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Michael Fancher (w/ collaborators at EYP, Weidt, Perkin Elmer & NY Power Authority)

Cyber-Physical Systems for System-of-Systems Modeling and Control

TEAM, MISSION AND VISION: A public-private partnership (P3) to develop Cyber-Physical Systems (CPS) under a cross-platform strategy into adjacent markets beginning with a System-of-Systems (SoS) building application that leverages established: 1) open-access shared-use \$200M (net-) Zero Energy Nano (ZEN) "Living Laboratory" facility with \$30M of passive and active clean energy (CE) measures; 2) open-data (closed-source) modeling & analytics tools developed through industry partnerships; 3) open-innovation model with co-located design engineering (DE), data science (DS) & network operation center (NOC) entities. (Figure 1)



Figure 1

TECHNOLOGY: Design, integrate & demonstrate a CPS Building Energy Management System (BEMS) using established CPS modeling and analytical tools that integrate passive and active CE measures in a "living laboratory" test-bed that reacts to constantly changing conditions.

IP POSITION: Background IP on closed-source modeling and analytics tools held by industry partners will enable open-data model generating broad IP with entrepreneurial innovation. Development of open-source BEMS (Control system) will generate joint IP ownership by SUNY Poly & industry partners.

CHALLENGE, BEMS currently act to address singular inputs and operate as independent systems. Bridging silos between components in separate systems for specific applications tied together in a BEMS required. (Figure 3). Access to real-world operational data used in determining both technical and financial viability is one of the leading obstacles to the deployment of CE technologies.

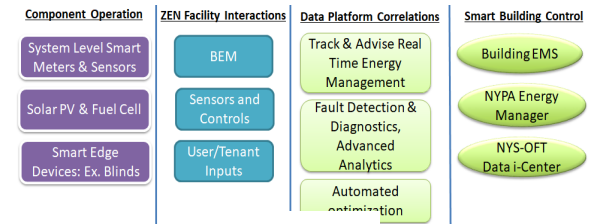


Figure 3

OPPORTUNITY: The CPS ZEN test-bed is truly a "living laboratory" constantly reacting to a changing Northeastern climate where each technology and design measure contribute to achieving the goal of net zero energy over the year as conditions change. To burden-share investment, integrate capabilities, adopt industry standards and accelerate emerging technology and business solutions is possible by establishing a framework for industry, university & government (IUG) partners to support the RD&D pathways of CPS.

IMPACT AND VALUE TO END-USERS: To provide partner visibility into progression of technology and workforce development transitions by demonstrating technical & market viability

PROJECT OBJECTIVES: To develop an open-source CPS using closed-source modeling and analytics tools by providing robust feedback loops among design/engineering > analytics/modeling > control/correlating > deployment/scaling for continuous improvement of the CPS continuum resulting in a field-ready BEMS. Second phase would scale deployment through networked buildings in a closed cluster and then in a distributed open configuration (Figure 2)

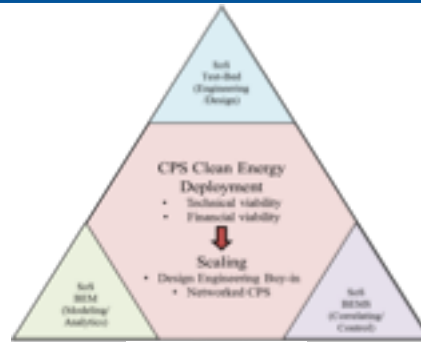


Figure 2

APPLICATIONS:

CPS can optimize each element within a SoS. While the first application for development and demonstration of an integrated Building Energy Management Systems will focus on a commercial building, it can be modified for fab operations.

KEY MILESTONES:

1. Demonstrate active control of the systems on the 5th floor using an existing closed-source/open-data BEMS while concurrently seeking to develop and deploy an open-source BEMS solution in this zone.
2. The BMS and BEMS package will be scaled up and implemented throughout the building, except for the Tier 3 data center located on the first floor.
3. Incorporate CPS related to operation of the Tier 3 data center on the 1st floor and then migrate the BEM, BEMS to an adjacent older building with legacy systems (Figure 1).

FUTURE DEVELOPMENT PLANS:

Subsequent phases with additional funding 1. Demonstrate BMS and BEMS in a network of distributed buildings using the NYP&A NOC for real-time monitoring/control and workforce training of facility operations engineers).