Requirements for Autonomous Unmanned Aerial Passive Wireless Multi-Modal Sensing Systems for Energy Applications

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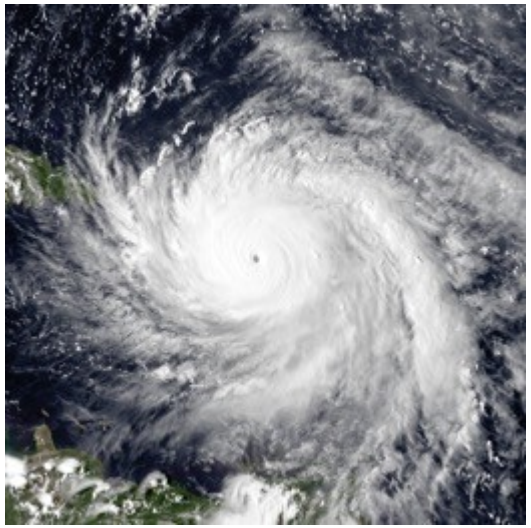
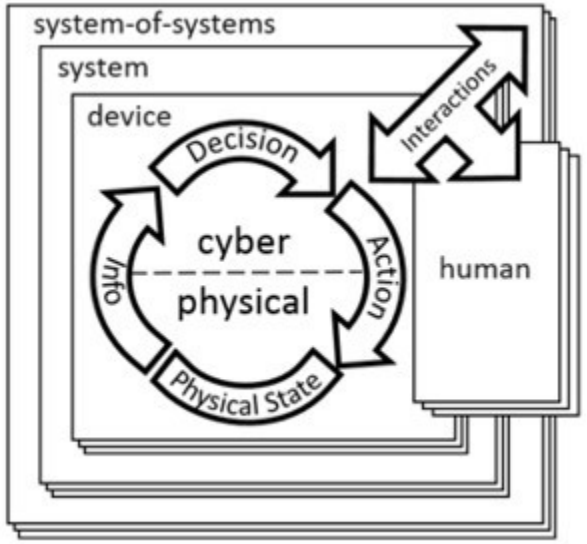
Overview

- Current Threats and Cascading Effects
- Technologies for Monitoring Infrastructure
- Sensing Parameters
- Demonstration at a Utility Service Area
- Future Efforts
- Q&A

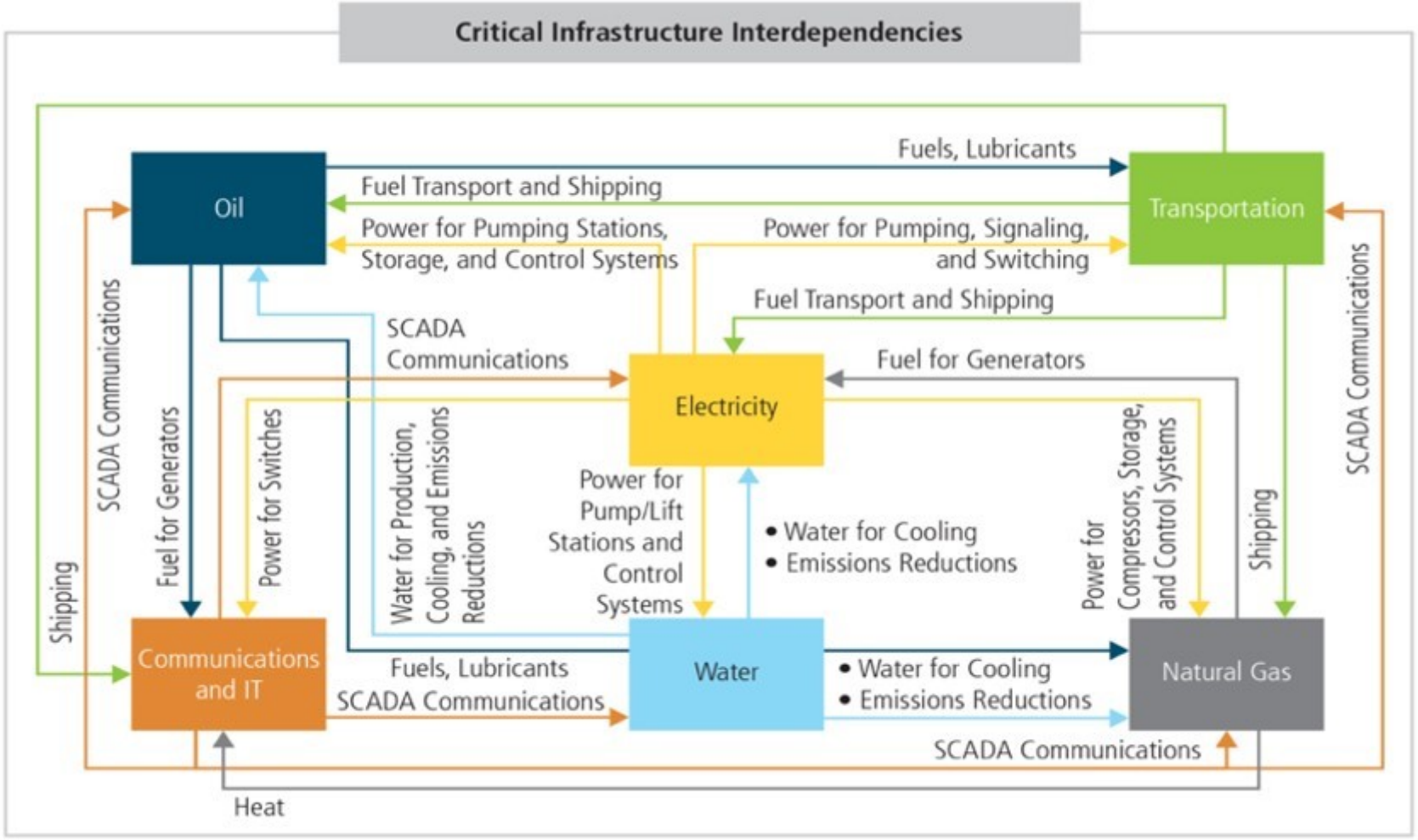
Increasing Threats of Extreme Events: Natural and Manmade





