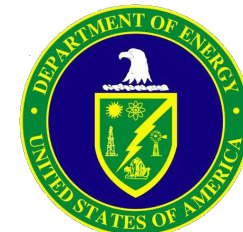# Cyber-Security Challenges for Smart Power Grids
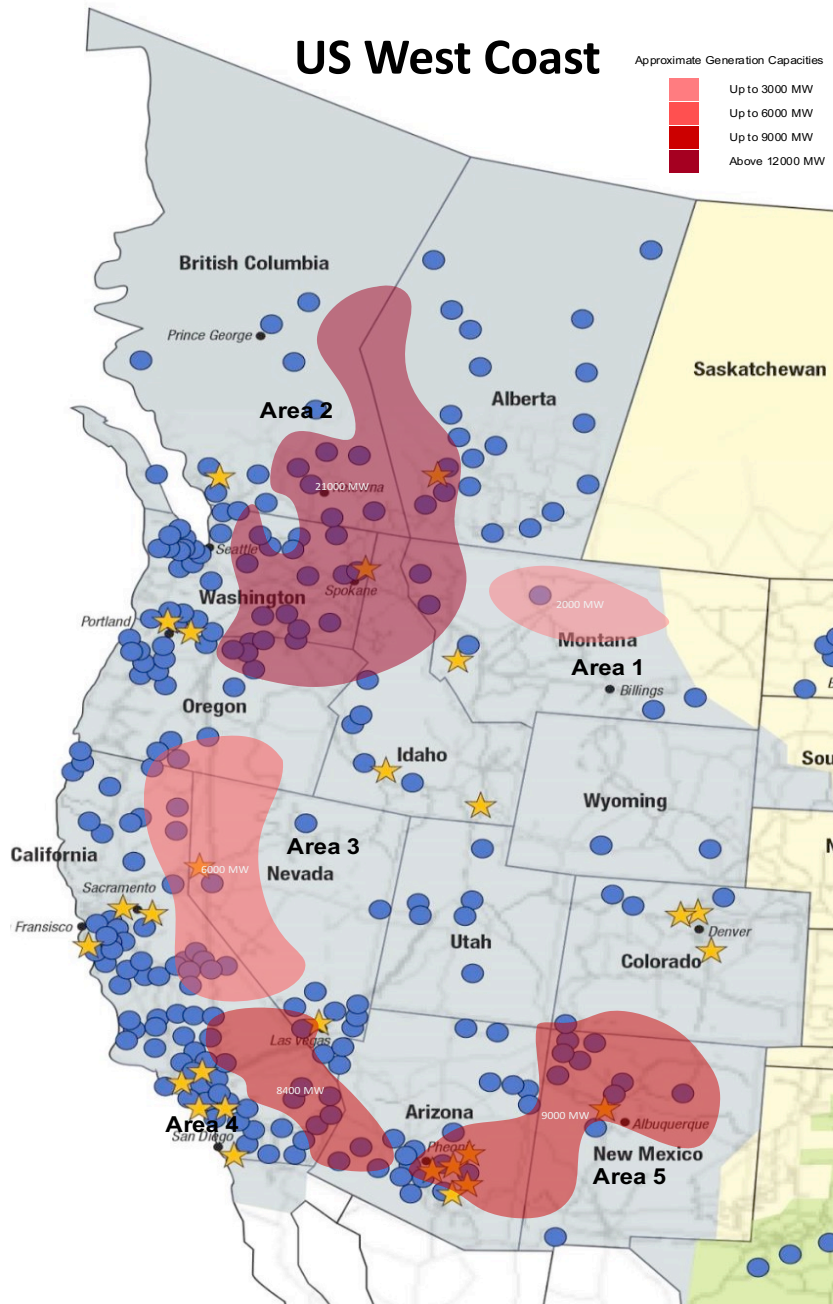
Aranya Chakrabortty

North Carolina State University

Internet2 Global Summit
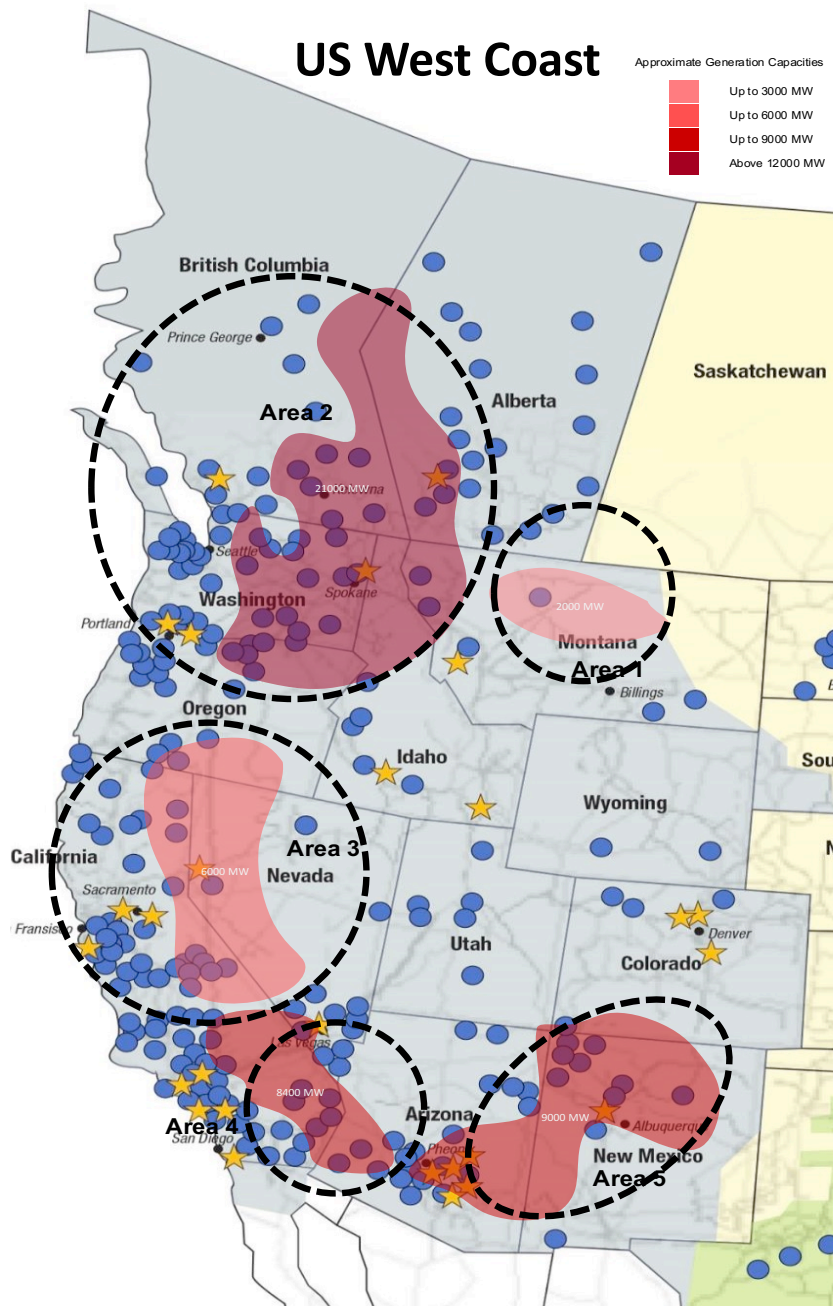
May 26, 2017, Washington DC

