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NCST Advisory
Committee Meeting

NWIRP Study of Hurricane Maria Impacts and Recovery in Puerto Rico:

Preliminary Project Plan for Evaluating Infrastructure Support of Critical Buildings and Emergency Communications

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NWIRP Project: Infrastructure Support of Critical Buildings

Project Objective (A):

- As they relate to critical buildings, investigate power, water, and transportation infrastructure dependencies in
  - Impacts
  - Recovery
- Make recommendations for increasing resilience through changes to codes, standards and practice

Areas of Study

Impacts

- Damage to components
- Cascade of 'Loss of function'
- Mitigating factors (e.g., backup capacity, redundancy)

Recovery

- Time to recover functionality
- Time/resource dependencies
- Temporary measures (e.g., generators)
- Critical path – set of activities, any of which if shortened, would have shortened recovery

Planning:

- Where in the system to
  - Increase hazard resistance?
  - Add backup capacity?
  - Employ new technologies?
- Which changes to codes, standards and practice would be supportive?

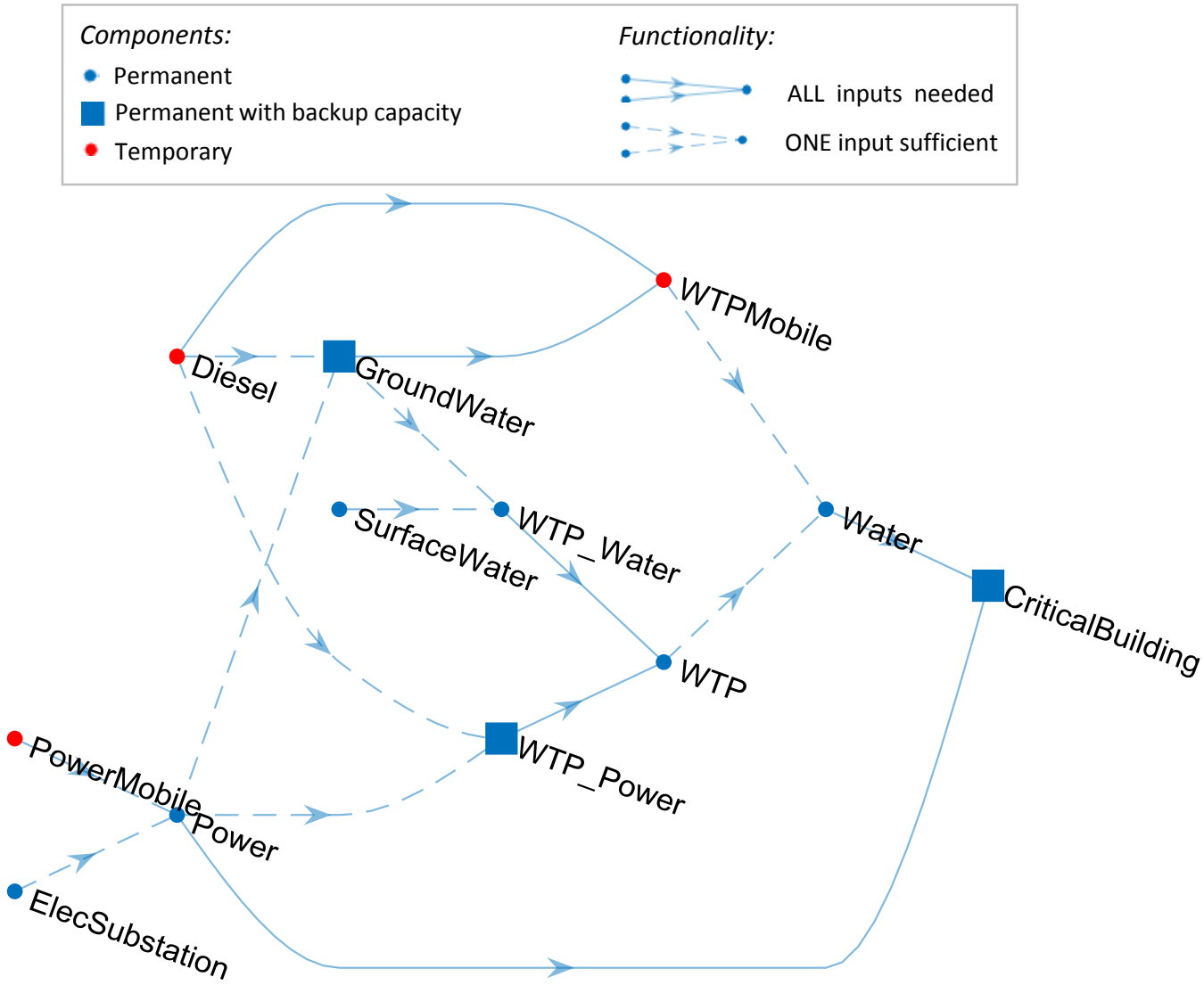


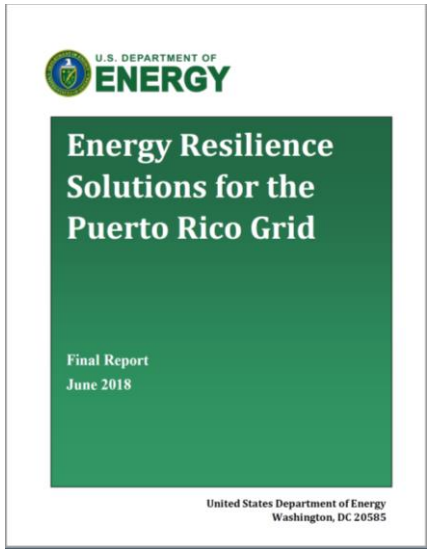
Figure: A highly simplified network showing critical building functional dependencies on infrastructure (and other components/services), based on NIST field deployments/studies, including 2016 Hurricane Matthew and 2017 Hurricane Harvey. Such networks are needed input to the systems models developed within the NIST Community Resilience Group

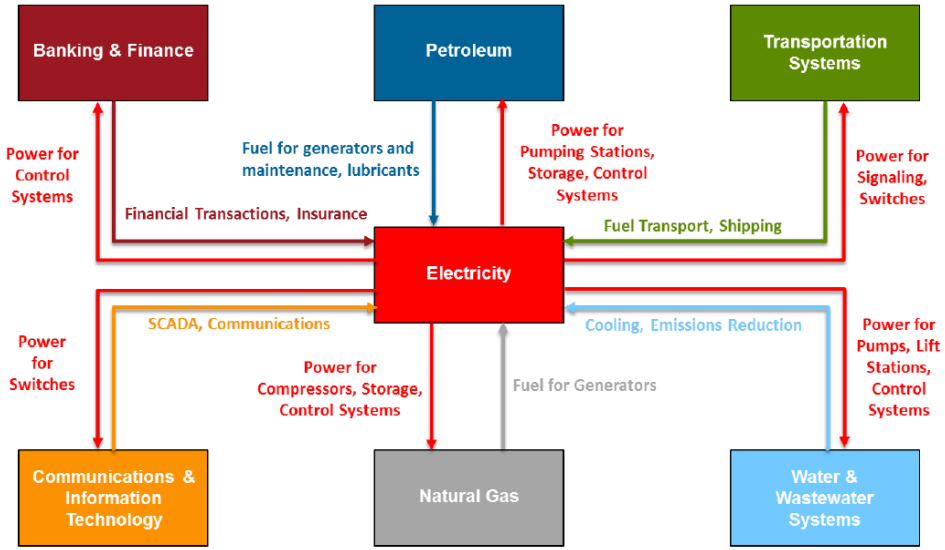
NWIRP Project's Preliminary Study Plan

