Climate-Cybersecurity-Resilient Infrastructure: Relevant R&D underway at NSF

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Workshop:

Unravelling the Cyber- Physical-Social Infrastructure Climate Change Nexus

July 29 - August 1, 2024, Washington D.C.





NSF: Where Discoveries Begin



Directorate for Technology, Innovation and Partnerships (TIP)

Mathematical & Physical Sciences

Integrative Activities

International Science & Engineering

"To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes"



Coupled Social & Cyber Physical Systems (CPS)

Research, Infrastructure, Applications and Services

- > Food
- Water
- Agriculture
- > Health
- > Financial services
- > Financing of next-gen investments
- Supply chains
- > International trade, negotiations















R&D efforts across CISE, ENG, GEO, OISE, SBE and other NSF Directorates and Offices.

Cyber Physical Systems (CPS)



- Network, Applications
- Identity Management
- Mobile Security
- Information, Data, Cloud
- Future of work
- Operational Security
- Disaster Recovery
- Business Continuity Planning





- Direct impacts on CPS heatwaves, wildfire, flooding
- Compound CPS threats and vulnerability to cyber attacks

Robust & Resilient
Cyber Physical
Systems





September 2023 NSF Press Release

US-Canada Center on Climate-Resilient Western Interconnected Grid

Goal of Global Center: to assess the risk of extreme event for power grids using state-of-the-art modeling tools

Infrastructure Dynamics and Adaptive Recovery from Repeated Shocks through Resilience Stress Testing in Complex Human/Natural Systems: Testing in Ukraine Partners: USA – Ukraine – Poland – Estonia – Lithuania

Quantitative identification of functions and failures

Identification of Key Performance

Indicators and Mapping Out

Development of the

Generalizable Tools and

Metrics for Stress Testing and

Recovery Pathways for

Infrastructure Resilience

Perform Stress Testing and Recovery Know-How Explore factors and Interactions System Improvements / Practitioners

Real-world case studies



1. DESIGN :DFW Airport Infrastructure Resilience

2. TESTBEDS: Poland, Estonia, Lithuania

Testbed 1: Security and Recovery of Cyber-energy distributed networks

- Poland
- System Failure and Recovery Traces Analysis
- Development and validation of the analytical model
 MI techniques to identify the persistance of the drivers
- ML techniques to identify the persistence of the drivers



Testbed 2: Last-mile electrification and energy supply security of end users

• Application of recovery tools to user-based energy systems

Resilience-by-design and optimization study

Testbed 3: Cyber-resilience of Ukrainian universities



3. IMPLEMENTATION: Ukraine Infrastructure

Building resilient communities in Ukraine, Stress Testing, Preparedness Training

- Identification of essential services and goods
- Map out supply chains
- Vulnerability and resilience assessment
- Minimum viable components assessment
- Mitigation tactics
- · Stress-testing training

Resilience Stress-Testing and Recovery Case studies from five different focal points

A Global Team on Quantitative Resilience Analytics Rapid guidance on recovery pathways

Improved preparedness for future shocks



Team building and Co-Creation Activities

International Mobility and Exchange of Data Scientists

Open Access
Quantitative
Resilience Analytics
Training Modules

Talks and posters in IEEE, IES, SRA

Educational outreach in Ukrainian Institutes

UF Biocomplexity Seminar Activities

Multi-lingual outputs

Outreach activities involving academics, young professionals, government officials in partner institutes

Examples of ongoing projects

CISE: NSF-JST: Enabling Human-Centered Digital Twins for Community Resilience



Disaster Digital Twin framework that integrates diverse data sources to improve community resilience for disaster response strategies to support vulnerable populations

ENG: Operational and economy-wide impacts of compound cyber-attacks and extreme

weather events on electric power networks

- Compound cyber–physical threat can exacerbate regional electricity disruptions by 3 times
- A compound cyber-physical threat can exacerbate economy-wide losses by 10 times

TIP: SBIR Phase I: CAS: Digital Twin for Climate Resilience Analytics

- Create and design state-of-the-art digital twin technology that harnesses power of big data and machine intelligence
- Enable proactive and predictive lens on community preparedness, evacuation measures, protective actions, and post-emergency event recovery

EPSCOR: Funding of \$ 77.8 M to build climate resilience capacity







Strategy for Cyber Physical Resilience: Fortifying our Critical Infrastructure for a Digital World PCAST, 2024

- **CPSR** the capacity of an integrated system to keep running even if not at peak performance should it lose specific functions. Challenges include degradation or cessation of one or more aspects of the computational or physical functions due to component failures, human errors, natural disasters, or malicious attacks.
- **RECOMMENDATION** Formulate a National Plan for Cyber-Physical Resilience Research. Partner across federal agencies to define priorities and support research in those areas.

Goal: to create focused research across programs that increase the likelihood of successful research results, but more importantly help ensure that such results will transition into actual use.



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Science and Technology

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FTAC Organization

- Co-Chairs
 - David Alexander, DHS
 - David Corman, NSF
 - Kristin Ludwig, OSTP
 - Martin Stanley, NIST
- 26 Participating Federal Agencies
- Meet on a monthly basis
- Report on R&D Needs Late June 2025



National Academy Climate Security Roundtable

Roundtable Expertise:

- Food, Water, Energy
- Health
- Urban
- Earth Systems
- Conflict, Governance
- Development, Adaptation
- Computing
- Risk



Forthcoming

- Urban Systems
- Food & Agriculture































