

DOD NEW JPADS PROGRAMS & NATO ACTIVITIES

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The US Army Research Development and Engineering Command, Natick Soldier Research Development & Engineering Center (NSRDEC) is teamed with all Department of Defense (DoD) services and organizations with interest, programs and investments in Joint Precision Airdrop System (JPADS) technology and systems. These organizations include: Deputy Under Secretary of Defense (DUSD) Advanced Systems and Concepts (AS&C), US Joint Forces Command (USJFCOM), US Air Force Air Mobility Command (USAF AMC), the US Army Product Manager Force Sustainment Systems (PM-FSS), US Army Product Manager Clothing & Individual Equipment (PM-CIE), US Transportation Command (TRANSCOM), US Special Operations Command (USSOCOM), United States Marine Corps (USMC), and many other DoD, government agencies, and contractors to plan and execute JPADS programs. This paper will provide an overview of the JPADS programs, Rapid Fielding Initiatives (RFIs), new programs to include a focus on a 2009 new start DUSD AS&C Joint Capability Technology Demonstration (JCTD) known as Joint Medical Distance Support & Evacuation (JMDSE). JMDSE is focused on low weight payloads (10-150lbs known as Micro Light Weight (MLW) and 250-700lbs known as Ultra Light Weight (ULW)) JPADS for delivery of small medical bundles, sensors, robots and Psychological Operations (PSYOP) payloads from fixed wing, rotary wing and unmanned aerial vehicles (UAVs). In addition, the paper will provide updates on the use of JPADS in Combat Operations, and an update of Precision Airdrop (PAD) activities within the North Atlantic Treaty Organization (NATO).

The purpose of the JPADS is to meet the Combatant Commander (COCOM) requirement of sustaining combat power using high altitude, precision airdrop as a direct and theater delivery method, into a dynamic, dispersed, and unsecure battlespace. This must be done with speed and flexibility to provide an optional capability previously unavailable to the COCOM, and to enable decisive operational superiority.

The JPADS programs include five primary weight classes of self guided systems, an equivalent range of high altitude low opening ballistic non-steerable systems, and navigation aids for military free fall (MFF) jumpers all of which are linked to a common JPADS Mission Planner (JPADS-MP). All payloads are required to be airdroppable from up to 25,000 feet Mean Sea Level (MSL) and each have specific accuracy requirements that increase with increased system weights.

In addition, this paper will provide an overview of NATO precision airdrop activities. NATO has prioritized eleven Defense Against Terrorism (DAT) activities. One DAT is "Precision Airdrop for Special Operation Forces" (PAD for SOF). Each DAT has a "lead nation" and the precision airdrop DAT is the only DAT for which the US is the lead Nation. NATO established a Joint Precision Airdrop Capability Working Group (JPACWG) in 2004. The PAD for SOF DAT is the first of the eleven NATO DATs to complete its program of work and meet NATO exit criteria. A summary of this four year effort and planned future NATO activities related to precision airdrop will be provided.

I. Background

A. JPADS General

1. JPADS Weight Classes

The DoD Joint Precision Airdrop System (JPADS) programs¹ encompass a family of systems being executed through a variety of efforts, partners and funding sources. The JPADS family of systems consisting of "self-guided"

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cargo parachute systems, an equivalent range of high altitude low opening ballistic non-steerable systems, and navigation aids for MFF parachute systems all linked to a common mission planning & weather system (JPADS-MP²). The weight classes and names used for guided systems are as follows:

- Micro Light Weight (MLW): 10-150lbs
- Ultra Light Weight (ULW): 250-700lbs
- Extra Light (XL, also known as 2K): 700-2200lbs
- Light (L, also known as 10K): 5,000-10Klbs
- Medium (M): 15-30Klbs (potentially up to 42Klbs)

The “2Klb” Program of Record (POR) variant (known as Firefly) completed operational testing (OT) in Sept08 and is scheduled to reach a Milestone C (MS-C) decision by the end of April 2009. The 10Klb variant transitioned from the very successful JPADS Advanced Concept Technology Demonstration³ (ACTD) to a formal POR, MS-B approved in Aug07. The 10Klbs (known as Dragonfly⁴) variant is in design validation (DV) testing, and is scheduled to enter developmental testing (DT) during the summer of CY09. The ACTD residuals (6+ 10K Screamer systems⁵) have been rapidly fielded to US Army Special Operations Command (USASOC) and are in theater for potential use in Operation Enduring Freedom (OEF). The Capability Development Document (CDD) which covers both the 2K and 10Klb increments was approved by the Joint Requirements Oversight Council (JROC) on 5Mar07 and includes an objective weight of 250-700lbs. The USMC is expected to release a Request for Proposals (RFP) for the ULW during fiscal year 2009 (FY09) and First Unit Equipped (FUE) starting 2nd Quarter FY11 (2QFY11) with approximately 700 systems planned to be fielded. An Army Technology Objective (ATO) science and technology project demonstrated a 30Klb JPADS capability parafoil (9,000sqft)⁶, dropped from 25Kft MSL and landing within 100M of the pre-planned target numerous times with a 3.4+ lift to drag ratio. A 42Klb demonstration (10,500sqft parafoil) was conducted in Jan09. US Army Combined Arms Support Command (CASCOM) is the JPADS combat developer for JPADS XL and L. USA CASCOM announced in May08 that they do not plan to pursue a CDD for a 30Klb JPADS capability at this time. Numerous MFF Navigation Aids (NAVAID) have been examined under JPADS. The USMC are fielding one variant and a USASOC CDD is expected to be approved in FY09 with a MS-B start, lead by PM-CIE, soon after. A new 3-year DUSD AS&C supported JCTD known as Joint Medical Distance Support and Evacuation (JMDSE) was approved in Dec08 and will include the JPADS MLW capability focused on 10-150lb payloads and dropped from fixed wing, rotary wing and UAS aircraft to deliver a wide range of payloads to include medical support bundles, sensors, robots and PSYOP items. In addition, JMDSE will mature and demonstrate higher weight payloads with the chosen USMC ULW JPADS.

2. JPADS Use to Support Current operations

Under a Feb06 Operational Need Statement (ONS) generated by Combined Joint Task Force 76 (CJTF-76) which was elevated to a Joint Universal Operational Need (JUONs) by Central Command (CENTCOM) in Aug06 and approved as an Immediate Warfighter Requirement (IWN) on 12Sept06, 50 2Klb JPADS systems (known as 2K Screamers) were rapidly fielded by NSRDEC to OEF by Feb07. A Feb07 ONS requested 300 more 2K systems. PM-FSS delivered 100 more 2K Screamers and began fielding Firefly systems to OEF under an Urgent Material Release in Sept08. The DoD has used the JPADS-MP for USSOCOM Military Free Fall (MFF) missions since FY04. The USAF 1st used the JPADS-MP in combat on 29Jul06 with the improved container delivery systems (ICDS) which are ballistic Army inventory/fielded cargo parachute systems (26 foot Ring Slot, G-12 parachute system, Hi Velocity and Low Velocity Low Cost Aerial Delivery Systems (HV and LV LCADS)) when used with the JPADS-MP for increased accuracy. The JPADS-MP is also used for all JPADS drops (1st 2K Screamers were dropped on 31Aug06). The first Firefly 2K combat airdrops occurred in Sept08. Airdrop operations in Afghanistan and to a lesser extent in Iraq have continued to increase. The total pounds of supplies delivered via airdrop per year are as follows: 2005: 2Mlbs, 2006: 3.5Mlbs, 2007: 8.2Mlbs, 2008: 16.6Mlbs. In addition, recent press releases from theater (OEF) have stated that doubling 2008 drops is anticipated in 2009 (i.e. up to 32M pounds of airdrops expected during CY09).

