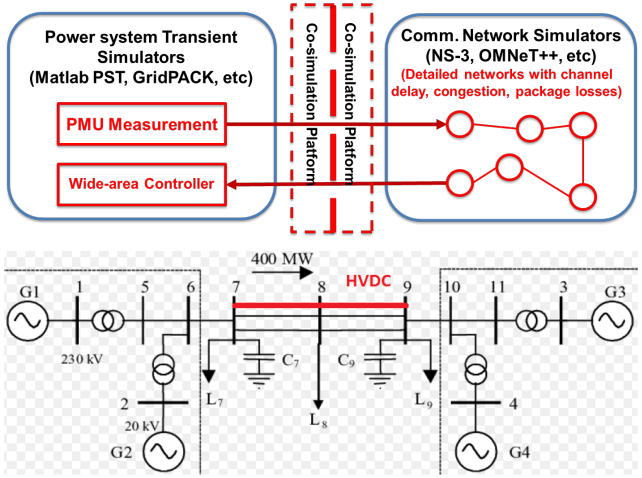
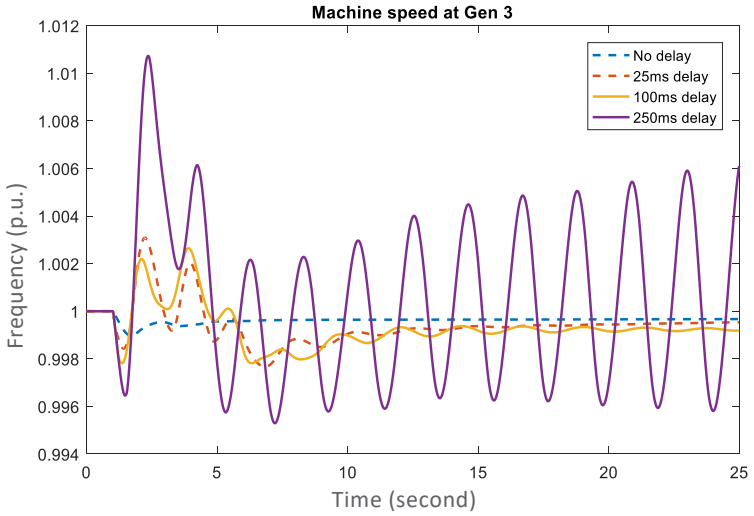
Use Case Example: Communication System Effects on Wide-Area Frequency Control

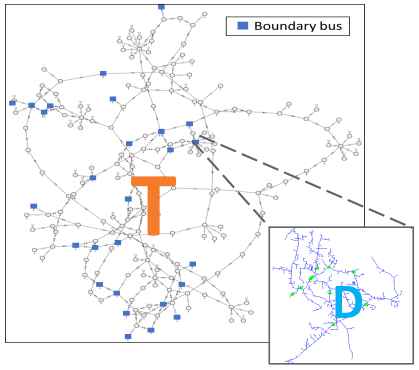
- Wide-area control critically depends on the performance of communication networks for stabilizing power systems.
- T+C co-simulation (e.g. HELICS + GridPACK + NS3) enables the design and evaluation of wide-area control with realistic communication characteristics instead of assumed arbitrary properties.



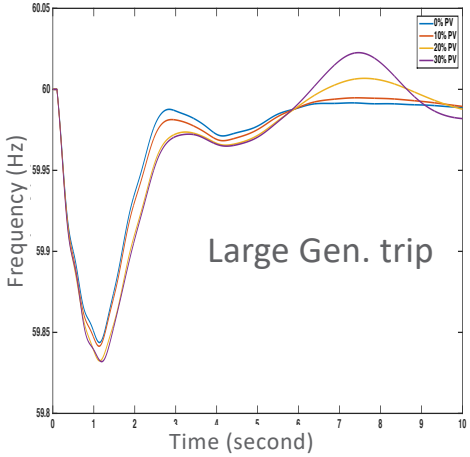


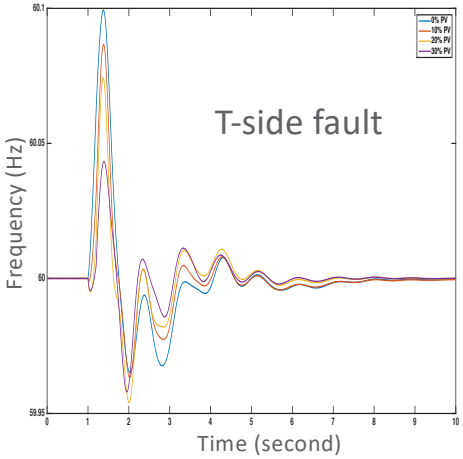
Use Case Example: Combined Transmission-Distribution Stability Analysis

- Assess impact of very high DER penetration on bulk system stability – fulfill a very important industry need as a result of increasing DER penetration (PVs, EVs, etc.)
- Very large (0.5 million buses) T+D dynamics co-simulation provides a practical way to achieve this objective.



