UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee Technology

Fee Application

Real-Time Digital Simulator Request

Title

Dr. Farzad Ferdowsi/Dr. Afef Fekih/Mr. Shelby A. Williams, Jr.

Name of Submitter
(Faculty or Staff Only)

Electrical and Computer Engineering/College of Engineering

Organization

Title: Real-Time Digital Simulator Request Date: 01/12/2020

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Department/College/Org: EECE/Engineering/University of Louisiana at Lafayette

ABSTRACT

Energy technologies related fields are critical to the state of Louisiana and the nation. To ensure a better prepared workforce and help ensure the competitiveness of UL Lafayette it is important to provide students with a high quality education and mentorship in fields associated with energy technologies. Additionally, it is crucial to connect theoretical material taught in lecture courses with the realities of physical hardware by providing a realistic environment. Well-equipped and realistic teaching laboratories are the cornerstone of effective education for future engineers. Real-time simulation plays an important role in teaching and research labs these days. *Real-time simulators provide a "safe", "cost effective" and "flexible" testbed for modeling the behavioral dynamics of a wide range of power and energy systems*. It is becoming difficult for students to get access to an efficient realistic power system lab due to the scarcity, cost, and inherent danger associated with high power and high voltage equipment. Therefore, well equipped digital power education platforms and laboratories are vital in educating the next generation of engineers and researchers.

Hence, in order to endow the students with the theoretical foundation for this important discipline, we propose to equip the power lab with a real-time simulator in order to enable the students to conduct a wide array of experiments and take a more effective hands-on approach. With the new proposed equipment, the power laboratory can really be a flexible teaching/research lab. Additionally, the proposed equipment will be made available to students in the following courses: EECE 447, EECE 448, EECE 450, EECE 570, EECE 571, EECE 461, ENGR 517, EECE 550, EECE 505, EECE 437, MCHE 461, MCHE 474, and MCHE 483.

Purpose of the grant and impact to the student body as a whole

This proposal requests funds to equip the power laboratory with a Real-Time Digital Simulator (RTDS) testbed. In order to conduct experiments on power systems (power distribution networks, renewable energies, high voltage transformers, power electronic devices and large-scale generators) there are always two important concerns. The first and foremost concern is the cost of components in high power/high voltage applications which becomes worse when additional components are required for different experiments. In the power and energy area, students are expected to become familiar with the operation and control of electrical machines (generators and motors), power electronic-based components, renewable energy modules (e.g. solar and wind turbines), battery storage systems and different types of electric loads that impose a considerable cost to the University.

The second concern is safety that is currently keeping students away from experiments in this area. Components shown in Figure 1 that are high voltage/high power are not safe for students neither for research nor for educational purposes. Using an RTDS will provide students with great insights into the behavior of power and energy components along with their associated control systems. Additionally, all of the experiments provide a flexible, realistic and safe environment. Such equipment will have a tremendously impact on the students, the university and the state. The beauty of using such a simulator is that a physical hardware or a controller can be added in the loop making a hybrid hardware-simulation test system.

By incorporating as many hands-on experiments as possible into the classroom, we will provide the students with a more effective education, enhance their learning experience, improve their engagement and increase retention. Additionally, we will strengthen the infrastructure of the college, upgrade and increase the availability of technology in the college and on campus and promote the state's economic development by producing a better prepared workforce for the region.

The equipment that we are proposing to purchase will give the students better up-to-date knowledge of the state of the art in energy technologies field. In addition to supplementing the undergraduate power and control courses, this equipment can also be projected as of great value to our graduate program. The courses that will be impacted by the proposed equipment are listed in Table (1).

Table 1. Courses that will use the proposed real-time simulator to enhance the educational goals

Area	Undergraduate	Graduate
Power and Energy	EECE 447, EECE 448, EECE 450, EECE 437, MCHE 483, MCHE 461	EECE 570, EECE 571
Control	EECE 461, MCHE 474	ENGR 517, EECE 550, EECE 505

The incorporation of the RTDS in the educational plans and activities will start with four (4) courses: EECE 447, EECE 570, EECE 461 and EECE 550 that are undergraduate and graduate courses in the power and control areas with the highest enrollment within the College of Engineering. In terms of the research enhancement, graduate research assistants and undergraduate research apprentices in two research labs (Power and Energy Systems lab and

Advanced Control lab) will use the proposed simulator for research studies.

Only within the past academic year, more than 130 students enrolled in power and control courses offered by the EECE department. Considering other courses and also graduate students involved in research, we estimate that at least 150 students will be directly impacted by the new proposed equipment in the first year. More tangible impact is expected after the first year.

By having well equipped facilities, we will provide a complete up to date knowledge for our students, increase their retention, and get better prepared students for the local industry. Moreover, hands on experiments will stimulate their curiosity, complete their knowledge and provide potential recruits for our graduate programs. In summary, the availability of technology in our unit will attract more students to our program and therefore impact the recruitment to our university and promote the state's economic development by providing well prepared engineers.

Figure 1. Components in modern power systems

This proposal requests the purchase of the following real time simulator along with the DSP interface and the TI controller board. The PI has done an extensive research to select the most appropriate RTDS in the market that fulfills both educational and research plans.

