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# Distribution Linear State Estimator: A Synchrophasor-based Platform for Real-Time Situational Awareness, Analysis and Control

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**NASPI Work Group Meeting ● DisTT**
**Charlotte, NC ● September 26 - 27, 2023**

# Question/Response #1

- Q1. What has V&R Energy identified as ideal target audience and message ensuring the use of PMU and/or point-on-wave (PoW) applications in distribution? The reason of this aim, is because we have previously attempted to "educate"/attract the engineers, but we have lately found out that it is directors and "decision-making-level" management that gets PMUs/PoW "through the door".
- R1. There should be champions and visionaries at all levels, starting from engineers and up to high-level management, as various levels of support (e.g., engineering, business, financial, etc.) are required to accept, deploy, and trust new technology:
  - The key to success is to have a truly collaborative effort that requires multiple teams to work seamlessly and coherently together: engineering, project management, and field crews at a utility, software vendors, hardware vendors, technology companies, etc.
  - Extremely important to have qualified workforce at a utility who can understand, and properly analyze and validate the technology
  - Training is very important to understand how the technology works, how to interpret the results, and how to troubleshoot and fix issues

# Question Q2

- Q2. Which applications, crises or value propositions were the ones that have had ComEd prioritize PMU/PoW use, who championed the project(s) or made/shaped that decision within ComEd, and how? If there were metrics or indices used driving these decisions (RoI, SAIDI/SAIFI rates, etc) would be ideal to get some insights there, too.
- R2. Distribution Linear State Estimator (DLSE) for real-time analysis, situational awareness, and control at Bronzeville Community Microgrid (BCM):
  - The deployment of PMUs in BCM enables ComEd to develop and implement DLSE
  - DLSE technology fully deployed in BCM, will help achieve SAIFI <0.4h on two feeders which servs 1000 customers in the micro grid footprint
    - The 2020 SAIFI rate for BCM was 0.75

# Question Q2 - Continued

- Q2. Which applications, crises or value propositions were the ones that have had ComEd prioritize PMU/PoW use, who championed the project(s) or made/shaped that decision within ComEd, and how? If there were metrics or indices used driving these decisions (RoI, SAIDI/SAIFI rates, etc) would be ideal to get some insights there, too.
- R2. Distribution Linear State Estimator (DLSE) for real-time analysis, situational awareness, and control at Bronzeville Community Microgrid:
  - A synchrophasor-based platform for advanced monitoring and control of the distribution grid has a great potential in enabling the dynamic grid of the future which delivers higher resilience, more granular control, and better ability to integrate distributed energy resources
  - DLSE is expected to be an integral part of the distribution management system to enable intelligent control of DERs and optimize the mix of DERs and wide area controls in distribution grids and microgrids
  - Effective tool for monitoring critical assets within the microgrid and its overall state

# DLSE Use Case at ComEd

- A synchrophasor-based platform for **advanced real-time monitoring, analysis, situational awareness and control of the distribution grid**
- This platform enables the dynamic grid of the future which delivers:
  - Higher resiliency,
  - More granular control, and
  - Better ability to integrate distributed energy resources (DER)
- The platform is based on distribution linear state estimator (DLSE) and is implemented using D-PMU ROSE application

# Why DLSE?

- **Increasing levels of DER penetration** - causing bi-directional power flows, which represents a challenge for  protection, control, and fault location, among others
- **Measurement and control –** PV, BESS, DER integration
- **Asset management –** what assets might fail
- **Beneficial electrification** (i.e., electric vehicles) - will result in operational and system planning challenges (what if cloud goes over PV site when EVs are charging; EV charging is stochastic in nature, so capacity planning for EV adoption and charging patterns will require additional field measurements)
- **ADMS/DERMS –** model integrity, control thousands of devices (including residential), phase identification
- **Transmission operations –** DERs on distribution system have major impact of transmission system operations
- **Power quality –** voltage sags, swells, short term/long term flicker, rapid voltage change (RVC), harmonics (location and direction), system dynamics, oscillatory behavior

# How is DLSE Addressing the Need

- Data (and sensor) refinery
  - DLSE is the first layer of PMU data anomaly check, which is necessary for other downstream PMU-based applications to perform reliably and accurately (oscillations detection, fault detection, load modeling, etc.)
  - DLSE can detect drifting sensors before critical function failure
- Speed and impact on real-time functions
  - PMU based State Estimation (as compared to traditional) is much faster (e.g., every 16 ms as opposed to every 30 seconds to 2 minutes). It provides real-time state of the grid and can enable time-sensitive applications such as adaptive protection
- Observing the dynamics of the grid
  - It is important to be able to observe and learn the behavior of the microgrid and its interaction with different components, both in islanded and grid connected operation

# How is DLSE Addressing the Need (continued)

- Topology detection
  - DLSE has topology detection and event detection capabilities that informs the operator in real-time about any switching events that happen in the grid. It enables timely control actions to mitigate issues.
  - Correctly identifying network topology is needed for estimation of the system state.
  - One of the key advantages of DLSE is that it estimates network topology (e.g., switch status) **only using voltage and current measurements from PMUs, without knowing switch status** (which may be problematic to obtain).
- DLSE is more than just the SE function
  - DLSE with its situational awareness, bad-data detection, topology detection and event detection capabilities can help with higher penetration of DERs and benchmark performance of controllers like MGMS and other controllers
- Need fewer physical PMUs
  - For the same level of observability, DLSE reduces the number of PMUs needed, roughly by a factor of 3, a very significant cost saving

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# Thank you