**Facilities, Equipment and Other Resources**

***Florida Institute for Cybersecurity Research (FICS)***

At the University of Florida, the project will be conducted at the Florida Institute for Cybersecurity Research (or FICS). FICS was organized in 2015 to provide the University with a physical and intellectual environment necessary for interdisciplinary cybersecurity research and applications to meet the challenges of the future in the field of assurance and security. The FICS Research Institute covers all areas of information and hardware security including security of mobile devices and networks, integrated circuits and systems, internet-of-things, cyber physical systems, and emerging nanotechnology devices. PI Traynor is co-director of FICS and PI Butler leads systems security research within the institute. As part of its mission, FICS is committed to enhancing the educational experiences for a diverse set of top-quality graduate and undergraduate students, and to developing revolutionary knowledge and technologies with a tangible impact on industry and government. FICS disseminates research and research-education information through publications, invited talks, poster sessions, tutorials, and webinars at leading international conferences, workshops, and events as well as the FICS annual conference.

FICS is sufficiently equipped to provide the appropriate technical, computing, algorithmic, equipment, or other relevant services needed to successfully carry out the work described in this proposal. We recently developed the FICS SeCurity and AssuraNce (SCAN) Lab, which consists of 2500 square feet of newly renovated lab space, over $7M in research equipment (listed below), and operating personnel to support research activities. The main sponsors of SCAN Lab are TESCAN, ZEISS, Tektronix, and Intel. Ellisys has also contributed through donation of a USB protocol analyzer, and we are in discussion with them to acquire new USB protocol analyzers to support Type-C devices, for which they offer us freely available access, and Bluetooth protocol analyzers supporting both classic and Bluetooth Low Energy protocols. This equipment along with the oscilloscopes and logic analyzers listed below will aid in our analysis of mobile devices and their communication capabilities. The inspection and test equipment below, particularly the X-Ray tomography device and the NanoFab chip editor, will assist in our firmware extraction and analysis activities, while our server infrastructure will aid with the application analysis and network simulation and emulation.

*I. Physical Inspection Equipment:*

1. *Tomography-* Bruker SkyScan 2211 MultiScale X-ray Nano-CT System
2. *Spectroscopy and Spectrometry-* (i) Magritek KEA MF 1-50 KEA2 Spectrometer: Dual Transmit Channels, Frequency Range 1 MHz – 50 MHz, Fast USB2.0 DSP module, Broadband op-amp duplexer, 1 Watt amplifier; (ii) EDAX detector mounted on SEM to perform Energy Dispersive Spectroscopy (EDS)
3. *Microscopy and Circuit Edit-* (i) TESCAN FERA-GM Xe Plasma FIB-SEM; (ii) TESCAN LYRA-XM Ga LMIS FIB-SEM; (iii) ZEISS ORION NanoFab He-Ne System

*II. Electrical Test Equipment:*

1. *Automatic Testing Equipment (ATE)-* Verigy Ocelot ZFP, Loadboard designed for acelot ZFP, and ASIC test setup using FPGA board
2. *Burn-in Test and Thermal Cycling Setup-* Temptronic Bench Top Temperature Test System ATS 605 Thermostream, -20 to +225°C
3. *Mixed Signal Oscilloscopes-* (i) Tektronix MSO70404C, 4 GHz Mixed Signal Oscilloscope; 4 analog / 16 logic channels; (ii) Tektronix MSO2022B Mixed Signal Oscilloscope; Digital Phosphor, 200 MHz, 1 GS/s, 1M record length, 2+16−ch; (iii) Tektronix MDO3102 Mixed Domain Oscilloscope; (2) 1GHz analog channels, 10M record length, 1GHz spectrum analyzer
4. *USB Protocol Analyzer –* (i) Ellisys USB Explorer 200 Protocol Analyzer
5. *Digital Oscilloscopes-* (i) Tektronix DSA8300 Digital Serial Analyzer Sampling Oscilloscope; (ii) Tektronix TDS3032C DPO, 300MHZ, 2.5 GS/S, 2 CHANNEL; (iii) Tektronix TBS1202B−EDU Digital Storage Oscilloscope: 200MHz bandwidth, 2GS/s sample rate, 2 channel, 2.5K record length
6. *Logic Analyzers-* (i) Tektronix TLA6401 34 Channel, 25 GHz MagniVu Timing, 333 MHz State Clock, 2Mb Record Length Logic Analyzer; (ii) Tektronix TLA6404 136 Channel, 25 GHz MagniVu Timing, 333 MHz State Clock, 2Mb Record Length Logic Analyzer
7. *Spectrum Analyzers-* (i) Tektronix PA1000 Single−Phase Power Analyzer; (ii) Tektronix RSA5115B Real Time Signal Analyzer 1 Hz−15 GHz
8. *Arbitrary Waveform Generator-* Keithley3390 50MHz Arbitrary Waveform Generator
9. *Arbitrary Function Generators-* (i) Tektronix AFG3101C Arbitrary Function Generator: 1Channel, 100MHz Bandwidth, 1GSa/s sampling rate, 128k points arbitrary waveform memory, 14−bit vertical resolution, 10Vpp to 50ohm; (ii) Tektronix AFG3252C Arbitrary Function Generator: 2Channel, 240MHz Bandwidth, 2GMSa/s sampling rate, 128k points arbitrary waveform memory, 14−bit vertical resolution, 5Vpp to 50ohm
10. *Power Supplies-* (i) Keithley 2200−20−5 Power Supply, 20 Volts, 5 Amps DC Programmable; (ii) Keithley PWS2185 Power Supply,0−18 V, 5 Amp DC; (iii) Keithley 2231A−30−3 Manual Triple Channel DC Power Supply
11. *Digital Multimeters-* (i)Keithley 2100/120 6.5 Digit Dmm set to 120V; (ii) Keithley 2110−120 5.5 Digit DMM; (iii) Tektronix DMM4040 Digital Precision Multimeter, 6.5 digits 0.0035% accuracy, dual/graphic display

