



MIAMI FL



SEPTEMBER 25-28

# COLLABORATIVE INNOVATION COMMUNITY MEETING PART I: SMART CAMPUS AND IOT



# Collaborative Innovation Community Meeting Part I: Smart Campus and IoT

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- **NCSU Smart Grid Testbed:** *Marc Hoit, North Carolina State University*
- **IoT Education:** *Ed Aractingi, Marshall University*
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# Smart Campus Initiative & CIO Advisory Council



# Smart Campus Initiative Goals & CIO Advisory Council

- Equip Internet2 members with the skills and guidance to effectively deploy Smart Campus capabilities by:
  - Sharing best practices from current Smart Campus projects
  - Engaging campus strategic stakeholders through the CIO to share interest and vision for a Smart Campus
  - Identifying needs and challenges that can be addressed with potential Smart Campus and IoT approaches
  - Providing recommended courses of action that resolve challenges, leveraging best practices
- Guided by a Smart Campus CIO Advisory Council



# CIO Smart Campus Advisory Council Interview Results

## Expectations

- Knowledgeable knowledge transfer e.g., Arizona State University Smart Stadium
- Technology diffusion
- Stakeholder discussions for longer-term campus planning
- Enable the facilitation of smart campus to extend to a smart community

## Smart Campus Potential Focal Areas

- Student experience & success
- Facilities/Buildings: lighting, HVAC, etc.
- Smart stadiums: fan experience & revenues
- Identify & define common infrastructure standards
- Security: physical, data, holistic approach
- Connected vehicles
- Identify adoption roadblocks
- Smart Campus 2025: Anticipating future needs

## Smart Campus Challenges

- Managing the data
- Standards
- Ethics
- Infrastructure management
- Power supply: batteries, PoE
- Privacy & security
- Enterprise risk management

# Smart Campus & IoT at Virginia Tech

# Smart Campus & IoT at Virginia Tech

- Facilities and IT Partnership
  - SCADA systems vulnerability & configuration testing – focused mutually on operations and security
  - Dragos Security Partnership
- Intelligent Infrastructure & Human Centered Environments
- Autonomous Vehicles: Air, Land & Sea
- Hands on, minds on learning in the classroom and beyond
- Academic Partnership with Business & Government
- Student design & entrepreneurship

# Partnering for ICS & SCADA Systems

- On the Live VT Network
  - Use of monitoring software for operations & network security
  - Consulting & usability support
- In the Classrooms
  - Guest Lectures or Project Mentoring
  - Use of monitoring software for education and research
- In the Laboratory
  - Engagement with our researchers and mentoring for our faculty

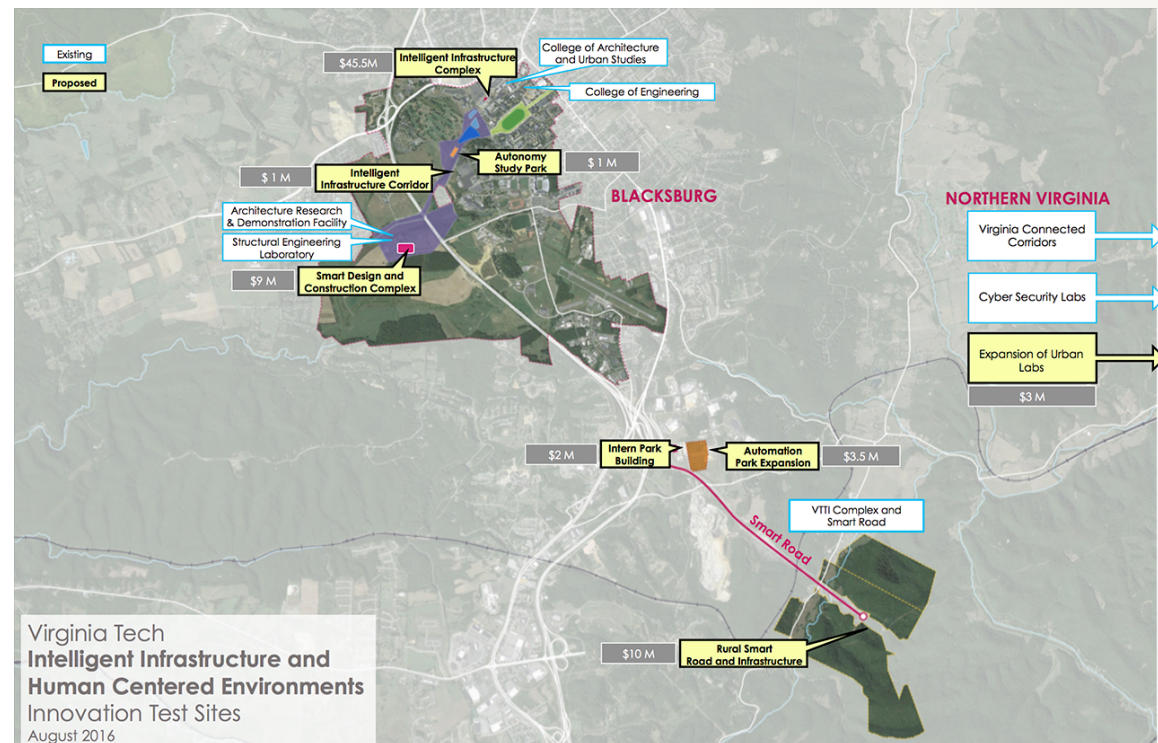
<http://www.robertmlee.org/a-collection-of-resources-for-getting-started-in-icsscada-cybersecurity/>





