

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                |                                                          |                                                          |                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------|----------------------------------------------------------|----------------------------------------------------------|---------------------------------------|
| <b>REPORT DOCUMENTATION PAGE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                                | Form Approved OMB NO. 0704-0188                          |                                                          |                                       |
| <p>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA, 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p> <p>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</p> |                   |                                |                                                          |                                                          |                                       |
| 1. REPORT DATE (DD-MM-YYYY)<br>24-12-2015                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   | 2. REPORT TYPE<br>Final Report |                                                          | 3. DATES COVERED (From - To)<br>1-Sep-2014 - 31-Aug-2015 |                                       |
| 4. TITLE AND SUBTITLE<br>Final Report: Development System for FPGA-Controlled, Portable Processing Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |                                | 5a. CONTRACT NUMBER<br>W911NF-14-1-0548                  |                                                          |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                | 5b. GRANT NUMBER                                         |                                                          |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                | 5c. PROGRAM ELEMENT NUMBER<br>611103                     |                                                          |                                       |
| 6. AUTHORS<br>Maciej Noras                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                   |                                | 5d. PROJECT NUMBER                                       |                                                          |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                | 5e. TASK NUMBER                                          |                                                          |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                | 5f. WORK UNIT NUMBER                                     |                                                          |                                       |
| 7. PERFORMING ORGANIZATION NAMES AND ADDRESSES<br>University of North Carolina - Charlotte<br>9201 University City Boulevard<br><br>Charlotte, NC 28223 -0001                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                                | 8. PERFORMING ORGANIZATION REPORT NUMBER                 |                                                          |                                       |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS (ES)<br>U.S. Army Research Office<br>P.O. Box 12211<br>Research Triangle Park, NC 27709-2211                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |                                | 10. SPONSOR/MONITOR'S ACRONYM(S)<br>ARO                  |                                                          |                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                | 11. SPONSOR/MONITOR'S REPORT NUMBER(S)<br>65095-EL-RIP.1 |                                                          |                                       |
| 12. DISTRIBUTION AVAILABILITY STATEMENT<br>Approved for Public Release; Distribution Unlimited                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |                                |                                                          |                                                          |                                       |
| 13. SUPPLEMENTARY NOTES<br>The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                |                                                          |                                                          |                                       |
| 14. ABSTRACT<br>The goal of this proposal was to establish an infrastructure for Field programmable Gate Array (FPGA) programming and development of algorithms which will be used in work on implementing custom data processing capabilities in small, ultra-low power, portable devices. This system is intended to support existing DoD projects and will enable work on future generation of "smart" electronics for use in military and other applications. The equipment will be used in the Laboratory for Instrumentation, Sensors and Power Electronics (LISPEL) at the University of North Carolina at Charlotte (UNCC). The platform will be based on a Peripheral Component                                                                                                                                                                                                                                          |                   |                                |                                                          |                                                          |                                       |
| 15. SUBJECT TERMS<br>field gate programmable array system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |                                |                                                          |                                                          |                                       |
| 16. SECURITY CLASSIFICATION OF:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                | 17. LIMITATION OF ABSTRACT                               | 15. NUMBER OF PAGES                                      | 19a. NAME OF RESPONSIBLE PERSON       |
| a. REPORT<br>UU                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | b. ABSTRACT<br>UU | c. THIS PAGE<br>UU             |                                                          |                                                          | Maciej Noras                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |                                |                                                          |                                                          | 19b. TELEPHONE NUMBER<br>704-687-5053 |



## Report Title

Final Report: Development System for FPGA-Controlled, Portable Processing Systems

### ABSTRACT

The goal of this proposal was to establish an infrastructure for Field programmable Gate Array (FPGA) programming and development of algorithms which will be used in work on implementing custom data processing capabilities in small, ultra-low power, portable devices. This system is intended to support existing DoD projects and will enable work on future generation of “smart” electronics for use in military and other applications. The equipment will be used in the Laboratory for Instrumentation, Sensors and Power Electronics (LISPEL) at the University of North Carolina at Charlotte (UNCC). The platform will be based on a Peripheral Component Interconnect eXtensions for Instrumentation (PXI) system. This modular instrumentation architecture will allow for easy deployment of our data processing schemes on the devices. Right now all the processing is done after transmitting the acquired data to a computer. By moving the processing to the front end of the data gathering chain, we expect to reduce or completely eliminate communication between any external data gathering center and the peripheral devices collecting the information. Only the essential information will be conveyed, thus eliminating the data “clutter” haunting multi-node, data acquisition systems. In addition to the FPGA development capabilities the system will allow us to automate tests of the devices, as it includes all the necessary signal generation, control, and acquisition modules.