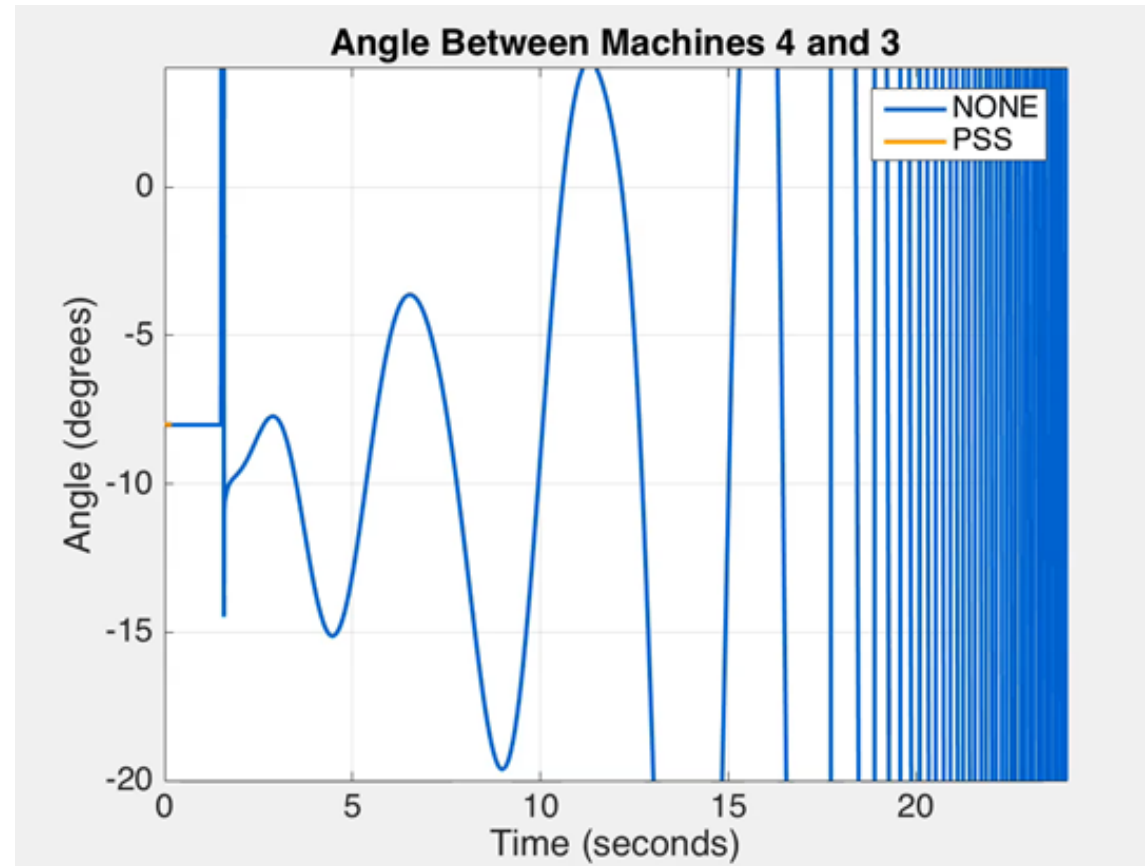# Why is Communication So Important for Controlling Power Systems?

