

All-Digital Plug and Play Passive RFID Sensors for Energy Efficient Building Control



U.S. DEPARTMENT OF
ENERGY

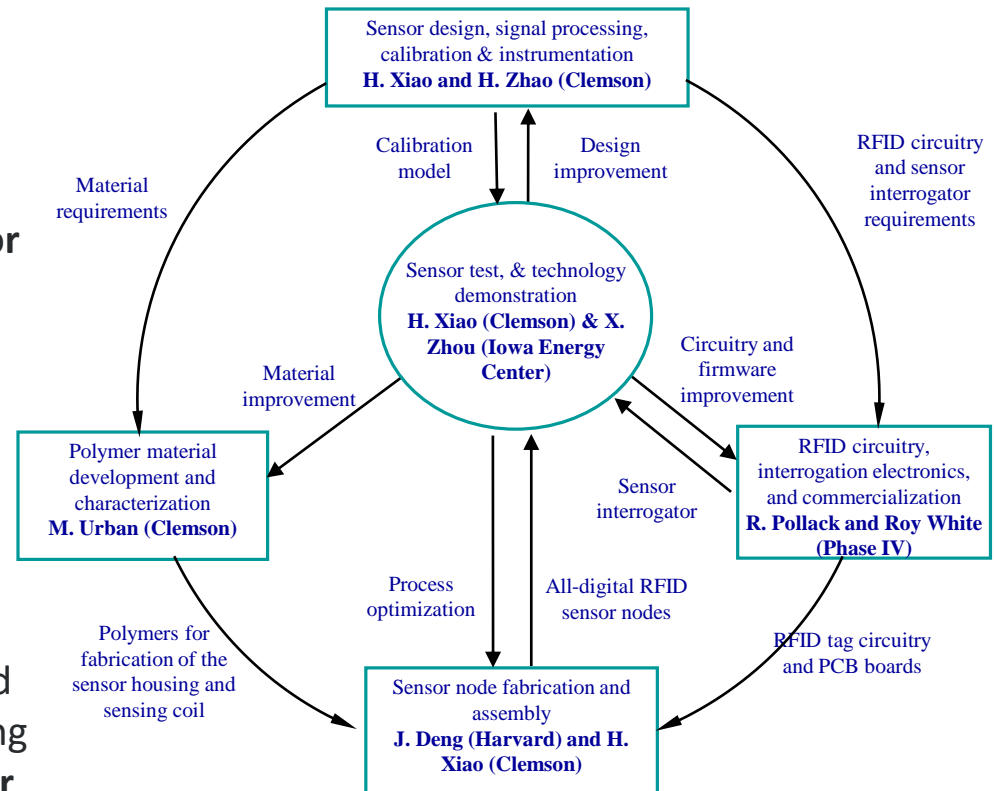
Energy Efficiency &
Renewable Energy

Clemson University
Hai Xiao, Bell Distinguished Professor

All-Digital Plug and Play Passive RFID Sensors for Energy Efficient Building Control

Team

- **PI:** Prof. Hai Xiao, Electrical Engineering, Clemson, **Sensors and instrumentation**
- **Co-PI:** Prof. Marek Urban, Materials Engineering, Clemson, **Sensor materials**
- **Co-PI:** Prof. Jane Zhao, Mechanical Engineering, Clemson, **Modeling and sensor structure design**
- **Co-PI:** Dr. Jiangdong Deng, Nanofabrication and Characterization, Harvard University, **Sensor device fabrication**
- **Co-PI:** Mr. Richard Pollack, CTO, Phase IV Engineering Inc., Boulder, Colorado; **RFID interrogator**
- **Co-PI:** Mr. Roy White, Director Products and Business Development, Phase IV Engineering Inc., Boulder, Colorado; **Technology transfer and commercialization**
- **Co-PI:** Dr. Xiaohui Zhou, building expert, Iowa Energy Center, **Technology validation towards building control**



