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Project Number: **02**

Project Sponsor:

Parsons, Centreville, VA

Project Title: **F23-02 (Parsons 2) Multipath Router Implementation**

SME: tbd, tbd

Customer POC: Jordan Scott, Parsons, Jordan.Scott@parsons.us

Parsons develops and integrates systems and platforms with multiple communication systems. This project interests us with the potential integration of cross-vendor/platform/technology to enhance our systems' communication capabilities. The project's results would be used to develop solutions that could be directly applicable to the Parsons customers and missions. We request the students design. Implement, test, and deliver a simple multi-path communications router capable of routing over rf, wire/fiber, laser, etc. The specific set of protocols will be proposed by the design team and approved by both the customer and SME NLT architecture design concepts. The intent of this router would be to integrate communication systems within platforms or missions to automatically enhance redundant communication data flows. It should intelligently allocate paths for optimal performance, function in degraded networks, and ensure integrity.

- The routing should contain a protocol to wrap existing communication data and formats to reduce other component modifications.
- The protocol should be flexible enough to adjust routing based on the environment and success of configurations.
- The configuration should be easy to establish and reduce human error.
- The product could be software-based, but FPGA solutions would add value and would be preferred.
- Performance data evaluation must include latency to switch, characterization of passthrough limitations, and error/loss rates.
- The product must be compatible with current mesh network technologies and should be adaptable to 5G networks.

NOTES: Project team members need to be US Citizens.

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Project Number: **03**

Project Sponsor:

Parsons, Centreville, VA

Project Title: **F23-03 (Parsons 3) 2-4 GHz Energy Detection Device**

SME: tbd, tbd

Customer POC: Anthony Kempka, Parsons,

Parsons provides Technical Surveillance Countermeasures (TSCM) systems and services to its customers. This project interests us with the potential development of new tools platforms and technologies to enhance TSCM services. The project's results would be used to develop solutions that could be directly applicable to the Parsons customers and missions. Today the 2.4Ghz RF band is very crowded with unlicensed RF devices using Wi-Fi, Bluetooth, Zigbee, and other protocols. This spectrum crowding makes it difficult to locate and assess if there are any transmitters within a defined area. We request the students research and develop a simple 2.4Ghz band RF energy detector and recorder. The intent of this detector is to identify and help to locate unknown 2.4GHz sources within a defined area, such as a particular room within a building, and differentiate them from the ambient 2.4Ghz transmissions created by nearby Wi-Fi or other known devices.

- Ideally, the detector will be a self-contained portable system that records RF energy in a standard format that can be visualized using industry standard tools.
- Use audio or visual feedback to guide user to locate a device when surveying a room.
- Devices to test with may include BLE emitters (Apple Air Tag), Zigbee IoT devices, bluetooth speaker, or cell phone with Wi-Fi or Bluetooth enabled.
- Possible designs could use a chip such as LT5581 (e.g., Mikroe RF Meter 3 Click)
- Possible processor choices could include but are not limited to a Sparkfun Thing Plus RP2040 or RP2040 mikroBUS, Adafruit Feather RP2040, PIMORONI PICO, or the PI PICO itself.

NOTES: Project team members need to be US Citizens.

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Project Number: **04**

Project Sponsor:

Parsons, Centreville, VA

Project Title: **F23-04 (Parsons 4) String Obfuscation Software**

SME: Paul Plassmann, pep3@vt.edu

Customer POC: Brent Goodwin, Parsons,

Parsons develops and deploys software that represents significant investments of intellectual property and capital by our customers. Developing and applying anti-reverse engineering techniques such as this helps prevent other parties from discovering algorithms and techniques used in the deployed software. This is of interest to Parsons as it helps us assure the customer that their investments are protected from unnecessary loss.

We request the students design, implement, test, and deliver novel techniques to obfuscate constant strings present in compiled executables and libraries so-as to prevent (or at least hinder) their discovery during reverse engineering. One approach we have been considering is to use a pre-compile step to remove all constant strings from the source code and place them into some sort of encrypted storage blob, replacing with some form of indexing hash that can be used to retrieve the decrypted original when needed at run-time.

