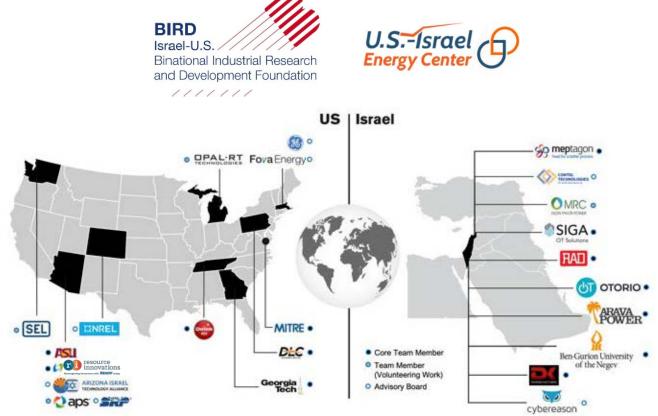
# BIRD-ICRDE Comprehensive Cybersecurity Technology for Critical Power Infrastructure Al-Based Centralized Defense and Edge Resilience

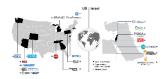


Converging Cybersecurity Solutions for Energy Systems to Practice

**Grid360 Platform for Cybersecurity Threat** Simulation, Detection, and Mitigation

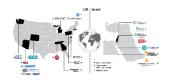
John Dirkman P.E. VP Product Management Resource Innovations jdirkman@resource-innovations.com

1 March 2022



- 1. Grid360 Overview
- 2. Commercialization Approaches
- 3. State Estimation Applicability
- 4. Q&A

## Grid360 Overview



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#### State estimation, optimal power flow, contingency analysis, fault analysis

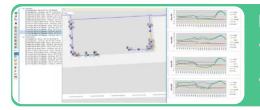
• Determine the current operating state of networks using AMI/SCADA/sensor data, discover and eliminate data/topology/latency errors, and recommend sensor placement

• Calculate and display system loading and voltage warnings and violations, including contingency analysis, calculate fault level, run optimizations, generate alerts, recommending switching, and dispatch resources



#### Analysis of DR, DG, DER, PED, EV, microgrids, improved customer engagement

 Evaluate the current and near-term energy and economic state of distribution grids including demand response (DR), distributed generation (DG - solar and wind, including smart inverters), distributed energy resources (DER - energy storage), power electronic devices, electric vehicle (EV) supply equipment, microgrids, volt/VAR optimization (VVO), and Grid Interconnection programs, improving customer service



#### Load profiling, short-term, and long-term load and DER forecasting

- Create load profiles, develop short-term (days ahead) and long-term (months to years ahead) energy and economic forecasts including DR, DG, DER, PED, EV, and microgrids
- Generate alerts and dispatch resources based on forecast conditions



## Management of independent grids and microgrids, reliability coordination/market operations

- Manage independently-owned commercial and industrial grids and microgrids
- Coordinated capacity calculation and security analysis, outage planning coordination, short- and medium-term adequacy forecasts