1 T + 135 D's:
540,000 T+D buses

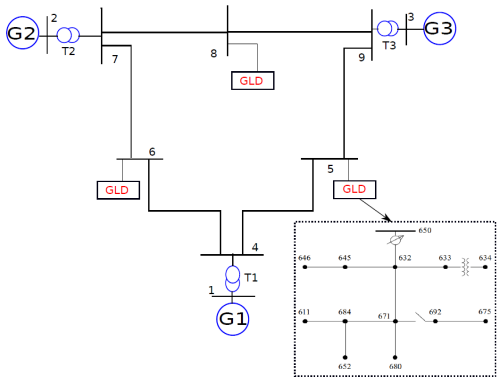




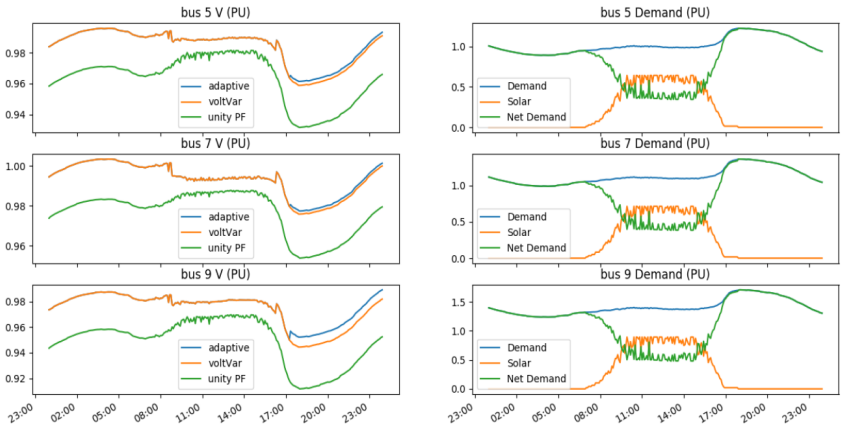
Impact of % PV penetration on system frequency

Use Case Example: Adaptive volt-VAR control at high PV penetration: Impact on transmission system voltages

- Assess the ability of smart inverters in regulating transmission system voltage: Unity Power Control, Fixed Volt/Var Control, and Adaptive Volt/Var Control.
- Adaptive Volt/Var control demonstrates the best voltage performance.
- T+D co-simulation (e.g. HELICS + PFLOW + GridLAB-D) enables the design and evaluation of such an adaptive control across transmission and distribution.



1 T + 3 D's with smart inverters

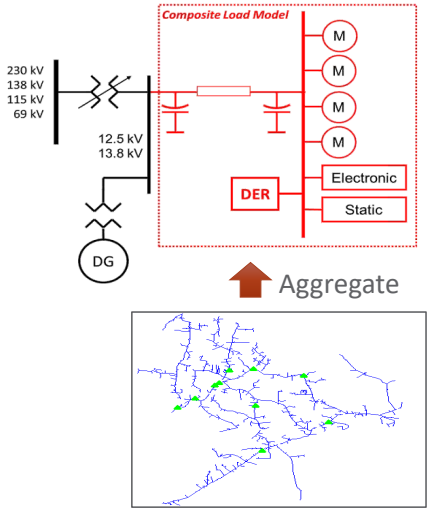


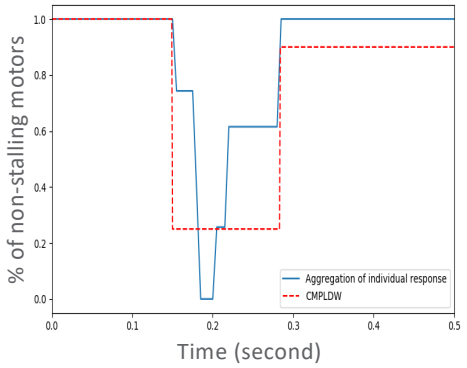
Comparison of 3 smart inverter control strategies

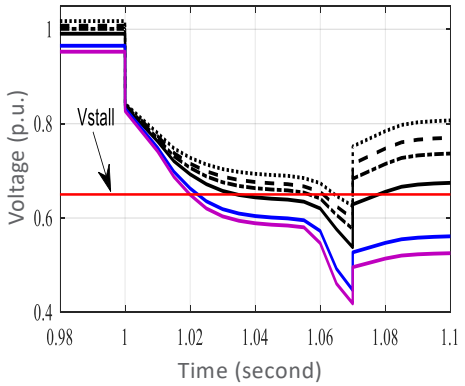
Adaptive Volt-VAR - no voltage violation.