- Following the obfuscation stage, plain text constant strings must not be accessible in the binary using common system tools such as strings.exe.
- At runtime, the actual value of the strings are re-assigned to their appropriate variables as needed, but are removed from memory when no longer needed.
- The design should be portable across operating systems (Windows, MacOS, Android, iOS), and platforms (ARM 64, Intel x86-64)
  - MVP solution must compile and correctly execute on two different hardware and OS platforms approved by the customer in advance
  - Most successful solution would support 3 or more configurations

NOTES: Project team members need to be US Citizens.

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Project Number: **05**

Project Sponsor:

Parsons, Centreville, VA

Project Title: **F23-05 (Parsons 5) Secure Python compiler and bytecode interpreter**

SME: Sook Ha, sook@vt.edu

Customer POC: Brent Goodwin, Parsons,

Parsons develops and deploys software that represents significant investments of intellectual property and capital by our customers. Developing and applying anti-reverse engineering techniques such as this helps prevent other parties from discovering algorithms and techniques used in the deployed software. This is of interest to Parsons as it helps us assure the customer that their investments are protected from unnecessary loss.

We request the students design, implement, test, and deliver an extension to the Python language compiler and bytecode interpreter that allows python to create, load and execute encrypted bytecode.

- Application sources will need to be compiled and encrypted prior to being deployed to the host where they will execute. Application sources themselves may not be required to be encrypted but unencrypted source files must not be deployed to the host where the application is executing.
- While a common encryption algorithm should be used, encrypted bytecode that's deployed to different hosts should be unique, verifiable by comparing their SHA 256 hash digest values.
- The design should use established encryption standards, such as AES.
- The design must include efforts to prevent discovery of the encryption key/IV used to decrypt the files.
- The decrypted files should not be written to disk prior to being executed. Protection of the plain-text bytecode while in memory is not required for this project, but would be a desirable option.

NOTES: Project team members need to be US Citizens.

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Project Number: **06**

Project Sponsor:

Science Systems and Applications, Inc. , Lanham, MD

Project Title: **F23-06 (SSAI) Next Gen DC/DC Converter for CubeSats**

SME: Chris Green, christopher.m.green-1@nasa.gov, Customer POC: Jackie Kendall, jackie.kendall@ssaihq.com,

For this project, we seek development and evaluation of concepts and production of at least one working prototype for a next generation DC/DC converter that: 1) utilizes emerging technologies to exceed the power output capacity and efficiency ratings of currently available off-the-shelf (OTS) products; and 2) is suitable for use in a very small spacecraft instrument.

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Project Number: **07**

Project Sponsor:

VT ECE NSF-SWIFT-IC

Project Title: **F23-07 (VT ECE) L-Band Satellite Tracking and Characterization System**

SME: Steve Ellingson, ellingson.1@vt.edu

Customer POC: Steve Ellingson, ellingson.1@vt.edu,

We seek a portable system consisting of a high-gain antenna on a portable mount with motorized two-axis (i.e., “az-el” or equatorial) positioning to keep the antenna pointed at the satellite for the duration of an observation. The system includes a sensitive receiver with high immunity to spectrally-disjoint signals not of interest, and continuous Nyquist-rate sampling and streaming to local non-volatile storage.

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Project Number: **08**

Project Sponsor:

Virginia Commonwealth University (VCU)

Project Title: **F23-08 (VCU) Machine Learning - Computer Vision / Object-Detection**

SME: Creed Jones, crjones4@vt.edu

Customer POC: Creed Jones, crjones5@vt.edu

The fields of computer vision and object detection are evolving rapidly, and AIP Branch is invested in identifying and applying state-of-the-art detection model concepts from sources such as academia. This proposal seeks to identify one or more promising new methods, apply them to real data, and quantitatively assess their performance against a test data set. Countermine / AIP currently has a new unclassified RGB dataset that consists of various vehicles and people cleaned and amassed from several public datasets. AIP would like to task ASPIRE participants with developing real-time object-detection models to examine novel model architectures to be leveraged for internal algorithm development.