NIST Cyberphysical Conceptual Model

Energy Interdependencies Critical Infrastructure



Quadrennial Energy Review Transforming the Nation's Electricity System: The Second Installment of the QER, January 2017

Illustration of the Cascading Effect

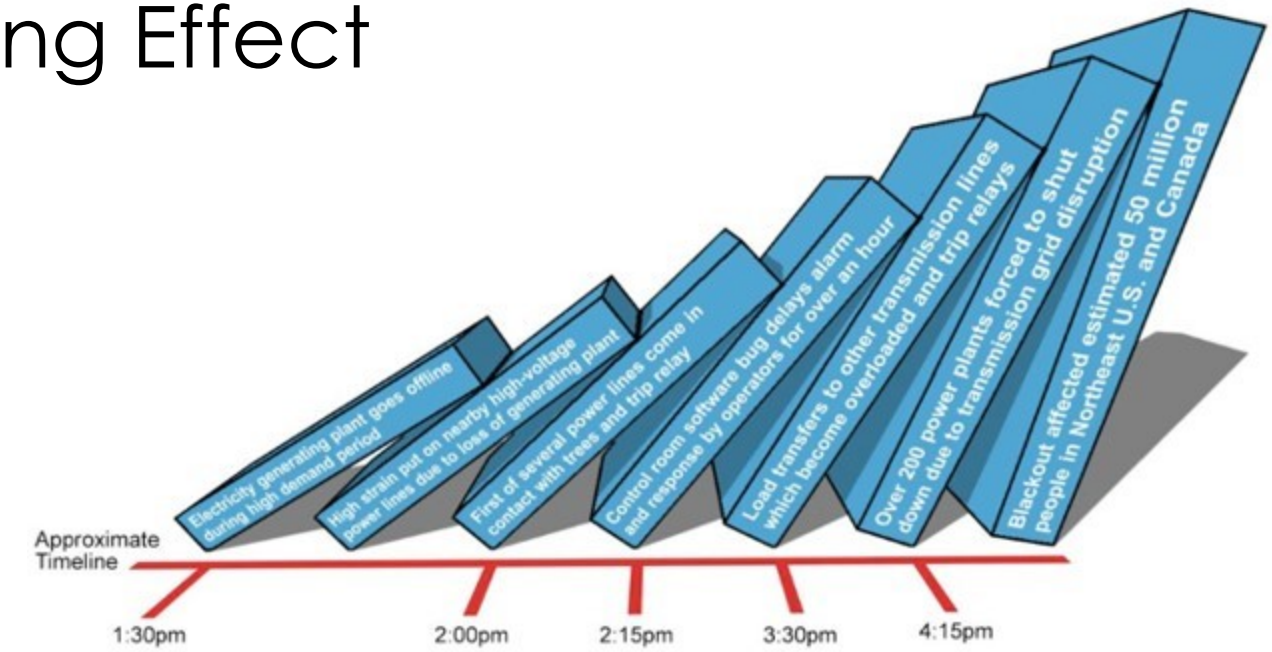
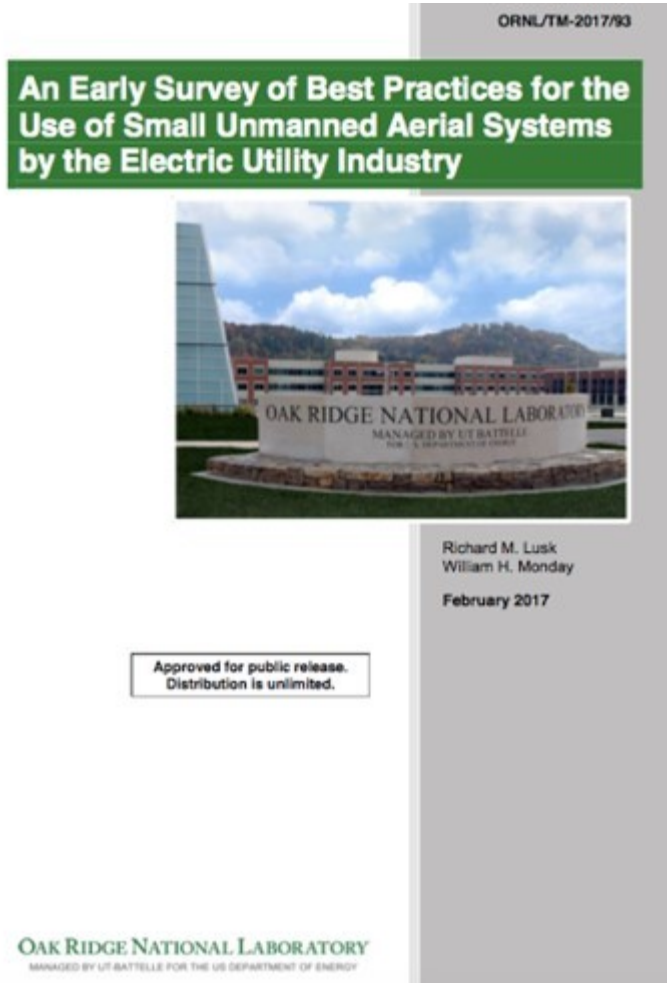


Figure 11-3: Power system internal dependence cascading failure in the 2003 Northeast Blackout

Figure 11-4: External dependence cascading failure in the 2003 Northeast Blackout

NIST " Community Resilience Planning Guide for Buildings and Infrastructure Systems