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**Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:**

**(a) Papers published in peer-reviewed journals (N/A for none)**

Received

Paper

**TOTAL:**

**Number of Papers published in peer-reviewed journals:**

---

**(b) Papers published in non-peer-reviewed journals (N/A for none)**

Received

Paper

**TOTAL:**

**Number of Papers published in non peer-reviewed journals:**

---

**(c) Presentations**

Number of Presentations: 0.00

---

**Non Peer-Reviewed Conference Proceeding publications (other than abstracts):**

Received      Paper

**TOTAL:**

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

---

**Peer-Reviewed Conference Proceeding publications (other than abstracts):**

Received      Paper

**TOTAL:**

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

---

**(d) Manuscripts**

Received      Paper

**TOTAL:**

Number of Manuscripts:

Books

Received      Book

TOTAL:

Received      Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

none

Graduate Students

| <u>NAME</u>     | <u>PERCENT_SUPPORTED</u> |
|-----------------|--------------------------|
| FTE Equivalent: |                          |
| Total Number:   |                          |

Names of Post Doctorates

| <u>NAME</u>     | <u>PERCENT_SUPPORTED</u> |
|-----------------|--------------------------|
| FTE Equivalent: |                          |
| Total Number:   |                          |

---

### Names of Faculty Supported

| <u>NAME</u>            | <u>PERCENT SUPPORTED</u> | National Academy Member |
|------------------------|--------------------------|-------------------------|
| Maciej Noras           | 0.00                     |                         |
| Aidan Browne           | 0.00                     |                         |
| <b>FTE Equivalent:</b> | <b>0.00</b>              |                         |
| <b>Total Number:</b>   | <b>2</b>                 |                         |

### Names of Under Graduate students supported

| <u>NAME</u>            | <u>PERCENT SUPPORTED</u> |
|------------------------|--------------------------|
| <b>FTE Equivalent:</b> |                          |
| <b>Total Number:</b>   |                          |

### Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: ..... 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense ..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields: ..... 0.00

---

### Names of Personnel receiving masters degrees

|                      |
|----------------------|
| <u>NAME</u>          |
| <b>Total Number:</b> |

### Names of personnel receiving PHDs

|                      |
|----------------------|
| <u>NAME</u>          |
| <b>Total Number:</b> |

### Names of other research staff

| <u>NAME</u>            | <u>PERCENT SUPPORTED</u> |
|------------------------|--------------------------|
| <b>FTE Equivalent:</b> |                          |
| <b>Total Number:</b>   |                          |

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Sub Contractors (DD882)

## **Inventions (DD882)**

### **Scientific Progress**

The acquired equipment was put to use as intended.

### **Technology Transfer**

none

**The University of North Carolina at Charlotte**  
**PI Report (Condensed Version) - Generated: 12/08/15 10.42.25**

Fiscal Year: 2016   Period: 05 (Ending 11/30/2015)  
Grant Title: 553193 - Development System for FPGA-Controlled, Portable P  
Fund: 530193 - Development System for FPGA-Control  
Agency: Army Research Office  
PI: Noras, Maciej A.  
Grant Type: G - Grant                      Category: F - Federal  
Organization: 21800 - Engineering Technology  
Project Start: 2014/09/01   Project End: 2015/08/31   Project Close: N  
Budget Start: 2014/09/01   Budget End: 2015/08/31

Proposal Number (NORM Format): 14-0244

Indirect Cost Base: -  
Indirect Cost Rate:% -  
Indirect Cost Charge: -  
Indirect Cost Distribution Code: -

Distribution of Facilities & Administrative Overhead Charges:

| Fund | Organization | Account | Program | Percent of Distribution |
|------|--------------|---------|---------|-------------------------|
|------|--------------|---------|---------|-------------------------|

