Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Office of the Secretary Of Defense	Date: February 2016
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 3: *Advanced Technology Development (ATD)*	**R-1 Program Element (Number/Name)** PE 0603662D8Z / *Networked Communications Capability*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	0.000	5.967	9.331	-	9.331	12.718	7.822	2.934	2.992	Continuing	Continuing
P663: *Network Communications Analysis*	-	0.000	5.967	9.331	-	9.331	12.718	7.822	2.934	2.992	Continuing	Continuing

Note

The Department made the decision to sunset the initial thrust of this program in fiscal year (FY) 2014. The program element (PE) has been refocused in FY 2016.

A. Mission Description and Budget Item Justification

Currently fielded satellite communications (SATCOM), terrestrial, and Tactical Data Links (TDLs) will be adversely affected during operations in contested Anti-Access/ Area-Denial (A2/AD) environments. The primary threat is from sophisticated electronic warfare capable of advanced jamming and signal collection techniques that are rapidly evolving to be more capable and agile. Department of Defense (DoD) advances in smart sensors and smart weapons have created a strong need for robust and resilient networks that are composed of tactical data links of today. In FY 2016, the Network Communications Capability Program (NCCP) will return with a new focus that seeks to enable the development and deployment of Joint assured communications networks. The goals of this program are: to mitigate degradation across battlespace tiers (strategic, operational, and tactical) and domains (nuclear, intelligence surveillance and reconnaissance [ISR], command and control [C2], etc.) and to provide agility that will support the mission needs of Joint Functional Component Commanders (JFCCs), Joint Force Commanders (JFCs), and deployed forces.

The DoD's current TDLs platforms and capabilities (with large investments) are not sufficiently protected from emerging adversary threats and contain insufficient capacity for current and future needs. In order to enable the promise of net-centric operations for the warfighter, the next generation airborne tactical network must provide higher network capacity, greater robustness to electronic attack, better network connectivity, and faster response times to the changing demands from airborne, maritime, and ground users. Many line-of-sight (LOS), beyond LOS, and SATCOM waveforms have been integrated onto airborne platforms for various missions. In addition, there have been a number of design, development, and demonstration efforts to provide improved or specialized performance for air operations. These waveforms necessarily exhibit tradeoffs in target performance attributes including capacity, latency, protection, and complexity. As such, no single waveform capability will be able to satisfy all emerging mission needs. The challenge is to understand the essential needs of the users, avoid needless redundancy, evolve each capability as needed, and integrate separate capabilities into a cohesive network. This transformative research will develop new technologies and exploit existing methodologies to ensure performance in contested A2/AD environments by focusing on future communications networks that are a "leap ahead" of today's capabilities.

Beginning in FY 2016, the NCCP's Robust Tactical Data Links Modernization (RTDLM) project will specifically develop next generation communications layer architecture for airborne networks for operations in anti-access and area denial (A2/AD) threat environments and also seamlessly work with future smart sensors and smart weapons. The network architectures will be flexible enough to allow for the network to support Commander's Intent in any mission, environment, operating tactical platform, and weapon under any threat condition. RTDLM's efforts will specifically focus on developing the advanced component technologies, such as Anti-Jam(AJ)/ Low Probability of Interference (LPI)/Low Probability of Detection (LPD)/ Low Probability of Exploitation (LPE) waveforms, adaptive processing algorithms, adaptive antenna technologies (transmit/receive/nulling), variable power control, Dynamic Spectrum Access (DSA)/Dynamic Spectrum Management (DSM) techniques, self-healing mechanisms, and advanced routing with Quality of Service (QoS) approaches. The guiding tenets for creating this new airborne (C4I) capability encompass

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enabling new missions, i.e. providing robust and resilient TDLs, communications and networking "service level" capabilities, interoperation, cost (affordable), and improved performance in terms of military value.