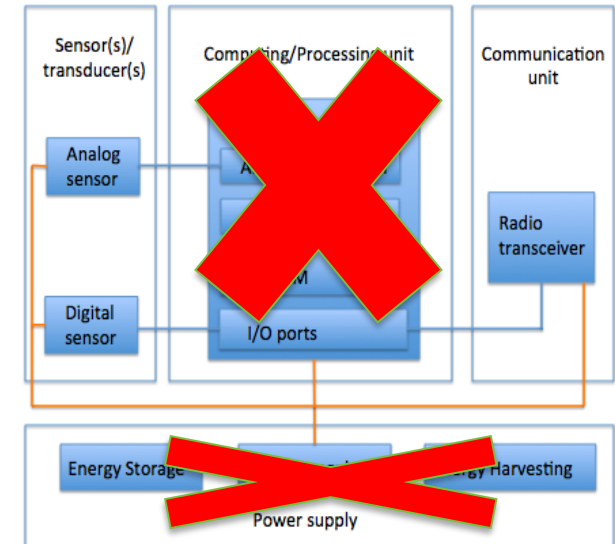
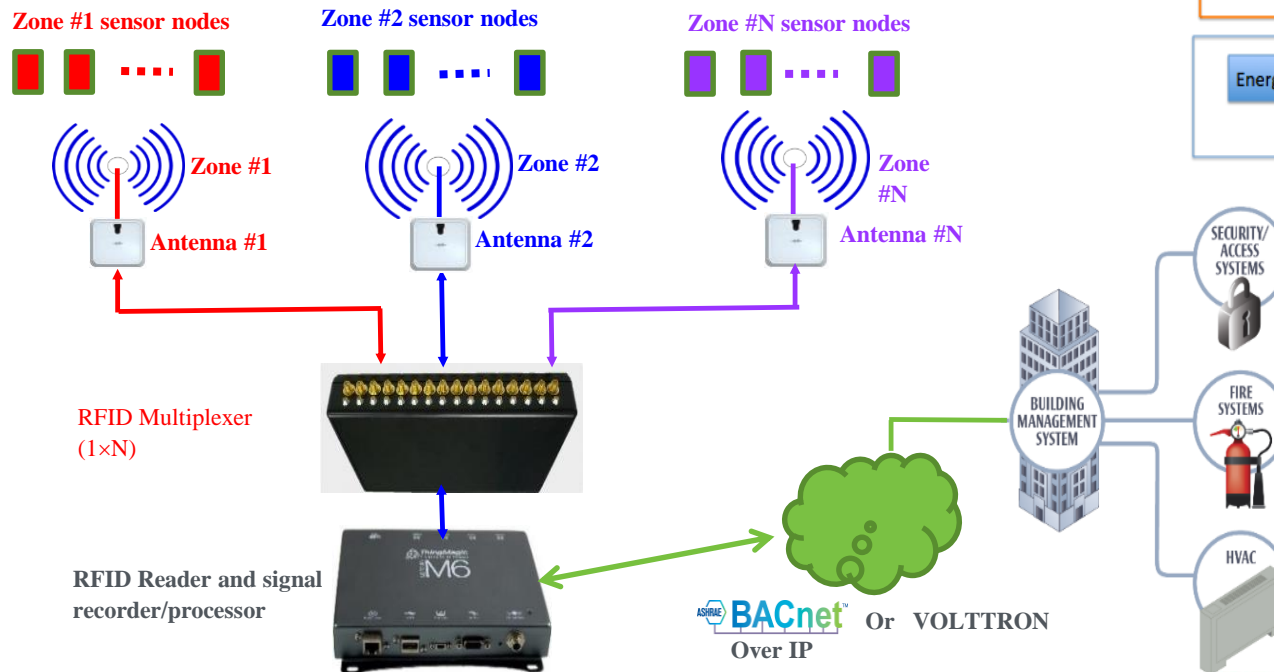
All-Digital Plug and Play Passive RFID Sensors for Energy Efficient Building Control

- **Objective:** Plug & play, battery-free, low-cost (<\$10 per node) wireless temperature and humidity sensor technology for energy efficient building controls and operations.
 - Buildings are responsible for about 40% of total energy consumption in the U.S. – A great potential for energy saving.
 - Sensors are preferred to be small in size, non-intrusive, wireless and low power, easy to install, long lifespan, and convenient for the retrofit of the old buildings.
 - Existing wireless sensors are costly (~ \$100/node), the battery lifetimes are still short, and their integrations into the Building Management System (BMS) are still difficult.
 - Low cost (<\$10/node), multi-functions, long lifetime (10 years), and easy integration (e.g., plug & play) into the BMS network could save an average of 3% (0.3 Quads) and up to 8% in overall building energy consumption.

All-Digital Plug and Play Passive RFID Sensors for Energy Efficient Building Control

Technology Solution

- All digital
- Plug & play
- Passive RFID sensors



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Advantage, Differentiation, and Impact

- **All digital** – No signal processing on the sensor node (low cost)
- **Passive** – No on-board battery (long lifetime and low cost)
- **RFID** – Wireless interrogation and plug & play (low cost, many sensors and easy registration/reconfiguration into the BMS)
- **Key approaches**
 - **Technology development:** design, fabrication, material optimization, interrogation electronics, interface development and laboratory tests
 - **Technology demonstration:** validation and demonstration of the novel sensor nodes for building applications at the Iowa Energy Center
 - **Tech to market:** partner with a small business company (Phase IV Engineering Inc., very successful experts and entrepreneurship) for tech transfer and commercialization

Thank You

Clemson University, Harvard University, Phase IV Engineering Inc., Iowa Energy Center

- **PI:** Dr. Hai Xiao, Bell Distinguished Professor of Electrical and Computer Eng., Clemson University
- **Co-PI:** Dr. Marek Urban, J.E. Sirrine Foundation Endowed Chair and Professor of Materials Science and Engineering, Clemson University
- **Co-PI:** Huijuan (Jane) Zhao, Assistant Professor, Mechanical Engineering, Clemson University
- **Co-PI:** Dr. Jiangdong Deng, Manager and Principal Scientist - Nanofabrication Facility, Center for Nanoscale Systems, Harvard University
- **Co-PI:** Mr. Richard Pollack, Founder and CTO, Phase IV Engineering Inc.
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