Research About Real-Time Hardware-in-the-Loop (HIL) Simulator for Distributed Energy Resources using IEEE 2030.5 Network Protocol

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1. What is Distributed Energy Resources (DER)?
2. IEEE 2030.5 Network Protocol
3. Real-Time Hardware-in-the-Loop Simulator for DER
4. Future works
What is Distributed Energy Resources (DER)?

**DER (Distributed Energy Resources)**
A Distributed Energy Resource (DER) is any resource on the distribution system that produces electricity.*


Solar Panel

Wind Turbine
What is Distributed Energy Resources (DER)?

Carbon Neutrality

Increase of renewable energy usage

Smarter management and control of DER are needed!
What is Distributed Energy Resources (DER)?

California Public Utilities Commission

Established the IEEE 2030.5 network protocol as the default protocol

Rule 21.
What is IEEE 2030.5 Network Protocol?

History of IEEE 2030.5

1. ZigBee Smart Energy Profile 2 initiated in 2008
   • Designed to use widely-adopted technologies
2. Standard completed and adopted as IEEE 2030.5 in 2013
3. Selected as the “default protocol” for California Rule 21 in 2016

Key Technology Decisions

1. Internet Protocol (IP)
   • Can mixing various link layer technology (e.g., WiFi, ZigBee)
2. RESTful HTTP
   • Large ecosystem
3. TLS 1.2 (HTTPS)
   • Desire to meet US NIST requirement
4. IEC 61968 (CIM)
   • Smart Grid “dictionary”

IEEE 2030.5 is communication layer independent
Real-Time Hardware-in-the-Loop Simulator for DER

Real-Time HIL DER Simulation Model

DER Client

IEEE 2030.5

DER Server (DERMS)

System data

Control command
Real-Time Hardware-in-the-Loop Simulator for DER

Matlab/Simulink + OPAL-RT

Distributed energy resource model

1. Created by Matlab/Simulink
   • Consists of solar systems, wind systems, energy storage systems and distribution systems
2. Conjunction with OPAL-RT
3. System data are sent to distributed resource management systems
Real-Time Hardware-in-the-Loop Simulator for DER

IEEE 2030.5 Network

- Use Raspberry Pi 4 (Client, Server)
- Implement using Python 3.9.5
- Use REST API
- Set TLS_ECDHE_ECDSA_WITH_AES_128_ccm_8 as a cipher suite in HTTPS/TLS 1.2
- Using xml resources between client-server
Future works

HIL Testbed

Performance evaluations & improvement

Distributed resource control platform

Cybersecurity research
THANK YOU FOR LISTENING!