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HEL Deconfliction Safety: Bridging the Gap for Fielding Operational Systems

Christopher Washer, Mike Walter, LeAnn Brasure
Schafer Corporation, Albuquerque, NM 87106

Frank Arena
Southern Aerospace Company, Huntsville, AL 35758

Kurt Peterson
Myzeta Inc., Las Cruces, NM 88007

Richard Damron
OSD/HEL-JTO, Albuquerque, NM 87106

ABSTRACT:

High Energy Laser (HEL) systems have demonstrated weapons class capabilities against relevant target sets that will potentially shape the arsenal for future military operations. To operate without restrictions certain laser safety measures must be established that protect friendly forces and high value assets from inadvertent illumination. Predicative Avoidance (PA); the process used to determine discrete windows of time for safe laser illumination from laser platform interference, was established under DoD Instruction (DoDI) 3100.11 to minimize the risk of unintentional lasing of satellites and other space assets. DoD and United States Strategic Command (USSTRATCOM specific instructions for implementing PA are currently the responsibility of the Joint Functional Component Command for Space JFCC Space), Joint Space Operations Center (JSPOC), and Laser Clearing House (LCH). Similarly, current DoD laser safety policy stipulates all DoD laser systems operating outdoors must have plans in place for airspace deconfliction (AD), a process for tracking aircraft potentially in the path of the laser system to determine safe firing windows based on local air traffic. As laser technology has evolved, laser system testing architectures have remained within the bounds of the Research, Development and Test and Evaluation (RDT&E) environments. The current safety processes in RDT&E environments do not meet the requirements for real-time operations and will be a limiting factor if not addressed.

This paper examines existing laser deconfliction safety processes mandated by the DoD and Service Agencies by reviewing current laser safety system policy and analyzing potential changes that will lead to unrestricted use of operational HEL laser systems while protecting critical assets. This paper also addresses the groups and stakeholders working to improve the laser deconfliction safety process and the various tools available to simplify laser test planning activities.

BACKGROUND:

High Energy Laser (HEL) systems have demonstrated capabilities that will potentially shape the arsenal the US will use in future operations and conflicts. In order to smoothly transition from the RDT&E environment to operational use, HEL systems require an integrated safety system that addresses PA, AD, and designated keep out zones. The PA and AD process used today in the test and evaluation environment, where no-fire times are calculated before testing at a centralized location, does not meet the requirements for real-time HEL operations.

HEL system development has matured over the past few years, driven by advances in technology and operational system requirements for precision strike with limited collateral damage. HEL technology is rapidly maturing beyond R&D as designs for operational systems are being developed. This maturity brings with it the requirement for demonstrating enabling technologies, hardware and software test-bed concepts, and modeling and analysis tools to support architecture development and prototype demonstrations. These will lead to system level Developmental Test and Evaluation (DT&E), Operational Test and Evaluation (OT&E), and fielding operational systems.

The DoD architecture for testing lasers has remained within the bounds of the R&D environment. As systems mature, weapons platforms will require full engagement access across the full spectrum of joint warfighter operations. Increased DT&E and OT&E and the ability to demonstrate laser propagation in unrestricted environments, is critical to maturing and fielding laser systems as viable weapons. To support this transformation, PA and AD are mandatory capabilities for the safe employment of HEL systems in unrestricted environments. For operational venues, laser systems will operate under Rules of Engagements that are integral to the Concepts of Operations-that allow the laser system operator to develop fire control solutions to prosecute targets, sustain the operations tempo of the joint warfighter, and maintain safety.

CHALLENGES:

Current policy and guidance is overly restrictive for safeguarding satellites and manned spacecraft and ill-defined when it comes to conventional airspace control methodologies. The majority of DoD policy, guidance, and processes that impact laser system tests are centered on zero risk tolerance PA methodologies to prevent incidental hazardous illumination of satellites and manned spaceflight. The USSTRATCOM is the Unified Command within DoD with responsibility for safeguarding satellites under (DoDI) 3100.11[1] and Chairman of the Joint Chiefs Instruction (CJCSI) 3225.01 for inadvertent illumination by lasers. The process for gaining approval for laser testing is well documented, structured, and understood by the laser community. However, the process for dynamic source targeting normally requires a minimum of six (6) to eight (8) months lead-time to gain all approvals, are system/platform specific, and is not conducive to unrestricted decentralized operations. This process is manpower intensive and previous approvals can be rescinded at any time for reasons outside the HEL system's control. This has occurred on occasions resulting in increased cost for range use, as well as overall program cost or lost opportunities to meet program test requirements, thus incurring program delays.