B. JMDSE JCTD

The JMDSE JCTD will address the military need for a combat casualty care capability to significantly enhance land, air and sea medicine, provide precision logistical delivery and be a force multiplier for high demand low density assets. The JCTD is focused on a twofold approach to accomplish the objectives which are:

- 1) Joint Combat Casualty Care System (JCCCS) is focused on: Integrated medical support systems and telemedicine: Remote casualty care on land, in air and at sea; Virtual triage (monitoring and automated casualty care) on noncontiguous areas of operations; Automated monitoring and care stations connected to a closed loop casualty care system and to medical forces at a distance; Audio/video data & voice

communications between First Responder and higher Health Service Support Capabilities (HSSC); Remote monitoring of vitals, dispense fluids and medicines as directed by higher HSSC, as needed; and Quick reaction response to biological attack scenarios. This aspect of JMDSE will not be elaborated on in this paper.

- 2) Joint Precision Airdrop System – Medical (JPADS-Med) focused on: Ultra Light Weight (ULW: 250-700 lbs) small medical bundles or equipment delivery; Micro Light Weight (MLW: 10-150 lbs) medical bundles, robot/sensor/PSYOP delivery and manned and UAS deployable variants; Integration into Manned USAF/USMC Platforms such as: HH-60, CH-53, C-130, C-17, V-22; Integration into existing UAS: Tigershark/others, utilize and demonstrate quick reaction response to Biological Weapon of Mass Destruction (BIO WMD) attack scenarios.

C. NATO JPACWG

Defense Ministers at the 2004 Istanbul Summit agreed to the NATO Conference of National Armament Directors (CNAD) strategy for Defense Against Terrorism (DAT) programs. The primary objective for NATO DAT program of work (PoW) is to develop and deploy technical countermeasures that mitigate terrorist attacks. To provide NATO forces short-term cutting edge capabilities and solutions in support of current operations, CNAD DAT PoW program continues to cultivate multinational interoperable NATO capabilities that detect, disrupt and pursue terrorists.

The NATO DAT PoW number five (5) “Precision Airdrop for Special Operation Forces” (PAD for SOF) has met critical path items and the CNAD DAT program exit criteria. A “Mission accomplished” consensus was reached by the lead nation (U.S) and supporting nations, including: Belgium, France, Canada, Denmark, Germany, Italy, the Netherlands, and the United Kingdom. After accomplishing mission goals since 2004, the DAT PoW for PAD for SOF initiated the DAT-5 program close-out phase during CY08 which was accepted and approved by the CNAD in Oct08 with a close out date of 31 December 2008. The work was accomplished within a Joint Precision Airdrop Capability Working Group (JPACWG) which will continue to work on NATO PAD related Long Term Capability Requirements (LTCRs).

II. Discussion, Results and Plans

A. JMDSE JCTD

The JMDSE JCTD program will refine the warfighter requirements, develop the Concept of Operations (CONOPs), identify the materiel solution and select mature government off-the-shelf or commercial-off-the-shelf technologies (GOTS/COTS) for integration during calendar year 2009 to include technical tests. This will be closely followed by a series of Technical Demonstrations (TD) to validate that the technologies are ready for follow-on Operational Demonstrations (OD) beginning in CY10 in relevant operational environments to assess the military utility of the JMDSE JCTD. The program will conclude in CY11 after the final OD and sponsor approved submission of the Operational Utility Assessment (OUA) with residual support through FY12.

JPADS (MLW and ULW) will provide aerial delivery of therapeutics, medical equipment, combat care kits, combat critical care systems, expendable re-supply items for biological detection systems, prophylaxis, and robot/sensor/PSYOP systems. Through competitive prototyping, two precision aerial delivery systems will be integrated for the precision delivery mission to include: MLW system for delivery of 10-150 lbs. In addition, the ULW system for 250-700 lbs payloads will be used to demonstrate higher weight medical payload delivery. Each system, guided by an airborne guidance unit (AGU), will be developed to support both land and maritime units and will be integrated into the USAF JPADS Mission Planner (MP) System. The MP will integrate forecasted and actual winds aloft to establish a drop aircraft’s launch acceptability range (LAR) to ensure the systems will reach the intended point(s) of impact. This, in effect, will keep aircraft and aircrew out of harms way and enable the anticipated system accuracy threshold of MLW - 50 meters and ULW - 150 meters (Objectives are: 10M for MLW and 50M for ULW) at 80% Circular Error Probable (CEP) with a system reliability of 94%. All payload capabilities will be aerial delivered from representative USAF, USMC and possible other service manned fixed and rotary wing aircraft platforms (ex. HH-60, CH-53, C-130, C-17, V-22) and select UAS. Figure 1 is a graphical representation of the Operational View for the JMDSE JCTD.

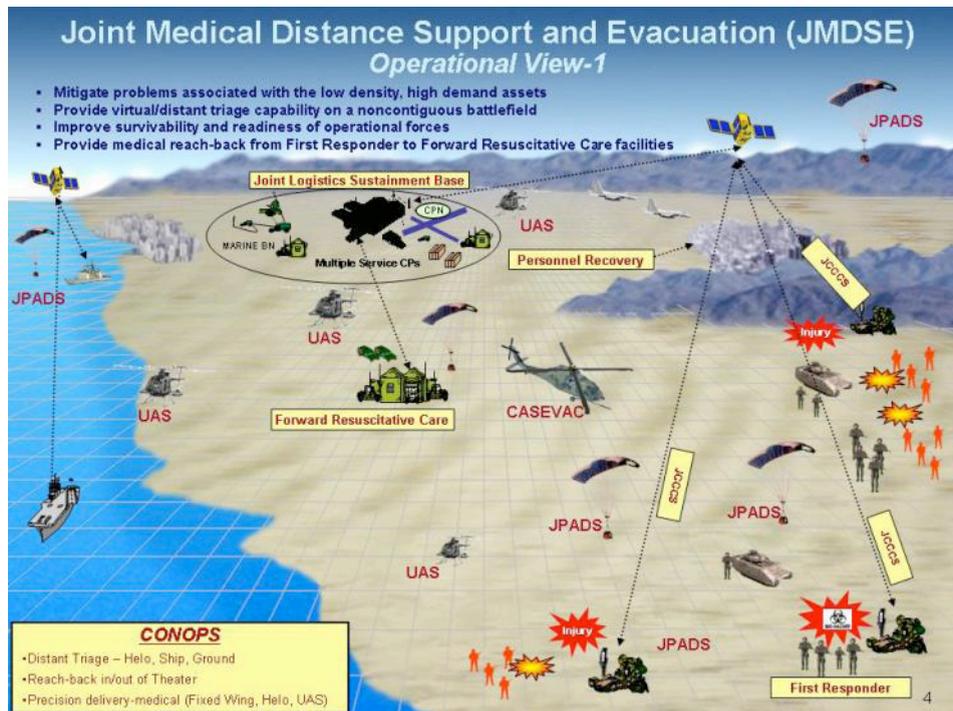


Figure 1. Operational View Concept for the JMDSE JCTD

The technologies developed during the JMDSE JCTD could be used in a variety of scenarios. Such scenarios include:

- Emergency delivery of medical supplies to a remote SOF team with a venomous animal bite casualty (e.g. jungle snake or spider bite)
- Delivery of medical supplies anywhere in the world within 24 hours after a biological or chemical attack is detected to include treatment for warfighters and local population
- Resupply of stranded or disabled ship or downed pilot at sea
- Pre-positioned medical supplies on board manned aircraft for “on call” resupply
- Aerial delivery of a Unmanned Ground Vehicle (UGV) for IED detection and defeat
- Aerial delivery of sensors and supplies to warfighters operating in an urban environment
- Delivery of PSYOP leaflets from high altitude and high offset
- Humanitarian resupply during a natural disaster (i.e. Katrina hospital resupply)

The JMDSE MLW JPADS capability will compete a Stara Technologies, Inc system and an Atair Aerospace system through at least 2QCY10. The Atair system design has just recently begun and will not be described in this paper. The Stara Mosquito system is a guided parachute “kit” comprised of a flight computer, steering servos, payload interface mechanism and parachute that can be packaged into various form factors. The Mosquito 2 technology was repackaged into the MDS3 form factor to accommodate light weight resupply bundles. Stara is also supported through a Phase II Small Business Innovative Research (SBIR) contract with the Armaments Research Development and Engineering Center (ARDEC). Figure 2 shows the current prototype system. The Airborne Guidance Unit (AGU) is approximately 12 inches by 10 inches by 2 inches and weighs 10lbs. The MDS3 has been designed to accurately deliver payloads weighing between 1 and 150 pounds within 50 meters of a pre-programmed GPS impact point (IP). It is expected to also be reusable (15 times minimum) and will be tested with inventory MC-5 parachutes with weights up to 250lbs.

The JMDSE JCTD has determined a set of requirements for each weight class to be used during this program (MLW and ULW). The Micro Light Weight system must be able to be deployed from C-130, C-17, V-22, CH-53 or CH-46 aircraft anywhere from 3,000 to 25,000 ft MSL. Ability to be deployed from Unmanned Aerial Vehicles is also an objective. The system must have an accuracy of 50m CEP with an objective of 10m CEP and ensuring 85% load survivability in 17 knot ground winds (25 knot objective). A horizontal offset of 8 km from 25,000 ft MSL is required with an objective of 30 km offset. The Ultra Light Weight system has the same requirements for

deployment altitude and aircraft, offset, load survivability and reuse. The accuracy requirement for the ULW is 150m CEP threshold with a 50m CEP objective.

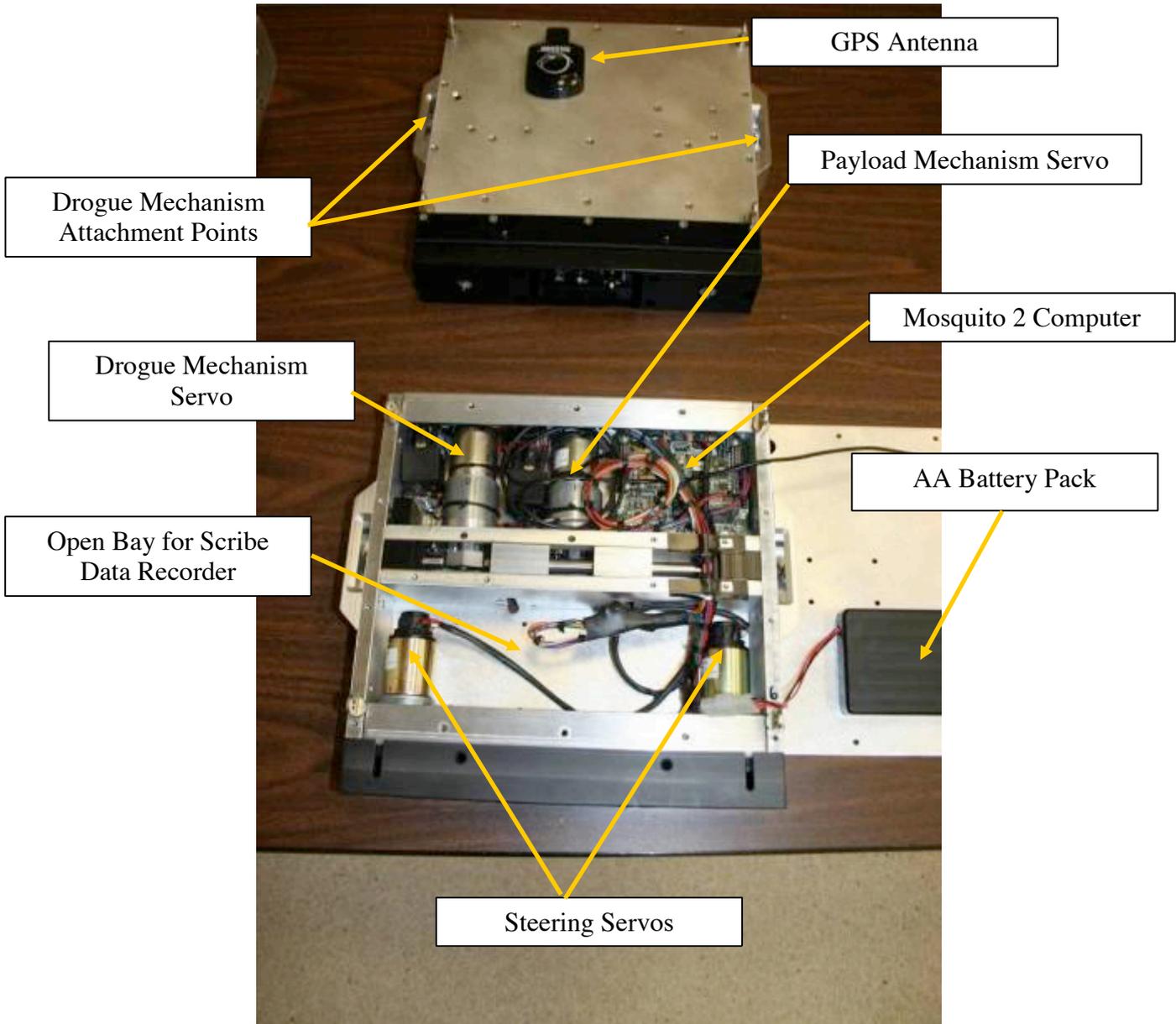


Figure 2. MDS3 Components and Functionality

The NSRDEC has supported Strong Enterprises to support the development of three parafoil sizes for the wide (10-150+lb) payload range of the MDS3 system. The parafoils were designed for low cost (rectangular plan form, common sized cells, etc.). Strong is currently collaborating with NSRDEC on materials research and testing to develop a low cost one time use parafoil in this MLW weight range that could be dissolvable, biodegradable etc to help ensure unattended ground sensors are less visually exposed after a predetermined amount of time after landing. Strong Enterprises has also designed and fabricated an AGU fabric/protective cover, a common 30 inch drogue parachute for all three sized parafoils and the parachute/drogue bags for the MDS3. Table 1 shows the top level drogue and parafoil parameters.

Table 1. Mosquito Parafoil Size and Weight Range

Parafoil Size	Estimated L/D	Dimensions (Span x Chord)	Cells	Payload Weight
40 sq ft	2.5	7.7 ft x 5.2 ft	7	20 – 40 pounds
80 sq ft	2.5	13.2 ft x 6.1 ft	7	40 – 110 pounds
150 sq ft	2.5	16.8 ft x 8.9 ft	7	100 – 165 pounds

Initial testing of the MDS3 has been conducted during a small series of test weeks to collect performance data on the parafoils and tune the Guidance, Navigation and Control (GN&C) for each size parafoil and weight range. Tests have been conducted at the US Army Yuma Proving Ground (Huey helicopter), Kingman Arizona (C-123), Stara’s “Dateland” AZ dropzone from a Buckeye powered parafoil and in Florida (radio controlled tests). During these tests the MDS3 units have been dropped using all three canopy configurations. It should be noted that in each weight class the exact same type of guidance system was used while the only component that changed was the parafoil. Table 2 shows a summary of the best drops for each canopy size. Figure 3 shows a typical trajectory (birds eye view) from deployment to ground impact.