Technologies for Emergency Management and Restoration

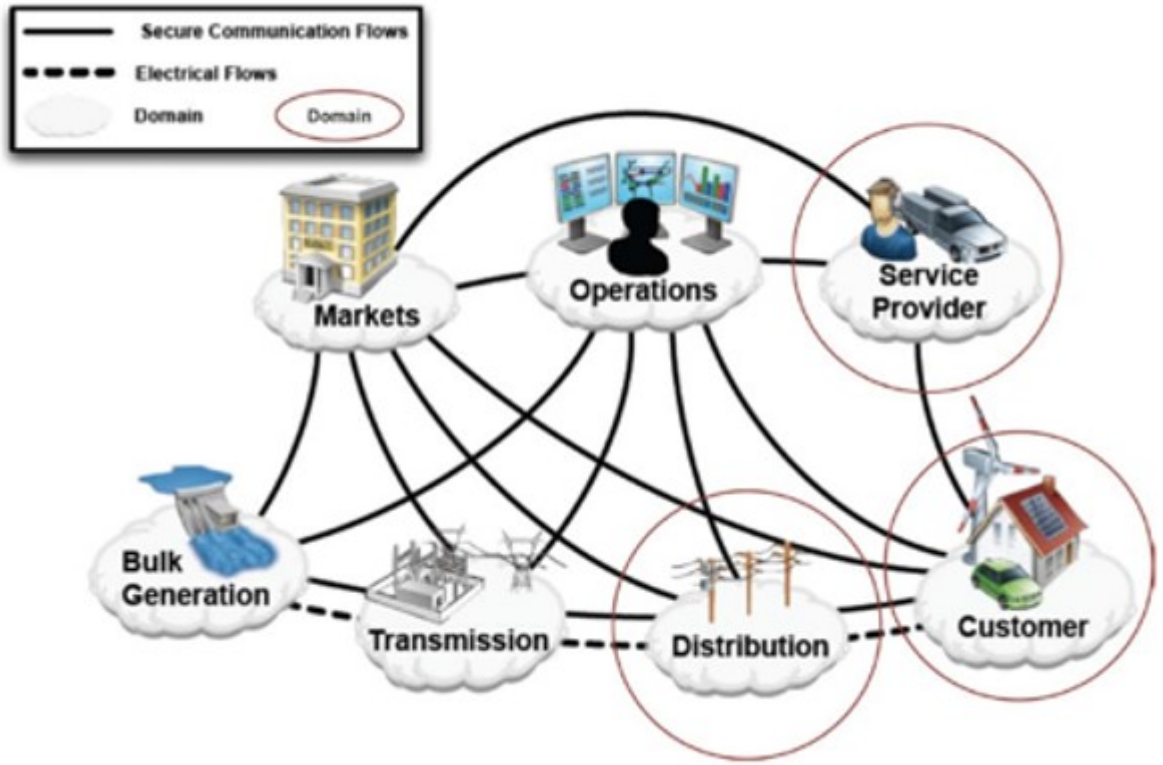


EAGLE-I's National Outage Map tracks transmission line status and customer outage numbers by County, State, and FEMA Region

Early drone testing by Duke Energy was done at its Marshall Steam Station in Terrell, N.C.