Use Case Example: Aggregate protection modeling and evaluation of dynamic composite load model

- Correctly modeling motor behaviors in loads for system stability analysis: Evaluate and calibrate composite load model (CMPLDWG) in response to faults.
- T+D dynamics co-simulation (e.g. HELICS + InterPSS + GridLAB-D) reveals motors stalling at different levels instead of all at once – accurately representing load recovery in system stability analysis.







Transmission-side fault causes slow voltage recovery due to motor stalling behaviors

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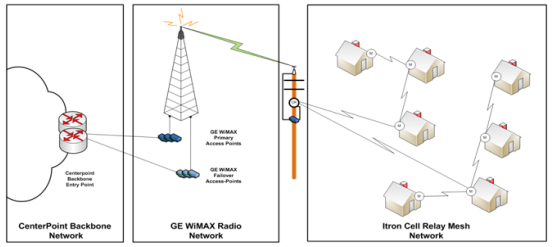
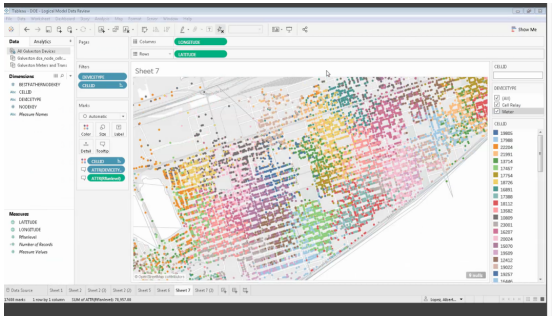
Application Example: Distribution and Communication Network Co-Simulation

- Objective: Validate the communication modeling capability; Develop/Validate distribution and communication co-simulation (DISCO) capability; assess the benefits of enhancing resilience against extreme weather and potential cyber risks.
- Demo Site: CenterPoint, Galveston, TX
  - 2017 system scenario Harvey
  - Communication Model– RF Mesh, WiMax
- HELICS Application: Distribution and Communication Network coupling for extreme weather and cybersecurity





CYME INTERNATIONAL T&D
EATON'S CYME POWER ENGINEERING SOFTWARE

HELICS

ns-3 NETWORK SIMULATOR

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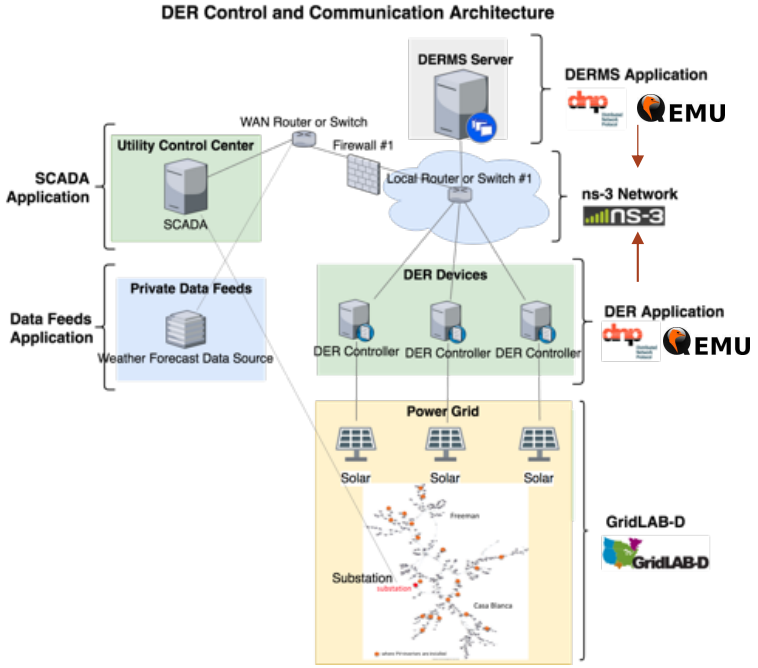
Application Example: Cybersecure Interconnection of Distributed Energy Resources

- Objective: Develop a tool that can evaluate the cybersecurity risk of various DER integration architectures, and design remediation strategies for a grid with high-penetration of DER can become more resilient and better able to survive a cyberattack.
- Demo Site: HECO, Hawaii
- HELICS Application: Distribution and Communication Network coupling for DER cybersecurity