Table 2. Mosquito Testing Best Flights

Parafoil Size	Payload	Drop Aircraft	Release Altitude	Date	Miss Distance
40 sq ft	Cargo Box – 30 lbs	C-123	7,000 ft MSL	18 Sept 08	25 meters
40 sq ft	Cargo Box – 30 lbs	UH-1 Huey	9,500 ft MSL	6 Oct 08	5 meters
40 sq ft	Cargo Box – 30 lbs	UH-1 Huey	9,500 ft MSL	6 Oct 08	6 meters
40 sq ft	Cargo Box – 32 lbs	UH-1 Huey	9,500 ft MSL	8 Oct 08	55 meters
40 sq ft	Cargo Box – 32 lbs	UH-1 Huey	9,500 ft MSL	9 Oct 08	97 meters
40 sq ft	Medical Bundle – 40 lbs	C-123	10,000 ft MSL	3 Feb 09	26 meters
80 sq ft	Cargo Box – 60 lbs	UH-1 Huey	9,500 ft MSL	19 Aug 08	45 meters
80 sq ft	Cargo Box – 60 lbs	C-123	7,000 ft MSL	18 Sept 08	56 meters
80 sq ft	Cargo Box – 64 lbs	UH-1 Huey	9,500 ft MSL	6 Oct 08	47 meters
80 sq ft	Cargo Box – 61 lbs	UH-1 Huey	9,500 ft MSL	6 Oct 08	41 meters
80 sq ft	Cargo Box – 64 lbs	UH-1 Huey	9,500 ft MSL	7 Oct 08	75 meters
80 sq ft	Cargo Box – 64 lbs	UH-1 Huey	9,500 ft MSL	8 Oct 08	71 meters
80 sq ft	Cargo Box – 61 lbs	UH-1 Huey	9,500 ft MSL	8 Oct 08	50 meters
80 sq ft	iRobot Model – 85 lbs	C-123	10,000 ft MSL	3 Feb 09	50 meters
80 sq ft	iRobot Model – 85 lbs	C-123	10,000 ft MSL	4 Feb 09	77 meters
150 sq ft	Cargo Box – 130 lbs	C-123	7,000 ft MSL	16 Sept 08	21 meters
150 sq ft	Cargo Box – 130 lbs	C-123	7,000 ft MSL	18 Sept 08	57 meters
150 sq ft	Cargo Box – 130 lbs	C-123	7,000 ft MSL	19 Sept 08	68 meters
150 sq ft	Cargo Box – 134 lbs	UH-1 Huey	9,500 ft MSL	6 Oct 08	77 meters
150 sq ft	Cargo Box – 133 lbs	UH-1 Huey	9,500 ft MSL	7 Oct 08	54 meters
150 sq ft	Cargo Box – 134 lbs	UH-1 Huey	9,500 ft MSL	7 Oct 08	10 meters
150 sq ft	Cargo Box – 144 lbs	UH-1 Huey	9,500 ft MSL	8 Oct 08	51 meters
150 sq ft	Cargo Box – 97 lbs	UH-1 Huey	9,500 ft MSL	8 Oct 08	43 meters

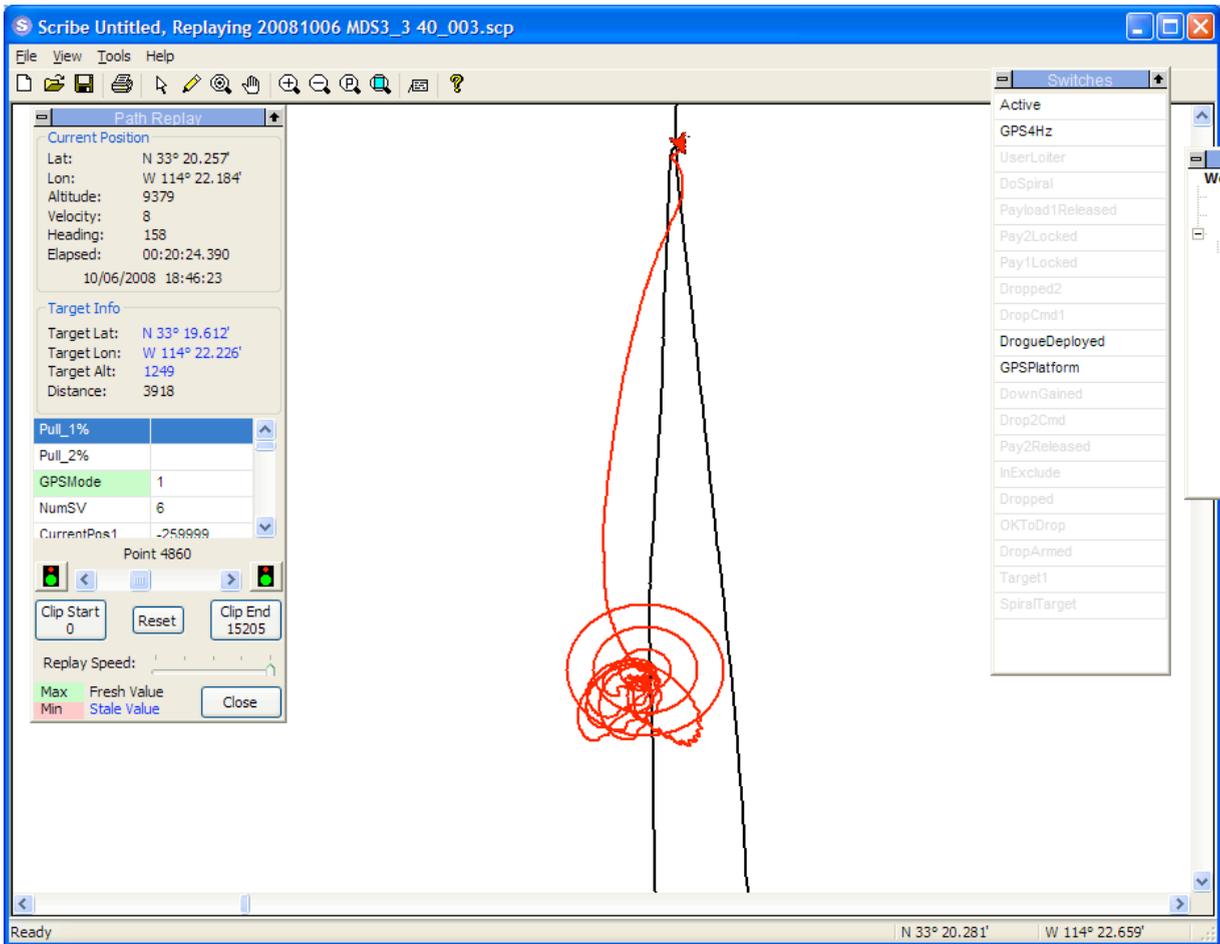


Figure 3. Mosquito Flight Path from 40 sq ft Parafoil Flight (Miss Distance: 6m)

Many drops were conducted during the initial series of test weeks, using many different payloads, including cargo bundles, medical resupply bundles, leaflet delivery, an Intelligent Munitions System (IMS) mock-up and an iRobot mass model. Airdrops were conducted from up to 10,000 ft MSL on the previously mentioned aircraft. During successful flights, accuracies have been consistently within 75 meters of the intended target with a few landings within 10 meters. These tests were used to improve parafoil and drogue design and rigging as well as the GN&C algorithms. Figure 4 shows the Mosquito system landing near the target with a mock medical bundle. Figure 5 shows the Mosquito system dropping leaflets and the IMS.