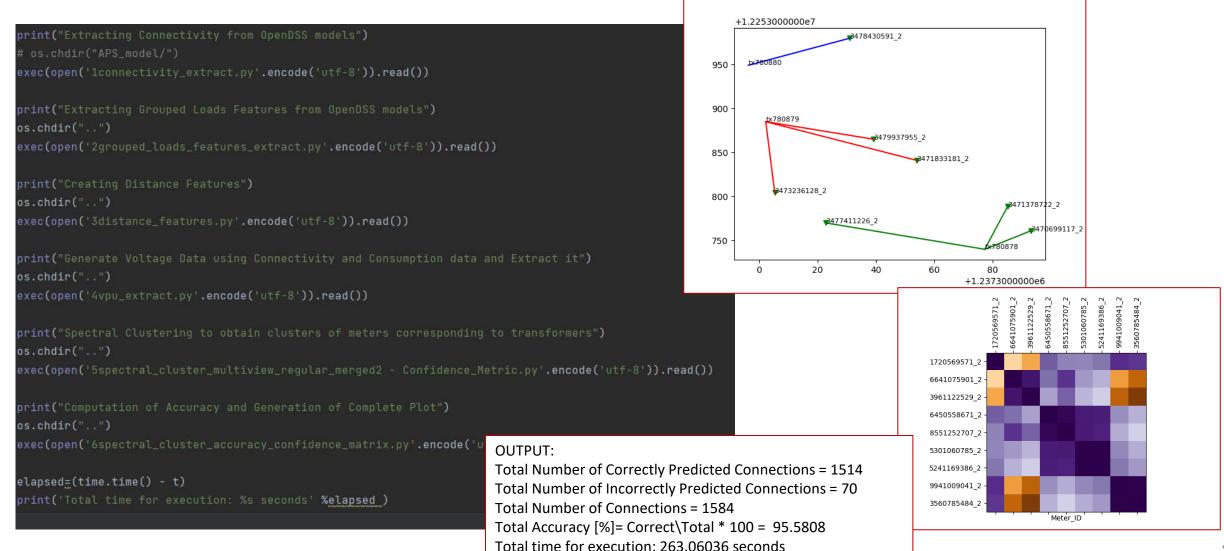


#### Advanced security, data quality, and reliability analytics

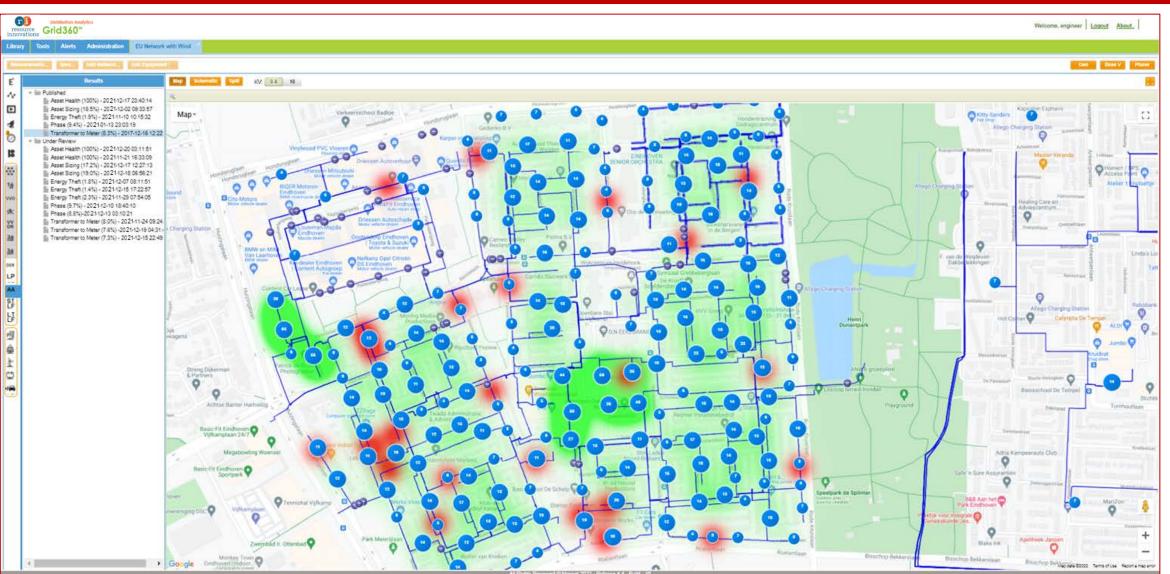
Track critical and vulnerable assets, communication channels, protocols and encryption, patches and mitigations, ownership, and access and safety
 Analyze and improve transformer to meter assignment, phase assignment, sizing of devices and conductors, asset health forecasting, energy theft, outage causes and prediction, and other data quality and operational factors based on AMI/SCADA/sensor data and network models

