

Resilient Cyber-Physical Societal Scale Systems Research in the Philippines



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FORCES NSF Review Meeting
Arlington, VA 25-26 January 2017

The Philippines



Source: Google images

- Southeast Asian country
- 2013 census puts 99M population
- 2015 GDP USD 292B
- Current GDP growth rate 6.6%

Philippine Colonial History

- 333 years of Spanish colonization (1565-1898), ending with the end of the Spanish-American War (Battle of Manila Bay, 1898)
- 1899-1902 Philippine-American War
- ~50 years as American colony, becoming a commonwealth with semi-independence in 1935; interrupted by Japanese occupation during WWII
- Independence in 1946

PCARI

- Commission on Higher Education (CHED)
 - 2012 Joint Agreement between PH and US government for Philippine California Advanced Research Institutes (PCARI)
- Two virtual institutes:
 - Information Infrastructure Development (IID)
 - Health Innovation and Translational Medicine (HITM)
- Initial UC partners: UC Berkeley and UCSF
- USAID STRIDE

PCARI Funding

- Budgeted in 2013 and 2014 of PH GAA (P1.763 B annually, now approximately USD\$35M/year)
- Mission:
 - "... enhance skills and expertise of faculty and staff of PH universities and colleges..."
 - Scholarships, training, and research partnerships with research universities in California (UC Berkeley, Davis, San Francisco, Los Angeles)

Current PCARI Projects Cycle I (2013)

■ IHITM

- High Throughput Screening of Philippine Terrestrial and Marine Organisms for Antimalarial Properties and Identification of Novel Drug Targets
- Philippine UC-Collaboratory for Device Innovation
- Accessible Detection of Dengue using BioMems and MIP Materials
- Expansion of the Shared Genomics Core Facility in the Philippines

■ IIID

- Resilient Sensory Swarms for Smart Energy and Environment Monitoring
- Village Base Station
- Resilient Cyber Physical Societal Scale Systems
- Cost-Effective Manufacturing Using Printing Fabrication Technologies for Energy Generation, Conditioning, and Monitoring Devices

Cycle 2 Projects (2015)

■ IHITM

- Increasing the Rates of Newborn Hearing Screening with Novel Technologies and Telehealth
- Metagenomic Contributions to Type 2 Diabetes Among Filipino Populations

■ IIID

- E-Participation 2.0: Connecting Diverse Philippine Populations for Disaster Risk Management with a Toolkit Integrating Text and Speech Analytics
- GREEN POWER: Generating Renewable Energy via Electrolysis of Water using New Power Hybrid Systems
- Resilient Electricity Grids
- CITAS: Cloud-based Intelligent Total Analysis System using Geospatial Wireless Sensors and Mobile Microscopy
- 3rd Generation VCSEL for Resilient Communication Networks (3V-ReCoN)

Cycle 3 Projects (2016)

■ IHITM

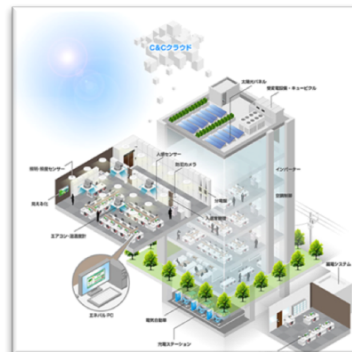
- Wearable Cardiac Arrhythmia Monitor based on Low-Power Radar Principles
- One Health: Innovations in Early Detection and Interventions in Human, Animal, and Plant Health
- Establishment of a Philippine Cancer Phenome-Biobanking System and Biomonitoring Program

■ IIID

- AIRSCAN: Collaborative Aerial Robotics in Large-Scale Urban Infrastructure Management
- nanoQuench: Synthesis and Modelling of Porous Activated Graphene Nanofilters for Precise Water Purification and Desalination
- Development of Wireless Sensor Network-Based Water Information System For Efficient Irrigation Water Management in the Philippines
- Chemical and Environment - Portable Sensor Technologies (CE-PoST)

PCARI IIID 54 Objective

Improve the safety, security, and reliability of key Philippine infrastructure systems and services & partner with Philippine universities to advance the country's research and development capacity in CPS