Duke Energy

Requirements for Smart Grid Sensors Deployment

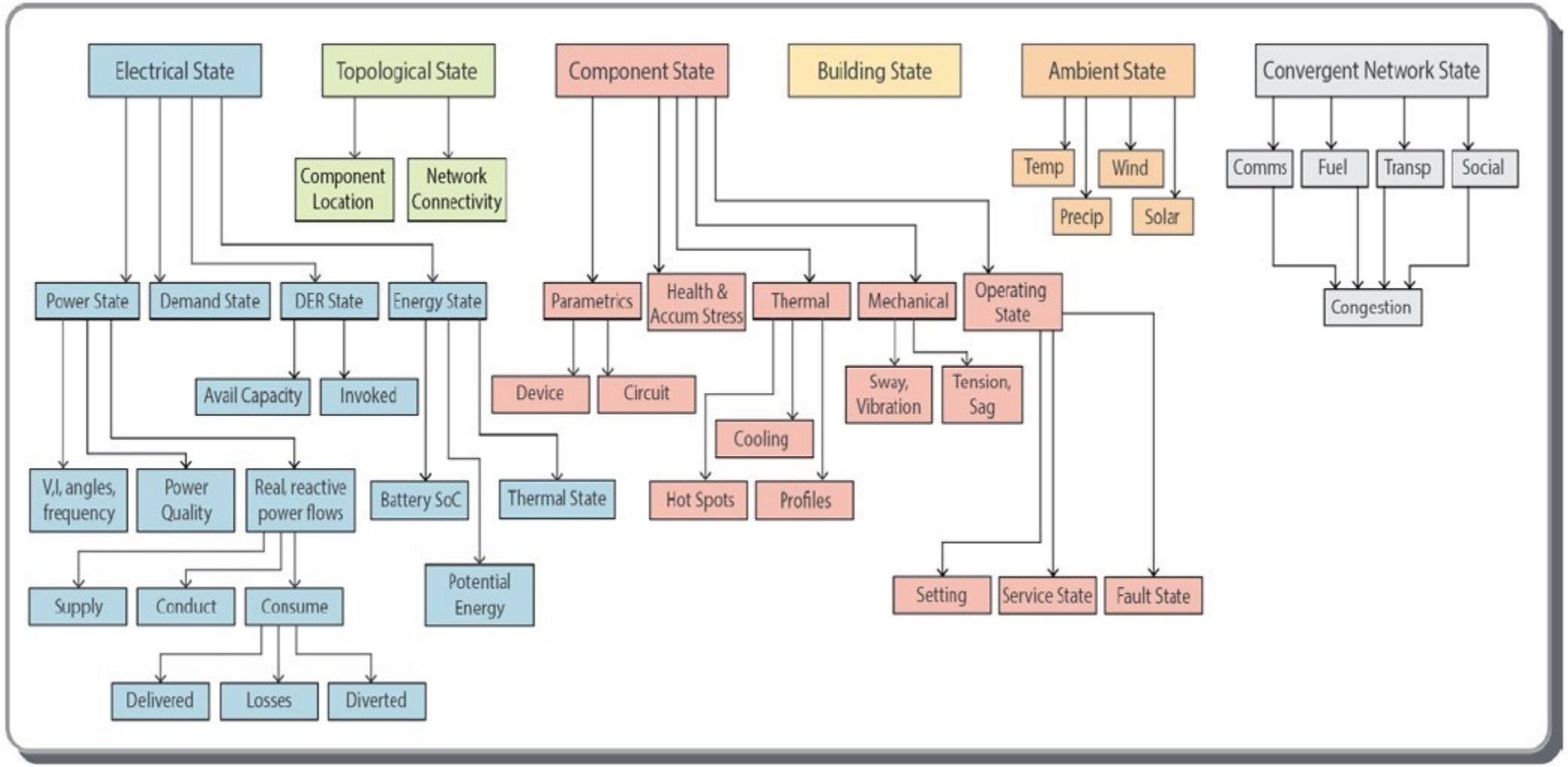
- Time Sensitive
- Cost effective
- Sensitivity
- Reliability
- UAVs – weight considerations
- Data processing, analytics and visualization tools