# Why is Communication So Important for Controlling Power Systems?



**Companies take control actions inside their regions agnostic of the health of other parts of the grid**

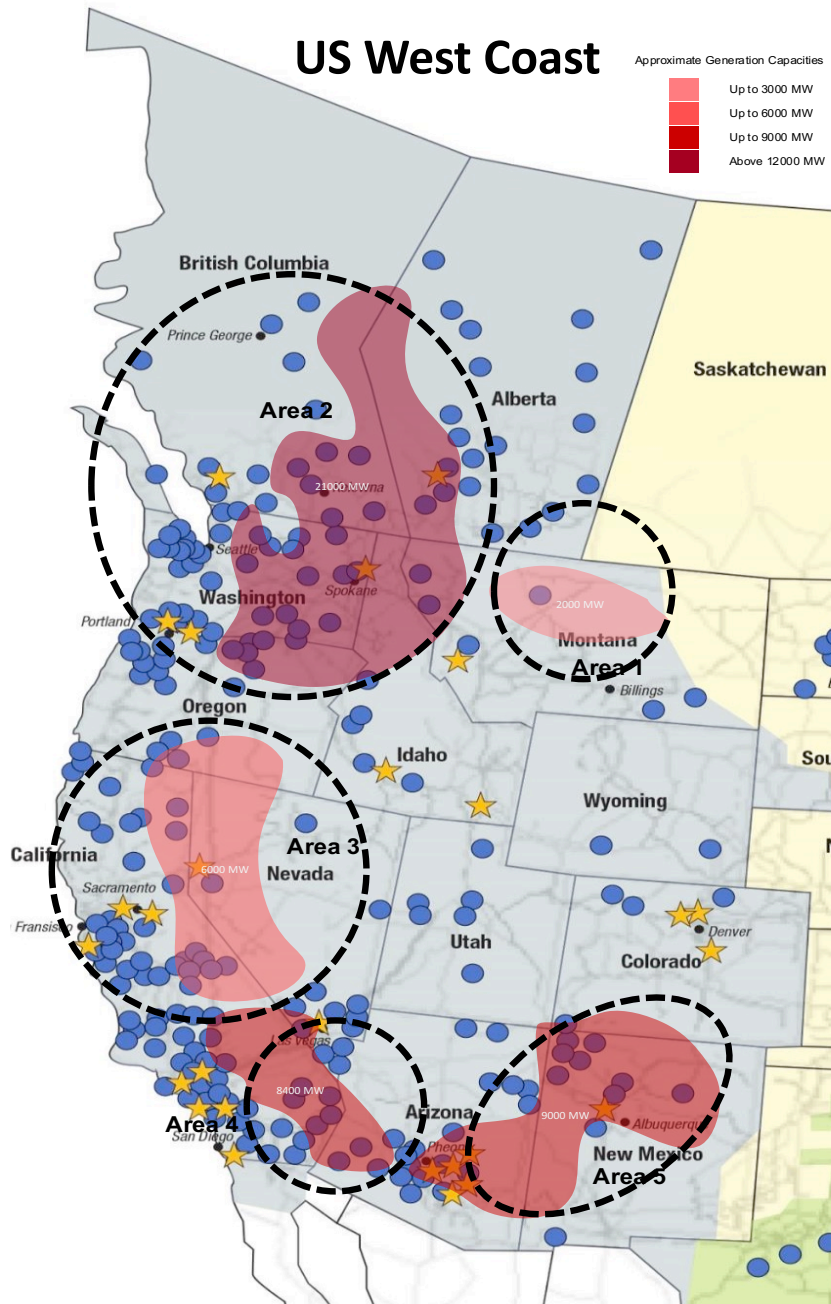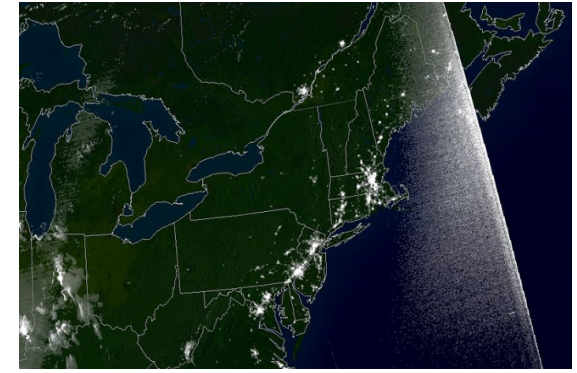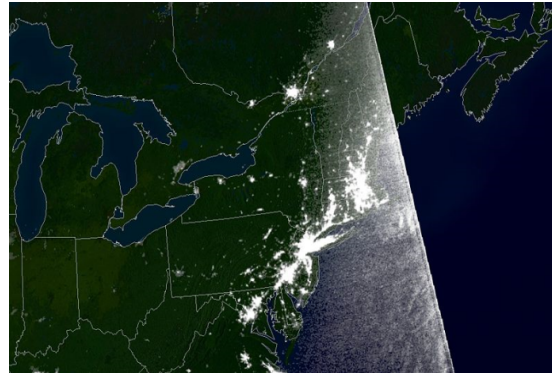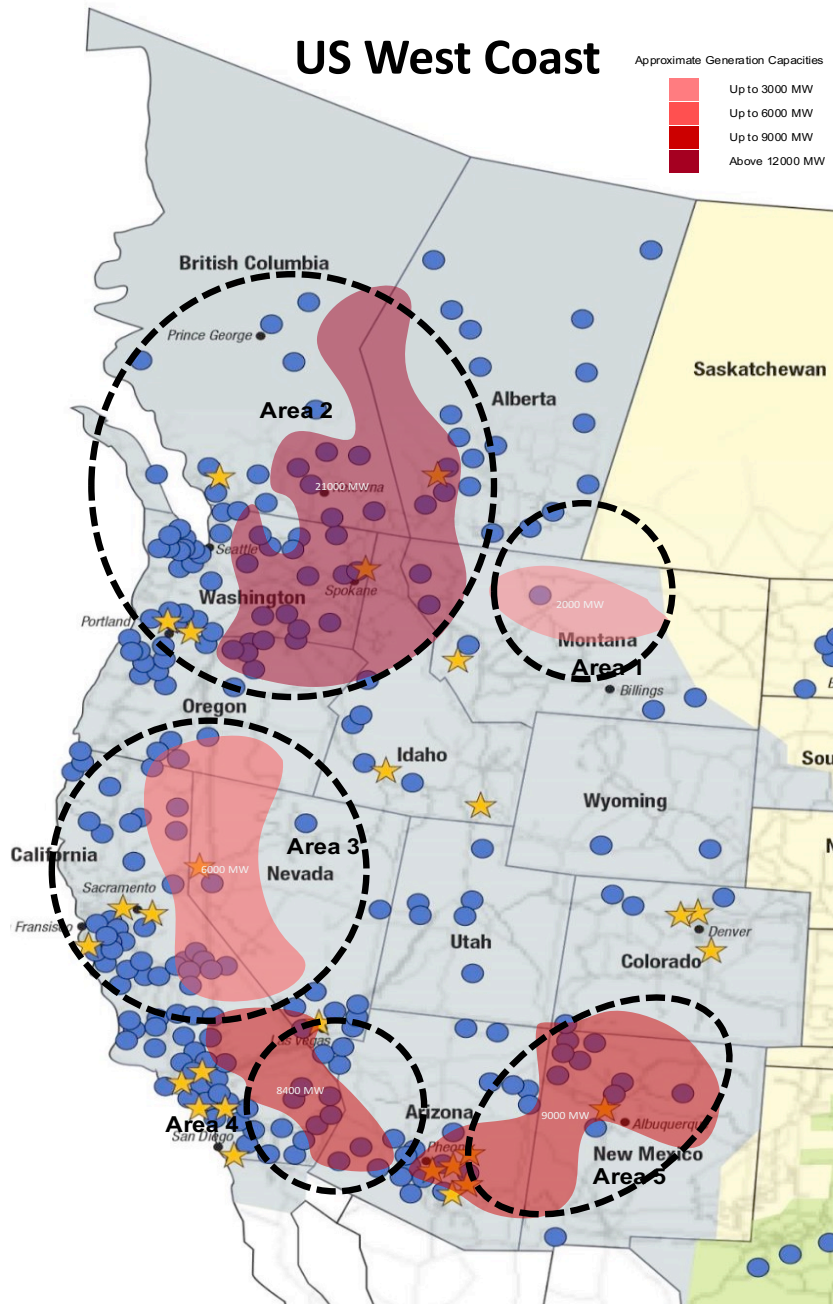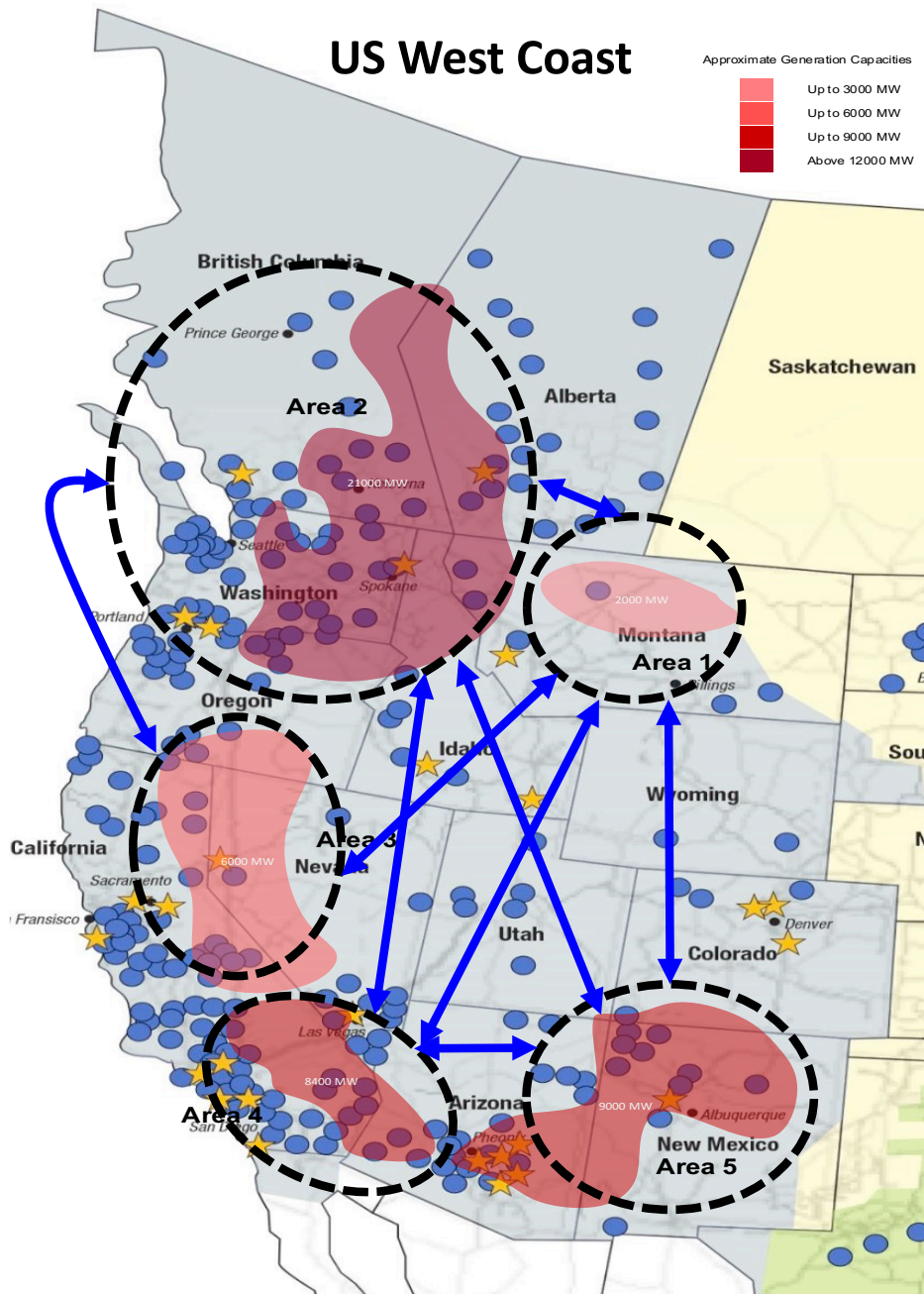# Why is Communication So Important for Controlling Power Systems?