B. Program Change Summary ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	0.000	6.980	9.931	-	9.931
Current President's Budget	0.000	5.967	9.331	-	9.331
Total Adjustments	0.000	-1.013	-0.600	-	-0.600
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-1.000			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Realignment for Higher Priority Programs	-	-	-0.528	-	-0.528
• FFRDC Reduction	-	-0.013	-	-	-
• Economic Assumptions	-	-	-0.072	-	-0.072

Change Summary Explanation

FY 2017 internal realignment reflects funding for higher Departmental priorities and requirements.

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Appropriation/Budget Activity 0400 / 3	R-1 Program Element (Number/Name) PE 0603662D8Z / *Networked Communications Capability*	Project (Number/Name) P663 / *Network Communications Analysis*	

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
P663: *Network Communications Analysis*	-	0.000	5.967	9.331	-	9.331	12.718	7.822	2.934	2.992	Continuing	Continuing

Note

The Department made the decision to sunset the initial thrust of this program in fiscal year (FY) 2014. The program element (PE) has been refocused in FY 2016.

A. Mission Description and Budget Item Justification

Currently fielded SATCOM, terrestrial, and TDLs will be adversely affected during operations in contested A2/AD environments. In FY 2016, the NCCP will return with a new focus that seeks to enable the development and deployment of joint robust/resilient and assured communications networks. Initial plans were based only on providing anti-jam enhancements for current TDLs, but with newer requirements for enhancements to LPI/LPD/LPE and the integration of smart sensors/smart weapons, the plans evolved. Initial efforts in FY 2016 are focused on developing the required network architectures. The specific advanced component technologies required for implementation will be prioritized and will form the foundations of the planned prototype designs, experimentation, and demonstration.

Robust Tactical Data Links Modernization (RTDLM) – In a contested environment, especially when conducting forward operations, platforms face a significant electronic warfare threat. The primary threat is from sophisticated electronic warfare capable of advanced jamming and signal collection techniques that are rapidly evolving to be more capable and agile. DoD advances in smart sensors and weapons are creating a need for robust tactical waveforms and networks that are beyond the individual communications links of today. Improvements in tactical communication systems for Joint airborne networking are required to mitigate advances in threat electronic warfare systems and enable the smart sensors and weapons of the future.