GridLAB-D HELICS ns-3 NETWORK SIMULATOR

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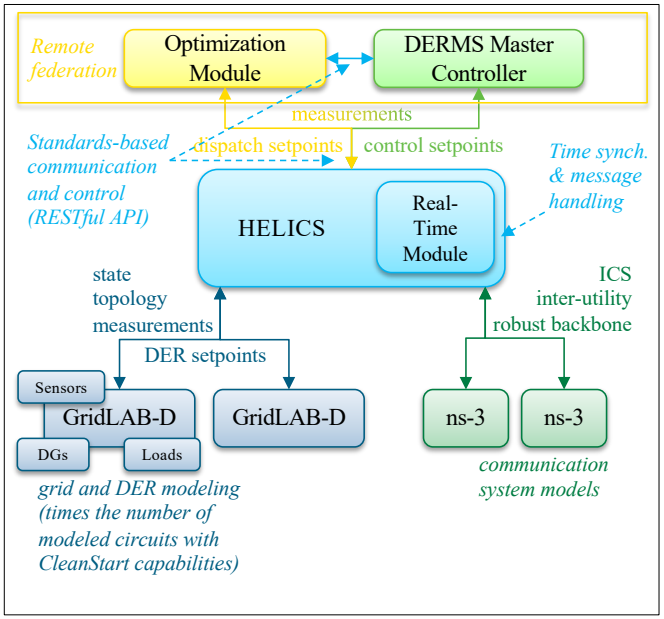
Application Example: CleanStart DERMS –utilizing high penetration of DERs for transforming distribution resiliency

- Objective: Demonstrate at scale a DER-driven outage mitigation, restoration and black start strategy for distribution with integration of novel distributed controls, communication and high fidelity predictive analytics to implement a coordinated secure hierarchical solution for the electric grid.
- HELICS Application: Transmission, Distribution and Communication Network coupling for DER cyber performance to support emergency restoration



GridLAB-D HELICS ns-3 NETWORK SIMULATOR

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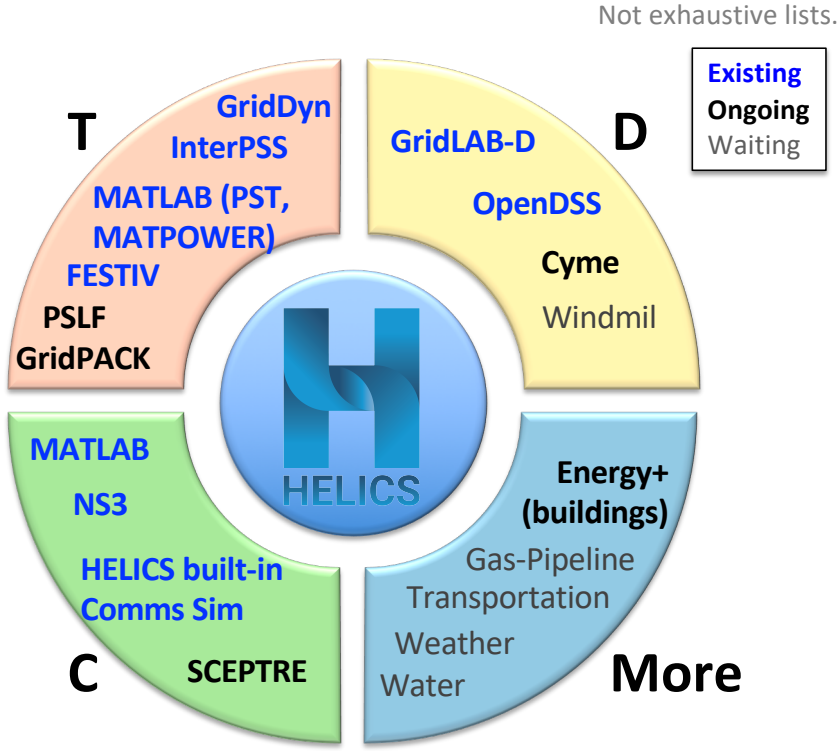
HELICS interfaces to popular domain simulators, ready for user testing

- Enable large-scale interdependency all-hazards studies: scale 2 to 100,000+ domain simulators
- Diverse simulation types:
  - Continuous, discrete, time series
  - Steady-state, dynamic, transient
  - Other energy systems
- Support multiple platforms: HPC, cloud, workstations, laptops (Win, Linux, Mac)
- Support standards: HLA, FMI, …



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Summary

- HELICS v2.0 was successfully released as a result of a multi-lab effort.
- HELICS is designed to be the most comprehensive co-simulation platform for the grid + associated systems by converging prior lab efforts and being compatible with standards.
- HELICS current capabilities support key co-simulation applications for grid resiliency and security, demonstrated with select use cases.
- Expand HELICS core capabilities to federate with more domain simulators, with improved usability and validated scalability. (potential for co-simulation beyond T, D, and C)
- Continue user engagement through workshops, tutorials, webinars, web forums, etc. And build open-source community support of HELICS development.

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Questions?

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