Pursue investigations and experimentation with independent, conditioned, reliable power sources to dismounted and/or distributed forces operating in austere conditions. Wrap-up assessments and experimentation in order to provide logistics common operational picture for commanders and logistics planners across the area of operations. Continue to develop and study technologies that enhance unit survivability; to include various aspects of critical care and medical related protocols and processes.					
FY 2020 Base Plans: Develop prototypes and experiment with logistics enablers and air defense enhancements in support of Expeditionary Advanced Base Operations (EABO) and Littoral Operations in a Contested Environment (LOCE) as prescribed by the Marine Operating Concept (MOC). This includes development and experimentation with autonomous sea-based surface connectors for over-the-horizon missions during ship-to-shore maneuvers. Experiment with efficient and redundant hybrid energy platforms providing reliable electrical power using multiple fuel input sources. Develop a highly mobile and efficient hybrid power generation and storage capability that provides the flexibility to operate with a variety of energy sources in support of EABO. Effort includes developing a modular design combining JP-8 fuel cell, solar, battery and energy scavenging technologies. Integrate hybrid/electric capabilities within the MAGTF to experiment with alternative vehicle power, extended mobility, and logistics demand reduction functions; building Concepts of Operations (CONOPS) and TTPs for tactical mobility utilizing electric/hybrid power as a fuel source. Improve ground maneuver force and critical installation defense against small unmanned aerial systems (UASs). Effort includes development of new counter UAS architectures, integration of new sensors for detection and tracking, and development of new counter-UAS defeat mechanisms. Develop, test, and evaluate autonomous/automated aerial platforms for logistics resupply. Develop and experiment with highly autonomous and synchronous logistics capabilities in support of expeditionary MAGTF operations, offering increased flexibility and speed to Marines by means of seamless, end to-end logistics chain management and execution. Effort includes air, sea, and ground based systems, providing tactical commanders with an organic, responsive, and flexible option(s) to support disbursed and semi-independent maneuver operations. Develop an autonomous explosive detection and defeat capability. Continue to develop and experiment with medical technologies that enhance survivability; includes power management and energy scavenging capabilities which will enable more effective casualty warming and blood storage/distribution. Integrate and experiment with systems to provide battlefield medical command and control and information management.					
FY 2020 OCO Plans:					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The funding increase from FY19 to FY20 is directly attributable to the development and enhancement of capabilities to provide a hybrid logistics design to a more distributed technologically advanced force and increase range and effectiveness of the Marine Corps Air-Ground Task Force (MAGTF) against airborne threats. Funding supports the Commandant of the Marine Corps' (CMC's) priorities of Logistics Transformation and Air Defense.					
Title: MARINE AIR-GROUND TASK FORCE (MAGTF) COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4) ***Description:*** This activity encompasses all Marine Corps Warfighting Laboratory/Futures Directorate (MCWL/FD) Command, Control, Communications, and Computers (C4) experimentation efforts including assessment of equipment, new Tactics, Techniques, and Procedures (TTPs), training programs, and proposed organizational changes associated with enhanced C4 capabilities. The area provides cutting edge/enhanced Over-The-Horizon (OTH), Beyond Line of Sight (BLOS), satellite and non-satellite based C4 capabilities to support experimentation. Although this category covers a few small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity will be conducted under the Thrust Areas of Command, Control, Communications, and Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and Cyber/Electronic Warfare (Cyber/EW). ***FY 2019 Plans:*** Continue to identify and assess a collaborative solution that provides tailorable Over-the-Horizon (OTH), On-the-Move (OTM) communications, situational awareness, and fires for the forward deployed Marine Air-Ground Task Force (MAGTF) to include Digital Integration (DI). Experiment with a BLOS, OTH, OTM voice, data, and position location information network in an Expeditionary Force 21 (EF-21) environment. Continue to research an organic and persistent capability to receive, process, and disseminate digital information wirelessly to dismounted users and dismounted operations (operations conducted on foot). Conclude development and assessment of systems that permit Unmanned Aerial System (UAS) operations in a Global Positioning System (GPS) denied environment. ***FY 2020 Base Plans:*** Conduct research to identify and assess a collaborative solution that provides tailorable Over-the-Horizon (OTH), On-the-Move (OTM), and Beyond Line of Sight (BLOS) communications, situational awareness, and	10.525	8.614	9.269	0.000	9.269

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