# Intelligent Infrastructure & Human Centered Environments

- Joseph F. Ware Jr. Advanced Engineering Lab
- Intelligent Infrastructure & Construction Complex
- Autonomy Study Park
- Virginia Tech's Mid-Atlantic Aviation Partnership
- Smart Design and Construction Complex
- Intern Park Building
- Rural Smart Road project
- Virginia Automation Park



# Virginia Tech Reveals \$75M Plan to Emphasize Intelligent Infrastructure

September 1, 2016



Virginia Tech Mid-Atlantic Aviation Partnership team members Tyson LeRoy (left) and Matt Burton fly unmanned aircraft in Blacksburg, Virginia, earlier this year. The university will invest \$75 million over five years to building

Follow Virginia Tech



Related



New facilities, programs, and partnerships will enable Virginia Tech to lead the nation in intelligent infrastructure

# New facilities, programs, & partnerships will enable Virginia Tech to lead the nation in intelligent infrastructure

May 30, 2016



Virginia Tech's intelligent infrastructure projects include FutureHAUS, a prototype residence full of cutting-edge home technologies.

# Academic, Government & Private Partnerships

Project Wing partners with Virginia Tech to test delivery by unmanned aircraft

September 8, 2016



<http://vtnews.vt.edu/articles/2016/09/ictas-maaprojectwing.html>

Project Wing will be conducting research flights with Virginia Tech's Mid-Atlantic Aviation Partnership to explore food delivery by unmanned aerial vehicles. They will gather data on these operations to share with the Federal Aviation Administration as a step towards safely integrating deliveries by unmanned aircraft into everyday life.

The Virginia Tech Mid-Atlantic Aviation Partnership and X's Project Wing will conduct research flights this fall at Virginia Tech, delivering food using unmanned aerial vehicles.

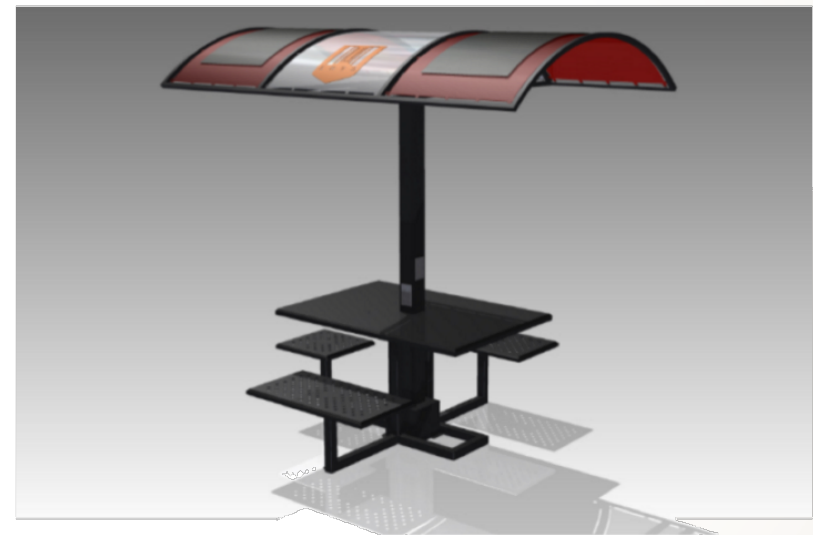


# Student Innovation & Entrepreneurship

- Student envisioned & proposed
- Co-designed
  - Patrick Gallagher, '15, Bio Sys Eng
  - VT University experts
  - Commercial firm in Roanoke, VA
  
- Solar powered USB charging stations

Solar table created by student is first of its kind

April 13, 2016



The ADA accessible table is made from steel and will have eight USB power stations charged through three 45-watt solar panels on the roof.

# IoT Systems Risk Management Task Force

# Internet2 IoT Systems Risk Management Task Force

- Launched during May 2016 Internet2 Global Summit
- Over 10 participating schools
- Monthly calls
- Quarterly updates to Smart Campus CIO Advisory Group
- Initial efforts:
  - IoT Systems Vendor Requirements Document
  - Benchmarking/Baselining via Shodan & Censys tools



# Internet2 IoT Systems Risk Management Task Force: Vendor Requirements Documents

- Why an IoT Systems Vendor Requirements Document?
- If IoT Systems not implemented well ...
- IoT Systems are different from IT enterprise systems ...