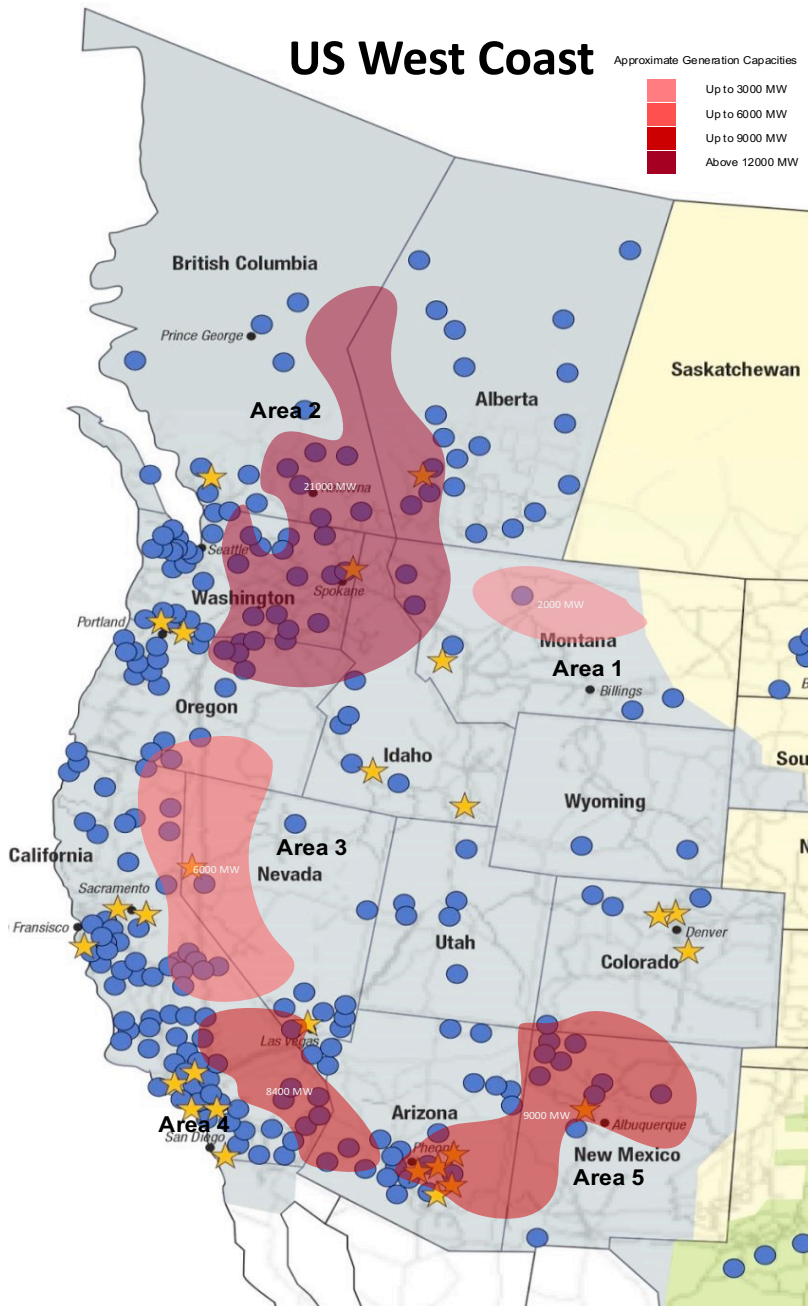# Why is Communication So Important for Controlling Power Systems?



