MEMORANDUM OF AGREEMENT

between

THE U.S. ARMY YUMA PROVING GROUND

and

THE U.S. NAVY NAVAL POSTGRADUATE SCHOOL

SUBJECT: Agreement for a Cooperative Working Relationship between the U. S. Army Yuma Proving Ground (YPG) and the Naval Postgraduate School (NPS). All parties to this Memorandum of Agreement (MoA) agree to identify and develop open technology areas and novel approaches/systems with maximum potential of providing critical improvements and new capabilities to the Aerodynamic Decelerator Systems (ADS) technology area. This MoA also formally re-establishes the Aerodynamic Decelerator Systems Center (ADSC) to foster the advancement of ADS research and technology advancement among government agencies, academia and non-profit public institutions. The ADSC will be governed by this MoA and a subsequent agreed upon charter to be developed jointly by the participants.

1. **PURPOSE**: This document establishes the framework of an agreement between YPG and NPS to work together on Aerodynamic Decelerator System research, technologies, and programs. This MoA also re-establishes the Aerodynamic Decelerator Systems Center (ADSC) of which each party is a founding member.

This document outlines the work to be performed under this MoA. Projects covered under this MoA will include but not be limited to the following:

- to re-establish the ADSC with a two-member Board of Directors (BoD), chaired by YPG with one member from NPS (BoD members are listed under "Points of Contact" section below);

- to conduct research and development in agreed upon ADS technology areas;

- to maintain and continuously upgrade the rapid prototyping methods and capabilities to support all types of ADS initiatives;

- to continue supporting the Affordable Guided Airdrop System (AGAS) precision airdrop capability; a circular-parachute guided cargo system;

- the pursue the development of a Payload Derived Position Acquisition System (PDPAS), an instrumentation set and software algorithms, to be installed onto ADS, to estimate ADS parameters in real-time for testing and operational use without continuous use of the Differential Global Positioning System;

- to continue developing and upgrading a Guidance, Navigation, and Control (GN&C) suite (software and hardware) for high-glide and powered payload delivery systems deployed singly and in formations;

- to support the development of a family of various weight precision guided airdrop systems, which

enable conventional military aircraft to drop sensors, munitions, and/or supplies at high-offsets onto the battlefield with near pinpoint accuracy, minimizing risk to the airdrop aircraft and limiting the need for ground vehicle convoys;

- to instrument current and future YPG UAS with a modern autopilot capable of way-point and feature-based navigation, single and multiple ADS deployment;

- to pursue the development and implementation of an autonomous payload tracking capability for determining time, space, position information (TSPI) for all types of airdrop loads and UAS;

- to pursue the development of software for autonomous scene recognition and objects tracking based on combined stream of EO/IR data.

This MoA will also formally engage all members to actively promote additional government, academic and non-profit industry partnering in critical and emerging ADS technology areas while searching for external resources and customers to support and expand ADSC initiatives. The ADSC will also seek partners to the ADSC that will be accepted by and directed by the BoD. Implementation of this MoA does not guarantee any specific funding levels for any organization. External funding breakouts will be agreed upon by the BoD. Funding of ADSC initiatives can be from any partner to this MoA to any other partner within this MoA. Nothing herein shall be construed as obligating either party to act in violation of any applicable Federal, state, or local statute, rule, or regulation including, but not limited to, the Anti-Deficiency Act.

2. **BACKGROUND**: Originally, ADSC was established in 2001 by three parties: Natick Soldier Research Development and Engineering Center (NSRDEC), YPG and NPS, with NSRDEC being recognized as the leading experts in the area of personnel and cargo airdrop systems and applications, and having the DoD mission for precision airdrop systems research and technology development. All parties to the original trilateral MoA have collaborated on a number of ADS projects including the Affordable Guided Airdrop System (AGAS), Personnel Airdrop Instrumentation Package, Autonomous High Glide Delivery System, and Automated TSPI Retrieval System. This MoA revitalizes this relationship between YPG and NPS, expands the projects undertaken by all parties through the re-establishment of the ADSC and seeks to bring in both additional resources and partners to the ADSC as agreed to by the original partners. NSRDEC remains an interested party in the goals and objectives of this agreement and will participate as a cooperative observer. The two partners of the present MoA have the following areas of expertise:

a. YPG is the primary U.S. Army developmental test agency for airdrop and UAS systems. YPG teams with NSRDEC with on the vast majority of Science and Technology (S&T) projects and developmental airdrop tests. YPG has extensive experience in testing airdrop systems to include airdrop rigging, airdrop instrumentation, video coverage, load tracking, and data collection systems. In addition, YPG maintains a comprehensive systems analysis capability. Resources of the Proving Ground have been successfully applied to the development of systems and systems improvements including the development of GN&C systems. In cooperation with NPS, YPG supports the rapid prototyping of GN&C systems and the development of GN&C computer software and hardware;

b. NPS has extensive expertise in advanced mission planning, high-fidelity modeling, system identification, GN&C algorithm development and testing via rapid prototyping of capabilities. NPS was actively involved in the AGAS GN&C system development, hardware-in-the-loop and real system testing. NPS also participated in the early stages of system identification, modeling and GN&C algorithms development for the Pegasus high-glide delivery system. In addition, linear and non-linear parameter identification tools have been developed and thoroughly investigated. Recently NPS has developed and

tested the prototype of an autonomous system for YPG allowing rapidly and accurately acquire TSPI. NPS has extensive instrumentation experience and was involved in the development of a personnel airdrop instrumentation package with YPG. NPS also has expertise in UAS autopilots and sensor systems.