# Internet2 IoT Systems Risk Management Task Force: Vendor Requirements Documents

- Vendor requirements provides guidance for different phases:
  - Planning
  - RFI
  - RFP
  - Contract negotiation/renegotiation

# Internet2 IoT Systems Risk Management Task Force: Vendor Requirements Documents

- Part of vendor requirements document as checklist. Example items include:
  - What data feeds are anticipated?
    - Data to be consumed by system
    - Data to be produced by system
    - Privacy considerations?
    - Is the feed well-defined (& written down!! ) ?
    - Who will maintain?
  - What is the schema for changing default logins and passwords on each device?
    - How does the vendor demonstrate compliance with this requirement?
  - What is the schema for disabling all non-required ports/services?
    - How does the vendor demonstrate compliance with is requirement
  - What dependencies does this IoT System have on other systems?
  - Is there a documented commissioning plan for this IoT System & associated devices?
  - Is there a Design Guide for this IoT System?
  - How many endpoints (IoT devices) will be deployed?
    - Who will support these?
      - If local FTE, is capacity available?
      - Will it remain available?
      - If not local, vendor availability?
  - What are vendor requirements for hosting aggregating server, database, & redundancy hardware/services?
    - Who pays for this?
    - If cloud, who pays & manages this?
  - Is a risk sharing agreement in place w/vendor?
  - Others ...

# Internet2 IoT Systems Risk Management Task Force: Vendor Requirements Documents

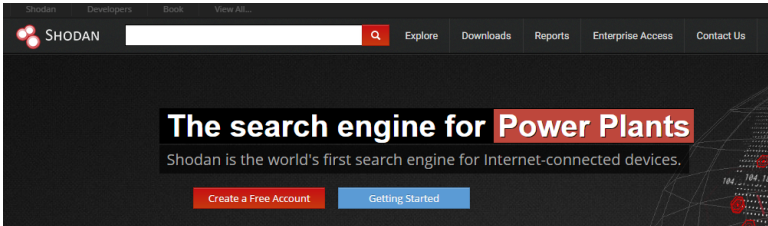
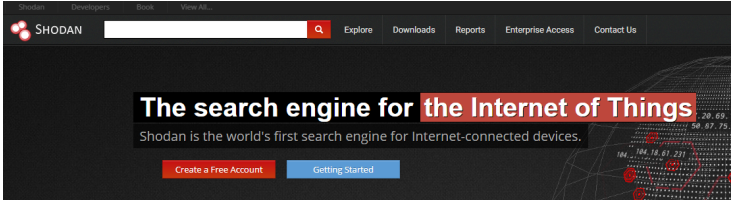
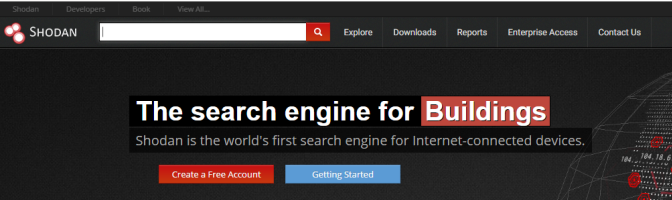
Future work includes:

- Consider new items
- Develop guidance for models of organizational ownership, e.g.
  - Central IT
  - Facilities
  - Local IT
  - End user/tenant
  - Building coordinator



Benson | 082216

# Internet2 IoT Systems Risk Management Task Force: Initial Exposure Benchmarking/Baselining via Shodan & Censys tools



Censys is a search engine that allows computer scientists to ask questions about the devices and networks that compose the Internet. Driven by Internet-wide scanning, Censys lets researchers find specific hosts and create aggregate reports on how devices, websites, and certificates are configured and deployed. [\[more information\]](#)



# Internet2 IoT Systems Risk Management Task Force: Initial Exposure Benchmarking/Baselining via Shodan & Censys tools

- Shodan & Censys scan Internet for public IP spaces
  - Looks for ports/services often associated with
    - Industrial Control Systems
    - Internet of Things
  - Returns 'banner' information
    - Descriptive information about the device



# Internet2 IoT Systems Risk Management Task Force: Initial Exposure Benchmarking/Baselining via Shodan & Censys tools

- Why a benchmark/baseline of IoT Systems risk with these tools?
  - Higher Ed institutions are small to medium-sized cities
    - Power plants
    - Building automation systems
    - Research systems
    - Classroom & Conference IP-based AV
    - Other ...
  - Shodan, Censys, & similar unpublished tools identify attackable/targetable systems on public networks
  - Benefits of baseline
    - Longitudinal analysis (profile changes over time)
    - Latitudinal analysis (how does an institution compare to its peers)



# Internet2 IoT Systems Risk Management Task Force: Early Insights

- IoT Systems vendor requirements document
  - Need to make the document useful for multiple parties
    - IT, Facilities, Procurement, others
  - Develop common language for IoT
- Benchmarking/baselining with Shodan, Censys, similar tools
  - Documentation is sparse
  - Tools require explorer mindset
    - Shodan is one-man show
    - Censys is based out of academic work
  - Sharing organizational risk is sensitive