AIP will also be initiating an approval process for an additional dataset that was collected from long-wave infrared (LWIR) sensors on various vehicles and people. If this data is formally approved for release when the program begins, all participants will need to be U.S. citizens in order to support this work. The participants involved for this project should focus design and development in small object-detection modelling. The field of small object-detection is under researched and could give way to publishable material.

AIP will work with participants and standup bi-monthly meetings to discuss updates and deliverables. A baseline model for the RGB dataset will be delivered by the students 2 months from the program start date with an expected minimum mAP@0.5 of approximately 0.5. AIP will expect additional fine-tuned models at the program's conclusion.

NOTES: Project team members need to be US Citizens.

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Project Number: **09**

Project Sponsor:

Aerospace Corp

Project Title: **F23-09 (Aerospace) Sensor Fusion for Autonomous Navigation**

SME: John Janeski, John.A.Janeski@aero.org

Customer POC: John Janeski, John.A.Janeski@aero.org

Autonomous vehicles (e.g. self-driving cars, satellites, UAVs) rely on Position, Navigation and Timing (PNT) systems to determine the vehicle's current position/attitude and time, the next desired position/attitude and the required position, velocity and acceleration corrections needed to get to the desired state. A prior design team developed a low Size, Weight and Power (SWaP) sensor suite for a PNT sensor designed to help a vehicle navigate in through short periods where it's primary PNT system does not have access to Global Navigation Satellite System (GNSS) signals. The focus of this design effort is to implement the sensor fusion algorithms to form a navigation solution. The design team will be responsible for developing the code needed to ingest data from the PNT sensors, translate the data into the correct coordinate frames, run the provided sensor fusion algorithms and form a navigation solution. The team will also need to characterize both individual sensor performance (required to tune the navigation algorithms) and fused navigation solution performance.
The project will develop the navigation software needed to implement sensor fusion algorithms and provide a full navigation solution. The sensor fusion algorithms will be provided to the team as well as the hardware on which the software will run.
In addition to developing the software, the team will need to characterize the performance of the sensor suite that when integrated will provide the navigation solution in order to tune the sensor fusion algorithms. The design effort will culminate in characterizing the performance improvement of the fused solution over individual sensor outputs.
Deliverables:
* Fully functional navigation software that will blend outputs from multiple sensors to form a position and attitude solution.
* Test procedure and results from characterization of each sensor's performance in a static environment.
* Characterization of the unit's SWaP to ensure it meets provided requirements

NOTES: Project team members need to be US Citizens.

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Project Number: **10**

Project Sponsor:

Interstellar Dreams Space Center

Project Title: **F23-10 (Dreams Space) Simulation Development**

SME: tbd, tbd

Customer POC: Robin McDougal,

The Interstellar Dreams Space Center is a program of the Pearl Project Institute for Innovation in S.T.E.M. Literacy, which is a 501(c)3 non-profit organization. The Interstellar Dreams Space Center is committed to expanding the aerospace workforce by creating S.T.E.M. literate youth—especially girls.

It is a unique blend of virtual and real-time space science learning designed to inspire, incite, and nurture S.T.E.M. literacy. Our purpose is to leverage space exploration as a tool to cultivate an awareness of S.T.E.M. careers in aerospace, beyond being an astronaut. Our mission is to nurture the next generation of "Top Tier" S.T.E.M. talent, especially among underrepresented populations, to take a seat at the global leadership table. The Interstellar Dreams Space Center specializes in simulation and immersion as an educational tool designed to simulate NASA's mission control, an off-planet space station and planetary habitat for students in a mix of videos and LED lighting.

The student team will design, build, test, and deliver a solution based on the "LED wall" in our facility. It may be either a mobile, transportable, or smaller installable version which can support remote locations. The design will include at least two different interactive educational activities which can be used for STEM camp kids aged 6-18 years old. The solution will engage, analyze, and cultivate an understanding of how information technology, audio visual technology and 3D technology are used to create a simulated learning environment made of LED Walls.

The LED wall is a 12foot immersive LED environment designed to appear to be a "NASA like" Space Station and Planetary habitat.