fires for units across a wide spectrum of air, ground, and sea operations. Experiment with an organic and persistent capability to wirelessly receive, process, and disseminate digital information from organic sensors (to dismounted users), with relevant and/or immediately actionable information. This is done while simultaneously enabling BLOS digital connectivity to both higher and adjacent units (supporting dismounted operations). Effort will enable BLOS digital connectivity to higher and adjacent units. Initiate efforts to automate the identification of targets and expedite the sharing of information between sensors, shooters, and approval authority. Integrate electronic warfare technologies (ground and airborne sensors) and cyber space warfare technologies into demonstrations and live-force experiments to inform requirements and develop Tactics, Techniques, and Procedures (TTPs) for use by operational forces. Experiment with a cyber mission execution framework enabling military commanders, planners, and operators to collaborate, understand, plan, and manage cyber operations in real-time against large-scale and dynamic network environments. Initiate cyber and communications infrastructure common operational picture tactics and procedures for situational awareness and coordination of battlefield effects. Experiment with worldwide social media mapping. This technology will enable real-time situational awareness of the information environment (IO), including content and location of social media users. Open IO technology will provide Marines at the tactical edge with alerts using civilian and adversary open source communications. Provide units at the tactical edge IO situational awareness, planning, and command and control tools to include measures of effectiveness. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The funding increase from FY19 to FY20 is directly attributable to the development and enhancement of capabilities to communicate, shoot, and move in a degraded environment; increasing situational awareness and influencing decision making. Funding supports the Commandant of the Marine Corps' (CMC's) priorities of Command and Control and Information Warfare.					
Title: FIRES, TARGETING, AND MANEUVER	6.114	6.029	7.174	0.000	7.174
Description: This activity includes Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) experimentation efforts in the areas of fires, targeting, and maneuver including assessment of equipment, new Tactics, Techniques, and Procedures (TTPs), training programs, and proposed organizational changes associated with enhanced capabilities. This area increases fires, targeting, and maneuver related troop environmental awareness, lethality, and mobility using fused sensors as well as unmanned weaponized and reconnaissance air and ground vehicle platforms to support experimentation. Although this category covers					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
a few small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity will be conducted under the Thrust Areas of Marine Air-Ground Task Force (MAGTF) Fires, Maneuver, and Autonomy and Robotics. ***FY 2019 Plans:*** Continue to develop technologies, demonstrate, and experiment with robotic systems organic to an infantry company for intelligence collection, indirect fires, direct fires and breaching capabilities. Complete assessment of the expeditionary utility of autonomous swarming technologies for unmanned air and ground systems. Pursue company level precision guided munitions. Initiate efforts to provide a missile system with a real-time wireless data link to provide lethal beyond line of sight fires (sea-land and land-land) against static and moving targets in the urban littoral environment. Automate robotic control systems/software to reduce the burden of control and increase manned and unmanned teaming. Initiate and complete investigations into battery configuration and ruggedization as well as associated battery-driven gearbox of an amphibious electric all-terrain vehicle. ***FY 2020 Base Plans:*** Continue to provide a multi-purposed Unmanned Ground Vehicle (UGV) which hosts a government-owned modular payload architecture and provides the ability to rapidly modify payloads for a variety of missions across the MAGTF. In concert, evaluate various payloads that enhance dismounted unit abilities across the warfighting functions. Continue to pursue company level precision guided munitions to increase responsiveness, survivability, and lethality to the ground combat element. Specifics include development of: a multi-tubed launcher integrated with a UGV and the ability to remotely launch Unmanned Aerial Systems (UASs) from distributed positions. Experiment with a multi-purpose, electro-optical missile system with a real-time wireless data link for ranges up to 25km; operated in either direct attack or mid-course navigation based on target coordinates. The system has the ability to carry a heat, fragmentation, or anti-armor payload and can be integrated with a variety of sea, air, and land platforms. Initiate pursuit into a recoverable, long-range reconnaissance and precision strike asset with lethal capability against armored targets. Facilitate the integration of a small UAS with the identification, engagement, assessment, and adjustment of indirect fires for an individual Marine operating with an indirect fire weapon. Increase lethality of ground forces through rapid design iteration and testing of small UASs (sUASs), including advanced sensors and warheads. Experimentation efforts will include integration of critical payloads for immediate use and will enable earlier force training. Assess potential solutions to identified marksmanship capability gaps. Ensure the availability of Utility Task Vehicles (UTVs) for integration, testing, assessment throughout the experimentation cycle. Pursue technologies to dramatically					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