# How to get involved in the IoT Systems Risk Management Task Force

- Contact Chuck Benson, University of Washington:
  - [iotsys-tf@internet2.edu](mailto:iotsys-tf@internet2.edu)
  - [cabenson@uw.edu](mailto:cabenson@uw.edu)



# NCSU Smart Grid Testbed

# Cloud-in-the-Loop Control of Power Systems using GENI



3-Year project funded by the National Science Foundation through the Cyber-Physical Systems (CPS) Program

Project Objective: Use a metro-scale, high-bandwidth ExoGENI cloud computing network for distributed implementation of power system monitoring and control

Team: **NC State University** (lead), **University of North Carolina Chapel Hill**, **University of Illinois Urbana Champaign**



**Aranya Chakraborty**  
(Power, Controls)



**Frank Mueller**  
(Real-time Computing)



**Yufeng Xin**  
(Networking, GENI)



**Nitin Vaidya**  
(Distributed Algorithms)

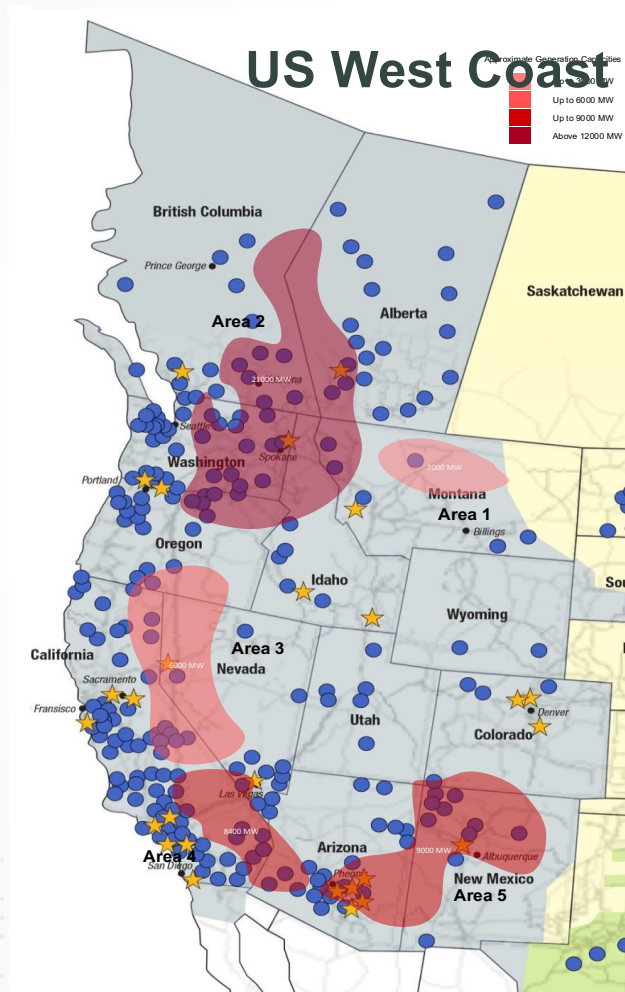


**Rakesh Bobba**  
(Cyber-Security)

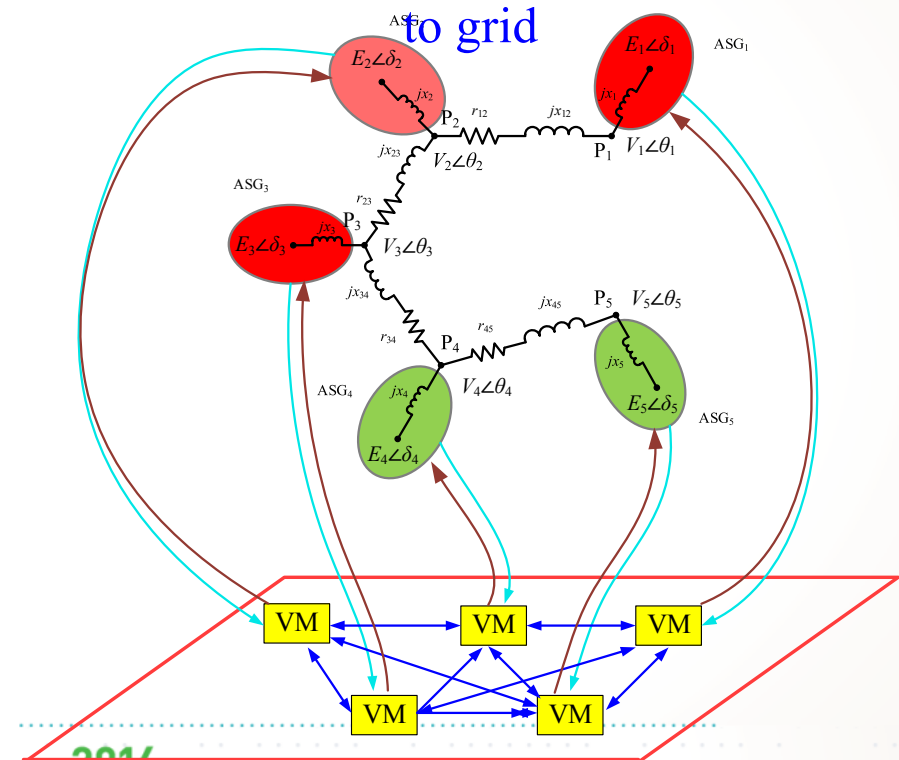


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# Cloud-in-the-Loop Control of Electric Power Systems