1. Establish partnerships and official collaborations
2. Gather information at the community level on cascade, recovery, and considered resilience-improving actions
   - 200 semi-structured interviews with Power, Water, and Transportation officials at local and regional levels and Municipal officials
3. Extend and test NIST community resilience planning systems models
4. Apply model in a Puerto Rico based resilience planning case study

NWIRP Project updates

1. Establish partnerships and official collaborations
   - Argonne National Laboratory (ANL) (Resilience Assessment, Decision and Infrastructure Sciences)
     - Contributor to DOE Energy Resilience report
     - Potential contribution: Puerto Rico - wide network dependency modeling complementary to NIST modeling
     - Webinar planned for September
   - NIST Smart Grid Program
     - Microgrid potential interactions with building design





Electric Power Interdependency Examples (Source: DOE)

https://www.energy.gov/sites/prod/files/2018/06/f53/DOE%20Report_Energy%20Resilience%20Solutions%20for%20the%20PR%20Grid%20Final%20June%202018.pdf

NWIRP Project updates

2. Gather information at the community level on cascade, recovery, and considered resilience-improving actions
   - 200 semi-structured interviews with Power, Water, and Transportation officials at local and regional levels and Municipal officials

   - Data collection related to infrastructure to support sampling of buildings
     - Infrastructure: GIS shapefiles
     - Maps: Precipitation, Peak Wind gusts
     - Recovery data: Power (regional-level)

   - Contract for interview research services has been written and submitted to NIST's Acquisition Management Division