# **Commercialization - ASU Topology Processor Engine**





## **Commercialization - Topology Processor Visualization**



### **Commercialization - Cyber Metrics API**

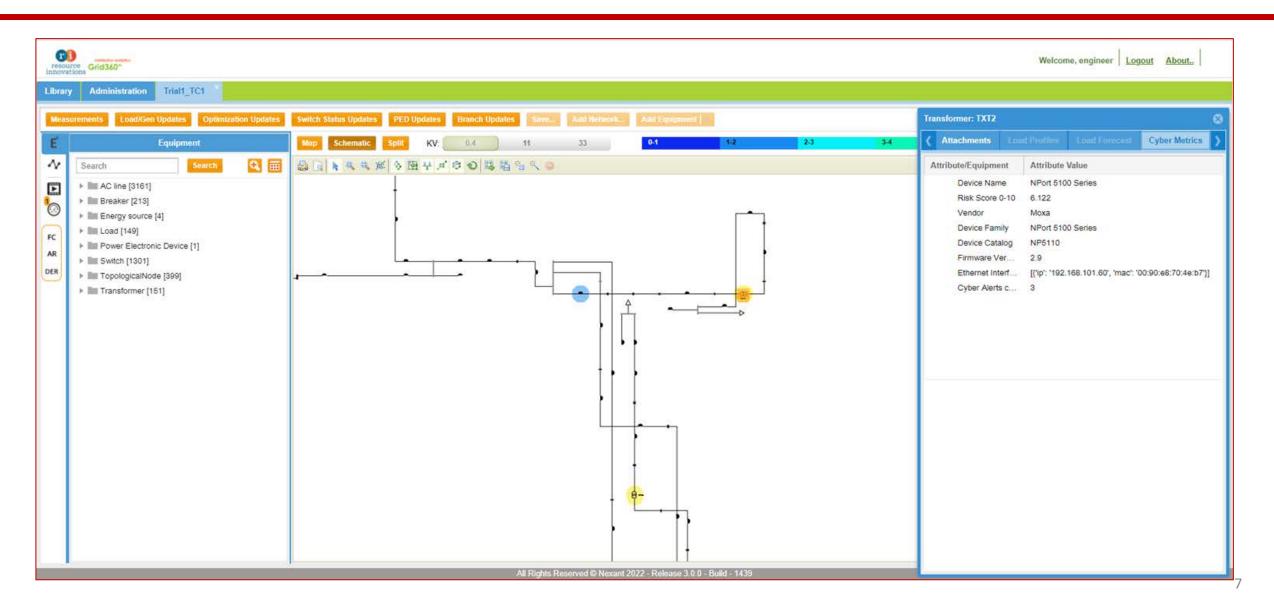




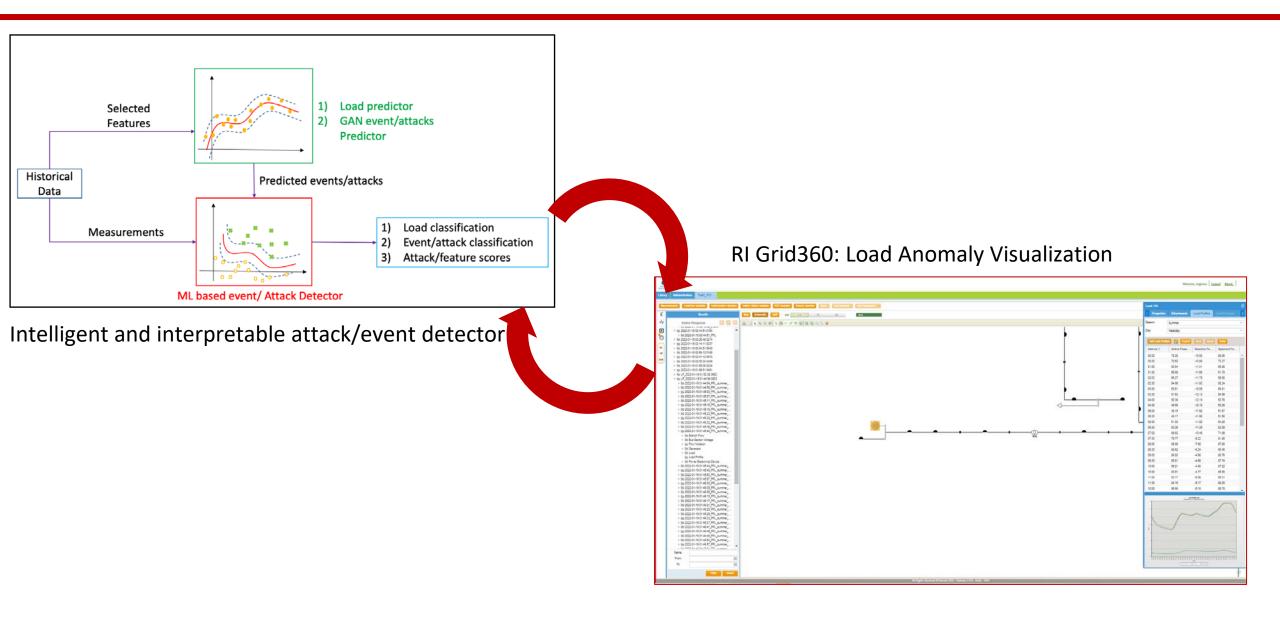
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## **Commercialization - Cyber Metrics Visualization**