**2003 Northeast blackout**
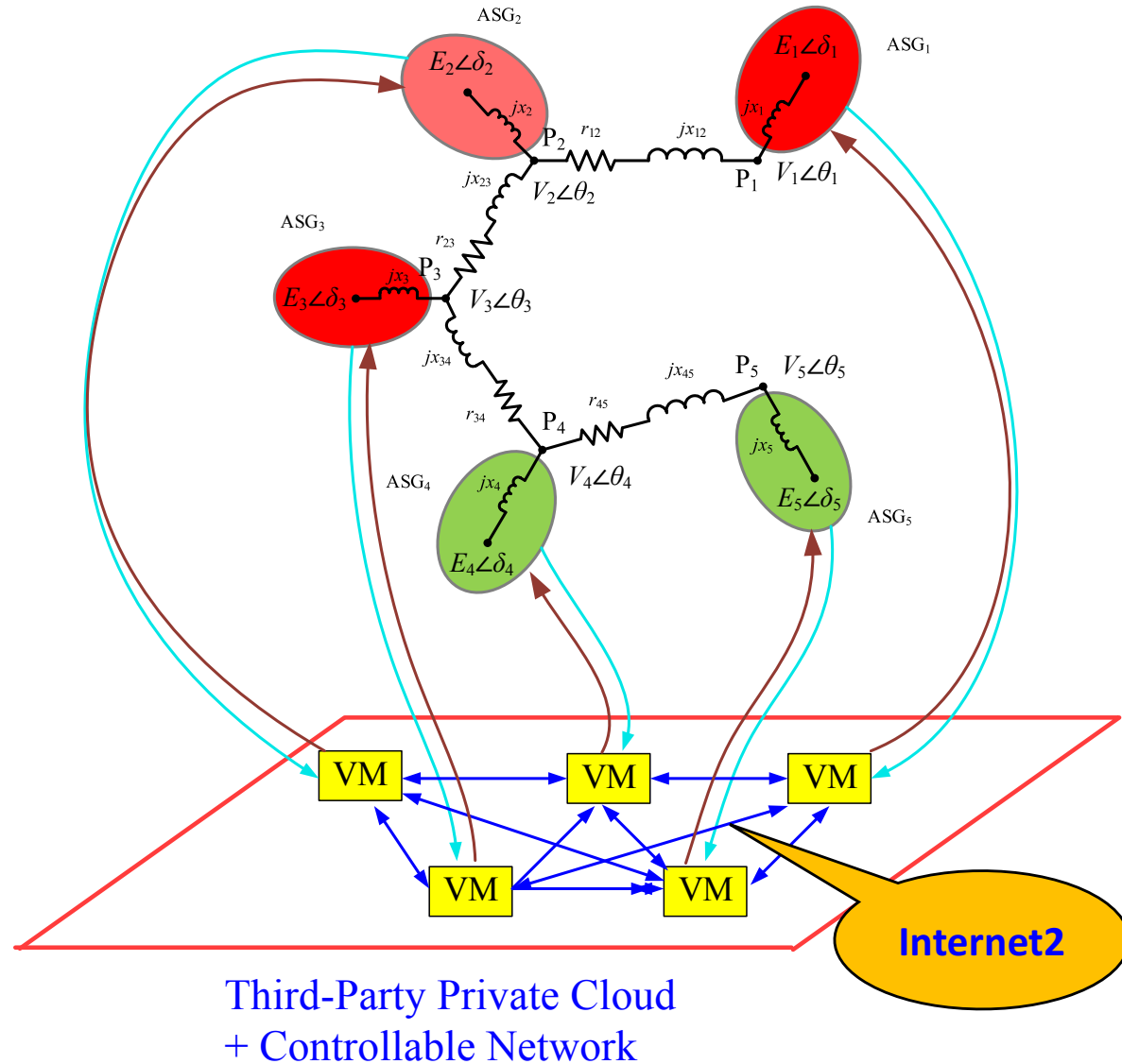
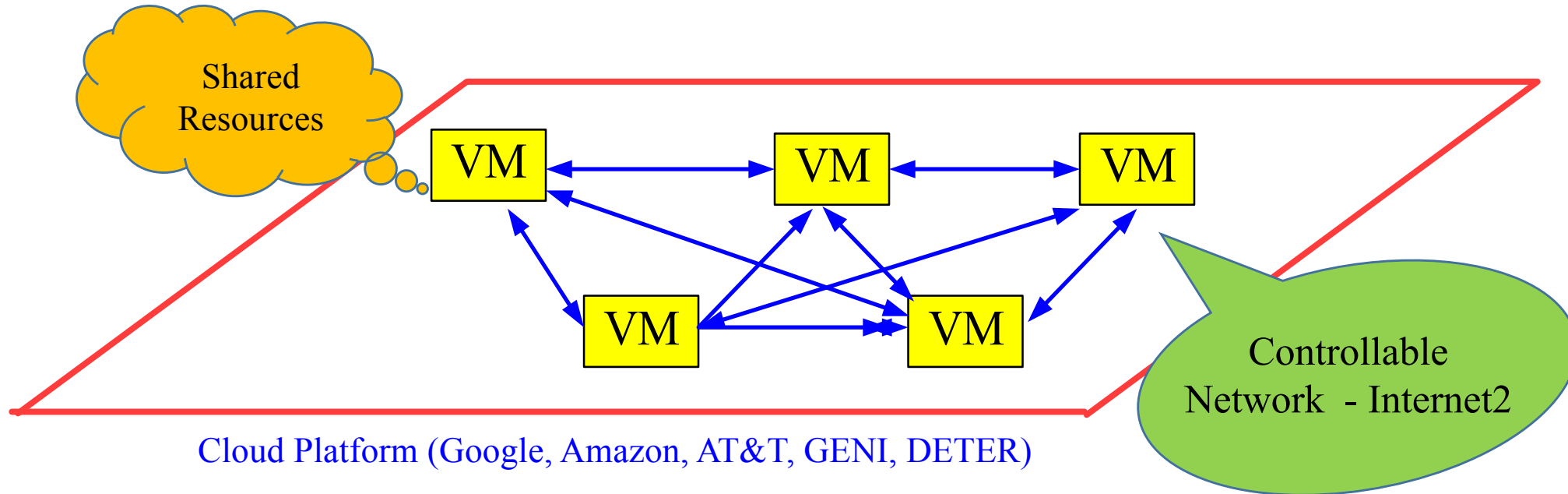# Why is Communication So Important for Controlling Power Systems?

