SAND2012-1676P

Project Accomplishment Summary

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Operated for the U.S. Department of Energy by
Sandia Corporation
Albuquerque, New Mexico

PROJECT ACCOMPLISHMENTS SUMMARY

Cooperative Research and Development Agreement (#1714)

between **Sandia National Labs** and Northrop Grumman Systems Corporation

Note: This Project Accomplishments Summary will serve to meet the requirements for a final abstract and final report as specified in Article XI of the CRADA.

Title: Unmanned Air Vehicle (UAV) Ultra-Persistence Research

Final Abstract:

Sandia National Laboratories and Northrop Grumman Corporation Integrated Systems, Unmanned Systems (NGIS UMS) collaborated to further ultra-persistence technologies for unmanned air vehicles (UAVs). The greatest shortfalls in UAV capabilities have been repeatedly identified as 1) insufficient flight persistence or "hang time," 2) marginal electrical power for running higher power avionics and payload systems, and 3) inadequate communications bandwidth and reach. NGIS UMS requested support from Sandia to develop an ultra-persistent propulsion and power system (UP3S) for potential incorporation into next generation UAV systems. The team members tried to determine which energy storage and power generation concepts could most effectively push UAV propulsion and electrical power capabilities to increase UAV sortie duration from days to months while increasing available electrical power at least two-fold.

Primary research and development areas that were pursued included these goals: perform general system engineering and integration analyses; develop initial thermal and electrical power estimates; provide mass, volume, dimensional, and balance estimates; conduct preliminary safety assessments; assess logistics support requirements; perform, preliminary assessments of any security and safeguards; evaluate options for removal, replacement, and disposition of materials; generally advance the potential of the UP3S concept.

The effort contrasted and compared eight heat sources technologies, three power conversion, two dual cycle propulsion system configurations, and a single electrical power generation scheme. Overall performance, specific power parameters, technical complexities, security, safety, and other operational features were successfully investigated. Large and medium sized UAV systems were envisioned and operational flight profiles were developed for each concept. Heat source creation and support challenges for domestic and expeditionary operations were considered. Fundamental cost driver analysis was also performed. System development plans were drafted in order to determine where the technological and programmatic critical paths lay.

As a result of this effort, UAVs were to be able to provide far more surveillance time and intelligence information per mission while reducing the high cost of support activities. This technology was intended to create unmatched global capabilities to observe and preempt terrorist and weapon of mass destruction (WMD) activities. Various DOE laboratory and contractor personnel and facilities could have been used to perform detailed engineering, fabrication, assembly and test operations including follow-on operational support. Unfortunately, none of the results will be used in the near-term or mid-term future. NGIS UMS and SNL felt that the technical goals for the project were accomplished. NGIS UMS was quite pleased with the results of analysis and design although it was disappointing to all that the political realities would not allow use of the results. Technology and system designs evaluated under this CRADA had previously never been applied to unmanned air vehicles (UAVs). Based upon logistic support cost predictions, because the UAVs would not have had to refuel as often, forward basing support costs could have been reduced due to a

decrease in the number and extent of support systems and personnel being required to operate UAVs in remote areas.

Basic application of the advanced propulsion and power approach is well understood and industry now understands the technical, safety, and political issues surrounding implementation of these strategies. However, the overall economic impact was not investigated. The results will not be applied/implemented. No near-term benefit to industry or the taxpayer will be encountered as a result of these studies.

Background:

The state of the art in unmanned flight systems prior to this effort was to depend entirely on hydrocarbon or hydrogen fuels for propulsion and electrical power creation. This leads operational units to be reliant on costly and fragile long haul fuel supply chains in order to accomplish their missions. This CRADA effort was instituted to learn whether it was possible to break expensive traditional logistical support constructs and create a propulsion and power configuration that would drastically increase operational performance and remove the primary logistical load on operational units thereby allowing them to focus their critical resources on providing "more tooth" and "less tail." NGIS UMS and Sandia teamed to tackle this challenge since NGIS UMS had the industrial leadership position in unmanned flight systems while Sandia had extensive knowledge in the realm of alternative power technologies.

Description:

The purpose/objective of the project was to further ultra-persistence technologies for unmanned air vehicles (UAVs). The greatest shortfalls in UAV capabilities have been repeatedly identified as 1) insufficient flight persistence or "hang time," 2) marginal electrical power for running higher power avionics and payload systems, and 3) inadequate communications bandwidth and reach. This effort was broken into four task areas: Task 1 - UP3S Systems Engineering Analyses, Task 2 - UP3S Project Planning, Task 3 - Briefing Support, and Task 4 - Interim and Final Reports.