Figure 4. Mosquito delivering a medical resupply bundle to the target (white post)



Figure 5. Mosquito delivering the IMS under a 150 sq ft parafoil (left) and dropping simulated leaflets under an 80 sq ft parafoil (right)

Many upgrades are planned for this system over the coming 6 months to include: GN&C enhancements and porting of the Draper Lab/NSRDEC software to the MDS3 AGU⁷. Integration of a RADAR based height sensor⁸ for both terrain avoidance and near ground flare has begun and will be augmented with the incorporation of Defense Terrain Elevation Data (DTED) within the AGU for the planned area near the impact point GPS coordinate. In addition, peer to peer communications will be utilized to provide measured wind information from lower systems in a stick to upper systems to enhance accuracy and for in-flight and ground impact “tracking” which is described later in this paper.

B. JMDSE MLW JPADS UAS Variant Plan

The MDS3 is also currently being repackaged in a cylindrical form factor (8 inch diameter) to support Unmanned Aerial Systems (UAS) “Pod” drops. This repackaging effort will utilize the same AGU components and maintain the same capabilities, software etc. as the MDS3 units. The system will also use the same drogue parachutes and the same three (different packing configuration) parafoil sizes discussed above with the same Pod tail end. The front end and cargo capacity will vary with user feedback to ensure maximum compatibility with priority payloads. The design is modular in that it will allow the AGU to detach a resupply pod while flying under the parafoil by separating the Pod front end at the AGU fitting. The Stara Technology name for this system is PROVIDER. The JMDSE JCTD will focus on integration and airdrop testing on the UAS known as “Tigershark” (as a start) on which a similar Stara system has been integrated and tested in the past. Figure 6 shows the Tigershark loaded with a PROVIDER mock up.

The nose of the PROVIDER Pod is a shock absorbing material that can be reused. The Pod will conform to a 14 inch bomb rack configuration to allow for maximum compatibility with UAS (Tigershark, Shadow, Predator, Hunter, Hummingbird) and tap the UAS for power to maintain AGU battery only during flight.



Figure 6. Mockup 8 Inch PROVIDER Mounted Under Tigershark UAS

The repackaging is anticipated to be very similar to the Mosquito 2 packaging for the sonobuoy tube shown in Figures 7 and 8. This tube contains a 4 7/8 inch diameter AGU. The system shown in figures 7 and 8 does not include a cargo carrying capable volume.

The exterior components of the Mosquito 2 are:

- Packed Parafoil (not shown packed)
- Housing
- Status LEDs
- Pull Out Power Switch
- Payload Attachment Mechanism



Figure 7. Stara Mosquito 2 Repackaged in Navy Sonobuoy sized (4 7/8" diameter) Tube

The interior components of the Mosquito 2 are:

- GPS Receiver (4hz Commercial)
- Drogue Release Mechanism
- Winch Drum / Steering Servos
- Mosquito 2 Flight Guidance Computer
- RF Modem (Optional)
- Battery

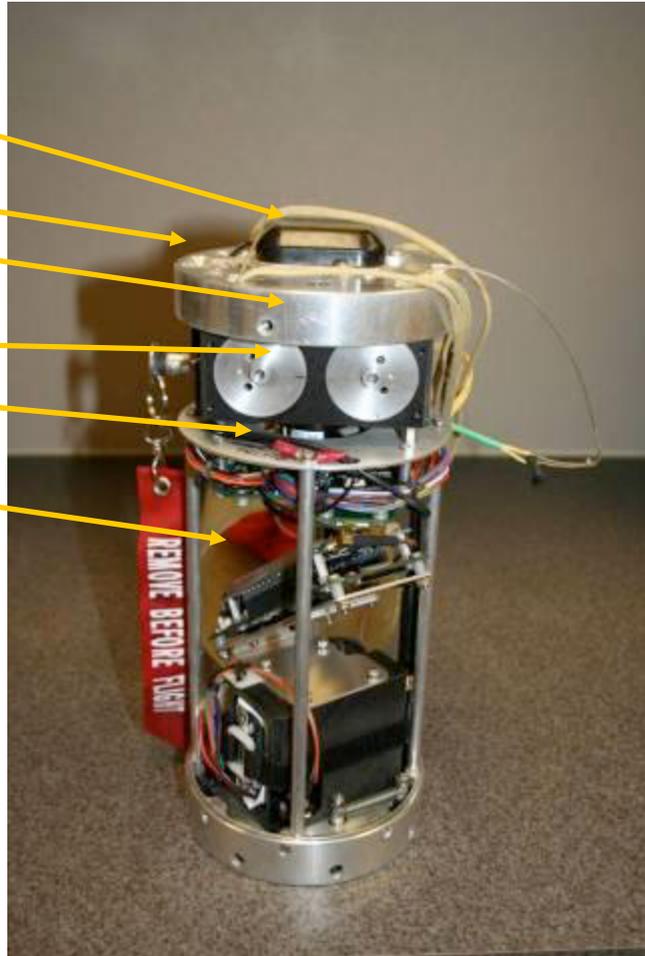


Figure 8. STARA Mosquito 2 Packaged in a Sonobuoy Tube (Interior View)

The deployment sequence for UAS drops is planned as follows:

- 1) Target located/defined, UAS ground controller provides to PROVIDER/JPADS-MP ground control operator (will likely be same person with software run on same ground laptop)
- 2) JPADS-MP ground operator utilizes GPS target point to determine a Launch Acceptability Region (LAR) within which the PROVIDER can be dropped.
- 3) JPADS-MP ground operator computes a mission file for PROVIDER, sends it via Iridium (A Satellite Communication (SATCOM) system being used for concept demos) ground unit linked to JPADS-MP laptop to an Iridium system mounted on the UAS.
- 4) The Iridium on the UAS utilizes 802.11 WI-FI to wirelessly update the mission file to the (each) PROVIDER. The AGU acknowledges the new mission, which is fed back via SATCOM to the JPADS-MP ground user who in turn informs the UAS ground control operator of the LAR for the UAS to drop the PROVIDER within to ensure delivery to the planned target.
- 5) The UAS operator instructs the UAS to release the PROVIDER from within the LAR.
- 6) A spring loaded mechanism is used to deploy the PROVIDER drogue chute after safe clearance from the UAS (2-3 seconds). The AGU drogue release time begins count down and the PROVIDER operates as a self guided parafoil system for the remainder of its flight to ground impact.

Figure 9 shows the initial sequence of a UAS drop of PROVIDER.