increase the range and lethality of the MAGTF using a Low-Cost Unmanned Aerial Vehicle (UAV) with integrated swarming technology to create a Lethal Miniature Aerial Munition (LMAM). Experiment with loitering munitions launched from a variety of platforms (air, ground, and sea). Conduct swarming follow-on efforts to develop distributed, cognitive, collaborative, and cooperative swarming behaviors for maximum effect and complexity on target. Investigate Naval Surface Missile (NSM) simulators for experimentation of weapons system and integration with naval system queuing. NSM simulator systems will be used to exercise the NSM coastal defense system in coordination with Naval target sensing and tasking, allowing Naval vessels to queue and task NSM launch. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The funding increase from FY19 to FY20 is directly attributable to the development and enhancement of capabilities to increase range and precision of indirect fires and enhance maneuver at sea with sustained mobility ashore. Funding supports the Commandant of the Marine Corps' (CMC's) priorities of long range precision fires and protected mobility.					
Title: MARINE AIR-GROUND TASK FORCE (MAGTF) INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR) ***Description:*** This activity includes Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) Intelligence, Surveillance and Reconnaissance (ISR) related experimentation efforts including assessment of equipment, new tactics, techniques, and procedures (TTPs), training programs, and proposed organizational changes associated with enhanced ISR capabilities. Using a variety of fused sensors to mesh data, video, and images and incorporating a common tactical controller to operate multiple air and ground ISR platforms, this area enhances small unit situational awareness as well as exploitation and forward engagement ability via experimentation. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. Investments in this activity will be conducted under the Thrust Areas of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and Autonomy and Robotics. ***FY 2019 Plans:***	6.414	4.376	20.869	0.000	20.869

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Continue to increase situational awareness of battlespace in order to defend against and repel enemy attacks in those domains at the company and lower echelons. Assess systems to combine sensor and telemetry data from multiple unmanned platforms (ground, surface (water), and air) in order to provide a more relevant and usable tactical picture. Initiate efforts to provide a small, lightweight, semi-autonomous system that can self-navigate structure interiors while simultaneously visibly inspecting and creating real-time three-dimensional (3D) maps. ***FY 2020 Base Plans:*** Expand development of government-owned Unmanned Aerial Systems (UAS) architecture to allow for rapid design iterations in support of experimentation. Effort will continue to provide situational awareness of the battlespace, incorporating payloads that improve navigation and allow for multi-mode sensors. Experiment with enabling technologies to combine sensor and telemetry data from multiple unmanned platforms (ground, surface (water), and air); minimizing operator intervention over current systems, with the ability to react in a wide range of operational tasks, environmental conditions, and landscapes. Continue to develop a capability to display and control a myriad of unmanned platforms and sensor inputs in a fused network on a common controller for Intelligence, Surveillance and Reconnaissance (ISR) as well as target identification and prosecution. Initiate experimentation with an autonomous reconnaissance system, improving threat situational awareness and reducing tactical surprise to assault forces on long range missions. Initiate an effort to receive, transmit, and fuse joint asset specialized sensor information to communications nodes afloat and ashore via an aerial gateway. Expand investigations to add a Mission-Configurable Software Defined Radio with an Electronically Steerable Array (ESA) to the currently developed communication pod. Missions will include, but not be limited to, Early Warning radar, Cueing radar and/or Electro-magnetic Spectrum Operations. Effort will utilize Artificial Intelligence (AI) software to fuse sensor information in order to generate track information on-board the pod and then push it to both terrestrial communications nodes and directly to aircraft. Seek to provide a multi-role, long reach, expeditionary, next generation network of ISR capabilities. This includes the enhancement of capabilities for multi-sensor collection, fusion and real-time transmission; multi-electro-magnetic spectrum operations; C4 network bridge and relay; escort and protection for assault forces; persistent and precision fires and targeting; integration of an early warning air defense network; and informing assault support. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The FY19 to FY20 funding increase is directly attributable to the development and enhancement of capabilities to increase situational awareness and influence decision making. Funding supports the Commandant of the					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Marine Corps' (CMC's) priority of Command and Control. Notably, this increase includes $15M to pursue Phase II of efforts initiated to receive, transmit, and fuse joint asset specialized sensor information to communications nodes afloat and ashore via an aerial gateway.					