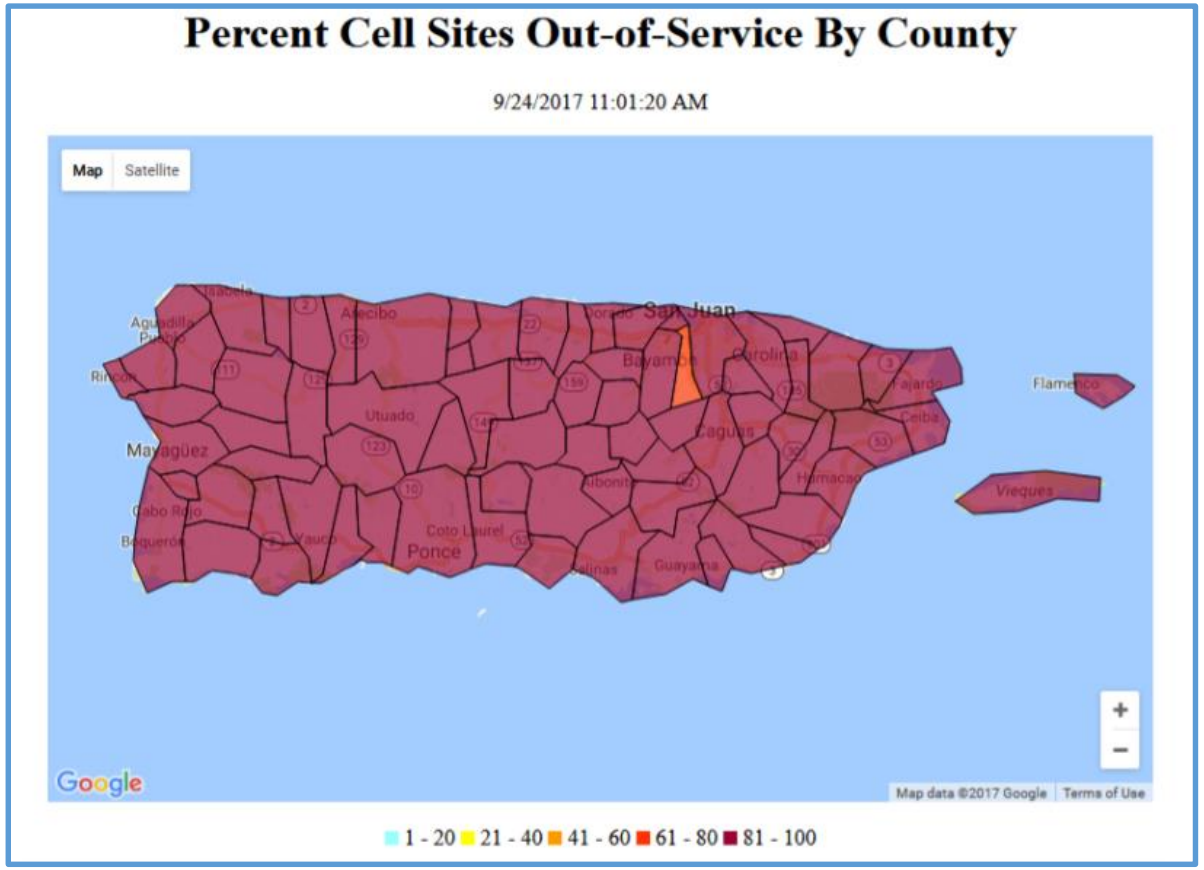
Next Steps

1. Establish partnerships and official collaborations
2. Gather information at the community level on cascade, recovery, and considered resilience-improving actions
   - 200 semi-structured interviews with Power, Water, and Transportation officials at local and regional levels and Municipal officials
     - Continue infrastructure-related data collection
     - Application of the infrastructure –related data to support sampling critical buildings and other NCST and NWIRP projects
     - Develop interview instrument questions, drawing from prior field studies
3. Extend and test NIST community resilience planning systems models
     - Equations representing reserve capacity (e.g., diesel generators) within NIST systems modeling framework (mixed-integer linear programming)
4. Apply model in a Puerto Rico based resilience planning case study

NWIRP Project: Infrastructure Support of Emergency Communications Systems

Project Objective (B):

- To investigate causes of the loss of functionality and extended-duration outage of the wireless communication system in Puerto Rico following Hurricane Maria.



Source: Federal Communications Commission

NWIRP Project's Preliminary Study Plan

- Collect data on damage caused by Hurricane Maria to cell towers, equipment, cabling, and related components of wireless communications systems, from regulatory agencies, telecommunications companies, and telecommunications support industries
- Collect information on codes, standards and regulations governing the design and construction of cell towers and wireless communication equipment
- Determine the hazard levels experienced at cell site locations identified by the Hazard Characterization project
- Evaluate tower and equipment performance with respect to the hazard levels experienced at each site and code design requirements

Progress Updates

- Types of information gathered so far include:
  - Daily cell cite outage information by county[1]
  - Information on recovery of daily call and text volume over time[2]
  - Locations of the 1,039 registered communications towers in Puerto Rico, as of 2006[3]
  - Post-Maria aerial imagery of towers and surroundings
    - Only a few towers appear to have collapsed (image resolution was generally insufficient to observe finer scale damage such as to tower-mounted equipment and cables)

Collapsed Trussed Tower in Humacao

Source: Federal Emergency Management Agency

[1] https://www.fcc.gov/maria
[2] http://about.att.com/inside_connections_blog/hurricane_maria
[3] http://www.jrtpr.pr.gov/registro-de-torres/

Next Steps

- Contact government agencies and private sector entities for data collection, including
  - Federal Communications Commission
  - Federal Emergency Management Agency
  - Junta Reglamentadora de Telecomunicaciones de Puerto Rico (Regulatory Board of Telecommunications of Puerto Rico)
  - Wireless communications service providers
- Identify codes, standards, regulations and practices governing the wind load design and construction of communications towers and the equipment such towers support, as well as any design requirements for other hazards (e.g. wind-driven rain)

Collapsed Roof-Mounted Tower in Caguas