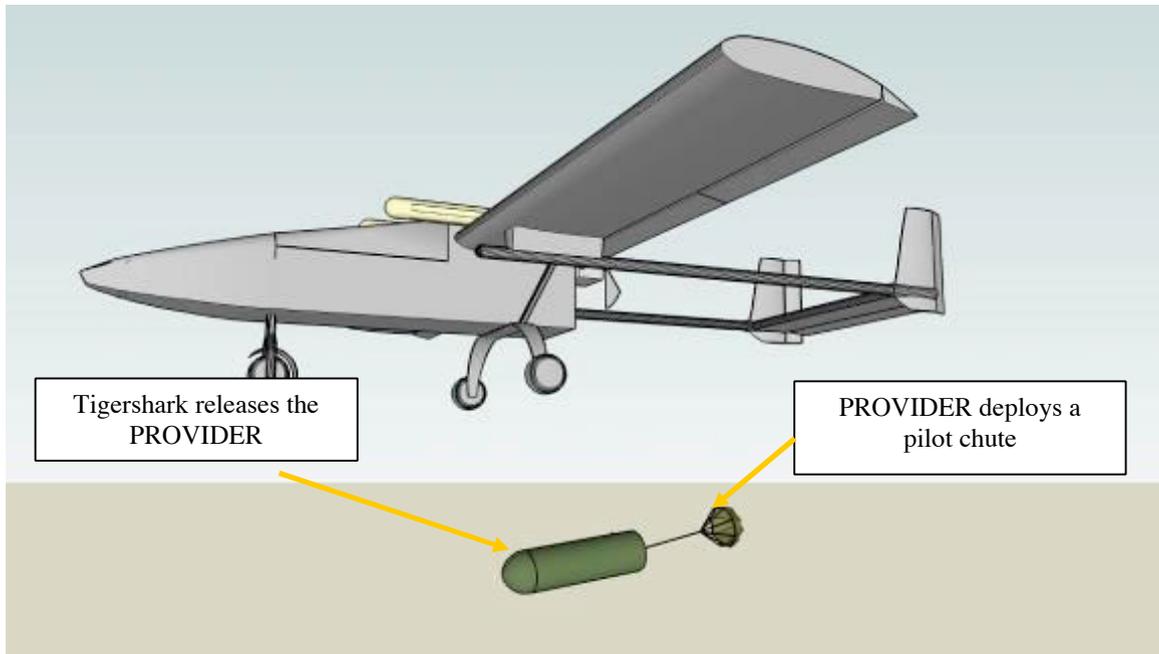


Figure 9. PROVIDER releases from Tigershark UAV

After flying to the target area the modular PROVIDER can (optional) release the Payload Pod(s) which descends downward to the ground and lands on a crushable nose cone that reduces shock of impact, as shown in Figure 10.

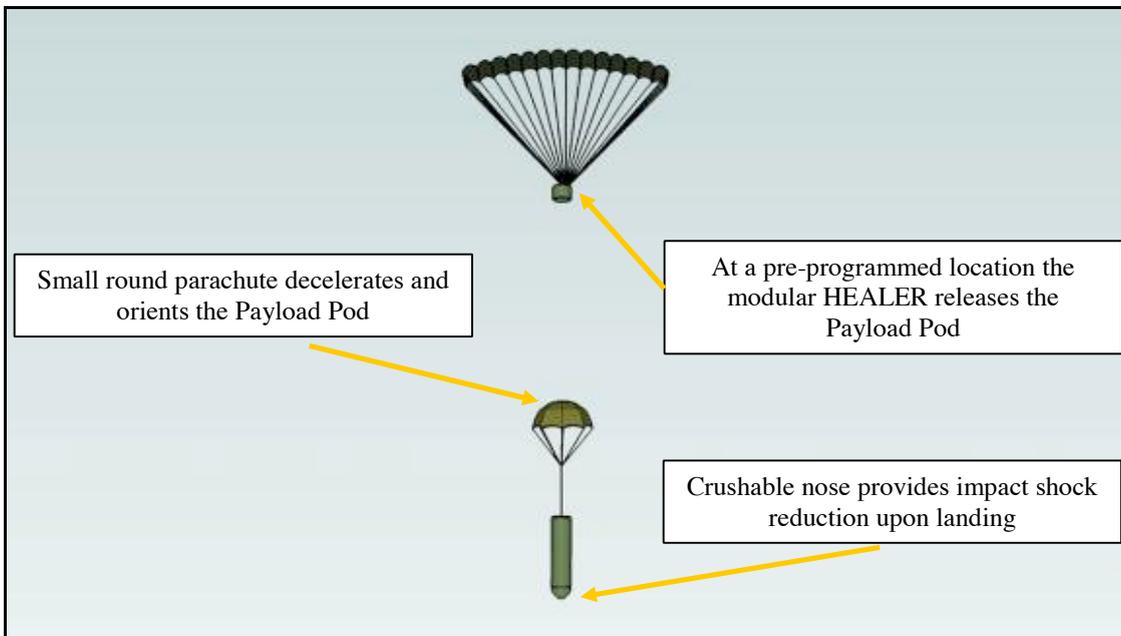


Figure 10. PROVIDER releases the Payload Pod at a pre-programmed location

The mounting rack will tap into the external aircraft/UAS power system for continuous AGU power during flight and may also connect to the serial connection of the UAS autopilot for tactical payload mission reprogramming in flight in the future.

C. Tracking and Other Iridium (SATCOM) Data Link Usages

Each AGU records system flight trajectory data in real time. Tracking of JPADS (single or multiple systems) during flight is a desired capability and will be executed under JMDSE via a SATCOM system which will relay

JPADS positions (near real time) to either ground users and/or other aircraft in the area. To demonstrate these capabilities, each system will transmit its location information to the master system which includes a non-integrated SATCOM system (Iridium and 802.11 link for concept demonstrations). Through the use of a long range RF link between systems (line of sight) each system will be able to pass/receive information regarding other systems such as current location and/or measured winds. Measured winds will be passed from lower systems to higher altitude systems to improve accuracy, while location information will be passed from lower system to the highest altitude (SATCOM equipped) system to allow for remote tracking and ground impact locating. This capability will be demonstrated by passing live (10-30 second latency) position information of MLW JPADS airdrops to a web browser (Google Earth mapping application) anywhere in the world during a flight. Military tracking systems are also being explored by NSRDEC and others but will not be discussed in this paper. The concept is depicted in Figures 11 and 12 below.

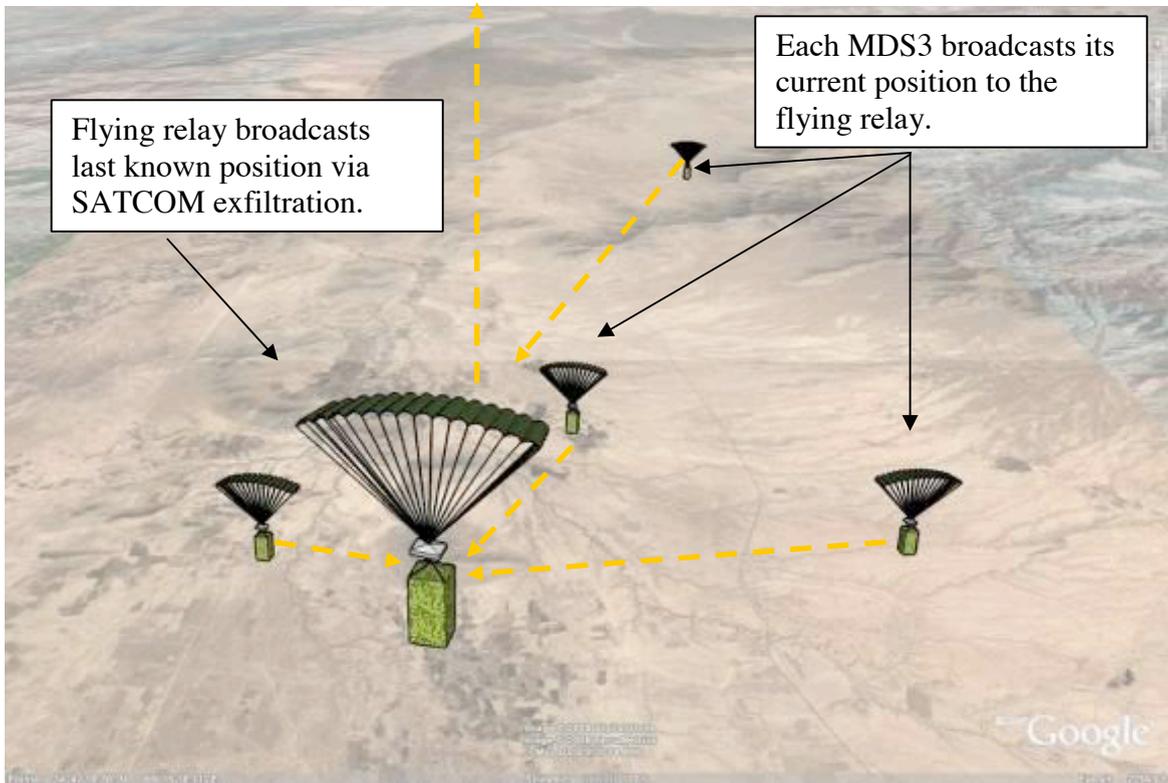


Figure 11. In-flight RF information passing and SATCOM link for tracking, etc.