3. **AUTHORITY**: Authority to enter into this agreement is pursuant to authority contained in DoD Instruction 4000.19, "Interservice and Intragovernmental Support", August 9, 1985.

4. **JOINT OBJECTIVES**: It is agreed that YPG and NPS will work together to define and execute specific research and/or development projects within the ADSC (which is re-established under this MoA) of mutual interest through a collaborative partnership. This cooperative venture will be coordinated through the Board of Directors and will focus on technologies, concepts and products related to NSRDEC's airdrop missions, YPG's airdrop test missions and NPS's academic programs. Specific focus areas will be advanced mission planning, high-fidelity modeling, GN&C (software and hardware with an emphasis on affordability, simplicity, accuracy and commonality between systems), airdrop instrumentation suites (software and hardware with an emphasis on affordability, reliability, reusability, commonality of suite for all types of airdrop loads, etc.), high-efficiency system for autonomous tracking of aviation and air delivery test articles, system identification, and exploration of advanced ADS technologies agreed on by all parties to this MoA.

5. **RESPONSIBILITIES IN ACHIEVING THE OBJECTIVES**: The parties to this MoA intend to support the joint objectives through the following efforts:

- All parties will maintain an active participant on the ADSC Board of Directors (BoD). Meetings of the BoD will be held as needed (with at least one formal face to face meeting per year at rotating locations) to prioritize projects, update all members ADSC activities, and coordinate all ADSC efforts;

- BoD meetings will be open to all members of YPG and NPS, but the BoD may have closed door sessions to prioritize and assign projects to members of each organization;

- All parties agree to maintain continuous dialog and work towards accurate forecast scheduling and the meeting of all BoD agreed upon milestones;

- All parties agree to partner with other government agencies, academic partners and non-profit industry partners whom are made partners to the ADSC. The BoD will have the authority to include or not include any proposed new partner. All potential accepted new partners will be subject to potential restricted access to the full spectrum of ADSC activities;

- All parties will allow access to the use of each other's facilities and equipment (when agreed to by the BoD), outlined and agreed upon on a case-by-case basis at each organizations primary location and or other locations;

- YPG and NPS will support academic enhancement and advanced ADS training programs, such as workshops, seminars, special courses and special projects, as needed;

- "Quick return on investment" technical projects will be selected to enhance the overall theoretical academic experience while also contributing to the objectives of related airdrop missions;

- NPS will offer ADSC projects to qualified students on a project-by-project basis with special agreed upon considerations given to security of ADSC products and agreed upon dissemination of ADSC products;

- YPG will be the primary test agency for all airdrop related projects under this MoA; it will be

involved in all research activities under this MoA, and will maintain a secure database of ADSC activities, documents, and products developed under this MoA;

- NSRDEC may participate in some research activities conducted under this MoA as an observer, helping to prioritize these activities (with ADSC BoD approval) and ensure that all participants are informed on known relevant research and development programs not falling under the ADSC.

All participants to this MoA will assure that materiel (software/hardware/system performance data, etc.) will be protected and not provided to any third party without the written permission of all parties. All participants will also share information, software and resources to ensure that ADSC products are developed rapidly, cost effectively and will minimize duplication of effort.

6. **PRODUCTS**: Products of the ADSC will include but not be limited to the following:

- New ADS algorithms and advanced concepts;
- Developed, tested, and validated models, GN&C algorithms for ADS prototypes;
- Developed, tested, and validated architectures and algorithms for onboard and ground instrumentation suites (software and hardware);
- Documented GN&C source code (applicable to a wide range of precision ADSs);
- A developed and integrated process for the design and implementation of a complete ADS GN&C package;
- Documented flight and hardware-in-the-loop test results;
- Potential Invention Disclosures (Patents);
- Technical papers, reports, journal, conference and theses publications;
- White papers and state-of-the-art papers/articles;
- Organization and hosting of conferences, workshops, seminars and potentially short courses on relevant ADS technologies with proceedings;
- Additional formalized partnerships within the ADSC (potential partners are: University of Connecticut, Saint Louis University, Draper Laboratory, University of Alabama in Huntsville, Georgia Institute of Technology, California State University Northridge, University of Massachusetts at Lowell or other designated organizations, and others as agreed to by the BoD).

7. **POINTS OF CONTACT**:

YPG

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NPS

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8. **EFFECTIVE DATE/REVIEW/TERMINATION**: This agreement is effective upon signature of the YPG and NPS. Upon signing the current agreement, the previous version (signed 14 Aug 01), becomes invalid. This agreement will be in effect for three (3) years. Changes may be suggested by either party, but must be agreed upon in writing. This agreement may be terminated by mutual agreement of YPG and NPS, or by any one party providing 60 days advanced written notice to the other party.

Johnny R. Bullington

COL JOHNNY R. BULLINGTON
Commander, U.S. Army Yuma Proving Ground

Date: 17 Feb 2009

DTOliver

DANIEL T. OLIVER
President, Naval Postgraduate School

Date: 3/16/09