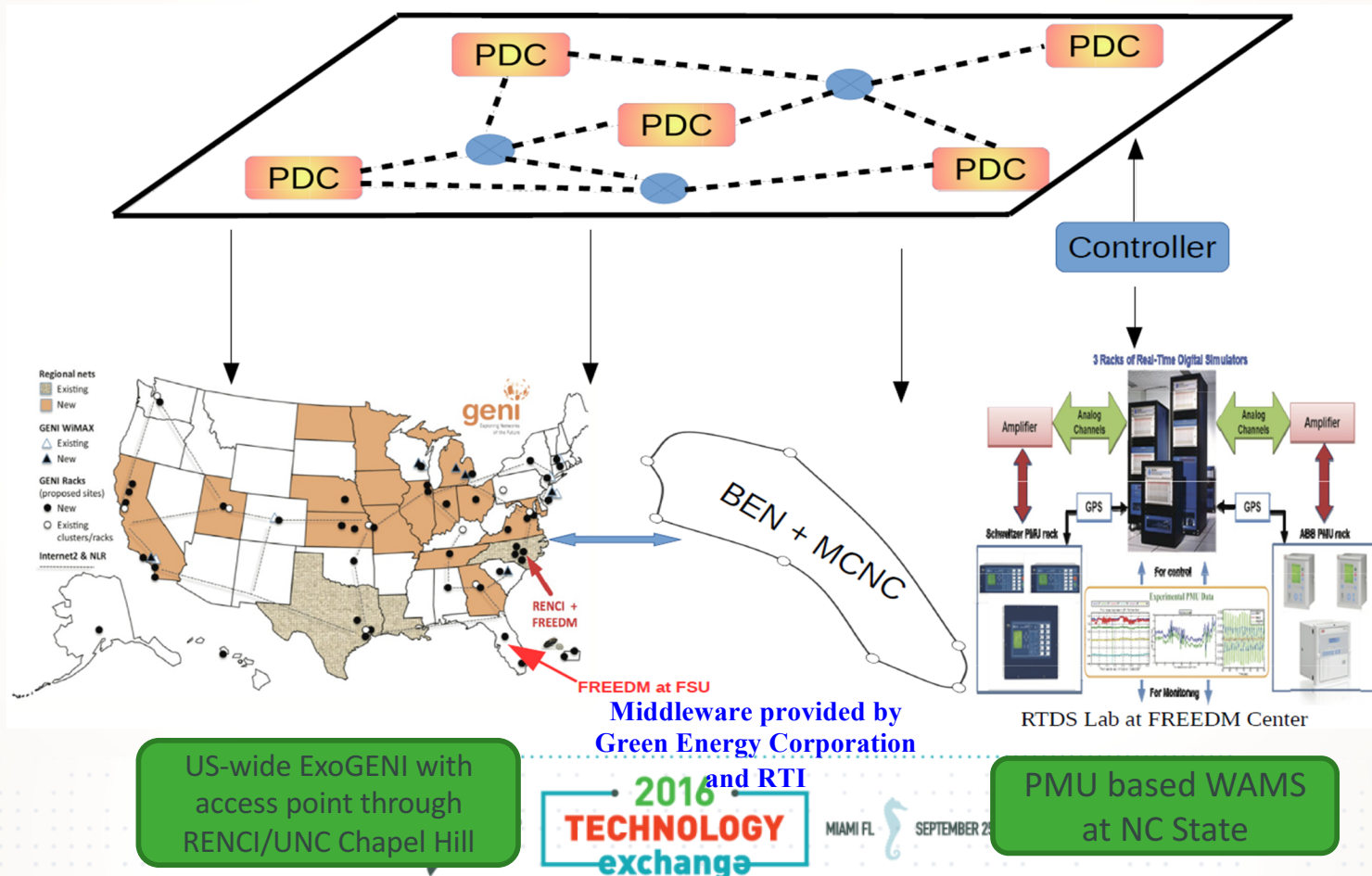


Close the control loop from cloud to grid



2016  
**ECHNOLOGY** Third-Party Private Cloud  
**-exchange** Controllable Network such as Internet 2