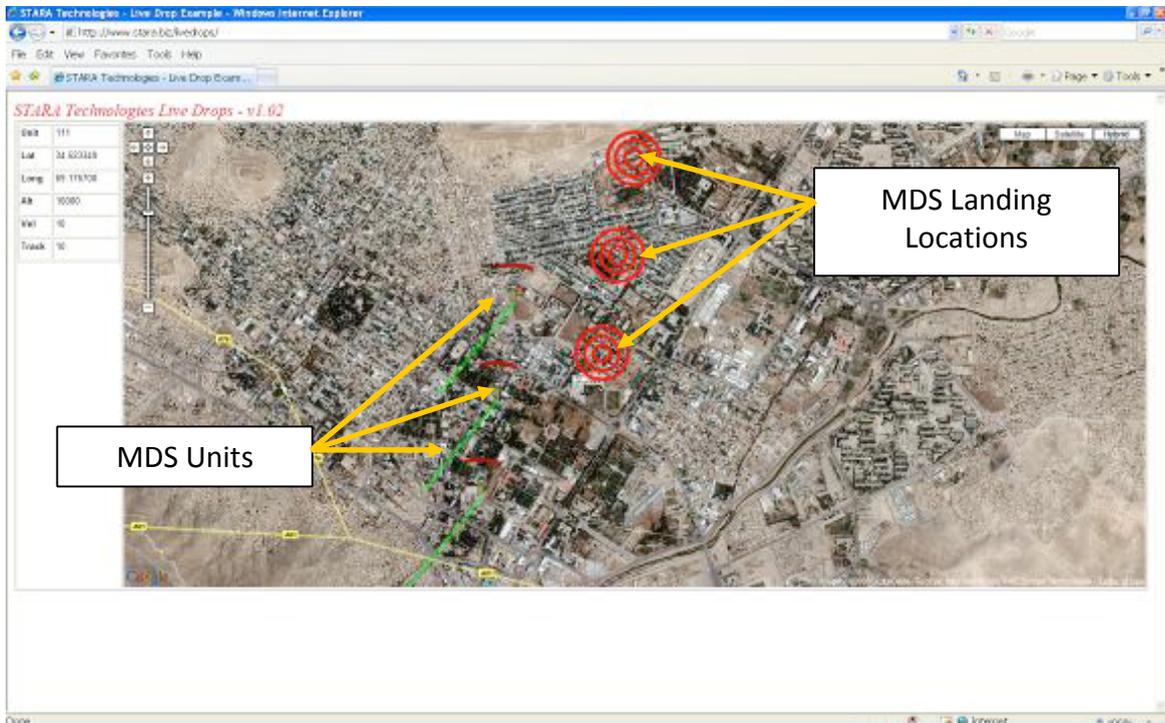


Figure 12. Graphical Display of MLW JPADS systems in flight over Google Earth Mapping Engine displayed in a web browser

Some flight tests of Stara and Draper Labs GN&C software and a very low cost test bed are executed by integrating new NSRDEC technologies with the Mosquito powered GU-11 autonomous powered parafoil. This system will be used to quickly and efficiently evaluate performance at the Dateland, AZ test facility. The system is shown in Figure 13 and can carry a 400lb payload.

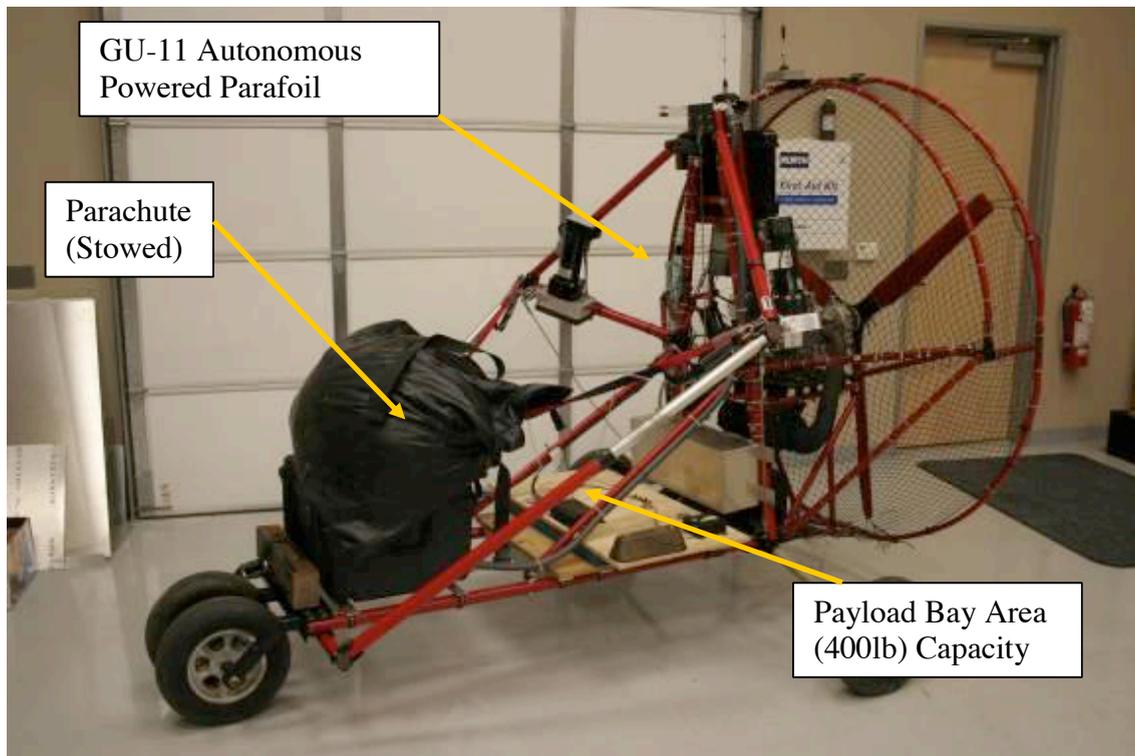


Figure 13. GU-11 “Buckeye” Autonomous Powered Parafoil

D. NATO JPACWG

Although the DAT has been closed, work within NATO will continue on PAD activities which will continue through CY10 at a minimum. The following captures the highlights of the PAD for SOF DAT-5 program. In addition, the U.S. continues to offer partnerships with any/all NATO Nations or partner nation for training, testing and participating in US based trials (for example the upcoming Precision Airdrop Technology Conference and Demonstration (PATCAD’09) scheduled to take place at the US Army Yuma Proving Ground (YPG) 19-23 October 2009). The US continues to chair PAD activities within the NATO armament community as outlined below.