NIST Domains for the current electricity delivery systems landscape. *(Source: Roadmap to Achieve Energy Delivery Systems Cybersecurity)*

Renewable and Sustainable Energy Reviews 59 (2016) 710–725

DoE Grid Modernization Laboratory Consortium Sensor Roadmap



The needs of low-cost passive wireless sensors

UAS for the Electric Utility Industry

- UAS are being used to monitor
  - T&D lines
  - Substations
  - Switchyards
  - Vegetation Management
- Cost Effective
  - Who needs helicopters?
- Rapid assessment and restoration
  - Reducing labor costs

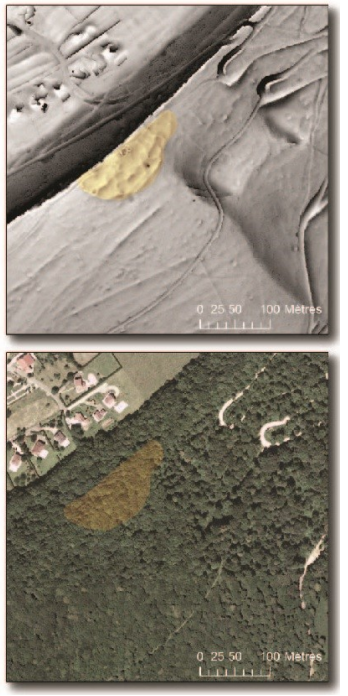
Drone monitoring substation equipment (EPB of Chattanooga)

UAS for the Electric Utility Industry

- Some traditional monitoring methods
  - Synthetic aperture radar (SAR)
  - Airborne laser scanner (ALS) data
  - Thermal images
  - UAV

- Red indicates methods not widely used by UAS
  - Data processing, storage, weight, etc.

SAR image



ALS – terrain detail (yellow) through forest canopy (Univ. of Arkansas)

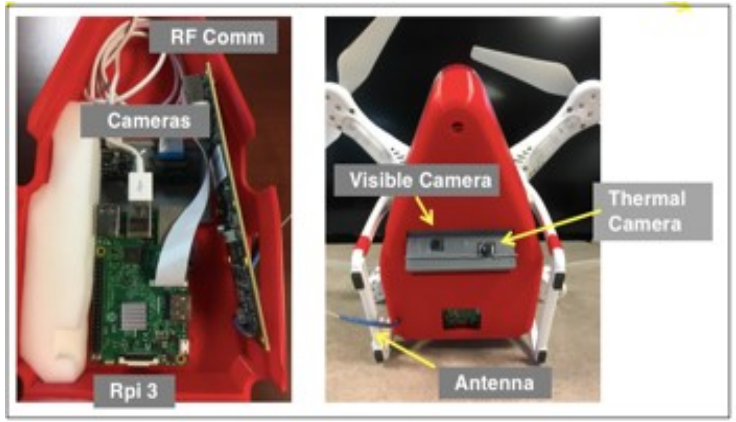
ORNL Current Efforts – EPB Substation Monitoring