IID54 Team

- University of the Philippines (UP)
 - Computer Science
 - Susan Festin
 - Adrian Roy Valdez
 - Electrical and Electronics Engineering
 - Michael Pedrasa
 - Jhoanna Ibabao-Pedrasa
 - Roel Ocampo
 - Isabel Montes
- UC Berkeley
 - Larry Rohrbough
 - Kameshwar Poolla
 - Anil Aswani
 - Anthony Joseph

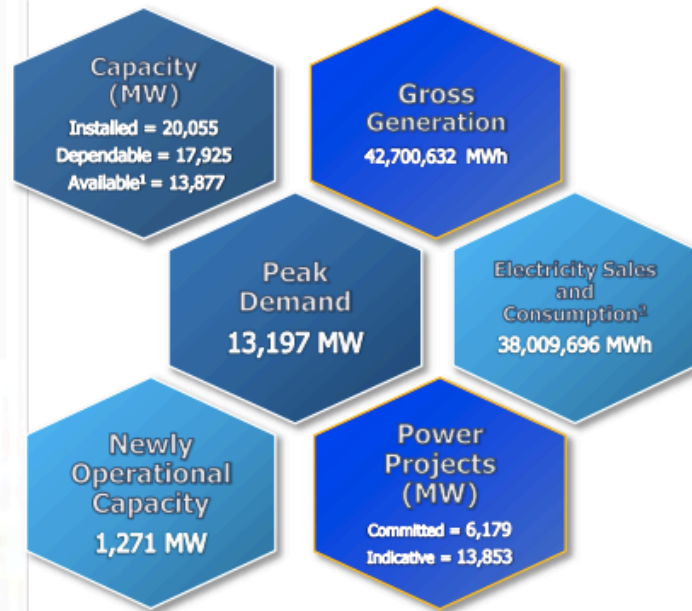
Resilient CPS in the Philippines

- There are various possible applications of resilient CPS in the Philippines:
 - Micro-grid design
 - Sensor placement for water distribution networks
 - Building energy management using retrofitted sensors
- There is likewise a need to integrate CPS concepts into EECS programs in PH as well as to expand cyber system security awareness.

IID54 Application Domains

1. Micro-grid Design for Rural Areas in PH

JANUARY-JUNE 2016 POWER SITUATION HIGHLIGHTS



¹Total Average Available Capacity
²Preliminary Data as of May 2016

- 1999: 76.9% of barangays (villages) had electricity
- Goal: 100% rural village electrification by 2008; 90% household electrification by 2017
- 2006 status:
 - Luzon: 97.15%
 - Visayas: 96.24%
 - Mindanao: 87.43%

1. Micro-grid Design for Rural Areas in PH



- Flat rate charge for electricity
- Diesel generator (no renewable)
- Ad hoc, community run
- Light demand

1. Micro-grid Design for Rural Areas in PH

- 2014 Palawan Green Island Hybrid Renewable Energy Power System
- USAID
 - 25.5kW
 - Solar, biomass, wind
 - 50 households