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[1] *Illumination of Objects in Space by Lasers,* March 2000

DoD, through USSTRATCOM, has addressed the illumination of satellites through DoDI 3100.11, CJCSI 3225.01 and US Strategic Command Instruction (SI) 534-12. These documents only address PA associated with satellites and manned spacecraft and, while considered current, the DoDI was last updated in March 2000; the CJCSI was published in August 2008; and, the SI was last updated in July 2007. In addition, current implementation of PA policy puts the complete burden of safety on the laser owner/operator and imputes zero risk to satellite owner/operators from inadvertent laser illumination. The cost and complexity involved with ensuring no harm to space assets places an enormous burden on the laser owner/operators and is inconsistent with safety hazard assessment/mitigation processes referenced in MIL-STD-882D and throughout the rest of the DoD.

AD for HEL systems is the least mature capability for integration into HEL system's fire control solutions. The AD architecture process is mainly addressed through range/airspace restrictions, and thus requires minimal engagement by the HEL system owner/operators. As a result, AD is not integrated into many HEL systems. Current procedures mandate that the ranges activate Special Use Airspace (SUA) for laser system tests. This clears the airspace over the test area ensuring laser deconfliction within a specified SUA. For many laser R&D sites, however, it is not possible to restrict airspace from encroaching aircraft completely, and therefore processes for AD have been developed and put in place. The Federal Aviation Administration FAA oversees AD and safeguards the National Airspace System NAS through FAA Order 7400.2. This order is augmented through current agreements between the FAA Regional Centers and the DoD Major Range Test and Facility Base MRTFBs. These agreements are not well documented, nor are they standardized. The MRTFBs take the lead in safeguarding aircraft in the range airspace; laser programs rely upon the current range processes to clear the airspace for test operations. This inconsistency creates challenges at the program level and does not lend itself to testing systems at multiple ranges under various environmental and operational conditions.

To address these challenges, the High Energy Laser-Joint Technology Office (HEL-JTO) has identified five major stakeholders who have vested interests and capabilities which they safeguard. Within each stakeholder community are many different organizations but at top level they include: the Laser Community, the DoD Operations Community, the Space Community, the Test & Evaluation Community, and Aviation Community. The development of new or changes to existing processes will require coordination and consensus across all five communities.

CONCLUSION and WAY FORWARD:

The end state for fielding this capability is a standardized Joint Laser Deconfliction Safety System (JLDSS) that provides a decentralized command and control/fire control capability. JLDSS program planning is being pursued by the HEL-JTO and the Navy under a Joint project environment. The principle hurdle for fielding JLDSS capabilities is policy and guidance changes to DODI 3100.11. The stakeholder's have been working with OSD Space Policy to revise DODI 3100.11 to create a balance between the HEL weapon system operators and Space owner/operators and the risk associated with inadvertent illumination. JLDSS will require a decentralized PA and AD capability integrated into a risk based and comprehensive safety process for HEL systems. This probabilistic risk-based methodology is in development at the Air Force Research Laboratory's Satellite Assessment Center. Timelines for implementing JLDSS will be driven by analysis-based revision of DoD policies, the implementation of FAA operational procedures, DoD weapons demonstrations, and associated safety analysis and certifications. Initial work is underway at the Naval Surface Ware Center Dahlgren Division where they are developing a government off-theshelf Hybrid Predictive Avoidance Safety System (HPASS) that will integrate the HEL platforms with space, air, and surface asset protection systems within the current command and range control systems. A deliberate approach is necessary to lay the groundwork for an operational JLDSS capability. This program plan will identify and recommend cross-governmental partnering, teaming, and collaboration so that the laser community can take advantage of key transformational technologies leading to a JLDSS capability to support the design, build, test, and operation in a DoD/FAA network-centric compliant system.

The JLDSS is proposed as a safety-based toolset that provides HEL fire control solutions. These solutions must incorporate mission planning, operational use, and post-mission analysis associated with HEL system test and operations. Use of the JLDSS will operate at a system high security classification level needed for interfacing with command and control nodes, and classified/ unclassified data sources for aviation, surface and space operational situational information. HEL system pointing angle information will provide the basis for command and control and fire control which will link information to operators.

As envisioned, the JSPOC will automatically push satellite orbital element updates, to include protected satellites, to the JLDSS where space object and satellite positional information could be computed using Air Force Space Command's (AFSPC) Astrodynamics Standards compatible algorithms. In this construct, real-time PA and AD results will be combined with HEL system information to provide a "safe to fire" signal to the HEL system. A similar push is anticipated for the aviation data feeds.

The HEL-JTO is focusing on improving the posture of the laser community in addressing PA and AD during test, training and operations. Championing HEL technologies and capabilities is a charter mission for the HEL-JTO. Without this push and the collaborative work from the HEL-JTO and the stakeholder community, the potential payoff in enhanced joint warfighter capabilities derived from HEL operations will not be realized in the tactical battlespace environment.