The PAD for SOF successfully demonstrated that this technology/capability provides a solution to the warfighter (all services, not just SOF) that: Decreases forward logistics footprint; Reduces aircrew threat exposure (survivability), Links to DAT-1: Protection of Large Body Aircraft Against MANPADs & DAT-3: Protection of Helicopters from Rocket Propelled Grenades; Provides vertical and horizontal standoff and fewer deployed/exposed personnel; Precisely delivers critical assets to ground forces; Reduces convoy exposure to IEDs and # of helicopter airland missions.

NATO investments during 2005-2008 in JPACWG activities have totaled 1M euros. The funding was used to support four international PAD demonstrations (150K euros/demo for the first 3-demonstrations and 250K euros for the fourth demonstration). In addition a NATO Industrial Advisory Group (NIAG) study (completed in Oct06) was supported at 200K euros and the development of a Concept of Operations (CONOPs) was funded at 100K euros.

The US proposed to “declare victory” on the NATO PAD DAT during 2QCY2008. The CNAD approval to close DAT-5 took place in Dec08. Nearly all exit criteria outlined by NATO International Staff has been met on the PAD for SOF DAT. The current plan is for the US to remain as chair of the JPACWG and continue to work with the alliance on the PAD LTCR and approved program of work. This DAT closure was the 1st of the current 11 DATs to close.

Specific examples of JPACWG objectives and accomplishments over the past four years are included in Table 3 below.

Table 3. DAT 5 Accomplishment Highlights to Meet Program Objectives

Objectives	Accomplishments
<p>Analyzed the short term DAT requirements with the longer term capability requirement on “Precise delivery of equipment and supplies by airdrop and propose solutions.” Outreach to Partners.</p>	<p>Accomplished: Short term DAT requirements were analyzed and clearly defined in coordination with numerous NATO bodies. In addition, the JPACWG developed and published a Concept of Operations (CONOPS) and a Concept of Employment (CONEMP) for NATO</p>
<p>OPERATIONAL: Demonstrate emerging technologies/systems capabilities in Precision Airdrop</p> <ul style="list-style-type: none"> • Demonstrate systems • Expose senior NATO and national leaders and troops to emerging precision Airdrop capabilities • Promote standardization and interoperability through training, policy and CONOPS • Foster Joint NATO/coalition PAD development • Collect high quality demonstration test data 	<p>Accomplished: The JPACWG supported the execution of four (4) one week long demonstration/conferences with three days each of live technical and/or scenario-driven airdrops as listed below.</p> <p>1) Precision Airdrop Technology Conference and Demonstration (PATCAD) 05⁹ - The U.S. hosted Precision Airdrop Technology Conference and Demonstration in November of 2005 (300+ attendees, and 17 nations represented),</p> <p>2) Precision Airdrop Capability Demonstration (PACD) 06¹⁰ – The French hosted Precision Airdrop Capability Demonstration in July of 2006 (5 nations contributed, with over 120 attendees),</p> <p>3) PATCAD 07¹¹ – The U.S. hosted the Precision Airdrop Technology Conference and Demonstration in October of 2007 with 25 systems, 20+ nations represented, 500 attendees, 250Klbs+ dropped,</p> <p>4) PACD 08 – The French hosted Precision Airdrop Capability in May of 2008, 11 nations represented, 5 aircraft with 3 days of drops all 2Klb or less, 150+ attendees</p> <p>The success of this Joint NATO program will continue to produce global mobility capabilities for the NAFAG and also for the NAAG relating to post-processing of data/results. The NATO Army Armaments Group (NAAG) SG2 (led by Demark) is working to add a ballistic parachute model to allow for remote Computed Air Release Point (CARP) calculations. The U.S. is providing data from numerous ICDS tests (PATCAD 07, Yuma and PACD08) to test this capability.</p>

The CNAD Exit Criteria for DAT PoW on PAD for SOF included the following items. Each is followed by a brief explanation of the JPACWG accomplishments:

- Military Requirements and/or Lead Nation or interoperability objectives for item have been met,
 - US deployed PAD systems based upon military requirements and Joint Urgent Operational Need (JUONs); systems deployed and multinational use and training underway
 - UK has tested US JPADS-MP (Direct Commercial Sales (DCS)) and procured systems.
 - AU has purchased JPADS-MPs through DCS since a US/AU interoperability demonstration was executed in Sept07.
 - Other Foreign Military Sales (FMS) and DCS with numerous nations are close to being executed.
 - Other Nations are developing and purchasing many other Nations systems

NATO Military Agency is considering a JPADS-MP purchase recommendation and rapid fielding initiative to support ISAF (work supported/conducted under CNAD helicopter shortfall IPT.)
- Product, technology or concept in use by NATO operational forces (ISAF, NRF, OAE)
 - A PAD Force Proposal (FP) exists detailing the requirements and desired timetable for Nations to have PAD capabilities.

- 150+ prototype 2Klb JPADS systems (known as 2K Screammers) were rapidly fielded to OEF by Feb07 under a JUON. A new Feb07 JUON requested 300 more 2K systems and 95 2K Firefly systems were sent to the AOR in Sept08
- The DoD has used the JPADS-MP for USSOCOM Military Free Fall (MFF) missions since FY04. The JPADS-MP is also used for all JPADS drops (1st 2K Screammers were dropped on 31Aug06). Most AOR drops have been ICDS (JPADS-MP used with traditional “dumb” parachute systems from high altitudes) US theater airdrop totals are approximately: 2005: 2Mlbs, 2006: 3.5Mlbs, 2007: 8.2Mlbs, 2008: 16.6Mlbs. In addition, recent press releases from theater (OEF) have stated that doubling 2008 drops is anticipated in 2009 (i.e. 32+M pounds of airdrops expected).
- Force Proposal developed and nations establishing Force Goals for capability.
 - ACT has completed a PAD Force Proposal and 10 Nations have agreed to comply.
- Concept of Operation or Concept of Employment developed, CONOPS/CONEMP developed, NATO IS formally staffing to SCs
- Outreach to Partners achieved.
 - To date, nine nations have contributed to DAT 5: Belgium, Canada, Germany, Denmark, France, the United Kingdom, Italy, the Netherlands, and the United States. Over 24 nations participating and over 1,000 attendees at DAT 5 demonstrations during the life of the program.
- Identify best practices and develop lessons learned.
 - Annual PAD demonstrations have allowed industry and military personnel to build on their knowledge of PAD capabilities and utilize lessons learned from previous events.
 - JPACWG collaboration with RTO to produce Research Technology Office (RTO) capability studies.
 - Two PAD RTO studies are under consideration.
 - JPACWG participated in an RTO Air Vehicle Technology (AVT) Specialist meeting (Oct06)
 - JPACWG POCs authored an Advisory Group for Aeronautical Research and Development Graph (AGARDOGraph) titled “Precision Airdrop”¹²
 - NIAG Study on technologies relating to PAD was completed in 2006
 - Resupplies efforts are key lesson learned. (Jul 2006-April 2008)

The JPACWG will continue its work with focus on wider range of PAD systems (weights, offsets, applications, accuracies, etc.), development of Standardization Agreements (STANAGs), interoperability, and continued joint demonstrations.

III. Conclusion

JPADS interest and usage continues within the Department of Defense and other allied nations. Use of precision airdrop has saved numerous lives through emergency resupply and as an alternative to helicopter or truck convoys for resupply of remote Forward Operating Bases (FOBs). The use of precision aerial resupply doubled from CY07 to CY08 to 16 million pounds of supplies delivered to troops in Operation Enduring Freedom. This number is expected to double again in CY09 to over 32 million pounds. New JPADS programs continue to develop systems to support many new anticipated missions in many weight ranges. NATO nations are continuing to work together on the interoperability of precision airdrop systems which will allow for a more unified airdrop community among coalition forces.

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