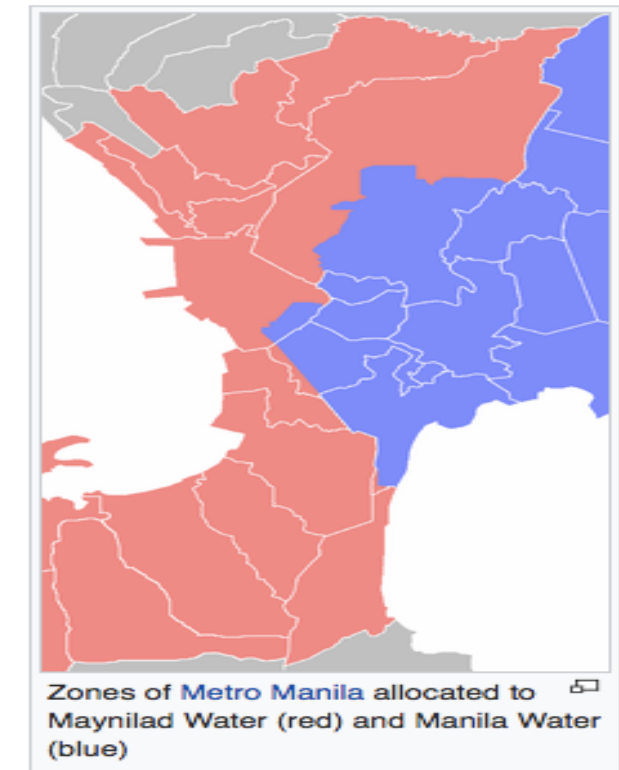


Micro-grids for Resilient Rural Electricity Service

- UCB Work
 - Initial modeling by Porter, Poolla, et al on microgrid setup (generator + battery)
 - Find optimum dispatch for an off-grid microgrid
- UPD work
 - Design of off-grid microgrid systems with spatial constraints
 - Resilience of microgrids with decentralized decision making models
 - Hybrid energy storage technologies for isolated microgrids
 - Techno-economic assessment of autonomous microgrids
 - Optimal economic dispatch solver for remote isolated microgrids with storage
 - Estimating Rural Load Profiles from Public Data Sources

2. Resilient Sensor Placement in PH WDNs

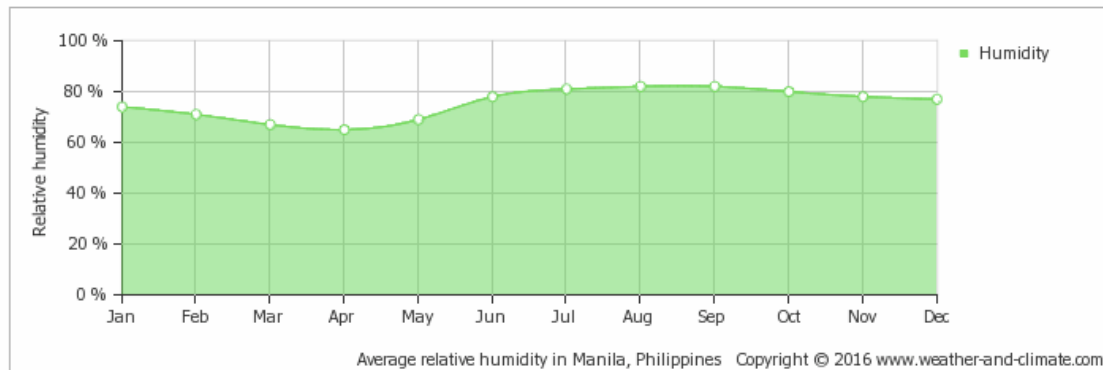
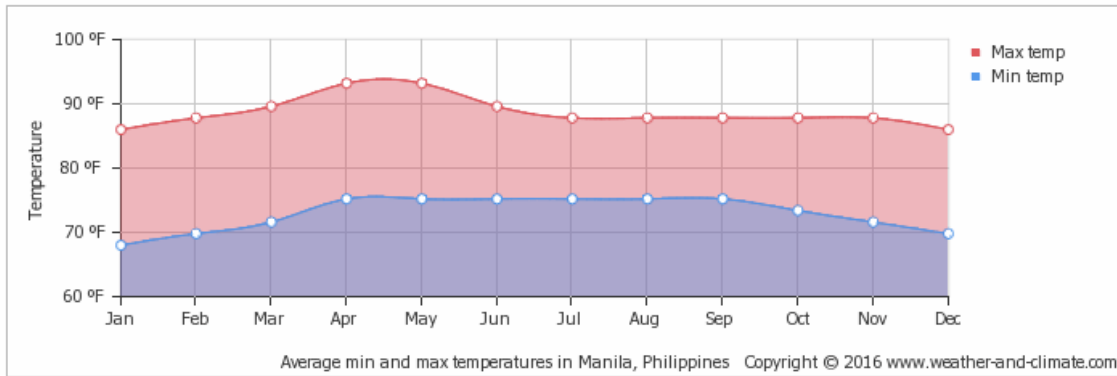
- Metropolitan Waterworks and Sewerage System (MWSS)
- Privatization 1997
- Asset maps of several business areas of water utility
- Data on faults reported
- Sensor placement analysis wrt hazard maps



