

**Contract No. R-022-031**  
**“Solar Soaring Power Manager”**  
Submitted by Packet Digital LLC  
Principal Investigator: Andrew Paulsen

**PARTICIPANTS**

<b>Sponsor</b>	<b>Cost Share</b>
Packet Digital	\$250,000
Naval Research Lab	<u>\$260,000</u>
Subtotal Cash Cost Share	\$ 510,000
North Dakota Industrial Commission	<u>\$500,000</u>
Total Project Cost	\$1,010,000

Project Schedule – 9 months	Project Deliverables:
Contract Date – October 8, 2014	Status Report: February 15, 2015 ✓
Start Date – October 1, 2014	Final Report: July 31, 2015 ✓
Completion Date – June 30, 2015	

**OBJECTIVE/STATEMENT OF WORK:**

The primary objective of this project is to enable a persistent, low-altitude UAS to initially double fly times and ultimately provide unlimited endurance. This will be achieved by:

- Harnessing solar energy with high efficiency, flexible photovoltaics,
- Autosoaring technology to enable the UAV to autonomously gain lift from rising hot air, and
- Advanced power management algorithms.

The project involves a variety of partners including the Naval Research Lab (NRL), ComDel Innovation, NDSU, and UND. Of the 50% match, \$250,000 comes from Packet Digital (Private Investor) and \$260,000 comes from NRL. This is the first stage of a multi-phase project.

If successful, this project offers opportunities for the advancement of UAS and solar energy utilization in North Dakota. It also offers North Dakota companies partnership opportunities for manufacturing in the emerging UAV industry.

**STATUS:**

Final Status report has been received and is posted on the website. The applicant has received approval for funding of the next phase of this project.

Summary of Phase I Deliverables:

Target: Produce a solar cell covering the desired spectrum with 30-50% efficiency, with a target of 40%  
Result: 37% efficiency has been achieved in the lab, a path to 40% identified, and manufacturing of 27% efficient cells has begun.

Target: Develop an algorithm for achieving Maximum Power Point Tracking (MPPT) for the prototype solar cell

Result: MPPT hardware is complete in a small package (45g) with rapid convergence (1kHz update frequency).

Target: Create a prototype power management solution with greater than 90% efficiency, with a target of 95%.

Result: PMAD achieves 97.2% (12V) and 95.6% (5V) efficiency.

Target: Define the architecture for the power electronics solution to be implemented in custom silicon

Result: Architecture has been defined.

Target: Develop improved soaring algorithms based on the mathematical model for thermal updrafts

Result: Hardware prototype for onboard algorithm execution is complete.

Target: Test all prototyped solutions integrated in a lab environment.

Result: Entire system functions together in a mock-UAS setup.

During Phase 1, NRL made significant progress increasing the efficiency of solar cells, including flexible cells required for mounting on a UAS. Packet Digital successfully completed the design of the solar soaring UAS power delivery system. The MPPT, PMAD, and smart battery are working together as per requirements. A custom UAS integrated circuit architecture has been defined, and a full system test flight is scheduled for September.

8/25/2015