Inception to Date Fund Overview  
Fiscal Year: 2016 Period: 05 (Ending 11/30/2015)  
Fund: 530193 - Development System for FPGA-Control  
Generated: 12/08/15 10.42.25

|                              | Revised<br>Budget | ITD Activity | Encumbrances | MTD Activity | Remaining<br>Balance |
|------------------------------|-------------------|--------------|--------------|--------------|----------------------|
| Salaries                     |                   |              |              |              |                      |
| Faculty Release Time         |                   |              |              |              |                      |
| Faculty Summer Salary        |                   |              |              |              |                      |
| Post Doc Students            |                   |              |              |              |                      |
| Graduate Students Contract   |                   |              |              |              |                      |
| Student Temp Wages           |                   |              |              |              |                      |
| Undergraduate Students       |                   |              |              |              |                      |
| SPA Regular Salaries         |                   |              |              |              |                      |
| EPA Regular Salaries         |                   |              |              |              |                      |
| Overtime/Premium             |                   |              |              |              |                      |
| Non Student Regular Wages    |                   |              |              |              |                      |
| Work Study                   |                   |              |              |              |                      |
| Total Salaries               |                   |              |              |              |                      |
| Benefits                     |                   |              |              |              |                      |
| Workers Compensation         |                   |              |              |              |                      |
| Medical Insurance            |                   |              |              |              |                      |
| Optional Retirement          |                   |              |              |              |                      |
| Other Retirement             |                   |              |              |              |                      |
| Social Security              |                   |              |              |              |                      |
| Unemployment Compensation    |                   |              |              |              |                      |
| Other Benefits               |                   |              |              |              |                      |
| Total Benefits               |                   |              |              |              |                      |
| Supplies and Materials       |                   |              |              |              |                      |
| Supplies                     |                   |              |              |              |                      |
| Non Capital Equipment        | 76,420.00         | .00          | .00          | .00          | 76,420.00            |
| Capital Equipment            | .00               | 76,420.00    | .00          | -135.00      | -76,420.00           |
| Other Non Capital Resources  |                   |              |              |              |                      |
| Other Capital Resources      |                   |              |              |              |                      |
| Total Supplies and Materials | 76,420.00         | 76,420.00    | .00          | -135.00      | .00                  |
| Services                     |                   |              |              |              |                      |
| Honorariums/Consulting Fees  |                   |              |              |              |                      |

Participant Stipend  
Other Participant Cost  
Research Subcontracts Under \$25K  
Research Subcontracts Over \$25K  
Service Contracts  
Domestic Travel  
Foreign Travel  
Fixed Purchased Services  
Other Purchased Services  
Other Services  
Other Administrative Expenses  
Fixed Charges  
Administrative Fees

Total Services

Tuition and Fees

Transfers-Out

Utilities

Other Non-Operating Expenses

Accounts Not Applicable

Total Direct Expenses76,420.0076,420.00.00-135.00.00

Facilities and Admin

Total Expenses76,420.0076,420.00.00-135.00.00

**YTD Fund Overview****Fiscal Year: 2016 Period: 05 (Ending 11/30/2015)****Fund: 530193 - Development System for FPGA-Control****Generated: 12/08/15 10.42.25**

|                                     | <b>Revised<br/>Budget</b> | <b>YTD Activity</b> | <b>Encumbrances</b> | <b>MTD Activity</b> | <b>Remaining<br/>Balance</b> |
|-------------------------------------|---------------------------|---------------------|---------------------|---------------------|------------------------------|
| <b>Salaries</b>                     |                           |                     |                     |                     |                              |
| Faculty Release Time                |                           |                     |                     |                     |                              |
| Faculty Summer Salary               |                           |                     |                     |                     |                              |
| Post Doc Students                   |                           |                     |                     |                     |                              |
| Graduate Students Contract          |                           |                     |                     |                     |                              |
| Student Temp Wages                  |                           |                     |                     |                     |                              |
| Undergraduate Students              |                           |                     |                     |                     |                              |
| SPA Regular Salaries                |                           |                     |                     |                     |                              |
| EPA Regular Salaries                |                           |                     |                     |                     |                              |
| Overtime/Premium                    |                           |                     |                     |                     |                              |
| Non Student Regular Wages           |                           |                     |                     |                     |                              |
| Work Study                          |                           |                     |                     |                     |                              |
| <b>Total Salaries</b>               |                           |                     |                     |                     |                              |
| <b>Benefits</b>                     |                           |                     |                     |                     |                              |
| Workers Compensation                |                           |                     |                     |                     |                              |
| Medical Insurance                   |                           |                     |                     |                     |                              |
| Optional Retirement                 |                           |                     |                     |                     |                              |
| Other Retirement                    |                           |                     |                     |                     |                              |
| Social Security                     |                           |                     |                     |                     |                              |
| Unemployment Compensation           |                           |                     |                     |                     |                              |
| Other Benefits                      |                           |                     |                     |                     |                              |
| <b>Total Benefits</b>               |                           |                     |                     |                     |                              |
| <b>Supplies and Materials</b>       |                           |                     |                     |                     |                              |
| Supplies                            |                           |                     |                     |                     |                              |
| Non Capital Equipment               | 76,420.00                 | .00                 | .00                 | .00                 | 76,420.00                    |
| Capital Equipment                   | -76,555.00                | -135.00             | .00                 | -135.00             | -76,420.00                   |
| Other Non Capital Resources         |                           |                     |                     |                     |                              |
| Other Capital Resources             |                           |                     |                     |                     |                              |
| <b>Total Supplies and Materials</b> | <b>-135.00</b>            | <b>-135.00</b>      | <b>.00</b>          | <b>-135.00</b>      | <b>.00</b>                   |