Sensor placement and scheduling for Water Distribution Networks

- FORCES work
 - Laszka, Abbas, et al
 - Detecting fault and failures in WDN
 - Sensor placement
 - Sensor scheduling (sleep schedule to conserve battery power)
 - Detection performance
- IIID54 work
 - Specific for water utility company in PH
 - Differences:
 - Sensor types
 - Different constraints
 - Attack/fault classification

3. Building Energy Efficiency Using Retrofitted Sensors



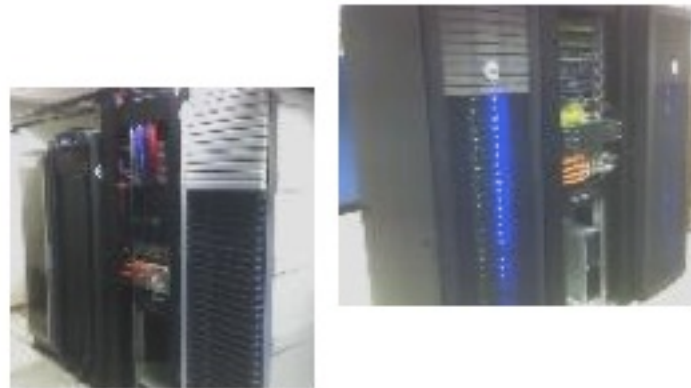
- Most buildings do not have centralized ACUs
- Rooms have dedicated ACUs for cooling
- Monitoring energy efficient use of ACUs using retrofitted sensors
- Test setup at UP campus (2 rooms)

3. Building Energy Efficiency Using Retrofitted Sensors

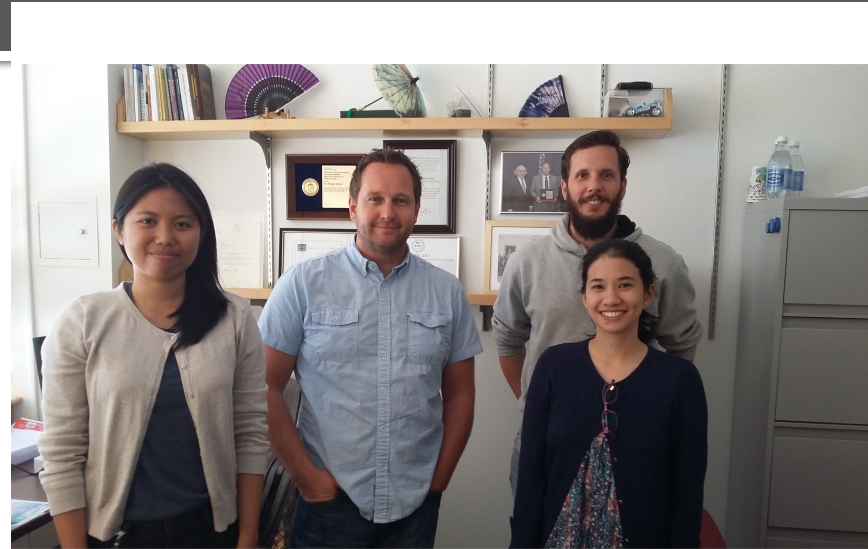
- UCB Work
 - Anil Aswani, et al
 - Learning-based model predictive control (LBMPC)
 - Statistics + learning with control engineering
 - Safety, robustness and convergence guarantees
 - BRITE (Berkeley Retrofitted and Inexpensive HVAC Testbed for Energy Efficiency)
- IIID54 Work
 - Setup at UPD
 - Integration of occupancy count into LBMPC
 - Dynamic Pricing Demand Response with LBMPC
 - Fault Detection and Classification of Sensors
 - Comfort Level of Users (Tropics)

4. DETER-PH

- UCB work:
 - With USC's ISI
 - Testbed for critical cybersecurity experimentation and educational exercises
- UPD work
 - 32-node DETER testbed at UPD
 - Support PH-based research and education on cybersecurity



Visits and Exchanges



Thank you.

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