# Balancing Regions are Sensitive to Data Privacy!



**US West Coast**

Close the loop from cloud to grid

**Third-Party Private Cloud + Controllable Network**

Internet2

# Interesting Things Going on in the Communication Plane



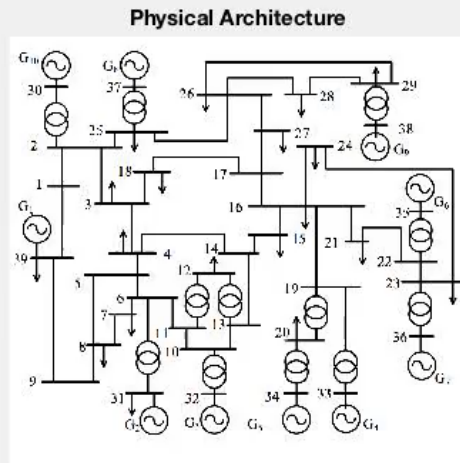Cloud Platform (Google, Amazon, AT&T, GENI, DETER)
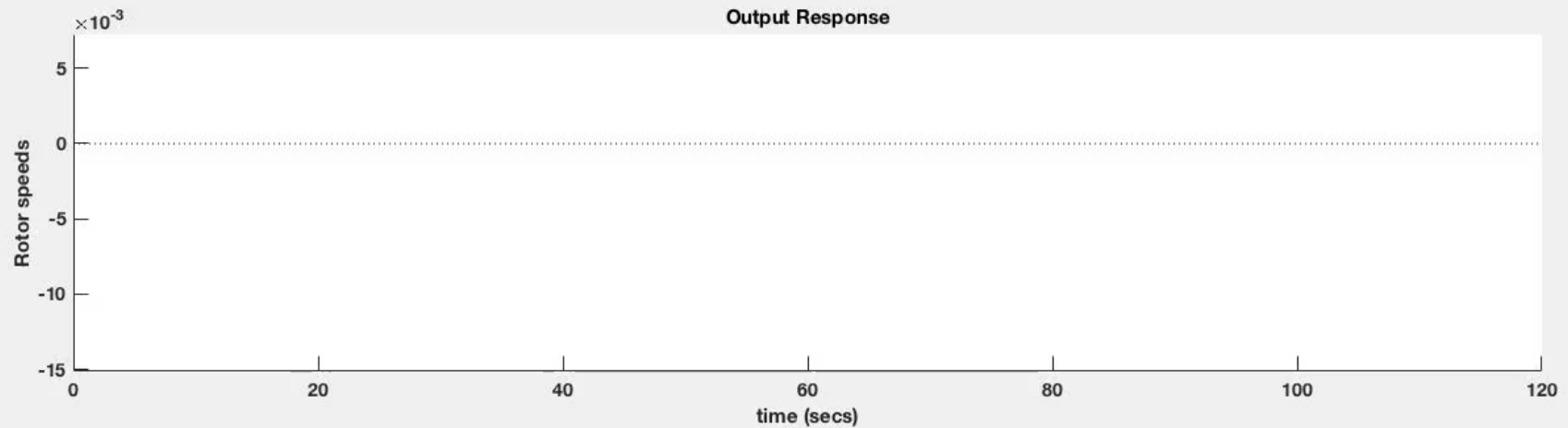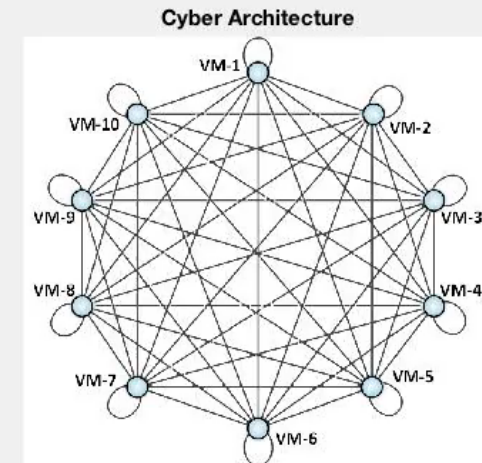
## Different types of attacks:

1. Denial-of-Service
2. Data manipulation
3. GPS spoofing
4. Replay attacks

# Denial-of-Service Attack
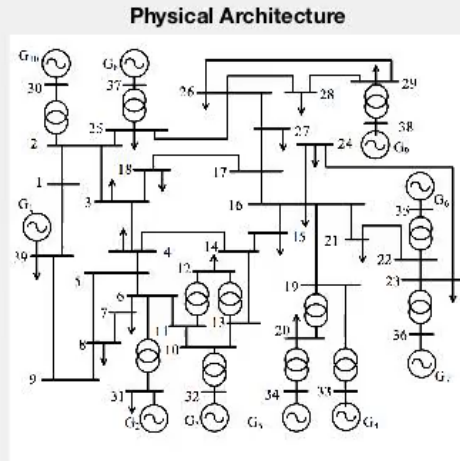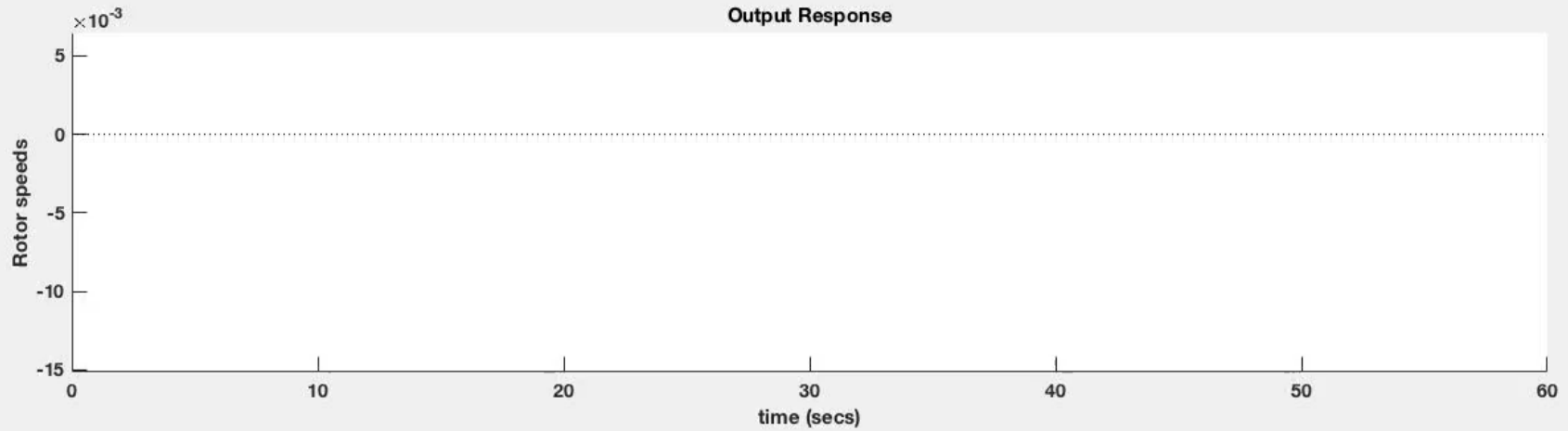


New England Power System Model
with LQR control

**Physical Architecture**

**Cyber Architecture**

Status:

**STABLE**

(Dense)