- Analyze emissive vs reflective method of displaying an image.
- Evaluate multiple panels made up of smaller modules to determine how color is emitted.
- Identify the relationship between pixel pitch and resolution
- Classify optimum installation procedures.

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Project Number: **11**

Project Sponsor:

VT CPES, Blacksburg, VA

Project Title: **F23-11 (CPES 1) Programmable Impedance Network**

SME: Jiaxiong Yu, jxyu@vt.edu

Customer POC: Richard Zhang, zhangr@vt.edu,

This project is to build a programmable impedance network for low- and medium-voltage lab environment. The impedance network consists of multiple semiconductor switches. By controlling on and off of each switch, the network can behave as a controllable impedance network with each line Z=f(t).

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Project Number: **12**

Project Sponsor:

Breeze-Eastern, LLC

Project Title: **F23-12 (Breeze-Eastern) Swing stabilization for MEDEVAC rescues**

SME: Mary Lanzerotti, Walter Lacarbonara,

Customer POC: Ian Azeredo,Thomas R. Aldhizer,

There is a need for a mechanical stabilization system for low-mass sling loads in medical evacuation (MEDEVAC) rescues. Such a system has potential for integration for use by Black Hawk helicopters in the U.S. Army. Breeze-Eastern LLC manufactures the hoists on Black Hawk helicopters used in the U.S. Army. Collaborators also include an expert in nonlinear dynamics who is a faculty member at Sapienza University in Rome, Italy as well as a faculty in Blacksburg, VA. An officer in the U.S. Army expressed interest in the possibility of the team participating in a "Marne Innovations Challenge." The main objective of this research is to characterize the existing device, simulate the variables, and characterize a 30-foot cable with scaled weights in the Virginia Tech Institute for Creativity, Arts, and Technology (ICAT).

Participating students will design, test, and characterize stabilization control models of suspended loads, simulating live rescue scenarios from helicopter platforms. Building from work from previous cadets, students, and industry professionals, participants in this program will model rescue hoist scenarios, develop creative approaches, perform engineering trade-off analyses, and account for realistic variables and constraints (see section 3.0) in the design and executed simulations. Students will document their work and processes to sponsors and peers. A primary goal will be to engineer a proof-of-concept demonstration in order to justify next-step testing on combat helicopter platforms.

Students may also have the opportunity to participate in a "Marne Innovations Challenge" organized through the U.S. Army contact LT Thomas Aldhizer at Ft. Stewart, GA.

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Project Number: **13**

Project Sponsor:

VT CPES, Blacksburg, VA

Project Title: **F23-13 (CPES 2) Communication Interface Development for Power Converters in Microgrids**

SME: Haris Bin Ashraf, Vladimir Mitrovic,,

Customer POC: Dushan Boroyevich, Richard Zhang,,

In a microgrid, there are multiple power converters connected to different energy sources, such as PV panels, wind energy generators, and battery storage. In order to form a microgrid, these power converters need to work in collaboration. For this purpose, a communication interface will be developed through this MDE project. Several converters will be connected to a central controller (computer) through wired communication. The software interface will send and receive data packets to and from the converters, so that a control algorithm can dispatch commands and receive measurements from any of the converters.

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Project Number: **14**

Project Sponsor:

VT ECE, Wireless@VT

Project Title: **F23-14 (VT ECE) Measurement and Test Automation using Low Cost Instruments**

SME: Carl Dietrich, cdietric@vt.edu

Customer POC: Carl Dietrich, cdietric@vt.edu

Design, develop, and make available on Github, an open-source VISA/SCPI interface for the tinySA (Sub-$100 spectrum analyzer that has its own command set and USB interface [1]) for use with PyVISA [2]. Demonstrate use of the interface by automating measurements and data analysis. The successful project will include general purpose tools and analytics that can be programmed to implement at least three different test routines including multiple measurements and at least two different composite data analysis and visualization routines.

[1] https://tinysa.org/wiki/pmwiki.php?n=Main.USBInterface
[2] https://pyvisa.readthedocs.io/en/latest/

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