*III. Computing Equipment and Software*

1. *Workstations*- 30 Dell OptiPlex workstations equipped with Windows and Linux
2. *Servers-* 4 Supermicro servers, each with two 10-core Xeon E5 v4 processors, 40 TB of raw storage, 12 Gbps SAS backplane, 128GB of RAM (one with 512 GB of RAM), and dual 10 Gb Ethernet.
3. *CAD Tools-* HSPICE, Cadence (Analog Artist, Analog Virtuoso, Diva, Pdracula, SpectreRF), Synopsys and Cadence Digital flow, ADS and HFSS and Ensemble for Electro-magnetic field simulations, Matlab

More details about FICS SCAN lab and equipment can be found at <http://fics-institute.org/facilities/>.

***UF College of Engineering***

The Office of Research and Facilities in the UF College of Engineering supports the college’s faculty, staff, and students in developing and maintaining internationally recognized research programs in areas such as Advanced Manufacturing, Autonomous Systems, Big Data, Cybersecurity, Human Centered Computing, Materials Innovation, and Renewable Energy. The Associate Dean for Research and Facilities oversees this office, working within and outside the college to identify new research opportunities, facilitate interdisciplinary pursuits, and interface with federal and state agencies, industry, and foundations. Units within this office include the ***Research Service Centers*** – providing UF persons and external users with fee-based access to major experimental facilities for characterization and fabrication, and the ***Office of Laboratory Safety*** – developing and implementing policies and procedures that contribute to the safe operation of all College of Engineering laboratories.

***UF******Research Computing***

In 2011, the University of Florida made a 5-year commitment to build out the facility into a comprehensive cyber infrastructure for research computing, creating the department of Research Computing as a part of UF IT. UF Research Computing has grown to a permanent staff of 12.25 FTE. A matching program started in the summer of 2011 has added over 100 new research groups making the commitment to work with UF Research Computing for their needs for high-performance computing and research data storage. Further details on UF Research Computing can be found at <http://www.it.ufl.edu/units/> and <http://www.rc.ufl.edu>

*Florida Cyberinfrastructure.* Universities in the state of Florida joined forces in the Sunshine State Education & Research Computing Alliance (SSERCA) to build a robust cyberinfrastructure to share expertise and resources (<http://sserca.org>). The current members are Florida Atlantic University (FAU), Florida International University (FIU), Florida State University (FSU), University of Central Florida (UCF), University of Florida (UF), University of Miami (UM), and University of South Florida (USF). The affiliate institutions are Florida Agricultural and Mechanical University (FAMU), University of North Florida (UNF), and University of West Florida (UWF), Florida Polytechnic University (FPU), Florida Institute of Technology (FIT), Nova South Eastern University, and New College of Florida.

The Florida Lambda Rail (FLR) provides the underlying fiber optic network and network connectivity between these institutions and many others. The FLR backbone completed the upgrade to 100 Gbps in June 2015. The University of Florida is connected to this backbone at the full speed of 100 Gbps and has been connected at that rate to Internet2 backbone since Jan 2013.