Under task 1, Sandia conducted computer-based engineering and literature-based process analyses to meet the technical and programmatic requirements. Based on requirements and direction provided by NGIS UMS, Sandia performed focused studies to translate stated needs into conceptual designs and processes that could be transferred easily from Sandia to industry design and production personnel. Propulsion and power system topics included include fuel cycle analyses, scalability of systems, control systems, safety, security and safeguards analyses, electronic system survivability and hardness, decommissioning and disposal analyses, logistics support analyses including main operating base (MOB) issues, and life cycle cost analyses. Also, Sandia helped identify new processes, designs, hardware, software, safety, and reliability required for improved national UAV performance. Sandia assisted NGIS UMS to baseline at least one future UAV configuration with new energy and power systems to meet emerging U.S. military operational needs. Sandia conducted analyses at component and system-levels that emerged during the project. No physical asset testing or demonstrations was performed during this effort. Deliverables from Task 1 included the results of the analyses and studies, including presentation materials. Under task 2, Sandia and NGIS UMS developed technology development requirements, projected costs, schedule, manpower, facilities, equipment, associated resources, key experiments, demonstrations, tests, and decisions, operational system modifications versus new system acquisition. Deliverables from task 2 included the results of the analyses and studies. Under task 3, Sandia helped the NGIS UMS UP3S team to develop and present briefing materials. Due to the nature of topical expertise required for the project and the dependence of NGIS UMS upon Sandia's subject matter experts (SMEs), Sandia supported NGIS UMS in providing "tag team" briefings to Northrop Grumman Corporation (NGC) upper management and non-NGC entities (e.g. industry partners, government). NGIS UMS staff presented the materials that NGIS UMS developed and in which they had expertise; Sandia did the same for its materials. Finally, under task 4, Sandia provided progress reports to NGIS UMS at their request, using their format.

Upon completion of the CRADA, Sandia provided a final out-brief to NGIS UMS. Accomplishments: The effort concentrated on propulsion and power technologies that went well beyond existing hydrocarbon technologies. It contrasted and compared eight heat sources technologies, three power conversion, two dual cycle propulsion system configurations, and a single electrical power generation scheme. Overall

performance, specific power parameters, technical complexities, security, safety, and other operational features were successfully investigated. Large and medium sized UAV systems were envisioned and operational flight profiles were developed for each concept. Heat source creation and support challenges for domestic and expeditionary operations were considered. Fundamental cost driver analysis was also performed. System development plans were drafted in order to determine where the technological and programmatic critical paths lay. NGIS UMS and SNL felt that the technical goals for the project were accomplished. NGIS UMS was quite pleased with the results of analysis and design although it was disappointing to all that the political realities would not allow use of the results.

Benefits to the Department of Energy:

This project was intended to support specific strategic Defense Programs R&D goals, core competencies, and plans at the DOE facilities if the results were to be implemented. This project focused on supporting Sandia's Defense Systems and Assessments (DS&A) Strategic Management Unit (SMU) from the Integrated Military Systems (IMS) Center 5400 by promoting development of advanced propulsion and electric power generation for more electric unmanned aircraft (MEUA). Results were to be used in the next generation of unmanned air vehicles used for military and intelligence applications. Through these technologies, UAVs were to be able to provide far more surveillance time and intelligence information per mission while reducing the high cost of support activities. As investigation, development, and fielding of this new unmanned air vehicle (UAV) propulsion and power approach were to be achieved through the national labs, the United States would have created unmatched global capabilities to observe and preempt terrorist and weapon of mass destruction (WMD) activities. Various DOE laboratory and contractor personnel and facilities could have been used to perform detailed engineering, fabrication, assembly and test operations including follow-on operational support. None of the results are currently in use by DOE and it is doubtful that they will be used in the near-term or mid-term future. Currently, none of the results can be shared openly with the public due to national security constraints.

Economic Impact:

Technology and system designs evaluated under this CRADA have previously never been applied to unmanned air vehicles (UAVs). Use of these technologies would have provided system performance unparalleled by other existing technologies. Northrop Grumman and the U.S. military would have received new propulsion and power options that are not currently available. Based upon logistic support cost predictions, because the UAVs would not have had to refuel as often, forward basing support costs could have been reduced due to a decrease in the number and extent of support systems and personnel being required to operate UAVs in remote areas. Basic application of the advanced propulsion and power approach is well understood; however, the overall economic impact was not investigated due to termination of the effort. The results will not be applied/implemented. However, industry now understands the technical, safety, and political issues surrounding implementation of these strategies. Industry now knows how significantly aerial operations can be improved by using these propulsion and power approaches even though current political conditions will not allow use of the results. No near-term benefit to industry or the taxpayer will be encountered as a result of these studies.

Project Status:

Completed

ADDITIONAL INFORMATION

Laboratory/Department of Energy Facility Point of Contact for Information on Project

Steven B. Dron
Sandia National Laboratories
PO Box 5800 MS 1158
Dept 5424, Bldg 971
Albuquerque, NM 87185

505.845.7126 (office)
505.284.1373 (FAX)

Company Size and Points of Contact

Industrial partner:

Northrop Grumman Integrated Systems / Unmanned Systems (NGIS/UMS)
Rancho Bernardo, CA

Technical POC:

Stephen Johnson
17066 Goldentop Rd
Rancho Bernardo, CA
stephen.johnson@ngc.com
949-678-9534

CRADA Intellectual Property

None

Technology Commercialization

No commercialization

Project Examples

There are no tangible items related to the project that could be used in a show and tell situation (e.g. during Congressional testimony). There are no photographs that help explain what was accomplished under the CRADA.

PROJECT ACCOMPLISHMENTS SUMMARY
Cooperative Research and Development Agreement (SC05/01714)
between **Sandia National Laboratories** and **Northrop Grumman Systems Corporation**

This summary has been approved for public release by Sandia and Northrop Grumman Systems Corporation

Sandia National Laboratories

By Steven B. Dron — 24 June 2011

Steven B. Dron
Principal Investigator — Date

Sandia National Laboratories

By [signature] — 6/23/2011

Manager
WFO/CRADA Agreements — Date

Northrop Grumman Systems Corporation

By _____ _____

Title: — Date

In order to expedite the process, if we do not receive your signed reply by 7/24/2011 we will assume your concurrence for the release of this document to the public.