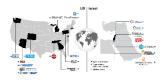




# Commercialization – From Detection to Anomaly Visualization

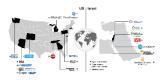


## **Commercialization - Alert Dashboard**



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### **Commercialization - Alert Configuration**



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**Distribution Analytics** Grid360™

Library Tools Alerts Administration IEEE11 E5100K

Results

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\*\* > III Test DR 1 + Solar DG + EVCS +SUMMER+ \*\* > 1 Test OR 1 + Solar DG + EVCS +SUMMER+ ...

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Solar DG + Storage + EVCS +SUMMER+Sc ... • • Im Storage + EVCS +SUMMER+Scale Load10

■ ■ Bill 00:00 Storage(0.00K0VH)+EVCS(0K0V)

· · · Im 01:00 Storage(3.50KWH)+EVCS(0KW) 

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■ \* IIII: 04:00 Storage(3.50KWH)+EVCS(0KW)

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• + 100 07:00 Storage(2.00KWH)+EVCS(0KW)

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Ease+summer+ScaleLoad14+31-01-2019 00...

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•• \* 🖿 Shopping Center + Solar DG + Storage +SU.

• > 12.00 Storage(-5.50KWH)+EVCS(29.4KW) \* \* im 13:00 Storage(-3.50KWH)+EVCS(29.4KW)

Unbalanced Power Flow DR/DER

All Generator

System Summary

Transformer

Violation

Voltage Unbalance Index

Summary for V

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US | Israel

## **Commercialization - Software Deployment**



#### **Primary Markets:**

- 1. Energy Management Systems (EMS)
- 2. Distribution Management Systems (DMS)
- 3. Supervisory Control and Data Acquisition (SCADA)
- 4. Programmable Logic Controller (PLC)
- Industrial Control Systems (ICS)/Cyber-Physical Systems (CPS)
- 6. IoT devices

Integration/add on of new technology without need for wholesale replacement of systems/devices

Licensing mechanism is preferred



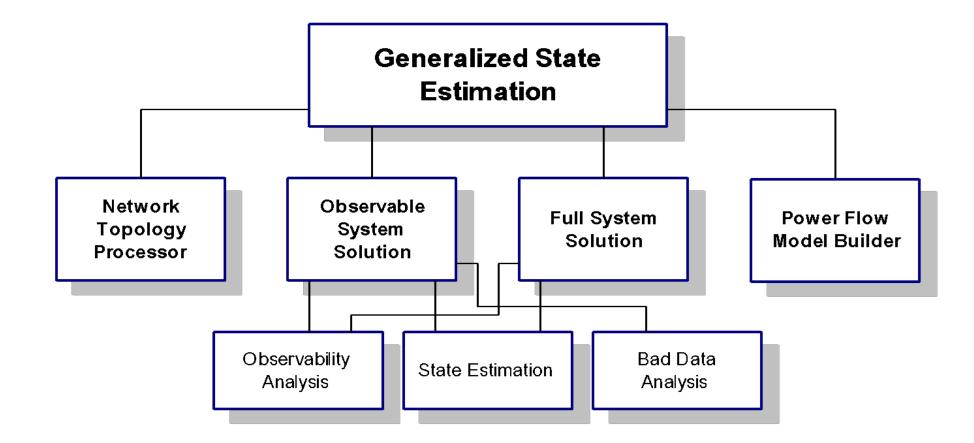


Form Industry Advisory Board

Board member organizations from previous collaboration of Resource Innovations with ASU: ComED, Entergy, Oncor, PSEG, Salt River Project, San Diego Gas & Electric Company, Southern California Edison, Southern Company, UK Power Networks