# Architecture of ExoGENI-WAMS-DETER CPS Testbed



# IoT Education

## IoT Education

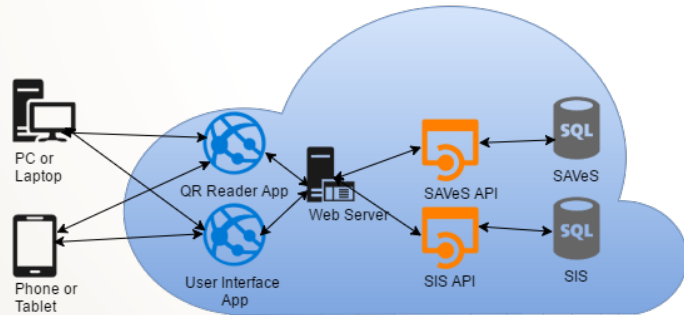
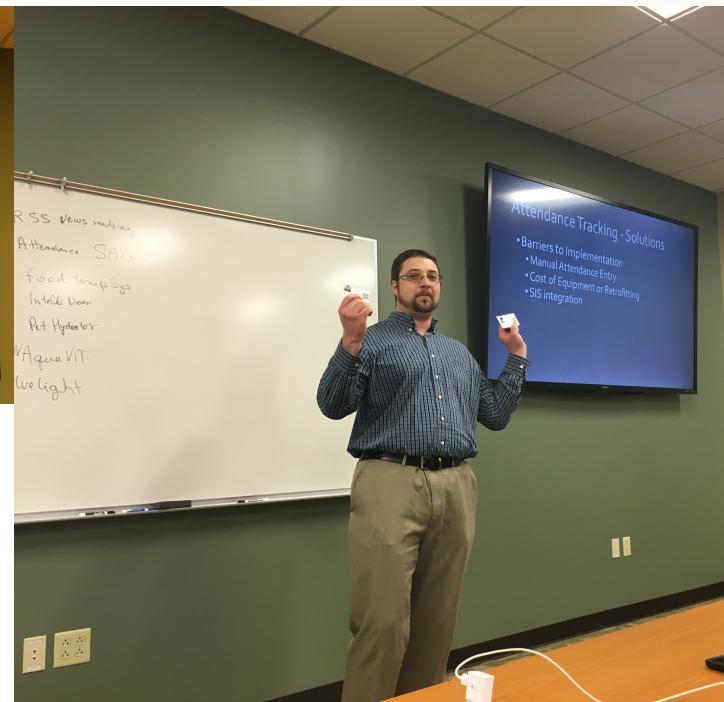
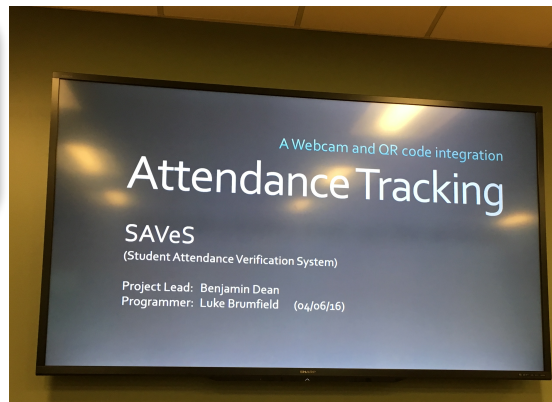
- IoT Working group acknowledge the importance of establishing a curriculum for teaching IoT in the classroom.
- Started building and collecting materials to support professors.
- Information is located at the working group wiki <https://spaces.internet2.edu/display/CWVG/IoT+Curricula>

# IoT Education at Marshall University

- Used connected devices (Raspberry Pi, Arduino...etc)
- Sensors (motion, distance, humidity, temperature.....etc.
- Cloud services for IoT (Bluemix IoT Foundation, AWS IoT, Azure IOT Hub)

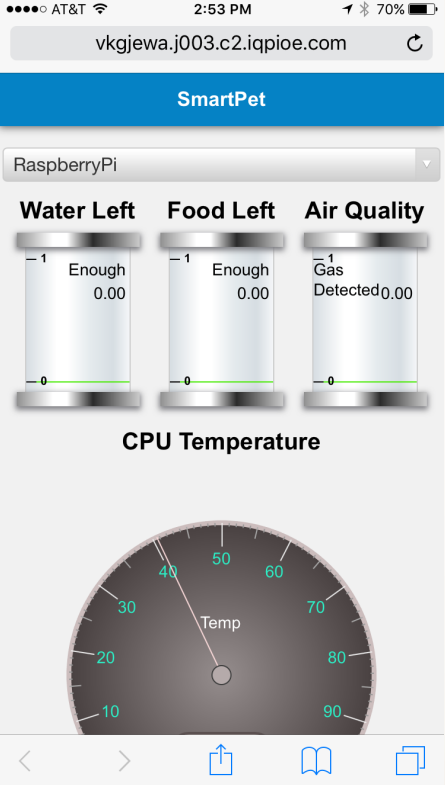
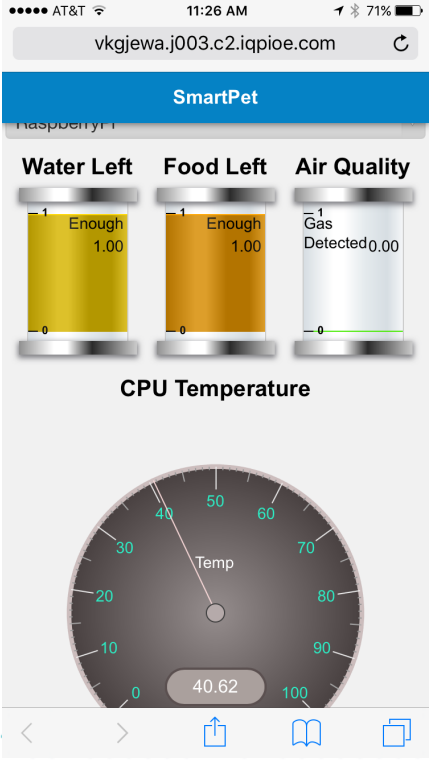