Output Response

# Denial-of-Service Attack



**New England Power System Model with LQR control**

**Physical Architecture**

**Cyber Architecture**

**Status:**

**STABLE**

**(Dense)**

**Output Response**
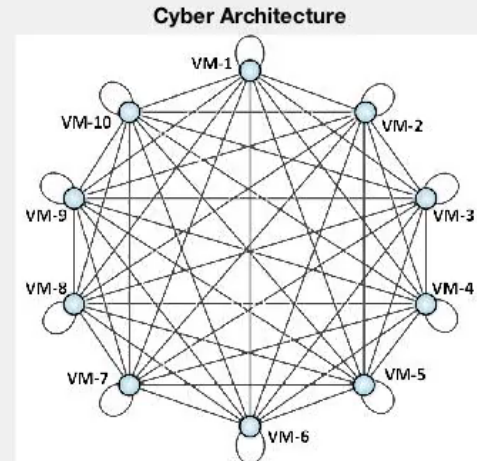
# ExoGENI-DETER-WAMS Testbed at NC State



**DoS Attack in DETER Testbed**

FRESCO
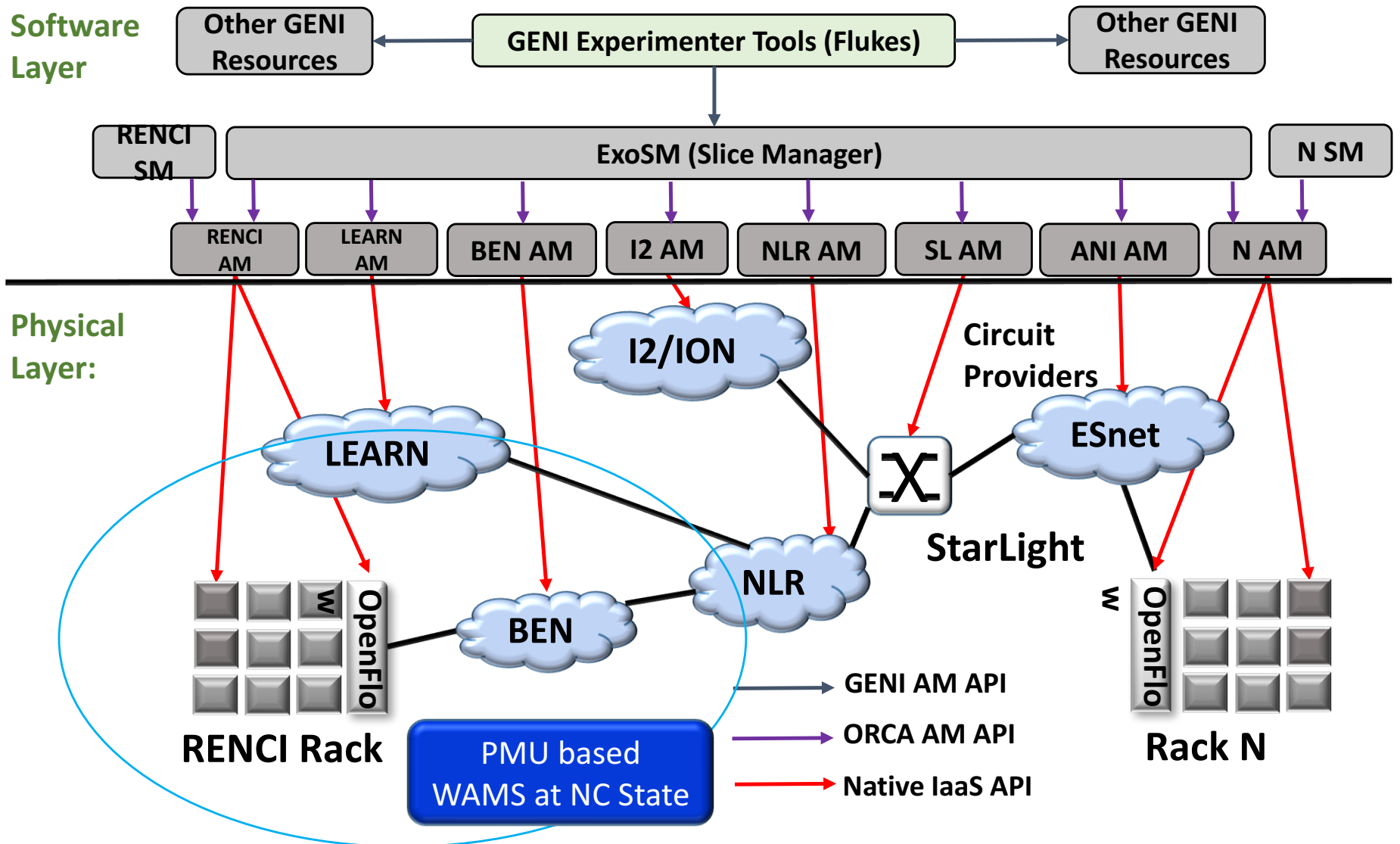
Controller
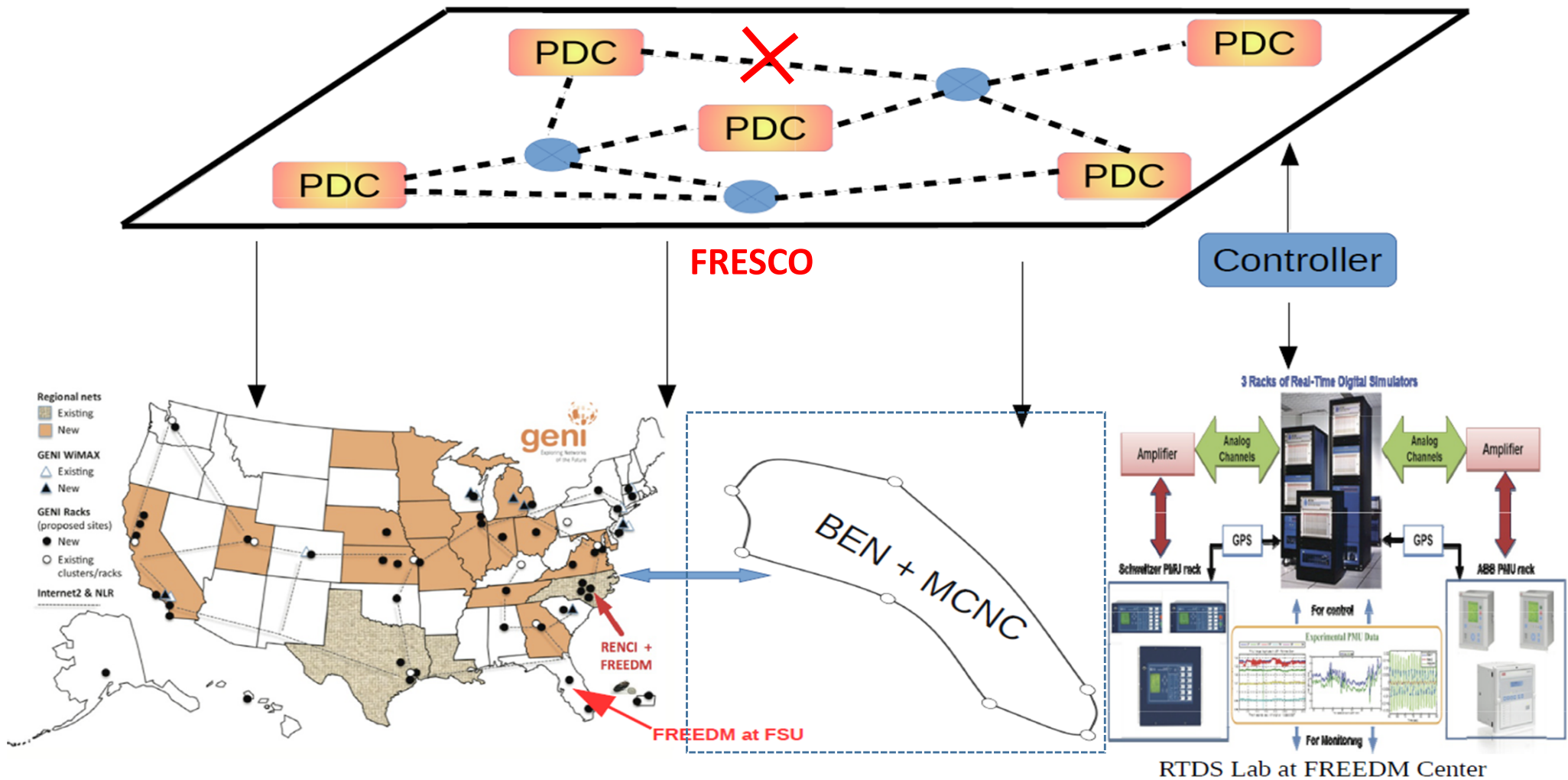
Middleware provided by Green
Energy Corporation and RTI