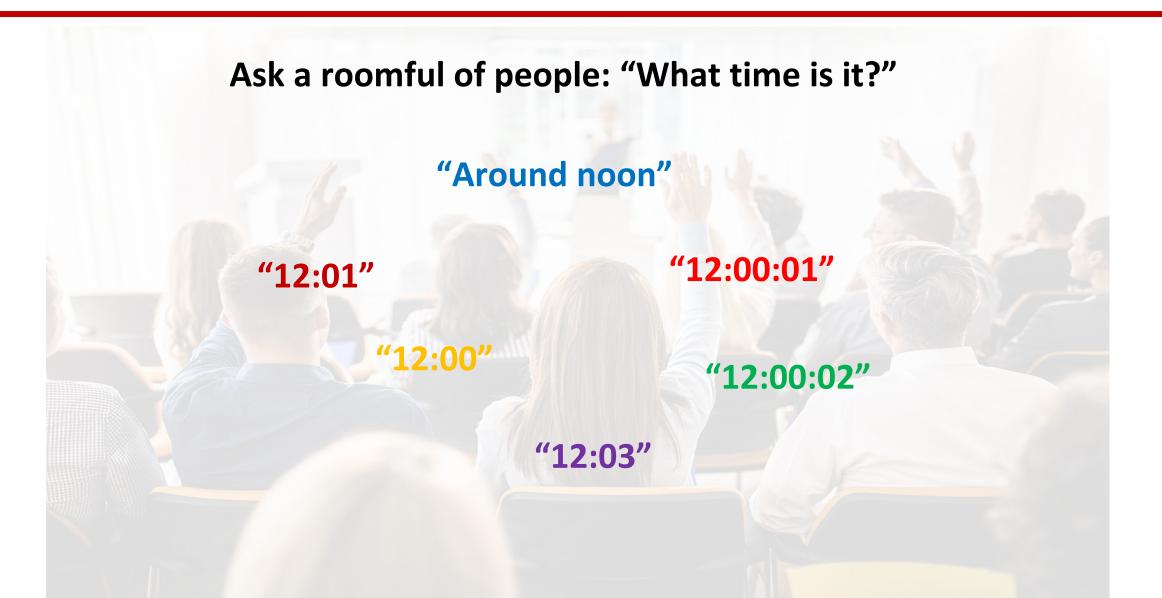
Future Industry Advisory Board will include Arava Power, Duquesne Light Company , Salt River Project, and Arizona Public Service plus many other utility companies





State Estimation - Example







- Recognizes the interaction between status & analog measurement errors
  - Avoids camouflaging of topology errors as multiple analog measurement errors does not assume correct topology
- Performs estimation using a mixed model
  - Parts of the network are represented at a physical level using explicit bus-section/switchingdevice modeling
- Estimates analog states & breaker statuses simultaneously
  - Supports largest weighted & normalized residual methods an efficiency / accuracy tradeoff
- Measurement redundancy is of paramount importance



#### SCADA Checks

• Rejection of bad data by source SCADA system

#### **Gross Error Checks**

• Rejection of data outside limits

#### **Plausibility Checks**

• Rejection of suspect data based on known data

#### Bad Data Analysis

• Weighted Residual Test and Normalized Residual Test (default)

#### **Final Solution**



- Detection & identification
  - Weighted residuals
  - Normalized residuals
- State estimation solution during bad data analysis
  - Linear (non-iterative)
  - Non-linear (iterative)
- Cycling with state estimation solution after bad data analysis
- Automatic & multi-level Bad Data Analysis (Screening Pockets and Zoomed Windows)
  - Screening Performs rigorous analysis on identified "bad data pockets"
  - Zooming Remodels pockets for Bad Data Analysis at bus-section/switching-device level and "zooms in" if topology errors are suspected
    - Handles any expansion, contraction, creation & merging of electrical & observable islands
    - Provides effective pinpointing of bad data locations



- Switch & bus injection pseudo-measurements are subject to bad data analysis
  - Pseudo-measurements are used to augment available realtime measurements
  - Pseudo-measurements are typically calculated using short-term load forecasts or historical data
- Gross errors do not propagate extensively
- Searching for bad data in the locality of the problem is efficient, particularly for large networks
- Local bad data analysis involves "windowing" and "pocketing"
  - Pockets and windows can change, overlap or merge on the fly



# **Thank You!**

# **Questions?**