Title: MARINE CORPS WARFIGHTING LABORATORY / FUTURES DIRECTORATE (MCWL/FD) OPERATIONS (SUPPORT) ***Description:*** Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) Operations (Support) efforts include overall MCWL/FD experimentation doctrine, planning, analysis, data collection, as well as technology transition tracking efforts. This area provides overarching experimentation doctrine, planning, management, technical/engineering support, analysis, data collection, and reporting. Programs listed below are considered major (valued at $500K or more) or have near real-time operational impact. ***FY 2019 Plans:*** Continue to provide encompassing experimentation doctrine, planning, analysis, and data collection in order to conduct relevant enactments and report on experimentation results. Look to the future and identify up and coming (cutting edge) technology areas of interest. Provide generalized as well as specific program engineering, technical, and management support. ***FY 2020 Base Plans:*** MCWL/FD will elicit a broad range of unique analytical expertise to evaluate experiments in various warfighting areas. Design experimentation plans, collect data during experiments, perform reconstruction and analysis of experiments, and prepare experiment analysis reports. Identify global commercial technology trends/innovations and disruptive technologies which may impact future Marine Corps capabilities. Expand upon generalized as well as specific program level engineering, technical, and management support. In addition, technical program area management capability increased. Initiate investigations into development of a narrow Artificial Intelligence (AI) capability which is capable of automating data collection to assist in tracking and decision making regarding technology based programs of interest. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:***	11.029	12.420	13.087	0.000	13.087

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
The increase from FY19 to FY20 is due to initiating an automated data collection effort to assist in tracking technology-based programs of interest in support of portfolio decision-making.					
Title: WARFIGHTING EXCELLENCE	6.066	7.249	13.200	0.000	13.200
Description: This activity includes Marine Corps Warfighting Laboratory / Futures Directorate (MCWL/FD) efforts in the development and assessment of joint and service warfighting concepts, joint and service missions, analysis of emerging threats and opportunities, and joint capability experimentation. It also includes MCWL/FD service experimentation in areas that impact multiple warfighting functions. Although this category covers several small (less than $500K per FY) efforts being pursued by MCWL/FD, most programs listed below are considered major (valued at $500K or more) or have near-real-time operational impact. ***FY 2019 Plans:*** Continue to support the combat development process by helping to develop and refine emerging concepts, conceptualize force design, and identify future capabilities and deficiencies within future operating environments. This is accomplished by means of enhancing current functional capabilities by investigations into Next Generation Wargaming tools as well as conducting extensive wargaming as an augmentation to live force experimentation. Efforts include 11 planned wargames (4 large, 5 medium, and 2 small) with areas of interest covering Expeditionary Force-21 (EF21) related concepts. Focusing 15 to 30 years in the future, continue to offer top level identification and analysis of emerging asymmetric threats and opportunities. This is accomplished by capitalizing on a myriad of foresight assessments of future operating environments. Continue to develop, assess, and provide insight into joint efforts and warfighting concepts. Specific areas of investment include: 1) Demonstrating the military utility of a resilient, low-cost, effective, high-altitude balloon-borne communications platform that can be rapidly deployed to enhance warfighter communication capabilities and 2) Informing the development of distributed mobile amphibious (and ground) assault fuel logistics capabilities as well as demonstrating the feasibility of executing the concept in support of a "fight tonight" scenario using current fleet assets, by adapting current naval practices. Initiate investigations into candidate technologies that support urban operations, in an effort to identify/eliminate capability gaps and develop TTPs to include subterranean maneuver. This is an attempt to: 1) Develop a 5th generation force capable of ship to shore movement against a peer adversary, enabling distributed maneuver at varied distances and 2) Develop a 6th generation force capable of dominating the urban environment. The concepts: 1) Explore innovative delivery systems to augment current ability to maneuver troops, effects, and materiel from ship to shore in contested environments and 2)					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 2297 / *Futures Directorate*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Involve integration by engineers and scientists with planners and operators to identify key capability concept areas for development.					