The RTDLM project will develop the required network architectures that are critical to the warfighter to operate a robust tactical network that seamlessly acts as a SoS with future smart sensors and smart weapons. The required network architectures will be flexible enough to allow for the network to support Commander's Intent in any mission, environment, operating tactical platform, and weapon under any threat condition. Based on the developed thresholds and objectives for the required network architectures, the specific advanced component technologies required will be prioritized and form the foundations of the planned prototype designs, experimentation, and demonstration. The RTDLM project will develop the advanced component technologies to address these needs by designing and building prototype systems to verify the technology in operationally relevant environments against representative threats, and manage the migration and transition of these technologies to service platforms, radios, and other combat mission systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Robust Tactical Data Links Modernization (RTDLM)	-	5.967	9.331
Description: NCCP will address the required network architectures that are critical to the warfighter to operate a robust tactical data link/waveforms and resilient network that seamlessly acts as a SoS with future smart sensors and smart weapons. The RTDLM project will research, develop and employ the capabilities based framework, advanced component network technologies, SoS integration technologies, experimentation, and analytical efforts to support advances in DoD TDLs to effectively create a			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
robust tactical network to operate in contested A2/AD environments. Spectrum awareness, agile spectrum access/management, and adaptive networking significantly mitigate the effectiveness of interference or collection/identification by the adversary and retain reliable connectivity and C2. This project will investigate and develop the required advanced component technologies and integration efforts that yield the flexibility in the tactical network, supporting capability changes as a mission progresses from phase to phase. The Commander's Intent will evolve according to dynamic changes in the utilization/access of the spectrum, and the choices of: waveforms, power, adaptive directional networking, and cross-banding, along with the associated latencies, capacities, and the Quality of Service (QoS) required to enable critical mission applications. It will develop and mature technologies to support direct transition of the algorithms, prototype implementations, waveform improvements, and system design improvements to radio, waveform, and weapon systems programs managed by each military department via fully instrumented field demonstrations and assessments. Overall Goal: Increase communication and network performance (i.e. "Buy-Back" degraded capabilities and enable agile/resilient SoS tactical network operations), while improving robustness and availability of these communication waveforms and networks to adversary electronic warfare attack or collections. ***FY 2016 Plans:*** - Develop and prototype innovative/transformative Tactical Data Link/Waveform (Anti-Jam/LPI/LPD) technologies such as, but not limited to, " Adaptive Coding, Advanced Receiver Processing algorithms, Adaptive Nulling antenna algorithms and control subsystems and adaptive data forwarding and routing overlay" for integration into TDL radio systems for improved operations in contested A2/AD environments. The goal is to achieve enhanced capacity, connectivity and spatial/time adaptive algorithms. - Develop the next generation communications layer architecture for airborne networks for operations in anti-access and area denial (A2/AD) threat environments in a capabilities based framework. This effort will support the planning, development, design, and assessments of the advanced component technologies that will be further ranked and prioritized for development of the planned prototypes, experimentation, and demonstration. - Develop/conduct the specific technology (simulation/emulation based) assessments and recommendations for prioritized investments in the various elements of the required network architecture(s) and the technology roadmap. These assessments will guide the development of both laboratory and field/operational demonstrations. ***FY 2017 Plans:*** Continue research, design, and development of advanced adaptive antenna, control subsystems, and waveform and receiver algorithms (these products will be used for full hardware/software prototype implementations). Begin development of robust tactical data links/waveforms and network components for initial laboratory component level evaluations in FY 2017. - Advanced waveforms for enhanced AJ and LPI/LPD/LPE capabilities - Adaptive Coding/Enhanced Capacity Prototype			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
- Adaptive Coding/Enhanced Connectivity Prototype - Advanced Feature Suppression/Variable Power Control Prototype - Adaptive Receiver Based mitigation algorithms - Single Jammer Prototype - Adaptive Directional Antennas - Transmit/Receive Prototype - Dynamic Switching Control Prototype - Adaptive Nulling Antennas - Enhanced Spatial/Time Filtering Prototype(s) - Dynamic spectrum access (Variable cognitive channels with supporting sensing) - Multichannel Prototype - Cross-banding - Adaptive Multi-band Translation Prototype - Adaptive Networking - Knowledge Based Intelligent Situational Awareness Prototype - Advanced Routing/QoS Prototype - Develop updated technology assessments of the proposed network architecture in end to end mission based scenarios.			
Accomplishments/Planned Programs Subtotals	-	5.967	9.331

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

The RTDLM project will address capability gaps for Joint TDL networks by developing the technologies that the Military Departments can incorporate in future platform and radio acquisitions. The proposed experimentation, with field demonstrations and modeling, will increase the Technology Readiness Level (TRL) of critical technology components, suitable for transition to acquisition programs. This will also help provide DoD leadership with the supporting technical and cost details to identify candidate "building blocks" for timely incremental improvements.

E. Performance Metrics

The Research, Development, Test, and Evaluation (RDT&E) goal for RTDLM is capability improvements that achieve 70 percent “Buy-Back” of the tactical data link range ratio and 80 percent of the area of operation lost in the A2/AD environment.

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Actual Performance Improvements: Prototype and transition designs, software, and hardware; usage of federated test beds; and demonstration of radio prototypes and modeling tools. The goal is to achieve the following metrics:

- Enhanced Capacity: 5X-10X Faster
- Enhanced Connectivity: 4X-10X Range
- Enhanced Spatial/Time Filtering: 4-7 Adaptive Nulls (Scenario Dependent)
- Receiver Based Mitigation: 20-30dB per Jammer Type (Scenario Dependent)
- Enhanced LPI/LPD: 4X-10X Closer Range to Target with Same Percent LPI/LPD

Achieve significant DoD savings for radio modifications or integration into new terminals (economies of scale), as services share non-recurring development costs for common and successful TDL enhancements.