



2021 Virtual HBCU-UP/CREST PI-PD Meeting



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Targeted Infusion Project: Infusion of Cyber Physical System Education and Research Training in the Undergraduate Curriculum in the College of Engineering at TSU

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Project Overview

The evolution of CPS has outpaced the current workforce skills and there is an urgent need to train the future workforce to meet the growing need.

What are Cyber Physical Systems (CPSs)?

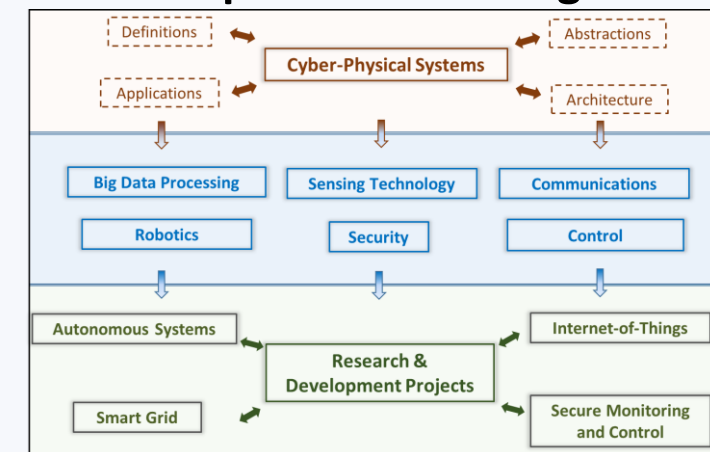
- CPSs integrate *computation, networking, and physical* processes for decision-making and control.
- Can have *humans-in-the-loop* to form *Cyber-Physical-Human Systems (CPHS)*



CPS Education: A Top-Down Approach

- **Proposed Approach:** Orient students with CPSs from an early stage with students gradually gaining detailed understanding of its building blocks.
- Implement a top-down learning paradigm at the *macroscopic* as well as at the *microscopic* levels.

Top-Down Learning

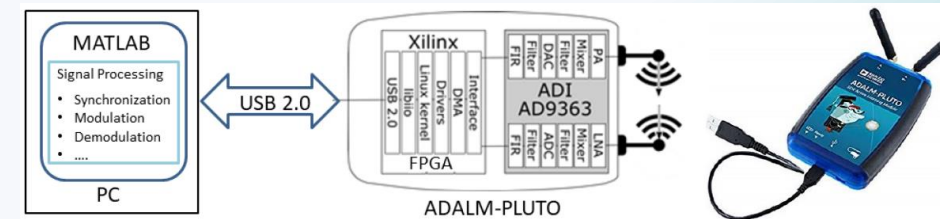


Project Activities

- **Development of two complementary *undergraduate concentrations* related to CPSs in the College of Eng. (CoE):**
 - A new *Cyber-Physical System* concentration in the ECE Dept.
 - A new *Cyber-Security and Networking* concentration in the CS Dept.
- **Development of top-down CPS learning modules, such as on:**
 - *CPS communications, IoT, Sensing Sys., and CPS Programming.*
- **Development of project-based experiential learning platform.**
 - IoT Transceiver design using an affordable Software Defined Radio (SDR) Platform.
- **Integration of Research & Education on CPSs on topics including:**
 - Game theory-based UAV-swarm Sensing.
 - Resource constrained Smart Sensing in CPS.
 - CPS security.
- **Dissemination of project results.**

Example Top-down Learning Modules: CPS Communications and Networking

- **Module 1:** Application layer of CPSs: Provide students abstract view of CPSs
- **Module 2:** OPC Unified Architecture (OPC-UA): A service-oriented architectures for CPSs having various communication abstractions
- **Module 3:** Transport layer mechanisms (OPC UA Binary, UA TCP) that enables OPC-UA
- **Module 4:** OPC router and routing protocols that enable transport layer
- **Module 5:** Machine-to-Machine (M2M) communications in CPSs



Example Lab Module: IoT Communications using ADALM-PLUTO SDR

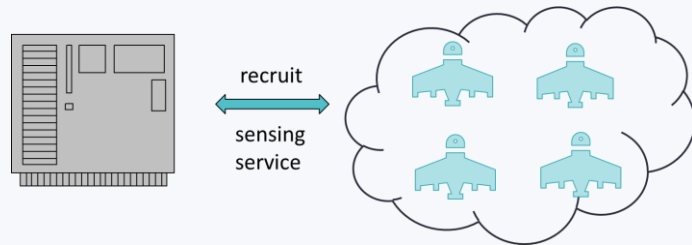
Implications

Helped to greatly enhance student engagement & learning

- Maintain *desired focus* in students.
- Not only imparted knowledge on CPSs, but also imparted *generally applicable knowledge* on areas beyond CPSs.

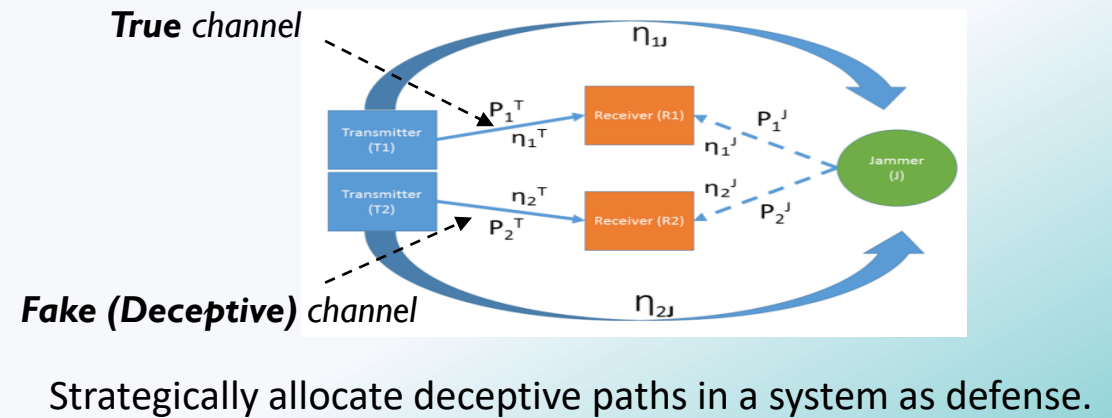
Catalyzed Research & Development efforts on CPS

Example: Game theory-based UAV-swarm Sensing



A central platform recruits UAVs by strategically incentivizing them to move to desired regions for localizing an object.

Example: Deception-based CPS Security



The Road Ahead and Enhancements

- Continue development and refinement of the concentrations on *Cyber-Physical Systems* and *Cyber-Security and Networking* for enhancing education and preparing a competitive workforce in CPSs.
- Continue development of CPS related top-down *learning modules* and refine them based on procured feedback and evaluation.
- *Integrate research with education* and catalyze interdisciplinary research and development activities in areas related to CPSs.
- Continue to disseminate project results.