FY 2020 Base Plans: Aid the combat development process by conducting 11 core wargames. Focus areas include Marine Operating Concept (MOC) supported Expeditionary Advanced Base Operations (EABO) and Littoral Operations in a Contested Environment (LOCE). Create an effective collaborative wargaming environment that will increase the use of automated and analytical tools, and will provide the necessary quantitative and qualitative output for Marine Corps capability/concept development. Coordinate with the Marine Corps Systems Command's (MCSC's) Wargaming Center of Excellence to provide an encompassing wargaming ability throughout the Marine Corps. Focusing 15 to 30 years in the future, continue to offer top level identification and analysis of emerging asymmetric threats and opportunities. This is accomplished by capitalizing on a myriad of foresight assessments of future operating environments. Maintain insight and continue making contributions to support approved Joint Concept Technology Demonstrations (JCTDs) and Emerging Capability Technology Demonstrations (ECTDs) efforts and warfighting concepts; intended to provide rapidly fieldable capabilities by using emergent mature technologies matched with innovative operational concepts. This includes furthering demonstrations with a high-altitude balloon-borne communications platform and continuing development efforts of distributed mobile amphibious (and ground) assault fuel logistics capabilities. The communications platform effort involves demonstrating and experimenting with the military utility of a resilient, low cost, effective, high-altitude balloon-borne communications platform that can be rapidly deployed to enhance warfighter communications capabilities. The fuel logistics efforts include demonstration and experimentation to build the concept of employment as well as tactics, techniques, and procedures (TTPs) for inflatable, scalable, double-walled fuel storage, transport, and transfer systems for bulk fuel logistics. Continue in the conduct of a multi-year effort to enhance situational awareness; Command and Control (C2); and fires and maneuver in the dense urban environment. Conduct experimentation events to identify changes in training, organizing, and equipping future forces and provide venues for live-force evaluation and assessment. Bring concept developers, operational Subject Matter Experts (SMEs), and technologists together in order to discover, purchase, and assess new and advanced technologies that can aid in the implementation and refinement of the Expeditionary Advanced Base (EAB) concept. Additionally, by exposing technology and acquisition professionals to the concept, future development can be guided. Explore the use of modeling and simulation tools and techniques to gather, process, analysis, and utilize operational data in support of experiment development, execution, and assessment. Capitalizing on an OSD 2 year investment, provide organic, experimental opposition force capability (Red Team, Red Cell and Live Adversary Force). This will assist in providing a more realistic,					

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 2297 / *Futures Directorate*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
adaptive, and cohesive enemy force/civil infrastructure for wargames, command post exercises, simulations, and experimentation events in order to support free-play, friendly force adaptation and decision-making skills. ***FY 2020 OCO Plans:*** N/A ***FY 2019 to FY 2020 Increase/Decrease Statement:*** The FY19 to FY20 increase is due to expanded investments into: coordinated efforts to enhance wargaming capabilities, participation in joint rapidly fieldable efforts, and testing/experimentation with new technologies identified to enhance the Expeditionary Advanced Base Operation (EAB) concept. In addition, the increase in funding is due to the initiation of providing an organic, experimental opposition force capability to augment live-force experimentation.					
Accomplishments/Planned Programs Subtotals	58.354	46.830	73.046	0.000	73.046

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 Maneuver 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 / 3	R-1 Program Element (Number/Name) PE 0603640M / *MC Advanced Technology Demo*	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	4.474	-	4.474	4.476	4.477	4.566	4.657	Continuing	Continuing

Note

The plans and associated programs contained in this Project are realigned from the Expeditionary CYBER Project 2223 in PE 0603640M MC ADVANCED TECHNOLOGY DEMO 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	4.474	0.000	4.474
FY 2019 Plans: N/A					
FY 2020 Base Plans: Cyber related demonstrations and experimentations will be conducted to verify the secure transfer of information across mobile tactical user platforms. Controlled demonstrations will be conducted to assess battle damage on a class of systems from the use of cyber effects. Demonstrations of cyber hardened operational systems will be conducted to showcase improved resiliency. Software redesign of modular Cyber/Electronic Warfare systems will be demonstrated as a proof of concept prototype. Initiate research to develop a rapid testing tool of major C2 and weapon systems to provide acquisition sponsors and operational planners a method to identify and project vulnerabilities and impacts within computing systems and networks as well as an operational assessment measures to determine how to proactively address these issues and maximize projection power.					