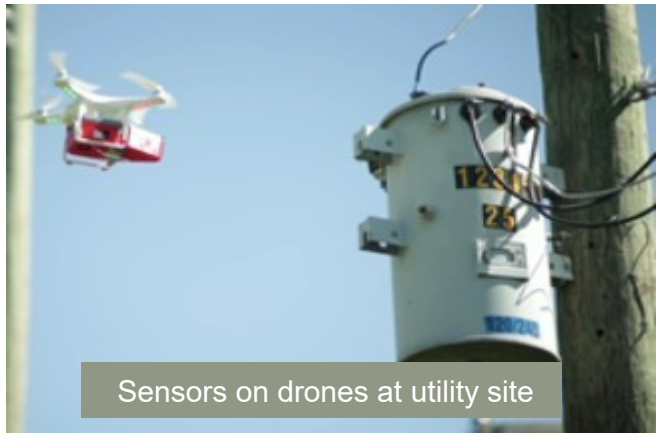
Drone monitoring a mounted transformer

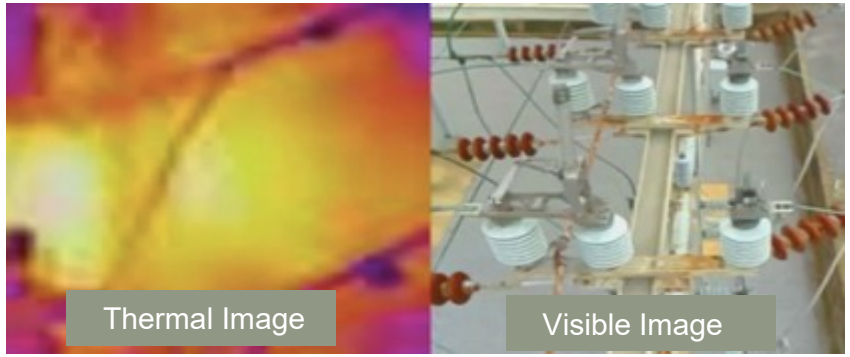
Drone camera feed at EPB control center

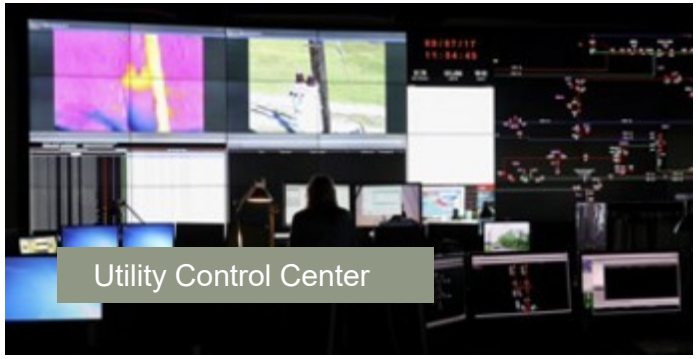
ORNL Current Efforts – EPB Substation Monitoring

- IoT Sensors on Mobile Platforms for real time assets monitoring
- Sensor readings and video are transmitted via wireless communication to control center
- Field crew and dispatchers receive data simultaneously from the site, accelerating the assessment and restoration process
- Autonomous capability for coordinated and automatic scheduled assessment.