1- **Typhoon Hardware in the Loop Real-Time Emulator (602 series):**[1]

2- **HIL UGrid DSP Interface**[2]

3- **TI DSP DIM100 Card**

The above components are suited to introduce fundamental concepts and theories in power and control relevant to real world applications. It comes with ready-made teaching materials for high-power digital control, comprehensive user manual as well as pre-designed controllers and a system model allowing a quick deployment of the lab experiments. A variety of topics in power systems, control theory and system dynamics can be covered, including:

[1] https://www.typhoon-hil.com/products/hil602
[2] https://www.typhoon-hil.com/products/hil-ugrid-dsp-interface

- Testing complex, fast, adaptive, and multilayered control and communication actions
- Electric motors
- Inverters, engine-generators and switchgears
- Central control desk
- Battery storage systems
- Derivation of simple dynamic models
- Incorporating of
- Control parameters tuning
- Implementation and analysis of various control designs

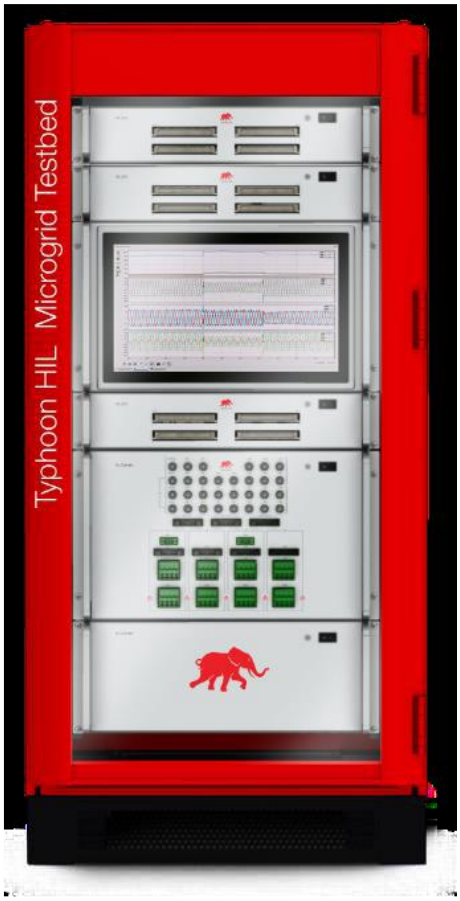

Figure 2. Typhoon real-time digital simulator

Projected lifetime of enhancement

The projected lifetime of the equipment requested is ten years. 2 years warranty is included in the quote.

People Responsible

Mr. Shelby Williams is the laboratory manager for the Electrical and Computer Engineering Department. He will be responsible for the implementation, installation and provisioning of the equipment.
Dr. Farzad Ferdowsi & Dr. Afef Fekih will manage the equipment operation by managing teaching labs on power and control courses respectively.

Activities and Timeline

Year 1

Upon receipt of the STEP funding in May 2020, the PI will place orders to purchase the equipment and supplies. During summer 2020, the simulator will be installed in room#240 in Madison Hall and will be tested/calibrated. Four class projects will be developed by Dr. Ferdowsi and Dr. Fekih (two for power classes and two for control classes at undergraduate and graduate levels). Also, potential research activities have been already been identified in our internal meetings and also meetings we have had with local industries within the past year (e.g. Entergy and Cleco).

Year 2 to 10

The proposed RTDS will be incorporated in more relevant courses in the college of Engineering. Also, the proposed equipment can really shine on our future grant proposals showing UL's capability in modeling complex interconnected systems in real-time.

Previous Funded Grants

The PI (Ferdowsi) has not previously received any STEP grant.

Budget

	Description	Quantity	Unit Price	Price
Equipment	HIL602+ package w/ permanent license	1	$48,500	$48,500
Discount offered by the company	Academic Discount	1	–$13,112.5	–$13,112.5
Software[1]	Included	Unlimited license	N/A	N/A
Supplies	uGrid DSP Interface	1	$3,950	$3,950
	Daughter Cards & OEM Boards F28379D controlCARD	3	$164.62	$493.86
	Sockets & Adapters	3	$51.77	$155.13
Shipping & Handling[2]				$53.39
Total				**$40,040**

[1]: The permanent software license with unlimited number of seats, remote online support, and approach to the special Power Electronics course materials are all included in the quote above. Also, the company is committed to 1 day of on-site training.

[2]: $40 and $13.39 will be charged as shipping fees for HIL and TI boards respectively.

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Customer #:	Customer #
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Datasheet:	TMDSCNCD28379D Datasheet
ECAD Model:	Build or Request PCB Footprint or Symbol

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1	$51.77	$51.77

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Typhoon HIL, Inc.
15 Ward Street
Somerville, MA 02143 US

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DATE 01/13/2020

EXPIRATION DATE 03/13/2020

ACTIVITY	QTY	RATE	AMOUNT
4.0 Academic packages:HIL602+ package w/ permanent licence Premier University Package. Includes: 1. HIL602+ emulator unit with 2 years of warranty, 2. Permanent device license, Typhoon HIL (Control Center) Software with 4 software updates per year, 3. Online technical support, online HIL academy courses, and the following toolboxes: Expert Power Electronics, Microgrid and Communications.	1	48,500.00	48,500.00
1.0 Hardware:Accessories:HIL uGrid DSP Interface HIL Microgrid DSP Interface Board	1	3,950.00	3,950.00
		Subtotal:	52,450.00
Strategic Academic Partner Discount 20% 25 % special discount for academic customer.	-0.25	52,450.00	-13,112.50
Shipping and handling	1	40.00	40.00

Payment terms: Net30.
Shipping terms: ExWorks Somerville, MA.
Point of Contact:
caroline.almeida@typhoon-hil.com

TOTAL **$39,377.50**