**Services****Honorariums/Consulting Fees**

Participant Stipend  
Other Participant Cost  
Research Subcontracts Under \$25K  
Research Subcontracts Over \$25K  
Service Contracts  
Domestic Travel  
Foreign Travel  
Fixed Purchased Services  
Other Purchased Services  
Other Services  
Other Administrative Expenses  
Fixed Charges  
Facilities and Admin  
Administrative Fees

Total Services

Tuition and Fees

Transfers-Out

Utilities

Other Non-Operating Expenses

Accounts Not Applicable

|                       |         |         |     |         |     |
|-----------------------|---------|---------|-----|---------|-----|
| Total Direct Expenses | -135.00 | -135.00 | .00 | -135.00 | .00 |
|-----------------------|---------|---------|-----|---------|-----|

Facilities and Admin

|                |         |         |     |         |     |
|----------------|---------|---------|-----|---------|-----|
| Total Expenses | -135.00 | -135.00 | .00 | -135.00 | .00 |
|----------------|---------|---------|-----|---------|-----|

**YTD Expense Detail**  
**Fiscal Year: 2016   Period: 05 (Ending 11/30/2015)**  
**Fund: 530193 Development System for FPGA-Control**  
**Generated: 12/08/15 10.42.25**

| Fiscal Year                                                              | Fiscal Period | Document # | Activity Date | Encumb Amount | YTD Activity Description                 | User Id  |
|--------------------------------------------------------------------------|---------------|------------|---------------|---------------|------------------------------------------|----------|
| Account Type: Supplies and Materials                                     |               |            |               |               |                                          |          |
| Account: 944085      ( 944000      ) Fabricated Equipment                |               |            |               |               |                                          |          |
| 2016                                                                     | 05            | I0535102   | 2015/11/03    | .00           | -135.00 National Instruments Corporation | SCALLAWA |
|                                                                          |               |            | 2015/11/13    | .00           | 135.00 National Instruments Corporation  | SCALLAWA |
| * Total Account 944085                                                   |               |            |               | .00           | .00                                      |          |
| Account: 944520      ( 944000      ) Engineer/Draft Equip Cap 2-8yr life |               |            |               |               |                                          |          |
| 2016                                                                     | 05            | DL011376   | 2015/11/25    | .00           | -135.00 Overpayment to vendor            | PABOETTC |
| * Total Account 944520                                                   |               |            |               | .00           | -135.00                                  |          |
| * Total Account Type   Supplies and Materials                            |               |            |               | .00           | -135.00                                  |          |
| Total Expenses                                                           |               |            |               | .00           | -135.00                                  |          |

YTD Labor and Benefit Expense Detail

Fund:  
Generated: 12/08/15 10.42.25

| Fiscal |    |      |         |              |          |          | Trans | Document | Payroll | Payroll |       | Trans  |
|--------|----|------|---------|--------------|----------|----------|-------|----------|---------|---------|-------|--------|
| Year   | Id | Name | Account | Account Desc | Position | Document | Date  | Date     | Event   | Number  | Hours | Amount |