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 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**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
The FY20 increase will initiate a concerted research effort to develop a rapid testing tool of major C2 and weapon systems addressed in NDAA 1647. Adversaries are finding vulnerabilities in our systems faster than our acquisition cycle can patch them. This effort is to provide acquisition sponsors and operational planners a method to identify and project vulnerabilities and impacts within computing systems and networks as well as an operational assessment measures to determine how to proactively address these issues and maximize projection power. The plans and associated programs contained in this activity and Project 2958 are realigned from the Marine Corps ATD Project 2223 in PE 0603640M Marine Corps Advanced Technology Demonstrations beginning in FY 2020.					
Accomplishments/Planned Programs Subtotals	0.000	0.000	4.474	0.000	4.474

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 / 3	R-1 Program Element (Number/Name) PE 0603640M / *MC Advanced Technology Demo*	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	12.071	27.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.071

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	12.071	0.000
FY 2018 Accomplishments: Research conducted under this Project includes advanced technology programs sponsored and managed from both the Office of Naval Research (ONR) and the Marine Corps Warfighting Laboratory/Futures Directorate (MCWL/FD). ONR is funding the development and demonstration of a variant of the 81mm Advanced Capability Extended Range Mortar (ACERM) with improved size, weight, power and cost (SWAP-C) through the insertion of an optimized actuator. The ACERM technology enhances the mission effectiveness of USMC infantry forces through a significant increase in maximum range, while providing a first round on target capability against both stationary and moving targets while minimizing the relative increase in unit cost. In addition, the development of a Cannon Delivered Area Effects Munition (CDAEM) payload will be developed for the 155mm Moving Target Artillery Round (MTAR). The capability will greatly enhance the USMC's ability to effectively engage area targets to destroy, neutralize, and/or suppress threat platforms and facilities, and deny threat forces full operational freedom within the targeted area when there is a lack of precise target location, as is often the case with moving forces, counter fire missions, or when threat forces employ battlefield obscurants. MCWL/FD is sponsoring experiments to determine the military utility of small tactical autonomous unmanned ground vehicle systems to support logistics, fires and maneuver. Funds support the development and demonstration of tactical ground robotic vehicle systems as well as autonomy and perception algorithms utilizing a common ground control system. The capability will greatly enhance the tactical effectiveness, survivability, and lethality of tactical infantry formations in close combat operating environments. ***FY 2019 Plans:*** N/A		
Congressional Add: Common Unmanned Aerial Vehicle Simulation System	0.000	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2020 Navy		Date: March 2019
Appropriation/Budget Activity 1319 / 3	**R-1 Program Element (Number/Name)** PE 0603640M / *MC Advanced Technology Demo*	**Project (Number/Name)** 9999 / *Congressional Adds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019
FY 2018 Accomplishments: N/A ***FY 2019 Plans:*** Develop technology for mission simulation to help reduce the development cycle time of UAVs.		
Congressional Add: Flight Motion Simulator and Testing of UAVs ***FY 2018 Accomplishments:*** N/A ***FY 2019 Plans:*** Conduct research using computer simulation sensor modeling and actuator modeling in real-time with UAV hardware and software.	0.000	6.000
Congressional Add: Modular Advanced Armed Robotic System 2.0 ***FY 2018 Accomplishments:*** N/A ***FY 2019 Plans:*** MCWL/FD continues to explore the military utility of small tactical autonomous unmanned ground vehicle systems to support logistics, fires and maneuver. FY19 funds include investment to develop fully autonomous operation, utilizing a common controller and Command and Control (C2) data links.	0.000	4.000
Congressional Add: UAS Air-Delivered Extended Range Munitions Demo ***FY 2018 Accomplishments:*** N/A ***FY 2019 Plans:*** Conduct research for technology maturation and testing of a full cartridge level solution prototype extended range guided projectile for an airborne platform. This proposed effort will develop and integrate enabling technologies with 81mm and 120mm extended mortar cartridges for launch from an airborne platform rather than ground launch from a mortar tube.	0.000	7.000
Congressional Adds Subtotals	12.071	27.000

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.