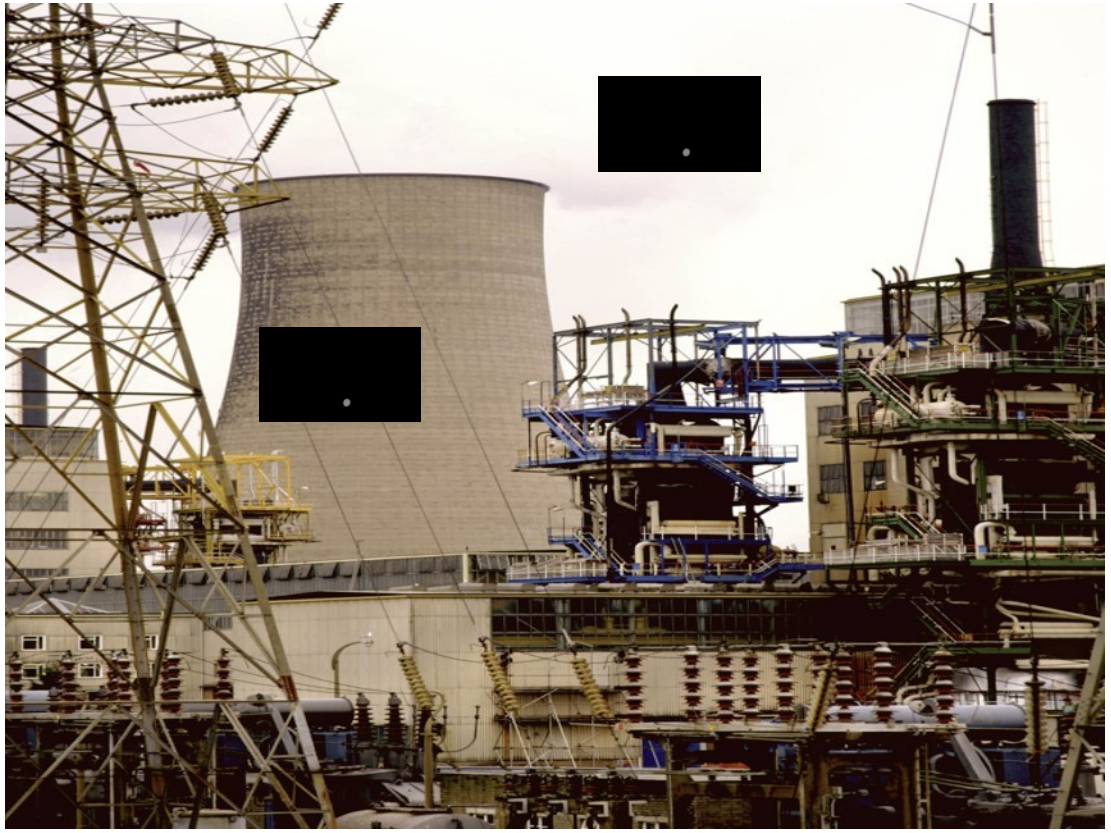






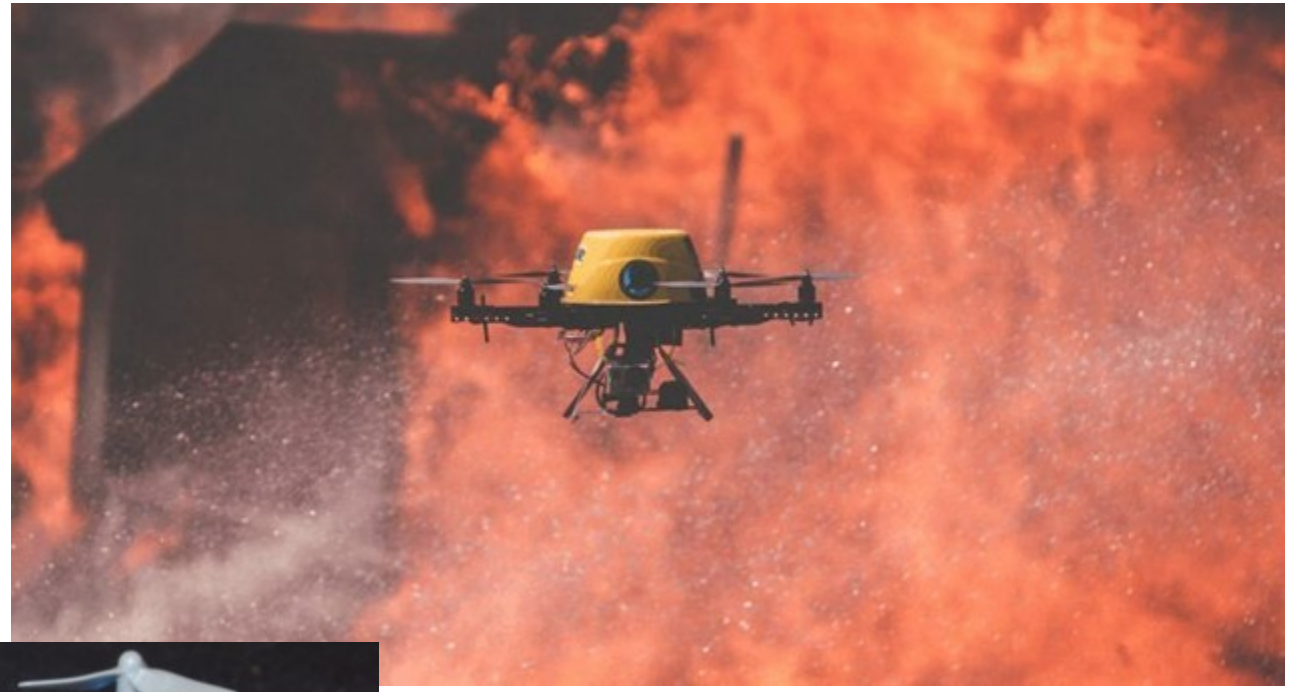


ORNL Future Efforts



ORNL Future Efforts – Particle Detection in Hazardous Environments

- PWST development requirements
  - Robustness for hazardous zones deployment
  - Low Weight
  - Cost Effective
  - Data Processing
  - Autonomous

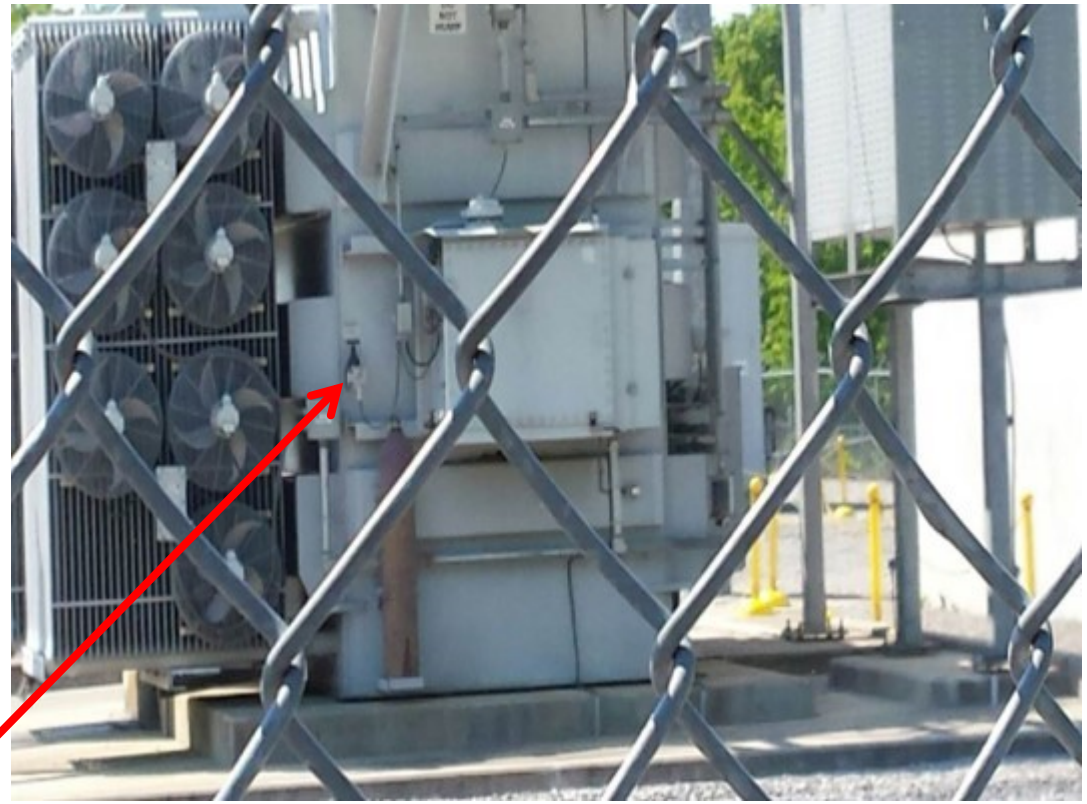


ORNL Future Efforts – Oil Rig Monitoring in Lafayette, LA

- Deploy PWST on 1000's of pipeline flanges to measure methane leaks
- Use a drone to take readings
- Currently performed by a group of people working in hazardous conditions
- Ideally perform this on offshore rigs as well

ORNL Future Efforts – Sensing of Electrical Transformers

- Investigate a suitable method of installing such a device on an existing transformer
- Picture shows possible location of test chamber for our device
- The chamber would be made of non-conducting materials and therefore ensure strong RF signal strength reaching the SAW



EPRI, Charlotte NC

ORNL Future Efforts – "Smart City" Application

- With the Smart City communication infrastructure in place, the Laboratory Shift Supervisor (LSS) will be able to deploy drones from autonomous emergency vehicles thereby allowing them to obtain situational awareness of the Lab from the safety of the LSS Control Center

Q&A