# Attendance tracking system

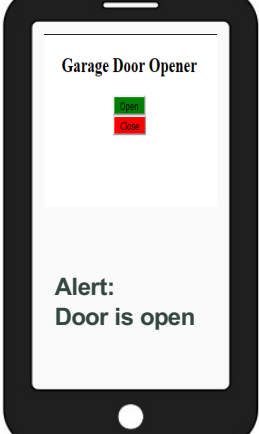




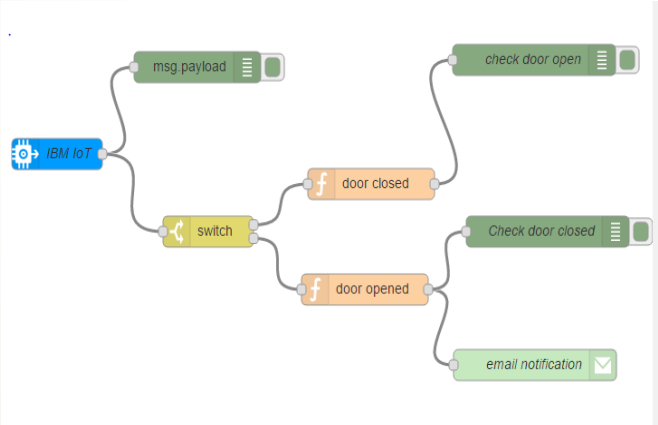
# Pet care system



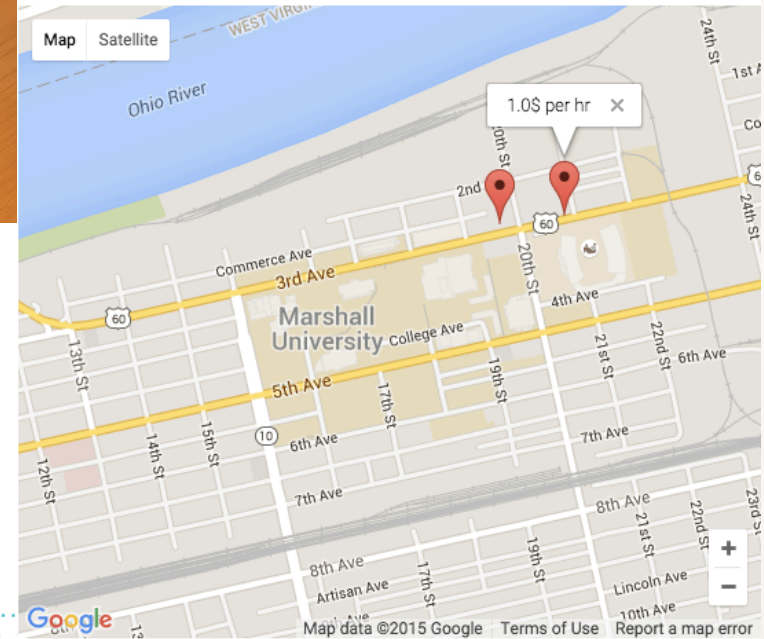
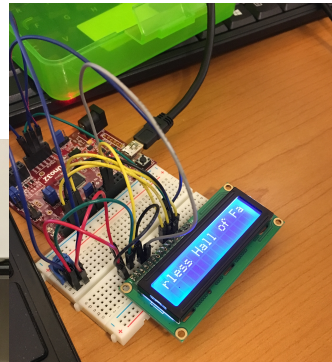
# Garage door opener