*High-performance computing and big-data analytics.* Research Computing operates the **HiPerGator** supercomputer, a cluster-based system with a combined capacity of about 21,000 cores in multi-core servers. In November 2015, this capacity was expanded by adding 30,000 new Intel cores, described at <http://www.rc.ufl.edu/resources/hardware/hipergator-2-0/>, bringing the total to 51,000 cores. The servers are part of an integrated InfiniBand fabric. The clusters share over 5 PetaBytes of distributed storage via the Lustre parallel file system. In addition, Research Computing houses about 2 PB of storage for the High Energy Physics collaboration of the Compact Muon Solenoid (CMS) experiment. The system includes over 100 NVIDIA GPU accelerators and 24 Intel Xeon Phi accelerators, available for experimental and production research, as well as for training and teaching.

*Restricted data storage and analytics.* Research projects may involve storing and processing restricted data, including intellectual property (IP), protected health information (PHI), Controlled Unclassified Information (CUI) regulated by Health Insurance Portability and Accountability Act (HIPAA), International Trade in Arms Regulation (ITAR), Export Administration Regulation (EAR), Family Educational Rights and Privacy Act (FERPA). For such projects Research Computing supports two environments

1. Research Shield <https://shield.ufl.edu/> meets the NIST 800-53 rev4 “moderate” rating for contracts that require FISMA compliance and has been operating since June 2015, and
2. GatorVault <http://www.rc.ufl.edu/resources/hardware/gatorvault/> is approved for PHI, FERPA, IP, and ITAR/EAR restrictions and started operating in December 2015.

More details can be found at <http://www.rc.ufl.edu/services/compliant-environment/>.

*Network infrastructure.* The Research Computing systems are located in the University of Florida data center. The machine room is connected to other campus resources by the 200 gigabit per second Campus Research Network (CRN), now commonly called Science DMZ. The CRN was created with an NSF Major Research Instrumentation award in 2004 and has been maintained by the University since the end of that award. The CRN connects the HPC systems to the Florida Lambda Rail, from which the National Lambda Rail and Internet2 are accessible. The University of Florida was the first institution (April 2013) to meet all requirements become an Internet2 Innovation Platform, which implies the use of software defined networking (SDN), the implementation of a Science DMZ, and a connection at 100 Gb/s to the Internet2 backbone. An NSF CC-NIE award in 2012 funded the 100 Gb/s switch and an NSF MRI grant awarded in 2012 funded the upgrade of the CRN (Science DMZ) to 200 Gb/s. The upgrade has been operational since the winter of 2013.

*UFNet2 virtual network environments.* By the end of 2014, the campus network infrastructure was upgraded to support virtual network environments. These virtual environments enable extending physical networks beyond their physical boundaries that traditionally coincide with individual buildings. There are three physical networks:

1. The Academic network,
2. The Health network that allows protected health information to be stored and accessed,
3. The Campus Research network or Science DMZ connecting HPC resources with data generating instruments.

With the virtual network environments it is possible to connect instruments in any enabled building to the Science DMZ virtual environment, even if the instrument resides in a building that is served by the physical Health network. Similarly researchers can choose to be connected to the Academic virtual network even if their offices are in a Health network building. The virtual environments allow deployment of the correct policies and security measures on a fine-grained scale to meet the needs of the activities of the people using the network. Future virtual network environments to be added include

1. Administrative virtual network environment, with a level of security in between academic and health.
2. Industrial building control network environment will allow separating traffic for monitoring and controlling building systems from the networks used by the occupants of the buildings.

*Space, Power and Cooling.* The funding model for Research Computing includes the commitment from the Provost, the VP for Research, and the VP and CIO to provide for machine-room facilities with electrical power and cooling and professional staff. The University has a substantial investment in research computing infrastructure including a data center completed in 2013 on the East Campus that provides 10,000 sq. ft. of machine room space, of which 5,000 sq. ft. is dedicated to research computing.

*Staffing.* The University pays the salaries of the 20 highly-qualified, staff members, including several with a PhD or Master degree in science or engineering. Staff members, in addition to sharing in the system design, installation, and administration duties, provide application support and consulting services to faculty members, their research associates, and their graduate students. This support ranges from assistance with job flow management and installation of open-source software to teaching students how to improve the MPI performance of their programs.

*Training and Outreach.* Research Computing provides advanced support and training to the user community. Many training materials are now available online. The schedule can be found at <http://wiki.rc.ufl.edu/doc/Training>. In addition, user feedback meetings are held as well as periodic training workshops called *Research Computing Day* are organized every semester. Several graduate courses use HiPerGator and train and prepare graduate students to use the clusters and the software for their thesis research.