# Networked Cloud Computing Testbed - ExoGENI

ExoGENI provides in virtual IaaS services for innovative research on distributed applications for Wide-Area Monitoring and Control (14 rack sites at universities & labs over the US)
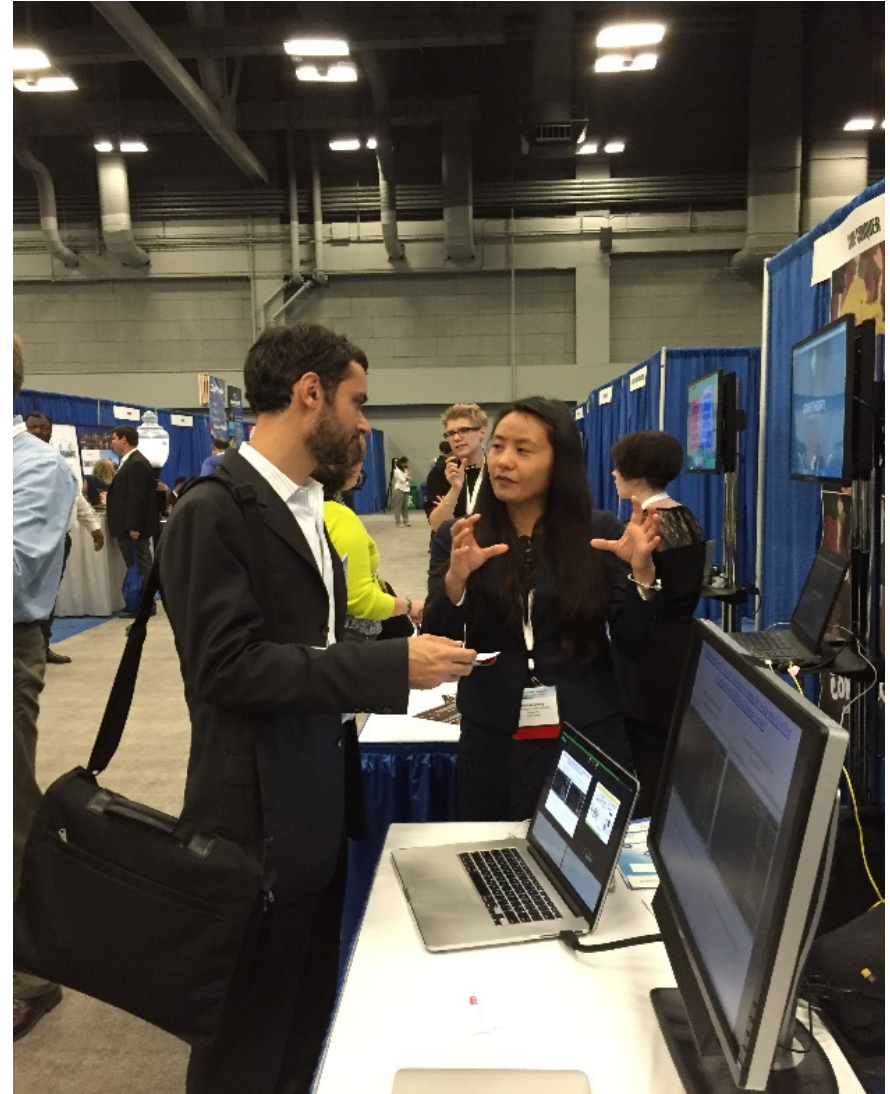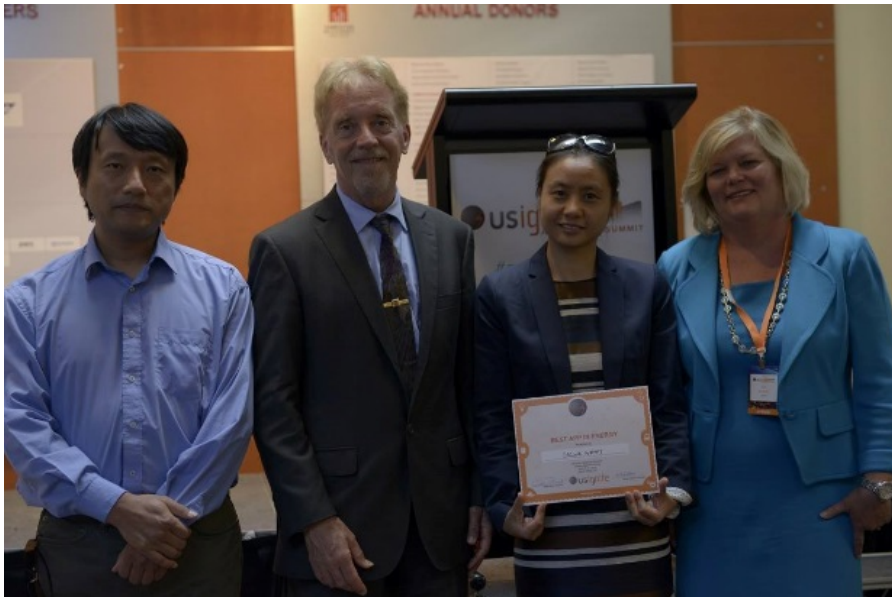
# Project Impacts:



DETER Demo at NIST & Smart-America 2014

Best Energy App Award at US Ignite 2015





US Ignite & NIST
Smart Cities Application
Summit, Austin, TX, 2016

# Thank You

Email: achakra2@ncsu.edu

Website: http://people.engr.ncsu.edu/achakra2