• Sends signal to raspberry pi

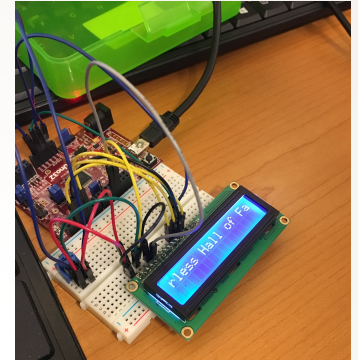


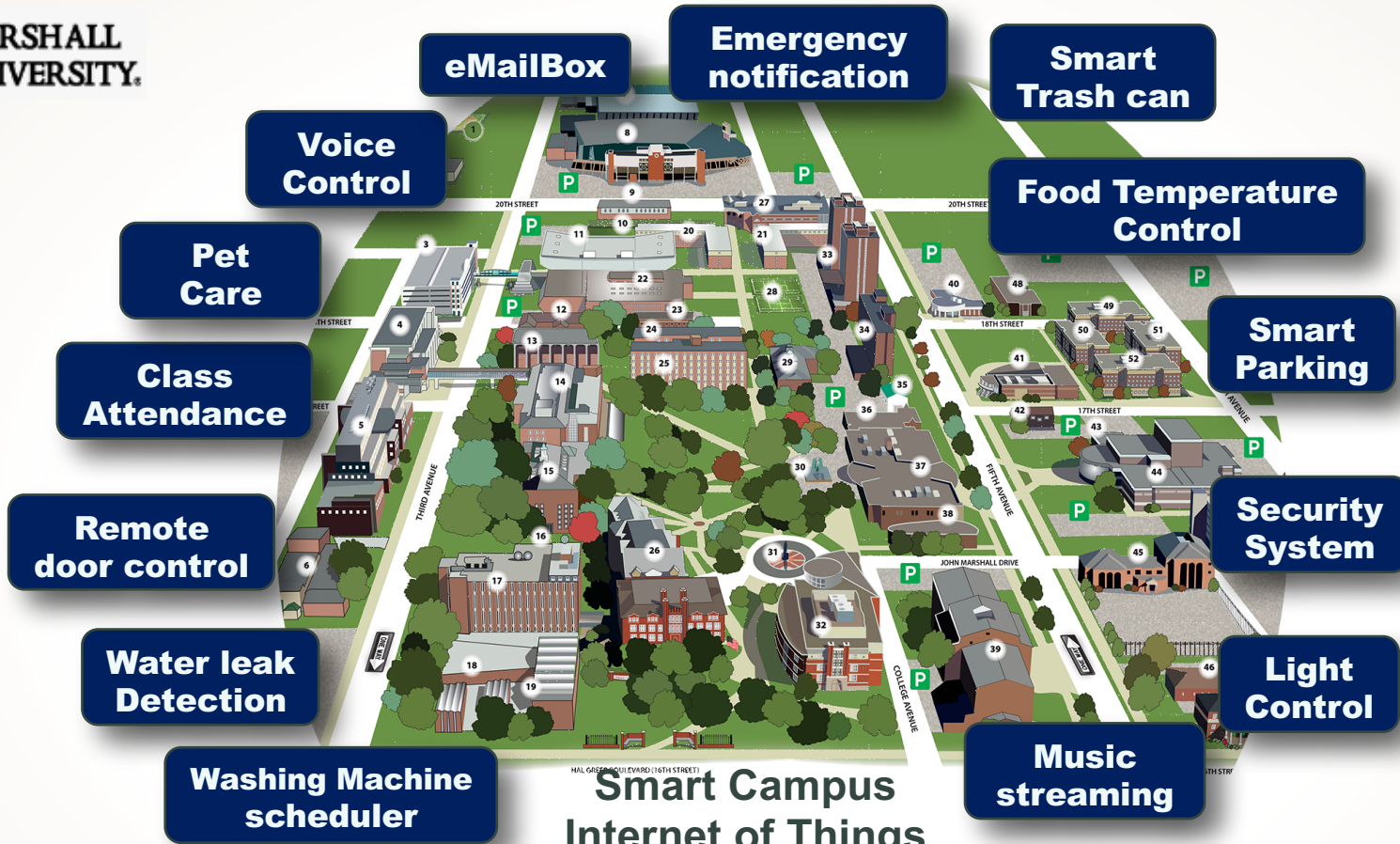
# IoT Education at Marshall University



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# IoT Education at Marshall University





**Smart Campus  
Internet of Things  
Class Projects**

# Recommended Next Steps



# Smart Campus and IoT Recommended Next Steps

- **Smart Campus**

- Increase awareness of IoT risk on campus
  - Shodan, Censys.io
- Manage IoT systems and IoT vendors on campus
  - Leverage IoT vendor requirements document and process
  - Partner cross-organization and campus: IT, Facilities, Public Safety, Procurement
  - Inventory existing IoT devices: segment fixed vs mobile IoT devices
  - Develop guidelines on detecting, integrating, managing, and decommissioning fixed, mobile IoT devices
  - Develop infrastructure plan to support community owned IoT devices

- **IoT exploration and collaboration**

- For Research and Education: IT, researchers, lecturers, students
- Collaborate with “The Things Network”

- **Your ideas and discussion**



## Next steps

- Continue the knowledgeable knowledge transfer: let us know if you have use case examples ([cino@internet2.edu](mailto:cino@internet2.edu))
- Potential in person workshops:
  - February 2017 at the Microsoft's Campus Connections Summit: Big Data, Big Campus
  - City University of New York or Arizona State University
- Join us after the break to continue the conversation: **End-to-End Trust & Security for IoT and TIPSS**





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